COSEWIC
Assessment and Status Report

on the

Buff-breasted Sandpiper
Tryngites subruficollis

in Canada

SPECIAL CONCERN
2012

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:

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Buff-breasted Sandpiper — Photo courtesy Ted Swem.

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COSEWIC
Assessment Summary

Assessment Summary – May 2012

Common name
Buff-breasted Sandpiper

Scientific name
Tryngites subruficollis

Status
Special Concern

Reason for designation
The Canadian Arctic supports about 87% of the North American breeding range of this shorebird, and about 75% of its global population. The species was once common and perhaps even abundant historically, but it suffered severe declines stemming from intensive market hunting in the late 1800s and early 1900s. By the 1920s, it was thought to be at the brink of extinction. Its population has grown since hunting was banned in North America, but numbers remain much lower than those before hunting began. There is evidence for population decline in recent decades, and many conservation organizations consider the species to be of concern throughout its range. However, this species is difficult to monitor effectively, and data necessary to estimate population trends are currently lacking. Outside the breeding period, loss and degradation of its specialized grassland habitat, both on its wintering grounds in South America and along its migration routes, are believed to pose the most significant threats.

Occurrence
Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec

Status history
Designated Special Concern in May 2012.

COSEWIC
Executive Summary

Buff-breasted Sandpiper
Tryngites subruficollis

Wildlife Species Description and Significance

The Buff-breasted Sandpiper (*Tryngites subruficollis*) is a medium-sized, shorebird with a buff-coloured face and underparts, and brown to black speckling on its wings and back. It is the only North American shorebird with a lek mating system, in which males congregate to display to females during courtship.

Distribution

The Buff-breasted Sandpiper breeds in the Arctic regions of eastern Russia, Alaska, Yukon and northcentral Canada. It winters in South America, mainly in Argentina, Brazil and Uruguay. About 87% of the species' North American range occurs in Canada, where it breeds along the mainland north coast of Yukon, Northwest Territories and Nunavut, and within the Canadian Arctic Archipelago. Adults migrate south to the wintering grounds through the North American interior, while juveniles tend to spread out to the Atlantic and Pacific coasts before heading south. Migration north to the breeding grounds is concentrated through the central parts of the United States and Canada, with a large proportion of the population passing through Alberta and Saskatchewan.

Habitat

The breeding grounds are exclusively within tundra habitats. On migration and during the winter, Buff-breasted Sandpipers occur primarily in grassland habitats. Prior to European settlement in North America, stop-over habitat for migrants was primarily native short-grass prairie that was grazed by bison. Most such habitat has since been cultivated. Nowadays, the birds primarily use a variety of human-altered sites for stopovers, such as crop fields, golf courses, airport runways, sod farms, and pastures grazed by domestic livestock. Buff-breasted Sandpipers winter mainly in the South American Pampas, where livestock grazing maintains their preferred short-grass habitat structure. Wintering populations also are commonly found next to coastal lagoons.

Biology

Males and females arrive simultaneously on the Arctic breeding grounds from late May through mid June. Males perform courtship displays on territories to attract females. Females lay a single clutch of four eggs in a nest on the ground. Most birds depart for the wintering grounds by early September. The diet of Buff-breasted Sandpipers includes terrestrial insects and spiders, aquatic invertebrates and plant seeds.

Population Sizes and Trends

The most recent global estimate of Buff-breasted Sandpipers is 56,000 birds (range: 35,000-78,000). About 42,000 likely breed in Canada (range: 26,250-58,500), which accounts for about 75% of the species' global population. The population is believed to have once numbered in the hundreds of thousands to millions prior to precipitous declines stemming from commercial hunting in the late 1800s and early 1900s. Recent observations suggest that the species has continued to decline over the past few decades, but no long-term monitoring data exist to verify this apparent trend.

Threats and Limiting Factors

Habitat loss, fragmentation and degradation are likely the primary threats to Buff-breasted Sandpiper populations. In the Arctic, breeding habitat overlaps areas of mineral, coal, oil and gas development. Throughout much of the rest of the migration and winter range, native grasslands have largely disappeared, and the species has switched to using human-altered habitats. The Buff-breasted Sandpiper's regular use of croplands may expose the birds to agrochemicals, while changing agricultural practices (e.g., altered grazing regimes, switch to no-till farming) may decrease food availability and limit suitable habitat. In addition, the development of wind energy projects along the North American migratory route could have negative consequences for the species.

Climate change may impact Buff-breasted Sandpipers in several ways. Northward advancement of shrub cover will dramatically alter its tundra breeding habitat. Rising sea levels and increased rainfall could flood the birds' coastal habitat on both breeding and wintering grounds. More frequent and intense storms could increase mortality of juveniles migrating along the Atlantic coast. Climate change is also expected to cause more frequent and severe droughts in the Canadian Prairies and the U.S. Great Plains, which may negatively impact wetland and seasonal pond habitat and lead to decreased food availability during migration.

Protection, Status, and Ranks

The Buff-breasted Sandpiper is protected in Canada under the federal *Migratory Birds Convention Act*. It is considered near threatened on the IUCN Red List and of high conservation concern by both the U.S. Fish and Wildlife Service and the Canadian Shorebird Conservation Plan. The U.S. Shorebird Conservation Plan designates the Buff-breasted Sandpiper as highly-imperiled. In Canada, the Buff-breasted Sandpiper is ranked nationally as sensitive to extinction or local loss of populations. On the wintering grounds, it is classified as threatened in Argentina, vulnerable in part of Brazil, near threatened in Paraguay, and a priority species for conservation in Uruguay. None of the existing protections extend to conservation of the species' habitat.

TECHNICAL SUMMARY

Tryngites subruficollis
Buff-breasted Sandpiper Bécasseau roussâtre
Breeding: Northwest Territories, Yukon, Nunavut
Non-breeding: British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec
Accidental: Nova Scotia, New Brunswick, Prince Edward Island, Newfoundland and Labrador

Demographic Information

Generation time (average age of parents in the population)	~4-5 years
Is there an observed or inferred continuing decline in number of mature individuals?	Unknown, but suspected
Estimated percent of continuing decline in total number of mature individuals within 5 years	Unknown
Inferred percent reduction in total number of mature individuals over the last 3 generations	Unknown
Projected percent reduction in total number of mature individuals over the next 3 generations	Unknown
Observed percent reduction in total number of mature individuals over any 3-generation period, over a time period including both the past and the future.	Unknown
Are the causes of the decline clearly reversible and understood and ceased? - Initial cause of decline (commercial hunting) has ceased; other potential causes not well understood, but likely include ongoing habitat loss	No
Are there extreme fluctuations in number of mature individuals? - Annual fluctuations in the density and distribution of birds occur at the site level, but individuals likely shift to different areas	No

