Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Prothonotary Warbler (*Protonotaria citrea*) in Canada

Prothonotary Warbler

2011

Environment Canada Environnement Canada

Canada

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For copies of the recovery strategy, or for additional information on species at risk, including COSEWIC Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk Public Registry (www.sararegistry.gc.ca).

Cover illustration: Judie Shore

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PREFACE

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA) the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years.

The Minister of the Environment is the competent minister for the recovery of the Prothonotary Warbler and has prepared this strategy, as per section 37 of SARA. It has been prepared in cooperation with Parks Canada Agency, the Province of Ontario (Ministry of Natural Resources) and Bird Studies Canada.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Environment Canada or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Prothonotary Warbler and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Environment Canada and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

This document is a revised version of the *Recovery Strategy for the Prothonotary Warbler (*Protonotaria citrea) *in Canada [PROPOSED]* originally posted on the Species at Risk Registry on July 23, 2007, for a 60-day comment period. As significant changes were made to the Recovery Strategy in response to comments received during that period, a revised version of the strategy was posted as 'proposed' to allow for a second 60-day comment period on October 12, 2010.

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EXECUTIVE SUMMARY

In Canada, the Prothonotary Warbler's breeding range is restricted entirely to the Carolinian forest zone, and almost entirely to sites located on the north shore of Lake Erie. The Prothonotary Warbler has been designated as Endangered in Canada by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and is listed as Endangered under both the federal *Species at Risk Act* and Ontario's *Endangered Species Act, 2007*. Its population has declined continentally at an average annual rate of 1.1% from 1966 to 2007. In Canada, the population declined from an estimated 40+ pairs in the 1980s to fewer than a dozen pairs in 2008.

There are unknowns regarding the feasibility of recovery of the Prothonotary Warbler. In keeping with the precautionary principle, this recovery strategy has been prepared as per section 41(1) of SARA as would be done when recovery is determined to be feasible. This recovery strategy addresses the unknowns surrounding feasibility of recovery.

Degradation and loss of swamp forest nesting habitat and mangrove forest wintering habitat have been identified as key threats. These impacts are compounded by a high level of competition from other species for nest sites, high levels of nest predation and brood parasitism, encroachment of invasive plants, and emerging issues related to climate change and exotic insect infestations.

The long-term objective is to recover the Canadian population of the Prothonotary Warbler to what is believed to be its historical population size and distribution (i.e. at least 40 breeding pairs spread among at least six geographically distinct nesting areas). The population and distribution objective of this recovery strategy is to increase the current population to at least 15 to 20 pairs, spread among at least five geographically distinct nesting areas by 2015.

Over the next five years, the population and distribution objective will be achieved by implementing the following recovery objectives:

1. enhance, restore, monitor, and create habitat at current and potential breeding sites;
2. increase the number of nesting opportunities;
3. increase nesting success (proportion of nests that fledge at least one young) to an average of at least 60% annually.
4. mitigate potential effects from catastrophic weather;
5. assess and address the current and expanding threat to Prothonotary Warbler habitat from invasive species;
6. protect occupied habitat from application of insecticides;
7. establish a dialogue and relationship with agencies and organizations that are interested in recovery efforts in New York, Michigan, Pennsylvania, and Ohio to help further species recovery in both countries.

Critical habitat for the Prothonotary Warber in Canada is partially identified within this revised recovery strategy. It has been identified within the municipalities of Chatham-Kent, Essex,

Hamilton and Norfolk. A schedule of studies for the identification of additional critical habitat is outlined in this document.

One or more action plans will be posted on the SAR Public Registry by December 2015. The action plan(s) may include an area-based, multi-species approach for some areas.

RECOVERY FEASIBILITY SUMMARY

Based on the following four criteria outlined by Government of Canada (2009), there are unknowns regarding the feasibility of recovery of the Prothonotary Warbler. In keeping with the precautionary principle, a recovery strategy has been prepared as per section 41(1) of SARA as would be done when recovery is determined to be feasible. This recovery strategy addresses the unknowns surrounding the feasibility of recovery.

1. **Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.**
   Yes. Individuals capable of reproduction are present in Ontario and in the United States, however the numbers within Canada are extremely low. Based on Tischendorf's (2003) population viability analysis, immigration from the United States is necessary to maintain the species in Canada. Hence, recovery in Canada will depend on population trends and recovery activities in the adjacent Great Lakes states.

2. **Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.**
   Yes. Sufficient swamp habitat is available within the Prothonotary Warbler's Canadian range on both private and protected areas (including provincial parks, National Wildlife Areas, National Parks, and Conservation Authority lands). As well, there are areas of habitat which could be and have been made available through various techniques including habitat restoration and management.

3. **The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.**
   Unknown. Some threats can be avoided or mitigated through recovery actions, such as habitat loss and degradation on the breeding grounds. However, it is unknown if significant threats such as House Wren competition, invasive species, and threats to the wintering grounds and U.S. breeding populations can be mitigated enough to sustain a population within Canada.

4. **Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.**
   Yes. The necessary recovery techniques are available. However, a number of recovery actions must be tested to determine their effectiveness within Canada. Recovery techniques such as using nest boxes have been used in Canada with some success. Other similar recovery techniques along with habitat restoration/management can be and have been used to recover the species in Canada.

As the small Canadian population of Prothonotary Warbler occurs at the northern part of its continental range, and the vast majority of its continental distribution and population occurs further south in the United States, it is important to note that population changes at the continental level may have a significant effect on recovery feasibility in Canada. As the continental population of the Prothonotary Warbler is experiencing an ongoing downward population trend, its range may contract away from the current periphery, and individuals

may immigrate towards the centre of the range. In such a case, despite best efforts described in this strategy to ensure that sufficient suitable habitat is available and key threats are mitigated, the numbers of Prothonotary Warbler in Canada may continue to decline.

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1. COSEWIC SPECIES ASSESSMENT INFORMATION

Date of Assessment: April 2007

Common Name: Prothonotary Warbler

Scientific Name: *Protonotaria citrea*

COSEWIC 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.

Canadian Occurrence: Ontario

COSEWIC 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.

2. SPECIES STATUS INFORMATION

The Prothonotary Warbler is considered globally secure (G5) and is a secure breeder in the United States (N5B) (NatureServe 2008). However, in the United States, the species has sub-national conservation ranks varying from critically imperilled to secure (Appendix B). In Canada, the species is considered imperilled to critically imperilled nationally (N1BN2B) and as a critically imperilled breeder in Ontario (S1B). The species is listed as Endangered under both the federal *Species at Risk Act* and Ontario's *Endangered Species Act, 2007*. It is estimated that less than 1% of the Prothonotary Warbler's global population occurs in Canada while over 99% occurs in the United States.

3. SPECIES INFORMATION

3.1 Species 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 azure blue wings and tails. Prothonotary Warblers do not have wing bars, but white tail spots are quite prominent. Although rather large for a warbler, Prothonotary Warblers are small birds, weighing about 14 g and measuring about 14 cm in length. The male's territorial song is a loud, ringing "*tsweeet-tsweet-tsweet-tsweet*," uttered emphatically in groups of four to six.

3.2 Population and Distribution

The continental population of the Prothonotary Warbler is estimated to consist of about 900,000 pairs[1] (Rich et al. 2004), with more than 99% of pairs residing in the United States. It has been placed on Partners In Flight's "watch list" for landbirds in North America because of declines and threats (Rich et al. 2004). According to results from the Breeding Bird Survey (Sauer et al. 2008), the continental population has experienced a statistically significant decline, averaging −1.1% annually during the period 1966–2007, or about 40% overall.

It is estimated that less than 1% of the Prothonotary Warbler's global population occurs in Canada. As of 2008, Canada currently supports approximately 10 pairs, down from an estimated 40+ pairs during the mid-1980s (McCracken and Vande Somple 2009).

The Prothonotary Warbler breeds in suitable habitat in the eastern United States and north to extreme southwestern Ontario (Figure 1). It is most abundant in the southeastern United States and along the northern sections of the Mississippi River. Its wintering range extends from southern Mexico through Central America and northern South America. Its centres of winter abundance apparently include northern Venezuela, northern Colombia (Bent 1953; Lefebvre et al. 1992, 1994), and coastal Panama north to coastal Costa Rica (Lefebvre and Poulin 1996). However, quantitative surveys of wintering populations have not been conducted.

