COSEWIC
Assessment and Status Report

on the

Barn Swallow
Hirundo rustica

in Canada

THREATENED
2011

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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For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, ON
K1A 0H3

Tel.: 819-953-3215
Fax: 819-994-3684
E-mail: COSEWIC/COSEPAC@ec.gc.ca
http://www.cosewic.gc.ca

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COSEWIC
Assessment Summary

Assessment Summary – May 2011

Common name
Barn Swallow

Scientific name
Hirundo rustica

Status
Threatened

Reason for designation
This is one of the world's most widespread and common landbird species. However, like many other species of birds that specialize on a diet of flying insects, this species has experienced very large declines that began somewhat inexplicably in the mid- to late 1980s in Canada. Its Canadian distribution and abundance may still be greater than prior to European settlement, owing to the species' ability to adapt to nesting in a variety of artificial structures (barns, bridges, etc.) and to exploit foraging opportunities in open, human-modified, rural landscapes. While there have been losses in the amount of some important types of artificial nest sites (e.g., open barns) and in the amount of foraging habitat in open agricultural areas in some parts of Canada, the causes of the recent population decline are not well understood. The magnitude and geographic extent of the decline are cause for conservation concern.

Occurrence
Yukon Territory, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador

Status history
Designated Threatened in May 2011.

COSEWIC
Executive Summary

Barn Swallow
Hirundo rustica

Wildlife species description and significance

The Barn Swallow is a medium-sized songbird that is easily recognized by its steely-blue upperparts, cinnamon underparts, chestnut throat and forehead, and by its deeply forked tail. Sexes have similar plumage, but males have longer outer tail-streamers than females and tend to be darker chestnut on their underparts.

Distribution

The Barn Swallow has become closely associated with human rural settlements. It is the most widespread species of swallow in the world, found on every continent except Antarctica. It breeds across much of North America south of the treeline, south to central Mexico. In Canada, it is known to breed in all provinces and territories. It is a long-distance migrant and winters through Central and South America.

Habitat

Before European colonization, Barn Swallows nested mostly in caves, holes, crevices and ledges in cliff faces. Following European settlement, they shifted largely to nesting in and on artificial structures, including barns and other outbuildings, garages, houses, bridges, and road culverts.

Barn Swallows prefer various types of open habitats for foraging, including grassy fields, pastures, various kinds of agricultural crops, lake and river shorelines, cleared rights-of-way, cottage areas and farmyards, islands, wetlands, and subarctic tundra.

Biology

The Barn Swallow is social throughout the year, travelling and roosting in flocks during migration and on the wintering grounds. It is socially monogamous, but polygamy is common. The Barn Swallow nests in small, loose colonies that usually contain no more than about 10 pairs. Nests are built largely of mud pellets. Egg-laying starts in the second week of May in southern Canada. Two broods are frequently produced each year, except in the far north. This species forages in the air, and specializes on a diet of flying insects.

Population sizes and trends

In Canada, the current Barn Swallow population is estimated at about 2.45 million breeding pairs (about 4.9 million mature individuals). Although the species is still common and widespread, Breeding Bird Survey (BBS) data for the period 1970 to 2009 indicate a statistically significant decline of 3.6% per year in Canada, which corresponds to an overall decline of 76% in the 40-year period. Most of the decline started to occur sometime in the mid-1980s. Over the most recent 10-year period (1999 to 2009), BBS data show a statistically significant decline of 3.5% per year, which represents an overall decadal decline of 30%. Regional surveys, such as breeding bird atlases in Ontario and the Maritimes, and the Étude des populations d'oiseaux du Québec, also show significant declines over the long term, as do surveys from the United States. Despite these losses, the distribution and numbers of this species are acknowledged to be far greater than they were before European settlement created a large amount of artificial nesting and foraging habitat that the species readily exploited.

Threats and limiting factors

Although poorly understood, the main causes of the recent decline in Barn Swallow populations are thought to be: 1) loss of nesting and foraging habitats due to conversion from conventional to modern farming techniques; 2) large-scale declines (or other perturbations) in insect populations; and 3) direct and indirect mortality due to an increase in climate perturbations on the breeding grounds (cold snaps). Other limiting factors include high nestling mortality due to high rates of ectoparasitism; and interspecific competition for nest sites with an invasive species (House Sparrow). Additional threats may also be affecting the species during migration and on the wintering grounds, including loss of foraging habitat and exposure to pesticides.

Protection, status, and ranks

In Canada, the Barn Swallow and its nests and eggs are protected under the *Migratory Birds Convention Act, 1994*. It is ranked as secure in Canada by NatureServe, but is ranked as sensitive in several provinces and territories, including Alberta, British Columbia and most Maritime provinces.

TECHNICAL SUMMARY

Hirundo rustica
Barn Swallow Hirondelle rustique
Range of Occurrence in Canada : Yukon Territory, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland/Labrador

Demographic Information

Generation time (average age of parents in the population)	2 to 3 yrs
Is there an observed continuing decline in number of mature individuals?	Yes
Estimated percent of continuing decline in total number of mature individuals within 5 years	Unknown
Observed percent reduction in total number of mature individuals over the last 10 years. Long-term BBS data show a significant decline of 3.6% per year between 1970 and 2009, which corresponds to an overall population decline of about 76% over the last 40 years. For the most recent 10-year period (1999 to 2009), BBS data show a significant decline of 3.5% per year which represents a 30% decline over the last 10 years (95% CI = -39.5% to -18.3%).	~30%
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline clearly reversible and understood and ceased?	No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence - Based on a minimum convex polygon	~7.3 million km²
Index of area of occupancy (IAO) - IAO based upon the 2x2 km grid cell method cannot be calculated at this time because precise locations of nesting colonies have not been mapped. However, IAO would be far greater than COSEWIC's minimum threshold of 2000 km^2	Unknown (>2000 km^2)
Is the total population severely fragmented?	No
Number of “locations”	Unknown (but far greater than 10)
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	No
Is there an inferred continuing decline in index of area of occupancy? Based on breeding bird atlas results in Ontario and the Maritimes that show significant declines in the number of 10 x 10 km squares occupied.	Yes
Is there an [observed, inferred, or projected] continuing decline in number of populations?	Not applicable

Is there an [observed, inferred, or projected] continuing decline in number of locations?	Unknown
Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat?	Yes
Are there extreme fluctuations in number of populations?	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 population)

Population	**N Mature Individuals**
Total = about 2.45 million breeding pairs. The estimate incorporates an estimated 55% decline that occurred between the mid-1990s and 2009 (see **Abundance** section)	~ 4.9 million
Number of populations	1

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not done

Threats (actual or imminent, to populations or habitats)

Threats are not well understood, but are thought to include:

- loss of nesting and foraging habitats on the breeding grounds due to conversion from conventional to modern farming techniques;
- large-scale decline or some other change in populations of flying insects;
- increased mortality of adults and/or young due to a possible increase in climate perturbations (cold snaps that are out of phase with the species' annual cycle);
- issues on the wintering grounds and/or during migration (pesticides, habitat loss);
- high levels of inter-specific competition for nests with an invasive species (House Sparrow);
- high loads of ectoparasites that reduce nesting success; and
- human persecution (e.g., removal of nests from bridges and other structures).

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? USA: significant rangewide decline of 1.0% per year (1980-2007); declines are greatest for many states bordering Canada.	
Is immigration known or possible?	Yes
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes, but nesting and foraging habitats continue to be lost
Is rescue from outside populations likely?	Yes, but tempered somewhat by population declines in states bordering Canada

Current Status

COSEWIC: Threatened (May 2011)

Status and Reasons for Designation

Status: Threatened	**Alpha-numeric code:** A2b
Reasons for designation: This is one of the world's most widespread and common landbird species. However, like many other species of birds that specialize on a diet of flying insects, this species has experienced very large declines that began somewhat inexplicably in the mid- to late 1980s in Canada. Its Canadian distribution and abundance may still be greater than prior to European settlement, owing to the species' ability to adapt to nesting in a variety of artificial structures (barns, bridges, etc.) and to exploit foraging opportunities in open, human-modified, rural landscapes. While there have been losses in the amount of some important types of artificial nest sites (e.g., open barns) and in the amount of foraging habitat in open agricultural areas in some parts of Canada, the causes of the recent population decline are not well understood. The magnitude and geographic extent of the decline are cause for conservation concern.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Meets Threatened A2b, because the population decline is at the threshold level of 30% over the most recent 10-year period.
Criterion B (Small Distribution Range and Decline or Fluctuation): Does not meet criterion; exceeds thresholds for extent of occurrence and area of occupancy.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable; exceeds thresholds for population size.
Criterion D (Very Small or Restricted Total Population): Not applicable; exceeds thresholds for population size, area of occupancy and number of locations.
Criterion E (Quantitative Analysis): Not done

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 (2011)

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.

Canada

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

COSEWIC Status Report

on the

Barn Swallow

Hirundo rustica

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and classification

The common name of *Hirundo rustica* Linnaeus (1758) is Barn Swallow in English and Hirondelle rustique in French. The taxonomy of the Barn Swallow is as follows:

Class: Aves
Order: Passeriformes
Family: Hirundinidae
Genus: *Hirundo*
Species: *Hirundo rustica*
Subspecies: *erythrogaster*

Morphological description

The Barn Swallow (*Hirundo rustica)* is a medium-sized passerine (total length: 15-18 cm). Adults have steely-blue upperparts, cinnamon underparts, and a chestnut throat and forehead. The tail is deeply forked and the outer feathers are elongated. A white band appears across the tail. Sexes are similar in plumage, but males have longer outer tail-streamers than females (79-106 mm in males versus 68-84 mm in females; Pyle 1997) and tend to have darker chestnut colouration on their underparts (Brown and Brown 1999a).

Barn Swallows can be easily distinguished in all plumages and ages from all other North American swallows by their long and deeply forked tails, the white spots on the inner webs of the tail feathers, and extensive cinnamon underparts (Godfrey 1986; Brown and Brown 1999a).