Extent and Occupancy Information

Estimated extent of occurrence - based on minimum convex polygon	1,614,700 km²
Index of area of occupancy (IAO) - Lack of detailed information on occurrence	Unknown
Is the total population severely fragmented?	No
Number of locations	Unknown but > 10
Is there an observed continuing decline in extent of occurrence?	No
Is there an observed continuing decline in index of area of occupancy?	Unknown
Is there an observed continuing decline in number of populations?	No
Is there an observed continuing decline in number of locations?	Unknown
Is there a projected continuing decline in area, extent and/or quality of habitat? - Extent of grassland habitat on the wintering grounds and along migration routes is being lost and habitat quality is likely declining due to changes in agricultural practices (e.g., grazing management, zero tillage farming) and use of agrochemicals. Breeding habitat in the Arctic is projected to be affected by climate change, but impacts on the species are currently unknown.	Yes
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Population	N Mature Individuals
Total	42,000 birds (range: 26,250-58,500)

Quantitative Analysis

Probability of extinction in the wild.	Not calculated

Threats (actual or imminent, to populations or habitats)

- Habitat loss at migration stop-over sites and on wintering grounds due to cultivation of native short-grass prairie
- Habitat degradation at migration stop-over sites and on wintering grounds due to incompatible farming and ranching practices (e.g., no-till farming, reductions in grazing intensity, biofuel crops) and oil and gas development
- Exposure to pesticides, especially on the wintering grounds
- Climate change (e.g., causing flooding, more frequent and intense storms during fall migration, changes in phenology of food supplies, changes in habitat conditions on Arctic breeding grounds)
- Increased rates of nest depredation on the breeding grounds, which follows development

Rescue Effect (immigration from outside Canada)

Status of outside populations? Alaskan population considered to be of high conservation concern because known or thought to be declining. Small numbers in Russia likely represent relict population.	
Is immigration known or possible?	Unknown, but probable due to strong migratory abilities of species and proximity to sites in Alaska
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes (breeding habitat)
Is rescue from outside populations likely? - Rescue is possible from Alaska, but the population there is considered of high conservation concern and is only about a quarter the size of the Canadian population.	Unlikely

Current Status

COSEWIC: Special Concern (May, 2012)

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Special Concern	Not applicable

Reasons for designation:

The Canadian Arctic supports about 87% of the North American breeding range of this shorebird, and about 75% of its global population. The species was once common and perhaps even abundant historically, but it suffered severe declines stemming from intensive market- hunting in the late 1800s and early 1900s. By the 1920s, it was thought to be at the brink of extinction. Its population has grown since hunting was banned in North America, but numbers remain much lower than those before hunting began. There is evidence for population decline in recent decades, and many conservation organizations consider the species to be of concern throughout its range. However, this species is difficult to monitor effectively, and data necessary to estimate population trends are currently lacking. Outside the breeding period, loss and degradation of its specialized grassland habitat, both on its wintering grounds in South America and along its migration routes, are believed to pose the most significant threats.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Does not meet criterion. Though historical declines are known to have occurred and future declines are suspected, there is presently insufficient information available to quantify the rate of population change over any time period.
Criterion B (Small Distribution Range and Decline or Fluctuation): Does not meet criterion. Exceeds thresholds for extent of occurrence and area of occupancy.
Criterion C (Small and Declining Number of Mature Individuals): Does not meet criterion. Exceeds thresholds for population size (> 10,000 mature individuals). There is no reliable quantified estimate of rate of population change and, while declines are suspected, there is not sufficient information available to assess the extent to which continuing declines are observed, projected or inferred.
Criterion D (Very Small or Restricted Total Population): Not applicable. Exceeds thresholds for population size, area of occupancy and number of locations.
Criterion E (Quantitative Analysis): Not done.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2012)

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.

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

COSEWIC Status Report

on the

Buff-breasted Sandpiper

Tryngites subruficollis

in Canada

2012

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

The Buff-breasted Sandpiper (*Tryngites subruficollis*) is a Charadriiform shorebird in the Scolopacidae family. No subspecies or varieties have been identified. Strauch (1976) suggested that *Tryngites* should be merged with *Calidris* because of similar morphologies between the two genera. Johnsgard (1981) believed that *Tryngites* might represent an intermediate form between *Calidris* and *Philomachus*. More recently, Van Rhijn (1991) suggested that the Buff-breasted Sandpiper may be a sister species to the Ruff (*Philomachus pugnax*). Both these species belong to monotypic genera.

Other common names for the species include Bécasseau roussâtre in French, Chorlito Canela, Chorlito Ocraceo, Correlimos Canelo, Correlimos Ocraceo, and Playerito Canela in Spanish, Maçarico-acanelado and Pilrito-canela in Portuguese, Higyariaq in Inuinnaqtun, and Sigjariarjuk in Inuktitut (Lanctot *et al.* 2010; C. Alaralak, J. Kusugak, L. Otak, and L. Taipana pers. comms. 2011).

Morphological Description

The Buff-breasted Sandpiper is a medium-sized shorebird. Like most other North American shorebirds, only slight dimorphism in plumage and size exists between the sexes, with females being smaller than males (Prevett and Barr 1976; Lanctot *et al.* 1998). Distinguishing the two sexes in the field is challenging, except during the mating period when males exhibit courtship display behavior (Lanctot *et al.* 2010). Adult males differ from females in having larger underwing spots. Adults of both sexes have larger underwing spots than juveniles (Lanctot and Laredo 1994; Lanctot *et al.* 2010).

As its name implies, the Buff-breasted Sandpiper is characterized by a buffy colouring (i.e., a pale yellow-brown wash) over much of its plumage. In adults, the crown, hindneck and sides of breast have brown spots or streaks, while the back, scapulars, upper tail and upper wing coverts have narrow, lanceolate, dark brown feather centres, edged with buff (Lanctot and Laredo 1994). In flight, the upperwings appear buffy, and the flight feathers (primaries and secondaries) have faint dusky spotting or vermiculations. The underwing axillaries are bright white, with a dark bar at the tips (Peters and Burleigh 1951; Lanctot *et al.* 2010). The otherwise unmarked breast is edged on the sides with dark speckles. The legs are bright yellow-ochre and the eyes are dark, with a white eye ring. The bill is short, straight and black. Juveniles can be distinguished from adults by the broader, paler fringes of their buff feathers. In addition, juveniles have more rounded spotting on their backs, giving them a more scaly appearance, and the undersides of the primary and secondary flight feathers are speckled grey, compared with the larger blackish spotting found in adults (Lanctot and Laredo 1994; Lanctot *et al.* 2010).