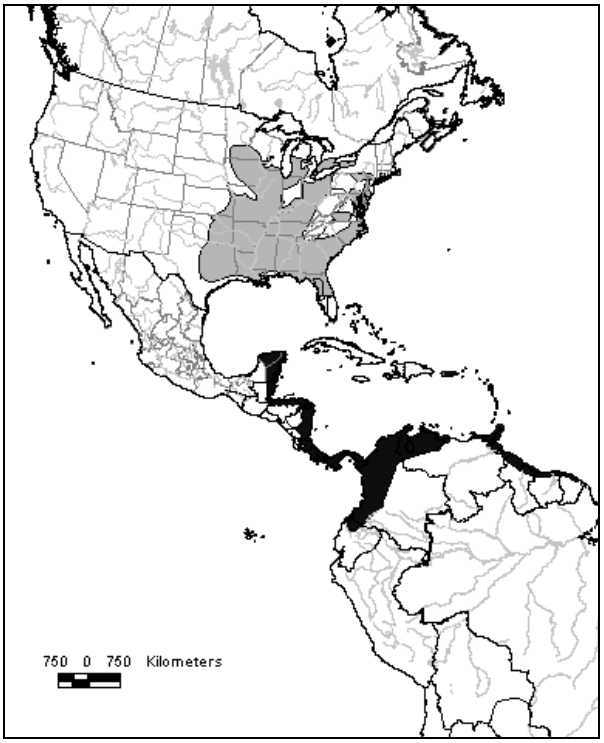

Figure 1. Breeding (grey shading) and wintering (black shading) range of the Prothonotary Warbler (from COSEWIC 2007).

[1] The continental estimate provided by Rich et al. (2004) was based on roadside counts and not surveys in suitable habitat, so it is likely an overestimate.

Being at the northern edge of its range in southwestern Ontario, the Prothonotary Warbler breeds primarily along and adjacent to the Lake Erie shoreline (e.g. Holiday Beach, Wheatley Beach Provincial Park, and Rondeau Provincial Park; Figure 2). Nesting has occurred fairly regularly at one site along the Lake Ontario shoreline (Hamilton), and infrequently at one site along the Lake Huron shoreline (Pinery Provincial Park). The Prothonotary Warbler also occasionally nests in some inland sites in southwestern Ontario (McCracken 2007). It formerly nested at other sites, including Point Pelee National Park, Turkey Point, near London (at Lobo), and near Orwell (east of Aylmer) and Copenhagen (south of Aylmer).

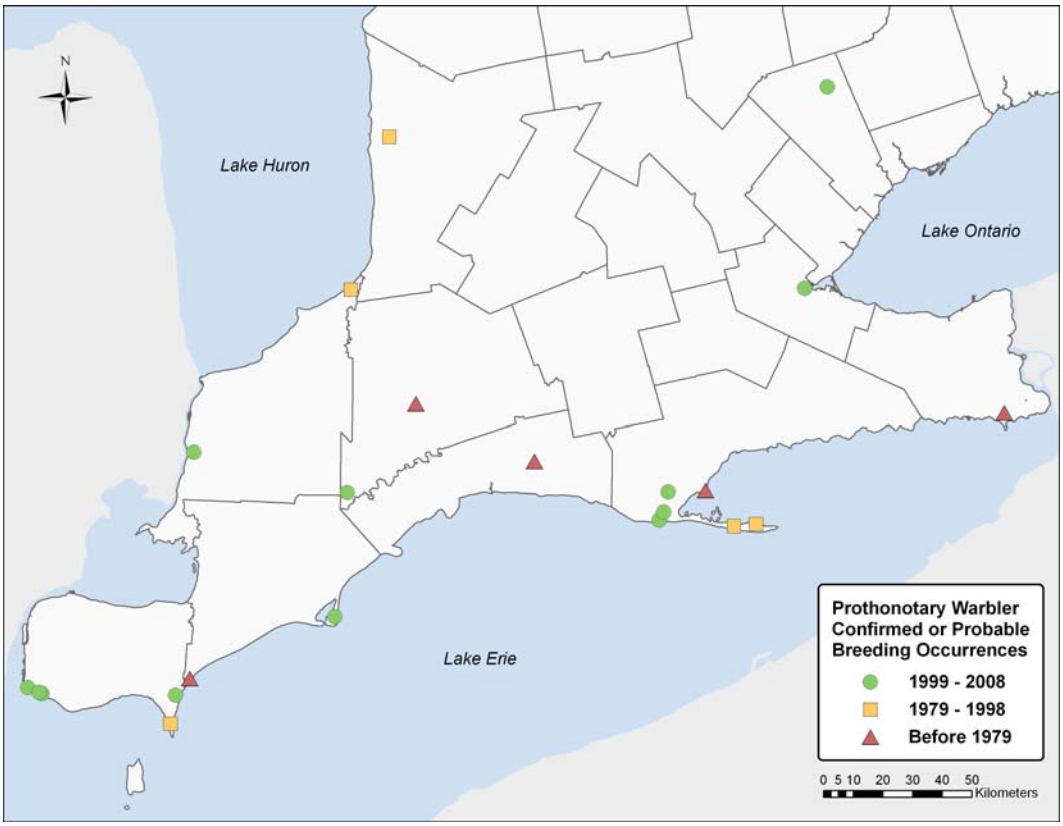

Figure 2. Current and historical confirmed and probable breeding occurrences of Prothonotary Warblers in Canada (as of 2008).

3.3 Needs of the Prothonotary Warbler

Prothonotary Warblers return to Ontario from wintering areas in the first week of May (sometimes late April); females typically arrive about two weeks later than males, and older birds of both sexes usually precede younger birds. The entire adult population is usually on its nesting grounds by the first week in June. By the time the females are back, the males have usually established their breeding territories and begun to select potential nest sites for the females to inspect. The Prothonotary Warbler is the only warbler in eastern North America that builds its nests in tree cavities. The species is a secondary cavity nester, meaning that it does not excavate its own cavities, but instead uses cavities that were created naturally (e.g. by rot or decay) or by primary cavity nesters. Most commonly, they occupy cavities that have been excavated by Black-capped chickadees (*Poecile atricapilla*) and Downy Woodpeckers (*Picoides pubescens*) in Ontario. Males often build one or more incomplete "dummy" nests (Bent 1953;

Petit 1989; Blem and Blem 1992). Dummy nests are non-functional nests whose quantity and quality are potentially important influences on pair formation (Petit 1999). The female often selects one of these dummy nests to complete, but may occasionally build an entirely new nest on her own. Clutch size is usually five to six eggs, but seven- and even eight-egg clutches have been reported. Females incubate the eggs for approximately 12 days, while the male tends to her with food. Both parents feed the nestlings for about 10–12 days. On their first flight, fledglings risk drowning in water that is usually under the nest while attempting to make it to the closest shrub. Throughout the breeding season, adults and juveniles depend on a wide variety of insects; the bulk of food taken includes larvae of butterflies and moths, and various flies, beetles, spiders, and mayflies (Petit 1999). By mid-August, nearly all birds will have begun their migration south for the winter.

Availability of nesting sites is a known limiting factor for this species since it is a cavity nester. The Prothonotary Warbler is not a serious competitor for cavity nest sites in Canada. More details of specific habitat elements are provided below.

Presence of standing or slowly flowing water – Typically, territories are almost entirely covered with standing water (e.g. permanent and semi-permanent pools of open water in swamp forests along the shore of, or inland from, the Great Lakes) or slowly flowing water (e.g. as found in wide, slow-moving, warm-water forested creeks draining into the Great Lakes). During the nesting season, optimal water depth near nests ranges from 0.5 to 1.5 m, and the surface area of water represents between 70% and 100% of the territory. Pools in these territories may be 1 ha or more in size, although sites containing smaller pools will also be occupied if several pools are in close proximity. Nests are nearly always situated over or within 5 m of standing water or in low-lying, easily flooded areas (Petit 1999). The most productive territories are inundated year-round, but warblers will nest in seasonal sloughs that may dry up entirely by mid- or late summer. Pools of water that are sustained from May through at least mid-June are important.

Swamp forest – In Ontario, Prothonotary Warblers typically occupy mature and semi-mature deciduous swamp forest and riparian floodplains. Tree cover is typically dominated by silver maple (*Acer saccharinum*), ash (*Fraxinus* spp.), yellow birch (*Betula alleghaniensis*), and willows (*Salix* sp.), often with a buttonbush (*Cephalanthus occidentalis*) component (McCracken and Dobbyn 1997). The extent of canopy cover ranges from 20% to 90%, averaging slightly more than 50%, and is usually extensive enough to limit the development of a prominent herbaceous and shrubby plant understorey. Nest sites are usually shaded for at least part of the day (Blem and Blem 1991, 1992; Best and Fondrk 1995). However, in more open, deep-water habitats, mature buttonbush often dominates. One or more shrubs or saplings located within a few metres of a nest provide immediate refuge for fledglings.

