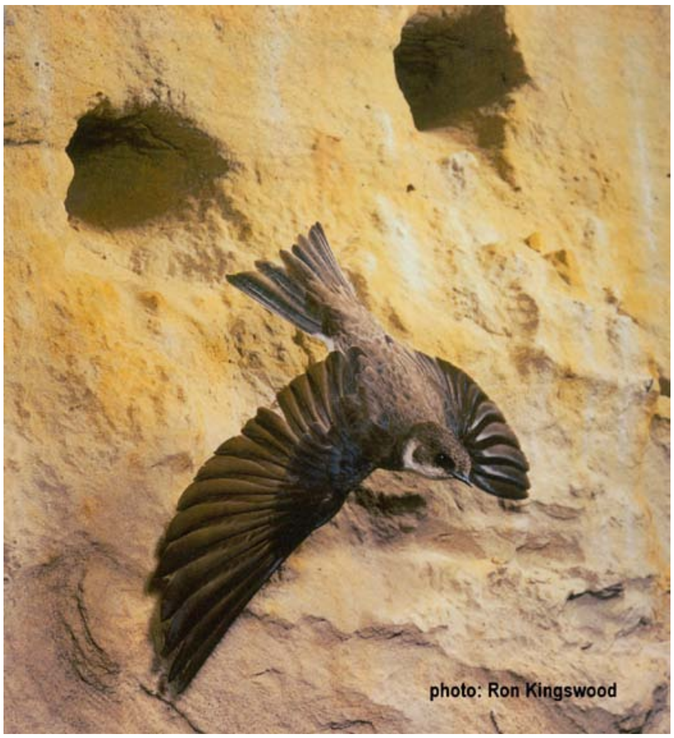
COSEWIC
Assessment and Status Report

on the

Bank Swallow
Riparia riparia

in Canada



THREATENED
2013

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

COSEWIC. 2013. COSEWIC assessment and status report on the Bank Swallow *Riparia riparia* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 48 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).

Production note:
COSEWIC would like to acknowledge Myles Falconer and Debra Badzinski for writing the status report on the Bank Swallow, *Riparia riparia,* in Canada, prepared under contract with Environment Canada. The report was overseen and edited by Marty Leonard, Co-chair of the COSEWIC Birds Specialist Subcommittee.

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

Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur L'Hirondelle de rivage (*Riparia riparia*) au Canada.

Cover illustration/photo:
Bank Swallow — Photo courtesy of Ron Kingswood.

Catalogue No. CW69-14/669-2013E-PDF
ISBN 978-1-100-22396-4

Recycled paper

COSEWIC
Assessment Summary

Assessment Summary – May 2013

Common name
Bank Swallow

Scientific name
Riparia riparia

Status
Threatened

Reason for designation
This widespread species has shown a severe long-term decline amounting to a loss of 98% of its Canadian population over the last 40 years. As with many other aerial insectivores, the decline continues, albeit at a slower rate since the 1980s. Breeding Bird Survey data from 2001-2011 indicate a potential loss of 31% of the population during that 10-year time period. The reasons for these declines are not well understood, but are likely driven by the cumulative effects of several threats. These include loss of breeding and foraging habitat, destruction of nests during aggregate excavation, collision with vehicles, widespread pesticide use affecting prey abundance, and impacts of climate change, which may reduce survival or reproductive potential.

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

Status history
Designated Threatened in May 2013.

COSEWIC
Executive Summary

Bank Swallow
Riparia riparia

Wildlife Species Description and Significance

The Bank Swallow is a small insectivorous songbird with brown upperparts, white underparts and a distinctive dark breast band. It is distinguishable in flight from other swallows by its quick, erratic wing beats and its almost constant buzzy, chattering vocalizations. The species is highly social at all times of year and is conspicuous at colonial breeding sites where it excavates nesting burrows in eroding vertical banks.

Distribution

The Bank Swallow has an extensive distribution, occurring on every continent except Antarctica and Australia. In North America, it breeds widely across the northern two-thirds of the U.S., north to the treeline. It breeds in all Canadian provinces and territories, except perhaps Nunavut. The Bank Swallow winters primarily in South America.

Habitat

The Bank Swallow breeds in a wide variety of natural and artificial sites with vertical banks, including riverbanks, lake and ocean bluffs, aggregate pits, road cuts, and stock piles of soil. Sand-silt substrates are preferred for excavating nest burrows. Breeding sites tend to be somewhat ephemeral due to the dynamic nature of bank erosion. Breeding sites are often situated near open terrestrial habitat used for aerial foraging (e.g., grasslands, meadows, pastures, and agricultural cropland). Large wetlands are used as communal nocturnal roost sites during post-breeding, migration, and wintering periods.

Biology

The Bank Swallow breeds in colonies ranging from several pairs to a few thousand. In North America, the Bank Swallow is single-brooded and nest success is often relatively high. The average age of individuals in the breeding population likely ranges between 1.7 and 2 years old.

Population Sizes and Trends

Long-term Breeding Bird Survey (BBS) data showed a significant annual rate of decline of 8.84% between 1970 and 2011. At this rate, the population will have decreased by approximately 98% over the last 41 years. Data from the most recent 10-year period (2001–2011) showed a non-significant decline of 3.69% per year, amounting to a potential loss of 31% of the population over the last 10 years. These declines are supported by provincial Breeding Bird Atlases that show substantial declines in area of occupancy and probability of observation.

Threats and Limiting Factors

Although no single threat appears responsible for the decline of the Bank Swallow, cumulative effects from several sources may be driving declines. Loss of breeding and foraging habitat is apparent, especially through erosion control projects, flood control (dams), aggregate management activities, conversion of pastureland to cropland and afforestation. The destruction of nests during aggregate excavation may also pose a significant threat in some areas. Climatic changes may reduce overwinter survival or reproductive potential, while widespread pesticide use may cause decreases in the abundance or diversity of flying insects. Threats during migration and on the wintering grounds are largely unknown, but may be critical in understanding the species' decline.

Protection, Status, and Ranks

In Canada, the Bank Swallow is federally protected under the *Migratory Birds Convention Act*, 1994. It is considered "Least Concern" by the IUCN Red list (2011) of Threatened Species, "Secure" in Canada and the U.S. by NatureServe, although it is ranked as "may be at risk" in Nova Scotia and "sensitive" in New Brunswick and Ontario by the Canadian Endangered Species Conservation Council.

TECHNICAL SUMMARY

Riparia riparia
Bank Swallow Hirondelle de rivage
Range of occurrence in Canada: Yukon Territory, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Newfoundland/Labrador, New Brunswick, Nova Scotia, Prince Edward Island

Demographic Information

Generation time (average age of parents in the population)	1.7 - 2 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 (based on 10 year trend).	N/A
Observed percent reduction in total number of mature individuals over the last 10 years. - Long-term BBS data show a significant annual rate of decline of 8.84% between 1970 and 2011, which amounts to a population loss of 98% over the last 41 years. Data from the most recent 10-year period (2001–2011) show a non-significant decline of 3.69% per year, which amounts to a potential loss of 31% of the population over the last 10 years.	31%
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown, but long-term decline expected to continue
[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, but long-term decline expected to continue
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 - breeding range	9.95 million km²
Index of area of occupancy (IAO) (IAO cannot be calculated with enough precision, although the value would be far greater than the minimum COSEWIC threshold of 2,000 km^2).	Not available (>>2000 km²)
Is the total population severely fragmented?	No
Number of locations∗	Unknown, but greater than 10 locations
Is there an observed continuing decline in extent of occurrence?	No
Is there an observed continuing decline in index of area of occupancy? - Breeding bird atlas projects in Ontario and the Maritimes indicate reductions in area of occupancy	Yes
Is there an [observed, inferred, or projected] continuing decline in number of populations? - Subpopulation structure is unknown	Unknown
Is there an [observed, inferred, or projected] continuing decline in number of locations*?	Unknown Number of locations is not known

∗ See Definitions and Abbreviations on COSEWIC website and IUCN 2010 for more information on this term.

Is there an observed 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**
Estimate based on BBS data from 1998-2007 (Blancher, unpubl. data) - does not include recent population loss	1.4 million

Quantitative Analysis

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

Threats (actual or imminent, to populations or habitats)

- Breeding, foraging, and roosting habitat loss from erosion and flood control practices, aggregate management policies, agricultural and land use changes (e.g., increase in intensive row crop farming)
- Incidental take (i.e., destruction of nests) during aggregate extraction operations
- Potential declines or changes in populations of flying insects
- Climatic changes (e.g., droughts, inclement weather) on wintering and/or breeding grounds causing reduced adult survival and/or reproductive output

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? United States: although overall population in the U.S. is showing non-significant declines on the long-term and non-significant increases on the short-term, 8 of 13 states bordering Canada are showing evidence of declines.	
Is immigration known or possible?	Yes
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely?	Possible, but may be limited by the declines in U.S. states bordering Canada

Current Status

COSEWIC: Designated Threatened in May 2013.

Status and Reasons for Designation

Status: Threatened	**Alpha-numeric code:** A2b
Reasons for designation: This widespread species has shown a severe long-term decline amounting to a loss of 98% of its Canadian population over the last 40 years. As with many other aerial insectivores, the decline continues, albeit at a slower rate since the 1980s. Breeding Bird Survey data from 2001-2011 indicate a potential loss of 31% of the population during that 10-year time period. The reasons for these declines are not well understood, but are likely driven by the cumulative effects of several threats. These include loss of breeding and foraging habitat, destruction of nests during aggregate excavation, collision with vehicles, widespread pesticide use affecting prey abundance, and impacts of climate change, which may reduce survival or reproductive potential.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Meets Threatened A2b because of reasonable probability of decline of at least 30% over the last 10 years based on Breeding Bird Survey data, which are an appropriate index of abundance (b).
Criterion B (Small Distribution Range and Decline or Fluctuation): Does not meet criterion, range exceeds thresholds.
Criterion C (Small and Declining Number of Mature Individuals): Does not meet criterion, population size exceeds thresholds.
Criterion D (Very Small or Restricted Total Population): Does not meet criterion, both population and distribution exceed thresholds.
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
(2013)

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.

Environment Canada | Environnement Canada
Canadian Wildlife Service | Service canadien de la faune

Canada

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

COSEWIC Status Report

on the

Bank Swallow
Riparia riparia

in Canada

2013

TABLE OF CONTENTS

List of Figures

List of Tables

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Common English names:	Bank Swallow (Americas) Sand Martin (Eurasia, Africa) Collared Sand Martin (southern Asia)
Common French name:	Hirondelle de rivage
Scientific name:	*Riparia riparia* Linnaeus (1758)
Subfamily:	Hirundininae
Family:	Hirundinidae
Order:	Passeriformes
Class:	Aves

The Bank Swallow is considered to be among the more evolutionarily basal-branching or “primitive” groups of swallows due to its burrow-excavation habits (Sheldon and Winkler 1993).

Morphological Description

The Bank Swallow is the smallest swallow in the Americas. Total body length averages 12 cm (wing chord: 95-106 mm, tail length: 43-52 mm, mass: 10-18 g). Sexes appear similar in size and plumage, but can be identified in the hand during the breeding season by the presence of a brood patch (in females) or cloacal protuberance (in males). Bank Swallows have a grey-brown head, mantle, rump and wing coverts, contrasting with darker brown remiges and white underparts (see cover photo). Separating the white underparts is a well-defined, brown upper breast-band. In flight, the Bank Swallow is best distinguished from other swallows by its small size, distinctive breast-band and flight pattern, in which the bird’s wings are held at a sharper angle while giving quicker wing-beats (Garrison 1999). Plumage characteristics are similar throughout the year, but juveniles (<6 months old) can be distinguished from adults by whitish- or buff-edged upperparts and a buff-pink wash to the throat (Pyle 1997).

Population Spatial Structure and Variability

The only subspecies recognized as regularly occurring in Canada is *R. r. riparia*, which also occurs across Europe and much of Asia and Africa. Several other recognized subspecies occupy smaller areas in parts of eastern and southern Asia and northeastern Africa (Turner and Rose 1989).

Individuals in western populations in North America are longer-winged on average than eastern populations (Oberholser 1974), but a clear distinction between populations is not apparent. No studies of genetic variation in Bank Swallows exist.

Designatable Units

In Canada, one subspecies of Bank Swallow occurs and there are no other distinctions that warrant assessment below the species level. This report therefore deals with a single designatable unit, *R. r. riparia*.

Special Significance

The Bank Swallow belongs to a guild of aerial-foraging insectivorous bird species. Over the last several decades, many species in this guild have undergone substantial population declines, especially in eastern Canada (Nebel *et al.* 2010), and several species have been assessed as at risk in Canada (e.g., Chimney Swift, *Chaetura pelagica*, Common Nighthawk, *Chordeiles minor*, Whip-poor-will, *Caprimulgus vociferous*, Barn Swallow, *Hirundo rustica*).

In general, Aboriginal Traditional Knowledge for the Bank Swallow is unknown at this time. Gwich'in community members note that this species is becoming rarer in the Gwich'in Settlement Area (A. Thompson, pers. comm. 2012).

DISTRIBUTION

Global Range

The Bank Swallow has an extensive global distribution, occurring on every continent, except Australia and Antarctica. In the Americas, the breeding range extends across most of Canada and Alaska below the tree line, and over the northern two-thirds of the United States (Garrison 1999). The Bank Swallow winters widely across South America, Central America, Mexico and the West Indies. However, it winters primarily in South America, where it is most common east of the Andes, south to eastern Peru, Bolivia (rare), Brazil, Paraguay and northern Argentina (Ridgley and Tudor 1989, Turner and Rose 1989, Winkler 2006). Few large concentrations of wintering Bank Swallows are known or described (Ridgley and Tudor 1989, Winkler 2006). Bank Swallows are widespread breeders across most of Europe and Asia, north to the tree line and south to the Mediterranean region, Egypt, Afghanistan, northern India and Pakistan, southeastern China, and Japan. Wintering grounds include much of Arabia, Africa, India and parts of southeastern Asia (Turner and Rose 1989).

The North American distribution of the Bank Swallow likely initially increased post-European settlement, due to anthropogenic landscape changes (e.g., opening forests, increasing pastureland, etc.). However, many other anthropogenic changes continued throughout the pre-industrial era, some of which would have been beneficial (e.g., aggregate pits as nesting sites) and others detrimental (e.g., water level and erosion control; see Habitat Trends and Fluctuation and Trends).

Canadian Range

The Bank Swallow has an extensive Canadian breeding range, occurring throughout the entire Yukon Territory and western part of the Northwest Territories, south to the southern interior of British Columbia, east across the entire provinces of Alberta, Saskatchewan, Manitoba, Ontario and Quebec to southwestern Newfoundland, Labrador and the Maritimes (Figure 1, Figure 2). There is evidence of reductions in area of occupancy for the southern Canadian Shield of Ontario, northern Alberta, throughout New Brunswick and Nova Scotia, and possibly throughout southern Quebec (Cadman *et al.* 2007, FAN 2007, BSC 2011a, Quebec Breeding Bird Atlas 2012). The distribution of the Bank Swallow in northern regions of most jurisdictions may be more extensive than described here because survey effort across these vast regions is limited.

