

COSEWIC **Assessment and Status Report**

on the

Louisiana Waterthrush *Parkesia motacilla*

in Canada



THREATENED
2015

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada



COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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Page, A.M. 1996. Update COSEWIC status report on the Louisiana Waterthrush *Parkesia motacilla* in Canada. Committee on the Status of Endangered Wildlife in Canada. 1-24 pp.

McCracken, J.D. 1991. COSEWIC status report on the Louisiana Waterthrush *Parkesia motacilla* in Canada. Committee on the Status of Endangered Wildlife in Canada. 1-26 pp.

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Louisiana Waterthrush — Photo by © Michael Patrikeev.

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COSEWIC Assessment Summary

Assessment Summary – November 2015

Common name

Louisiana Waterthrush

Scientific name

Parkesia motacilla

Status

Threatened

Reason for designation

During the breeding season in Canada, this songbird nests along clear, shaded, coldwater streams and forested wetlands in southern Ontario and southwestern Quebec. It occupies a similar habitat niche in Latin America during the winter. The Canadian population is small, probably consisting of fewer than 500 adults, but breeding pairs are difficult to detect. Population trends for the Canadian population are uncertain. Declines have been noted in some parts of the Canadian range, particularly in its stronghold in southwestern Ontario, while new pairs have been found in others. Immigration of individuals from the northeastern U.S. is thought to be important to maintaining the Canadian population. However, while the U.S. source population currently appears to be fairly stable, it may be subject to future population declines due to emerging threats to habitat.

Occurrence

Ontario, Quebec

Status history

Designated Special Concern in April 1991. Status re-examined and confirmed in April 1996 and April 2006. Status re-examined and designated Threatened in November 2015.



COSEWIC Executive Summary

Louisiana Waterthrush *Parkesia motacilla*

Wildlife Species Description and Significance

The Louisiana Waterthrush (*Parkesia motacilla*) is a relatively large, drab wood-warbler that resembles a small thrush. Males and females are identical in appearance. The upper parts are dull brown. The lower parts are cream-coloured, with dark streaking on the breast and flanks. A bold, broad, white streak over the eye extends to the nape. The legs are bubble-gum pink, and the bill is rather long and heavy for a warbler.

Distribution

Most of the global breeding range (>99%) is within the eastern United States. In Canada, the Louisiana Waterthrush breeds in southern Ontario, where it is considered a rare, but regular local summer resident. It is also a rare, but sporadic breeder in southwestern Quebec. The bulk of the Canadian population is concentrated in two areas of Ontario: the Norfolk Sand Plain region bordering the north shore of Lake Erie, and the central Niagara Escarpment between Hamilton and Owen Sound.

Its wintering range extends from northern Mexico through Central America to extreme northwestern South America, and also throughout the West Indies.

Habitat

The Louisiana Waterthrush occupies specialized habitat, showing a strong preference for nesting and wintering along relatively pristine headwater streams and wetlands situated in large tracts of mature forest. Although it prefers running water (especially clear, coldwater streams), it also inhabits heavily wooded swamps with vernal or semi-permanent pools, where its territories can overlap with its sister species the Northern Waterthrush. It is often classified as both an area-sensitive forest species, and a riparian-obligate species. Louisiana Waterthrush nests are constructed within niches in steep stream banks, in the roots of uprooted trees, or in mossy logs and stumps, usually within a few metres of water.

Biology

The Louisiana Waterthrush is a long-distance migrant that typically arrives in southern Ontario much earlier in the spring than other neotropical songbirds. It displays annual fidelity to both breeding and wintering sites. Louisiana Waterthrush clutch size ranges from 4-6 eggs and incubation extends from 12-14 days. The species is generally single-brooded.

The Louisiana Waterthrush spends most of its time on or near the ground, along the margins of streams and pools. It has a specialized diet, feeding mostly on aquatic macro-invertebrates, especially insects, and sometimes eats small molluscs, fish, crustaceans, and amphibians.

Population Sizes and Trends

The Canadian population is estimated to be 235 to 575 adults. Population trends are poorly understood. The species has declined locally in parts of Canada in the past century and in the past few decades (related to habitat degradation and/or population fluctuations), but targeted surveys have found higher numbers in some parts of the Canadian range in recent years. Overall, populations in Canada and much of the U.S. currently appear to be relatively stable.

Threats and Limiting Factors

The Louisiana Waterthrush is a habitat specialist and its global population is limited by the supply of high-quality aquatic habitat on both its breeding and wintering grounds. There is no single imminent threat to the survival of the Canadian population; rather, it is the cumulative effects of many threats at different stages of its annual life cycle that are of particular concern. Habitat loss and changes in water quality/quantity due to agricultural intensification, and suburban residential development may have contributed to declines observed in parts of southern Ontario. Habitat conditions in Canada are expected to deteriorate due to the anticipated spread of Hemlock Woolly Adelgid, an exotic forest pest, into eastern Canada. Habitat fragmentation and degradation on its U.S. breeding grounds due to the combination of exotic forest pests and resource development could reduce immigration into the Canadian population. Habitat loss and degradation, including degraded water quality and deforestation due to agricultural and development activities, are ongoing threats in the wintering range. During migration, this species also experiences relatively high rates of mortality due to collisions with tall buildings and communication towers.

Protection, Status and Ranks

The *Migratory Birds Convention Act* currently provides the most specific legislation protecting the Louisiana Waterthrush in Canada. A high proportion of known nesting sites are in protected areas. The specific habitats used by this species in Ontario are also provided some protection through various legislative policies. In addition, their physical characteristics generally preclude most kinds of agricultural and development activities.

TECHNICAL SUMMARY

Parkesia motacilla

Louisiana Waterthrush

Paruline hochequeue

Range of occurrence in Canada: Ontario, Quebec

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines is being used)	2 to 3 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? The outcome from the threats calculator suggests that a future decline could be projected.	Unknown
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	N/A
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last 10 years.	Unknown, but overall population estimates have generally been stable
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next 10 years.	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any 10 year period, over a time period including both the past and the future.	Unknown
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	N/A
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence	110,000 km ²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	Estimated <500 km ² (known 368 km ²)
Is the population "severely fragmented"	No
Number of "locations"*	Unknown, but more than the threshold of 10 locations
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	N/A

* See Definitions and Abbreviations on [COSEWIC website](#) and [IUCN](#) (Feb 2014) for more information on this term

Is there an [observed, inferred, or projected] decline in number of "locations"*?	Unknown
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, inferred and projected decline in habitat quality owing to loss of hemlock and effects of stream acidification.
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations/Regions: <i>Based on estimated number of territories extrapolated from numbers of males detected during targeted surveys and assuming 75% of males are paired</i>	N Mature Individuals
Southwestern Ontario	Estimated 116 to 254 adults (66 to 145 males and 50 to 109 females)
South-central Ontario	Estimated 93 to 234 adults (53 to 134 males and 40 to 100 females)
Southeastern Ontario (including Southern Shield region)	Estimated 26 to 70 adults (15 to 40 males and 11 to 30 females)
Southwestern Quebec	Estimated 0 to 17 adults (0 to 10 males and 0 to 7 females)
Total	Estimated 235 to 575 adults (134 to 329 males and 101 to 246 females)

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	No recent quantitative analysis is available. A very preliminary population modelling analysis in 2001 suggested that the Canadian population should persist for over 100 years (see Fluctuations and Trends section).
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* See Definitions and Abbreviations on [COSEWIC website](#) and [IUCN](#) (Feb 2014) for more information on this term

Threats (actual or imminent, to populations or habitats, from highest impact to least)

Ongoing declines in water quality/quantity due to agricultural intensification, rural and suburban residential developments, and increased variability and severe weather due to climate change.

Habitat fragmentation and degradation on breeding grounds due to combination of new exotic forest pests (hemlock mortality due to Hemlock Woolly Adelgid ongoing or imminent on U.S. range, and emerging threat on Canadian range) and new resource developments (shale gas extraction, ridge-top wind turbine installations, mountaintop-removal coal mining ongoing or imminent in northern U.S. range). Habitat loss and degradation on the wintering grounds, including degraded water quality and deforestation.

Collisions with buildings and towers during migration.

Disturbance to nesting birds due to recreational activities (ATVs fording streams, trampling of streambanks by fishers and hikers, etc.)

Was a threats calculator completed for this species and if so, by whom? Yes.

Dwayne Lepitzki, Jon McCracken, Audrey Heagy, Julie Perrault, Marcel Gahbauer, Lyle Friesen, Don Sutherland, François Shaffer, Ben Walters, Zoe Lebrun-Southcott, Brady Mattsson.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada. <i>See Population and Trends section.</i>	Populations in adjacent U.S. states have mostly been stable or increasing (Ohio, Pennsylvania, Vermont, New Hampshire), but recent declines in New York and Michigan.
Is immigration known or possible?	Yes
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada? ⁺	Uncertain, but probably
Are conditions for the source population deteriorating? ⁺	Habitat conditions are currently deteriorating or are expected to deteriorate in large parts of the US range.
Is the Canadian population considered to be a sink? ⁺	No
Is rescue from outside populations likely?	Yes (at least in the short term).

Data Sensitive Species

Is this a data sensitive species? No

Status History**COSEWIC:**

Designated Special Concern in April 1991. Status re-examined and confirmed in April 1996 and in April 2006. Status re-examined and designated Threatened in November 2015.

⁺ See [Table 3](#) (Guidelines for modifying status assessment based on rescue effect)

Status and Reasons for Designation:

Status: Threatened	Alpha-numeric codes: D1
Reasons for designation: During the breeding season in Canada, this songbird nests along clear, shaded, coldwater streams and forested wetlands in southern Ontario and southwestern Quebec. It occupies a similar habitat niche in Latin America during the winter. The Canadian population is small, probably consisting of fewer than 500 adults, but breeding pairs are difficult to detect. Population trends for the Canadian population are uncertain. Declines have been noted in some parts of the Canadian range, particularly in its stronghold in southwestern Ontario, while new pairs have been found in others. Immigration of individuals from the northeastern U.S. is thought to be important to maintaining the Canadian population. However, while the U.S. source population currently appears to be fairly stable, it may be subject to future population declines due to emerging threats to habitat.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Rates of decline cannot be specified.
Criterion B (Small Distribution Range and Decline or Fluctuation): Does not meet criteria. Potentially meets Endangered because IAO is < 500 km ² and there is a continuing decline in habitat quality. However, the population is not severely fragmented, there are > 10 locations, and there are no extreme fluctuations.
Criterion C (Small and Declining Number of Mature Individuals): Does not meet criteria. Could meet Threatened C2a(i) because there are < 1000 individuals, but there is insufficient evidence for a continuing population decline.
Criterion D (Very Small or Restricted Population): Meets Threatened D1, because there are < 1000 mature individuals.
Criterion E (Quantitative Analysis): Not applicable. Not done.

PREFACE

Since this species was last assessed by COSEWIC in 2006, new information on the distribution and abundance is available as a result of targeted surveys in southwestern Quebec and southern Ontario, as well as the completion of 5 years of fieldwork for the second Québec Breeding Bird Atlas. In addition, information on nesting productivity and parasitism rates in Canada is available as a result of nest monitoring efforts in southwestern Ontario. Some information on site fidelity, site turnover, and return rates in Ontario is also available as a result of a 4-year colour-banding project.

New and emerging threats on the breeding grounds are impacting breeding habitat in the northern United States range, which is considered an essential source of immigrants to sustain the small Canadian population. New forest pest species are also expected to affect forest habitat in the Canadian breeding range in the near future. Other threats to the population in southern Ontario are continuing.



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 (2015)

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

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

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

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



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

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Louisiana Waterthrush

Parkesia motacilla

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Scientific name: *Parkesia motacilla* (formerly *Seiurus motacilla*)

English name: Louisiana Waterthrush

French name: Paruline hochequeue

No subspecies have been recognized or described (American Ornithologist's Union [AOU] 2013). This member of the New World wood-warbler (Parulidae) family was formerly classified in the genus *Seiurus*, along with Northern Waterthrush (now *Parkesia noveboracensis*) and Ovenbird (*S. aurocapilla*). Both waterthrush species were recently transferred to the new genus *Parkesia* based on genetic data indicating that the two waterthrushes are sister species (Sangster 2008; Chesser *et al.* 2010).

Morphological Description

The Louisiana Waterthrush is a relatively large, drab warbler that resembles a small thrush (Figure 1). Males and females are identical in appearance. The upper parts are dull brown. The lower parts are cream-coloured, with dark streaking on the breast and flanks, which fades out in the undertail coverts. A bold, broad, white supercilium (eye brow) extends to the nape. The legs are bubble-gum pink, and the bill is rather long and heavy for a warbler (Curson *et al.* 1994; Dunn and Garrett 1997).