Population spatial structure and variability

Six subspecies are known to occur in the world, but only one breeds in North America (*H. r. erythrogaster*; Brown and Brown 1999a). Few studies have compared genetic variation among subspecies, but the level of differentiation (in morphology and behaviour) found between Eurasian and North American populations suggests that more than one species may exist (Zink *et al.* 1995). Phylogenetic analysis of mtDNA haplotypes on worldwide subspecies of Barn Swallow revealed four main genetic clades: Europe, Asia, North America and the Baikal region of Asia (Zink *et al.* 2006). It appears that the North American subspecies shares a common population history and ancestry with the Baikal clades in Asia (Zink *et al.* 2006). No information is available on population structure or variability within Canada or North America.

Several species that are very similar to Barn Swallows in their appearance, behaviour and ecology are found in sub-Saharan Africa, Malaysia, and Australia, but the genetic relationship of these to the Barn Swallow is currently unclear (Brown and Brown 1999a).

Designatable units

The Barn Swallow breeds across a large portion of Canada. There are no large disjunctions in range, nor any known genetic differences, that would merit a treatment of more than one designatable unit.

Special significance

As a consequence of both its wide distribution and its capacity to nest on accessible artificial structures near human populations, the Barn Swallow is well known to the general public and has been studied extensively throughout the world. It has figured prominently in studies on the costs and benefits of group-living (Snapp 1976; Møller 1987; Shields and Crook 1987), and has served as a model organism for detailed studies on the mechanisms of sexual selection (Møller 1994) and the effects of climate change and ectoparasites on breeding ecology (Brown and Brown 1999a). However, most of the research has been done on European populations, and relatively few studies have been conducted in North America (Brown and Brown 1999a).

The Barn Swallow is perhaps the only northern temperate breeder that commonly winters in South America and occasionally also breeds there during the boreal winter (Brown and Brown 1999a). No Aboriginal Traditional Knowledge is currently available (but see **Habitat requirements**).

DISTRIBUTION

Global range

The Barn Swallow is the most widespread swallow in the world, found on every continent except Antarctica (American Ornithologists' Union 1998). Its current breeding range in North America includes south-coastal and southeastern Alaska, all Canadian provinces and territories, the conterminous United States (except most of Florida), most of northern and central Mexico, and a few areas in Argentina (Brown and Brown 1999a; Figure 1).

There is no overlap between the breeding and winter ranges except in portions of Central Mexico (Brown and Brown 1999a; Figure 1). The Barn Swallow winters from Mexico southward throughout Central America (Howell and Webb 1995). The bulk of the North American population winters in lowlands across South America (including the Galápagos Islands; Brown and Brown 1999a). Vagrants are known from Tierra del Fuego and the Falkland Islands, and the species is rare in eastern Brazil and south of central Chile and northern Argentina (Paynter 1995; Ridgely and Tudor 2009; Figure 1). Based on Christmas Bird Count results, small (but apparently increasing) numbers of Barn Swallows are recorded in the winter in parts of the U.S. and Canada, including British Columbia (D. Fraser pers. comm. 2011).

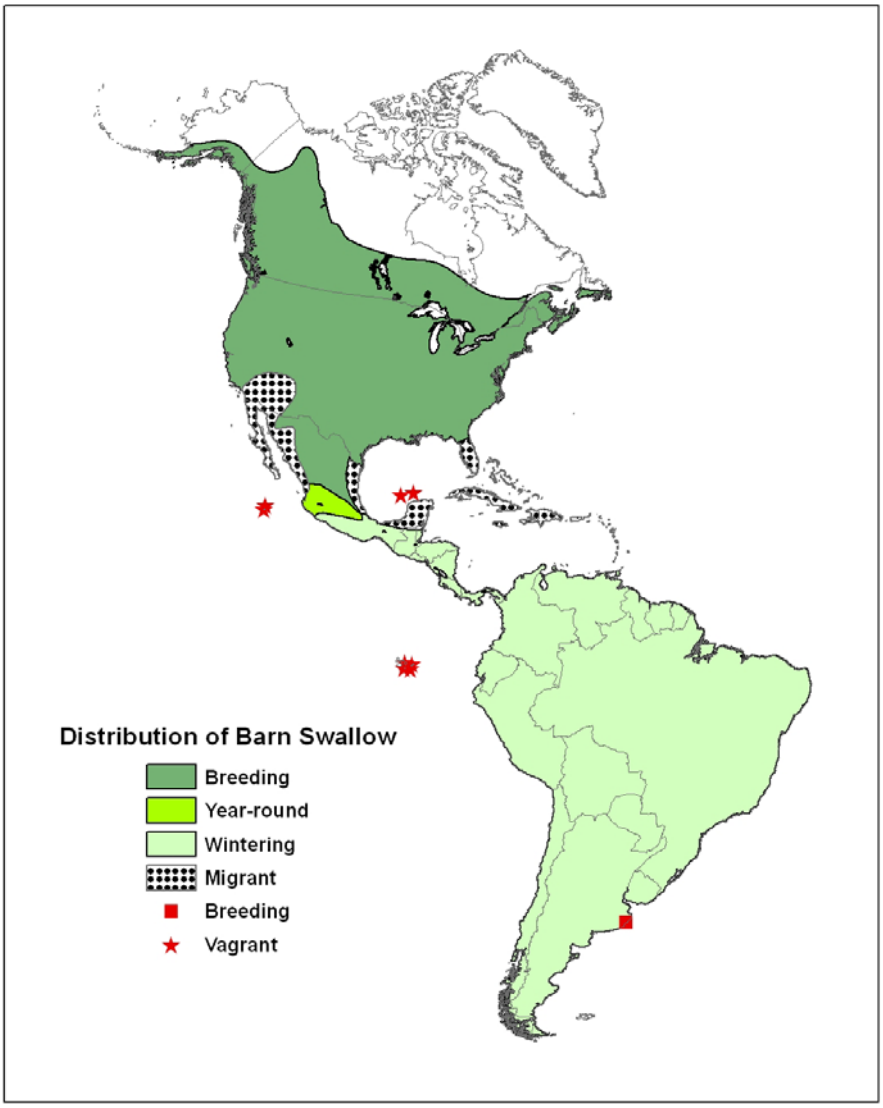

Figure 1. Range of the Barn Swallow in the Western Hemisphere (data provided by NatureServe in collaboration with Robert Ridgely, James Zook, The Nature Conservancy – Migratory Bird Program, Conservation International – Centre for Applied Biodiversity Science, World Wildlife Fund – US, and Environment Canada – WILDSPACE; modified from Ridgely *et al.* 2007).

Canadian range

In Canada, the Barn Swallow breeds in all provinces and territories (Figure 2), from the southern part of the Yukon (widespread across the region north to Ross River but also breeding occasionally on the Arctic coast; Sinclair *et al.* 2003) and the central part of the Northwest Territories, and south through British Columbia and the prairies (Godfrey 1986; Smith 1996; Campbell *et al.* 1997; American Ornithologists' Union 1998; Manitoba Avian Research Committee 2003). It breeds rarely and sporadically in Nunavut, where it is considered a vagrant (Richards and White 2008). Farther east, it breeds throughout most of Ontario, including the Hudson Bay Lowlands (where it is very local and rare), but is absent from most of the forested and muskeg-covered areas of

the Boreal Shield Ecozone (Peck and James 1987; Cadman *et al*. 2007). It breeds throughout southern Quebec (Landry and Bombardier 1996), and east through the Maritime provinces and southern Newfoundland (Godfrey 1986).

Following European settlement, humans constructed buildings and other structures that were readily adopted by Barn Swallows as suitable nesting sites. At the same time, the amount of open habitat needed for foraging also greatly increased. In response, Barn Swallows expanded their breeding populations and extended their breeding range into areas where they formerly did not occur; most of these documented range expansions occurred in the second half of the 19th century (Brown and Brown 1999a). In Canada, such range expansion (mostly northward) has been noted in Alberta (Erskine 1979), Quebec (Landry and Bombardier 1996), and Ontario (Cadman *et al.* 2007).

The Barn Swallow's current distribution has remained largely static since about 1980 in most provinces, but in the last two decades its occurrence has grown more sparse in the Southern Shield region of Ontario (Cadman *et al.* 2007) and across the Maritimes (Bird Studies Canada 2010a). In British Columbia, its current distribution (based on the first 3 years of breeding bird atlas data) is similar to that given for the period 1923-1994 (Campbell *et al.* 1997; Bird Studies Canada 2010b).

The extent of occurrence in Canada is about 7.3 million km^2 as measured using a minimum convex polygon based on Figure 2 (A. Filion pers. comm. 2011). An index of area of occupancy (IAO) in Canada based upon the 2x2 km grid cell method cannot be calculated at this time, because coordinates of the vast number of nesting sites are impossible to map. Nevertheless, any estimate of IAO would be far greater than COSEWIC's minimum threshold of 2000 km^2.