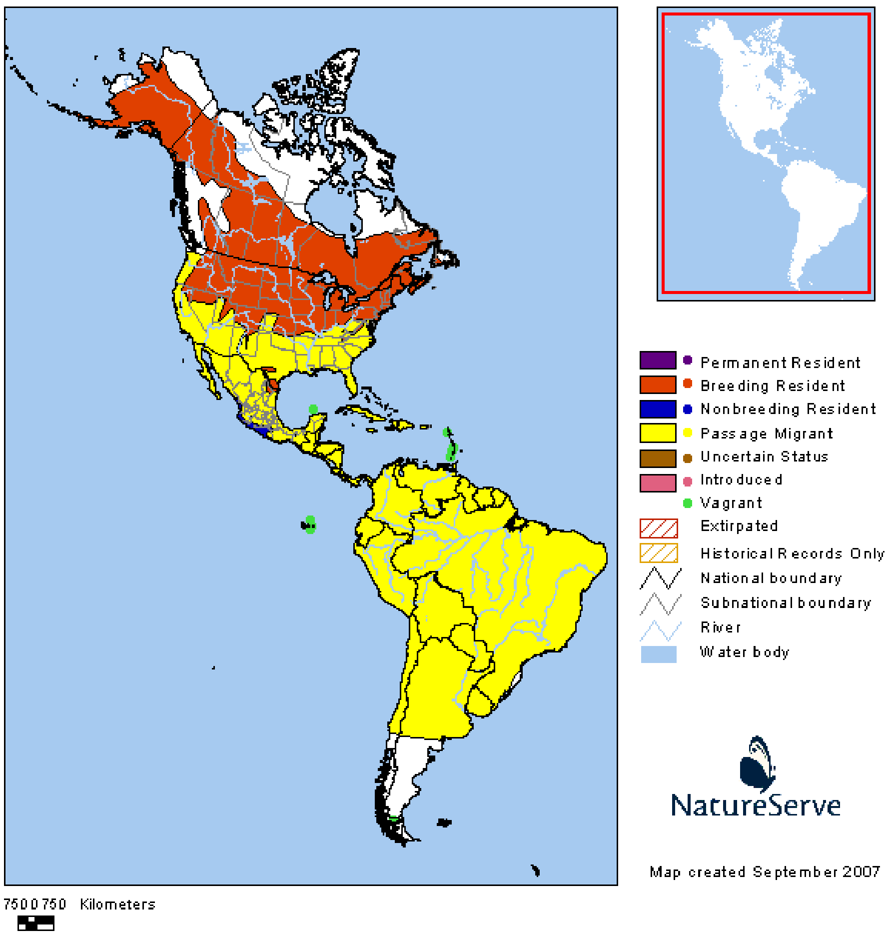


Figure 1. Distribution of the Bank Swallow in the western hemisphere. Note: the wintering range is not clearly delineated here (see Global Range description for clarification). Data provided by NatureServe in collaboration with Robert Ridgely, James Zook, The Nature Conservancy–Migratory Bird Program, Conservation International–Center for Applied Biodiversity Science, World Wildlife Fund–US, and Environment Canada–Wildspace.

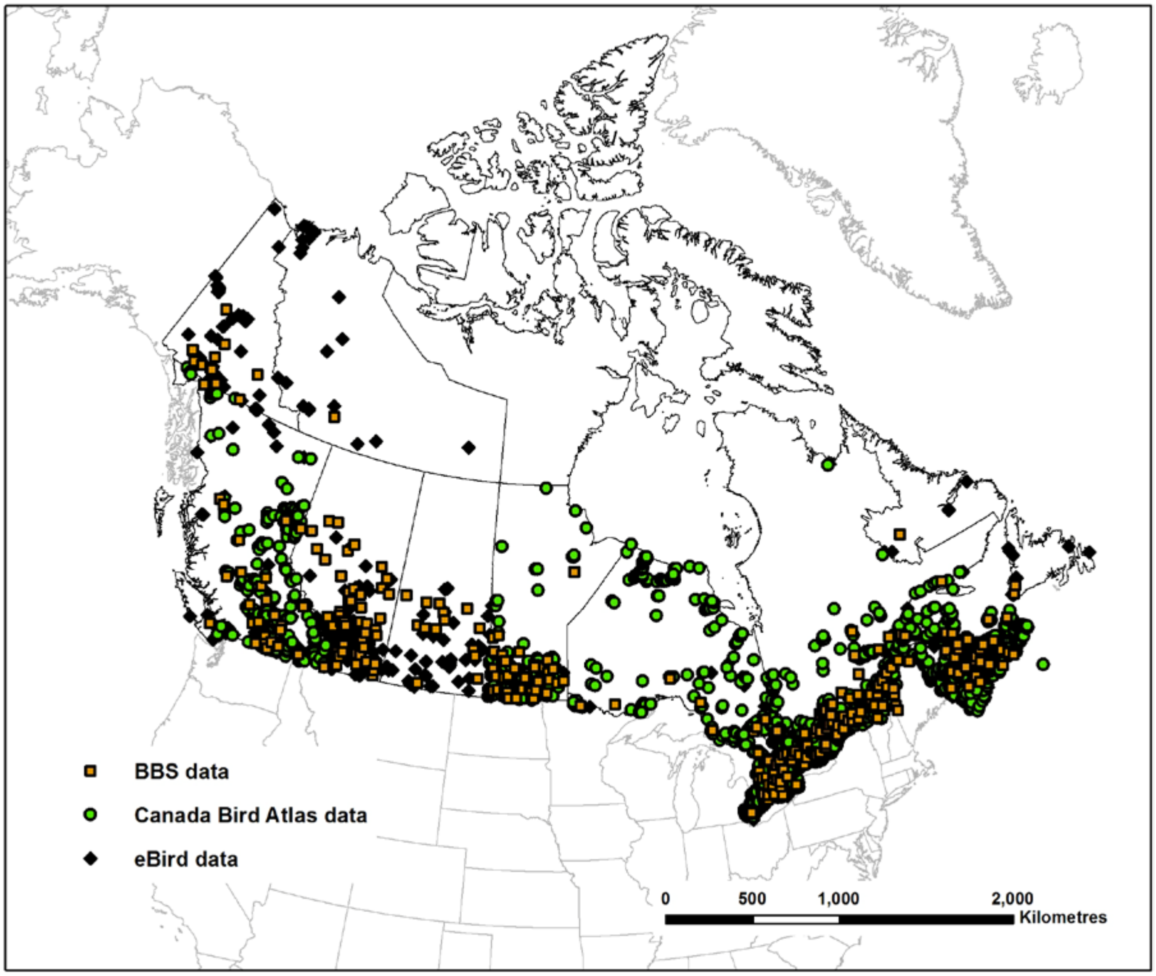


Figure 2. Canadian breeding distribution of the Bank Swallow compiled using recent data from 2000 to 2010 (Cadman *et al.* 2007; BSC 2010a,b,c; Quebec Breeding Bird Atlas 2012; Breeding Bird Survey data; and breeding season observation records from eBird Canada [which includes NWT/NU Bird Checklist Survey]).

In the Yukon Territory, major rivers in the south (e.g. the Yukon, Teslin and Liard), which cut through large post-glacial lacustrine silt deposits, support Bank Swallow colonies of up to 100-200 pairs (Sinclair *et al.* 2003, P. Sinclair, pers. comm.). Colonies composed of >100 pairs also occur on some of the southern lakes where appropriate banks occur (e.g. Aishihik Lake; D. Mossop, pers. comm.). On northern rivers, colonies tend to be fewer and smaller (i.e., several dozen pairs) because the region was not glaciated and suitable nesting banks are limiting. A major exception is along the Eagle, Porcupine and Old Crow Rivers, where Bank Swallow colonies are common, but relatively small in size (D. Mossop, pers. comm.). At least one colony occurs north of the Arctic treeline along the Babbage River (Sinclair *et al.* 2003).

Based on the Northwest Territories – Nunavut Bird Checklist Survey and eBird Canada (June – July) observation records, Bank Swallows have been recorded throughout rivers and lakes of the Nahanni National Park Reserve, southern Great Slave Lake area, throughout the central Mackenzie River valley and north to the Mackenzie Delta and Inuvik. Similar to the Yukon, southern records indicate higher numbers of birds than northern records.

In British Columbia, the Bank Swallow occurs east of the Coast and Cascade Mountains, and is less common or local in the Sub-Boreal Interior, Northern Boreal Mountains and Rocky Mountain Trench (Campbell *et al.* 1997, BSC 2011b). It is most common and widely distributed throughout the Southern Interior and Southern Interior Mountains and Boreal Plains Ecoprovinces where post-glacial lacustrine deposits occur (Campbell *et al.* 1997, BSC 2011b).

In Alberta, Saskatchewan, and Manitoba, the Bank Swallow occurs most commonly across grassland, aspen parkland, and plains ecoregions. It occurs throughout other regions (e.g., Boreal forest) of these provinces, but is recorded infrequently (FAN 2007, Saskatchewan Ministry of the Environment 2011, BSC 2011c).

In Ontario and southern Quebec, the Bank Swallow occurs most commonly in the lower Great Lakes, St. Lawrence Valley and the Abitibi-Témiscamingue and Lac-Saint-Jean regions. In Ontario, large colonies (i.e., 1000+ pairs) occur along the shores of the Saugeen River, Lake Ontario, Lake Erie and in some large aggregate pits (Cadman *et al.* 2007). The Bank Swallow is sparsely distributed throughout the Canadian Shield and Hudson Bay Lowlands, where they also occur in aggregate pits and large river corridors (M. Cadman, pers. comm.). The Bank Swallow occurs as far north as the Ungava Peninsula in Quebec (e.g., Kuujjuaq, Umiujaq and Kuujjuaraapik) (Gauthier and Aubry 1996, Quebec Breeding Bird Atlas 2012, M. O'Connor, pers. comm.).

In eastern Canada, the Bank Swallow breeds in Labrador (e.g., Churchill Falls, Goose Bay, and the Northwest River), western Newfoundland, and throughout the Maritime Provinces (SSAC 2009, BSC 2011a). It is most common and widespread on Prince Edward Island and the Northumberland Coast of New Brunswick and Nova Scotia (BSC 2011a, unpubl. data.).

The Bank Swallow is present in many national parks; however, the species is not closely monitored and confirmed breeding records are scarce. Consistently active colonies are reported from Prince Edward Island, Kootenay, Nahanni, Wapusk, and Ivvavik (P. Nantel, pers. comm., P. Giroux, pers. comm.).

The extent of occurrence in Canada is approximately 9.95 million km^2 using a minimum convex polygon based on Figure 2 (A. Filion pers. comm.). The index of area of occupancy cannot be calculated because the large number of nest sites cannot be mapped. The value would, however, be far greater than the minimum COSEWIC threshold of 2,000 km^2 (A. Filion, pers. comm.).

Search Effort

Distributional information for Bank Swallows was compiled using recent breeding bird atlas data. Although atlas projects were used as a primary source of information, other sources were used where atlas projects did not exist (see Table 1). Historical data from British Columbia (Campbell *et al.* 1997) and data from the first Quebec Breeding Bird Atlas (Gauthier and Aubry 1996) were added to improve coverage because current atlas projects in those provinces are still in progress. In addition, eBird Canada observation records (June and July, 2000 – 2011) were used to supplement spatial gaps in the distributional information for Bank Swallows in Canada.

Table 1. Information sources used to determine the distribution of Bank Swallows in Canada.

Province / Territory	Source of Distribution Information	Cited as	Timeframe
YK	Birds of the Yukon Territory	Sinclair *et al.* 2003	Historic - 2003
NT	NT-NU Bird Checklist Survey	C. Machtans, pers. comm.	2000 - 2010 (10y)
BC	British Columbia Breeding Bird Atlas	BSC 2011a	2007 - 2012 (4y)*
AB	2nd Alberta Breeding Bird Atlas	FAN 2007	2000 - 2005 (6y)
SK	Saskatchewan Bird Atlas	Sask. MOE 2011	1970 - present (+40y)
MN	Manitoba Breeding Bird Atlas	BSC 2011b	2010 - 2014 (2y)*
ON	2nd Ontario Breeding Bird Atlas	Cadman *et al.* 2007	2001 - 2005 (5y)
QC	2nd Quebec Breeding Bird Atlas	QBBA 2012	2010 - 2014 (2y)*
NL	Bank Swallow Status Report for NL	SSAC 2009	Historic - 2008
NB, NS, PE	2nd Maritimes Breeding Bird Atlas	BSC 2011a	2006 - 2010 (5y)

* atlas in progress / fieldwork not yet completed

Breeding bird atlas projects are very effective in assessing the distribution of Bank Swallows because atlassers can target predictable habitats where the species occurs. However, some areas may not be adequately searched and thus may be underreported (e.g., inaccessible lake or ocean bluffs, remote areas in the north, and pits).

HABITAT

Habitat Requirements

Breeding

The Bank Swallow readily breeds in a wide variety of low-elevation (< 900 m), natural and anthropogenic (herein referred to as artificial) habitats, including: lake and ocean bluffs; stream and river banks; sand and gravel pits; roadcuts; and piles of sand, topsoil, sawdust, coal ash, and other materials (Peck and James 1987, Garrison 1999). Nest burrows are nearly always in a vertical or near-vertical bank (range: 76-105° slope; Hjertaas 1984). In some cases, Bank Swallows have nested in drain pipes and in structures designed and built specifically for nesting Bank Swallows (Garrison 1999, Environment Agency 2001, Gulickx *et al.* 2007). The proportion of Bank Swallow nesting records occurring in natural and artificial sites varies across Canada (Erskine 1979; Table 2). Artificial sites represent the dominant nesting habitat in British Columbia (87% of records), while the reverse is true in the Maritimes (25%; Table 2). Nest records may be biased toward higher proportions of colonies in artificial sites compared to natural sites, but the level of bias may be similar across Canada.

Table 2. Regional variation in the proportions of natural and artificial (human-made) sites used by Bank Swallows in Canada (Erskine 1979).

Region	Proportion of assignable nests		Total nests	Mean colony size	Proportion of nests unassigned
	Natural sites	Artificial sites			
Maritimes provinces	0.75	0.25	8207	56	0.01
Quebec and Ontario	0.35	0.65	9934	38	0.39
Prairie provinces	0.57	0.43	509	5	0.00
British Columbia	0.13	0.87	8568	59	0.35
All regions	0.4	0.6	27218	42	0.29

Perhaps the most limiting habitat requirement for nesting Bank Swallows is the availability of eroding, vertical banks composed of unconsolidated substrates (e.g., silty fine sands). Micro-scale habitat selection of nest sites (i.e., the substrate characteristics) has received considerable attention (Petersen 1955, Spencer 1962, Hickman 1979, Hjertaas 1984, Jones 1987, John 1991, Heneberg 2001, Lind *et al.* 2002, Heneberg 2003, Johnson 2006, Heneberg 2009, Silver and Griffin 2009). In general, substrate penetrability and the varying proportions of substrate particle sizes are important for burrowing. Higher proportions of very fine sands (<900 µm) allow birds to excavate deeper burrows that may result in higher reproductive success (Heneberg 2003). Colony sizes also tend to be larger where the proportion of silt to sand is greatest (Hjertaas 1984, John 1991, Garrison 1999).

The distribution and density of breeding Bank Swallows appears to be correlated to the distribution of exposed unconsolidated deposits of glacial lacustrine origin (e.g., sand plains, BSC unpublished data, Gauthier and Aubry 1996). Thus, large areas where post-glacial lakes existed provide appropriate substrate conditions for breeding Bank Swallows, especially where the sediment deposits are thickest (e.g., lower Great Lakes region, St. Lawrence Plains and the southern interior of British Columbia). Other local areas where appropriate substrate conditions may exist include river valleys, ocean coasts, sand dunes, eskers, and moraines (Gauthier and Aubry 1996).

Home ranges during the nesting season are thought to be relatively small, as foraging birds appear to use open areas within 200-500 m of the colony (Garrison 1999, BSC unpubl. data). Occasionally, radio-tagged adult birds were observed to make longer foraging trips up to 1 km or more away from breeding sites (BSC unpubl. data). Bank Swallow breeding sites are typically situated in the vicinity of open foraging areas, such as rivers, lakes, oceans, grasslands, agricultural croplands, wetlands and riparian woodlands; however, forested areas are generally avoided (Garrison 1999). Water is often associated with Bank Swallow colonies, probably indirectly though, as it is often the source of erosion for suitable nesting banks. Notable exceptions include aggregate pits, where banks are created and maintained using heavy machinery. If the vertical face of a bank is not maintained (through natural erosion or machinery), it usually slumps and stabilizes within several years, at which point the colony disappears (Garrison 1999, Ghent 2001).

Migration

During migration, a wide variety of lowland habitats and open areas are used by Bank Swallows (Garrison 1999). In Florida, prairies, marshes, and agricultural areas are used during migration (Stevenson and Anderson 1994). In Trinidad and Tobago seashores and savannas are used (ffrench 1991). Large marshes and reed beds are used as nocturnal roost sites by Bank Swallows mostly during post-breeding, migration and winter (Winkler 2006). At Long Point, Ontario, inner bay cattail marshes are used as nocturnal roost sites by tens of thousands of Bank Swallows during post-breeding and migration periods (BSC, unpubl. data).

Winter

Existing information regarding Bank Swallow habitat requirements during winter is relatively scant. In general, wintering birds are observed over grasslands, savannas, open agricultural terrain, and freshwater and brackish wetlands, reservoirs, and beaches (Ridgely and Tudor 1989, Hayes *et al.* 1990, Garrison 1999). Winter nocturnal roosts occur in large wetlands or reed beds, as they do during migration (see above).