The species is easily confused with the Northern Waterthrush (*Parkesia noveboracensis*), which is much more common and widespread in Canada. The most notable plumage difference between the two species is that the Northern Waterthrush's supercilium (eye-brow) is cream-coloured or yellowish, relatively thin, and tapers behind the eye, whereas it is white and more extensive in the Louisiana Waterthrush. The Northern Waterthrush also has brown blotches on its undertail coverts, which are less distinct in the Louisiana Waterthrush. The two species are best separated in the field by song, and also by behaviour and habitat differences. The Louisiana Waterthrush's distinctive song is preceded by a short series of very loud, down-slurred, piercing whistles, followed by a cascading series of jumbled whistles. Tail-bobbing is characteristic of both waterthrushes but, this behaviour is particularly exaggerated in this species (Dunn and Garrett 1997). Where their breeding ranges overlap, both species can sometimes be found occupying swamp forest, but the Louisiana Waterthrush is more apt to be found along coldwater streams (Craig 1985).



Figure 1. Adult Louisiana Waterthrush at nest with young (photo by Michael Patrikeev with permission).

Population Spatial Structure and Variability

There is no evidence of population structuring within the small Canadian population of this species. Within the United States, eastern birds tend to be slightly larger than those in the west (Eaton 1958).

Designatable Units

There are no biological, genetic or geographic distinctions that warrant assessment below the species level. This report deals with a single designatable unit.

Special Significance

This species is considered a habitat specialist and is the only stream-dependent songbird in eastern North America (Mulvihill *et al.* 2008). Within its breeding and wintering ranges, the Louisiana Waterthrush is likely an excellent bio-indicator of the health of headwater, medium-gradient, coldwater streams and large, intact, mature deciduous forested swamps (Buffington *et al.* 1997; Prosser and Brooks 1998; Mulvihill *et al.* 2002; O'Connell *et al.* 2003; Mattsson and Cooper 2006; Mattsson and Cooper 2009). Due to its preference for clear, coldwater streams, the breeding habitat of this species often overlaps with trout streams (e.g., Stucker 2000).

It is also classified an area-sensitive forest bird that requires large tracts of contiguous, closed canopy forest for breeding (Robbins 1979; Freemark and Collins 1992). The breeding habitat requirements overlap with those of two other forest songbirds that are designated as Endangered in Canada: the Acadian Flycatcher (*Empidonax vireescens*) and Prothonotary Warbler (*Protonotaria citrea*); these species co-occur at some sites in Ontario (COSEWIC 2007, 2010; Environment Canada 2012).

No Aboriginal traditional knowledge is currently available for this species.

DISTRIBUTION

Global Range

Breeding

The Louisiana Waterthrush breeds from eastern Nebraska, north central Iowa, east central and southeastern Minnesota, central Wisconsin, southern Michigan, southern Ontario, central New York, central Vermont, central New Hampshire, and southern Maine south to eastern Kansas, eastern Oklahoma, eastern Texas, central Louisiana, southern Mississippi, southern Alabama, northern Florida, central and southwestern Georgia, central South Carolina, and central and northeastern North Carolina (Figure 2). The bulk of its 2,400,000 km² breeding range (>99%) is within the eastern United States (Partners in Flight Science Committee [PIFSC] 2013).

Over the last century, its breeding range expanded slowly northward in the northeastern U.S. (Mattsson *et al.* 2009). This range expansion is probably attributed to re-colonization of formerly held territory that was heavily lumbered in the 1800s and is now largely reforested (Brewer *et al.* 1991). The northward expansion of the U.S. range seems to have halted (Mattsson *et al.* 2009). Since the 1980s, a reduction in distribution has been observed in northern New York (Rosenberg 2008) and southwestern Michigan (Hull 2011), but not in Vermont (Kibbe 2013) or Pennsylvania (Mulvihill 2012).



Figure 2. Global range of the Louisiana Waterthrush (map from Environment Canada 2012, based on Ridgely *et al.* 2007).

Wintering

The Louisiana Waterthrush winters from northern Mexico, south through Central America (mainly at higher elevations; both slopes, although more commonly on the Gulf/Caribbean side) to central Panama, rarely to northeastern Colombia and northwestern Venezuela; also throughout the West Indies but progressively less numerous moving southward (Mattsson *et al.* 2009; Figure 2). Over 25% of the 1,729,000 km² wintering range is in Mexico (Berlanga *et al.* 2010).

Canadian Range

Breeding

In Canada, the Louisiana Waterthrush breeds regularly in southern Ontario (Figure 3), where it is considered a rare, local summer resident (Eagles 1987; James 1991; McCracken 2007; Environment Canada 2011, 2012; Sandilands 2014). It is a rare and sporadic breeding bird in southwestern Quebec (Figure 4), where in 2006 it was confirmed nesting at one site (Savignac 2006) and has also been reported during the breeding season at several other sites (David 1996; St-Hilaire and Dauphin 1996; Savignac 2005, 2006, 2007, 2008; Les Oiseaux du Québec 2014; M. Robert, pers. comm. 2014; Québec BBA 2015).

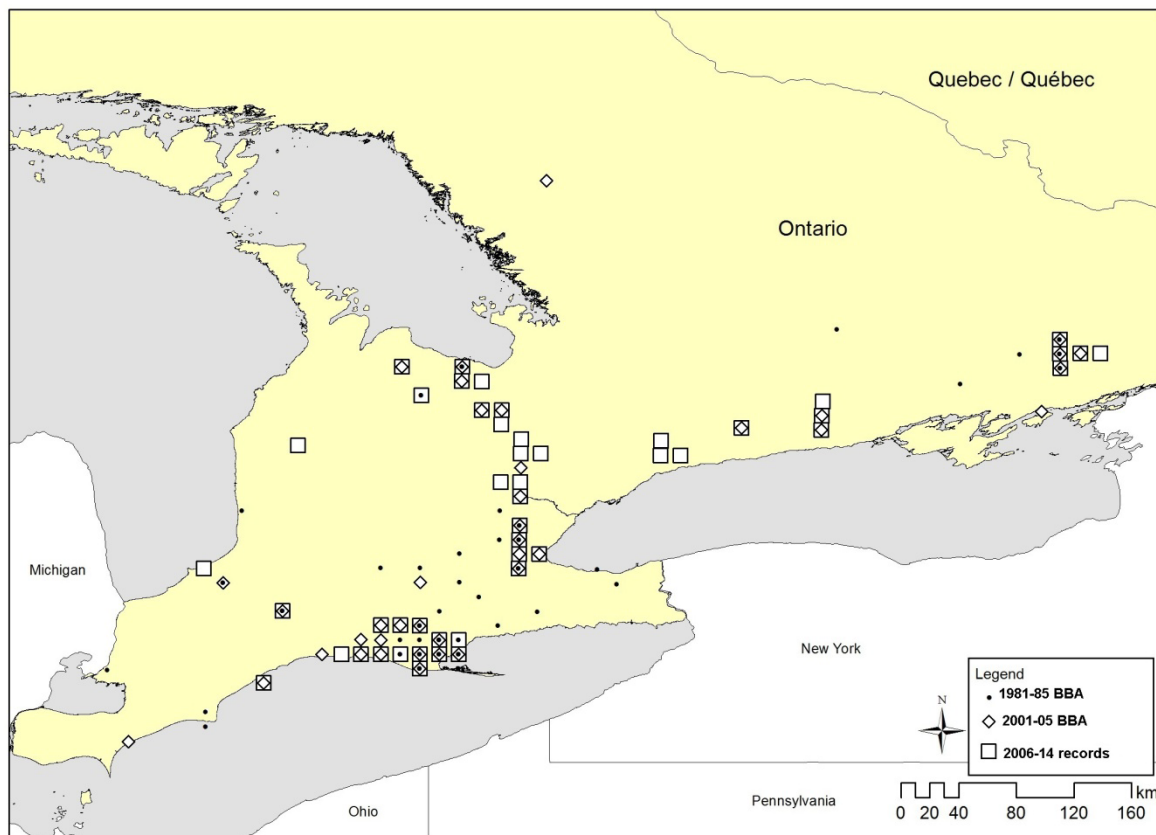


Figure 3. Breeding distribution of the Louisiana Waterthrush in Ontario in three time periods: 1981-1985 (Cadman *et al.* 1987), 2001-2005 (Cadman *et al.* 2007) and 2006-2014 (compiled records).

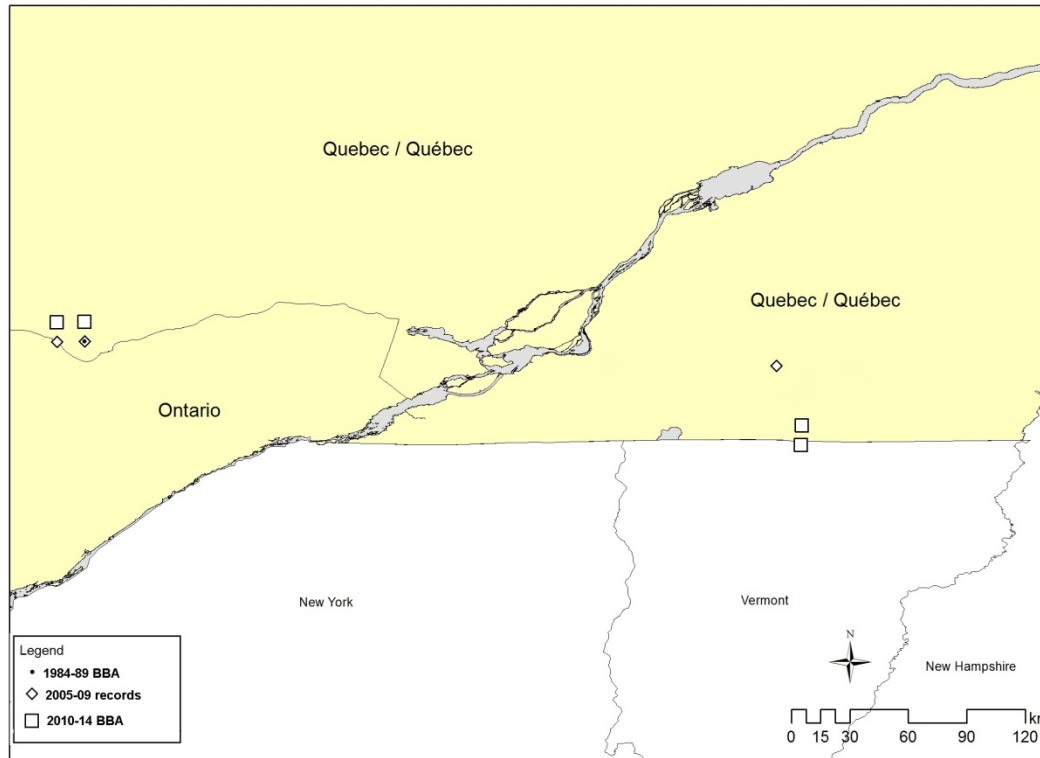


Figure 4. Breeding distribution of the Louisiana Waterthrush in Quebec in three time periods: 1984-1989 (Gauthier and Aubry 1996), 2005-2009 (compiled records; see Table 1 for details) and 2010-2014 (Québec Breeding Bird Atlas 2014).

In Canada, this species is highly localized, because it is associated with various physiographic features that provide the necessary combination of habitat and climatic conditions. The main concentration of Louisiana Waterthrush in Ontario is associated with the forested ravines and wetlands in the Norfolk Sand Plain (Norfolk, eastern Elgin, and southern Oxford counties). Other isolated breeding sites in southern Ontario are associated with various river systems (Ausable, Bayfield, Grand, Thames, and Maitland rivers), forested sites along the Great Lakes shoreline, and some inland forested wetlands. In south-central Ontario, this species breeds along relatively pristine headwater streams (and also some higher order streams with seepages and/or side streams) associated with the Niagara Escarpment, particularly in the central section of the escarpment from Hamilton to Collingwood. In southeastern Ontario, there is a small cluster of occurrences associated with small streams and wetlands near Frontenac Park in Ontario's Frontenac Arch physiographic region. This species has also been found sporadically at other scattered sites in southeastern Ontario, including the eastern Oak Ridges Moraine, the Rice Lake Plains and the fringe of the Southern Shield.

The only confirmed nesting records in Quebec are from a site on the Eardley Escarpment in Gatineau Park in the Outaouais region, an area where the species has been observed intermittently since at least 1974 (Savignac 2005, 2006, 2007, 2008). There are also several historical and recent breeding season reports from a cluster of sites in the Estrie region in southern Quebec, at the northern end of the Appalachian Mountain region (St-Hilaire and Dauphin 1996; Savignac 2005, 2008; Les Oiseaux du Québec 2014). During the 2010-2014 Québec Breeding Bird Atlas fieldwork (Figure 4), this species was reported from four 10 x 10 km squares, including two squares with probable breeding evidence in the Estrie region and two squares with possible breeding evidence in the Outaouais region (Québec BBA 2015).

A single singing male sighted in Welsford, New Brunswick was the only record in the first Maritimes Breeding Bird Atlas (1986-1990; Erskine 1992), and it likely represents a transient unpaired bird. This species was not recorded in the second Maritimes atlas (2006-2010; Maritimes BBA 2014).