In Canada, open swamps with extensive emergent herbaceous vegetation are generally avoided by Prothonotary Warblers. Occasional scattered patches of cattails (*Typha* sp.), common reed (*Phragmites australis*), grasses, and sedges will frequently occur in the territory, but are not usually dominant cover types, particularly early in the nesting season (May to mid-June). Emergent vegetation around nest sites is usually sparse (open water is generally a dominant feature).

Forest size – Little information is available about the effects of woodland size or forest fragmentation on Prothonotary Warblers. 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 southeastern United States, populations of Prothonotary Warblers and other forest wetland birds can likely be conserved if a 100-m-wide patch of suitable habitat is protected (Hodges and Krementz 1996), whereas Kilgo et al. (1998) found that the probability of occurrence for Prothonotary Warbler was greatest in forests that were at least 500 m wide. In Canada, nearly all known breeding sites occur within forest tracts that are at least 25 ha.

Dead or dying trees with cavities – As noted above, cavities chosen by Prothonotary Warblers are almost always situated directly above open water. Several suitable cavities appear to be required in each territory, in order to accommodate both the functional nest plus one or more "dummy" nests. The number of cavities within 25 m of a nest ranges widely, from 1 to 10 (mean = 2.3) (McCracken and Dobbyn 1997). When tree cavities are used, they are small and shallow (a volume of about 1.0–1.5 litres) and typically located 0.5–2.5 m above the water, though some may be at heights of 5 m or more.

Suitably designed artificial nest structures (e.g. wooden nest boxes) are readily accepted by the species and perhaps even preferred (e.g. Best and Fondrk 1995; McCracken and Wood 2005). Prothonotary Warblers have also occasionally been known to nest in unusual situations such as a coffee can, tin pail, glass jar, an old hornet's nest, and a mailbox (Bent 1953).

Availability of nest material – Green mosses and dead leaves, as well as fine rootlets, lichens, and grasses, are used for building and lining both incomplete ("dummy") and functional nests. Habitats with plentiful moss are clearly favoured. Mosses are typically most abundant in swamps that have a long history of flooding, especially where canopy cover provides shade sufficient for moss growth. Moss is considered a limiting factor, but there is no information on whether one or more particular species of mosses are favoured by nesting Prothonotary Warblers.

Post-fledging habitat – No published studies are available concerning the characteristics of the Prothonotary Warbler's habitat needs once the young have left the nest. Nevertheless, there is evidence that fledged young range widely, often occupying the upper tree canopy within 300 m or more of the nest site for several weeks, regardless of the presence of standing water (J.D. McCracken, pers. obs.). Hence, once the young fledge, the species can and will occur anywhere within a forest tract, including dry upland portions. By and large, Prothonotary Warblers utilize the upper forest canopy during the post-fledging period, probably favouring trees that are at least 15 m in height (J.D. McCracken, pers. obs.).

Wintering habitat – The Prothonotary Warbler's key wintering habitat is coastal mangrove forest in Central America and northern South America (Lefebvre et al. 1992, 1994; Petit et al. 1995; Lefebvre and Poulin 1996). It also winters in swamps and wet woodlands and occasionally in drier woodlands (including pine forest), mainly below an elevation of 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 been quantitatively described, although black mangrove (*Avicennia germinans*) forest is a primary

habitat type in Venezuela and Panama (Lefebvre et al. 1994; Lefebvre and Poulin 1996; Woodcock et al. 2004; Woodcock and Woodcock 2007).

4. THREATS

The following is a list and description of the known and perceived threats that the Prothonotary Warbler faces. Threats to the survival of the species* or its habitat** are presented in order of significance:

*i) Loss/degradation of breeding habitat***

Habitat loss and degradation is the most significant threat facing Prothonotary Warblers on their breeding grounds. The decline of Prothonotary Warbler populations in the United States is attributable to losses in wetland habitat (Petit 1999). In the contiguous United States, only 10% of the original bottomland forest habitat remains (Dickson et al. 1995). In the southeastern United States, forested wetlands have been lost at a high rate (Winger 1986; Hefner et al. 1994). Losses have been particularly high in coastal Louisiana and the Carolinas (U.S. Department of the Interior 1994), which are two of the Prothonotary Warbler's core breeding regions. A similar pattern of habitat loss has occurred in the Prothonotary Warbler breeding range in Canada, where nearly all deciduous swamp forests have been drained to varying degrees or logged. In southern Ontario, Snell (1987) estimated that wetlands had been reduced by about 1.5 million hectares (61%) from the time of European settlement to 1982. Between 1967 and 1982, wetlands in southern Ontario were reduced by about 39,000 ha, mostly due to agricultural activities (Snell 1987). While there is no updated information on the extent of wetland loss in southern Ontario since the 1980s, sites continue to be drained.

In Canada, drainage of swamp forests, whether through ditching, agricultural tiling, municipal drains, or irrigation, depletes the water table and removes standing water. This is one of the most significant, widespread, and ongoing threats facing Prothonotary Warblers in this country.

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/trailer park (McCracken 1981). Because some jurisdictions in southern Ontario do not have tree-cutting bylaws, some forms of development are also likely to involve removal of large swaths of forest and infilling of swamps. For example, attempts were recently made to develop a large swamp forest in Essex County ("Marshfield Woods"), which was believed to support one or more Prothonotary Warblers, into a golf course (McCracken and Mackenzie 2003). In addition, residential/estate development adjacent to swamp forests is likely to artificially increase local populations of nest predators (e.g., raccoons [*Procyon lotor*]) and/or competitors (e.g. House Wrens [*Troglodytes aedon*]).

Logging disturbances that take place in important habitat create forest openings and edge habitat that can reduce the amount of open water cover in swamp forests through heightened evaporation. The resulting increased light penetration can also result in rapid encroachment of invasive plants (e.g. Eurasian form of common reed [*Phragmites spp.*] and European alder

[*Alnus glutinosa*]). In addition, removal of standing dead timber (e.g., for firewood) results in loss of potential cavity trees and is considered the primary negative effect of silviculture on this species (Petit 1999).

*ii) 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). Mangrove habitat is also under increasingly intense pressure from commercial shrimp farmers (e.g. Arendt 1992). Loss and degradation of wintering habitat are believed to have a strong negative effect on wintering Prothonotary Warblers (Lefebvre et al. 1994; McCracken 1998) and are likely contributing to the species' decline continentally.

There is little information on the degree of year-to-year site fidelity to wintering sites, but existing data (McNeil 1982; Faaborg and Arendt 1984; Lefebvre et al. 1994; Woodcock et al. 2004; Woodcock and Woodcock 2007) suggest that the Prothonotary Warbler exhibits site fidelity. This attribute may increase the species' sensitivity to habitat loss and disturbance (e.g. Holmes and Sherry 1992; Warkentin and Hernandez 1996).

*iii) Threats that increase nest site competition and reduce breeding productivity**

Several alterations to habitat (e.g. loss or reduction of forest cover through logging, increased forest fragmentation) result in declines in breeding success of Prothonotary Warblers, due to increased levels of nest competitors, nest predators, and brood parasites. This is a very significant threat to Canadian populations of Prothonotary Warblers.

In regions where it is common, the House Wren is the most serious (and damaging) competitor for nest sites (Walkinshaw 1941, 1953; Bent 1953; Best and Fondrk 1995; Flaspohler 1996; Knutson and Klaas 1997). Wrens prefer forest edges and fragmented forests and are a major problem at several sites that are important to Prothonotary Warblers in Canada (McCracken and Wood 2005). Not only do wrens directly attack ("vandalize") the eggs and young of Prothonotary Warblers, they also build many "dummy" nests, often filling every available nesting cavity in the Prothonotary Warbler's territory with sticks. This directly displaces nesting Prothonotary Warblers and indirectly reduces cavity availability, thereby further increasing competition for nest sites. Moreover, the sticks can persist in the cavities for several years, effectively rendering the nesting cavities unsuitable for occupation by all other species but wrens. Also, House Wrens produce at least two broods per year, which means that their impacts extend throughout the duration of the Prothonotary Warbler's limited nesting season. Walkinshaw (1941) largely blamed House Wrens for the poor nesting success of Prothonotary Warblers in Michigan, noting that wrens were absent from the warbler's breeding habitat in Tennessee, where Prothonotary Warbler nest success was much greater. Flaspohler (1996) and Knutson and Klaas (1997) likewise suggested that House Wrens played a major role in nest failure in their Wisconsin studies, again in regions where House Wrens were common. Wrens were also regarded as a problem in Ohio (Best and Fondrk 1995). In Canada, House Wrens figure very prominently in the destruction of Prothonotary Warbler nests, especially at sites that do not have extensive forest and canopy cover (McCracken 2004; COSEWIC 2007). In more

open areas, Tree Swallows (*Tachycineta bicolor*) can also be serious competitors for nest sites (Best and Fondrk 1995; COSEWIC 2007). 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 House Wrens. Moreover, unlike wrens, swallows do not aggressively destroy the eggs of competitors, nor do they usurp other potential nesting cavities by building "dummy" nests.