Habitat Trends

Natural habitat

Control of water-level fluctuations and peak discharge rates (via dams) has substantially reduced the stochastic processes regulating bank erosion along many streams and rivers throughout North America (Graf 2006, Monk *et al.* 2010). This has undoubtedly affected the historical distribution of breeding habitat for Bank Swallows. Large and often rapid fluctuations in water levels associated with the impoundment and release of water by hydroelectric dams can result in colony inundation (i.e., drowning of nestlings) and further habitat degradation (CEAA 2009). In theory, these activities could potentially lead to the creation of new nesting habitat; however, evidence of this has not been documented. Control of water levels on the Great Lakes has considerable influence on bluff erosion rates and thus may also impact available breeding habitat. Although Bain *et al.* (2008) suggested all existing water management plans for Lake Ontario result in positive effects on nesting Bank Swallows, they only considered accelerated erosion rates as a threat. It is likely that reduced erosion rates caused by prolonged low lake levels contribute to bank stabilization and in a decline in available breeding habitat for Bank Swallows.

Widespread erosion control measures have increased in riverine, lacustrine and ocean coast environments throughout Canada and elsewhere. Especially in human settlement areas, hardening or armouring shorelines and riverbanks is commonly used to negate property loss and may result in loss of Bank Swallow breeding sites. In California, the principal cause of Bank Swallow declines is thought to be directly related to the erosion control projects (Schlorff 1992, Garrison 1998). However, efforts are now underway to remove these structures and restore some of the shoreline to its previous state (Girvetz 2010). As of the early 1990s, nearly 10% of the coast in southeastern New Brunswick (an important region for Bank Swallows according to the Maritimes Breeding Bird Atlas) had been fortified by rock embankments or retaining walls (Bérubé 1993). Since the 1990s, the increased rate of erosion caused by climate change, increases in coastal development, and increases in erosion control measures have almost certainly resulted in further habitat loss for Bank Swallows in the Maritimes (Daigle *et al.* 2006, A. Hanson, pers. comm.). In Prince Edward Island, shoreline structures to control erosion represent an estimated 10% of the Province’s coast (Davies 2011). In the Great Lakes, bluff erosion control measures are widespread, probably a result of the higher density human population in the region (Herdendorf 1984, KCCA 1989, TRCA 2010).

Although wetlands and open water habitats are used as foraging areas at certain times, nesting Bank Swallows mainly rely on open terrestrial habitats for foraging (e.g., grasslands; Nakano *et al.* 2007). In California, increased distance between colonies and nearest grassland habitat was positively related to colony extinction probabilities (Moffatt *et al.* 2005). The widespread and ongoing decline of grassland-obligate birds is linked to a number of regional changes, such as conversion of native grasslands to row crops, afforestation and urbanization of abandoned farm and pasturelands, rangeland degradation, and agricultural intensification (i.e., from artisanal farms to monoculture annual crops) (Brennan and Kuvlesky 2005, Cadman *et al.* 2007, Jobin *et al.* 1996, 2009). Thus, it is conceivable that some (or all) of these changes have also led to a reduction in suitable foraging grounds for breeding Bank Swallows, although this needs further study. It is unclear if changes in foraging habitat have occurred on the wintering grounds.

Large wetlands and estuaries are used by Bank Swallows as nocturnal, communal roost sites during non-breeding periods (wintering, migration, etc.). Throughout southern Canada and especially in densely populated regions, wetlands and estuaries have undergone tremendous net losses, and cumulative impacts (e.g., climate change, invasive species, road expansion) continue to exacerbate wetland health and function (Bedford 1999, Daigle 2006, Bartzen *et al.* 2010, FPTGC 2010). Thus, it is possible that the trends in wetland loss and degradation are having some negative impact on Bank Swallow populations in Canada, although more study is needed. Because some wetlands may concentrate large numbers of roosting swallows, especially on migration routes or wintering grounds, these areas may have extremely important conservation value. However, it is unknown what specific changes have occurred in the availability of roost habitat on migration or the wintering grounds.

<u>Artificial habitat</u>

During the last ~100 years, the excavation of sand and gravel from pits, quarries, and roadcuts undoubtedly led to an increase in the availability of vertical banks for nesting Bank Swallows (Erskine 1979, Garrison 1999). Interestingly, the availability of artificial habitats likely increased at the same point available habitat in rivers and streams began to decline (due to dam construction and flood control).

Changes in government policies involving the use of roadcuts may have reduced habitat availability in some jurisdictions (M. Cadman, pers. comm.). Policy changes include removal of vertical slopes via grading. Summarized nest records for Bank Swallow colonies in Ontario show a decline in the proportion of colonies reported in roadcuts (Figure 3). In fact, no records of roadcut colonies have been reported to the Ontario Nest Record Scheme since the 1980s.

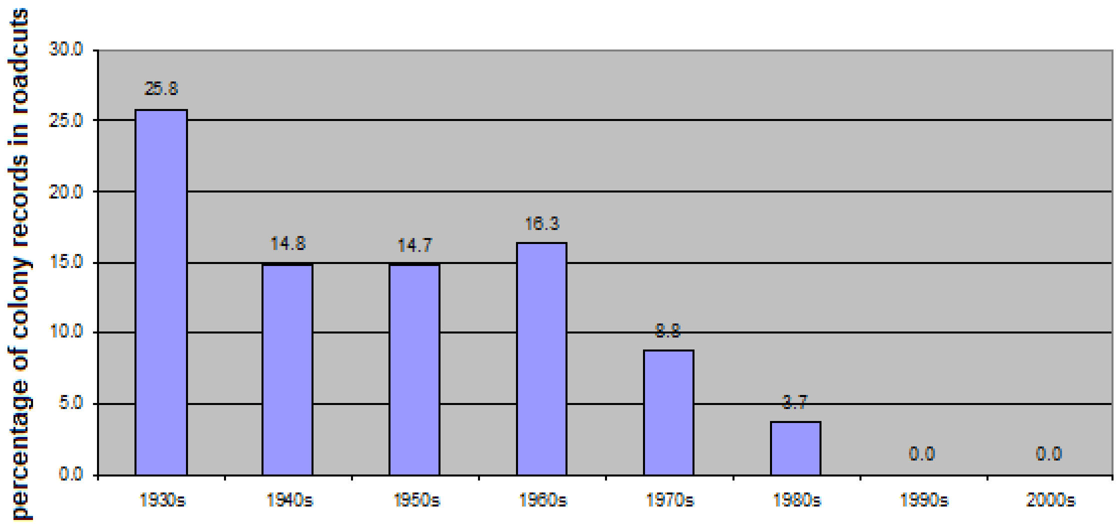


Figure 3. The percentage of Bank Swallow colony records situated in roadcut habitat (relative to other habitats) from the Ontario Nest Record Scheme over the last eight decades (Environment Canada and Royal Ontario Museum, unpubl. data).

At the beginning of the 1900s, the Ontario aggregate industry consisted of scattered borrow pits across the countryside, but as urban development advanced, some larger pits appeared near large cities (e.g., Toronto), and this remained relatively unchanged until the 1950s (Yundt and Messerschmidt 1979). Aggregate extraction grew substantially during the economic boom of the 1950s and 1960s, and with it, numerous pits opened, and annual extraction rates reached 5 million tonnes at some sites (Yundt and Messerschmidt 1979). The industry remained provincially unregulated until 1971 (*The Pits and Quarry Control Act*), when pit licensing and rehabilitation requirements came into effect. In Quebec, similar requirements came into effect with the regulation respecting pits and quarries under the *Environment Quality Act* (1981). Rehabilitation requires slope grading and erosion control practices in pits, resulting in the direct removal of Bank Swallow nesting habitat. Although aggregate extraction rates have generally increased since regulation, demand for sand and gravel appears to be declining in favour of crushed stone aggregates (Altus Group 2009). Thus, suitable artificial nesting habitat may be declining, as a result of changing industry demands and regulations.

In Sweden, large-scale declines in the Bank Swallow population have been associated with changes to gravel and sand pit operations (Lind *et al.* 2002): (1) decreasing demands for aggregates, (2) bank stabilization and restoration of pits, (3) a switch from pits to quarries as an aggregate source, and (4) concentrating gravel and sand extraction to fewer and larger pits. Clearly, these same changes have occurred in Ontario, and possibly in other areas of Canada.

BIOLOGY

The most comprehensive source of Bank Swallow biology, ecology, and general life-history information is the Birds of North America account (Garrison 1999), although very little of this information comes from Canada.

Life Cycle and Reproduction

Bank Swallows are highly colonial breeders. Colony sizes vary between solitary nests (rare) to several thousand nests (see Table 2 for regional averages). Over large areas of suitable habitat (e.g., Lake Erie bluffs), colonies are nearly continuous and are difficult to demarcate (BSC, unpubl. data). The breeding season is restricted to the months of May, June, July, and August across most of the breeding range (Turner and Rose 1989). Bank Swallows are socially monogamous, although both sexes pursue extra-pair copulations (Garrison 1999). The sex ratio is likely 1:1 (Cowley and Siriwardena 2005, Heneberg 2011). Both males and females can breed in their first year (i.e., 10-11 months of age), with annual breeding attempts thereafter (Cramp *et al.* 1988). Older birds often arrive first at traditional colony sites, followed 1-2 weeks later by first-year breeders (Kuhnen 1985). Different groups of birds arrive separately where suitable habitat exists, and breeding is synchronized within these areas, thus forming sub-colonies (Petersen 1955, Kuhnen 1985). Males initiate burrow excavation before securing a mate and females hover in front of burrow entrances, presumably assessing prospective mates (Kuhnen 1985). At the onset of nest building, there is a recognizable pair bond (Garrison 1999). Males excavate most of the burrow and nest chamber, while females build most of the nest. Mean burrow length ranges from 59 to 90 cm (across several studies; Garrison 1999). Burrow lengths are greater in less compact substrates (e.g., coarse sand) and when initiated earlier in the breeding season (Hickman 1979, Sieber 1980). The number of burrows within a colony is almost always more than the number of breeding pairs. Many burrows are abandoned due to obstacles (e.g., large roots or rocks), burrow instability, or simply because males are unable to attract a female (Garrison 1999). Mean burrow occupancy level (i.e., the percentage of active nests to total burrows in a colony) ranges from 42.6 to 73.5% (across seven studies) and varies annually, seasonally and by habitat characteristics (Garrison 1999, BSC unpubl. data).

Bank Swallows are likely single-brooded throughout most of their North American range, with most young fledging by mid-July (Garrison 1999). Second broods are known throughout Europe (Cramp *et al.* 1988), and have been suspected in North America based on a small number of late nesting attempts and nest reuse following successful fledging (Hjertaas 1984, Bull 1985). Confirmation of double-brooded individuals (through banding) is lacking. Clutch size is typically 3-6 eggs, but averages 5 eggs (Peck and James 1987, Turner and Rose 1989, Campbell *et al.* 1997). Eggs are incubated for 14 days (range: 12-16 days) mostly by the female. Both parents provision young in the nest up to one week after fledging. Nestlings move to the burrow entrance at 15-17 days of age and finally fledge at 18-22 days of age (Garrison 1999). However, the nest burrows are still used for roosting/resting for up to one week after fledging.

The longevity record for this species is an adult that was at least 8 years and 11 months old (Petersen and Mueller 1979). Most studies reporting survival estimates for Bank Swallows do not control for dispersal probabilities and thus, estimates should be cautiously interpreted. Average apparent annual survival is in the range of 33-35% for juveniles and 40-53% for adults and is comparable to survival rates of similar species (Macbriar and Stevenson 1976, Freer 1977, Persson 1987). The average age of breeding adults ranges from 1.7 to 2 years assuming a constant adult annual survival rate in the range of 40-50% and juvenile (first year) survival of 35%. In British populations, 96% of the breeding population is 1-3 years old; 69%, 20% and 7% for first, second and third year breeders, respectively (Cowley and Siriwardena 2005). There is no available information on annual reproductive success, or average annual female fecundity, because it is unknown what proportion of the population breeds annually (Garrison 1999). Males and females have similar annual survival rates (Cowley and Siriwardena 2005). Survival rates fluctuate annually and may be most influenced by rainfall on the wintering (Szep 1995, Cowley and Siriwardena 2005) or breeding grounds (Cowley and Siriwardena 2005).

Sources of Adult and Nest Mortality and Parasitism

Nest success is relatively high, often 70% of eggs laid result in fledged birds (Asbirk 1976, Sieber 1980). Greater burrow lengths are correlated with higher reproductive success (Sieber 1980). Nest success is also greater in earlier broods, and towards the centroid of the colony (Emlen 1971, Freer 1977, Sieber 1980). Predation can be an important cause of nest failure at colonies, but is thought to only cause localized impacts. A wide variety of mammals, birds, and snakes are predators of Bank Swallows. Raccoon (*Procyon lotor*), Grizzly Bear (*Ursus arctos*), Red Fox (*Vulpes vulpes*), Coyote (*Canis latrans*), American Badger (*Taxidea taxus*), American Mink (*Neovison vison*), Eastern Chipmunk (*Tamias striatus*), Norway Rat (*Rattus norvegicus*) and Common Raven (*Corvus corax*) have been observed depredating colonies (Potter 1924, Stoner 1937, Ginevan 1971, Morlan 1972, R. Curley and D. Mossop, pers. comm., M. Falconer, pers. obs.). Eastern Foxsnakes (*Pantherophis gloydi*), Gray Ratsnakes (*Pantherophis spiloides*), and Gopher Snakes (*Pituophis catenifer*) are also important predators of incubating adults and nests (Blem 1979, Garrison 1999, M. Falconer, pers. obs.). American Kestrels (*Falco sparverius*) and occasionally Merlins (*F. columbarius*) have been observed nesting in proximity to Bank Swallow colonies and are considered important avian predators of post-fledging and adult Bank Swallows (Freer 1973, Windsor and Emlen 1975, T. Hoar and D. Sutherland, pers. comm.).

Several flea species (Siphonaptera: *Ceratophyllus* sp.; *Celsus* sp.) are known to inhabit Bank Swallow burrows and can reduce nestling masses by about 5% (Alves 1997). Sites with high flea concentrations are generally not reused in subsequent years (Haas *et al.* 1980). Several larval blowfly species (Diptera: Calliphoridae) frequently infest colonies, and at least one species, *Protocalliphora chrysorrhoea*, is restricted almost entirely to inhabiting the nests of Bank Swallows and parasitizing nestlings (Sabrosky *et al.* 1989). Although *P. chrysorrhoea* infestations may cause physiological stresses in nestlings, nestling mortality rates are unaffected (Whitworth and Bennett 1992).

Most nestling mortality is apparently caused by starvation and is associated with periods of inclement weather and reduced aerial insect availability (Turner and Rose 1989). River flooding and bank collapse often result in nestling mortality (Garrison 1999). Colonies are sometimes persecuted by curious children, digging and inserting objects (e.g., tree branches) in burrows (Todd 1963, ROM nest records, unpubl., T. Hoar, pers. comm., F. Shaffer, pers. comm.). Some colonies are also either destroyed or partially destroyed during extraction operations at aggregate pits (Campbell *et al.* 1997, M. Cadman pers. comm.) and also during road construction (Petersen and Mueller 1979). Of 336 band recoveries of dead Bank Swallows, collisions with vehicles (45.2%) was the most frequent cause of mortality, and first-year birds were more likely than adults to be struck by vehicles (Mead 1979), although this may represent a demographic bias. The frequency of Bank Swallow road-kill mortality varies annually at Long Point, ON and may be positively related to prolonged inclement weather conditions (Ashley and Robinson 1996, BSC unpubl. data). In addition, conspecific attraction to road-killed corpses may increase rates of road-kill mortality in Bank Swallows (Dale 2001).

Diet and Foraging Behaviour

Bank Swallows feed singly, in pairs, or in flocks. Like other swallows, Bank Swallows tend to forage relatively low over water or land during prolonged cold or overcast periods (Turner and Rose 1989). The Bank Swallow is primarily an aerial forager, consuming mostly flying insects, although sometimes terrestrial/aquatic insects or spiders are taken when locally abundant. During the breeding season, flies (Diptera), ants, bees and wasps (Hymenoptera), beetles (Coleoptera), and bugs (Hemiptera) represent 80-95% of the diet by frequency (Garrison 1999). The results of a stable isotope analysis suggest that the main food source for nestlings is terrestrial flies (Nakano *et al.* 2007).

There is no information regarding diet and foraging behaviour on migration or wintering grounds.

Dispersal and Migration

The percentage of surviving juveniles returning to the natal area ranges from 46-59% (MacBriar and Stevenson 1976, Freer 1979, Szep 1990) and is greater for males than females (Freer 1979, Holmes *et al.* 1987). In the United Kingdom, 70, 17, 7, and 6% of juveniles dispersed distances of 10-49, 50-99, 100-199 and >199 km, respectively, away from natal colonies (Mead 1979). On a smaller scale in Hungary, 55, 31 and 14% of juveniles dispersed distances of 0-10, 10-25, and >25 km, respectively (Szep 1990).