The distribution of the Louisiana Waterthrush in Canada is governed by the availability of suitable habitat within climatic confines. In Ontario, it nests primarily in the extensively settled Carolinian ecoregion (Deciduous Forest region) and adjacent areas of the Great Lakes - St. Lawrence Forest region south of the Canadian Shield (McCracken 2007). The species' distribution in Ontario is consistent with regions above the 6°C mean yearly isotherm and elevations less than 300 m (McCracken 1991). In Quebec, this species may be restricted to areas with relatively mild microclimates, such as stream valleys on south-facing hillsides and escarpments in the extreme southwestern part of the province.

The extent of the known breeding range of this species in Canada has increased gradually over the past century (Page 1996). However, this apparent northward range expansion may be largely attributable to improved knowledge of a previously under-reported species and/or resettlement of its pre-European settlement historical range.

The cluster of occurrences on the north shore of Lake Erie has long been recognized (MacClement 1915). The species became established as a regular breeder at a handful of sites in Frontenac County near Kingston in southeastern Ontario during the 1980s (Weir 2008). Targeted surveys in 2012 and 2013 found that this species is more widespread along the Niagara Escarpment (Hamilton, Halton, Peel, Dufferin, Simcoe and Grey counties) than previously known (Friesen and Lebrun-Southcott 2012; Lebrun-Southcott and Friesen 2013). There are a few other isolated sites that are occupied somewhat regularly (e.g., some sites in Middlesex and Lambton counties), but most other scattered occurrences in Ontario and the few occurrences in southwestern Quebec appear to be sites with sporadic occupancy. Moreover, this species has not been reported recently in some parts of its former Ontario range (e.g., Essex, Chatham-Kent, Niagara; see also Population Trends section).

As indicated by changes in distribution for the three time periods shown in Figures 3 and 4, there has been a relatively high turnover in occupied sites in Ontario and Quebec. For example, of 40 squares (10 km x 10 km) with breeding evidence during the 1981-1985 Ontario BBA, only 15 (37.5%) were still occupied during the 2001-05 BBA (McCracken 2007). Since 2005, breeding evidence has been reported for 15 additional squares, where no breeding evidence was found during either Ontario BBA. In Quebec, this species has not been reported since 2007 at the only confirmed breeding site in the province, but probable nesting evidence was reported at other sites (Savignac 2008; Québec BBA 2015).

Non-breeding

Being at the northern limits of its range in Canada, the Louisiana Waterthrush is rare on migration. At migration hotspots such as Point Pelee and Long Point, it is considered a regular but uncommon spring migrant, and is rarely reported in fall (McCracken 1991; Parks Canada Agency 2012; Long Point Bird Observatory 2014).

It is considered a “rare vagrant” in Nova Scotia (Tufts 1986), where 12 of 16 records since 1966 are from the fall period (McLaren 2012). This reflects a well-established pattern of southwest to northeast fall vagrancy for migrant passerine species in the province (McLaren 1981).

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO) in Canada, as measured by a minimum convex polygon encompassing all occurrences with breeding evidence over the 2001-2014 period (as depicted in Figures 3 and 4) is about 110,000 km². The EOO is about 20% smaller if outlying occurrences with only possible breeding evidence are excluded, or if only records for the past 10 years (2005-2014) are considered.

The index of area of occupancy (IAO) in Canada based on a 2 x 2 km grid and using all breeding occurrences for the 2005-2014 period is 356 km². Given that new sites continue to be found, the actual IAO could approach 500 km². However, not all sites are occupied every year, so this would clearly represent an upper limit.

Search Effort

Understanding of the breeding distribution of this species in Canada has improved greatly as a result of breeding bird atlas projects in Ontario during 1981-1985 and 2001-2005 (Eagles 1987; McCracken 2007) and in Quebec during 1984-89 and 2010-2014 (St-Hilaire and Dauphin 1996; Québec BBA 2015), as well as the accumulation of breeding season observations detected during regional and local ecological surveys and bird checklist programs. Systematic targeted searches of known and potential Louisiana Waterthrush habitat have also been conducted in most parts of the Canadian range over the past decade. See Table 1 and Sampling Effort and Methods section for additional details.

Table 1. Survey effort, survey results and other sources of information on the recent distribution and abundance of the Louisiana Waterthrush in Canada, 2005-2014.

Project	Protocol	Project Area	Years	Results	Reference
Ontario Breeding Bird Atlas	General surveys of breeding birds in 10 km x 10 km squares	Ontario	2005	21 records from 11 atlas squares (2005 only).	Cadman <i>et al.</i> 2007
Environment Canada Quebec Region: Louisiana Waterthrush surveys	Targeted surveys of known sites and suitable Louisiana Waterthrush habitat	Southwestern Quebec: Outaouais Region and Gatineau Park	2005	1 single male at 1 of 18 sites	Savignac 2005
			2006	1 pair and 1 single male at 2 of 21 sites (including first confirmed breeding for Quebec)	Savignac 2006
			2007	1 pair at 1 of 6 sites	Savignac 2007
		Southwestern Quebec: Outaouais, Montérégie, Estrie Regions	2008	No birds at 20 sites	Savignac 2008
Frontenac Bird Studies: Louisiana Waterthrush surveys	Targeted surveys	Southeastern Ontario: Frontenac Park study area (Frontenac County, Ontario)	2010	1 pair, 4 single males at 5 of 17 sites	D. Derbyshire, pers. comm. 2014
			2011	2 pairs, 2 single males at 4 of 28 sites	
			2012	1 pairs , 2 single males at 3 of 14 sites	
Bird Studies Canada: Forest Birds at Risk surveys	Targeted surveys	Southwestern Ontario: Norfolk Sand Plain (Norfolk Co. and Elgin Co.)	2011	7 pairs, 6 single males, 7 nests at 11 of 31 sites	Allair <i>et al.</i> 2013
			2012	17 pairs, 7 single males, 8 nests at 17 of 67 sites	
		Southwestern Ontario: Carolinian ecoregion	2013	11 pairs, 6 single males, 8 nests at 13 of 54 sites	Allair <i>et al.</i> 2014
			2014	13 pairs, 4 single males, 12 nests at 12 of 59 sites.	
Environment Canada: Louisiana Waterthrush surveys	Targeted surveys.	South-central Ontario: Niagara Escarpment	2012	31 males, 8 females at 13 of 134 sites	Friesen and Lebrun-Southcott 2012
		South-central Ontario: Niagara Escarpment,	2013	34 males, 5 or 6 females at 13 of 94 sites	Lebrun-Southcott and Friesen 2013
		South-central Ontario: Oak Ridges Moraine	2014	4 males at 4 of 29 sites	Campomizzi <i>et al.</i> 2014
Québec Breeding Bird Atlas, 2 nd	General surveys of breeding birds in 10 km x 10 km squares	Quebec	2010-2014	5 records from 4 atlas squares	QBBA 2015
Ebird Canada	Casual birding observations	Ontario and Quebec	2005-2013	414 records (mostly migrants, includes duplicate records)	Bird Studies Canada and Cornell Lab of Ornithology 2014
Les Oiseaux du Québec	Summary of rare bird reports	Quebec	2005-2014	7 records published in QuébecOiseaux	Les Oiseaux du Québec 2014

HABITAT

Habitat Requirements

Breeding Habitat

The Louisiana Waterthrush nests amongst the roots of fallen trees, in niches of steep stream banks, and in and under mossy logs and stumps (Prosser and Brooks 1998; Mattsson *et al.* 2009; Ontario Nest Record Scheme [ONRS] 2014). Nests are generally well concealed by roots and hanging vegetation and are usually situated within a few metres of water (Mattsson *et al.* 2009; ONRS 2014). Mean canopy cover above 60 nests in Pennsylvania was 75% (Mattsson *et al.* 2009).

Of 40 nests found across several sites in Ontario in 2010-2014, 28 (79%) were found in ravines (Bird Studies Canada [BSC] 2014b). All of the ravine nests were situated in the stream bank, except for 2 in root tip-ups. Of 12 nests found in swamps, 9 were in root tip-ups and 3 in stumps. Almost all were located over water in mixed forests.

The Louisiana Waterthrush occupies specialized habitat, showing a strong preference for nesting along relatively pristine, headwater streams and associated wetlands situated in large tracts of mature forest (Mattsson *et al.* 2009). Breeding sites in the U.S. are typically along medium- to high-gradient, first- to third-order, perennial streams with gravel-bottoms in hilly areas (Mattsson *et al.* 2009). While the Louisiana Waterthrush favours running water, less frequently it inhabits heavily wooded swamps with vernal or semi-permanent pools, where its territories can overlap with Northern Waterthrush (Craig 1984, 1985). Habitat suitability models for parts of the U.S. range found that headwater streams with well-developed pools and riffles situated in large (>350 ha), late successional, deciduous or mixed forests with closed canopies and open understories in areas with high forest cover (>70%) are highly suitable habitat for this species (Prosser and Brooks 1998; Tirpak *et al.* 2009). Shrubby habitats near the nesting site may be important for young and adults during the post-breeding period (Vitz and Rodewald 2006, 2007).

Forests at occupied sites in Ontario and at Gatineau Park, Quebec are generally late-successional mixed or deciduous forest, typically with maple (*Acer* sp.) and Eastern Hemlock (*Tsuga canadensis*) components (unpubl. data from targeted surveys, see references in Table 1). Riparian territories in Ontario are typically associated with steep-walled forested ravines in sand plain areas, or rocky streams in incised valleys (Friesen and Lebrun-Southcott 2012; Lebrun-Southcott and Campomizzi 2014; J. Allair, pers. comm. 2014; J. Holdsworth, pers. comm. 2014).

Robbins (1979) regarded the Louisiana Waterthrush as an “area-sensitive” species — one that requires large tracts of unbroken forest. Based upon studies in Maryland, he estimated that the minimum contiguous forest cover required to sustain a viable breeding population of Louisiana Waterthrushes was about 100 ha, although this species also regularly occurs in smaller forest patches (~25 ha) in some parts of its U.S. range (Sandilands 2014). Freemark and Collins (1992) also listed the Louisiana Waterthrush as an area-sensitive species, but did not suggest a minimum forest size, noting that area requirements are very much influenced by the regional pattern of forest cover. Although the area-sensitive classification of this species has not been rigorously tested (Parker *et al.* 2005), there is evidence that the species is sensitive to forest fragmentation (Prosser and Brooks 1998; Tirpak *et al.* 2009).

In its U.S. range, this species is generally encountered infrequently in streams having very narrow (<100 m) forest corridors (Keller *et al.* 1993; Mason *et al.* 2007). However, occupancy of riparian strips is also influenced by land cover and land use in the surrounding landscape matrix (Triquet *et al.* 1990; Peak and Thompson 2006; Rodewald and Bakerman 2006).

An analysis of land cover within 200 m at 110 sites along the Niagara Escarpment where Louisiana Waterthrush had been detected from 1981 to 2013 was recently completed (Lebrun-Southcott and Campomizzi 2014). This study found nearly total mixed and/or deciduous forest cover within 200 m of the majority of detection locations. Most (85%) detection points also had >50 ha of total forest cover within the 100 ha buffer. However, many detection points (45%) had between 20 and 60 ha of agricultural land cover within the 100 ha buffer, suggesting that in some parts of its Ontario range this species may not be as area-sensitive as previously reported (Lebrun-Southcott and Campomizzi 2014).

Migration Habitat

During migration, the Louisiana Waterthrush occurs in habitats similar to those in the breeding range and in a variety of non-typical habitats where flowing or standing water and sufficient canopy cover is available (Curson *et al.* 1994; Dunn and Garrett 1997; Mattsson *et al.* 2009).

Wintering Habitat

In winter, it is found in tropical evergreen forests and favours riparian woodland in hilly and montane areas (Mattsson *et al.* 2009; Berlanga *et al.* 2010). It is less common along streams in lowland areas and mangrove forests, which are favoured by Northern Waterthrushes (Mattsson *et al.* 2009). In Costa Rica, radio-tagged birds foraged mostly along streams, but also exploited food-rich ground substrates in off-stream habitats, including residential areas and wet pastures (Master *et al.* 2005; Hallworth *et al.* 2011).

Habitat Trends

Breeding Habitat

Many of southwestern Ontario's historical wetland forests have disappeared, have been heavily fragmented, and/or have been drained for agricultural or development purposes (Snell 1987; Page 1996; Larson *et al.* 1999; Crins *et al.* 2007; Environment Canada 2014b). There are few, large intact blocks of deciduous swamp forest remaining in this region. Loss of Louisiana Waterthrush nesting habitat within forested ravines has occurred as well, but not to the same extent. Nonetheless, the quality of primary nesting habitat in forested ravines has undoubtedly declined appreciably in some regions owing to forest fragmentation, logging, stream pollution, and siltation. In contrast, the amount and quality of forested stream habitat in parts of southeastern Ontario, and along some sections of the Niagara Escarpment in south-central Ontario, have likely improved over the past century due to the replanting and regeneration of forests in protected areas and on marginal farmlands (Crins *et al.* 2007).

Forests and wetlands in much of southwestern Quebec have also been negatively impacted by agriculture, urbanization and forestry (Jobin *et al.* 2010). However, the Louisiana Waterthrush occurrences in this province are in areas with a relatively high proportion of forest cover (Environment Canada 2013a, b). Other than in areas affected by urban sprawl, there was little change in the extent of forest and wetland cover in southwestern Quebec between 1993 and 2001 (Jobin *et al.* 2010).