The Buff-breasted Sandpiper has an average length of 18-20 cm, with an average wing span of 43-47 cm. Adults range in weight from 41-117 g, depending on sex and time of year (e.g., males on Alaskan breeding grounds weighed 57-78 g and females 46-65 g, while on northward migration in Nebraska males weighed 80-117 g and females 62-81 g; Lanctot *et al.* 2010).

At least two other Canadian shorebird species resemble Buff-breasted Sandpipers somewhat, but differ in size, proportion of body parts and/or markings. These are Upland Sandpiper (*Bartramia longicauda*; larger with longer neck and tail) and Pectoral Sandpiper (*Calidris melanotos*; densely streaked breast; Lanctot and Laredo 1994). The Buff-breasted Sandpiper typically bobs its head when walking. This, together with its rounded head and short bill, gives it an odd, pigeon-like appearance.

Population Spatial Structure and Variability

Information on the population structure of the Buff-breasted Sandpiper is lacking. Though limited in number, studies suggest that breeding site fidelity is low, while non-breeding site fidelity is high (Pruett-Jones 1988; Lanctot and Weatherhead 1997; Lanctot *et al.* 2002; Almeida 2009), raising the possibility that distinct wintering populations exist.

The species is temporally and spatially unpredictable in its occurrence across the breeding range, and there is a paucity of data on breeding areas (Pruett-Jones 1988; Lanctot *et al.* 2010). Currently, no large discrete breeding populations have been described (Lanctot *et al.* 2010). Populations breeding in western Chukotka, Russia may represent a distinct management unit, as they potentially follow a separate migration route than other populations (Kessel 1989). However, no banding, morphological or genetic data exist to determine whether differences exist between birds in the western and eastern Arctic (Lanctot and Laredo 1994).

Small numbers of re-sightings of banded birds, combined with the absence of any population genetic research on the species, make it difficult to evaluate whether population subdivision occurs in the Buff-breasted Sandpiper. A molecular study to investigate population structure was initiated in January 2010 by researchers at Kansas State University (B. Sandercock pers. comm. 2011).

During migration, Buff-breasted Sandpipers tend to be broadly dispersed and sporadic in their occurrence (Lanctot *et al.* 2002). In contrast, they are restricted to a relatively small area on their South American wintering grounds (i.e., mainly coastal areas of Uruguay, southern Brazil, and northern Argentina), where high site fidelity has been documented at some sites (Almeida 2009; Lanctot *et al.* 2010).

Designatable Units

No information on morphometrics, genetics, population structure, or other features currently exists to support more than a single designatable unit for the Buff-breasted Sandpiper in Canada.

Special Significance

The Buff-breasted Sandpiper is the only member of the genus *Tryngites* (Thomas *et al.* 2004). Its primary breeding grounds are located in North America, and the majority of these birds breed in the Canadian Arctic (Andres and Gill 2000; Donaldson *et al.* 2000).

The Buff-breasted Sandpiper is one of only three shorebird species worldwide that has a lek mating system, and is the only lekking shorebird to occur in North America (Lanctot *et al.* 1997; Lanctot *et al.* 1998). In lekking species, males typically congregate in spatially-clumped territories where they display to prospecting females. Females attend leks to select a mate but obtain no further resources from males for raising their offspring. Once mated, females leave the lek area to nest and raise young elsewhere (Cartar and Lyon 1988; Pruett-Jones 1988; Lanctot *et al.* 2010).

Buff-breasted Sandpipers are unusual among lek breeders because they display both classical and 'exploded' lek behaviour. Most males defend relatively small display territories, ranging from 10-50 m in diameter, in close proximity to one another during courtship (Lanctot *et al.* 1997). However, some males defend much larger territories (up to 1 ha) and territory size can vary over the breeding season for individual males (Lanctot and Weatherhead 1997; Lanctot *et al.* 1997).

No published Aboriginal Traditional Knowledge is currently available for the species.

DISTRIBUTION

Global Range

The Buff-breasted Sandpiper is a long-distance migrant that breeds in the Arctic regions of western Canada, Alaska and eastern Russia, and winters in South America, primarily in coastal Argentina, Brazil and Uruguay (Figure 1; Lanctot *et al.* 2002; Lanctot *et al.* 2010). In Russia, the species breeds on Wrangel Island and in western Chukotka, from Ayon Island east to the Ekvyatan River Valley and the north coast of the Chukutski Peninsula (Lanctot *et al.* 2010). In Alaska, birds breed along most of the Beaufort Sea coast (Lanctot *et al.* 2010). It has been reported as an accidental migrant in Europe, Africa, Japan and Australia (Lanctot and Laredo 1994).