Adult return rates are considerably higher than first-year bird return rates and range from 56-92% (Petersen and Mueller 1979, Freer 1979, Szep 1990). Szabo and Szep (2010) found that although birds were philopatric to colonies, between years neighbouring birds resettled in different areas of the colony as a group, suggesting a non-random settlement pattern.

Approximately one week post-fledging, juveniles form large flocks (i.e. crèches) near colony sites perching along telephone, hydro and fence wires, trees, exposed roots, and cliff sides (Garrison 1999). At this point, adults and juveniles begin using nocturnal roost sites. Less is known about pre-migratory and migration activities in North America compared to Europe (Garrison 1999). In the United Kingdom, independent juveniles disperse widely (up to several hundred km) and use different nightly roost sites, whereas adults tend to use a single roost site close to the breeding colony (Mead and Harrison 1979). Juveniles visit multiple colonies during this dispersion, presumably assessing the suitability of breeding sites for future years (Mead and Harrison 1979). Juveniles initiate fall migration over a longer timeframe than adults and, once migrating, birds travel through lowland river valleys where foraging opportunities are high (Mead and Harrison 1979).

Bank Swallows are long-distance migrants. Banded birds from Ontario and Saskatchewan have been recovered in northern Peru and northern Bolivia, respectively (Brewer *et al.* 2000).

Interspecific Interactions

The Bank Swallow regularly flocks with other swallow species (Garrison 1999).

Several other avian species have been observed nesting within Bank Swallow colonies, often by enlarging burrows or simply occupying existing burrows. These include American Kestrel, Barn Owl (*Tyto alba*), Belted Kingfisher (*Megaceryle alcyon*), Northern Rough-winged Swallow, Violet-green Swallow (*Tachycineta thalassina*), Cliff Swallow (*Petrochelidon pyrrhonota*), Mountain Bluebird (*Sialia currucoides*), European Starling (*Sturnus vulgaris*), and House Sparrow (*Passer domesticus*) (Hjertaas 1984, Garrison 1999, T. Hoar, pers. comm., M. Falconer, pers. obs., N. Mahony, pers. comm.). It is unknown if interspecific competition occurs over nest sites.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Breeding Bird Survey

The North American Breeding Bird Survey (BBS) is an annual standardized, road-side survey designed to monitor changes in bird populations that began in 1966. Surveyors conduct the survey on a single day, usually in June, consisting of 50 station stops spaced every 0.8 km along a 39.2 km route. At each station, surveyors conduct a 3-minute point count, tallying all individuals of all species seen or heard. Routes are randomly generated and are resurveyed annually (Sauer *et al.* 2011). The BBS takes place across the majority of the Bank Swallow's range and has excellent coverage where the Bank Swallow is likely most abundant. However, some sampling biases likely exist for the Bank Swallow which may under- or over-represent regional abundance. For example, most sampling in northern regions is based on small sample sizes, and is often from the southern parts of these regions. Also, because the BBS is a roadside survey, it may over-represent birds breeding in roadcut habitat and aggregate pits compared to natural habitats. That said, large berms are now created around most pits and may be negatively impacting observer ability to detect Bank Swallows in pits (M. Cadman, pers. comm.). The BBS may also miss colonies further from the road, where Bank Swallows are still abundant (e.g., ocean and lake bluffs) and so may not reflect trends in those areas. Finally, although not peculiar to the BBS, Bank Swallows are difficult to monitor in general because colonies can move from year to year.

Recently, a Bayesian hierarchal modelling approach has been adopted to analyze BBS trends, which provides a better representation of population change patterns over time compared to previous analyses (Sauer and Link 2011, A. Smith, pers. comm.). Because spatial sampling gaps exist in less populated areas of Canada, BBS trends are combined by strata (i.e., Bird Conservation Regions [BCRs] at provincial intersects) and area weighted. Thus trends do not represent strata not sampled by the BBS, although there can still be sizable geographic gaps in strata that are included in the trends (A. Smith and P. Blancher, pers. comm.). Trend results from hierarchical models are generally more precise than the results of the earlier analysis (Sauer and Link 2011) and less susceptible to inter-annual variation due to sampling error (Smith, pers. comm. 2012). The BBS trends reported in this status report are based on the results of the Bayesian hierarchal modelling approach.

Population trends and population estimates have been calculated using BBS data for a variety of geographical scales (e.g., Rich *et al.* 2004). Blancher *et al.* (2007) calculated population estimates using area-based extrapolation methods. These may be inaccurate or imprecise for the Bank Swallow in some areas, because the abundance of this species is highly variable across the landscape due to its colonial lifestyle. Despite this, the BBS does have enough power to detect Bank Swallow population trends in most regions of North America because Bank Swallows are recorded frequently and the degree of spatial variation is similar across years (P. Blancher, pers. comm.). Population estimates provided in this report are based on a new, updated analysis by Blancher (unpubl. data), and should ultimately be available through the Partners in Flight Landbird Population Estimates database (see PIF LPED 2007). This analysis uses more recent BBS data (mean counts of birds/route during 1998-2007) and better-suited assumptions and adjustments than previous analyses to accurately estimate bird population abundances (P. Blancher, pers. comm.). This estimate will, however, overestimate the population size because of the declines experienced by the population since 2007.

<u>Breeding Bird Atlases</u>

Breeding Bird Atlases are 5-year surveys aimed at documenting the distribution and relative abundance of breeding birds over large geopolitical regions (i.e., Canadian provinces). Surveys are volunteer-based, with observers recording evidence of breeding for all species in 10 km X 10 km squares. Observers aim for a minimum of 20 hours of effort per square. Atlas data are highly valuable for comparing temporal changes in the distribution of breeding birds, as many atlas surveys are replicated every 20 years or so. The second atlas projects from Ontario and the Maritimes indicate large increases in observer effort, total breeding bird records, and numbers of survey squares with data (Cadman *et al.* 2007, BSC 2011a).

Bank Swallows are easily confirmed as breeders in atlas surveys because of the conspicuousness of colonies, crèche sites (e.g., fledging congregation on telephone wires), and the relative accessibility and predictability of breeding habitat (e.g., roadside aggregate pits, large rivers in remote northern regions, ocean coasts).

<u>Canadian Migration Monitoring Network (CMMN)</u>

The Canadian Migration Monitoring Network involves the cooperative efforts of 25 bird observatory stations across Canada, Bird Studies Canada and Environment Canada. Stations collect abundance data (i.e., Daily Estimated Totals) using a standardized protocol for all species during the migration season. Recently, population trend analyses have been established for these data, but not all station trend analyses were available at the time of this report and it is uncertain how reliable these trend estimates are for this species (compared to BBS and atlas data). Also, trends from at least some migration monitoring stations (e.g., LPBO) are confounded by roosting sites and local breeders and may not reflect birds that are moving directly through on migration.

Only recent nine-year (2001-2010) trends are considered from 12 bird observation stations that consistently count and monitor Bank Swallows. Stations are Mackenzie (BC), Vaseux Lake (BC), Lesser Slave Lake (AB), Last Mountain (SK), Delta Marsh (MB), Bruce Peninsula (ON), Long Point (ON), Ruthven (ON), Rock Point (ON), Prince Edward Point (ON), Innis Point (ON) and Tadoussac (QC).

Étude des populations d’oiseaux du Québec (ÉPOQ)

Since 1950, Étude des populations d’oiseaux du Québec (ÉPOQ) has compiled thousands of volunteer-submitted bird checklists in order to analyze population trends of birds in Quebec (Larivée 2011). The database includes checklists from all regions south of the 52nd parallel, which reflects most of the Bank Swallow’s range in Quebec. To examine Bank Swallow trends, a simple linear regression between year and the annual proportion of checklists including Bank Swallows was used. Annual proportions were used rather than the mean number of Bank Swallows per checklist because proportions are likely less biased by variation in effort. Only breeding season checklists were used (May 16 – July 31) from 1970-2010 because fewer checklists were available before 1970. Although ÉPOQ lacks a standardized protocol, if the trends produced by the ÉPOQ database are negative, they generally correlate well with those of the BBS and generate adequate trend assessments (Dunn *et al.* 1996, 2001).

Ontario Bank Swallow Research and Monitoring Project

Initiated in 2010, the Ontario Bank Swallow Research and Monitoring Project is a collaborative effort between Ontario Power Generation, Bird Studies Canada, Environment Canada (CWS), and Beacon Environmental, Ltd. The major goals of this project are to conduct intensive targeted colony surveys, assess burrow occupancy and nest success, and determine factors affecting habitat selection. The study area encompasses the north shores of Lakes Erie and Ontario, as well as an 11 km stretch of the Saugeen River and 20-30 sand/gravel pits in Wellington County. Pit colonies were randomly selected from a larger sample to make representative comparisons of pit colonies across Ontario. In addition, all active Bank Swallow colonies in Wellington County were searched by requesting records from local birders, checking historical nesting sites, and searching suitable habitat. These data are included in this report because they provide the only available census data for Bank Swallows in Canada and highlight gaps in knowledge about abundance of the species (compared to BBS and atlas surveys).

In June, surveyors count nesting burrows at colonies and determine burrow occupancy and nest success by visiting colonies 3-4 times during late May to early July. Burrow occupancy levels are estimated by video recording colonies during each visit and calculating the proportion apparently active and adjusting by a correction factor (i.e., mark-recapture removal model). The total population size is estimated by multiplying the number of burrows by two (for each pair) and then adjusting by the mean burrow occupancy level. These data sets are currently unpublished.

Ontario Nest Record Scheme

The Ontario Nest Record Scheme (coordinated by the Royal Ontario Museum) is a nest monitoring project in which researchers and volunteers submit nesting observations of any breeding bird species. Detailed information is recorded about the colony size, location, general habitat, nest site, and nest monitoring visits (Peck *et al.* 2001). A major limitation to this data set is the inability to control for observer effort and reporting. In some years, many nest records are completed and in others, very few. The most useful aspect of this project is the long-term coverage and the descriptions of habitats used. Recently, Environment Canada summarized nest records of Bank Swallows from 1930s to 2000s to examine temporal changes in habitat use and number of colony records and colony sizes (M. Cadman, Environment Canada, unpubl. data).

Abundance

The global population estimate for the Bank Swallow is 50 million individuals (PIF LPED 2007). Using BBS data from 1998-2007, Blancher (unpubl. data) estimated the total population of Bank Swallows in Canada to be 1.4 million individuals (see Table 3 for provincial estimates), although the current estimate is likely less because of the declines experienced by the population since 2007.

Table 3. Population estimates and summary statistics for Bank Swallows based on 1998 – 2007 Breeding Bird Survey mean abundance (P. Blancher, unpubl. data).

Province /Territory	Population Estimate (individuals)	Mean abundance per route ± SE	Proportion of BBS routes with Bank Swallow detections (no. of routes surveyed)
QC	280,000	1.06 ± 0.31	0.45 (99)
NT	40,000	0.20 ± 0.06	0.20 (5)
YK	160,000	1.83 ± 0.55	0.46 (28)
ON	200,000	0.99 ± 0.30	0.42 (139)
BC	350,000	1.82 ± 1.01	0.28 (111)
AB	110,000	0.83 ± 0.24	0.29 (137)
MB	130,000	1.04 ± 0.31	0.53 (66)
SK	70,000	0.51 ± 0.24	0.25 (55)
NB	20,000	1.61 ± 0.85	0.42 (31)
PE	30,000	27.4 ± 26.0	1.00 (4)
NS	11,000	1.02 ± 0.40	0.52 (29)
NL	3,000	0.04 ± 0.03	0.09 (23)
CANADA	1,400,000		

Erskine (1992) calculated Bank Swallow population estimates from the first Maritimes Breeding Bird Atlas (1986-1990) for general perspective, rather than for precision purposes. The Maritime Provinces population was estimated to be 184,000 ± 52,000 individuals.

The largest known concentration of breeding Bank Swallows in Canada exists along the north shore of Lake Erie, where BSC surveys (from Rondeau Provincial Park to Turkey Point) estimated 121,450 and 95,750 Bank Swallow burrows in 2010 and 2011, respectively (24% relative difference between years). Burrow occupancy levels in 2010 and 2011 were 59.1 and 53.4%, respectively. Thus the total population estimate for 2010 and 2011 was 143,550 and 102,250 individuals, respectively. In both years, the greatest concentrations of burrows occurred on the Norfolk Sand Plain (i.e., Long Point west toward Port Stanley).

In 2010, Beacon Environmental Ltd. surveys along the north shore of Lake Ontario (from the Rouge River, east edge of Toronto to Presqu’ile Provincial Park) reported a total of 20,500 Bank Swallow burrows. The majority of burrows were recorded between Ajax and Port Hope, ON.

In 2010, Environment Canada (CWS) conducted burrow count surveys on the Saugeen River (11 km) and in aggregate pits throughout Wellington County, ON. The Saugeen River population between Walkerton and north to the 8^{th} concession Brant Twp. was 2,800 individuals (i.e., 2105 burrows, 66.1% occupancy). Surveys from 27 aggregate pits in and around Wellington County totalled 5,300 individuals (i.e., 5,467 burrows, 48.8% occupancy). Within Wellington County, Bank Swallows were found breeding almost exclusively in aggregate pits. Fewer than 100 nests were in construction soil piles. No natural nest sites were found.

Fluctuations and Trends

North American Breeding Bird Survey

Long-term BBS data show a significant annual rate of decline of 8.84% per year (95% credible interval (CI): -11.31, -5.67) between 1970 and 2011 (Figure 4; Environment Canada unpubl. data 2012). At this rate, the population will have decreased by approximately 98% over the last 41 years. Data from the most recent 10-year period (2001 – 2011) show a non-significant decline of 3.69% per year (95% CI: -7.49, +3.87%; Figure 4; Environment Canada unpubl. data 2012), which amounts to a loss of 31% (-54%, +46%) of the population over the last 10 years. Because Bank Swallows are patchily distributed, counts tend to be highly variable making it difficult to detect statistically significant trends over short (e.g., 10 years) periods of time. If 50% credible intervals are used, which omit the relatively long tails of the population distribution, the plausible range for the 10-year population loss is -39% to -21% (Environment Canada unpubl. data 2012).

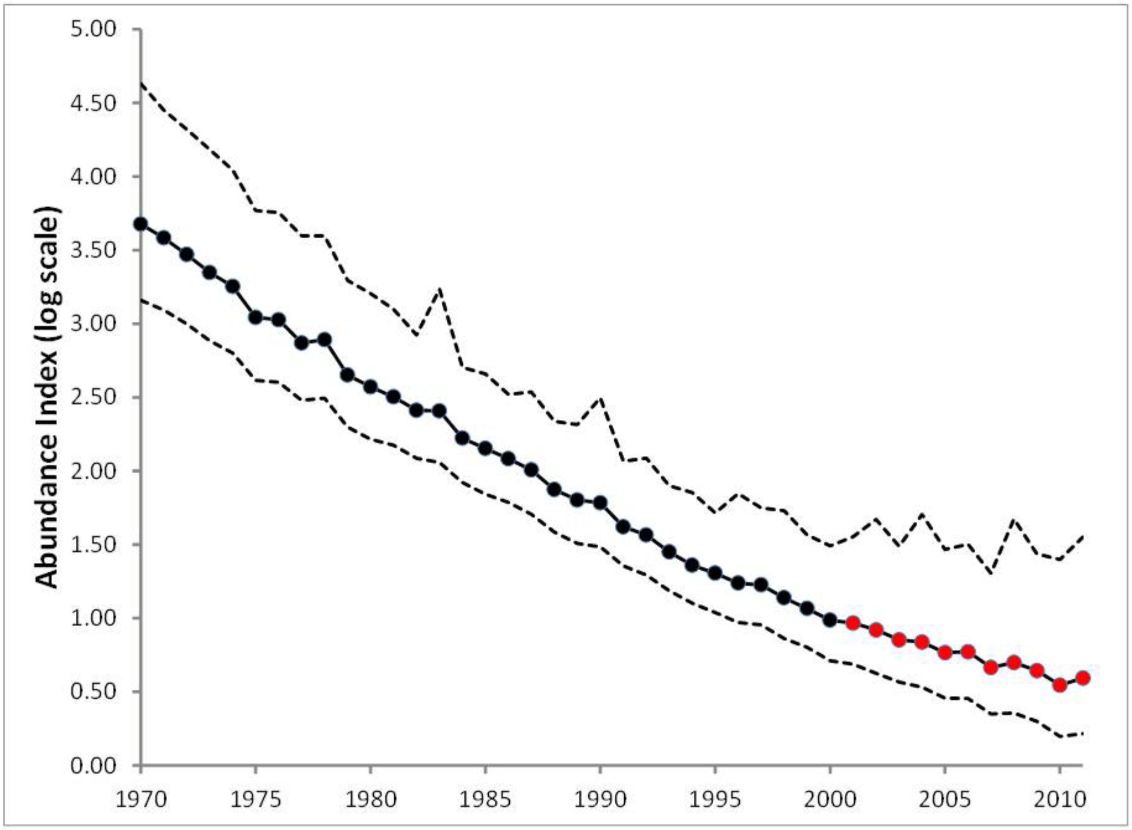


Figure 4. Annual rate of change for the Bank Swallow in Canada between 1970 and 2011 based on a hierarchical Bayesian model of Breeding Bird Survey data (Environment Canada unpubl. data 2012). Dotted lines correspond to the 95% upper and lower credible intervals. The trend for the last 10 years is highlighted in red.