Despite significant historical and ongoing losses in the extent of Louisiana Waterthrush habitat in southern Ontario, there are areas of suitable habitat that are either not occupied or are occupied intermittently (COSEWIC 2006; J. Allair, pers. comm. 2014; Friesen and Lebrun-Southcott 2012; D. Derbyshire, pers. comm. 2014). There are also areas of apparently suitable habitat in southwestern Quebec that are not occupied (Savignac 2008). Failure to occupy all available habitat in Canada is likely because this is the northern periphery of the species' range, and the population here is small and patchy.

Non-breeding Habitat

No specific recent information on habitat trends on migration stopover or wintering grounds is available. A recent threat assessment determined that this species faces elevated threats during the non-breeding period, due to deforestation and development pressures adversely affecting riparian forest habitat (PIFSC 2012). Since 2000, rates of deforestation in Central America and the Caribbean have slowed, and in some countries and regions reversed (Redo *et al.* 2012; Aide *et al.* 2013). However, degraded water quality is still a significant issue in some parts of the wintering range, including the Dominican Republic (Latta 2011) and Puerto Rico (Hallworth *et al.* 2011).

BIOLOGY

Life Cycle and Reproduction

Male Louisiana Waterthrushes sing profusely when they arrive on their breeding territories in April and early May. (Eaton 1958; Bent 1963; Mattsson *et al.* 2009; Bickerton and Walters 2011). Males aggressively defend their territories against conspecifics (Craig 1984; Mattsson *et al.* 2009). Along stream courses, territories are essentially linear (Mattsson *et al.* 2009). There is considerable local and regional variation in the length of riparian territories reported (range 90 to 1440 m), but most territories are in the 300 to 600 m range (Mattsson *et al.* 2009, 2011). Variation in territory size may reflect variable mating systems (polygynous males have large territories) and/or food availability (Mulvihill *et al.* 2002; Mulvihill *et al.* 2008; Mattsson and Cooper 2009). The average size of territories in Canada is not known, but the previous estimate of 2 ha (COSEWIC 2006) is likely reasonable (e.g., average territory length of 400 m and width of 50 m along streams, and 140 m diameter circle in forest swamps).

Mating is generally monogamous, but up to 2% of males may have two females (Mulvihill *et al.* 2002; Mattsson and Cooper 2009). Pairing success is generally high (e.g., in Pennsylvania 84% of males (n=55) on acidified streams and 92% (n=152) of males on circum-neutral streams (pH near 7) were paired; Mulvihill *et al.* 2008). Many territorial males in Canada, however, appear to be unpaired (Savignac 2006; J. Allair, pers. comm. 2014; D. Derbyshire, pers. comm. 2014). Pairing rates reported during intensive targeted surveys in Canada range from 36% in Frontenac Park, Ontario (Frontenac Bird Studies 2014) to 70% in the Norfolk Sand Plain (BSC 2014b) (see Table 1). As females can be secretive, reported pairing rates may underestimate the actual proportion of territorial males that represent breeding pairs. Given the available information, pairing success in Canada is likely between 66% and 75%.

Egg dates in Ontario range from 1 May - 8 July, including re-nesting attempts after failed nests (Peck and James 1998; ONRS 2014). Depending on latitude, the nesting period may start anywhere between late April in southwestern Ontario to early May in the northern part of the breeding range and may end anywhere between mid-June to early July (Rousseau and Drolet 2015). Incubation extends from 12-14 days. Both parents assist with feeding the young, which remain in the nest for about 10 days (Bent 1963; Mattsson *et al.* 2009). Parents attend to fledglings for up to 4 weeks (Mattsson *et al.* 2009).

Clutch size ranges from 4-6 eggs (Bent 1963; ONRS 2014). The Louisiana Waterthrush is generally single-brooded, but second broods have been documented in the U.S. (Mattsson and Cooper 2007; Mulvihill *et al.* 2009). Second (and even third) re-nestings are common if the first nest is destroyed early in the season (Mattsson *et al.* 2009).

Nests of the Louisiana Waterthrush are sometimes parasitized by Brown-headed Cowbirds (*Molothrus ater*). Parasitism rates are highly variable across the breeding range, but are generally higher in the U.S. midwest (e.g., 33% to 81% at two sites in Illinois, $n=15$ and $n=11$, respectively; Mattson *et al.* 2009) and low in the U.S. northeast (e.g., 4% in Pennsylvania, $n=222$, O'Connell *et al.* 2003), and southeast (0% in Georgia, $n=190$; Mattsson and Cooper 2009). In southern Ontario, a relatively high proportion of nests contain one or more cowbird eggs (e.g., 22.8% of nests with eggs reported to ONRS 2014). While Louisiana Waterthrushes can successfully fledge a brood containing cowbird and waterthrush young, the reduction in the number of host young fledged may approach 50% (Mattsson *et al.* 2009).

Mean daily nest survival is relatively high (0.97 in Georgia and Pennsylvania; Mattsson *et al.* 2011). Depredation was the main source of nest failure in U.S. studies (Mattsson and Cooper 2009; Mulvihill *et al.* 2009). Comparable productivity statistics are not available for the Canadian population, but nest monitoring in Norfolk and Elgin counties found that 63% of nests with known outcomes ($n=38$) fledged at least one Louisiana Waterthrush young (BSC 2014b). This is similar to nest success rates reported in U.S. studies (e.g., 59% of 190 nests in Georgia, Mattsson and Cooper 2009; 52% of 231 nests in Pennsylvania; Mulvihill *et al.* 2009).

Mean fecundity (number of young that reach fledgling age per female) in Georgia was 2.89 ± 1.86 , $n=130$ (Mattsson and Cooper 2007), and 3.4 ± 0.2 , $n=175$ in Pennsylvania (Mulvihill *et al.* 2008). In the latter study, there was no change in nest success or annual fecundity of nests on acidified streams compared to circum-neutral streams despite smaller clutch sizes. However, the number of young produced was much lower on acidified streams due to larger territories resulting in lower nesting densities (Mulvihill *et al.* 2008). An analysis using a stochastic individual-based model and data from 418 nests in Georgia and Pennsylvania predicted that about half of all females should fledge at least 1 young (Mattsson *et al.* 2011).

Louisiana Waterthrushes mature in one year and, like most small birds, generally have a short life span. The longevity record is 11 years, 11 months (Mattsson *et al.* 2009; Lutmerding and Love 2014). The average age of breeding adults in the population is likely 2-3 years.

Mean apparent annual survival rates range from 0.53 (SE=0.05, n=379) in the southeast U.S., to 0.46 (SE=0.11, n=86) in south-central U.S., and 0.47 (SE=0.06, n=222) in the northeast U.S. (Michel *et al.* 2011). The proportion of females banded as adults re-sighted the following year later ranged from 26% in Georgia (n=58), to 47% and 55% in two Pennsylvania studies; whereas the proportion of males ranged from 34% in Georgia, to 50% and 39% in the Pennsylvania studies (see Mattsson *et al.* 2009). In Pennsylvania, birds nesting on acidified streams were less likely to return and the proportion of inexperienced first-time breeding birds was higher there than on circum-neutral streams (Mulvihill *et al.* 2008). Relatively few birds (5% to 10%) continue to return for 2 or more years after banding. In a 4-year study in southwestern Ontario, 43% of colour-banded adult females (n=14) and 29% of males (n=14) were re-sighted the following year (Allair *et al.* 2014). Based on this small sample, return rates (apparent survival rates) in southwestern Ontario appear to be similar to those reported in the U.S.

For young birds, fidelity to natal areas is low. In two U.S. studies, very few (0 of 49 in Tennessee and 1 of 240 in Pennsylvania, Mattson *et al.* 2009) colour-marked nestlings were re-sighted in subsequent years. Five of 73 birds banded as nestlings at sites in the Norfolk County area of southwestern Ontario between 2011 and 2014 were re-sighted the following year, up to 12 km (average 8 km) from their natal site (S. Dobney pers. comm. 2015).

Physiology and Adaptability

The Louisiana Waterthrush spends most of its time on or near the ground, along the margins of streams and pools, and even wading in shallow water (Bent 1963; Mattsson *et al.* 2009). Although able to tolerate moderate levels of direct human disturbance, the Louisiana Waterthrush is particularly susceptible to habitat perturbations, including deforestation, loss of canopy cover, fluctuating water levels, water pollution, and siltation (Mattsson *et al.* 2009).

Dispersal and Migration

The Louisiana Waterthrush is a long-distance migrant that arrives in southern Ontario much earlier than most other wood-warblers. Usual dates in the province range from late April to early September (James 1991). By mid-August, most birds from Canada have migrated south (Curson *et al.* 1994).

No important areas of concentration of migrant Louisiana Waterthrushes are known, and the species is believed to migrate solitarily or in small numbers across a broad front (Dunn and Garrett 1997; Curson *et al.* 2004; Mattsson *et al.* 2009). During spring migration, the species occurs fairly regularly in small numbers along the north shore of Lake Erie (e.g., Long Point, Point Pelee, Rondeau).

Fledged young remain along natal streams for about a month, then wander progressively farther (up to 5 km) away, unattended by parents (Eaton 1958). There is some evidence that young and adults move into dense shrubby areas in the post-fledging period, which is when adult birds undergo a complete moult (Vitz and Rodewald 2006, 2007; Mulvihill *et al.* 2009).

Annual fidelity to breeding areas has been recognized (see Life Cycle and Reproduction above, and Mattsson *et al.* 2009). In Pennsylvania, Mulvihill *et al.* (2002) reported that up to 50% of females reoccupied territories from the previous year, “not infrequently with the same mate.” Site fidelity and fidelity to previous mates have also been observed in Ontario (Allair *et al.* 2014). Site-tenacity has also been documented in the wintering grounds (Mattsson *et al.* 2009). Wintering birds appear to actively defend feeding territories ranging from 0.3 ha to 11 ha (Mattsson *et al.* 2009).

Diet and Foraging Behaviour

The Louisiana Waterthrush feeds mostly on aquatic macro-invertebrates, including mature and immature insects. It also sometimes eats small molluscs, fish, crustaceans, and amphibians (Eaton 1958; Bent 1963; Mattsson *et al.* 2009). The diet is quite atypical of other songbirds.

Aquatic foraging is commonplace, particularly early in the breeding season. Submerged and floating organisms are eaten (Eaton 1958; Craig 1984). The following types of aquatic organisms have been reported in the summer diet: Trichoptera, Ephemeroptera nymphs, and Diptera larvae (especially chironomids), Culicidae, Dytiscidae, isopods, and gastropods (Eaton 1958; Craig 1984; Mattsson *et al.* 2009). Terrestrial organisms included centipedes, caterpillars, adult mosquitoes, earthworms, spiders, and various emerging aquatic insects.

Important aquatic prey includes taxa that are sensitive to changes in water quality, particularly Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). The Louisiana Waterthrush’s occupancy of headwater streams is positively associated with the proportion of these taxa in the macrobenthic biomass (Stucker 2000; Mattsson and Cooper 2006; Mulvihill *et al.* 2008).

Although the two species of waterthrush have similar diets and foraging ecologies (Craig 1984, 1985), the Louisiana Waterthrush typically selects larger prey items than the Northern Waterthrush and has a greater preference for Trichoptera larvae (Craig 1987). Its selection of larger prey may be related to its larger bill size (Craig 1987).

Interspecific Interactions

Where sympatric, Louisiana Waterthrushes do not appear to interact much with Northern Waterthrushes, even when occupying the same breeding habitats and sharing overlapping territories (Craig 1984, 1985; Mattsson *et al.* 2009). This lack of interspecific aggression may stem from differences in diet (Craig 1987).

Adults are preyed upon by small raptors, while nest contents are preyed upon by a variety of snakes, small mammals, and jays (Mattsson *et al.* 2009).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Specialized search effort is required for this species because of its early breeding season and its specialized breeding habitat, which is often hard to access (Mattsson *et al.* 2009; Bickerton and Walters 2011; Mordecai *et al.* 2011; Environment Canada 2012). In addition, Louisiana Waterthrushes have relatively large and/or linear breeding territories that contribute to low detectability during point count surveys (Buskirk and MacDonald 1995; Bickerton and Walters 2011; Reidy *et al.* 2011). Detectability is improved if surveys are conducted between late April and the first three weeks of May (Bickerton and Walters 2011; Friesen and Lebrun-Southcott 2012; L. Friesen, pers. comm. 2015a), if survey points are located along stream corridors (Mattson and Marshall 2009), and especially if conspecific playback of songs is used (Stucker 2000; Bickerton and Walters 2011). Linear territories in riparian areas can exceed 1 km, so individuals can be detected at multiple survey stations, which can lead to overestimates of population size (Mordecai *et al.* 2011).

Due to its rarity and localized distribution, standard, broad-scale bird monitoring programs like the Breeding Bird Survey do not detect sufficient numbers of birds to provide robust abundance estimates or trends for the Canadian Louisiana Waterthrush population (Environment Canada 2012). It is only in the past decade that systematic searches targeting this species have been conducted across most of its Canadian range.