Some protection from potential nest predators is probably conferred because Prothonotary Warbler nests are situated in cavities and are usually over open water (e.g., Nice 1957). Including artificial nest sites, nest predation rates reported in the literature are highly variable: 2.6–53.3% in Tennessee (Petit et al. 1987; Petit 1989, 1991; Petit and Petit 1996); 15.5% in Virginia (Blem and Blem 1992); 27.6% in Wisconsin (Flaspohler 1996); 41% in Tennessee/Michigan (Walkinshaw 1941); and about 40% in Ontario (COSEWIC 2007).

Loss of Prothonotary Warbler young and eggs is attributed to snakes, raccoons, mice (*Peromyscus* spp.), weasels (*Mustela* spp.), and squirrels (e.g. *Glaucomys* spp.) (Walkinshaw 1938; Bent 1953; Guillory 1987; Petit 1989; Blem and Blem 1992; Flaspohler 1996; Petit and Petit 1996). Predation of nests by raccoons in natural cavities (or in unprotected boxes that are affixed to trees rather than on slippery steel poles) also figures prominently, especially in human-modified landscapes. It is generally believed that birds (including Prothonotary Warblers) using nest boxes benefit from reduced rates of predation (e.g., Nilsson 1986; Moller 1989; Blem et al. 1999; Mitrus 2003; McCracken and Wood 2005) compared with birds using nests in natural cavities, because of protection afforded by overhanging rooftops, the controlled diameter of entrance holes, and the use of metal poles and protective guards.

Brood parasitism from Brown-headed Cowbirds (*Molothrus ater*) may limit population size and contribute to population declines by reducing the productivity of Prothonotary Warblers (Flaspohler 1996; COSEWIC 2007). Many Prothonotary Warbler breeding studies are based on artificial nest structures, which usually confer protection against cowbird parasitism (Walkinshaw 1991; Best and Fondrk 1995; Flaspohler 1996), because nest hole diameter is smaller than in natural situations and generally is too small to allow cowbirds access to the nest boxes. An exception was Twedt and Henne-Kerr (2001), who recorded a surprisingly high level of parasitism (45%) in their nest boxes, although they did not report nest hole diameter. In any case, for Prothonotary Warbler natural cavity nests, cowbird parasitism rates are 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). It is likely that land use patterns and regional forest fragmentation determine the regional abundance of cowbirds (Flaspohler 1996), perhaps explaining the extremely low incidence of parasitism (0.01%) found in Virginia (cited in Flaspohler 1996). Distance from the historical heartland of the cowbird's range may also be a factor (Hoover and Brittingham 1993).

*iv) Invasive forest insects***

Infestations of invasive forest insect species have the potential to kill large numbers of trees. While this could benefit Prothonotary Warblers in the short term through the creation of more nesting habitat (in the form of dead snags), 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 likely 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. In the slough forests at Rondeau Provincial Park, a recent study found that ash makes up about 47% of the tree cover (McCracken et al. 2006). In addition to direct loss of tree cover by the insect itself, aggressive attempts to curb or contain the invasion of the emerald ash borer can result in the loss of substantial tree cover. For example, across the currently infested zone in Essex County and Chatham-Kent, many of the ash have already succumbed to the insect. But programs which were aimed at curbing the insect invasion from spreading farther, also resulted in removal of ash from large areas of these regions.

The Asian long-horned beetle (*Anoplophora glabripennis*) may also emerge as an issue of concern, depending upon its ability to spread beyond its present area of containment in the vicinity of Toronto and its affinity for silver maple.

*v) Invasive plants***

Two invasive species of plants — the Eurasian form of common reed (*Phragmites australis*) and European black alder (*Alnus glutinosa*) — can significantly degrade Prothonotary Warbler breeding habitat, particularly when water levels are low or canopy cover is reduced.

Within the last decade at Rondeau Provincial Park, common reed 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 a major, recent windthrow event. This invasive emergent effectively fills in open pools of water, rendering the site unsuitable for Prothonotary Warbler.

Likewise, European black alder is a highly invasive shrub that can also significantly degrade Prothonotary Warbler nesting habitat in open swamp forest conditions. It is already abundant in at least one primary nesting location (Hahn Woods) and is a major problem at several sites undergoing restoration in Norfolk County. It is also common at Coote's Paradise (Dundas Marsh).

Other invasive species might also impact Prothonotary Warbler habitat to a lesser extent. For example, reed manna grass (*Glyceria maxima)* has become dominant in a large portion of the Dundas Marsh. This species is highly invasive and has the ability to out-compete native emergent wetland plant species.

*vi) Catastrophic weather events**

The intensity and frequency of storms (including hurricanes) on both the wintering and breeding grounds are anticipated to increase as a result of climate change. Owing to the Prothonotary Warbler's clumped and restricted distribution in Canada, disasters associated with catastrophic

weather events that occur along the north shore of Lake Erie pose a serious threat to this species. Ensuring that the population is spread out across a number of geographically separated breeding sites will buffer Canadian populations against local disasters.

*vii) Toxic chemicals and other pollution**

On the Prothonotary Warbler's breeding grounds in Canada, insect control programs (e.g., in response to West Nile virus and gypsy moth outbreaks) have the potential to negatively impact Prothonotary Warblers, through reduction in arthropod food supplies.

Detrimental effects from insecticides are perhaps of greatest concern on the Latin American wintering grounds, where DDT is still used widely for malaria control (Arendt 1992). As well, various kinds of water pollution associated with shrimp aquaculture seriously jeopardizes mangrove forest (Olson et al. 1996). A major oil spill in the Gulf of Mexico could also seriously damage wintering habitat (Arendt 1992).

5. POPULATION AND DISTRIBUTION OBJECTIVE

The long-term objective is to recover the Canadian population of the Prothonotary Warbler to what is believed to be its historical population size and distribution (i.e. at least 40 breeding pairs spread among at least six geographically distinct nesting areas). The population and distribution objective of this recovery strategy is to increase the current population to at least 15 to 20 pairs, spread among at least five geographically distinct nesting areas by 2015.

The population and distribution objective has been established using population data from the past 11 years, which indicate that the current habitat can support this objective. The population over the last 11 years had a maximum of 26 pairs with an average of 16.5 pairs; however, the current population is estimated to be 10 pairs. This objective targets a modest population increase which can be supported by the current suitable habitat within Ontario.

The geographically distinct nesting areas are to be separated by at least a distance of 20 km. This is believed to be a reasonable distance which will help safe-guard the species from highly-localized catastrophic events.

5.1 Recovery Objectives

In order to achieve the population and distribution objective, the following recovery objectives have been identified:

1. enhance, restore, monitor, and create habitat at current and potential breeding sites;
2. increase the number of nesting opportunities;
3. increase nesting success (proportion of nests that fledge at least one young) to an average of at least 60% annually.
4. mitigate potential effects from catastrophic weather;
5. assess and address the current and expanding threat to Prothonotary Warbler habitat from invasive species;

6. protect occupied habitat from application of insecticides;
7. establish a dialogue and relationship with agencies and organizations that are interested in recovery efforts in New York, Michigan, Pennsylvania, and Ohio to help further species recovery in both countries.

6. BROAD STRATEGIES AND GENERAL APPROACHES TO MEET OBJECTIVES

6.1 Actions Already Completed or Currently Underway

The following is a brief synopsis of recovery activities that have been undertaken on behalf of Prothonotary Warblers in Canada since 1997:

- A multi-agency recovery team was created in 1997, and a draft recovery plan was produced in 1998. Most of the current recovery team members have been involved since the team's inception.
- A nest box program has been in operation in southwestern Ontario since 1998. At its height, the program involved up to ~300 nest boxes distributed across nearly 20 sites. In recent years, the nest box program has been scaled back quite dramatically, primarily owing to severe problems encountered with competing House Wrens. Various side projects, which have tested experimental nest box designs and configurations with regard to their effectiveness for dissuading occupancy by House Wrens, have all failed.
- Population and nest productivity surveys have been conducted annually since 1998.
- A colour banding program (mostly focused on adults) was conducted annually in Ontario from 1998-2005 in order to study demographics and site fidelity. Among other things, this program demonstrated that there was some interchange among the different geographic areas in Ontario. Further colour banding has since been placed on hold, in part because sample sizes are now too small to yield meaningful results.
- Detailed quantitative habitat assessments were conducted at two of the most important breeding sites in 2005. Less detailed habitat assessments were conducted at all occupied sites in 1998.
- A preliminary population viability analysis and a landscape-scale habitat modelling analysis have been conducted. These studies concluded that the Canadian population could not be sustained without at least some level of annual immigration of breeding adults from the U.S.
- About 80 potential candidate sites have been assessed and scored for their restoration potential. Working with a number of partner agencies and organizations, a variety of habitat restoration activities have been conducted at about 10 of the most promising sites to date, with more in the planning stages.
- Field investigations (involving intensive banding and habitat assessments) have been conducted at several mangrove sites in Costa Rica for seven full winters (December through March). Information related to winter site fidelity and demographics has been analyzed and a manuscript has been submitted for publication. In addition, a study is presently being conducted on stable isotopes from a sample of tail feathers from winter and breeding sites to determine geographical connections.