Trend estimates are consistently negative across all provinces (Table 4), although the trends over the last 10 years are only significant for New Brunswick and Ontario (Table 4). Despite the ongoing declines in the trend estimates, the mean annual rate of population decline for Bank Swallows in Canada appears to have slowed since 1980 (Figure 5).

Table 4. Long- and short-term annual population trends for the Bank Swallow based on BBS surveys (Environment Canada unpubl. data 2012), with 95% lower (LCI) and upper (UCI) credible intervals. Results in bold are statistically significant declines, i.e., 95% credible intervals do not overlap zero.

Jurisdiction	1970-2011 ([a] 1980-2011; [b] 1986-2011)			2001-2011		
	Annual Rate of Change (%/yr)	LCI	UCI	Annual Rate of Change (%/yr)	LCI	UCI
Canada	**-8.84**	-11.31	-5.67	-3.69	-7.49	3.87
New Brunswick	**-10.41**	-12.95	-7.40	**-12.94**	-23.81	-3.97
Quebec	**-10.19**	-13.15	-5.95	-7.29	-14.26	5.80
Nova Scotia & PEI	**-8.82**	-11.53	-6.12	-8.10	-15.91	1.15
Ontario	**-6.53**	-11.17	-4.15	**-4.99**	-8.81	-1.83
Nfld & Labrador [a]	-4.36	-16.68	18.51	-6.68	-34.76	62.03
Alberta	**-4.31**	-8.85	-1.59	-3.94	-10.78	0.66
British Columbia	-3.32	-8.01	1.33	-2.23	-9.82	10.39
Manitoba	**-3.21**	-6.39	-0.20	-1.10	-5.98	3.86
Yukon [b]	-3.03	-10.26	5.72	-5.66	-22.35	8.76
Saskatchewan	-2.41	-5.57	1.29	-0.94	-6.74	13.71

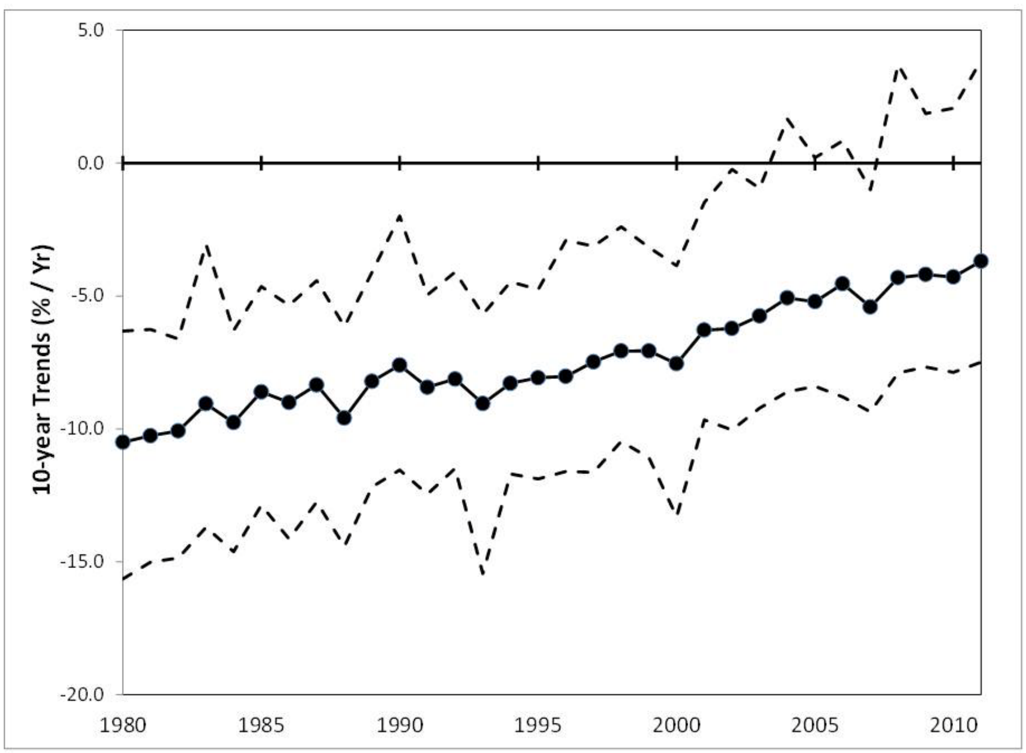


Figure 5. Running 10-year trends for Bank Swallows in Canada from 1970-1980 through to 2001-2011 based on Breeding Bird Survey data (Environment Canada unpublished data 2012). The figure illustrates how the trend has been ameliorating since the 1980s (i.e. % population change/year is lessening), but remains in decline. Dotted lines depict 95% credible intervals.

Breeding Bird Atlases

The probability of observation (per 20 hours of effort) for the Bank Swallow decreased by 45% in Ontario between atlas periods (1981-1985 and 2001-2005; Cadman *et al.* 2007). Declines in probability of observation were observed in all regions of Ontario, but were most pronounced in the Southern (-69%), and Northern Shield (-65%) regions. During the second atlas, Bank Swallows were recorded in 409 (-29%) fewer squares across Ontario than in the first atlas (Figure 6). The greatest distributional changes were observed in the Northern (-52% fewer squares occupied) and Southern Shield regions (-61% fewer squares occupied), despite observer effort being greater in the second atlas period (Cadman *et al.* 2007).

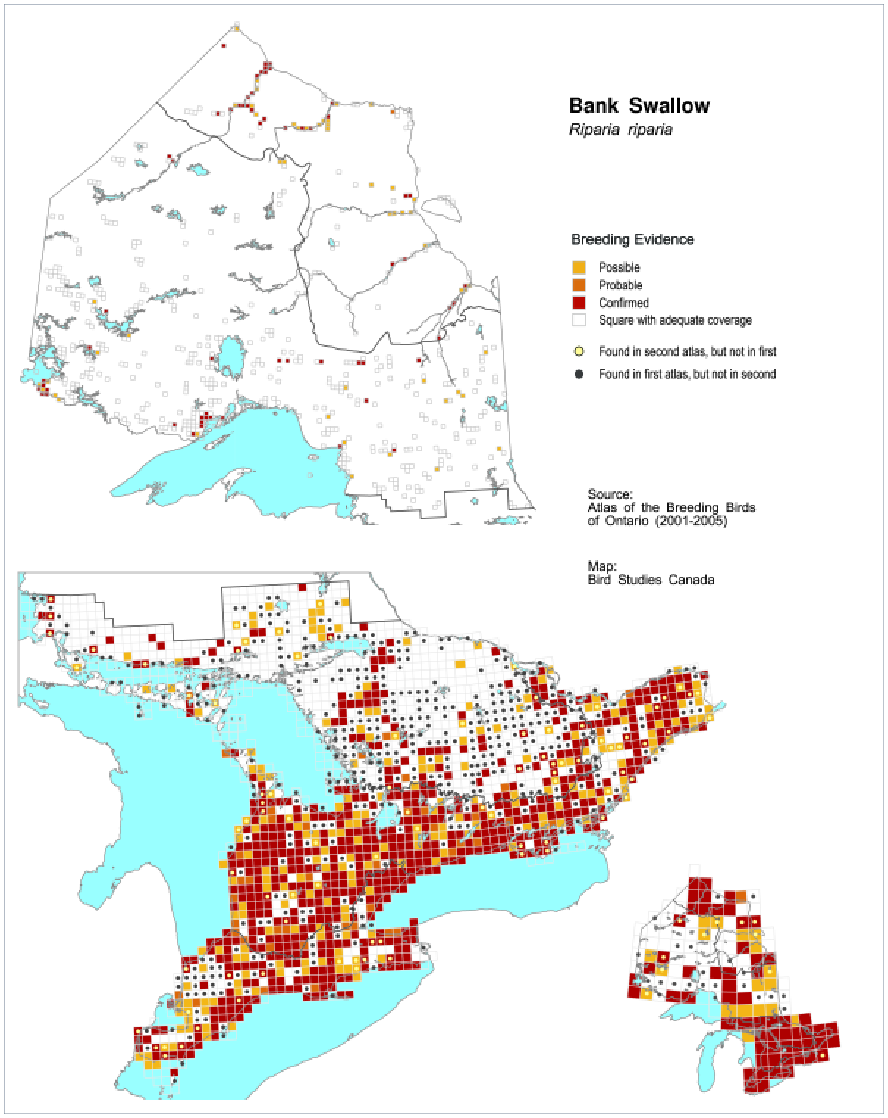


Figure 6. Bank Swallow distribution in Ontario during 2001-2005. Black dots depict distributional losses; squares where Bank Swallows were recorded during 1981-1985, but not 2001-2005.

The observed distribution of Bank Swallows in Alberta appears to have contracted between atlas periods (1987-1992 and 2000-2005; FAN 2007). The number of squares surveyed in northern Alberta is almost identical in both atlas periods and none of the squares with observations in the first atlas that were visited in the second had Bank Swallows. All natural regions in Alberta, except the Rocky Mountains, experienced declines in relative abundance of Bank Swallows between atlas periods (FAN 2007). Quantitative differences between atlas periods for abundance or distribution are not available for the Alberta Breeding Bird Atlas.

Preliminary analyses comparing the probability of detecting a Bank Swallow within its Maritime range (per 20 hours of effort) between the first and second atlas periods indicate strong, significant declines. Probability of observation declined from 65% to 17% between atlas periods in the Maritimes, corresponding to a significant annual decline of 6.5% over the last 20 years. The decline was stronger in New Brunswick (-7.5% annually) and Nova Scotia (-6.6% annually) than in Prince Edward Island, but was significant in all provinces (Figure 7; BSC 2011a, M. Campbell, BSC, unpubl. data).

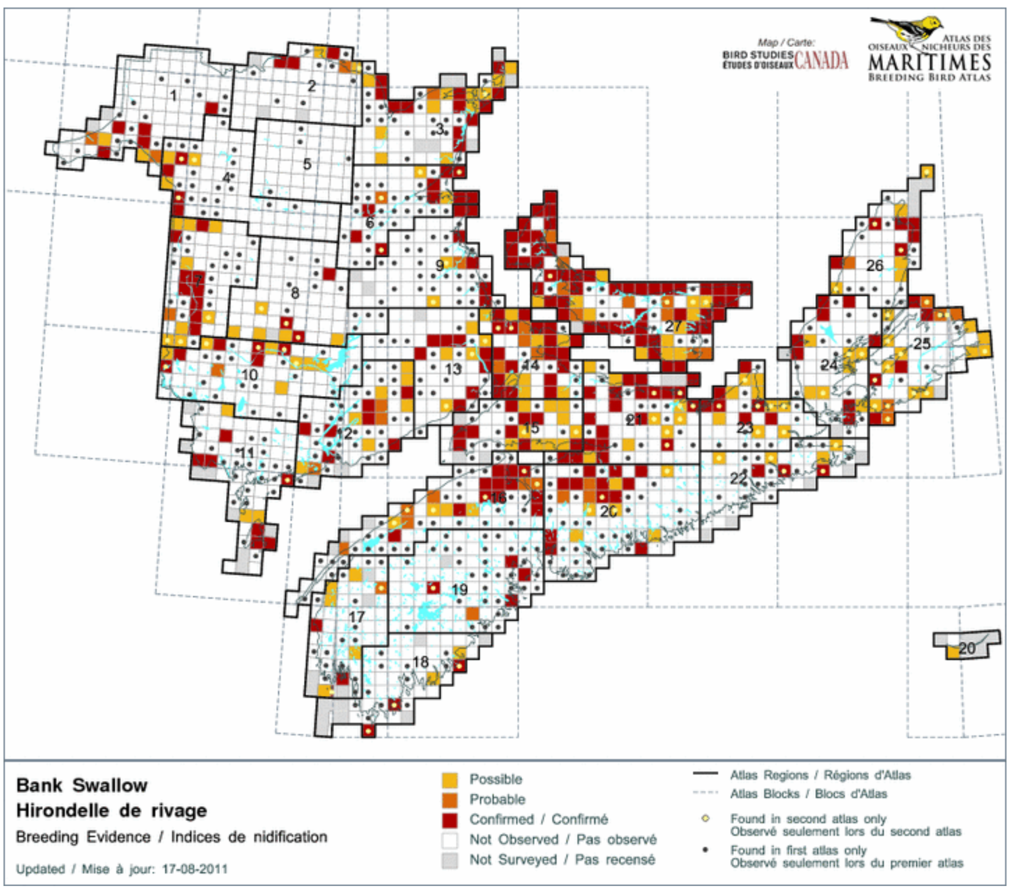


Figure 7. Bank Swallow distribution in the Maritimes provinces during 2006-2010. Black dots depict distributional losses; squares where Bank Swallows were recorded during 1986-1990, but not 2006-2010.

Breeding bird atlases in British Columbia (1st atlas), Manitoba (1st atlas), and Quebec (2nd atlas) are underway. Preliminary map data from the Quebec Breeding Bird Atlas suggest declines in area of occupancy for Bank Swallows (Quebec Breeding Bird Atlas 2012); however, this project is still in the early stages (2nd of 5 years).

Canadian Migration Monitoring Network (CMMN)

Preliminary short-term trends indicate significant declines of Bank Swallows in the fall season at three stations: Bruce Peninsula (-69% annually), Ruthven (-27% annually) and Rock Point (-56% annually). There was a significant increasing trend at Last Mountain, SK for the fall season (+41% annually). Spring migration data indicate a statistically significant positive trend (+41% annually) for Bank Swallows at Long Point, ON (T. Crewe, BSC, unpubl. data). All other migration monitoring stations showed non-significant trends for Bank Swallows (T. Crewe, BSC, unpubl. data).

Étude des populations d'oiseaux du Québec (ÉPOQ)

From 1970 to 2010, the proportion of ÉPOQ checklists including Bank Swallow declined at a rate of -4.4% annually (C.I. -3.8, -5.0). Bank Swallows were recorded on a 39% lower proportion of checklists during the 2000s (mean=0.08) compared to the 1970s (mean=0.20) (Figure 8).

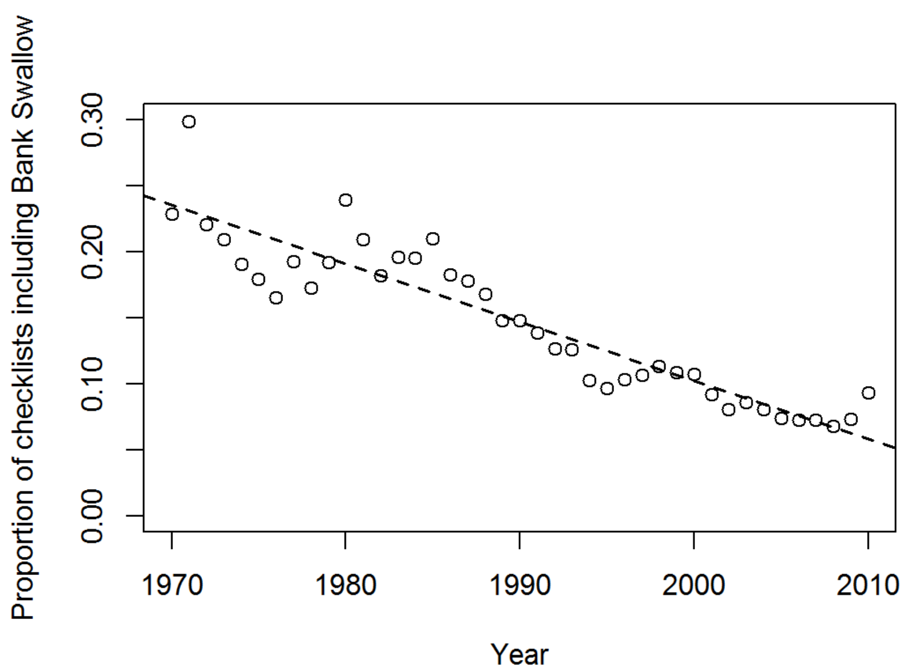


Figure 8. The proportion of checklists that included the Bank Swallow submitted to Étude des populations d'oiseaux du Québec (ÉPOQ) from 1970-2010 (Larivée 2011). See Sampling effort and methods for details.