Breeding Bird Survey (BBS)

The Breeding Bird Survey (BBS) is a volunteer survey designed to monitor trends in North American breeding bird populations (Environment Canada 2014c; Sauer *et al.* 2014). BBS routes consist of 50 roadside points along randomly selected, stratified routes throughout North America. Each point is surveyed (3-minute point count) once annually during the breeding season. BBS data are analyzed using a hierarchical Bayesian model (Sauer and Link 2011). While this species is not well-sampled by this roadside-based survey and the timing of BBS surveys is later than its main calling period, the BBS is still the best source of information on continental population trends (Mattsson *et al.* 2009; PIFSC 2013; Sauer *et al.* 2014). However, it is not an effective method for monitoring Canadian trends because of small sample sizes here.

Breeding Bird Atlases

The two Ontario Breeding Bird Atlases provide comparable information on changes in bird distribution in the province between 1981-1985 and 2001-2005 (Cadman *et al.* 1987, 2007). Atlas data were gathered based on searches for all bird species within 10 km x 10 km squares for at least 20 hours over each of the two atlas periods. Although effort was comparable between the two atlases, better information on known and suitable habitat for this species was available to surveyors during the second atlas. Similarly, the two Quebec Breeding Bird Atlases reflect changes in bird distribution in that province between 1984-1989 and 2010-2014 (Gauthier and Aubry 1996; Québec BBA 2015).

Targeted Surveys

From 2005-2014, there have been several targeted surveys for Louisiana Waterthrushes in Ontario and Quebec (see Table 1). These systematic surveys largely focused on sites where the species had been previously reported, but additional sites with suitable habitat were also searched. Surveys were conducted following a species-specific survey protocol (similar to Bickerton and Walters 2011). To maximize detectability, surveys were generally conducted early in the breeding season and made use of conspecific audio-playbacks to elicit responses. The intensity of these targeted surveys varied considerably, with many sites being visited only once, while others received multiple visits in multiple years. Bird Studies Canada also carried out nest monitoring and colour banding of adults and young in Norfolk County, Ontario between 2011 and 2014.

Migration Counts

Standardized migration count data are collected annually at more than 20 Canadian Migration Monitoring Network (CMMN) stations across Canada (Bird Studies Canada 2014), but only Long Point Bird Observatory has recorded this species in sufficient numbers for population trend analysis. Analysis of spring migration data for Louisiana Waterthrushes at Long Point for 1961-2012 was provided by T. Crewe (pers. comm., 2014), using a generalized additive model with Poisson distribution.

Other Information Sources

Breeding occurrences of this species are tracked by provincial conservation data centres in Ontario and Quebec. The Ontario database includes information on 62 sites (element occurrences), whereas the Quebec database includes 4. Additional occurrence information is available in the eBird Canada program, and the Étude des population d'oiseaux du Québec (ÉPOQ database).

Abundance

The global Louisiana Waterthrush population is currently estimated to be 360,000 mature individuals (180,000 pairs) based on BBS data from 1998-2007 (PIFSC 2013). Its population is small relative to most other wood-warbler species (e.g., the Northern Waterthrush population is estimated at 19 million individuals). The bulk of its population is within the eastern United States, particularly in the Appalachian Mountain region (46%, Mattsson *et al.* 2009; PIFSC 2013). The PIF database provides an estimate of 140 individuals for Canada, but this estimate is flagged as being of very poor quality (Blancher *et al.* 2007b, 2013; PIFSC 2013). Nevertheless, the Canadian population clearly represents <1% of the total population.

As in past status reports, a Canadian population estimate was developed for each municipality (Table 2). This approach provides flexibility in accounting for considerable regional variation in search effort and habitat availability. The estimates are based on the number of known occurrences with breeding evidence between 2005 and 2014. This 10-year period includes targeted surveys, the final year of fieldwork during the second Ontario BBA, and fieldwork for the second Québec BBA (see Table 1). Occurrences were defined by assigning records to 1 km x 1 km grid squares. Available information was used to determine the maximum number of territories reported for each 1 km x 1 km site in any single year.

Table 2. Estimated size of Louisiana Waterthrush breeding population in various regions of Ontario and Quebec.

Region	County/ Regional Municipality	Estimated No. Pairs 2005 ¹		Known Territories (Max/year) 2005–2014 ²	Estimated No. Territories 2014 ³	
		Min.	Max.		Min.	Max
Southwestern Ontario	Essex, Chatham-Kent	1	3	0	0	2
	Lambton	5	8	1	2	5
	Middlesex	5	11	1	2	5
	Huron, Perth, Bruce	0	1	1	0	2
	Elgin	30	45	14 (10)	30	60
	Norfolk	45	75	35 (14)	30	60
	Oxford	6	13	1	2	5
	Haldimand	0	1	-	0	2
	Brant	0	4	0	0	2
	Waterloo	1	4	0	0	2
	Wellington	-	-	-	-	-
Sub-total		93	165	53	66	145
South-central Ontario	Niagara	0	3	0	0	2
	Hamilton	2	3	4 (2)	2	5
	Halton	1	4	20 (13)	20	50
	Peel			5 (3)	5	12
	Dufferin			7 (4)	6	15
	Simcoe	1	4	8	10	25
	Grey	2	4	10 (6)	10	25
Sub-total		6	18	54	53	134

Region	County/ Regional Municipality	Estimated No. Pairs 2005 ¹		Known Territories (Max/year) 2005–2014 ²	Estimated No. Territories 2014 ³	
		Min.	Max.		Min.	Max
Southeastern Ontario	Durham	-	-	3 (2)	2	5
	Northumberland	0	1	2	0	2
	Peterborough	1	2	1	0	2
	Hastings	0	1	0	0	2
	Lennox & Addington	-	-	0	0	2
	Frontenac	5	8	12 (5)	8	15
	Leeds & Grenville	-	-	1	0	2
	Sub-total	6	12	19	10	30
Central Ontario	Southern Shield	-	-	0	5	10
Southwestern Quebec	Estrie	-	-	0	0	1
	Montérégie	-	-	3 (2)	0	3
	Outaouais	-	-	4 (2)	0	3
	Sub-total	-	-	7	0	7
CANADA	TOTAL	105	195	133	134	326

¹ COSEWIC 2006 estimates for Ontario based largely on information provided by regional coordinators of the second Ontario Breeding Bird Atlas and assuming an average annual site occupancy rate of about 75%.

² **Known territories 2005-2014:** sum of the maximum number of males reported in any year at each site (1 km²) where breeding evidence was reported at least once during past 10 years; **(Max/year):** is the maximum count of males in that region in any one year in the past 10 years.

³ **Estimated No. Territories 2014:** estimated number of territorial males per region based on occurrence information for past decade, amount of habitat, and input from individuals with local knowledge.

In total, 126 Louisiana Waterthrushes at 99 sites in 49 10 x 10 km squares were reported in Ontario over the 2005-2014 period (Table 2). In Quebec, 7 Louisiana Waterthrushes at 7 sites in 7 atlas squares were reported.

As noted in the previous status report (COSEWIC 2006), most Louisiana Waterthrush sites in Canada are occupied intermittently. Sites may be occupied for several successive years before being abandoned, presumably due to the death of one or both members of the pair, or changes in habitat suitability (COSEWIC 2006). In developing the regional population estimates, the distribution and intensity of the recent survey effort relative to the amount of potential habitat in each region was also taken into consideration. A high proportion of the historical sites have been surveyed at least once in the past 10 years, but targeted surveys did not include all historical sites on private lands, or regions with few occurrences. The targeted surveys also included many areas with apparently suitable habitat, which resulted in the discovery of many “new” sites for this species.

Two other factors considered were the proportion of the “known” sites with possible breeding evidence that constituted *bona fide* breeding territories (versus non-breeding, transient males), and the detectability of the species. About 21% (22 of 106) of the “known” sites are based on very limited breeding evidence, which was typically a singing male observed in suitable habitat on one occasion over the past 10 years. Several of these possible breeding records could represent transient males. As it is also likely that some birds were also missed during single-visit surveys at other sites, the net effect of these two factors on the population estimate was considered negligible.

As in previous status reports, regional population estimates were reviewed by individuals with local knowledge (see Acknowledgements). Unlike the previous population estimates, the estimates in Table 2 refer to the number of territories (males), rather than the number of breeding pairs. Recent intensive fieldwork indicates that many males do not appear to be paired (see Biology section). The overall Louisiana Waterthrush pairing rate in Canada is likely less than 75% (see Biology section). Therefore, the estimate of 134 to 326 territorial males in Canada (Table 2) likely represents a reproductive population of no more than 100 to 245 pairs. If the actual pairing rate is closer to 66%, then the reproductive population would be somewhat less (88 to 215 pairs, or 176 to 430 mature individuals). Taking all factors into consideration, it is estimated that there are 235 to 575 adults in the Canadian population. This would consist of 134-329 males and 101-246 females.

The number of squares with breeding evidence reported during the Ontario and Québec Breeding Bird Atlas projects provides a reasonably consistent, albeit indirect, measure of abundance. A previous population estimate based on the first Ontario Atlas in 1981-85 was 50-100 pairs based on 40 occupied squares (Eagles 1987), and 105 to 195 pairs based on the occupancy of 39 atlas squares (McCracken 2007). These previous estimates suggest the average number of pairs per reported square is somewhere between 1.25 and 5. Over the past 10 years, breeding evidence has been reported in a total of 56 squares in Canada (49 in Ontario, 7 in Quebec), which provides an alternative population estimate of 70 to 280 pairs (140 to 560 birds), which is fairly consistent with the estimate provided above.

Fluctuations and Trends

Documenting population change for the Louisiana Waterthrush in Canada is difficult because it is not monitored well by any survey program. As noted previously, ascertaining the presence/absence of this species requires specialized search effort. Moreover, intermittent site occupancy is common. While patterns of local extirpations and persistence are apparent in some regions, population increases are more difficult to assess, particularly in regions with little baseline information.

U.S. Population Trends

The continental population is sampled by many BBS routes (n=941) across the U.S., but abundance is low and the roadside survey design does not sample all breeding habitat (Sauer *et al.* 2014). The range-wide BBS data suggest that the continental population has been increasing modestly over both the long term (1966-2013: 0.55% per year; 95% credible intervals (CIs): 0.07, 1.01), and the past 10 years (2003-2013: 1.80% per year; 95% CIs: 0.75, 2.87; Sauer *et al.* 2014).

BBS population trends for U.S. states bordering Canada are not statistically significant. While Breeding Bird Atlas data show declines in distribution in New York (Rosenberg 2008) and Michigan (Hull 2011), modest increases were reported in Ohio (Ohio BBA II 2014), Pennsylvania (Pennsylvania BBA 2014), and Vermont (Vermont BBA 2014a, b). These atlas results have not been adjusted for increased effort and coverage.

Historical Changes in Canada

This species has long been recognized as a rare breeder in Ontario (Baillie and Harrington 1937). It is generally assumed that historically this species was more widespread and numerous prior to European settlement, and then declined as forests and wetlands were cleared (McCracken 1991).

The first Ontario BBA (1981-1985) fieldwork provided the first comprehensive assessment of this species in Canada, resulting in a population estimate of 50-100 pairs (Eagles 1987). Higher estimates of 150 to over 300 pairs made in the 1990s were influenced by new information that suggested that as many as 100 pairs could be breeding in Norfolk and Elgin counties (McCracken 1991; Page 1996). However, these higher estimates did not consider intermittent site occupancy and incomplete saturation of available habitat (COSEWIC 2006).

During the second Ontario BBA (2001-2005), this species was reported from 39 squares, and the population was estimated to be about 105-195 pairs (COSEWIC 2006; McCracken 2007). The two-fold difference between 1987 and 2007 BBA population estimates was attributed to the species being under-recorded during the first atlas, as the Ontario population was “believed to have remained essential[ly] stable over the last two decades” (McCracken 2007).

Recent Population Changes in Canada

As indicated in Table 2, current population estimates are higher in some regions and lower in others compared to the 2005 estimates. Due to these regional differences, population trends are reviewed separately for the four geographic regions within the Canadian range.

Southwestern Ontario

Southwestern Ontario is generally considered the stronghold for this species in Canada (McCracken 1991; Page 1996). Previous population estimates suggested that this region supported about 85% of the Canadian population (COSEWIC 2006). The current population estimate (Table 2) for southwestern Ontario of 50 to 109 pairs (66 to 145 males based on 75% pairing success) is slightly lower than the 2005 estimate of 93 to 165 pairs (COSEWIC 2006).

Within this region, the population is still concentrated in the Norfolk Sand Plain region (Norfolk, eastern Elgin, and southern Oxford counties). However, the current estimate of 47 to 94 breeding pairs (62 to 125 males, 75% pairing success rate) is about two-thirds of the 2005 estimate of 81 to 133 pairs. This region (particularly Norfolk County) was the focus of intensive surveys between 2010 and 2014 (Table 1). Louisiana Waterthrushes were detected at 41 different sites (including 7 sites with multiple males) in these three counties. The maximum numbers of birds detected in any given year was: 11 pairs and 3 single males in Norfolk in 2012; 6 pairs and 4 single males in Elgin in 2012, and a single male in Oxford in 2005.