- A web page was launched by the recovery team in 1999, which led to the production of an information pamphlet on the species. Over 15,000 pamphlets have been distributed, and the web page is the top-visited Internet page for people looking for reference information on Prothonotary Warblers.
- Detailed annual reports on all recovery activities have been produced for project partners since 1998.

6.2 Strategic Direction for Recovery

The broad strategies that are recommended to meet recovery objectives emphasize a combination of public outreach, stewardship, research, inventory, and monitoring efforts. Table 1 outlines broad strategies and approaches necessary to address threats, with reference to the pertinent recovery objective.

Table 1. Broad strategies and approaches necessary for recovery of the Prothonotary Warbler.

Objective No.	Priority	Broad Strategy	Threat addressed	General Description of Research and Management Approaches
1.	High	Habitat protection/ stewardship	Loss/degradation of breeding habitat	Prioritize potential/suitable habitat sites that are in most urgent need of protection. Determine ideal protection strategies for each high-priority site (stewardship, easement, covenant, acquisition).
1, 5	High	Habitat stewardship	Loss/degradation of breeding habitat Invasive forest insects Invasive plants	Develop guidelines/ information for recommended forestry activities/best management practices at occupied Prothonotary Warbler sites. Develop management strategies to address the threat of invasive forest insects and plants
1.	High	Public outreach	Loss/degradation of breeding habitat	Support the development of appropriate outreach materials.
1, 5	High	Inventory and monitoring	Loss/degradation of breeding habitat Invasive forest insects Invasive plants	Develop and implement protocol to monitor and mitigate threats to habitat in occupied sites. Develop a database to house monitoring results.
1.	High	Habitat restoration	Loss/degradation of breeding habitat	Identify and prioritize sites that would most benefit from strategic restoration activities. Develop and refine appropriate restoration and management tools to restore breeding habitat at each site.
2.	High	Habitat restoration/ stewardship	Loss/degradation of breeding habitat Threats that increase nest site competition and reduce breeding productivity	Refine nest box provisioning program.

Objective No.	Priority	Broad Strategy	Threat addressed	General Description of Research and Management Approaches
3.	High	Research/ monitoring	Threats that increase nest site competition and reduce breeding productivity	Investigate and implement techniques to reduce nest failures attributable to House Wrens.
3.	High	Inventory and monitoring	Threats that increase nest site competition and reduce breeding productivity	Monitor annual population trend and productivity in Canada in relation to predation, brood parasitism, and nest competition.
3.	Low	Public outreach	Threats that increase nest site competition and reduce breeding productivity	Minimize public disturbance of nest sites during the breeding season through outreach.
4.	Medium	Research and monitoring	Catastrophic weather events	Assess/evaluate potential impacts of future catastrophic weather events on critical habitat. Assess/evaluate potential impacts of changing water levels on habitat and species' productivity.
6.	Low	Research	Toxic chemicals and other pollution	Investigate potential for insect control programs (e.g. mosquitoes, gypsy moth) to directly or indirectly impact the species during the breeding season in Canada.
7.	Medium	Habitat protection	Loss/degradation of breeding habitat (United States)	Identify potential U.S. partners/collaborators in Great Lakes states that likely provide source populations to Canada.
7.	High	Research	Loss of wintering habitat	In cooperation with other researchers and agencies, define important wintering habitat components; locate and map important wintering areas, determine how much wintering habitat remains and its protection status.

7. CRITICAL HABITAT

7.1 Identification of the Species' Critical Habitat

Critical habitat for the Prothonotary Warbler in Canada is partially identified in this recovery strategy, to the extent possible based on the current data (up to and including 2008 data). The identification of critical habitat for Prothonotary Warbler is based on multiple year occupancy of sites and confirmed breeding of Prothonotary Warblers in suitable habitat. The Schedule of Studies (Section 7.2) outlines the activities required to identify additional critical habitat necessary to support the population and distribution objectives of this species. Additional critical habitat may be identified across the range of the species, as more information becomes available on Prothonotary Warbler biology and habitat usage in Ontario.

7.1.1 Site Occupancy

A site is defined as the 300 m area that surrounds a nest location, with overlapping areas merged as larger sites. A 300 m distance was selected to capture the estimated territorial area observed for Ontario Prothonotary Warblers and the additional habitat area necessary for post-fledging juveniles (J. McCracken, pers. comm.).

Site Occupancy Criterion:

Sites that have been occupied by a minimum of one breeding pair[2] of Prothonotary Warblers during the breeding season for at least two separate years from 1999 to 2008 AND where Prothonotary Warblers have been categorized as confirmed breeders[3] in any single year between 1999 and 2008.

The Site Occupancy Criterion identifies sites where confirmed breeding has been observed in a minimum of one year and where the site has evidence of species' fidelity (i.e., where the Prothonotary Warbler has attempted nesting in multiple years). Confirmed and probable breeding evidence must be observed by reliable sources[4] for the site to be considered critical habitat. Since the species is known to show relatively high site-fidelity, small, isolated pockets of habitat which Prothonotary Warblers may occupy for only one year will not be identified as critical habitat until site fidelity is established. The birds have been known to use such occasional breeding sites once and never return; repeated use of such sites highly uncommon. If repeated breeding at such sites is confirmed, the site could be considered as critical habitat if it meets the criterion.

The 10 year (1999 to 2008) window has been identified as an appropriate time frame for including Prothonotary Warbler breeding records that represent the current nesting habitat use. Records older than 10 years are considered to be historic and would need to be validated to determine the continued presence of suitable habitat at these sites and current use by Prothonotary Warblers. Further, a 10-year window provides a small buffer of time (one year) beyond the known longevity of the species to protect breeding Prothonotary Warblers should they return regularly to the site. The oldest Prothonotary Warbler in North America was recorded

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[2] The definition of one breeding pair can include a confirmed nest, a confirmed breeding pair or a probable breeding observation. A probable breeding observation, in suitable nesting habitat during the breeding season, includes a male and female pair, a courtship or display between a male and a female or 2 males (including courtship feeding or copulation), an adult visiting a probable nest location or building a nest, agitated behaviour or anxiety calls of an adult, or breeding evidence such as a brood patch or cloacal protuberance.

[3] Confirmed breeding means there must be observations of a functional nest (which includes natural and artificial cavities) with confirmed breeding evidence (i.e., nest containing eggs and/or young, and/or adults carrying food, and/or adults carrying fecal sacs, and/or fledged young, and/or sightings of both an adult male and an adult female entering the same cavity in circumstances that strongly suggest that the pair nested).

[4] Reliable sources may include but are not limited to: records within the Ontario Natural Heritage Information Centre, records in the Ontario Breeding Bird Atlas, observations from acknowledged species experts, observations from recognized birders with photographic evidence, the Ontario Ministry of Natural Resources, Canadian Wildlife Service, Bird Studies Canada survey reports, etc.

to be nine years old and the species tends to return to the same site for breeding in future years (COSEWIC 2007).

In accordance with the description of "residence" for Prothonotary Warbler in Canada, nests that are built in nest boxes specifically erected to attract the species (with landowner permission) are afforded the same level of protection as natural nests. As such, the Site Occupancy Criterion can apply to sites at which nest boxes in suitable habitat have been occupied by Prothonotary Warblers.

7.1.2 Suitable Habitat

Suitable habitat is characterized as the areas where individuals of the species carry out essential aspects of their breeding cycle (courtship, territory defense, feeding, nesting, and post-fledging) in Canada. For the Prothonotary Warbler, suitable habitat includes lowland deciduous swamp or floodplain forest and their transitional zones. Such areas are typically dominated by hydrophytic[5] species such as silver maple, red maple, red ash, black ash, mature willow, buttonbush, and alder. These areas will typically have pools of open water (<2m deep and usually covering >20% of the area) from spring through June, however, some areas may lack open water in some years due to drought or low water tables. Upland habitats (forest ridges, cropland, and urban areas) and anthropogenic features such as roads, houses, and other man-made structures (except for nest boxes) adjacent to or within suitable habitat are not components of suitable habitat.