Ontario Bank Swallow Research and Monitoring Project

There was a substantial drop in burrow numbers on the Saugeen in the years 2010-2011 (2015 down to 1886): however, numbers increased again in 2012 (to 2485), the highest since counts began in 2009 (M. Cadman pers. comm.).

Ontario Nest Record Scheme

The number of Bank Swallow colonies reported each decade since the 1930s is similar except during the 1970s and 1980s, when the number of colonies reported increased by 2-3 times (Figure 9). The increase in the 1970s and 1980s may be the result of increased reporting effort from a few observers rather than a real increase in the number of colonies (M. Cadman, pers. comm.). Mean colony size has remained relatively unchanged since the 1930s (Figure 9).

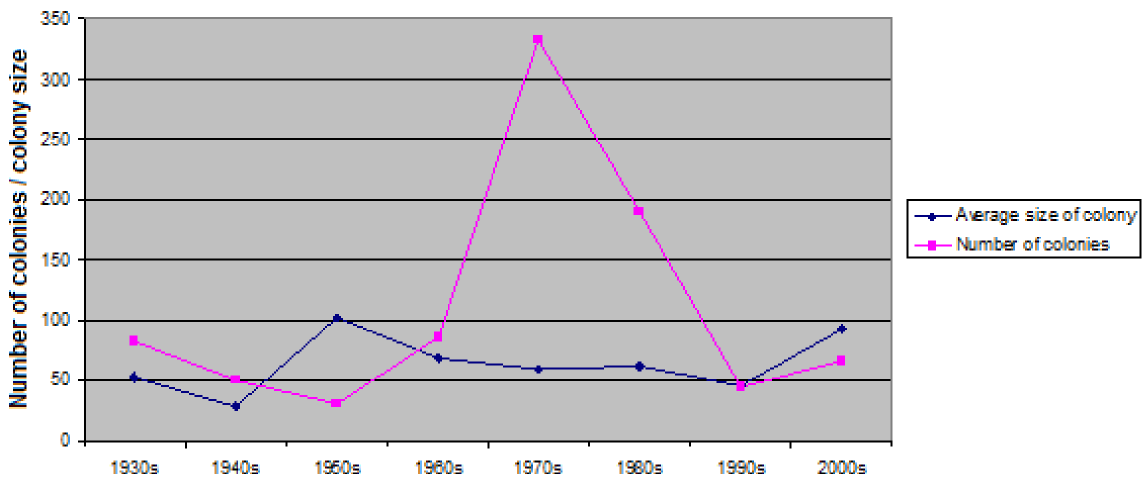


Figure 9. Mean colony size and the total number of Bank Swallow colonies reported to the Ontario Nest Record Scheme for the past eight decades (Environment Canada and Royal Ontario Museum, unpubl. data).

Population Trends in Europe

Overall in Europe, the Bank Swallow has undergone moderate population declines, both long-term (1970-1990) and more recently (1990-2000), causing the species to be evaluated as Depleted (BirdLife International 2004). In the UK, the BBS and the waterway bird survey (WBS) indicate no stable long-term trends, although a short-term increase exists for the BBS during 2003-2008 (Ballie *et al.* 2010). Several population crashes (45-70% reduction between years) have been observed over large areas of central Britain and smaller sites in Scotland over the last 50 years, which are thought to be related to poor overwintering survival caused by droughts (Cowley 1979, Jones 1987b, Bryant and Jones 1995; see Life Cycle and Reproduction). This may provide a potential explanation for observed population fluctuations on Lake Erie, but it is unclear whether droughts on wintering grounds are a concern for Western Hemisphere Bank Swallows.

Summary of Trends and Fluctuations

In summary, BBS data show both long- and short-term declines in Bank Swallow abundance in Canada. Although the decline continues, there is some suggestion that the rate may be slowing. A pattern of long- and short-term declines is supported by breeding bird atlases, which clearly indicate substantial losses in area of occupancy.

Rescue Effect

Long-term BBS data for the entire U.S. show a non-significant decline of -1.9% per year (95% CI: -4.2, 0.9) between 1966 and 2011 and a non-significant increase of 2.5% per year (CI: -3.1, 16.8) between 2000 and 2011 (Sauer *et al.* 2012). The majority of states bordering Canada, which could serve as a source of rescue, however, have shown declines on the short-term (2001-2011), with significant declines for Maine, New Hampshire, Wisconsin and North Dakota and non-significant declines for Vermont, New York, Minnesota and Ohio (Sauer *et al.* 2012). The remaining states show non-significant (Pennsylvania, Michigan, Montana, Washington) or significant (Idaho) increases (Sauer *et al.* 2012). These patterns suggest that although rescue may be possible in some parts of the Canadian range, it is likely to be limited overall, given the declines observed in many of the bordering states.

Recent Breeding Bird Atlas results from Michigan, New York, Vermont, and Pennsylvania consistently show evidence of substantial reductions in area of occupancy for Bank Swallows (McGowan and Corwin 2008, Pennsylvania Breeding Bird Atlas 2009, Wolinski 2011, R. Renfrew, pers. comm.).

It is unclear whether the U.S. Bank Swallow population will rebound and offset Canadian population losses, but rescue effects are also likely to be limited given the relatively high proportion of juveniles that do not disperse beyond their natal area and, for those that do, the generally short distances travelled (see Dispersal and Migration).

THREATS AND LIMITING FACTORS

Incidental Take – Aggregate Extraction and Erosion Control Projects

Incidental take, the destruction of birds and/or nests during legitimate human activities, has been identified as a threat for Bank Swallows breeding in aggregate pits. Williams (2010) reports a preliminary rough estimate of 58,000 eggs or nestlings destroyed annually by pit operations in Canada. British Columbia, Ontario, Quebec, and Alberta are responsible for 54, 22, 10 and 8% of these losses, respectively. However, variation in the parameters used to calculate this estimate (i.e., number of pits, number of colonies in pits, colony size, burrow occupancy levels, clutch size, etc.) means that this estimate could fluctuate substantially (C. Machtans, pers. comm.).

Ninety-five percent (20/21) of operational (i.e., excavation was underway) aggregate pits surveyed in Wellington County, ON during 2011 were occupied by nesting Bank Swallows (Environment Canada, unpubl. data). In the operational pit that did not have Bank Swallows, suitable nesting habitat was created late in the breeding season. That habitat was occupied the following year. An additional nine pits that were not operational (i.e., excavation had not yet begun or was completed) were also visited and none contained Bank Swallows.

Sixty-three percent of the occupied pits conducted excavation activities that directly destroyed some nesting burrows during the breeding season, amounting to a total loss of 32% of all burrows in the study area (1,762 of 5,868). Unpublished data from Environment Canada indicate that about 50% of burrows in pits in and around Wellington County were lost to various factors, including excavation, erosion, predators, and indirect damage. In contrast, 20% of burrows were lost due to erosion and 1% to predation in natural sites along the Saugeen River during 2011 (Environment Canada, unpubl. data). Because it appears nearly all Bank Swallows nest in aggregate pits in Wellington County, the destruction of nests in these habitats is potentially of some importance to the population (M. Cadman, pers. comm.).

In some cases, river and ocean erosion control projects taking place during the breeding season have directly resulted in nest damage and nestling mortality, caused by rock walls and other materials being placed directly in front of nest sites (B. Whittam and R. Curley, pers. comm.).

Habitat degradation and disturbance from motocross and ATV use in pits and other areas may be of significance (F. Shaffer, pers. comm.), as well as outright persecution of colonies by people (see Sources of Adult and Nest Mortality and Parasitism).

Habitat Loss

See Habitat Trends.

Climatic Change

No information exists on the direct impact of climate change on Bank Swallows and thus the following hypotheses are largely speculative.

Changes in the timing of emergent insects may be occurring as a result of climate change, such that there is a mismatch between the availability and demand in food supply for birds (i.e., for provisioning young, post-fledging, migration or during winter; Both *et al.* 2010, but see Dunn *et al.* 2011).

In the eastern hemisphere, apparent overwintering adult survival is reduced in drought years and negatively related to the rainfall levels from the previous breeding season (Szep 1995, Cowley and Siriwardena 2005). In addition, inclement weather events are considered the primary cause of nestling mortality (Turner and Rose 1989). Periods of prolonged rainfall can reduce insect availability, increase foraging constraints on adults, and cause colony bank collapse (Bryant and Turner 1982, Garrison 1999, M. Falconer pers. obs.). Climate change is thought to have resulted in increased numbers and intensity of hurricanes, potentially causing high mortality during migration (e.g., Dionne *et al.* 2008).

Considering the predicted impact of climate change on the Maritimes coast (Daigle *et al.* 2006), breeding habitat in coastal regions may be under threat due to accelerated coastal erosion and high water levels. Maritime Bank Swallows primarily rely on natural breeding habitat (Erskine 1979), and therefore declines in available natural habitat could impact populations more severely in Atlantic Canada compared to other areas.

Permafrost thaw slumps are increasing with arctic warming (Lantz and Kokelj 2008, Lantz *et al.* 2009) and may provide suitable nesting habitat depending on slumping activity (i.e., banks). Active thaw slumps likely retreat too quickly (20 m annually) for Bank Swallows to establish colonies, but stabilized thaw slumps may provide suitable habitat (S. Kokelj, pers. comm.). However, this is speculative because there are no records of Bank Swallows nesting in permafrost thaw slumps.

Aerial Insect Declines

Nebel *et al.* (2010) speculated that population declines in aerial insectivorous birds could be a result of a decline in insect diversity and abundance caused by widespread pesticide use. In particular, pesticide use in South America (on Bank Swallow wintering grounds) is of primary concern because banned organochlorine and organophosphate pesticides are still in use there. Surprisingly, even the use of highly selective, low toxicity mosquito control agents (i.e., *Bacillus thuringiensis israelensis* [*Bti*]) have been shown to alter diet compositions and reduce feeding and reproductive rates of House Martins (*Delichon urbicum*) (Poulin *et al.* 2010). *Bti* has been used worldwide, including Canada, since 1982.

Road Mortality

Bank Swallows are particularly susceptible to vehicle collisions (Mead 1979), in part due to a unique social behaviour in which individuals are attracted to, and sometimes attempt to copulate with intra-specific corpses (Dale 2001, M. Falconer, pers. obs.). Large flocks of birds will sometimes rest on the road with intra-specific carcasses. Thus, when one bird is hit by a vehicle, there is an elevated risk that others will be subsequently hit. Removing Bank Swallow carcasses from the road helps reduce large road mortality events. During Bank Swallow road mortality surveys near Long Point, dead birds were occasionally found in clusters (e.g., 115 birds along 30 m of road; BSC, unpubl. data). Bank Swallows were the most frequently encountered carcasses during road mortality surveys, but the estimated total mortalities over the breeding and post-breeding season was probably biologically insignificant considering the large local population estimate (<0.01%; BSC, unpubl. data).

Predation and Parasites

A large range of predators and parasites exist for Bank Swallows (see Sources of Adult and Nest Mortality and Parasitism). Changes in these species' populations may influence Bank Swallow numbers. Merlin and other raptor species (excluding American Kestrel) have undergone population rebounds over the last several decades, especially in southern Ontario and the Maritimes (Cadman *et al.* 2007, BSC 2011a). It is, however, unknown if raptor populations are negatively impacting Bank Swallows where both species coexist. It is also unknown if changes in parasite loads or species composition have occurred in Bank Swallows.

PROTECTION, STATUS, AND RANKS

Legal Protection and Status

In Canada, the Bank Swallow is protected under the *Migratory Birds Convention Act*, 1994 and in the U.S. under the *Migratory Birds Treaty Act*, 1918. The Bank Swallow is not considered a candidate species to be listed under the U.S. *Endangered Species Act* (USFWS 2011). The Bank Swallow is protected under various provincial legislation protecting most other native wildlife from harm: in Quebec, *the Act Respecting the Conservation and Development of Wildlife*, RSQ, c C-61.1; the *Wildlife Act (1998) of Saskatchewan*; the *Wildlife Act (2008) of British Columbia,* the *New Brunswick Fish and Wildlife Act* (S.N.B. 1980, c. F-14.1) and the *Wildlife Act of the Northwest Territories* (1988). In the U.S., the Bank Swallow is considered "threatened" in the state of California and "special concern" in Arkansas and Kentucky.

Non-legal Status and Ranks

The Bank Swallow is considered “Least Concern” on the IUCN Red List of Threatened Species (2011) and is ranked by NatureServe (2011) as G5-Secure globally; N5-Secure in both Canada and the United States (Table 5). Eastern provinces generally have higher conservation status ranks (Table 5). The species also has higher conservation status in the southern U.S.: SH (possibly extirpated) in Alabama; S1 (critically imperilled) in Mississippi and North Carolina; S2 (imperiled) in California, New Mexico, Texas, Oklahoma, Kansas, Arkansas, West Virginia, and Delaware (NatureServe 2011).

Table 5. Conservation status ranks for the Bank Swallow in Canada and provincial jurisdictions according to CESCC (2010), NatureServe (2011) and GNWT (2011).

Province/Territory	General Status Rank	NatureServe Rank *
Yukon	Secure	S4B
Northwest Territories	Secure	S3S4B
Nunavut	Accidental	---
British Columbia	Secure	S4S5B
Alberta	Secure	S5
Saskatchewan	Secure	S5B, S5M
Manitoba	Secure	S4B
Ontario	Sensitive	S4B
Quebec	Secure	S4B
New Brunswick	Sensitive	S3B
Nova Scotia	May be at risk	S4B
Prince Edward Island	Secure	S5B
Newfoundland	Secure	S3B

* S5 (Secure) - Common, widespread, and abundant in the jurisdiction. S4 (Apparently Secure) - Uncommon but not rare; some cause for long-term concern due to declines or other factors. S3 (Vulnerable) - Vulnerable in the jurisdiction due to a restricted range, relatively few populations, recent and widespread declines, or other factors. SNR (Unranked) - National or subnational conservation status not yet assessed.
B – Breeding. M – Migrant.

Habitat Protection and Ownership

Altogether, there is likely a considerable amount of available habitat on Crown lands, provincially protected parks and reserves, nationally protected areas and other conservation lands (e.g., Gwich'in Land Use Plan Conservation Zones). In the core range of the Bank Swallow, substantial amounts of available habitat likely occur on private lands (e.g., Great Lakes and Atlantic coast shorelines, sand and gravel pits, and construction sites). Because nesting banks are often ephemeral, the availability of suitable habitat can be spatially and temporally dynamic. More permanent colonies tend to have larger numbers of breeding birds (Garrison 1999). Thus, protecting small, ephemeral colonies may not provide as much conservation value as more permanent, larger colonies.

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

The contributions of many people made this status report as comprehensive and up-to-date as possible. Mike Cadman, Environment Canada and Brian Henshaw, Beacon Environmental made unpublished data sets available. Pete Blancher, Adam Smith, Don Sutherland, Chris Risley, Vivian Brownell, Paul Giroux, Craig Machtans, Brenda Dale, Gilles Falardeau, Patrick Nantel, Shelley Moores, Rosemary Curley, Ben Sawa, Marcel Gahbauer, François Shaffer, Nancy Mahony, Becky Whittam and Alain Filion provided useful information, maps, comments, and/or data.