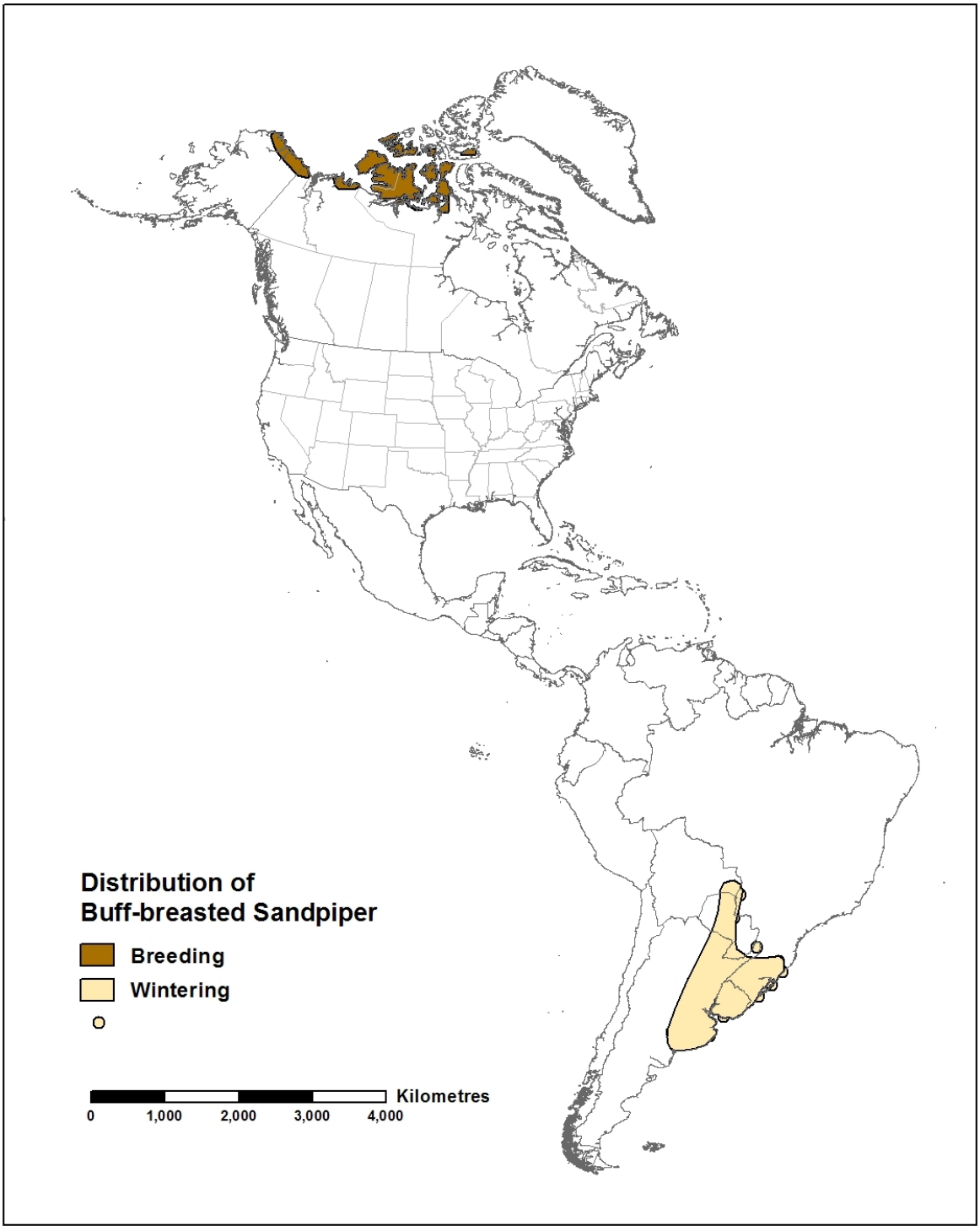

Figure 1. Distribution of the Buff-breasted Sandpiper on its North American breeding grounds and South American wintering grounds (adapted from NatureServe 2010). The breeding range has been modified to reflect new information provided by Environment Canada (J. Rausch pers. comm. 2011). The main wintering range occurs along a narrow coastal area of Brazil, Uruguay and Argentina; inland occurrences are much more scattered and occasional outside this zone (Lanctot *et al.* 2002).

Most southbound birds migrate along the Central Flyway of Canada and the United States (i.e., across the central Prairies and Great Plains) to the wintering grounds, although juveniles frequently occur along the Atlantic coast of North America. Birds are less commonly recorded along the Pacific coast of North America and in Western Europe (mainly Ireland and England) during fall migration (Lanctot *et al.* 2010). Once in South America, birds follow the Central Amazonia/Pantanal Flyway to reach the wintering area, crossing through Colombia, Venezuela, Suriname, Peru, Bolivia, Paraguay and Brazil (Lanctot *et al.* 2002). The northbound spring migration occurs along a similar, but less dispersed route, through central South America, across the Gulf of Mexico to the coasts of Texas and Louisiana, and up through the central United States and Canada to the Arctic breeding grounds (Lanctot *et al.* 2010).

Recent surveys on the wintering grounds of Buff-breasted Sandpipers indicate that birds are found over much of their historical wintering range. However, the species is no longer observed south of Buenos Aires, Argentina and in interior parts of the Pampas where it was previously known to have occurred. These areas have experienced widespread land-use changes (i.e., urban development around Buenos Aires and conversion of ranchland to cropland in the Pampas) that have likely eliminated suitable habitat (Lanctot *et al.* 2002).

Canadian Range

Buff-breasted Sandpipers occur in Canada both on migration and during the breeding season. Donaldson *et al.* (2000) estimated that about 87% of the species' North American range occurs in Canada. The primary ecozones in which it occurs are Southern and Northern Arctic for breeding, and Prairies on migration, although it also stops-over in other ecozones during migration (e.g., Atlantic Maritime, Hudson Plains).

The Canadian breeding range extends along the northern coast of Yukon, Northwest Territories and Nunavut, including the Yukon North Slope, the Boothia Peninsula and the following Arctic islands: Herschel, Banks, Victoria, Jenny Lind, Melville, Bathurst, Prince of Wales, King William, Somerset, and Devon (Rand 1946; Lanctot and Laredo 1994; Lanctot *et al.* 1997; Beckett *et al.* 2008; Figure 2).

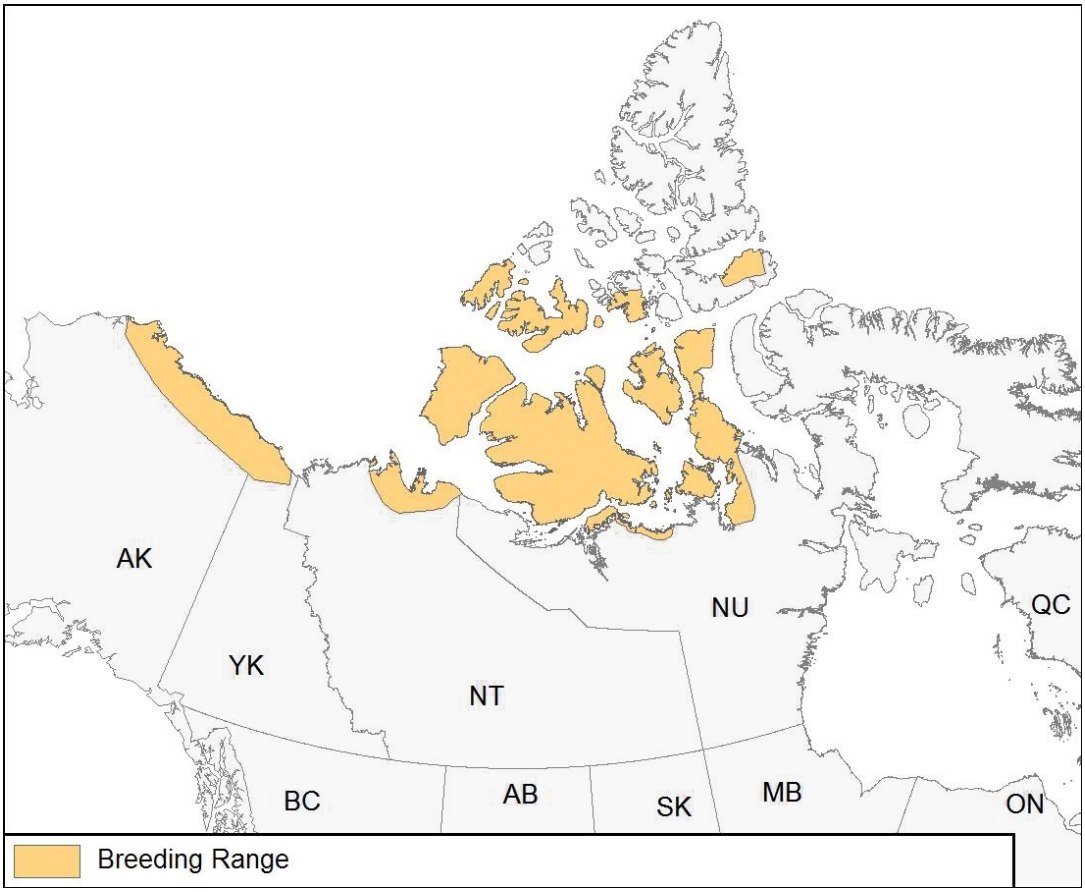

Figure 2. North American breeding distribution of the Buff-breasted Sandpiper (courtesy J. Rausch, Environment Canada). The species is distributed sparsely across the depicted breeding range.