Migration count data collected during spring migration at Long Point Bird Observatory from 1961 through 2012 shows increased numbers in the 1980s and 1990s (Figure 5). However, migration counts since 2000 have returned to the low levels experienced earlier (Figure 5).

Previous population estimates for Norfolk and Elgin counties were strongly influenced by the large number of birds reported during local, intensive biological surveys conducted during the 1980s, which suggested that “there are probably over 100 pairs in these two regions alone” (McCracken 1991). The recent targeted surveys, which included most historical sites plus many other areas of suitable habitat, suggested that the current population may be lower. Surveys in Norfolk County over the past 5 years indicate that a population estimate of between 30 and 60 pairs is realistic (J. Allair, pers. comm. 2014). There is more uncertainty associated with the estimate of 30 to 60 pairs in Elgin County, as recent coverage there has been less extensive and there is lots of potential habitat that has not been surveyed (J. Allair, pers. comm. 2014). Oxford County has received relatively little survey coverage since the 1990s, but suitable habitat is quite limited and habitat in the area where up to 9 pairs were present about 25 years ago is now degraded (J. Holdsworth, pers. comm. 2014; J. Skevington, pers. comm. 2014). The Louisiana Waterthrush also occurs in small numbers locally in other parts of southwestern Ontario where suitable habitat is present (e.g., Middlesex and Lambton counties).

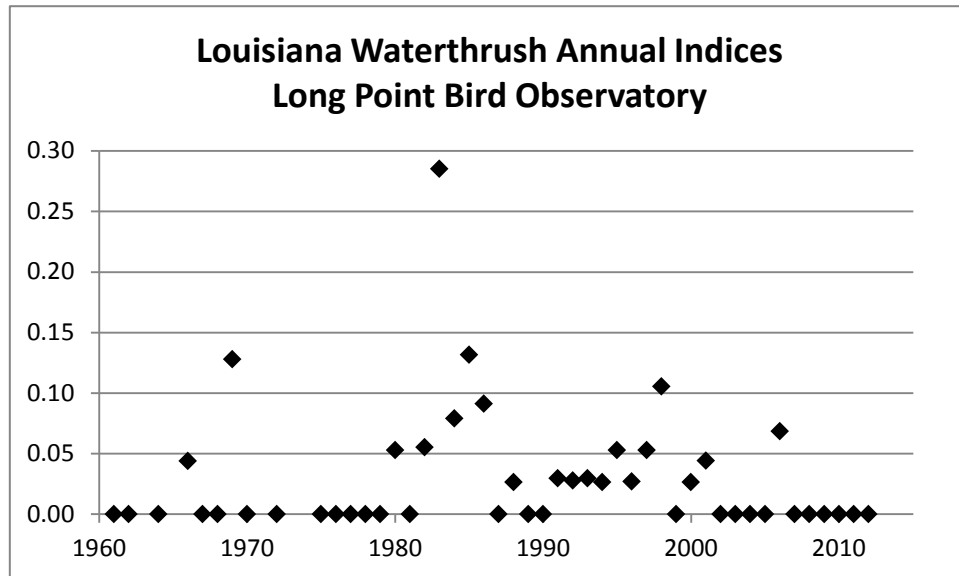


Figure 5. Annual indices of spring migration counts of Louisiana Waterthrushes at Long Point Bird Observatory, 1961-2012 (courtesy Bird Studies Canada).

The species appears to be virtually extirpated from some areas where it was considered a regular breeder a century ago (see Page 1996). It has disappeared as a breeding bird in Chatham-Kent and Essex regions in extreme southwestern Ontario. It may also be gone from Waterloo Region (K. Burrell, pers. comm. 2014; Table 1). In 2005, these three regions supported an estimated 2 to 7 breeding pairs (COSEWIC 2006). These regions are subject to particularly high rates of agricultural intensification, human population growth, and suburban development (Larson *et al.* 1999; Blancher *et al.* 2007a) that have contributed to loss, fragmentation, and degradation of breeding habitat.

South-central Ontario

The current population estimate (Table 2) for south-central Ontario of 40 to 100 pairs (53 to 134 males assuming 75% pairing success) is over five times the 2005 estimate of only 6 to 18 pairs (COSEWIC 2006). The latest estimate is based largely on targeted surveys (Table 1), along with some casual reports. Targeted surveys in 2012 and 2013 found this species to be more common and widespread along the central Niagara Escarpment than previously known. However, only a few birds were reported elsewhere in south-central Ontario (Figure 3).

In total, 31 males were located at sites along the Niagara Escarpment in 2012, and 34 males were found in 2013 (Friesen and Lebrun-Southcott 2012; Lebrun-Southcott and Friesen 2013). Relatively few females were detected (see Table 1). All sites on the central Escarpment with multiple pairs in 2012 were re-surveyed in 2013, when birds were found at six of seven sites (Lebrun-Southcott and Friesen 2013). In contrast, only 4 single males were found in surveys of headwater streams along the Oak Ridges Moraine in 2014 (Campomizzi *et al.* 2014).

The surveys focused on historical sites and potential habitat in public areas and along hiking trails. Occupancy at the historical sites was generally low (5 of 13 sites in 2012). Most birds were found at previously undocumented sites. It is unclear whether the presence of Louisiana Waterthrush at the previously undocumented sites along the Escarpment has simply gone unnoticed previously, or whether there has been an expansion in recent years (Lebrun-Southcott and Friesen 2013).

In stark contrast to the situation along the central Niagara Escarpment, the Louisiana Waterthrush appears to have abandoned most of its historical locales along the southern Niagara Escarpment, in Hamilton and Niagara regions. Birds were reported at only one of 15 historical sites along the Escarpment south of Hwy 401 during the 2013 surveys (Lebrun-Southcott and Friesen 2013). Many of these historical sites are forested stream valleys in small protected areas situated in a matrix of cropland and suburban development. In addition to habitat fragmentation, compromised water quality may be an issue at some of these unoccupied historical sites (Lebrun-Southcott and Friesen 2013).

Follow-up surveys along the central Niagara Escarpment in 2015 found only 8 singing males at 7 sites, where 20 to 23 singing males had been reported previously in 2012 and 2013, while three other sites with what appeared to prime habitat remained unoccupied (Friesen 2015b). This new information indicates that intermittent site occupancy is occurring in all parts of the Canadian range. It also suggests that current numbers in this region are nearer the lower end of the above population estimate.

Southeastern Ontario

The small population concentrated in the Frontenac Arch area north of Kingston has reportedly persisted since the early 1980s according to Weir (2008). However, targeted field work in 2010-2012 found few birds. In 2012, only 2 of 12 historical sites were occupied (Derbyshire 2012). These intensive studies indicated that fewer than 5 pairs were breeding in a large study area centred on Frontenac Park (D. Derbyshire, pers. comm. 2014). Elsewhere in this region, the species occurs only sporadically in Northumberland County (B. Walters, pers. comm. 2014).

Southwestern Quebec

The status of this species in Quebec has changed from being considered a rare vagrant to a rare and occasional breeding species. The only confirmed nesting was in 2006, at a site in Gatineau Park where the species had been reported occasionally for more than 25 years (Savignac 2006). In 2008, no birds were found at this site or during targeted surveys of the other historical sites with possible breeding evidence. During the second Québec BBA, this species was reported in 4 squares, compared to only 1 square in the 1984-1989 atlas (St-Hilaire and Dauphin 1996; Québec BBA 2015). Thus, available information suggests a small increase in numbers in southwestern Quebec, specifically in the Outaouais (Eardley Escarpment/Gatineau Hills) and Estrie regions. However, this apparent increase may be related to increased search effort and/or a short-lived fluctuation.

Summary

The current estimate of the size of the Canadian breeding population is similar to the 2005 estimate. Some local populations have declined or disappeared due to habitat loss and degradation. Recent surveys found that the population along the central Niagara Escarpment is larger than previously known, which could be related to greater search effort. This species seems to have established a small foothold in Quebec in the past decade, but its status there is still tenuous.

Rescue Effect

Although there is no direct evidence of immigration from the U.S., some immigration almost certainly takes place, particularly from the much larger breeding populations in Ohio, Pennsylvania and New York, and perhaps from smaller populations in Vermont, New Hampshire and Michigan (see population estimates for adjacent states in Table 3).

It has been suggested that the expansion of Louisiana Waterthrushes in the Kingston region of southeastern Ontario in the 1980s may have been driven by immigration from the nearby population in upper New York (COSEWIC 2006). Both of these populations have since contracted, providing further support for this linkage.

Table 3. NatureServe ranks, official status designations, and population estimates for Louisiana Waterthrush in Canadian provinces and in U.S. states adjacent to the Canadian range.

Jurisdiction	Rank¹ (NatureServe 2015)	Designation (NatureServe 2015)	Population Estimate (PIFSC 2013)	Proportion of global population (PIFSC 2013)
Ontario	S3B	Special Concern	140	<0.1%
Quebec	S1B	Critically Imperilled	-	-
Michigan	S2S3	Special Concern	-	-
New Hampshire	S4	Not listed	900	0.3%
New York	S5	Not listed	9,000	2.6%
Ohio	S5	Not listed	6,000	1.6%
Pennsylvania	S5	Not listed	20,000	6.3%
Vermont	S4	Not listed	1,100	0.3%

THREATS AND LIMITING FACTORS

The Louisiana Waterthrush is a habitat specialist and its population is limited by the supply of clear, clean, forested streams and forested wetland pools within its breeding and wintering ranges. In Canada, many areas of known or potential habitat are not regularly occupied owing to the small population. The persistence of the small, localized Canadian population may be dependent upon immigration from the U.S. (see Rescue Effect).

There is no single imminent threat to the survival of the Canadian population; rather, it is the cumulative effects of many different threats operating at various scales at different stages of its annual life cycle that are of concern. These threats are reviewed below, grouped geographically. Overall threat levels are considered to be high to medium (see Appendix 1 for details).

General Threats on Breeding Grounds in Canada

The nature and intensity of threats varies across its Canadian range. For example, impacts from agricultural activities are most intense in parts of extreme southwestern Ontario, pressures from increased development due to rapid human population growth and urban sprawl are most intense in the Niagara-Hamilton-Toronto corridor, and acid precipitation could be affecting habitats in the Frontenac Arch region of southeastern Ontario and southwestern Quebec.

i) Changes in water quantity

Due to its dependence on aquatic prey in streams and wetlands, the Louisiana Waterthrush is susceptible to changes in hydrology due to water-taking for irrigation (especially in the Norfolk Sand Plain), groundwater pumping for municipal and industrial water supplies (south-central Ontario), and construction and maintenance of agricultural drains through wetlands (across southern Ontario). The impact of these threats is particularly severe during drought conditions (Eaton 1958; COSEWIC 2006).

Extremes of water quantity can also affect habitat suitability. Habitat modifications that exacerbate storm run-off and result in “flashy” stream systems in southern Ontario include wetland drainage and forest clearing for development or agriculture, widespread use of tile drainage in croplands, and increased amounts of impervious surface areas associated with urban development and roads. High rainfall events that result in elevated water levels are also detrimental to Louisiana Waterthrush productivity due to direct loss of streamside nests and reduced access to prey (Stucker 2000; Mattsson and Cooper 2009; Mattsson *et al.* 2009).

ii) Changes in water quality

Anything that negatively affects the supply of aquatic insects in waterthrush habitat is likely to have a negative impact on breeding populations. Increased turbidity and acidification can reduce food availability (Mattsson and Cooper 2009). This species is absent from streams where water quality has been compromised by agricultural or urban activities (Prosser and Brooks 1998). This species may also bio-accumulate persistent chemical contaminants (Osborne *et al.* 2011; Latta *et al.* 2014).

Due to intensive land use and limited forest cover, water quality is poor in many watersheds in southern Ontario, which substantially limits the amount of suitable habitat for this species. Increased siltation and turbidity are commonly caused by agricultural run-off, road construction, forest clearing, and urban development (Kerr 1995). Other common pollutants include nutrients, bacteria, pesticides, road salt and contaminants from a range of agricultural, residential and industrial sources.

Acidification of aquatic habitats results in changes to benthic macroinvertebrate populations, which can negatively affect the food supply of Louisiana Waterthrushes (Mulvihill *et al.* 2008). Acidification also reduces the availability of calcium needed for eggshells (Graveland 1998), and amplifies the impacts of forest fragmentation and some other contaminants (e.g., mercury contamination, see below).

Louisiana Waterthrushes breeding density on acidified streams was significantly reduced compared to circum-neutral streams, indicating that acidification reduces habitat quality (Mulvihill *et al.* 2008). Despite improvements in treating airborne emissions since the 1980s, acid precipitation continues to affect aquatic systems in areas where the soil-buffering capacity is low, including the Frontenac Arch and Southern Shield regions in Ontario (Nantel *et al.* 2014). Acid-deposition rates do not exceed the soil-buffering capacity in most of the current Canadian range, but this is not the case in large parts of the U.S. range (Hames *et al.* 2002).