List of Authorities Contacted

Anderson, Robert, Research Scientist, Canadian Museum of Nature, Ottawa ON

Blancher, Pete, Research Scientist, Canadian Wildlife Service, Environment Canada, Ottawa, ON

Blaney, Sean, Botanist / Assistant Director, Atlantic Canada Conservation Data Centre, Dept. of Natural Resources, Sackville, NB

Boates, Sherman, Manager, Biodiversity, Wildlife Division, Dept. of Natural Resources, Government of Nova Scotia, Kentville, NS

Cadman, Mike, Songbird Biologist, Canadian Wildlife Service, Environment Canada, Burlington, ON

Carrière, Suzanne, Biologist, Wildlife Division, Dept. of Environment and Natural Resources, Government of Northwest Territories, Yellowknife, NT

Christensen, Michelle, Secretariat, Wildlife Management Advisory Council – North Slope, Whitehorse, YT

Chutter, Myke, Provincial Bird Specialist, Wildlife Management Branch, Ministry of Environment, Province of British Columbia, Victoria, BC

Clark, Karin, Wildlife Management Biologist, Wek'eezhii Renewable Resources Board, Yellowknife, NT

Court, Gordon, Provincial Wildlife Status Biologist, Fish and Wildlife Division, Dept. of Sustainable Resource Development, Government of Alberta, Edmonton, AB

Couturier, Andrew, Senior GIS analyst, Bird Studies Canada. Port Rowan, ON

Curley, Rosemary, Conservation Biologist, Protected Areas and Biodiversity Conservation, Forest, Fish and Wildlife Division, Environment, Energy and Forestry, Charlottetown, PE

Dale, Brenda, Wildlife Biologist, Population Assessment Unit, Conservation Section, Canadian Wildlife Service, Environment Canada, Edmonton, AB

De Smet, Ken, Species at Risk Specialist, Wildlife & Ecosystem Protection Branch, Manitoba Conservation, Winnipeg, MB

Duncan, Dave, Regional Director, Canadian Wildlife Service, Environmental Stewardship Branch, Prairie & Northern Region, Environment Canada, Edmonton, AB

Duncan, James, Manager, Biodiversity, Habitat and Endangered Species Section, Wildlife & Ecosystem Protection Branch, Manitoba Conservation, Winnipeg, MB

Easton, Wendy, Landbird Assessment Biologist, Canadian Wildlife Service, Environment Canada, Pacific Wildlife Research Centre, Delta, BC

Eaton, Samara, Wildlife Biologist, Species at Risk Recovery, Canadian Wildlife Service, Environment Canada, Sackville, NB

Elderkin, Mark, Provincial Species at Risk Biologist, Wildlife Division, Dept. of Natural Resources, Government of Nova Scotia, Kentville, NS

Falardeau, Gilles, Landbird Biologist, Canadian Wildlife Service, Environment Canada, Sainte Foy, QC

Filion, Alain, Scientific and GIS Project Officer, COSEWIC Secretariat, Canadian Wildlife Service, Environment Canada, Gatineau, QC

Fournier, François, Manager - Wildlife research, Science and Technology Branch, Environment Canada, Sainte Foy, QC

Fraser, David, Species at Risk Specialist, Ecosystem Branch, Conservation Planning Section, Ministry of Environment, Government of British Columbia, Victoria, BC

Giasson, Pascal, Manager, Species at Risk Program, Fish and Wildlife Branch, Dept. of Natural Resources, Fredericton, NB

Giroux, Paul, Monitoring Ecologist, PEI National Park of Canada, Charlottetown, PE

Gosselin, Michel, Collection Manager (Birds), Canadian Museum of Nature, Ottawa, ON

Gougeon, Nicole, Secretary Treasurer, Hunting, Fishing and Trapping Coordinating Committee, Montréal, QC

Gravel, Mike, Territorial Forest Ecologist, Dept. of Environment and Natural Resources, Government of Northwest Territories, Hay River, NT

Hanbidge, Bruce, Resource Biologist, Wildlife Management Advisory Council – Northwest Territories, Inuvik, NT

Hanson, Alan, Landscape Conservation Head, Canadian Wildlife Service, Environment Canada, Sackville, NB

Henshaw, Brian, Senior Ecologist, Beacon Environmental Ltd., Markham, ON

Hoar, Tyler, Biologist, Independent, Oshawa, ON

Hopkins, Chris, Executive Director, Sathu Renewable Resources Board, Tulita, NT

Howes, Lesley-Anne, Bird Banding Biologist, Canadian Wildlife Service, Environment Canada, Ottawa, ON

Jones, Neil, Scientific Project Officer & ATK Coordinator, COSEWIC Secretariat, Canadian Wildlife Service, Environment Canada, Gatineau, QC

Jung, Thomas, Senior Wildlife Biologist, Fish and Wildlife Branch, Environment Yukon, Government of Yukon, Whitehorse, YT

Lebrun-Southcott, Zoé, Canadian Wildlife Service, Environment Canada, Downsview ON

Legacy, Ken, Wildlife Officer, Enforcement Branch, Environment Canada, Burlington, ON

MacDonald, Bruce, Director, Northern Conservation Section, Canadian Wildlife Service, Environment Canada, Yellowknife, NT

Machtans, Craig, Forest Bird Biologist, Northern Conservation Section, Canadian Wildlife Service, Environment Canada, Yellowknife, NT

Mahony, Nancy, Research Biologist, Environment Canada, Delta, BC

Millikin, Rhonda, A/Head Population Assessment, Canadian Wildlife Service, Environment Canada, Pacific Wildlife Research Centre, Delta, BC

Moores, Shelley, Senior Manager, Endangered Species and Biodiversity, Wildlife Division, Dept. of Environment and Conservation, Government of Newfoundland and Labrador, Corner Brook, NL

Mossop, Dave, Biology Instructor, Professor Emeritus, Yukon Research Centre, Whitehorse, YK

Nantel, Patrick, Conservation Biologist, Species at Risk Program, Ecological Integrity Branch, Parks Canada, Gatineau, QC

Nernberg, Dean, Species at Risk Officer, Director of General Environment, National Defence Headquarters, Ottawa, ON

O'Connor, Mark, Director of Wildlife Management, Nunavik Marine region Wildlife Board, Inukjuak, QC

Paquet, Annie, technicienne de la faune, Service de la biodiversité et des maladies de la faune, Ministère des Ressources naturelles et de la Faune, Direction de l'expertise sur la faune et ses habitats, Ste-Foy, QC

Pepper, Janette, Zoologist, Biodiversity Conservation Section, Fish and Wildlife Branch, Saskatchewan Ministry of Environment, Regina, SK

Pittoello, Gigi, Habitat Ecologist, Fish and Wildlife Branch, Saskatchewan Ministry of Environment, Regina, SK

Quinlan, Richard, Provincial Species at Risk Specialist, Section Head, Non-game Wildlife, Species at Risk and Wildlife Division, Dept. of Sustainable Resource Development, Government of Alberta, Lethbridge, AB

Raillard, Martin, Manager, Population Conservation, Canadian Wildlife Service, Environmental Stewardship Branch, Environment Canada, Sackville, NB

Renfrew, Rosalind, Vermont Breeding Bird Atlas Coordinator, Vermont Center for Ecostudies, Norwich, VT

Sabine, Mary, Biologist, Species at Risk Program, Fish and Wildlife Branch, Dept. of Natural Resources, Fredericton, NB

Sawa, Ben, Data Manager, Saskatchewan Conservation Data Centre, Saskatchewan Ministry of Environment, Regina, SK.

Sinclair, Pam, Songbird Biologist, Canadian Wildlife Service, Environment Canada, Whitehorse, YT

Smith, Adam, Biostatistician, Canadian Wildlife Service, Environment Canada, Ottawa, ON

Snortland, Jody, Executive Director, Wek’eezhii Renewable Resources Board, Yellowknife, NT

Squires, Susan, Ecosystem Management Ecologist, Endangered Species and Biodiversity, Wildlife Division, Dept. of Environment and Conservation, Government of Newfoundland and Labrador, Corner Brook, NL

Stipec, Katrina, Information Specialist, BC Conservation Data Centre, Ministry of Environment, Province of British Columbia, Victoria, BC

Sutherland, Donald, Zoologist, Natural Heritage Information Centre, Inventory, Monitoring and Assessment Section, Science and Information Branch, Ontario Ministry of Natural Resources, Peterborough, ON

Thompson, Amy, Executive Director, Gwich’in Renewable Resources Board, Inuvik, NT

Tuininga, Ken, Senior Species at Risk Biologist, Canadian Wildlife Service, Environment Canada, Downsview, ON

Trefry, Helen, Wildlife Biologist, Population Assessment Unit, Conservation Section, Canadian Wildlife Service, Environment Canada, Edmonton, AB

Van Tighem, Graham, Executive Director, Yukon Fish and Wildlife Management Board, Whitehorse, YT

Vujnovic, Drajs, Parks Zoologist, Parks Ecology Program, Alberta Conservation Information Management System, Alberta Tourism Parks and Recreation, Edmonton, AB

Watkins, Bill, Zoologist, Wildlife and Ecosystem Protection Branch, Manitoba Dept. of Conservation, Winnipeg, MB

Whittam, Becky, Wildlife Biologist – Landbirds, Canadian Wildlife Service, Environment Canada, Sackville, NB

INFORMATION SOURCES

Altus Group. 2009. State of the Aggregate Resource in Ontario Study Paper 1: Aggregate Consumption and Demand. Toronto: Queens Printer for Ontario, 77 pp.

Alves, M.A.S.1997. Effects of ectoparasites on the Sand Martin *Riparia riparia* nestlings. Ibis 139:494-496.

Asbirk, S. 1976. Studies on the breeding biology of the Sand Martin *Riparia riparia* (L.) (Aves) in artificial nest sites. Videnskabelige Meddelelser Dansk Naturhistorisk Forening. 139:147-177.

Ashley E.P. and J.T. Robinson. 1996. Road mortality of amphibians, reptiles and other wildlife on the Long Point Causeway, Lake Erie, Ontario. Canadian Field Naturalist 110:403-412.

Bain M.B., N. Singkran, and K.E. Mills. 2008. Integrated Ecosystem Assessment: Lake Ontario Water Management. PLoS ONE 3(11): e3806. doi:10.1371/journal.pone.0003806 [accessed 6 September 2011].

Bartzen, B.A., K.W. Dufour, R.G. Clark, and F.D. Caswell. 2010. Trends in agricultural impact and recovery of wetlands in prairie Canada. Ecological Applications 20:525-538.

Bedford, B.L. 1999. Cumulative effects on wetland landscapes: Links to wetland restoration in the United States and southern Canada. Wetlands 19:775-788.

Bérubé, D. 1993. Distribution of coastal protection structures, Northumberland Strait, New Brunswick. Plate 93-319, New Brunswick Department of Natural Resources and Energy, Mineral Resources Division.

Blancher, P.J., K.V. Rosenberg, A.O. Panjabi, B. Altman, J. Bart, C.J. Beardmore, G.S. Butcher, D. Demarest, R. Dettmers, E.H. Dunn, W. Easton, W.C. Hunter, E.E. Iñigo-Elias, D.N. Pashley, C.J. Ralph, T.D. Rich, C.M. Rustay, J.M. Ruth, and T.C. Will. 2007. Guide to the Partners in Flight Population Estimates Database. Version: North American Landbird Conservation Plan 2004. Partners in Flight Technical Series No 5. http://www.partnersinflight.org/

Blem, C.R. 1979. Predation of black rat snakes on a Bank Swallow colony. Wilson Bulletin 91:135-137.

Brennan, L.A. and W.P. Kuvlesky, Jr. 2005. North American grassland birds: an unfolding conservation crisis? Journal of Wildlife Management 69:1-13.

Brewer D., A.W. Diamond, E.J. Woodsworth, B.T. Collins, and E.H. Dunn. 2000. Canadian Atlas of Bird Banding - Volume 1: Doves, Cuckoos, and Hummingbirds through Passerines, 1921-1995. Occasional Paper, Canadian Wildlife Service, Environment Canada.

Bryant, D.M. and A.K. Turner. 1982. Central place foraging by swallows (Hirundinidae): the question of load size. Animal Behaviour 30:845-856.

BSC (Bird Studies Canada). 2011a. Maritimes Breeding Bird Atlas: maps. Website: http://www.mba-aom.ca/jsp/map.jsp?lang=en [accessed 18 August 2011].

BSC (Bird Studies Canada). 2011b. British Columbia Breeding Bird Atlas: maps. Website: http://www.birdatlas.bc.ca/bcdata/maps.jsp [accessed 18 August 2011].

BSC (Bird Studies Canada). 2011c. Manitoba Breeding Bird Atlas: maps. Website: http://www.birdatlas.mb.ca/mbdata/maps.jsp?lang=en [accessed 18 August 2011].

Both, C., C.A.M. Van Turnhout, R.G. Bijlsma, H. Siepel, A.J. Van Strien and R.P.B. Foppen. 2010. Avian population consequences of climate change are most severe for long-distance migrants in seasonal habitats. Proceedings of the Royal Society B 277:1259-1266.

Bull, J. 1985. Birds of New York state. Cornell University Press, Ithaca, NY, 655 pp.

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

Campbell, R.W., N.K. Dawe, I. McTaggert-Cowan, J.M. Cooper, and G.W. Kaiser. 1997. The birds of British Columbia. Vol. 3. Univ. of British Columbia Press, Vancouver, 693 pp.

CEAA (Canadian Environmental Assessment Agency). 2009. Response to Lower Churchill Hydroelectric Generation Project: Environmental Impact Statement. Registry number 07-05-26178. Website: www.ceaa.gc.ca/050/documents_staticpost/26178/39444/v2-01.pdf [accessed 18 August 2011].

CESCC (Canadian Endangered Species Conservation Council). 2010. Wild Species 2010: the general status of species in Canada. Ottawa: Minister of Public Works and Government Services Canada. Website: http://www.wildspecies.ca/wildspecies2010/downloads.cfm?lang=e [accessed 26 July 2011].

Cowley, E., and G.M. Siriwardena. 2005. Long-term variation in survival rates of Sand Martins *Riparia riparia*: dependence on breeding and wintering ground weather, age and sex, and their population consequences. Bird Study 52:237-251.

Cramp, S., D.J. Brooks, E. Dunn, R. Gillmor, and J. Hall-Craggs. 1988. The birds of the western Palearctic, Vol. 5: tyrant flycatchers to thrushes. Oxford Univ. Press, Oxford, UK, 1136 pp.

Daigle, R., D. Forbes, G. Parkes, H. Ritchie, T. Webster, D. Bérubé, A. Hanson, L. DeBaie, S. Nichols, and L. Vasseur (eds.) 2006. Impacts of sea-level rise and climate change on the coastal zone of southeastern New Brunswick. Project Report. Environment Canada, Dartmouth, Nova Scotia, Canada, ISBN 0-662-43947-3, Cat. No.: En84-45/2006E, EPSM-773 (also available on CD-ROM): 644 p. + 5 appendices.

Dale, S. 2001. Necrophilic behaviour, corpses as nuclei of resting flock formation, and road-kills of Sand Martins *Riparia riparia.*.Ardea 89:545-547.

Davies, M. 2011. Geomorphic shoreline classification of Prince Edward Island. Atlantic Climate Adaptation Solutions Association Report. 70 pp.

Dunn, E.H., J. Larivée and A. Cyr. 1996. Can checklist programs be used to monitor populations of birds recorded during the migration season? Wilson Bulletin 108:540-549.

Dunn, E.H., J. Larivée and A. Cyr. 2001. Site-specific observation in the breeding season improves the ability of checklist data to track population trends. Journal of Field Ornithology 72:547-555.

Dunn, P.O., D.W. Winkler, L.A. Whittingham, S.J. Hannon, and R.J. Robertson. 2011. A test of the mismatch hypothesis: How is timing of reproduction related to food abundance in an aerial insectivore? Ecology 92:450-461.

Emlen, S.T. 1971. Adaptive aspects of coloniality in the Bank Swallow. (abstract) American Zoologist. 11:47.

Environment Agency. 2001. Best management guidelines: artificial bank creation for sand martins and kingfishers. Bristol, UK:Environment Agency. Website: http://www.lbp.org.uk/downloads/Publications/Management/artificial_bank_creation.pdf [accessed 18 August 2011].

Erskine, A.J. 1979. Man's influence on potential nesting sites and populations of swallows in Canada. Canadian Field-Naturalist 93:371-377.

Erskine, A.J. 1992. Atlas of the breeding birds of the Maritime provinces. Nimbus and Nova Scotia Museum (Chelsea Green), Halifax. 270 pp.

FPTGC (Federal, Provincial and Territorial Governments of Canada). 2010. Canadian Biodiversity: Ecosystem Status and Trends 2010. Canadian Councils of Resource Ministers. Ottawa, ON. vi + 142 pp.

FAN (Federation of Alberta Naturalists). 2007. The Atlas of Breeding Birds of Alberta: A second look. Federation of Alberta Naturalists. Edmonton. vii + 626 pp.

ffrench, R. 1991. A guide to the birds of Trinidad and Tobago. 2nd ed. Cornell University Press. New York. 426 pp.

Freer, V.M. 1973. Sparrow Hawk predation on Bank Swallows. Wilson Bull. 85:231-233.

Freer, V.M. 1977. Colony structure and function in the Bank Swallow, *Riparia riparia* L. Phd Thesis. State Univ. of New York, Binghamton, 312 pp.

Freer, V.M. 1979. Factors affecting site tenacity in New York Bank Swallows. Bird-Banding 50:349-357.