Both fall and spring migrations are concentrated in the central part of the country (i.e., the prairie provinces), although regular observations of migrants in several other parts of the country also occur. Juveniles disperse across Canada on their fall migration to the wintering grounds. A small number of juveniles migrate through the Maritime provinces, and even fewer along the Pacific coast (Lanctot *et al.* 2010). Some also fly east and then south along western Hudson Bay, across the Great Lakes into the U.S. (Lanctot and Laredo 1994).

During fall migration in Atlantic Canada, records of the species range from rare in New Brunswick and Newfoundland and Labrador, to uncommon but regular in Nova Scotia (Mactavish *et al.* 2003; Christie *et al.* 2004; S. Myers pers. comm. 2011). The species is considered a rare fall migrant in Saskatchewan, Manitoba, Ontario, and Quebec, and a rare to very rare fall migrant in British Columbia and southern Yukon (Campbell *et al.* 1990; Smith 1996; Sinclair *et al.* 2003; Aubry and Cotter 2007; Lanctot *et al.* 2010; NHIC 2010; C. Artuso pers. comm. 2010).

During spring migration north to the breeding grounds, almost the entire global population of Buff-breasted Sandpipers is believed to pass through Alberta and Saskatchewan. However, individual flock size tends to be small (i.e., less than 100 individuals) and numbers fluctuate annually (Lanctot and Laredo 1994; Smith 1996). The species is a rare spring migrant through Manitoba, a very rare spring migrant in Ontario and insular Newfoundland, and a casual spring transient in British Columbia (Campbell *et al.* 1990; Mactavish *et al.* 2003; NHIC 2010).

The global extent of occurrence of the Buff-breasted Sandpiper has been estimated by BirdLife International (2010) as 599,000 km^2 on the breeding grounds and as 1,500,000 km^2 on the non-breeding grounds. The Canadian extent of occurrence is estimated to be 1,614,700 km^2, based on the minimum convex polygon method. The reason for the discrepancy between the Canadian estimate and the lower global estimate used by BirdLife International is unknown; the latter estimate appears to be excluding discontinuities or disjunctions within the overall distribution of the species (e.g., large areas of obviously unsuitable habitat). The index of area of occupancy cannot be calculated because of the lack of detailed information on the species' occurrence.

Search Effort

Monitoring long-distance migratory shorebirds such as the Buff-breasted Sandpiper is a challenge. The species breeds in remote Arctic regions, where its occurrence is spatially sporadic. Furthermore, it migrates over a large area (from northern North America to southern South America) to relatively restricted wintering grounds. Unlike many other shorebirds, Buff-breasted Sandpipers seldom aggregate in large numbers during any part of their annual cycle, although flocks of hundreds to several thousand have been recorded periodically on migration and in the wintering range (Lanctot *et al.* 2010). The number of individuals recorded at particular sites also varies considerably from year to year (Lanctot and Laredo 1994).

Most survey work on Buff-breasted Sandpipers has been conducted during migration and on the wintering grounds in Argentina, Brazil and Uruguay. In contrast, information on its distribution and abundance during the breeding season is incomplete, and the breeding range is still poorly known (Lanctot *et al.* 2010). Furthermore, while some surveys on migration and during the winter are targeted at Buff-breasted Sandpipers (e.g., Lanctot *et al.* 2002; Jorgensen *et al.* 2007; Jorgensen *et al.* 2008), surveys on the breeding grounds are typically geared toward counting all shorebird species, which may be inclined to miss Buff-breasted Sandpipers without special search effort.

The Program for Regional and International Shorebird Monitoring (PRISM) is a long-term and coordinated shorebird monitoring program occurring in the Arctic. The program aims to meet the monitoring goals of the U.S. and Canadian Shorebird Conservation plans, namely the provision of reliable data on the distribution, abundance and population trends of shorebirds (see Donaldson *et al.* 2000; Brown *et al.* 2001). Since 2001, the program has surveyed parts of Alaska, Yukon, Northwest Territories and Nunavut. Surveys are conducted using double sampling (Bart *et al.* 2002), in which plots are first surveyed rapidly to estimate the number of shorebirds present, following which a subset of plots is surveyed intensively to find nests and delineate territories. Rapid surveys also incorporate blind surveys of intensive plots to generate a detection rate, which is then applied to all of the rapidly-surveyed plot results (V. Johnston pers. comm. 2010). In the Canadian portion of the program, 763 plots have been surveyed over the past 10 years (2001-2010), generating a search effort estimate of 1638 person days (V. Johnston pers. comm. 2010). Buff-breasted Sandpipers have been recorded in only three of the nine survey years, for a total of only 30 observations (where each count of a bird or nest represents one observation). In addition to the small sample sizes, caution should be exercised when interpreting these data, because the survey area encompasses both suitable and non-suitable habitat for Buff-breasted Sandpipers, and has not covered a large portion of its breeding range. The majority of the central Canadian Arctic is slated to be covered by Arctic PRISM surveys in the next 5 years (J. Rausch pers. comm. 2011). In the meantime, while this dataset provides some information on the breeding distribution of Buff-breasted Sandpipers, it is not particularly helpful for estimating population size or trends.

Long-term shorebird surveys have also been carried out along the migratory route of the Buff-breasted Sandpiper in Saskatchewan and Alberta. From 1989-2002, 5185 surveys were conducted, generating 544 individuals counted over 78 observations (W. Calvert pers. comm. 2010; P. Knaga pers. comm. 2011).

HABITAT

Habitat Requirements

Breeding Habitat

On its breeding grounds, the species occurs in tundra regions, where habitat use varies depending on gender and breeding stage. In Canada, breeding Buff-breasted Sandpipers occur primarily in wet/lowland habitat, often near a pond, lake or wetland, in sedge-dominated vegetation (J. Rausch unpubl. data). The availability and interconnectedness of different habitats may affect the suitability of the area for breeding (Lanctot *et al.* 2010).