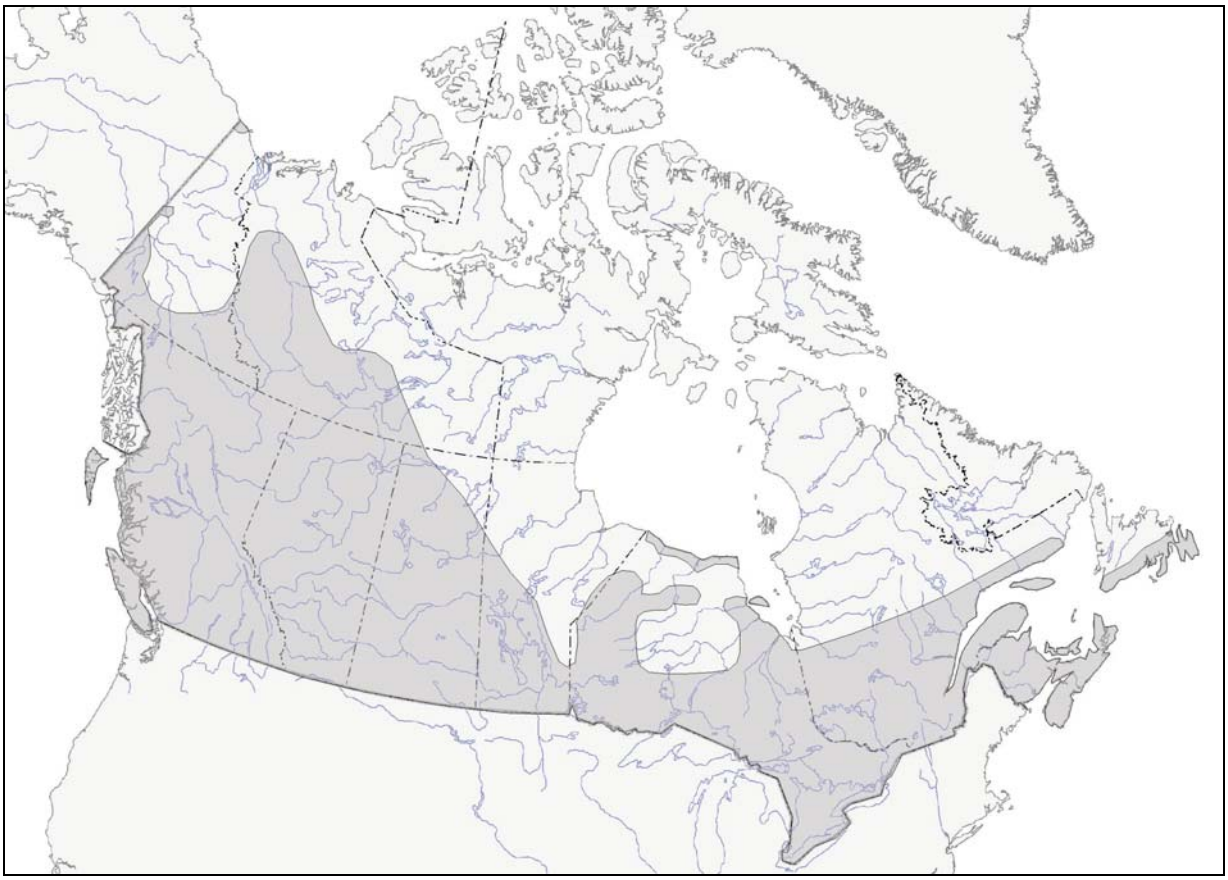

Figure 2. Canadian breeding range of the Barn Swallow (based on Godfrey 1986; Landry and Bombardier 1996; Campbell *et al.* 1997; Manitoba Avian Research Committee 2003; Cadman *et al.* 2007; Federation of Alberta Naturalists 2007; Bird Studies Canada 2010a,b,c). Areas inhabited in northern extremities of the range are mostly localized to human settlements and are less continuous than depicted.

Search effort

Search effort that yields distributional data on Barn Swallows mainly comes from intensive breeding bird atlas work conducted in the 1980s and in the 2000s in several provinces: Ontario (Cadman *et al.* 1987, 2007), Quebec (Gauthier and Aubry 1995), Alberta (Federation of Alberta Naturalists 2007), the Maritimes (Erskine 1992; Bird Studies Canada 2010a), and British Columbia (Bird Studies Canada 2010b). Distributional information on Barn Swallows is also provided by published summaries of historical observations compiled in the Northwest Territories (Bird Studies Canada 2010c), British Columbia (Campbell *et al.* 1997), Alberta (Semenchuk 1992), Saskatchewan (Smith 1996), Manitoba Avian Research Committee, Quebec (Cyr and Larivée 1995), and Nova Scotia (Tufts 1986).

HABITAT

Habitat requirements

Before European settlement, the Barn Swallow's nesting habitat was mainly characterized by natural features such as caves, holes, crevices, and ledges associated with rocky cliff faces (Speich *et al.* 1986; Peck and James 1987; Campbell *et al.* 1997). While there was undoubtedly a large shift in nesting site types following European settlement in North America (see below), Barn Swallows were probably already making use of First Nations habitations well before then. There are accounts of swallows nesting on Native American wooden habitations in the early 1800s (Macoun and Macoun 1909, cited in Brown and Brown 1999a). D. Fraser (pers. comm. 2010) notes that there were extensive First Nations villages along the entire coast of British Columbia prior to European contact, and that extensive clearings around these village sites are depicted in early illustrations. In eastern Canada, other First Nations peoples built wooden structures as well. For example, the Seneca, Cayuga, Onondaga, Oneida and Mohawk are collectively referred to as the *Haudenosaunee* or 'People of the Long House'. Some also practised burning and agriculture, thus creating open landscapes that Barn Swallows would presumably have found attractive.

With rapid expansion of the human population since European settlement, Barn Swallows have shifted largely from natural to artificial nesting sites (Speich *et al.* 1986). In Canada, it has been suggested that only about 1% of Barn Swallows now use natural nesting sites (Erskine 1979; Campbell *et al.* 1997). However, no systematic studies have ever been conducted to confirm this supposition. Indeed, the species persists in relatively "pristine" natural areas in at least some regions of Canada. For example, in British Columbia, D. Fraser (pers. comm. 2010) notes that Barn Swallows still nest in numbers on cliff faces, river edges and canyon walls.

Although Barn Swallows continue to nest in traditional natural situations, they are now most closely associated with human situations in rural areas. Such nesting sites include a variety of artificial structures that provide either a horizontal nesting surface (e.g., a ledge) or a vertical face, often with some sort of overhang that provides shelter. Nests are most commonly located in and around open barns, garages, sheds, boat houses, bridges, road culverts, verandahs and wharfs (e.g., Campbell *et al.* 1997), and are situated on such things as beams and posts, light fixtures, and ledges over windows and doors.

Barn Swallows typically select nesting and foraging sites close to open habitats such as farmlands of various description, wetlands, road rights-of-way, large forest clearings, cottage areas, islands, sand dunes, and subarctic tundra (Peck and James 1987). Because their nests are constructed of mud pellets, Barn Swallows require wet sites that have a source of nearby mud (Brown and Brown 1999a). In the tall-grass prairies of Oklahoma, Barn Swallows used habitats containing creeks and grasslands that have been annually burned (Coppedge *et al.* 2008). In the mixed-grass prairies of southern Alberta, Barn Swallows were positively associated with large fields and long

wetland edges (Koper and Schmiegelow 2006). In British Columbia, Barn Swallows have been recorded from near sea level to elevations of at least 2400 m and are frequently observed in suburban areas of cities and in towns and villages where they forage in gardens, parks, fields, and other similar open spaces. In the British Columbia countryside, they forage in and around coastal bays, lagoons, estuaries, beaches and harbours, powerline rights-of-way, forest and woodland glades, streams, sloughs, marshes, orchards, vineyards, farmyards, and feed lots (Campbell *et al.* 1997). In the Yukon, the species nests at low elevation, but has also been reported nesting to the treeline in alpine areas and even on the Arctic coast (Sinclair *et al.* 2003).

During migration, Barn Swallows gather in large numbers over marshes, lakes and sloughs to feed on aerial insects (Tufts 1986; Campbell *et al.* 1997). Roosting sites during fall migration in Canada are characterized by alder groves and cattail and bulrush marshes (e.g., Tufts 1986; Campbell *et al.* 1997).

On the wintering grounds, Barn Swallows are associated with various open, low vegetation habitats such as sugar cane fields (Hilty and Brown 1986; Ridgely and Tudor 2009), savannahs and ranch lands. In Latin America, they may be attracted to insects associated with burned or harvested sugarcane fields and the waste from the cane (Richard 1991; Hilty 2003; T. Salvadori pers. comm. 2010).

Habitat trends

There has been no net change in the availability of historic, natural nesting habitat provided by cliff faces and caves. However, the Barn Swallow benefited greatly by massive changes in the amount and diversity of anthropogenic nest sites and associated foraging habitats following European settlement.

In the 1800s and early 1900s, there was a significant increase in the amount of suitable anthropogenic habitat for Barn Swallows, especially in eastern North America. This was due to the large-scale removal of forests for agriculture, which not only provided suitable foraging habitat, but also greatly increased the availability of nest sites because of the wide-scale construction of barns and other wooden structures (Brown and Brown 1999a). Construction of bridges and culverts since the mid-1900s is also thought to be responsible for the species' range expansion (e.g., into areas of boreal forest; C. Machtans pers. comm. 2009).

Following this large pulse of expansion, the Barn Swallow's nesting habitat in rural regions has subsequently been decreasing in recent decades, primarily owing to the widespread conversion of old wooden farm buildings to more modern structures that often lack nesting structures for swallows and/or are typically sealed against their entry (Brown and Brown 1999a).

The amount of open foraging habitat in many parts of Canada (especially the east) has also been declining in recent decades due to conversion of dairy farms (pastures and hayfields) and wetlands to intensive agriculture such as row crops (Jobin *et al.*

1996; Latendresse *et al.* 2008). For example, in the St. Lawrence Lowlands of Quebec, the number of dairy farms fell by half from 1971 to 1988 due to farm abandonment, industrialization and urbanization (Jobin *et al.* 1996). The total area planted to row crops increased by 23% since 1960, due to, among other things, new policies favouring grain production for livestock (Jobin *et al.* 1996; Bélanger and Grenier 2002; Jobin *et al.* 2007). Loss of Barn Swallow foraging habitat has also occurred in Ontario (Cadman *et al.* 2007) and in the Maritime provinces (Stewart 2009), again owing to economic forces.

BIOLOGY

Many aspects of the biology of the Barn Swallow have been studied intensively in Europe for more than 30 years (Møller 1994 and others). In contrast, the biology of this species has been investigated in North America only recently (see Brown and Brown 1999a; Safran *et al.* 2005; Neuman *et al.* 2007).

Reproduction

Barn Swallows are socially monogamous, but extra-pair copulations are common, making this species genetically polygamous (Møller 1994). Females first breed at 1 year old; some males remain unpaired until 2 years old (NatureServe 2010).

Breeding pairs form each spring after arrival on the breeding grounds. Pairs that have nested together successfully may remain mated for several years (Shields 1984).