Garrison, B.A. 1998. Bank Swallow (*Riparia riparia*). In The riparian bird conservation plan: A strategy for reversing the decline of riparian-associated birds in California. California Partners in Flight Riparian Bird Conservation Plan. Website: http://www.prbo.org/calpif/htmldocs/species/riparian/bank_swallow_acct2.html [accessed 18 August 2011].

Garrison, B.A. 1999. Bank Swallow (*Riparia riparia*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.cat1.lib.trentu.ca:8080/bna/species/414doi:10.2173/bna.414 [accessed 18 August 2011].

Gauthier, J. and Y.E. Aubry. 1996. The breeding birds of Quebec: atlas of the breeding birds of Southern Quebec. Association Quebecoise des Groupes d'Ornithologues, Province of Quebec Society for the Protection of Birds, Canadian Wildlife Service, Environment Canada, Quebec Region, Montreal. xviii + 1295 pp.

Ghent, A.W. 2001. Importance of a low talus in location of Bank Swallow (*Riparia riparia*) colonies. American Midland Naturalist 146:447-449.

Ginevan, M.E. 1971. Chipmunk predation on Bank Swallows. Wilson Bulletin 83:102.

Girvetz, E.H. 2010 Removing erosion control projects increases bank swallow (*Riparia riparia*) population viability modeled along the Sacramento River, California, USA. Biological Conservation 143:828-838.

GNWT (Government of the Northwest Territories). 2011. NWT Species 2011-2015 – General Status Ranks of Wild Species in the Northwest Territories, Department of Environment and Natural Resources, Government of the Northwest Territories, Yellowknife, NT. 172 pp.

Graf, W.L. 2006. Downstream hydrologic and geomorphic effects of large dams on American rivers. Geomorphology 79:336-360.

Gulickx, M.M.C., R. Beecroft, A. Green. 2007. Creation of artificial sand martin *Riparia riparia* burrows at Kingfishers Bridge, Cambridgeshire, England. Conservation Evidence 4:51-53.

Haas, G.E., T. Rumfelt, and N. Wilson. 1980. Fleas (Siphonaptera) from nests and burrows of the Bank Swallow (*Riparia riparia*) in Alaska. Northwest Science 54:210-215.

Hayes, F.E., S.M. Goodman, J.A. Fox, T.G. Tamayo, and N.E. Lopez. 1990. North American bird migrants in Paraguay. Condor 92:947-960.

Heneberg, P. 2001. Size of sand grains as a significant factor affecting the nesting of bank swallows (*Riparia riparia*). Biologia Bratislava. 56:205-210.

Heneberg, P. 2003. Soil particle composition affects the physical characteristics of Sand Martin, *Riparia riparia* holes. Ibis 145:392-399.

Heneberg, P. 2009. Soil penetrability as a key factor affecting the nesting of burrowing birds. Ecological Restoration 24:453-459.

Heneberg P. 2011. Sex-specific differences in Sand Martin *Riparia riparia* nest attentiveness. Bird Study 58:107-110.

Herdendorf, C.E. 1984. Guide to Lake Erie bluff stabilization. Guide Series OHSU-GS-7. Sea Grant Program. The Ohio State University, Columbus, OH, 20 pp.

Hickman, G.R. 1979. Nesting ecology of Bank Swallows in interior Alaska. Master's Thesis. Univ. of Alaska, Fairbanks, 78 pp.

Hjertaas, D.G. 1984. Colony site selection in Bank Swallows. Master's Thesis. Univ. of Saskatchewan, Saskatoon, 129 pp.

Holmes, P. R., S. E. Christmas, and A. J. Parr. 1987. A study of the return rate and dispersal of Sand Martins *Riparia riparia* at a single colony. Bird Study 34:12-19.

IUCN (International Union for the Conservation of Nature). 2011. IUCN Red List of Threatened Species. Version 2011.1. Website: http://www.iucnredlist.org [accessed 25 July 2011].

Jobin, B., J-L. DesGranges and C. Boutin. 1996. Population trends in selected species of farmland birds in relation to recent developments in agriculture in the St. Lawrence Valley. Agriculture, Ecosystems and Environment 57:103-116.

Jobin, B., C. Latendresse, M. Grenier, C. Maisonneuve and A. Sebbane. 2009. Recent landscape change at the ecoregion scale in Southern Québec (Canada), 1993–2001. Environmental Monitoring and Assessment 164:631-647.

John, R.D. 1991. Observations on soil requirements for nesting Bank Swallows, *Riparia riparia*. Canadian Field Naturalist. 105:251-254.

Johnson, S.L. 2006. Song learning and syntax patterns in the American Robin and the soil characteristics of Bank Swallow nest sites. Phd. Thesis. University of Massachusetts, Amherst, 127 pp.

Jones, G. 1987. Colonization patterns in Sand Martins, *Riparia riparia*. Bird Study 34:20-25.

KCCA (Kettle Creek Conservation Authority). 1989. Shoreline management plan. 238 pp. Available online: http://www.kettlecreekconservation.on.ca/content.php?doc=90. [Accessed 13 January 2012].

Kuhnen, K. 1985. On pair-formation in the Sand Martin, *Riparia riparia*. Journal of Ornithology 126:1-13.

Lantz, T.C. and S.V. Kokelj. 2008. Increasing rates of retrogressive thaw slump activity in the Mackenzie Delta region, N.W.T., Canada. Geophysical Research Letters 35: L06502

Lantz T.C., S.V. Kokelj, S.E. Gergel, G.H.R. Henry. 2009 Relative impacts of disturbance and temperature: persistent changes in microenvironment and vegetation in retrogressive thaw slumps. Global Change Biology 15: 1664-1675.

Larivée, J. 2011. Studies of Bird Populations in Québec (2011-02-23 Version) [database]. Rimouski, Québec : Regroupement QuébecOiseaux.

Lind, B-B, J. Stigh and L. Larsson. 2002. Sediment type and breeding strategy of the Bank Swallow *Riparia riparia* in western Sweden. Ornis Svecica 12:157-163.

Macbriar, Jr., W.N. and D.E. Stevenson. 1976. Dispersal and survival in the Bank Swallow (*Riparia riparia*) in southeastern Wisconsin. Milwaukee Public Museum Contributions in Biology and Geology. no. 10, 14 pp.

Mead, C.J. and J.D. Harrison. 1979. Sand Martin movements within Britain and Ireland. Bird Study 26:73-86.

McGowan, K.J., and K. Corwin. 2008. The second atlas of breeding birds in New York State. Cornell University Press, Ithaca, NY, 688 pp.

Mead, C.J. 1979. Mortality and causes of death in British Sand Martins. Bird Study 26:107-112.

Moffatt, K.C., E.E. Crone, K.D. Holl, R.W. Schlorff, and B.A. Garrison. 2005. Importance of hydrologic and landscape heterogeneity for restoring Bank Swallow (*Riparia riparia*) colonies along the Sacramento River, California. Restoration Ecology 13:391-402.

Monk, W.A., D.J. Baird, R.A. Curry, N. Glozier, and D.L. Peters. 2010. Ecosystem status and trends report: biodiversity in Canadian lakes and rivers. Canadian Biodiversity: Ecosystem Status and Trends 2010, Technical Thematic Report Series: No. 20. Canadian Councils of Resource Ministers. Ottawa, ON. vi + 142 pp

Morlan, R.E. 1972. Predation at a northern Yukon Bank Swallow colony. Canadian Field Naturalist 86:376.

Nakano, D., T. Akasaka, A. Kohzu, and F. Nakamura. 2007. Food sources of Sand Martins *Riparia riparia* during their breeding season: insights from stable-isotope analysis. Bird Study 54:142-144.

NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Website: http://www.natureserve.org/explorer. [accessed: 29 September 2011].

Nebel, S., A.M. Mills, J.D. McCracken and P.D. Taylor. 2010. Declines of aerial insectivores in North America follow a geographic gradient. Avian Conservation and Ecology - Écologie et conservation des oiseaux. 5:1 [online] http://www.ace-eco.org/vol5/iss2/art1/

Oberholser, H.C. 1974. The bird life of Texas. Vol. 2. Univeristy of Texas Press, Austin, 530 pp.

PIF LPED (Partners in Flight Landbird Population Estimates Database). 2007. http://www.rmbo.org/pif_db/laped/default.aspx.

Peck, G.K. and R.D. James. 1987. Breeding birds of Ontario: nidiology and distribution, Vol. 2: passerines. Royal Ontario Museum. Life Sciences Misc. Publication. Toronto, 387 pp.

Peck, G.K., M.K. Peck, and C.M. Francis. 2001. Ontario Nest Records Scheme Handbook. ONRS, Toronto, Ontario. 32 pp.

Pennsylvania Breeding Bird Atlas (second). 2009. Cornell Lab of Ornithology, Ithaca, NY for Carnegie Museum of Natural History, Pittsburgh, PA. Website: http://www.carnegiemnh.org/atlas/home.htm [accessed: 19 March 2012].

Persson, C. 1987. Age structure, sex ratios and survival rates in a south Swedish Sand Martin (*Riparia riparia*) population, 1964 to 1984. Journal of Zoology Series B, 1:639-670.

Petersen, A.J. 1955. The breeding cycle in the Bank Swallow. Wilson Bulletin 67:235-286.

Petersen, P.C. and A.J. Mueller. 1979. Longevity and colony loyalty in Bank Swallows. Bird-Banding 50:69-70.

Potter, L.B. 1924. Badger digs for Bank Swallows. Condor 26:191.

Poulin, B., G. Lefebvre and L. Paz. 2010. Red flag for green spray: adverse trophic effects of Bti on breeding birds. Journal of Applied Ecology 47: 884-889.

Pyle, P. 1997. Identification guide to North American birds: Part I Columbidae to Ploceidae. Slate Creek Press, Bolinas, CA, 732 pp.

Quebec Breeding Bird Atlas. 2012. Website: http:www.atlas-oiseaux.qc.ca. Regroupement Québec Oiseaux, Canadian Wildlife Service of Environment Canada, Bird Studies Canada. [accessed 16 July 2012].

Rich, T.D., C.J. Beardmore, H. Berlanga, P.J. Blancher, M.S.W. Bradstreet, G.S. Butcher, D.W. Demarest, E.H. Dunn, W.C. Hunter, E.E. Iñigo-Elias, J.A. Kennedy, A.M. Martell, A.O. Panjabi, D.N. Pashley, K.V. Rosenberg, C.M. Rustay, J.S. Wendt, T.C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology. Ithaca, NY. Website: http://www.partnersinflight.org/cont_plan/ [accessed 18 August 2011]

Ridgely, R. S. and G. Tudor. 1989. The birds of South America. Vol. 1. University of Texas Press, Austin. 750 pp.

Sabrosky, C. W., G. F. Bennett, and T. L. Whitworth. 1989. Bird blow flies (Protocalliphora) in North America (Diptera: Calliphoridae) with notes on the Palearctic species. Smithson. Institute Press, Washington, D.C., 312 pp.

Saskatchewan Ministry of Environment. 2011. Saskatchewan Bird Atlas: Bank Swallow. Web site: http://gisweb1.serm.gov.sk.ca/imf/imf.jsp?site=birds [accessed 18 August 2011].

Sauer, J.R., J.E. Hines, J.E. Fallon, K.L. Pardieck, D.J. Ziolkowski, Jr., and W.A. Link. 2012. The North American Breeding Bird Survey, Results and Analysis 1966 - 2011. Version 12.13.2011 USGS Patuxent Wildlife Research Center, Laurel, MD

Sauer, J.R., and W.A. Link. 2011. Analysis of the North American breeding bird survey using hierarchical models. Auk 128:87-98.

Schlorff, R.A. 1992. Recovery Plan: Bank Swallow (*Riparia riparia*). Nongame Bird and Mammal Section Wildlife Management Division, Report 9302. California Department of Fish and Game: Sacramento, CA., 16 pp.

Sheldon, F.H. and D.W. Winkler. 1993. Intergeneric phylogenetic relationships of swallows estimated by DNA-DNA hybridization. Auk 110:798-824.

Sieber, O. 1980. Causal and functional aspects of brood distribution in Sand Martins (*Riparia riparia* L.). Zeitschrift für Tierpsychologie 52:19-56.

Silver, M. and C.R. Griffin. 2009. Nesting habitat characteristics of Bank Swallows and Belted Kingfishers on the Connecticut River. Northeastern Naturalist 16:519-534.

Sinclair, P.H., W.A. Nixon, C.D. Eckert, and N.L. Hughes. 2003. Birds of the Yukon Territory. University of British Columbia Press, Vancouver, BC. 595 pp.

Spencer, S.J. 1962. A study of the physical characteristics of nesting sites used by Bank Swallows. Phd. Thesis. Pennsylvania State University, University Park, 105 pp.

SSAC (Species Status Advisory Committee). 2009. The Status of the Bank Swallow (*Riparia riparia*) in Newfoundland and Labrador: Report #23. Department of Environment and Conservation. Government of Newfoundland and Labrador, 20 pp.

Stevenson, H.M. and B.H. Anderson. 1994. The Birdlife of Florida. University Press of Florida, Gainesville, Florida, 904 pp.

Stoner, D. 1937. The house rat as an enemy of the Bank Swallow. Journal of Mammalogy 18:87-89.

Szabó, Z.D. and T.Szép. 2010. Breeding dispersal patterns within a large Sand Martin (*Riparia riparia*) colony. Journal of Ornithology 151:185-191

Szep, T. 1990. Estimation of abundance and survival rate from capture-recapture data of Sand Martin (*Riparia riparia*) ringing. Ring 13:205-214.

Szep, T. 1995. Survival rates of Hungarian Sand Martins and their relationship with Sahel rainfall. Journal of Applied Statistics. 22:891-904.

Todd, W.E.C. 1963. The birds of the Labrador Peninsula and adjacent areas. University Toronto Press, Toronto, 819 pp.

TRCA (Toronto Region Conservation Authority). 2010. Meadowcliffe Drive Erosion Control Project: Environmental Study Report. Website: http://www.trca.on.ca/dotAsset/83297.pdf. [accessed 25 July 2011].

Turner, A.K. and C. Rose. 1989. Swallows and martins an identification guide and handbook. Houghton Mifflin Co., Boston, 258 pp.

United States Fish and Wildlife Service (USFWS). 2011. Endangered Species Program. Website: http://www.fws.gov/endangered/species/us-species.html [accessed 25 July 2011].

Whitworth, T.L. and G.F. Bennett. 1992. Pathogenicity of larval Protocalliphora (Diptera: Calliphoridae) parasitizing nestling birds. Canadian Journal of Zoology 70:2184-2191.

Williams, Jeremy. 2010. Avian Incidental Take due to Mining Operations in Canada. Report Prepared by ArborVitae Environmental Services Ltd. for Environment Canada, Western Arctic Unit, Yellowknife. 32 pp.

Windsor, D. and S.T. Emlen. 1975. Predator-prey interactions of adult and prefledgling Bank Swallows and American Kestrels. Condor 77:359-361.

Winkler, D.W. 2006. Roosts and migrations of swallows. Hornero 21:85-97.

Wolinski, R.A. 2011. Bank Swallow (*Riparia riparia*). In A.T. Chartier, J.J. Baldy, and J.M. Brenneman (eds.). The Second Michigan Breeding Bird Atlas. Kalamazoo Nature Center. Kalamazoo, Michigan, USA. Website: http://www.mibirdatlas.org/Portals/12/MBA2010/BANSaccount.pdf. [accessed 24 February 2012].

Yundt, S.E. and B.P. Messerschmidt. 1979. Legislation and policy mineral aggregate resource management in Ontario, Canada. Minerals and the Environment 1:101-111.

Zeranski, J.D. and T.R. Baptist. 1990. Connecticut birds. University Press of New England, Hanover, NH, 328 pp.

BIOGRAPHICAL SUMMARY OF REPORT WRITER(S)

Myles Falconer and Debra Badzinski work for Bird Studies Canada (BSC), a non-profit, non-governmental bird research organization with headquarters in Port Rowan, Ontario. Falconer is an Ontario Region Project Biologist, where his research focuses on Bank Swallow distribution, abundance and breeding ecology on the north shore of Lake Erie. His M.Sc. (Trent) research focused on the breeding ecology of the Eastern Wood-Pewee in managed forests. He has been conducting fieldwork on birds for over 10 years in a variety of landscapes. Badzinski is the Ontario Program Manager with Bird Studies Canada, where she is involved with a number of bird research and monitoring projects, including three species of aerial insectivores. Badzinski completed her M.Sc. (Trent) on the population dynamics of Semipalmated Plovers.

COLLECTIONS EXAMINED

No collections examined.