Upon spring arrival, males display in the first areas to be snow-free, frequently in upland habitats of the coastal tundra, such as barren ridges, creek banks, pingos (arctic mounds or hills having a central ice core covered in soil) and raised, well-drained areas (Pruett-Jones 1988). These areas are typically open, dry, and flat with short vegetation, such as Curly Sedge (*Carex rupestris*) or *Dryas* sp. (Cartar and Lyon 1988; Lanctot *et al.* 2010). As snow continues to melt, males display in moister areas, such as graminoid meadows, dominated by Water Sedge (*Carex aquatilis*) and Common Cottongrass (*Eriophorum angustifolium*; Lanctot *et al.* 2010). Display areas are characterized by non-patterned ground with closely spaced tussocks about 20 cm high and 25-50 cm in diameter and dwarf willow thickets (Prevett and Barr 1976; Lanctot *et al.* 2010). Males defend breeding territories ranging in size from 10-50 m in diameter to about 100 x 100 m (Lanctot and Weatherhead 1997; Lanctot *et al.* 1997).

Females typically nest on the drier parts of the tundra, including slopes with sedge tussocks and moss-willow-varied grass tundra (Peters and Burleigh 1951; Prevett and Barr 1976; Lanctot *et al.* 2010). Nesting also occurs in wetter tundra, such as sedge-graminoid meadows, often close to streams or open water wetlands (Beckett *et al.* 2008). Foraging, however, is concentrated in dry, elevated tundra that is sparsely vegetated, and along the banks of rivers and streams (Beckett *et al.* 2008). Females with broods are mainly observed in moist and emergent vegetation adjacent to stream beds (Lanctot *et al.* 2010). In Alaska, habitat for breeding and staging is located in tundra meadows (e.g., dwarf shrub meadows, salt grass meadows and wet meadows; Andres and Gill 2000). Buff-breasted Sandpipers are one of the few shorebirds that do not shift habitat use during brood-rearing to lowland pond sites (Lanctot and Laredo 1994).

Migration Habitat

Habitat use of the species on migration is not particularly well documented, especially in South America. Unlike many other shorebird species that congregate in large numbers at wetlands during migratory stopovers, Buff-breasted Sandpipers prefer open terrestrial habitats. In North America, this was historically short-grass prairie grazed by American Bison (*Bison bison;* Jorgensen *et al.* 2007). With the loss of bison and most of the native prairie across the U.S. and Canada, the species adopted newly planted croplands, golf courses, lawns, sod farms, mowed hayfields, airport runways, and grazed pastures as surrogate habitats (Lanctot *et al.* 2002; Jorgensen *et al.* 2007). During migration through Canada, the species is also found at sewage lagoons and sandy vegetated beaches (Campbell *et al.* 1990). In Ontario, the western Hudson Bay-James Bay habitats in fall migration include level to gently sloping shorelines (tidal flats, storm beaches) with short vegetation (D.A. Sutherland pers. comm. 2012) and goose-grazed turf habitat in coastal salt marshes and vegetated coastal ridges (Ken Abraham pers. comm. 2012).

The Rainwater Basin, Nebraska, appears to be an important stopover site during the northward spring migration. This area is a relatively flat to gently rolling loess plain extending approximately 10,000 km^2 over the south-central part of the state (Jorgensen *et al.* 2007). Buff-breasted Sandpipers use Corn (*Zea mays*) and Soybean (*Glycine max*) fields in the area primarily for foraging, and visit adjacent wetlands for maintenance (e.g., drinking, bathing) and resting (McCarty *et al.* 2009). They use soybean fields more frequently than corn fields, and are more common in open fields than those having trees, hedgerows or other forms of human obstructions (Jorgensen *et al.* 2007). Buff-breasted Sandpipers only use such cropland when it is newly planted and less than 5-7 cm in height. Spring migration through the U.S. Midwest seems to coincide with these conditions, so birds are able to take advantage of this ephemeral habitat (R. Lanctot pers. comm. 2011).

The species also uses rice fields in the Gulf Coastal Plain of Louisiana and Texas during migration (Morrison *et al.* 2006). In Canada, Buff-breasted Sandpipers prefer pastures and cultivated fields during spring migration, and lakeshores during fall migration (Smith 1996).

Other key stopover sites during spring migration in North America (based on maximum numbers of individuals recorded) include Beaverhill Lake, Alberta; between Duson and Crowley, Louisiana; Falfurrias, Texas; and Buffer Lake, Saskatchewan. For fall migration, key sites include Wagoner County, Oklahoma; Southern Kleberg County, Texas; and Riverton Wildlife Area, Fremont County, Iowa (Skagen *et al.* 1999).

During migration in South America, Buff-breasted Sandpipers are often observed using sandbars along rivers through the interior part of the continent (e.g., Amazonia regions of Bolivia, Brazil, Colombia, Ecuador, Peru and Venezuela; Lanctot *et al.* 2002). They also use recently harvested and burned sugar cane fields in Suriname (Haverschmidt 1972), short grass habitats in the Colombian Andes, rice fields in the Llanos-Orinoco region of Colombia and saline lagoons in Paraguay (Lanctot *et al.* 2010).

Wintering Habitat

On the South American wintering grounds, Buff-breasted Sandpipers are found mainly in the pampas biome. They occur almost exclusively in pasturelands, and appear to depend on intensive grazing by livestock to maintain suitable habitat conditions, which consists of relatively short vegetation that is <10 cm tall (Lanctot *et al.* 2002). Unlike during migration, cropland on the wintering grounds is not used frequently by Buff-breasted Sandpipers because vegetation usually exceeds the suitable height for them (R. Lanctot pers. comm. 2011). In Argentina, wintering habitat occurs within the coastal portion of the Rio de La Plata Grasslands, in the eastern part of the flooding Pampas. Land use in this area is dominated by cattle ranching, because frequent flooding and high salinity limit cultivation (Lanctot *et al.* 2002). In Brazil and Uruguay, wintering habitat is restricted to land adjacent to extensive lagoon complexes along the coastal plain. While cattle grazing does occur here, much of the vegetation appears to have a natural low structural profile (likely due to the flooding and saline conditions), which makes it ideal habitat for the sandpiper (Lanctot *et al.* 2002). To a lesser degree, Buff-breasted Sandpipers also use rice fields in Brazil and Uruguay (Lanctot *et al.* 2002).

Myers (1980) observed that many Buff-breasted Sandpipers wintering in Argentina defended small non-breeding territories, averaging 0.04 ha in area.

Habitat Trends

Breeding Habitat

Availability of breeding habitat for the Buff-breasted Sandpiper in the Arctic is extremely variable both within and between years due to unstable environmental conditions (e.g., differential snow accumulation and melt across the breeding range; Lanctot *et al.* 1997). As a result, the species shows low breeding site fidelity and is both spatially and temporally opportunistic in its habitat use, taking advantage of optimal habitat conditions when and where they become available (Pruett-Jones 1988).