Uptake of mercury has been identified as a potential threat to this species (Evers *et al.* 2011; Osborne *et al.* 2011). Sampling from sites across the northeastern U.S. found that while blood-mercury levels were elevated compared to other songbirds, they are generally below the low risk threshold for adverse biological effects (<0.5 ppm Hg, n=20; Evers *et al.* 2011; Osborne *et al.* 2011). Evers *et al.* (2011) concluded that while this species appears to be at low risk from atmospheric mercury deposition, it is nonetheless at high risk of mercury exposure from contaminated river systems throughout its life cycle. There is circumstantial evidence that mercury may be affecting local populations in New York. Of 20 individuals sampled by Osborne *et al.* (2011), 2 birds from southern New York had the highest levels of this neurotoxin (maximum 0.62 ppm), exceeding the low risk threshold. Louisiana Waterthrush populations in southern New York have been in decline since the 1980s, particularly in southeastern New York, where the species was formerly abundant (Rosenberg 2008). No information is available on mercury levels in this species in Canada, but exposure on the breeding grounds is expected to diminish over time due to reduced emissions (e.g., recent closure of all coal-burning plants in Ontario), as shown by declining levels of mercury in fish in the Great Lakes Basin (Monson *et al.* 2011).

A potential emerging threat to this species is the indirect effect of neonicotinoid insecticides (Gibbons *et al.* 2015). Recent studies have shown that widespread use of neonicotinoid treatments on agricultural crops in southwestern Ontario and globally since the 1990s has resulted in contamination of surface waters at levels that pose a significant risk to aquatic invertebrates (Morrissey *et al.* 2015; Schaafsma *et al.* 2015). These persistent chemicals are especially toxic to Ephemeroptera and Trichoptera, aquatic insects that are important prey species for Louisiana Waterthrush (Morrissey *et al.* 2015).

iii) Effects of logging and invasive forest pests

This species exhibits a strong preference for mature, shaded forest cover and is absent from early-successional habitats (Noon *et al.* 1979; Buffington *et al.* 1997; Prosser and Brooks 1998; Tirpak *et al.* 2009). Burke *et al.* (2011) indicate that it responds negatively to clear-cutting, shelterwood, and diameter-limit forest harvests. Logging operations, particularly in stream valleys and hilly areas, can also lead to increased run-off, increased siltation and turbidity, and higher water temperatures, all of which are likely to negatively impact this species' food supply (Eaton 1988).

Elevated mortality of canopy tree species due to invasive forest pests and diseases can have adverse effects on habitat conditions. Two non-native invasive forest insects are of particular concern as emerging threats. Due to the close association of the Louisiana Waterthrush with hemlock, the spread of the Hemlock Woolly Adelgid (*Adelges tsugae*) is seen as a significant emerging threat to breeding habitat in Ontario (Friesen, pers. comm. 2015). The insect has been detected at isolated locations in southern Ontario since 2012 (Ryan 2013). Widespread hemlock mortality is considered an ongoing threat to Louisiana Waterthrush habitat in its core breeding range in the Appalachian Mountains in the U.S. (Mattsson *et al.* 2009). The significance of this threat to the U.S. population is reviewed in more detail below, as declines in the U.S. would adversely impact Louisiana Waterthrush immigration into Canada.

The Asian Long-horned Beetle (*Anoplophora glabripennis*) is another exotic insect that could have a devastating impact on eastern deciduous forest ecosystems as it attacks and kills all broadleaved trees, with maple (*Acer* spp.) being its preferred host. In eastern Canada, this species has been detected in the Greater Toronto Area, where an infestation found in 2003 was successfully eradicated, but then a new infestation was discovered in 2013 (Ontario MNRF 2014). The majority of Canadian Louisiana Waterthrush occurrences are within 150 km of the current infestation. Local infestations are also present in the eastern U.S., including southern Ohio and southeastern New York (US Forest Service 2014).

Forest fragmentation and intensive logging have been linked to elevated levels of nest predation and parasitism in forest birds, which can suppress reproductive output (Burke *et al.* 2011). Despite relatively high rates of cowbird parasitism, there is no evidence of reduced productivity or elevated predation at Louisiana Waterthrush nests in southwestern Ontario (ONRS 2014). Moreover, Brown-headed Cowbird populations have undergone a steep decline in eastern Canada since the 1980s and the threat of parasitism is likely diminishing (Environment Canada 2014d).

iv) Climate change and severe weather

The ability of this species to adapt to climate change is uncertain. Due to its early arrival on the breeding grounds, it may be particularly sensitive to mismatches in phenology of insect prey (Nantel *et al.* 2014). There is also evidence that it is vulnerable to bouts of severe weather, including high rainfall events and droughts (Eaton 1958; Mattsson *et al.* 2009). Such extreme weather events are predicted to become more frequent in Canada, although regional and seasonal variability is expected (Chiotti and Lavender 2008; Bush *et al.* 2014). Precipitation changes are particularly uncertain, but potential declines in southern Canada, combined with increased evaporation, could increase seasonal aridity and reduce water availability in some areas (Bush *et al.* 2014).

On the other hand, the Canadian population of Louisiana Waterthrush could benefit from warming temperatures. A recent study predicted that the bioclimatic envelope of this species will shift northeastwards (National Audubon Society 2014). Any easing of the climatic constraints on the northern limit of the Louisiana Waterthrush could enable the species' range to expand into the Southern Shield region in Ontario and the Atlantic Forest Region in southeastern Quebec, regions that have considerably more forest cover and less pressure from human population growth than southern Ontario. However, climate warming will also promote the northward spread of forest pest species such as the Hemlock Woolly Adelgid, which currently appear to be somewhat constrained by cold winter temperatures (Paradis *et al.* 2008).

Specific Local Threats at Breeding Occurrences in Canada

Several specific threats to Louisiana Waterthrush occurrences in Canada have been observed recently (see references in Table 1):

- i) Residential developments situated in close proximity to Louisiana Waterthrush habitat are a local but serious and ongoing threat.
- ii) Disturbance of nesting birds by recreational users (fishers, hikers, dog walkers) along streams. Disturbance and siltation due to fording of streams by off-road vehicles also continues to be a problem at some sites, particularly in the Norfolk Sand Plain.
- iii) Forest clearing for new ski runs at resorts along the Niagara Escarpment. This threat was observed at only one site during recent surveys. Further expansion of ski resorts along the Niagara Escarpment is likely limited by current planning and land use restrictions (see Habitat Protection and Ownership below).

Threats on the Breeding Range in the United States

Until recently, threats to this species on its breeding grounds in the U.S. were generally considered localized or of low concern. Forest cover in the eastern U.S. is extensive, having rebounded from an historical low extent *circa* 1910 during a long-term cycle of deforestation for agriculture following European settlement, followed by an extended period of reforestation of abandoned agricultural lands (Drummond and Loveland 2010). Moreover, the numerous headwater streams occupied by this species are often within protected areas, public lands, or other sparsely populated areas. Stream acidification from acid precipitation and point-source discharge from abandoned coal mines was identified as the most significant and widespread threat to Louisiana Waterthrush habitat in the U.S. (Mulvihill *et al.* 2008).

Recently, a number of new threats have emerged which have the potential to seriously impact Louisiana Waterthrush populations in the northeastern United States, which could then impact resilience of the small Canadian population because of its reliance on continued immigration from U.S. source populations. A general concern is that the forest cover transition in the eastern United States has entered a new stage, with losses now exceeding gains (Drummond and Loveland 2010). Land use pressures driving the net forest conversion between 1973 and 2000 were largely forest harvest, development, and mining (Drummond and Loveland 2010).

Two emerging threats of particular importance to Louisiana Waterthrush habitat in the northeastern U.S. are described below.

i) Hemlock decline due to an invasive insect pest

There is considerable concern that widespread hemlock mortality due to Hemlock Woolly Adelgid will adversely impact forest and stream ecosystems in the eastern U.S. (Siderhurst *et al.* 2010; Trotter *et al.* 2013). This exotic insect causes severe defoliation and tree mortality within 4 to 15 years of infestation. Very few trees show any resistance and there are no known practical control measures that can be used at the landscape scale (Siderhurst *et al.* 2010; Trotter *et al.* 2013). First established in Virginia in 1951, this pest had gained a foothold in 45% of the hemlock's range in the eastern U.S. by 2003 (Trotter *et al.* 2013). The rate of spread is generally slow (up to about 20 km/year) and has been even slower in northern regions, where the insect faces high overwinter mortality (Paradis *et al.* 2008). To date, hemlock mortality in the U.S. is apparent at the stand level but not at the landscape scale (Trotter *et al.* 2013). However, Trotter *et al.* (2013) suggested that the situation in the U.S. is now at a tipping point, beyond which the impact of this species on eastern U.S. forests will rapidly transition from negligible to significant.

Hemlock mortality results in increased light penetration of riparian systems that can impact Louisiana Waterthrush habitat by increasing water temperature and shifting benthic insect communities (Mattsson *et al.* 2009) that the species relies on, and also by changing forest structure (increase in shrub layer) and composition (shift from mixed forest to deciduous forest). Changes in forest composition and structure related to widespread hemlock decline could have long-lasting impacts on Louisiana Waterthrush populations. Local population declines have been found in other hemlock-associated forest bird species (e.g., 70% fewer Acadian Flycatcher pairs at heavily infested sites; Allen *et al.* 2009), but the response of Louisiana Waterthrush to hemlock mortality is still unknown and there is presently no evidence of population declines in those parts of the U.S. range where the adelgid has been established for many decades. Thus, while there remains considerable uncertainty as to the timing and severity of this threat to Louisiana Waterthrush populations, the scope will likely be widespread and could result in major shifts in ecological communities and interactions.

ii) Habitat loss, fragmentation and degradation due to resource development

Louisiana Waterthrush populations in Kentucky and West Virginia, which support a quarter of the global breeding population (PIFSC 2013), are impacted by coal mining, particularly by the newer practice of mountaintop removal, as well as by acid-mine drainage from conventional mining practices. In West Virginia, 35,000 ha of mature deciduous forest have been converted to grassland and over 483 km of streams have been directly impacted by mountaintop removal practices, and an additional 4830 km of riparian habitat has been degraded by acid mine drainage (West Virginia DNR 2005). West Virginia has the highest relative abundance of this species, and populations in this state have undergone a long-term decline (Sauer *et al.* 2014).

In the past decade, two new forms of energy development have emerged that geographically overlap with prime Louisiana Waterthrush habitat in parts of its U.S. range. Shale gas development (by “fracking” or hydraulic fracturing) and ridge-top wind turbine installations give rise to a suite of new threats to Louisiana Waterthrush breeding habitat. Both of these forms of energy development require construction of extensive road networks, resulting in forest fragmentation and increased siltation and turbidity. In addition, new utility corridors are needed to transport the electricity and natural gas produced by these projects.

Furthermore, shale gas extraction is water-intensive. The potential exists for shale gas development to impact groundwater and surface water quantity and quality at various scales, and this risk is highest in smaller streams (Abdalla and Drohan 2010). Development of extensive shale formations in the U.S. will affect a high proportion of the global Louisiana Waterthrush breeding range. For example, about 75% of its breeding range in Pennsylvania overlaps the Marcellus Shale formation (Mulvihill 2012). Latta *et al.* (2014) reported preliminary findings that Louisiana Waterthrushes in watersheds with fracking activity carry significantly higher loads of contaminants associated with drilling-fluids than individuals in watersheds without fracking. The initial results of a 5-year study by Franz *et al.* (2014) in an area of West Virginia with increasing fracking activity suggested that waterthrush habitat quality was lower near nests impacted by fracking activity, although changes in breeding density and nest survival were not apparent.

Habitat Loss and Degradation on the Wintering Grounds

This species faces threats during the non-breeding portion of its life cycle due to loss and degradation of wintering and migration habitat in Latin America (PIFSC 2012). These regions are all being impacted by extensive and rapid land-use change due to development pressures (NABCI 2002). The conversion of forest to farmland is of particular concern due to the direct loss of forested riparian habitats and forested wetlands, as well as reductions in water quality and quantity as a result of logging and agricultural activities. As noted in the Habitat Trends section of this report, recent studies of land-use change patterns across this region suggest that the threat of deforestation has eased somewhat, at least in some parts (Redo *et al.* 2012; Aide *et al.* 2013). However, degraded water quality is still a significant issue in parts of the wintering range, including the Dominican Republic (Latta 2011) and Puerto Rico (Hallworth *et al.* 2011).

Collisions with Buildings and Communication Towers During Migration

During migration, this species is at risk from collisions with communications towers (Longcore *et al.* 2013; see also Mattsson *et al.* 2009) and tall buildings (Loss *et al.* 2014). To date, there have been no published reports of Louisiana Waterthrush mortality at wind turbines. These sources of human-induced mortality are of particular concern, given the relatively small global population size (360,000 individuals).