Suitable habitat for the Prothonotary Warbler is identified using the Ecological Land Classification (ELC) framework for Ontario (from Lee et al. 1998). The following ELC ecosite designations summarize the habitat characteristics that have been documented from sites currently and historically occupied by Prothonotary Warblers in Canada:

- Fresh-Moist Sugar Maple Deciduous Forest (FOD6)
- Fresh-Moist Lowland Deciduous Forest (FOD7)
- Oak Mineral Deciduous Swamp (SWD1)
- Ash Mineral Deciduous Swamp (SWD2)
- Maple Mineral Deciduous Swamp (SWD3)
- Mineral Deciduous Swamp (SWD4)
- Ash Organic Deciduous Swamp (SWD5)
- Maple Organic Deciduous Swamp (SWD6)
- Birch-Poplar Organic Deciduous Swamp (SWD7)
- Mineral Thicket Swamp: Willow (SWT2-2) and Buttonbush (SWT2-4) vegetation types
- Organic Thicket Swamp: Willow (SWT3-2) and Buttonbush (SWT3-4) vegetation types

The ELC framework provides a standardized approach to the interpretation and delineation of dynamic ecosystem boundaries. The ELC approach classifies habitats not only by vegetation community but also considers hydrology and topography, and as such may be able to adequately

[5] Hydrophytic species are plants that are adapted to living in or on aquatic environments, including waterlogged soils.

capture the ecosystem requirements for the Prothonotary Warbler. Critical habitat excludes any areas where there are existing human-made structures (except for nest boxes), or cultural communities (anthropogenic influenced land designations as described in Lee et al. 1998 or subsequent ELC catalogues).

7.1.3 Application of Prothonotary Warbler Critical Habitat Criteria

Critical habitat is identified in this recovery strategy as sites containing suitable habitat (see Section 7.1.2) currently known to be occupied by Prothonotary Warbler according to the Site Occupancy Criterion as described in Section 7.1.1. Application of the critical habitat criteria to available information (up to and including 2008) identified 11 sites containing critical habitat across 8 locations in Canada (Table 2). It is important to note that the centroids represent the site polygon that contains critical habitat, and not the extent or boundaries of the critical habitat itself. The extent and boundaries of the critical habitat within each site polygon are defined by the extent of suitable habitat as defined by the ELC ecosite designations, and will vary by location. As new information becomes available, additional critical habitat sites may be identified where they meet the critical habitat criteria across the range of the Canadian Prothonotary Warbler population.

Table 2. Locations in Ontario Identified as containing Critical Habitat sites for the Prothonotary Warbler.

Municipality	Location Name *(alias)*[6]	Site Name	Geographic Centroid of Site Polygon Containing Critical Habitat	
			UTM Easting	UTM Northing
Chatham-Kent	Rondeau Provincial Park	Rondeau Provincial Park	17 429746	4681535
Essex	Holiday Beach Conservation Area	Holiday Beach 1	17 330626	4655449
Essex		Holiday Beach 2	17 331323	4656038
Essex		Holiday Beach 3	17 332996	4654477
Essex	Mans' Marsh (ESA)	Mans' Marsh 1	17 325584	4657499
Essex		Mans' Marsh 2	17 326523	4656748
Essex	Big Creek Marsh ANSI (Malden Centre Marsh)	Big Creek ANSI	17 329919	4656507
Hamilton	Coote's Paradise SNA (Dundas Marsh)	Coote's Paradise SNA (Dundas Marsh)	17 587582	4791550
Norfolk	Hahn Unit -Big Creek National Wildlife Area	Hahn Unit - Big Creek NWA	17 538667	4713889
Norfolk	Backus Woods (SNA)	Backus Woods	17 541523	4724247
Norfolk	Big Creek Prothonotary Woods (SNA)	Big Creek Prothonotary Woods	17 543195	4715682

[6] Acronyms are as follows: **ANSI** (Area of Natural and Scientific Interest); **CA** (Conservation Area); **ESA** (Environmentally Sensitive Area); **NWA** (National Wildlife Area); **SNA** (Significant Natural Area).

7.2 Schedule of Studies

Table 3. Schedule of Studies to Identify Critical Habitat

Description of Activity	Rationale	Timeline
Conduct Prothonotary Warbler surveys to determine presence of breeding pairs across the Canadian range.	Confirm breeding presence in locations with suitable habitat	2011-2015
Apply criteria to available data and identify additional critical habitat where appropriate.	Identify additional critical habitat	2015

7.3 Activities Likely to Result in the Destruction of Critical Habitat

Activities that are likely to result in the destruction of Prothonotary Warbler critical habitat and its attributes are those which cause radical or lasting alterations to normal hydrological regimes (e.g. wetland drainage, construction of dams, infilling of swampy lowlands and associated marshes) or any reduction in the total canopy closure. See also Section 3.3 (Needs of the Prothonotary Warbler and Section 4 (Threats) that further discuss habitat attributes as well as activities that may destroy or degrade those attributes. Such activities include, but may not be limited to:

- High-grading forestry practices that selectively remove all of the largest diameter trees,
- The construction of new infrastructure (buildings, roads, trails, footpaths etc.),
- Upgrades and / or maintenance of existing infrastructure,
- Deliberate introduction of non-indigenous, invasive species in the critical habitat,
- Firewood harvest, unless it is done as part of a prescribed management plan that considers Prothonotary Warbler habitat/nesting requirements.

8. MEASURING PROGRESS

The recovery strategy and action plan must follow the adaptive management approach, whereby new information feeds back into planning on a regular basis in order to take advantage of new tools, knowledge, challenges, and opportunities. A five-year evaluation of the recovery strategy will be based upon the performance measures listed in Table 3, using 2008 as the benchmark year.

Table 4. Performance measures that will be used to evaluate the success toward achieving recovery by 2015

Recovery Objective	Performance Measure
1. Enhancing, restoring, monitoring and, creating habitat at current and potential breeding sites.	Habitat enhanced and restored within sites containing critical habitat, and new habitat created, where potential breeding sites exist. Numbers of sites and hectares that are enhanced and/or restored increased over 2008 levels.
2. Increasing the number of nesting opportunities	A steady increase in size of breeding population and numbers of nests over 2008 levels (10 pairs).
3. Increasing nesting success (proportion of nests that fledge at least one young) to an average of at least 60% annually	Increase in nesting success and overall productivity within the Canadian population to an average of at least 60% annually.
4. Mitigate potential effects from catastrophic weather events.	Number of geographically distinct nesting areas that are occupied is no less than five in any given year.
5. Assessing and addressing the current and expanding threat to Prothonotary Warbler critical habitat from invasive species.	Level of threat for each Prothonotary Warbler critical habitat site evaluated for invasive insects, pathogens, and plants. Results reported on. Management strategies to reduce the impact of these threats are formulated, and a minimum of one strategy initiated, in collaboration with other agencies and partners.
6. Protecting occupied habitat from application of insecticides.	Distribution of educational materials on Prothonotary Warbler and the threats to them provided to all of the municipalities with identified occupied habitat. Municipalities encouraged to adopt measures that inhibit the application of insecticides in occupied habitat is increased over 2008 levels.
7. Establishing a dialogue and relationship with agencies and organizations that are interested in recovery efforts in New York, Michigan, Pennsylvania, and Ohio to help further species recovery in both countries.	Collaboration initiated between Canada and the United States to benefit the recovery of the Prothonotary Warbler.

9. STATEMENT ON ACTION PLANS

One or more action plans will be posted on the SAR Public Registry by December 2015. The action plan(s) may include an area-based, multi-species approach for some areas.

10. REFERENCES

Arendt, W.J. 1992. Status of North American migrant landbirds in the Caribbean region: A summary. Pp. 143–171 *in* J.M. Hagan and D.W. Johnston (Eds.). Ecology and Conservation of Neotropical Migrant Landbirds. Smithsonian Institution Press, Washington, D.C.

Bent, A.C. 1953. Life Histories of North American Wood Warblers. U.S. National Museums Bulletin 203.

Best, D. and A. Fondrk. 1995. Feathered flames on the Cuyahoga River. Ohio Cardinal 18:117–120.

Blem, C.R. and L.B. Blem. 1991. Nest-box selection by Prothonotary Warblers. J. Field Ornithol. 62:299–307.