The Barn Swallow often nests solitarily, but is more frequently a colonial or semi-colonial species. Colonies in Canada contain up to 83 pairs (n = 135 colonies; Campbell *et al.* 1997), but generally average no more than 10 nests (n = 161 colonies; Peck and James 1987). Adult fidelity to breeding sites varies greatly among studies, ranging between 12 and 88% in eastern North America (Brown and Brown 1999a).

Nest construction starts in mid-May in Ontario (Peck and James 1987). Construction typically begins from 5 days to 2 weeks after spring arrival (Smith 1933; Barclay 1988). The cup-shaped nests are made principally of mud pellets, lined with grasses and feathers (Brown and Brown 1999a). From two studies in West Virginia and British Columbia, nest building takes an average of 6 to 15 days (Samuel 1971; Campbell *et al.* 1997), but takes less time if old nests are reoccupied and repaired (Brown and Brown 1999a). Indeed, old nests from previous years are commonly reused (Barclay 1988; Brown and Brown 1999a). In New York, 36% of returning birds used the same nests from the previous year (Shields 1984). In Oklahoma, 16% of returning birds reused the same nest, while most other returning birds moved within an average of only 12 m from their previous year's nest (Iverson 1988). Reusing old nests allows earlier breeding, which increases reproductive success owing to the ability to produce more than one brood per year (Safran 2006, 2007).

In Canada, most nests with eggs can be found from May through mid-July, but some nests still contain eggs into August (Peck and James 1987; Landry and Bombardier 1996; Campbell *et al.* 1997). Incubation, which is performed mainly by the female (Smith and Montgomerie 1991), lasts 13-14 days in Ontario (Peck and James 1987) and 12-17 days in British Columbia (Campbell *et al.* 1997).

Two broods are commonly produced each year in the southern part of the Barn Swallow's Canadian range, but these are rare in the far North (NatureServe 2010). In British Columbia, 37% of pairs laid a second clutch (Campbell *et al.* 1997). In Ontario, a second brood is common and is usually produced in the first nest (Peck and James 1987). In Manitoba, 90% of females initiated a second clutch (Barclay 1988).

Generally, first clutches are significantly larger than second clutches (Campbell *et al.* 1997; Brown and Brown 1999a). Clutch size may also be age-related. For example, in Europe, male Barn Swallows that reached at least 5 years of age (considered old birds) usually mated with females that produced larger clutches than those produced by the mates of younger males (Møller *et al.* 2005).

In Canada, clutch size is generally four to five eggs in the east (Ontario: range: 1-7 eggs, n = 467 nests; Peck and James 1987), and three to five in the west (British Columbia: range: 1-10 eggs, n = 1705; Campbell *et al.* 1997). Hatching success ($\geq$ 1 fledgling) in British Columbia is 70% (n = 609 nests; Campbell *et al.* 1997). Both parents equally tend nestlings (Brown and Brown 1999a). The nestling period is 19-24 days in British Columbia and extends from 10 May to 22 September, with 51% of nestling records being between 26 June and 30 July (Campbell *et al.* 1997).

In Ontario, an average of 3.1 fledglings survived in first broods (n = 20 nests) and annual reproductive success (including second broods) was estimated at 4.2 fledglings/pair (n= 201; Smith and Montgomerie 1991). In Manitoba, average annual reproductive success for birds with two broods was 6.9 ± 0.5 SD (range 3-11) fledglings/pair (Barclay 1988). Reasons for the differences in fledgling success between these two studies are unknown. After leaving the nest, fledglings stay together and are fed by parents for about a week (NatureServe 2010).

Survival

Few data exist on rangewide survival of Barn Swallows in North America. The mean annual apparent survival probability of adults in one large colony in Nebraska was estimated at 0.350 ± 0.054 SE (n = 300; Brown and Brown 1999a). In this study, survival probability did not differ between sexes. The apparent survival of adult Barn Swallows across the MAPS (Monitoring Avian Productivity and Survivorship) network in North America was estimated at 0.483 (SE 0.060; DeSante and Kaschube 2009). In Europe, studies of Barn Swallows reported a mean survival rate of 0.284 for adult males and 0.255 for adult females (Møller 1994). More recent European studies based on mark-recapture analyses report similar adult survival rates for males (0.343) and females (0.338; Møller and Szép 2002).

The Barn Swallow has a maximum reported life span of about 8 years (Clapp *et al.* 1983) and an average life span of 4 years (Turner and Rose 1989). With an annual survival rate of between 0.35 and 0.48 in North America (see above), and after accounting for delayed breeding by some males into their second year, the estimated generation time or average age of breeders is roughly 2-3 years (P. Blancher pers. comm. 2010).

Movements/dispersal

Barn Swallows are diurnal, long-distance migrants that winter in Central and South America (Brown and Brown 1999a). Most migrating Barn Swallows follow the Central American isthmus, but trans-Gulf and trans-Caribbean migrants have also been reported (Hailman 1962; Yunick 1977).

In Europe, there was a significant positive relationship between the mean first arrival date of Barn Swallows and mean March temperature (Sparks and Tryjanowski 2007). Migrating male European Barn Swallows with heavy infestations of ectoparasites arrived later than other males on the breeding grounds (Møller *et al.* 2004). There are no current indications if similar patterns occur in the North American Barn Swallow population.

In southern Canada, adults start to return in the spring by the end of April and the first week of May, but the main influx occurs in mid-May, tailing off in early June (Landry and Bombardier 1996). In the Fraser River delta in British Columbia, Barn Swallows have been reported throughout the year, and spring migrants can start to appear as early as late March (Campbell *et al.* 1997). In northern regions such as Yukon, they start to arrive between the second and third week of May (Sinclair *et al.* 2003).

In eastern Canada, fall migration generally starts by the end of August and extends until the first week of November (Landry and Bombardier 1996; Cyr and Larivée 1995). In the west, it begins in early August in British Columbia and peaks in late August or early September (Campbell *et al.* 1997).

After the breeding season and during fall migration, Barn Swallows gather in large numbers, often in association with other species of swallows, to forage and roost around marshes, lakes and sloughs. Roosting flocks often consist of several thousand birds (e.g., Tufts 1986; Weir 2008), whereas movements of actively migrating birds often consist of 200 or more birds (Campbell *et al.* 1997).

In Central and South America, the species can be found mainly from August to May, though some birds linger throughout the year (Hilty and Brown 1986; Brown and Brown 1999a; Ridgely and Tudor 2009).

Adults display a high-degree of fidelity to nest sites (Brown and Brown 1999a). Iverson (1988) reported that female Barn Swallows moved an average of 1.6 km from the previous year's nesting site (n=5). Yearlings often return to within 30 km of their natal sites (Shields 1984; Turner and Rose 1989). In Kansas, 95% of returning first-year birds (n=20 birds) were males, suggesting greater natal philopatry among males than among females (Mason 1953). No information is available on site attachment to wintering areas.

Diet and foraging behaviour

Barn Swallows feed on the wing, almost entirely on flying insects (99.8% of their diet during the breeding season; Beal 1918). In North America, the main insect groups are Diptera, but insects from many other families are consumed (Brown and Brown 1999a). Generally, the species prefers to feed on single, large insects rather than on swarms (Brown and Brown 1999a). Nestlings are fed a great variety of insects, but primarily flies; the most frequent families recorded in a study in Nebraska include members of the fly families Empididae, Dolichopodidae, and Syrphidae (Brown and Brown 1999a).

Barn Swallows forage individually or in small groups over open land and water. They forage at lower heights than most other North American swallows, usually <10 m above ground and often within 1 m (Brown and Brown 1999a). Most foraging takes place within a few hundred metres from the colony and usually within 500 m (Møller 1987). During the haying season, Barn Swallows are known to chase insects that flush up behind mowers. They also feed on insects flushed by farm animals, dogs, and humans moving through tall grass (Brown and Brown 1999a). The species will occasionally land on the ground to feed on dead insects or pick insects off plants as well as pick insects off the water surface (Brown and Brown 1999a). During bouts of cold weather, Barn Swallows often concentrate their foraging just above the surface of ponds and lakes (Brown and Brown 1999a), where the warmer water temperatures keep flying insects active.

Interspecific interactions

During the breeding season, interspecific interactions often involve other passerine species competing for the same nesting sites. For example, Barn Swallow numbers were reported to have decreased in the late 1800s in New England following the increase of House Sparrows (*Passer domesticus*) that usurped swallow nests (Brewster 1906 in Brown and Brown 1999a). Weisheit and Creighton (1989) reported a 45% reduction in Barn Swallow fledgling success at one site in Maryland due to competition with House Sparrows. In the Guelph area of Ontario, Barn Swallow nests are also usurped fairly frequently by sparrows, especially those nesting near barn entrances (M. Cadman pers. comm. 2010).

Competition for nest sites with other species of swallows has been reported in Nebraska, where Cliff Swallows (*Petrochelidon pyrrhonota*) usurped Barn Swallow nests (Brown and Brown 1999a). On the other hand, Barn Swallows sometimes use old nests of other bird species that also nest on human-made structures, such as Eastern Phoebe (*Sayornis phoebe*) and American Robin (*Turdus migratorius*; Peck and James 1987).

Avian predators of nestlings and/or eggs include several raptor species, corvids, House Wrens (*Troglodytes aedon*), and European Starlings (*Sturnus vulgaris*), while mammalian predators include feral cats, squirrels and mice (Campbell *et al.* 1997; Brown and Brown 1999a).

Home range and territory

Barn Swallows are not territorial while foraging. In West Virginia, breeding adults will venture out to within 1.2 km of their nest site (equivalent to a foraging home range of 4.5 km^2; Brown and Brown 1999a). Adults do not defend breeding "territories" per se, but do have minimum separation distances around active nests – ranging from 1.7 m in British Columbia (Campbell *et al.* 1997) to 3.7 m in Mississippi and Oklahoma (Grzybowski 1979; Lohoefener 1980).