Little is known about trends in the Buff-breasted Sandpiper's breeding habitat, because the species' breeding distribution is sporadic from year to year. It seems unlikely that the extent of suitable habitat has changed markedly over historical levels. Breeding habitat in the Arctic is projected to be affected by climate change, but impacts on this species are not entirely known.

Non-breeding Habitat

Detailed information is similarly lacking on habitat trends for the species' migration and wintering grounds. Nonetheless, habitat availability has undoubtedly declined in some areas. For example, the widespread conversion of native short-grass prairie to crop production and human settlement in the Great Plains has resulted in a profound loss of stopover habitat during migration (Lanctot *et al.* 2010). Historically, Buff-breasted Sandpipers likely relied on short-grass prairie maintained by natural fires and grazing by bison or prairie dogs (*Chnomys* spp.) at North American stopover sites (Jorgensen *et al.* 2007). What native grassland habitat remains today is seldom managed for the short vegetation structure required by the species (Lanctot *et al.* 2010), though it is important not to discount the importance of domestic grazers on pastureland. The ongoing loss and alteration of grassland habitat likely accounts for the Buff-breasted Sandpiper's heavy use of cultivated croplands today (e.g., corn, soybean and rice fields) in the United States. What is not clear, however, is whether these areas constitute high-quality habitat for the species (i.e., adequately provide required food resources during stopover) or whether they are used simply because they are the dominant habitat available (Jorgensen *et al.* 2007; Lanctot *et al.* 2010).

Most short-grass native grassland in the Canadian Prairies disappeared by the late 1800s as a result of widespread cultivation and the elimination of bison, which Buff-breasted Sandpipers presumably relied on to exert sufficient grazing pressure. Today, less than 2% of the original northern short grassland ecosystem remains in Canada, with much of it having been converted to annual crop production and to tame pasture for livestock grazing (Primm *et al.* 2001). In Alberta and Saskatchewan, the extent of native grasslands appears to have stabilized or declined slightly over the past 15 years (Saskatchewan Agriculture and Food 2006; Statistics Canada 2006; Watmough and Schmoll 2007). However, only a small proportion of existing grasslands likely provide suitable vegetation structure for Buff-breasted Sandpipers (Redmann 2006), and short grassland is under increasing threat by oil and gas development and associated road networks in the Prairie provinces (Primm *et al.* 2001). Though the extent of area is rather small, sod acreage increased by 26% in Saskatchewan between 2001-2006 (Saskatchewan Agriculture and Food 2006), potentially benefiting Buff-breasted Sandpipers.

Grazed habitat offers suitable habitat for the species during migration. Until recently, this habitat seemed relatively secure on the Canadian prairies. However, recent concerns stem from the Canadian government's announcement in spring 2012 that it will be phasing out the Community Pasture Program over the next 5 years. How this might affect Buff-breasted Sandpipers is unknown, but loss of this program has the potential to affect hundreds of thousands of hectares of native rangeland that have been conserved since the 1930s.

On the South American wintering grounds, significant changes to habitat have occurred over the last century. More than 60% of the rangelands have disappeared in the Argentine Pampas since the 1880s, especially in recent decades (Lanctot *et al.* 2010). In the future, risk of flooding due to climate change in coastal areas may diminish available habitat (Lanctot *et al.* 2010). These areas are currently the prime wintering habitat for Buff-breasted Sandpipers because they remain largely unsuitable for crop production due to high soil salinity. Farther inland, wintering habitat could be threatened by fluctuations in the demand for grain *vs.* beef, and also by increasing mining and pine plantations (in Brazil), road and building construction (in Brazil and Uruguay) and subdivision of ranches (in Argentina; Lanctot *et al.* 2002). Records of Buff-breasted Sandpipers wintering in northwestern Argentina and southwestern Bolivia over the past 20 years may be in response to habitat modification in the principal non-breeding habitat of eastern Argentina (Lanctot and Laredo 1994).

BIOLOGY

Few studies on the biology of the Buff-breasted Sandpiper were conducted prior to the late 1970s. Since then, research has focused on breeding behaviour (e.g., Prevett and Barr 1976; Cartar and Lyon 1988; Lanctot and Weatherhead 1997), non-breeding territoriality and site fidelity (e.g., Myers 1980; Almeida 2009), population estimates and distribution on migration and wintering grounds (e.g., Lanctot *et al.* 2002; Jorgensen *et al.* 2008) and ecotoxicology (e.g., Strum *et al.* 2010). Numerous gaps in our knowledge of this shorebird species remain.

Life Cycle and Reproduction

Age of first breeding is unknown due to the apparent lack of natal philopatry, but is assumed to be 1 year (Lanctot and Laredo 1994). No information is available on generation time. However, a rough estimate of 4 to 5 years can be made based on the assumed age of first breeding and available data on adult survival rates (0.71-0.78; see below). This corresponds with the average generation times of two closely-related shorebird species, Dunlin (*Calidris alpina*) and Red Knot (*C. canutus*), which are 5 and 6 years respectively (Wenink *et al.* 1993; Buehler *et al.* 2006).

The Buff-breasted Sandpiper is a polygynous species. Males display mainly in leks of two to three individuals (maximum 20) and females congregate in groups of three to eight individuals to observe them (Prevett and Barr 1976; Lanctot and Weatherhead 1997). Leks tend to be ephemeral within the breeding season, lasting between a few days to a few weeks, and males may attend multiple leks over a single breeding season (Lanctot *et al.* 1997). In addition, some males engage in solitary displays to females already on nests, while some males switch from lekking to solitary displays as the breeding season progresses (Pruett-Jones 1988; Lanctot and Weatherhead 1997; Lanctot pers. comm. 2011). Buff-breasted Sandpipers also display at stopover sites on their northward migration in the spring, suggesting that courtship activity may begin prior to arrival in the Arctic (Oring 1964; McCarty *et al.* 2009).

Once mating has occurred, females establish nests away from leks, laying a typical clutch of four eggs in a shallow depression often lined with grasses, moss or lichens (Peters and Burleigh 1951; Lanctot *et al.* 1997; Beckett *et al.* 2008). Females provide all parental care (i.e., they incubate eggs, brood young for an average of 4 days or longer in bad weather, and defend young for 2 to 3 weeks after hatching; Lanctot and Laredo 1994). Eggs hatch after 23-35 days of incubation, typically in early to mid July, and most young fledge within 18-20 days (Lanctot *et al.* 1997).

In the central Canadian Arctic, Cartar and Lyon (1988) found that male displays began in mid June, with an activity peak from 18-30 June. The first complete clutch was observed on 17 June, which hatched on 10 July. The last nest to hatch was on 24 July and no male displays were observed after 12 July. Although the length of the nesting period suggests that birds may renest if the first clutch fails, there have been no documented cases of second broods (Lanctot and Laredo 1994).