Blem, C.R. and L.B. Blem. 1992. Prothonotary Warblers nesting in nest boxes: clutch size and timing in Virginia. Raven 63:15–20.

Blem, C.R., L.B. Blem, and L.S. Berlinghoff. 1999. Old nests in Prothonotary Warbler nest boxes: effects on reproductive performance. J. Field Ornithol. 70:95–100.

Cadman, M.D., D.A. Sutherland, G.G. Beck, D. Lepage, and A.R. Couturier, eds. 2007. Atlas of the Breeding Birds of Ontario, 2001-2005. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources, and Ontario Nature, Toronto, xxii + 706 pp.

COSEWIC 2007. COSEWIC assessment and update status report on the Prothonotary Warbler *Protonotaria citrea* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 31 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Curson, J. 1994. New World Warblers. Helm Identification Guides. Christopher Helm, London.

Dickson, J.G., F.R. Thompson, R.N. Conner, and K.E. Franzreb. 1995. Silviculture in central and southeastern oak–pine forests. Pp. 245–266 *in* T.E. Martin and D.M. Finch (Eds.). Ecology and Management of Neotropical Migratory Birds. Oxford University Press, New York, N.Y.

Faaborg, J. and W.J. Arendt. 1984. Population sizes and philopatry of winter resident warblers in Puerto Rico. J. Field Ornithol. 55:376–378.

Flaspohler, D.J. 1996. Nesting success of the Prothonotary Warbler in the Upper Mississippi River bottomlands. Wilson Bull. 108:457–466.

Flaxman, M. and K. Lindsay. 2004. Habitat Identification and Mapping for the Acadian Flycatcher, Hooded Warbler and Prothonotary Warbler in Southern Ontario, Canada. Interdepartmental Recovery Fund Project No. 31, FY 2002–03. National Wildlife Research Centre, Canadian Wildlife Service, Environment Canada, Ottawa, Ontario.

Government of Canada. 2009. *Species at Risk Act* Policies, Overarching Policy Framework [Draft]. *Species at Risk Act* Policy and Guidelines Series. Environment Canada. Ottawa. 33pp.

Guillory, H.D. 1987. Cavity competition and suspected predation on Prothonotary Warblers by *Peromyscus* spp. J. Field Ornithol. 58:425–427.

Hefner, J.M., B.O. Wilen, T.E. Dahl, and W.E. Frayer. 1994. Southeast Wetlands: Status and Trends, Mid-1970's to Mid-1980's. Fish and Wildlife Service, U.S. Department of the Interior, Atlanta, Georgia.

Hodges, M.F., Jr. and D.G. Krementz. 1996. Neotropical migratory breeding bird communities in riparian forests of different widths along the Altamaha River, Georgia. Wilson Bull. 108:496–506.

Holmes, R.T. and T.W. Sherry. 1992. Site fidelity of migratory warblers in temperate breeding and Neotropical wintering areas: implications for population dynamics, habitat selection and conservation. Pp. 563–575 *in* J.M. Hagan and D.W. Johnston (Eds.). Ecology and Conservation of Neotropical Migrant Landbirds. Smithsonian Institution Press, Washington, D.C.

Hoover, J.P. and M.C. Brittingham. 1993. Regional variation in cowbird parasitism of Wood Thrushes. Wilson Bull. 105:228–238.

Keller, C.M.E., C.S. Robbins, and J.S. Hatfield. 1993. Avian communities in riparian forests of different widths in Maryland and Delaware. Wetlands 13:137–144.

Kershner, E.L., J.W. Walk, and R.E. Warner. 2004. Postfledging movements and survival of juvenile eastern meadowlarks (*Sturnella magna)* in Illinois. Auk. 121: 1146-1154.

Kilgo, J.C., R.A. Sargent, B.R. Chapman, and K.V. Miller. 1998. Effect of stand width and adjacent habitat on breeding bird communities in bottomland hardwoods. J. Wildl. Manage. 62:72–83.

Knutson, M.G. and E.E. Klaas. 1997. Declines in abundance and species richness of birds following a major flood on the Upper Mississippi River. Auk 114:367–380.

Lee, H.T., D.Leadbeater, P.Uhlig and K. Ursic. 1998. Ecological land classification for southern Ontario: training Manual. Ontario Ministry of Natural Resources, Science and Information Resources Division, Science and Information Branch, Southcentral Science and Information Section, SCSIS Training Manual TM-01

Lefebvre, G. and B. Poulin. 1996. Seasonal abundance of migrant birds and food resources in Panamanian mangrove forests. Wilson Bull. 108:748–759.

Lefebvre, G., B. Poulin, and R. McNeil. 1992. Abundance, feeding behaviour, and body condition of Nearctic warblers wintering in Venezuelan mangroves. Wilson Bull. 104:400–412.

Lefebvre, G., B. Poulin, and R. McNeil. 1994. Spatial and social behaviour of Nearctic warblers wintering in Venezuelan mangroves. Can. J. Zool. 72:757–764.

McCracken, J.D. 1981. Status Report on the Prothonotary Warbler (*Protonotaria citrea*) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario.

McCracken, J.D. 1998. Status of the Prothonotary Warbler's Critical Wintering Habitat in Latin America: A Focus on Mangrove Ecosystems. Unpublished report to World Wildlife Fund Canada from Bird Studies Canada, Port Rowan, Ontario. 44 pp.

McCracken, J.D. 2004. The 2003 Prothonotary Warbler Recovery Program in Canada. Unpublished report to Canadian Wildlife Service – Ontario Region from Bird Studies Canada, Port Rowan, Ontario. 42 pp.

McCracken, J.D. and J.S. Dobbyn. 1997. The 1997 Prothonotary Warbler Nest Box and Census Program. Unpublished report, Long Point Bird Observatory. 88 pp.

McCracken, J.D. and S.A. Mackenzie. 2003. The 2002 Prothonotary Warbler Recovery Program in Canada. Unpublished report, Bird Studies Canada, Port Rowan, Ontario. 94 pp.

McCracken, J.D. and R.W. Wood. 2005. The 2004 Prothonotary Warbler Recovery Program in Canada: Population Surveys, Nest Box Monitoring, and Colour Banding. Unpublished report to Canadian Wildlife Service – Ontario Region from Bird Studies Canada, Port Rowan, Ontario. 50 pp.

McCracken, J.D., R. Wood, and P. Patel. 2006. The 2005 Prothonotary Warbler Recovery Program in Canada: Population Surveys, Nest Box Monitoring, and Colour Banding. Unpublished report to Environment Canada and Nature Canada from Bird Studies Canada, Port Rowan, Ontario. 52 pp.

McCracken, J. 2007. Prothonotary Warbler, pp. 506-507 *In*: Cadman, M.D., D.A. Sutherland, G.G. Beck, D. Lepage, and A.R. Couturier, eds. Atlas of the Breeding Birds of Ontario, 2001-2005. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources, and Ontario Nature, Toronto, xxii + 706 pp.

McCracken, J.D. and K. Vande Somple. 2009. The 2008 Prothonotary Warbler Recovery Program in Canada. Unpublished report to Environment Canada and Ontario Ministry of Natural Resources. 45 pp.

McNeil, R. 1982. Winter resident repeats and returns of austral and boreal migrant birds banded in Venezuela. J. Field Ornithol. 53:125–132.

Mitrus, C. 2003. A comparison of the breeding ecology of Collared Flycatchers nesting in boxes and natural cavities. J. Field Ornithol. 74:293–299.

Moller, A.P. 1989. Parasites, predators and nest boxes: facts and artifacts in nest box studies of birds? Oikos 56:421–423.

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.7. NatureServe, Arlington, Virginia (www.natureserve.org/explorer; accessed August 8, 2008).

Nice, M.M. 1957. Nesting success in altricial birds. Auk 74:305–321.

Nilsson, S.G. 1986. Evolution of hole nesting in birds: on balancing selection pressures. Auk 103:432–435.

Olson, D.M., E. Dinerstein, G. Cintron, and P. Iolster. 1996. A Conservation Assessment of Mangrove Ecosystems of Latin America and the Caribbean. World Wildlife Fund U.S., Washington, D.C. 44 pp. + appendices.

Peck, G.K. and R.D. James. 1998. Breeding birds of Ontario: nidiology and distribution. Vol. 2: Passerines (First revision – Part B: Thrushes to warblers). Ont. Birds 16:11–25.

Petit, L.J. 1989. Breeding biology of Prothonotary Warblers in riverine habitat in Tennessee. Wilson Bull. 101:51–61.

Petit, L.J. 1991. Adaptive tolerance of cowbird parasitism by Prothonotary Warblers: a consequence of nest-site limitation? Anim. Behav. 41:425–432.