Behaviour and adaptability

Across their global range, Barn Swallows have proven themselves to be highly adaptable to changes in the availability of different types of nesting sites, as demonstrated by their propensity to nest in and on a variety of human-made structures. On the other hand, it is unknown the extent to which the species may be able to compensate for the recent decrease in the numbers of wooden farm buildings in many rural regions. In addition to wooden outbuildings, Barn Swallows have adapted to the increase of human infrastructure along road systems such as bridges and culverts. The species is capable of colonizing regions away from open agricultural areas as a result (e.g., logging roads in boreal forests; C. Savignac, pers. obs. 2009; C. Machtans pers. comm. 2009).

In Europe, Barn Swallows are responding to climate change by nesting earlier due to warmer temperatures in spring (Møller 2008).

POPULATION SIZES AND TRENDS

Sampling effort and methods

North American Breeding Bird Survey (BBS)

The BBS is a program that has been monitoring North American breeding bird populations since 1966 (Sauer *et al.* 2011). Breeding bird abundance data are collected by volunteers at 50, 400-m radius stops spaced at 0.8 km intervals along permanent 39.2 km roadside routes (Environment Canada 2010). In Canada, the surveys are generally conducted in June, at the height of the breeding period of most bird species. Surveys start one half hour before sunrise and last 4.5 hours. In Canada, BBS data give the most reliable estimations of the Barn Swallow's population size and trends.

The main advantages of the BBS are that data from across much of North America are collected according to a single standardized method and the surveys employ random start points, thus enhancing regional representation of the avifauna (roadside bias notwithstanding; Blancher *et al.* 2007). BBS is a suitable method for surveying Barn Swallows because the species is easily detected, most survey routes are located in suburban and rural regions where the species is most common, and the BBS covers most of the species' range in Canada (except extreme northern regions where it is far less abundant). One limitation of the BBS is that it probably does not wholly track colonial and semi-colonial species like the Barn Swallow. It also does a poor job of monitoring populations in remote, natural situations associated with cliff faces. Another limitation is that the database extends back only to the late 1960s, and therefore does not provide a full historical context.

Breeding Bird Atlases

Breeding bird atlas projects cover most of the Barn Swallow's breeding range in Canada. Atlas projects that were completed in the 1980s and repeated in the 2000s in Ontario, Alberta and the Maritimes provide 20-year comparisons of changes in breeding distribution (Cadman *et al.* 2007; Federation of Alberta Naturalists 2007; Bird Studies Canada 2010a). A second atlas project in Quebec began in 2010, while British Columbia's first 5-year breeding bird atlas started in 2007 and another was launched in Manitoba in 2010.

In addition to distributional information, population estimates of Barn Swallows can also be derived from recent atlas projects that incorporate large numbers of point counts that are conducted both on and off roadsides. Relative abundance mapping from this type of work provides an excellent depiction of species abundance patterns across large landscapes (see Cadman *et al.* 2007).

A major limitation of atlas projects is that they are typically conducted only at 20-year intervals. In addition, changes in species occurrence (based on presence/absence data within 10 x 10 km squares) of widespread, common species like the Barn Swallow underestimate changes in actual population size (Francis *et al.* 2009).

Étude des populations des oiseaux du Québec (ÉPOQ) / Study of Quebec Bird Populations (SQBP)

In Quebec, the SQBP database, which manages the bird checklists produced by thousands of volunteers since 1969 (totalling more than 500,000 checklists), is an additional reference for determining the Barn Swallow's regional population trend (G. Falardeau pers. comm. 2009). The SQBP database covers all regions south of the 52nd parallel and all seasons (Cyr and Larivée 1995). The abundance index is one of the two abundance measures produced by ÉPOQ and is a measure of the number of birds observed relative to the number of checklists produced.

The strength of this survey method lies in the fact that it covers most of the breeding range of the species in Quebec (Cyr and Larivée 1995). However, the current analysis method does not take into account the number of observers per checklist, weather conditions, or spatial variations in observation effort, but simply the number of hours of observation (Cyr and Larivée 1995). Nonetheless, the trends produced by the SQBP database are correlated with those of the BBS and generate adequate trend assessments (Cyr and Larivée 1995; Dunn *et al.* 1996).

Abundance

Numbers of Barn Swallows increased with the arrival of European settlers due to increased availability of suitable nest sites (Brown and Brown 1999a). The global population of Barn Swallows in the 1990s was estimated at 190 million adults (PIF LPED 2007), whereas the North American population was estimated at 51 million adults and the Canadian population at roughly 10.9 million (Table 1). Hence, Canada supports about 22% of the North American population and about 6% of the global population. The above abundance estimates are based on BBS count data from the mid-1990s; the current species' abundance in Canada is about 55% lower when declines that have occurred since then are taken into account (see **Fluctuations and trends**). Factoring in these declines yields a current population estimate of about 4.9 million mature individuals (equivalent to about 2.45 million breeding pairs).

Table 1. Population estimates and relative abundance of the Barn Swallow in Canada based on 1990-1999 Breeding Bird Survey data (PIF LPED 2007). Population estimates in this table do not take recent population declines into account (see text).

Province / Territory	Population estimate (birds)*	Relative BBS abundance (birds/route)	Standard deviation of relative abundance	Number of BBS routes	Number of routes with detections of Barn Swallows
SK	2,000,000	9.73	0.48	62	61
AB	1,800,000	7.18	0.41	131	127
ON	1,700,000	4.65	0.23	131	114
BC	1,600,000	4.44	0.50	100	75
QC	1,501,000	2.99	0.22	99	77
MB	1,500,000	6.33	0.54	59	52
NT	305,000	0.86	0.35	8	5
NB	200,000	7.83	1.09	30	27
NS	190,000	8.84	1.60	32	31
YT	60,000	0.36	0.14	29	7
PE	6,000	2.77	0.67	4	4
NL	4,000	0.03	0.01	29	4
Total	**10,866,000**			**1,363**	**587**

* Details of the methods are presented in Blancher *et al.* 2007.

Fluctuations and trends

As noted elsewhere in this report, there was a large increase in Barn Swallow populations across Canada following European colonization (Landry and Bombardier 1996; Campbell *et al.* 1997). Since the 1980s, however, data from BBS, breeding bird atlas projects and ÉPOQ all point to a significant and persistent decline of Barn Swallow populations. In North America, population trends tend to be slightly positive or stable in the southern regions of United States, but become progressively negative northward and eastward through the species' breeding range. As such, Barn Swallow declines tend to be most pronounced in the northeastern states and eastern Canada (Nebel *et al.* 2010).

North American Breeding Bird Survey

In Canada, long-term BBS data show a statistically significant decline of 3.6% per year between 1970 and 2009 (Environment Canada 2010; Figure 3; Table 2), which corresponds to an overall population decline of about 76% over the last 40 years. For the most recent 10-year period (1999 to 2009, or roughly three generations), BBS data show a significant decline of 3.5% per year (Table 2), which represents a 30% decline over the decade (95% CI = -39.5% to -18.3%).[1]

1 BBS data for Canada have recently been re-analyzed by the United States Geological Survey using a hierarchical approach (Sauer *et al.* 2011). This analysis method results in a significant decline of 4.1% per year for the most recent 10-year period (34% overall). The 95% Confidence Intervals around this estimate are -5.0% to -3.3%. The lower value produces an overall decline of 40%.

BBS results suggest that the species' decline started sometime in the mid-1980s (see Figure 3), which coincides with that seen in many other species of aerial insectivores (Nebel *et al.* 2010). In keeping with the latitudinal and longitudinal patterns suggested by Nebel *et al.* (2010), Barn Swallow populations in Canada have decreased most profoundly in the Maritimes, where the annual decrease over the most recent 10-year period was 8.1% and 11.8% in New Brunswick and Nova Scotia, respectively (Table 2).

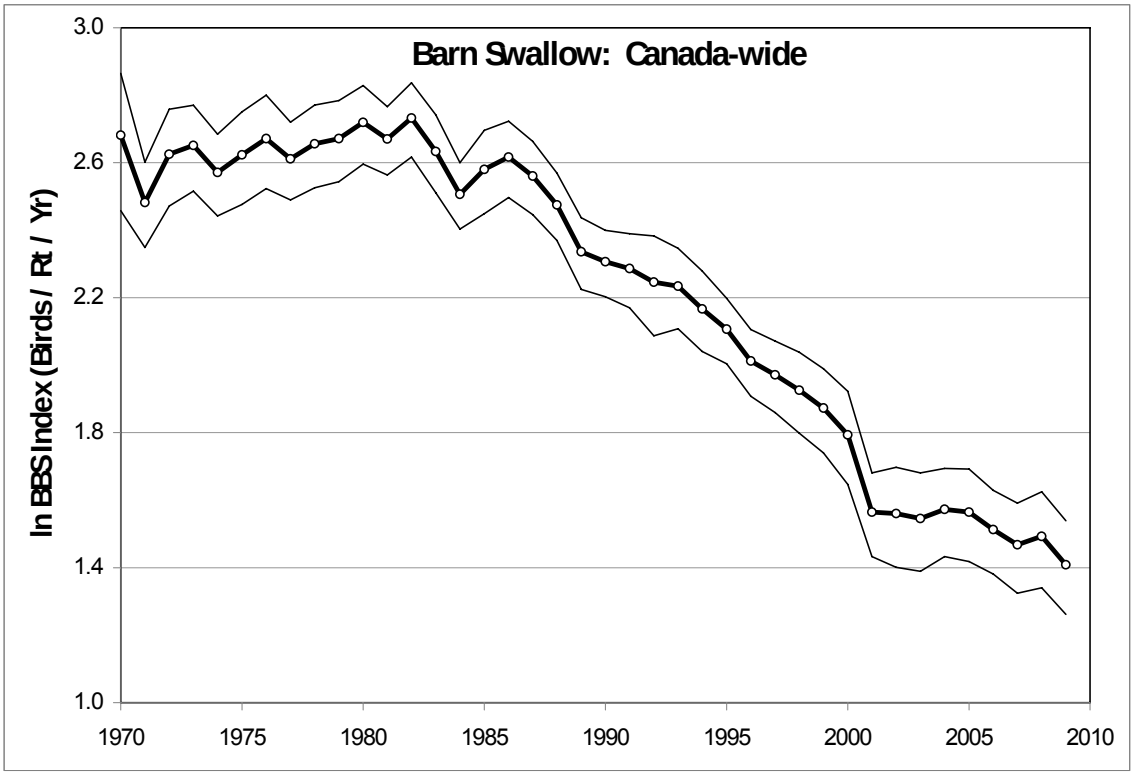

Figure 3. Trend in Barn Swallow annual abundance indices in Canada from 1970 to 2009, based on Breeding Bird Survey data (from Environment Canada 2010, courtesy P. Blancher). Indices are plotted on a log scale, showing 95% Confidence Intervals.