Number of Locations

The number of locations of this species in Canada cannot be quantified. Given the dispersed distribution of this species in many sites across multiple jurisdictional boundaries, and the notion that the most serious threats are likely site-based and caused by individual landowners, then there are clearly more than 10 locations.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

General protection for this species and its nest and eggs is afforded in Canada through the federal *Migratory Birds Convention Act 1994* and parallel legislation in the United States and Mexico, and on public land in Quebec through the provincial *Act Respecting the Conservation and Development of Wildlife*. COSEWIC assessed this species as Threatened in 2015. It is currently listed on Schedule 1 of Canada's *Species at Risk Act* as 'Special Concern', on Schedule 4 of Ontario's *Endangered Species Act, 2007*, and on the list of species likely to be designated threatened or vulnerable according to Quebec's *Act Respecting Threatened or Vulnerable Species*.

The management objective established by the federal Management Plan for this species is to maintain the current size and distribution of the Louisiana Waterthrush in Canada (Environment Canada 2012). Recent activities related to this Management Plan include the development of a draft monitoring protocol (Bickerton and Walters 2011) and increased survey effort.

Non-Legal Status and Ranks

At the global level, this species is considered Secure (G5) by NatureServe (2015) and of Least Concern according to the IUCN Red List (IUCN 2012). The species is also considered Secure (N5B) in the United States breeding range (NatureServe 2015).

Nationally, the Louisiana Waterthrush is ranked as N3B (Vulnerable, Breeding population) in Canada (last reviewed 15 January 2013), and N5B (Secure, Breeding population) in the United States (NatureServe 2015). At the subnational level, it is ranked as S3B (Vulnerable, Breeding population) in Ontario, and S1B (Critically Imperilled, Breeding population) in Quebec (NatureServe 2015). It is ranked as S2S3 in Michigan (Imperilled/ Vulnerable), where it has been designated "special concern". It is considered secure (S5) or apparently secure (S4) in other U.S. states bordering the species' Canadian breeding range (Table 3).

Within the Partners In Flight (PIF) North American Landbird Conservation Plan, the Louisiana Waterthrush is identified as one of 195 species of "continental importance" because it is a "stewardship species", as 94% of its global population breeds within the Eastern avifaunal biome (Rich *et al.* 2004). It is not on the continental PIF Watch List (the list of species of greatest continental conservation concern).

Due to its Special Concern status in Canada, it is identified as a conservation priority in two Bird Conservation Regions (BCRs) in Ontario (BCRs 12 and 13; Environment Canada 2014a,b) and in three BCRs in Quebec (BCRs 12, 13, and 14; B. Drolet, pers. comm. 2015).

Habitat Protection and Ownership

About half of all recently occupied breeding sites are located on public lands, including some formally protected areas (provincial parks and nature reserves) and other conservation lands (e.g., Conservation Authority lands and managed forests). This statistic is particularly notable given that over 90% of land in southern Ontario and southwestern Quebec is privately held. While the high proportion of public ownership is partly a reflection of the biased search effort, which has targeted accessible public lands, to a large extent it is also because the typical breeding habitat is frequently conserved by public agencies due to its scenic and ecological values, and because these areas are not easily developed, logged or converted to agriculture.

The largest area of suitable nesting habitat on federal lands is Gatineau Park in the Outaouais region of Quebec. In Ontario, this species is considered a regular rare migrant at Point Pelee National Park (Parks Canada Agency 2012) and the Long Point National Wildlife Area (LPBO 2014). There is some historical breeding evidence from the Six Nations reserve in Brant County (Chamberlain *et al.* 1985) and Walpole Island First Nation (Eagles 1987), but the evidence is rather weak and there have been no recent reports from these areas. The only Louisiana Waterthrush record from Department of National Defence lands is a 2009 report from the former Camp Ipperwash site (now Stony Point First Nations; A. McIsaac, pers. comm. 2014). Several occurrences are in provincial parks and nature reserves, including multiple territories at Pretty River Valley, Devil's Glen, and Frontenac parks in Ontario (Friesen and Lebrun-Southcott 2012; Lebrun-Southcott and Friesen 2013; D. Derbyshire, pers. comm. 2014). Several other occurrences with multiple pairs are in public conservation areas managed by local Conservation Authorities (Friesen and Lebrun-Southcott 2012; Lebrun-Southcott and Friesen 2013).

Louisiana Waterthrush breeding habitat along the Niagara Escarpment is afforded some protection from development under the *Niagara Escarpment Planning and Development Act, 1973* and the associated *Niagara Escarpment Plan* (2005). Many of the breeding sites are in public lands within the Niagara Escarpment Parks and Open Space System, which includes extensive natural environment areas (Niagara Escarpment Commission 2014). Some additional habitat and breeding sites are protected by the *Oak Ridges Moraine Conservation Action* 2001, and the *Greenbelt Act, 2005* and associated conservation and land use plans and natural heritage strategies. Several sites in Ontario occur in "Areas of Natural and Scientific Interest", "Environmentally Sensitive Areas", "Provincially Significant Wetlands", or other natural heritage designations which are afforded various levels of protection under provincial or regional land use planning policies.

While the bulk of suitable breeding habitat in Canada occurs on private lands, these areas are apt to receive some protection through various policies and regulations. For example, ravines, floodplains, and wetlands are apt to be zoned “hazard land”. Headwater streams and associated groundwater recharge areas in southern Ontario are often included in Source Protection Areas under the *Clean Water Act, 2006*. The Natural Heritage component of Ontario’s *Provincial Policy Statement* supports conservation measures for various areas and habitats where Louisiana Waterthrushes may occur. Similarly, in Quebec, the *Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains* protects habitat used by this species. There are also federal and provincial laws designed to protect streams and fish habitat. In Quebec, aquatic habitat and water quality for aquatic species are protected under the *Act respecting the conservation and development of wildlife*, and the *Environmental Quality Act*.

Several Important Bird Areas (IBAs) in Ontario have been identified based on nationally significant concentrations of breeding Louisiana Waterthrushes and other birds at risk, including the Little Otter Creek Complex, Norfolk Forest Complex, and Dundas Valley IBAs (IBA Canada 2014). The IBA designation does not provide any legal protection.

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BIOGRAPHICAL SUMMARY OF REPORT WRITER(S)

Audrey Heagy is a Bird Conservation Biologist with Bird Studies Canada (BSC), a non-profit, non-governmental bird research organization with headquarters in Port Rowan, Ontario. She has worked as a conservation biologist for environmental non-profit organizations and consulting firms for over 20 years, including more than 15 years' experience working on landbird conservation and the recovery of bird species at risk in Ontario. She has been the lead writer on numerous technical reports and publications, including three COSEWIC status update reports, the Ontario Barn Swallow Recovery Strategy, and four Ontario Landbird Conservation Plans. She coordinated and conducted Louisiana Waterthrush field surveys in Norfolk County, Ontario in 2011 and 2012, including colour banding and nest monitoring.

COLLECTIONS EXAMINED

No collections were examined.

Appendix 1. Threat Calculator results for Louisiana Waterthrush.

Species or Ecosystem Scientific Name	Louisiana Waterthrush <i>Larkesia motacilla</i>		
Date (Ctrl + ";" for today's date):	17/03/2015		
Assessor(s):	Dwayne Lepitzki, Jon McCracken, Audrey Heagy, Julie Perrault, Marcel Gahbauer, Lyle Friesen, Don Sutherland, François Shaffer, Ben Walters, Zoe Lebrun-Southcott, Brady Mattsson		
References:			

Threat Impact		Level 1 Threat Impact Counts	
		high range	low range
A	Very High	0	0
B	High	0	0
C	Medium	2	0
D	Low	3	5
Calculated Overall Threat Impact:		High	Medium
Assigned Overall Threat Impact:			
Impact Adjustment Reasons:			
Overall Threat Comments		Threats on the wintering habitat and during migration will also be considered here and specified where applicable. For the most part, unless otherwise specified, the threat refers to the breeding habitat of the species.	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development	D	Low	Small (1-10%)	Extreme (71-100%)	High (Continuing)	
1.1	Housing & urban areas	D	Low	Small (1-10%)	Extreme (71-100%)	High (Continuing)	In the Collingwood area along the escarpment there is a lot of housing development ongoing. This bird also exists in many protected areas. Development can occur right up to stream borders. The number of birds affected is likely to be closer to 1% end for Scope. Restrictions are also present in Niagara escarpment.
1.2	Commercial & industrial areas		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	Birds flying into office building windows during migration.
1.3	Tourism & recreation areas		Negligible	Negligible (<1%)	Extreme (71-100%)	Moderate (Possibly in the short term, < 10 yrs)	There are some ski resorts in some parts of Ontario (e.g., Osler Bluffs) and many have been in existence for 70 years. The impact will especially occur through drainage. Tree removal and resort expansion is ongoing.
2	Agriculture & aquaculture		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.1	Annual & perennial non-timber crops		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Loss of wetlands or agricultural expansion would be covered here. This was a threat in the past with definite impact but may not be as serious a threat going forward. New tile-draining and irrigation would affect the species which would lead to a water quality issue and lowering of the water table. It depends on the proximity to the streams. Ground water diversion is dealt with in 7.2 and not in this section. Tile-drainage related to agriculture is a negligible threat for this section. Water pollution will be captured in section 9.
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture						Shrimp farms in mangroves would be a threat on wintering grounds except this species is not likely to be found in those habitats.
3	Energy production & mining						
3.1	Oil & gas drilling						Fracking is not expected to happen in the LOWA breeding range. This may be an issue in the United States but the overall impact is unknown at this time.
3.2	Mining & quarrying						Gravel extraction was a historical threat on the Niagara Escarpment; not any more. Mountaintop coal mining in the U.S. may pose a threat, but this is primarily on water quality.
3.3	Renewable energy						Collision with wind turbines not considered a significant threat.
4	Transportation & service corridors	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	
4.1	Roads & railroads						Road improvements but no new road construction is expected.
4.2	Utility & service lines	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Collisions with communication towers and creation of corridors causing gaps in the habitat would be an issue.
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	Logging would have a great impact if it is right within their territory. Logging would occur in both breeding and wintering habitats. There is uncertainty around the effect this has.
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.1	Recreational activities		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Hikers, dog-walkers, fishing, and especially ATV use crossing streams affects the nesting areas. A high proportion of nests would be exposed to this type of activity but the effects are largely known. The documented effect in Gatineau park is due to trampling of the stream bank (dog-walking).
6.2	War, civil unrest & military exercises						
6.3	Work & other activities		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Scientific research has a negligible effect. The threat would increase as the status or interest is shown to have conservation issues.
7	Natural system modifications	CD	Medium - Low	Restricted - Small (1-30%)	Serious (31-70%)	High - Moderate	
7.1	Fire & fire suppression						
7.2	Dams & water management/use	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	Surface water diversions (irrigation) use is a significant threat to the bird. However, tobacco has become more localized on the sand plains and water take is not a serious issue in the central escarpment as it is on the sand plains. Productivity is affected by water diversions (especially during drought years).
7.3	Other ecosystem modifications	CD	Medium - Low	Restricted - Small (1-30%)	Serious (31-70%)	High - Moderate	Hemlock wooly adelgids and Asian longhorn beetle (localized) are affecting the ecosystem and the habitat, therefore, not covered under invasive species. Emerald Ash borer would also be an issue for this species. This is a threat which is also affecting the US population, and hence immigration into Canada.
8	Invasive & other problematic species & genes						
8.1	Invasive non-native/alien species						All invasive species that affect the birds are altering habitat and captured in 7.3.
8.2	Problematic native species						Cowbirds are not considered a serious threat to this species, and it is declining with declining cowbird populations.
8.3	Introduced genetic material						
9	Pollution	CD	Medium - Low	Restricted - Small (1-30%)	Serious - Slight (1-70%)	High (Continuing)	
9.1	Household sewage & urban waste water						
9.2	Industrial & military effluents						
9.3	Agricultural & forestry effluents	CD	Medium - Low	Restricted - Small (1-30%)	Serious - Slight (1-70%)	High (Continuing)	Lots of aquatic insects are vulnerable to pesticides (e.g., neonicotinoids), which could affect productivity.
9.4	Garbage & solid waste						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.5	Air-borne pollutants	D	Low	Restricted (11-30%)	Moderate (11-30%)	High (Continuing)	Waterthrushes have been affected by acidification. This would be less of an issue along the escarpment. Air-borne pollutants have been shown to be a problem for these birds in the US. Publication on acidification of streams has a great effect on the species (significant reduction of breeding density, delayed clutches). This threat refers specifically to acid rain in QC and acidification of breeding streams in the US. Mercury deposition (and release as a result of acid rain) is also an issue.
9.6	Excess energy						
10	Geological events						
10.1	Volcanoes						
10.2	Earthquakes/tsu namis						
10.3	Avalanches/land slides						
11	Climate change & severe weather						The effects of climate change are not expected to affect this bird in the next 10 years. The effect is unknown and could potentially benefit the species.
11.1	Habitat shifting & alteration						There will be a shift in tree species related to weather changes but this has been covered under ecosystem modifications.
11.2	Droughts						
11.3	Temperature extremes						
11.4	Storms & flooding						