Petit, L.J. 1999. Prothonotary Warbler (*Protonotaria citrea*). *In* A. Poole and F. Gill (Eds.). The Birds of North America, No. 408. The Birds of North America, Inc., Philadelphia, Pennsylvania.

Petit, L.J. and D.R. Petit. 1996. Factors governing habitat selection by Prothonotary Warblers: field tests of the Fretwell-Lucas models. Ecol. Monogr. 66:367–387.

Petit, L., W.J. Fleming, K.E. Petit, and D.R. Petit. 1987. Nest-box use by Prothonotary Warblers (*Protonotaria citrea*) in riverine habitat. Wilson Bull. 99:485–487.

Petit, D.R., J.F. Lynch, R.L. Hutto, J.C. Blake, and R.B. Waide. 1995. Habitat use and conservation in the Neotropics. Pp. 145–197 *in* T.E. Martin and D.M. Finch (Eds.). Ecology and Management of Neotropical Migratory Birds. Oxford University Press, New York, N.Y.

Rich, T.D., C.J. Beardmore, H. Berlanga, P.J. Blancher, M.S.W. Bradstreet, G.S. Butcher, D. Demarest, E.H. Dunn, W.C. Hunter, E. Inigo-Elias, J.A. Kennedy, A.M. Martell, A.O. Panjabi, D.N. Pashley, K.V. Rosenberg, C.M. Rustay, J.S. Wendt, and T.C. Will. 2004.

Partners in Flight North American Landbird Conservation Plan. Cornell Laboratory of Ornithology, Ithaca, N.Y. 84 pp.

Robbins, C.S., D.K. Dawson, and B.A. Dowell. 1989. Habitat area requirements of breeding forest birds of the middle Atlantic states. Wildl. Monogr. 103:1–34.

Sauer, J. R., J. E. Hines, and J. Fallon. 2008. The North American Breeding Bird Survey, Results and Analysis 1966 - 2007. Version 5.15.2008. USGS Patuxent Wildlife Research Center, Laurel, MD.

Snell, E.A. 1987. Wetland Distribution and Conversion in Southern Ontario. Canada Land Use Monitoring Program. Working Paper No. 48. Inland Waters and Lands Directorate, Environment Canada. 53 pp.

Terborgh, J. 1989. Where Have All the Birds Gone? Princeton University Press, Princeton, NJ.

Thompson, F.R., S.J. Lewis, J. Green, and D. Ewert. 1993. Status of Neotropical migrant landbirds in the Midwest: identifying species of management concern. Pp. 145–158 *in* D.M. Finch and P.W. Stangel (Eds.). Status and Management of Neotropical Migratory Birds. General Technical Report RM-229. U.S. Forest Service, Fort Collins, Colorado.

Tischendorf, L. 2003. The Prothonotary Warbler: Population Viability and Critical Habitat in Southern Ontario, Canada. Interdepartmental Recovery Fund Project. National Wildlife Research Centre, Canadian Wildlife Service, Environment Canada, Ottawa, Ontario. 17 pp.

Twedt, D.J. and J.L. Henne-Kerr. 2001. Artificial cavities enhance breeding bird densities in managed cottonwood forests. Wildl. Soc. Bull. 29:680–687.

U.S. Department of the Interior. 1994. The Impact of Federal Programs on Wetlands. Vol. 2. A report to Congress by the Secretary of the Interior, Washington, D.C.

Walkinshaw, L.H. 1938. Nesting studies of the Prothonotary Warbler. Bird Banding 9:32–46.

Walkinshaw, L.H. 1941. The Prothonotary Warbler, a comparison of nesting conditions in Tennessee and Michigan. Wilson Bull. 53:3–21.

Walkinshaw, L.H. 1953. Life-history of the Prothonotary Warbler. Wilson Bull. 65:152–168.

Walkinshaw, L.H. 1991. Prothonotary Warbler. Pp. 430–431 *in* R. Brewer, G.A. McPeek, and R.A. Adams, Jr. (Eds.). The Atlas of Breeding Birds of Michigan. Michigan State University Press, East Lansing, Michigan.

Warkentin, I.G. and D. Hernandez. 1996. The conservation implications of site fidelity: a case study involving Nearctic–Neotropical migrant songbirds wintering in a Costa Rican mangrove. Biol. Conserv. 77:143–150.

Winger, P.V. 1986. Forested Wetlands of the Southeast: Review of Major Characteristics and Role in Maintaining Water Quality. Resource Publication 163. U.S. Fish and Wildlife Service.

Woodcock, J., M. Woodcock, and J.D. McCracken. 2004. A Preliminary Investigation of Prothonotary Warblers on their Wintering Grounds on the Pacific Coast of Costa Rica. Unpublished report to Canadian Wildlife Service – Ontario Region from Bird Studies Canada, Port Rowan, Ontario. 23 pp.

Woodcock, J. and M. Woodcock. 2007. Species diversity, winter-site fidelity and ecology of winter resident 'landbirds' in Costa Rican mangroves. Zeledonia (Boletin de la Asociacion Ornitologica de Costa Rica) 11:1-13. (www.zeledonia.org).

Yackel Adams A.A., S.K. Skagen, and R.D. Adams. 2001. Movements and survival of lark bunting fledglings. Condor. 103: 643-647.

APPENDIX A: EFFECTS ON THE ENVIRONMENT AND OTHER SPECIES

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts on non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below.

This recovery strategy will clearly benefit the environment by promoting the recovery of the Prothonotary Warbler. The potential for the strategy to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this strategy will clearly benefit the environment and will not entail any significant adverse effects. The reader should refer to the following sections of the document in particular: Population and Distribution Objectives, Overall Strategies and Specific Steps for Recovery, and Effects on Other Species.

Recovery efforts that are focused on Prothonotary Warblers — especially efforts that are designed to protect, restore, or create swamp forest habitats — will benefit a great variety of species. No species of conservation concern are expected to be detrimentally affected. All species at risk listed in Table 4 utilize deciduous swamp forests and are known to occur in one or more sites occupied by Prothonotary Warblers in Canada. Several sites support multiple species at risk.

Table 5. List of COSEWIC species at risk that are expected to benefit from recovery activities directed at the Prothonotary Warbler, based upon confirmed records of overlap of occurrence at known occupied sites.

Common name	Scientific name	COSEWIC designation
Acadian Flycatcher	*Empidonax virescens*	Endangered
Red-headed Woodpecker	*Melanerpes erythrocephalus*	Threatened
Louisiana Waterthrush	*Seiurus motacilla*	Special Concern
Cerulean Warbler	*Dendroica cerulea*	Special Concern
Spotted turtle	*Clemmys guttata*	Endangered
Blanding's turtle	*Emydoidea blandingii*	Threatened
Eastern foxsnake (Carolinian population)	*Elaphe gloydi*	Endangered
Eastern ribbonsnake	*Thamnophis sauritus*	Special Concern
Eastern hog-nosed snake	*Heterodon platirhinos*	Threatened
Jefferson salamander	*Ambystoma jeffersonianum*	Threatened
Swamp rose-mallow	*Hibiscus moscheutos*	Special Concern

APPENDIX B: NATURESERVE RANKS AND DEFINITIONS

Table 6. Sub-national conservation ranks (S-ranks) in Canada and the United States for the Prothonotary Warbler (NatureServe 2008)

United States	Alabama (S5B), Arizona (S1M), Arkansas (S4B), Colorado (SNA), Connecticut (SNA), Delaware (S4B), District of Columbia (S1B), Florida (SNRB), Georgia (S5), Illinois (S5), Indiana (S4B), Iowa (S3B,S3N), Kansas (S3B), Kentucky (S5B), Louisiana (S5B), Maryland (S4B), Massachusetts (S3), Michigan (S3), Minnesota (SNRB), Mississippi (S5B), Missouri (S4), Nebraska (S2), New Jersey (S4B), New Mexico (S4N), New York (S2), North Carolina (S5B), Ohio (S3), Oklahoma (S4B), Pennsylvania (S2S3B), Rhode Island (S1B,S1N), South Carolina (S3B), South Dakota (SNA), Tennessee (S4), Texas (S3B), Virginia (S4), West Virginia (S2B), Wisconsin (S3B)
Canada	Ontario (S1S2B)

S1 – critically imperiled; S2 – imperiled; S1S2 – critically imperiled to imperiled; S2S3 – imperiled to vulnerable; S3 – vulnerable; S4 – apparently secure; S5 – secure; SNR – unranked; B – breeding population; N – non-breeding population; M – migrant/transient population; SNA – conservation status not applicable because the species is not a suitable target for conservation activities.