Table 2. National and regional annual average estimates of percent population change (including 95% Confidence Intervals) for the Barn Swallow in Canada over the long- and short-terms, based on Breeding Bird Survey results (from Environment Canada 2010).

	Long-term Trend (1970-2009)					10-year Trend (1999-2009)				
Region	%/yr[a]	Lower CI	Upper CI	P	n[b]	%/yr[a]	Lower CI	Upper CI	P	n[b]
CANADA	**-3.6**	-4.1	-3.0	0.000	708	**-3.5**	-4.9	-2.0	0.000	603
BC	**-4.7**	-6.6	-2.8	0.000	103	-3.5	-9.3	2.8	0.269	85
AB	**-3.4**	-4.4	-2.4	0.000	139	**-5.1**	-8.2	-1.9	0.002	123
SK	**-2.9**	-3.9	-1.8	0.000	76	-3.9	-7.8	0.3	0.065	56
MB	**-2.0**	-3.1	-0.8	0.001	64	0.4	-2.7	3.5	0.814	64
ON	**-2.5**	-4.1	-1.0	0.002	134	**-3.5**	-6.6	-0.3	0.031	119
QC	**-5.8**	-6.7	-5.0	0.000	102	**-4.3**	-7.3	-1.3	0.006	80
NB	**-7.7**	-9.4	-6.1	0.000	35	**-8.1**	-13.8	-2.1	0.011	29
NS	**-5.8**	-7.1	-4.4	0.000	32	**-11.8**	-16.7	-6.6	0.000	29

[a] Statistically significant values (P<0.05) are highlighted in grey
[b] n = number of survey routes used in the analysis.

Breeding Bird Atlases

A comparison of the Barn Swallow's probability of occurrence in Ontario between the first (1981-1985) and second (2001-2005) atlas periods shows an overall significant decline of 35% (Cadman *et al.* 2007). Declines appear to have been strongest in the Northern Shield (51%), the Southern Shield (32%) and the Lake Simcoe-Rideau region (7%; Cadman *et al.* 2007; Figure 4).

In the Maritimes, the number of atlas squares where Barn Swallows occur declined over the 20-year period between 1989 and 2010 (Figure 5). Based on results of preliminary unpublished analyses conducted by P. Taylor, who took survey effort into account, the probability of detection for Barn Swallow decreased significantly in all three Maritime provinces between atlas periods – from 0.87 to 0.53 (New Brunswick), from 0.90 to 0.67 (Nova Scotia), and from 0.93 to 0.48 (Prince Edward Island; B. Whittam pers. comm. 2010).

Barn Swallow populations have also declined substantially in several National Parks in the Maritimes (Fundy, Kouchibouguac, Kejimkujik and Cape Breton Highlands). The species might already be extirpated from Prince Edward Island National Park and possibly from Cape Breton Highlands National Park, two sites where it was fairly common in the late 1970s (S. Blaney pers. comm. 2009).

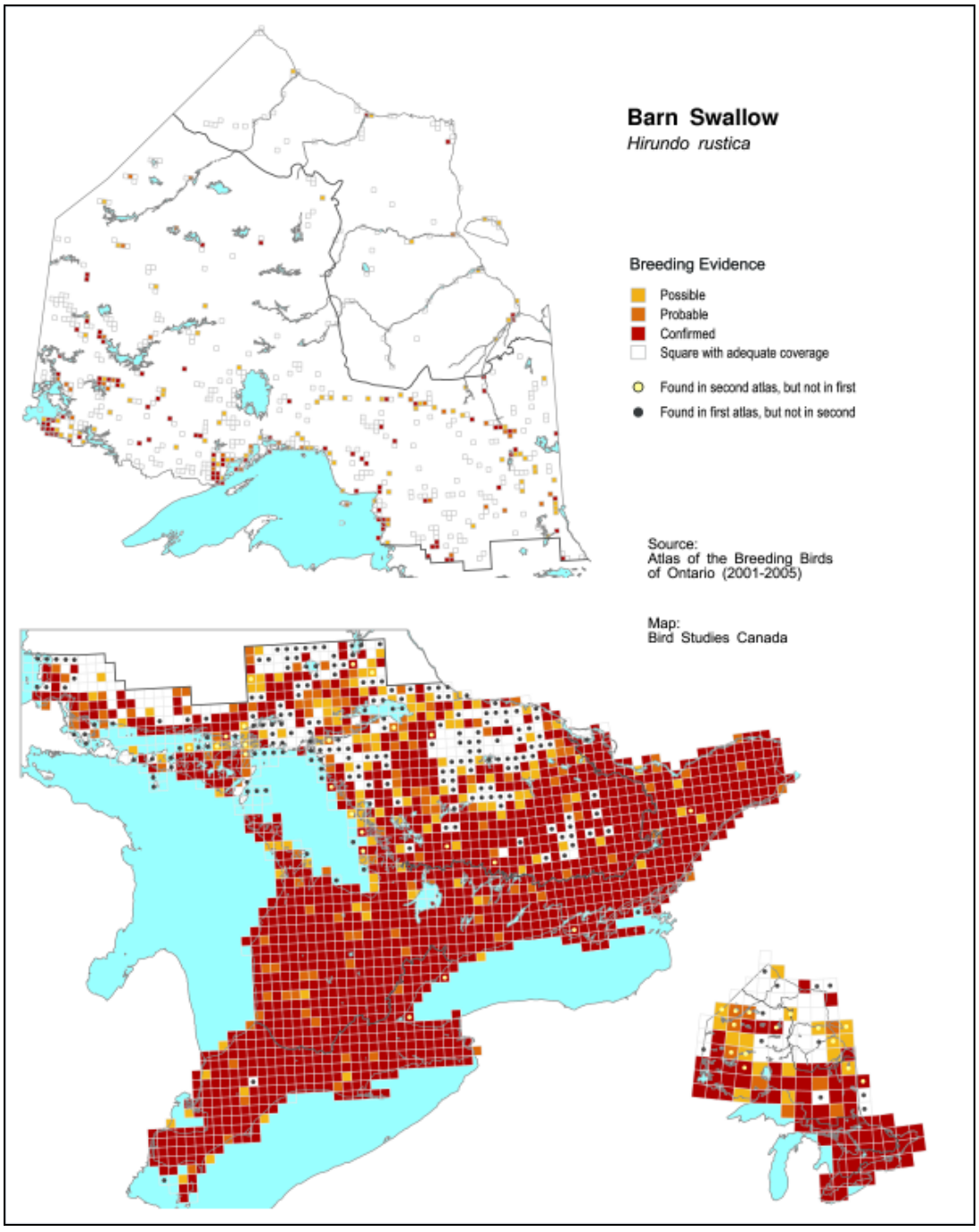

Figure 4. Ontario distribution of the Barn Swallow during the period 2001-2005 (reproduced with permission from Cadman *et al.* 2007). In the map of southern Ontario, squares with black dots are those in which the species was found in the first atlas period (1980-1985), but not in the second atlas (2001-2005). In the north, blank squares "with adequate coverage" are those that received at least 20 person-hours of survey coverage.

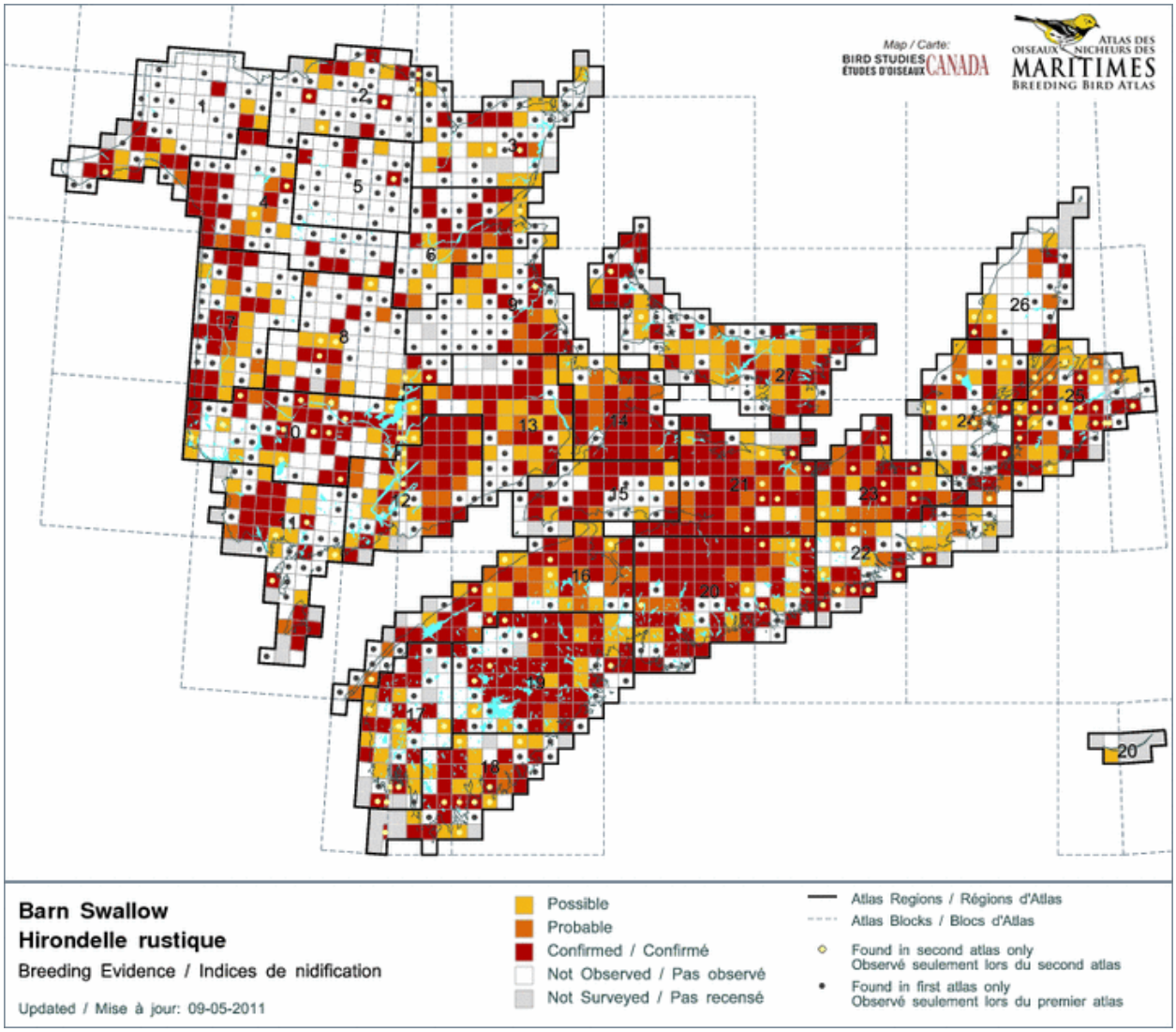

Figure 5. Maritimes breeding bird atlas distribution of the Barn Swallow during the period 2006-2010 (reproduced with permission from Bird Studies Canada 2010a). Squares with black dots are those in which the species was found in the first atlas period (1986-1990), but not in the second. Conversely, squares with yellow dots are those that were not occupied by Barn Swallows in the first atlas, but were occupied in the second.

In Alberta, comparison of the two atlas periods indicates that the Barn Swallow's relative abundance has declined in all Natural Regions of the province since the first atlas period that began in 1986 (Federation of Alberta Naturalists 2007).

Étude des populations des oiseaux du Québec (ÉPOQ) / Study of Québec Bird Populations (SQBP)

For the period 1970-2008, the ÉPOQ database shows a significant long-term decline in Barn Swallow abundance in Quebec of 2.4% per year ($P < 0.001$; Larivée 2009; Figure 6), representing a 60% decline over 38 years.

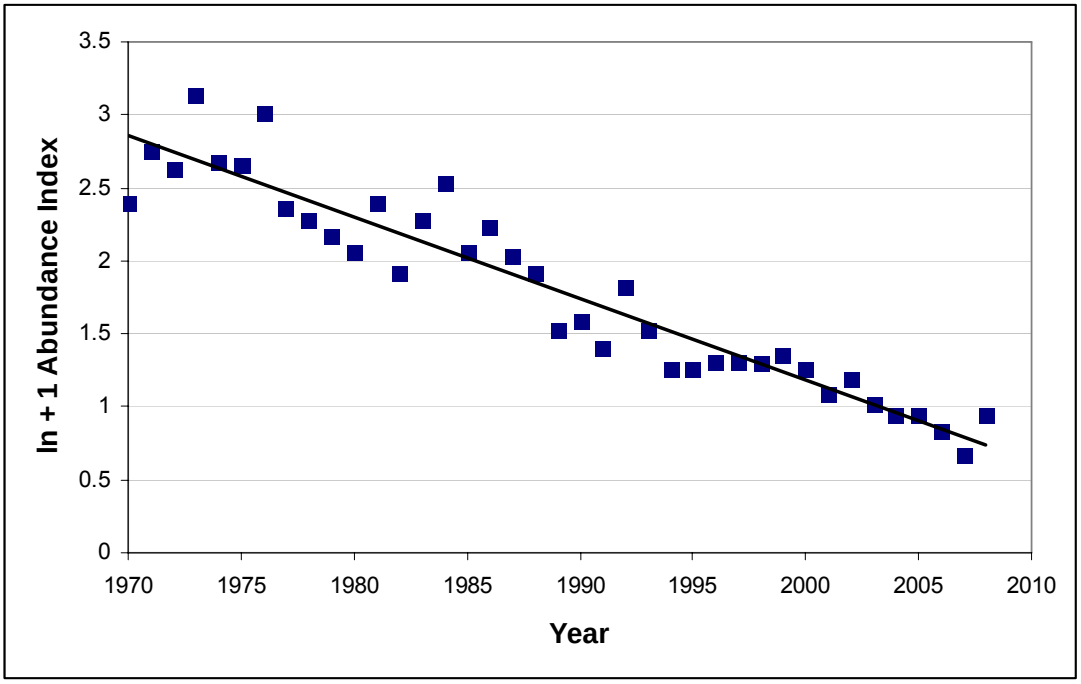

Figure 6. Annual indices of population change for the Barn Swallow in Quebec between 1970 and 2008 based on ÉPOQ data (Larivée 2009). Indices are plotted on a log scale,

Population trends in Europe

Burfield and van Bommel (2004) reported that the Barn Swallow's European breeding population underwent a moderate decline between 1970 and 1990. Although declines abated or even reversed in some countries during 1990–2000, the species continued to decline across much of Europe, and underwent a small decline overall. They concluded that "its population has clearly not yet recovered to the level that preceded its initial decline, and consequently it is evaluated as Depleted."

Population trend summary

In summary, BBS data show significant declines in Barn Swallow populations in Canada in recent decades, beginning sometime in the mid- to late 1980s. Evidence for this decline is supported by results from a variety of other types of regional surveys, including the Alberta, Ontario and the Maritimes breeding bird atlas projects and from Étude des populations des oiseaux du Québec surveys. Despite these losses, both the current distribution and abundance of the Barn Swallow in Canada (and North America) are still greater than they were before European settlement created large amounts of artificial nesting habitat and foraging opportunities that were readily exploited by the species. Nevertheless, declines are pervasive across most of the species' North American range, including the northern U.S. (see below).

Rescue effect

In the event of the extirpation of the Canadian population, immigration of individuals from the US could be viewed as likely, considering that the species is currently still common in most American states bordering Canada (NatureServe 2010). Despite the seemingly robust US population, recent (10-year) declines are apparent for virtually all states bordering southern Canada (Sauer *et al.* 2011; Table 3) – a pattern that diminishes the long-term potential for rescue.

Table 3. Barn Swallow population trends in adjacent jurisdictions of the United States, from west to east, for the period 1999-2009, based on Breeding Bird Survey results (Sauer *et al.* 2011).

State	Trend (average annual % change)	95% CI (lower)	95% CI (upper)	N (# of routes)
Washington	-3.8	-5.5	-2.1	83
Montana	-1.6	-4.0	0.8	54
Idaho	0.2	-2.9	3.6	48
North Dakota	-2.9	-5.3	-0.8	47
Wisconsin	-1.3	-3.0	0.4	95
Minnesota	-1.4	-3.1	0.2	79
Michigan	-1.5	-3.7	0.2	87
Pennsylvania	-1.2	-2.4	0.0	125
Ohio	-0.4	-2.0	1.0	78
New York	-1.8	-3.2	-0.4	123
Vermont	-4.2	-6.6	-2.5	26
New Hampshire	-4.7	-6.5	-3.4	25
Maine	-6.4	-8.4	-4.4	65

THREATS AND LIMITING FACTORS

The causes of the recent Barn Swallow declines, and indeed of those for many other aerial insectivore birds in Canada, are recent and poorly understood (Nebel *et al.* 2010). Something appears to have happened sometime in the mid- to late 1980s that seems to have triggered a sharp decline. The threats listed below are possible causes, and they are likely acting additively in unknown ways. As such, it is difficult to assign them in terms of priority. More research is necessary to determine the extent to which population bottlenecks are occurring on the breeding grounds versus the wintering grounds.

Habitat loss and degradation on the breeding grounds

In the last few decades, loss of nesting habitat due to the replacement of older-style wooden farm structures by modern buildings that lack easy access to suitable nesting sites has been cited as a principal reason for recent Barn Swallow declines in North America (Erskine 1992; Campbell *et al.* 1997; Brown and Brown 1999a; Cadman *et al.* 2007; Federation of Alberta Naturalists 2007). Even when newer structures remain

open and accessible to Barn Swallows, Tate (1986) noted that nestlings are far more subject to heat-induced mortality in modern metal-roofed barns than in older barns with wooden roofs.

The extent to which declines in the availability of artificial nesting sites is actually limiting the Canadian population is unclear. There are growing numbers of reports of suitable buildings, which were formerly heavily used by Barn Swallows, now standing empty. Moreover, the timing of the onset of Barn Swallow declines in the mid- 1980s does not appear to coincide well with changes in the availability of artificial nest sites.

The decline of Barn Swallows has also been attributed to loss of foraging habitat due to a reduction in the amount of open, grassland types of agricultural habitats (Cadman *et al.* 2007). Several studies, mainly conducted in Europe, have shown a strong link between maintaining farming activities with domestic animals (especially cattle) in the landscape and the occurrence of large colonies of Barn Swallows (Møller 2001; Ambrosini *et al.* 2002a,b; Evans *et al*. 2007). Generally, the removal of cattle from pastures causes a decline in aerial invertebrate abundance, which has been reported to be more than twice as abundant over pasture fields compared to cereal fields and silage (Ambrosini *et al.* 2002a,b; Evans *et al.* 2007). This directly affects swallow reproductive output and can cause the total disappearance of the species from local areas (Møller 2001a; Ambrosini *et al.* 2002a,b; Evans *et al.* 2007). There are currently no similar studies for North America, but the rapid conversion of cattle pastures and dairy farms to cereal crops in at least some regions (e.g., Jobin *et al*. 2007; Latendresse *et al*. 2008) could play an important role in the decline of Barn Swallows in parts of eastern Canada. Loss of foraging habitat is also occurring due to reforestation of large tracts of eastern Canada (Jobin *et al.* 2007; Latendresse *et al.* 2008), such as in the southern Shield region of Ontario, where it has been suggested that declines of Barn Swallows are linked to abandoned, non-productive farmlands returning to forest conditions (Cadman *et al.* 2007).

Elsewhere in Canada, however, the area of suitable foraging habitat may even be increasing, even in regions where Barn Swallow populations are in decline. For example, the area of open foraging habitat in the prairies is increasing due to the conversion of cropland to non-native grassland for pasture and hay (cattle numbers are increasing in the prairies) and to the conversion of forest to farmland (D. Duncan pers. comm. 2010). Watmough and Schmoll (2007) examined trends in habitat in the prairies during the period 1985 to 2001. While they did find a small decrease in the amount of natural grassland cover (from 24.2 to 23.6% of the landscape), they also found that the area of row cropland decreased, and that the area of planted pasture and hayfield increased from 9 to 16% of the landscape. This suggests that loss of foraging habitat does not, by itself, explain Barn Swallow population declines.

Large-scale changes in insect prey

It has been suggested that the decline of Barn Swallows in Canada, as for several other aerial-foraging avian insectivores, could be related to large-scale declines in the abundance of flying insects and/or a change in their seasonal phenologies (see Nebel *et al.* 2010). Light pollution in and around urban centres, climate change (see below), loss and degradation of wetlands, acid precipitation and resulting calcium depletion, changes in agricultural landuse practices (e.g., loss of pastureland in some regions), large-scale use of pesticides, and the recent genetic development of insect-resistant row crops are among the many factors that could be affecting insect abundance (McCracken 2008; Nebel *et al.* 2010; M. Cadman pers. comm. 2010).

Climate change

Studies of the effect of climate change on reproductive success of Barn Swallow have shown contrasting results between Europe and North America. In Europe, for example, climate change has been found to enable Barn Swallows to reproduce earlier in spring and to increase reproductive success (Møller 2008). On the other hand, climate change has been proposed as an important limiting factor affecting several species of aerial insectivores, including Barn Swallows, in North America (Nebel *et al.* 2010). This hypothesis is based on studies conducted in the northeastern United States and Europe where the El Niño Southern Oscillation and the North Atlantic Oscillation are suggested to have significantly reduced fecundity and survivorship in several species of insectivorous birds (Sillett *et al.* 2000; Stokke *et al.* 2005). By nesting earlier, insectivorous species could face greater risk of mortality and increased energetic costs during bouts of inclement weather (cold snaps) that occur in early spring and/or during the breeding season because of suppression of insect prey (Anthony and Ely 1976; Newton 1998; Brown and Brown 1999a). More studies are needed to test this hypothesis, and particularly how it might be operating across the Barn Swallow's range.

Interspecific competition for nest sites from invasive species

As noted earlier (see **Interspecific interactions**), Barn Swallow nests are frequently usurped by non-native House Sparrows, which can reduce swallow fledging success. While this threat could indeed have negative population-level effects, House Sparrow populations have been declining significantly in Canada and across most of North America persistently over the past several decades (Sauer *et al*. 2011; Environment Canada 2010). Not only has the level of this threat been diminishing over time, its timing does not overlap with the onset of recent decline in Barn Swallow populations. Nevertheless, House Sparrows remain numerous and widespread, and the threat they pose is likely additive.

Parasitism

Unlike many other songbird species, Barn Swallows are rarely exposed to nest parasitism by Brown-headed Cowbirds (Brown and Brown 1999a). Nestlings are, however, frequently exposed to high rates of ectoparasitism (mites, fleas, feather lice, blowflies), which can limit productivity. In British Columbia, the majority of mortality in nestlings resulted from nest infestation with the larvae of the parasitic blowfly (*Protocalliphora*), which often results in the young falling from the nest or the death of the young in the nest (Campbell *et al.* 1997).

Barn Swallows often reuse their nest sites from one year to the next and often within the same season. Hence, nests are often infested with a large number of ectoparasites (Barclay 1988; Møller *et al.* 2001a). Ectoparasitism by mites and blowflies causes delayed breeding, reduces the incidence of second clutches, induces nest failure, reduces reproductive success (up to 33%), slows the growth rate of young, reduces the condition of offspring produced, and decreases fledging success in Barn Swallows (Shields and Crook 1987; Barclay 1988; Campbell *et al.* 1997; Brown and Brown 1999a; Saino *et al.* 1999; Saino *et al.* 2002). Little information on the effect of parasites is available for North America, nor is there any information as to whether rates or severity of infestations has been increasing.

Human persecution

Although not quantified, unknown numbers (perhaps many) of Barn Swallow nests are intentionally destroyed, because the droppings that accumulate beneath them create sanitary and aesthetic issues (Brown and Brown 1999a). Nests are also disturbed or removed from bridges and other infrastructure during routine maintenance activities (Brown and Brown 1999a; N. Mahony and M. Chutter pers. comms. 2010). There is also the potential for harvest of Barn Swallows for food at large wintering roosts in South America (Brown and Brown 1999a). Whether there has been any recent increase in the intensity of human persecution, which might correspond to the timing of recent declines in Barn Swallow populations, is unknown.

Other threats and limiting factors

Very little is known about the Barn Swallow's ecological needs or threats on its Latin American wintering grounds. More research is needed in this large region, where the bird spends most of its life.

Other threats potentially affecting Barn Swallows include mortality due to increased numbers and intensity of hurricanes encountered during migration (e.g., Newton 1998), water contamination (Custer *et al.* 2006), and poisoning by pesticides (Turner 1991; Basili and Temple 1999; Nebel *et al.* 2010). Another threat is increased nest predation from non-native predators such as Fox Squirrels (*Sciurus niger*) in western Canada, rats in barns, and possibly increased predation of adults from increasing populations of several native species of diurnal raptors.

PROTECTION, STATUS, AND RANKS

Legal protection and status

In Canada, the Barn Swallow and its nests and eggs are protected under the *Migratory Birds Convention Act, 1994* (Environment Canada 2004), and related provincial legislation governing native species of migratory birds.

Non-legal status and ranks

At the global level, the Barn Swallow is considered 'Secure' (G5, Table 4). It is considered as 'Least Concern' according to the IUCN Red List (BirdLife International 2009). In Europe, it is 'Depleted' (Burfield and van Bommel 2004). In the United States, it is not listed under the *Endangered Species Act* and is considered 'Secure' (N5B). It is not considered a 'Watch List Species' or a 'Stewardship Species' in the North American Landbird Conservation Plan (Rich *et al.* 2004). In Canada, it is identified as being 'Secure' in six provinces/territories and as 'Sensitive' in six (Canadian Endangered Species Conservation Council 2006; Table 4).

Habitat protection and ownership

In Canada, most suitable Barn Swallow breeding habitat is located on private land, which for the most part is not protected. Little information is currently available on the amount of suitable habitat and the level of habitat protection for Barn Swallows on public lands in Canada. There is no doubt that they occur widely on public lands that are protected as federal and provincial protected areas, such as national parks (the Barn Swallow is present in at least 44 protected areas managed by Parks Canada; Parks Canada 2009), Migratory Bird Sanctuaries, National Wildlife Areas, and provincial parks.

Table 4. Ranks assigned to the Barn Swallow in North America, based on NatureServe (2010) and General Status Ranks (CESCC 2006).

Region	Rank*	General Status
Global	G5	---
United States	N5B	---
Canada	N5B	Secure
British Columbia	S3S4B	Sensitive
Alberta	S5	Sensitive
Newfoundland & Labrador	S1S2B	Secure**
New Brunswick	S3B	Sensitive
Nova Scotia	S4B	Sensitive
Prince Edward Island	S3B	Sensitive
Saskatchewan	S5B, S5M	Secure
Manitoba	S4B	Secure
Ontario	S4B	Secure
Quebec	S4B	Secure
Yukon Territory	S4B	Secure
Northwest Territories	SNRB	Sensitive

* G = is a global status rank; S = rank assigned to a province or state; N = is a national status rank. S1 indicates that a species is critically imperiled because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines, making it especially vulnerable to extirpation; S2 indicates that a species is imperiled because of rarity or other factors making it very vulnerable to extirpation, usually with 6 to 20 occurrences or few individuals remaining (i.e., 1000 to 3000); S3 indicates that a species is vulnerable at the subnational level because it is rare or uncommon, or found only in a restricted range, or because of other factors making it vulnerable to extirpation; S4 indicates a species is apparently secure; S5 indicates that a species is secure because it is common, widespread, and abundant in the state/province.

** Despite small numbers of individuals, the general status for Newfoundland & Labrador was recently changed from “May be at risk” to “Secure” owing to current population stability (*fide* Shelley Pardy Moores 2010).

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The following list includes only those persons who contributed substantial information to the report:

Blancher, Peter. Scientist, Environment Canada, National Wildlife Research Centre, 1125 Colonel By Drive, Ottawa, Ontario K1A 0H3

Blaney, Sean. Botanist and Assistant Director. Atlantic Canada Conservation Data Centre. P.O. Box 6416, Sackville, NB. E4L 1C6. Email correspondence to C. Savignac. November 2008.

Filion, Alain. Scientific and Geomatics Project Officer, COSEWIC Secretariat, Environment Canada, Ottawa, ON.

Nantel, Patrick., unpubl. data. 2009. Email correspondence to C. Savignac. July 2009. Specialist, Species Assessment. Ecological Integrity Branch, Parks Canada.

Shaffer, Francois. Wildlife Biologist. Canadian Wildlife Service, Environment Canada, Quebec Region. 1141, route de l'Église, P.O. Box 10100, Sainte-Foy, Quebec G1V 4H5. Email correspondence to C. Savignac. November 2008.

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BIOGRAPHICAL SUMMARY OF REPORT WRITER

Carl Savignac is director of Dendroica Environnement et Faune, an environmental consulting firm specializing in studies on the conservation of species at risk, wetlands conservation and the assessment of the impacts of industrial development projects on birds. Carl has been studying birds for over 19 years and has conducted numerous field studies in several Canadian provinces and territories in both Canada's temperate and boreal forests. He has written several scientific reports and publications on woodpeckers, raptors, passerines and species at risk including seven provincial and federal species status reports. He is currently coordinating stewardship conservation projects on the Red-headed Woodpecker, Golden-winged Warbler and American Ginseng in southern Quebec.