Limited demographic information exists for the species. Pruett-Jones (1988) recorded that nest failure and nest predation were high (about 72%) on the Alaskan breeding grounds. Only 28% (5/18) nests had eggs that hatched successfully, and clutches disappeared before hatching in 61% (11/18) of nests observed, likely due to predation. Fledging success in Alaska ranged from 7-18% (Lanctot and Laredo 1994).

Almeida (2009) reported adult apparent annual survival rates of 0.71 (±0.16, n=48) for males and 0.78 (±0.11, n=115) for females on Brazil wintering grounds. These estimates were based on a mark-recapture study of a single wintering population over a relatively short period (four winters). They did not account for yearly variation in annual survival or include hatch-year birds, which may have lower survival rates (Almeida 2009). Consequently, these estimates may not be accurate representations of the species' overall survival rate (Lanctot *et al.* 2010).

Physiology and Adaptability

The ability of male Buff-breasted Sandpipers to use multiple breeding tactics may be an effective strategy to deal with unpredictable weather conditions on the Arctic breeding grounds. In any given area, males have a small window of opportunity in which to establish territories, attract females and copulate. However, males may gain additional breeding opportunities by taking advantage of regional variability in habitat conditions, following the coastal gradient of snow melt north over the breeding season (Lanctot *et al.* 2002). The Buff-breasted Sandpiper's ephemeral site occupancysuggests that it is a highly opportunistic breeder, exploiting conditions when and where they exist to a much greater extent than other Calidridine sandpipers (Pruett-Jones 1988).

Buff-breasted Sandpipers are known to be extremely tame, and to return to wounded flock members, which, historically, made them particularly vulnerable to hunting. Indeed, population numbers declined precipitously in the late 1800s and early 1900s as a result of commercial hunting of the species (Lanctot *et al.* 2002; Beckett *et al.* 2008).

How the Buff-breasted Sandpiper will respond to the effects of climate change is unknown. In general, arctic-breeding shorebirds are expected to have difficulty adapting to a rapidly changing climate because of their low reproductive rates and longevity (Bart *et al.* 2007). On the breeding grounds, accelerated climate change may impact courtship and nesting habitat through the drying of tundra ponds (Walsh *et al.* 2005; Smol and Douglas 2007), shrub encroachment (Callaghan *et al.* 2005), and asynchrony between invertebrate food availability and chick hatch periods (Tulp and Schekkerman 2006). A mismatch between peak food levels (occurring earlier in the spring) and chick hatch may be of particular concern for the Buff-breasted Sandpiper, which breeds relatively late in the season compared to other shorebirds (Lanctot and Laredo 1994). It is also not known whether patterns of snow melt are occurring earlier in the season, nor whether the sandpipers might respond to this by migrating sooner to the Arctic (Tulp and Schekkerman 2008).

Dispersal and Migration

Breeding site fidelity and natal philopatry appear to be extremely low in the Buff-breasted Sandpiper, although data are limited. Pruett-Jones (1988) banded over 50 adults and young on the Alaskan breeding grounds, but none were resighted in the study area in subsequent years. Lanctot and Weatherhead (1997) reported that 8.5% (5/59) of male banded birds and 6.5% (5/76) of female banded birds were resighted in more than one year on Alaskan breeding grounds. Most of the resighted birds were seen over 2 years (4 males, 5 females), while a single male bird was seen over 3 years. In comparison, other shorebird species have much higher resighting rates on the breeding grounds (e.g., Pacific Golden-Plover, *Pluvialis fulva*: 25-100%; Spotted Sandpiper, *Actitis macularia*: 26-63%; Black Turnstone, *Arenaria melanocephala*: 79-88%; Johnson *et al.* 1993; Reed and Oring 1993; Handel and Gill 2000).

Buff-breasted Sandpipers cover a distance of about 26,000 km in their annual migrations (Lanctot *et al.* 2010). They are moderately to broadly dispersed in migration over mid-continental North America, meaning that 60% of the total number of sightings occur in six spring and 14 fall 0.1° lat-long blocks (Skagen *et al.* 1999).

Buff-breasted Sandpipers occur singly, in pairs and in flocks on migration (Laredo and Lanctot 1994; Lanctot *et al.* 2010). The southward migration to wintering grounds begins with males and non- or failed-breeding females departing breeding grounds during mid June to early July (Lanctot and Laredo 1994). Breeding females and their young depart later, from late July through early September (Lanctot and Laredo 1994; del Hoyo *et al.* 1996; Lanctot *et al.* 2010). As with other shorebirds in the Arctic, adults tend to leave before juveniles.

It is not known whether birds stage somewhere in the Arctic prior to fall migration, or how they reach the Central and Mississippi flyways (Lanctot *et al.* 2010). Lindström *et al.* (2002) found that juvenile Buff-breasted Sandpipers were relatively fat before departing natal areas compared to other shorebird species, but that their body mass was still significantly less than the maximum body mass recorded for the species during spring migration (i.e., 55.7 ± 6.4 g for juveniles in the Arctic *vs.* 89.0 g for spring migrants of unknown age). This suggests that juveniles may depart their natal grounds with small fuel stores and migrate in short hops through the Canadian Arctic for the first stage of their migration (Lindström *et al.* 2002). If higher-quality stopover sites exist farther south, it may benefit individuals to spend more time increasing fuel deposition there, rather than in the Arctic (Lindström *et al.* 2002). The fact that no major North American stopover sites are known for the species on its southward migration suggests that this strategy may be employed by both juveniles and adults along this part of the migration route (Lanctot *et al.* 2010).

Buff-breasted Sandpipers likely have a yet undiscovered staging area somewhere in northern South America during fall migration, perhaps in Colombia (Lanctot *et al.* 2010). Birds begin to arrive in South America in late August, although the majority arrive from mid September to mid October (Lanctot and Laredo 1994; del Hoyo *et al.* 1996). Individuals continue to arrive until January (Lanctot *et al.* 2010).

The northward migration begins in early February through to late March, with males typically initiating departure up to one month before females (Lanctot *et al.* 2010). Again, a staging area in northern South America likely exists, but has not yet been identified (Lanctot *et al.* 2010). Birds arrive in coastal Texas and Louisiana between mid March and early April, and stay into early May (Lanctot and Laredo 1994). Peak migration through Oklahoma and Nebraska occurs from 4-17 May (Oring and Davis 1966; Jorgensen *et al.* 2008; Lanctot *et al.* 2010).

Migration through North America occurs in mixed-sex flocks, and males and females arrive together to the breeding area (Pruett-Jones 1988; Lanctot *et al.* 2010). Birds begin to arrive on the southern Arctic breeding grounds in late May through early June, and at more northerly sites by mid June. Individuals have been observed in Saskatchewan throughout the summer and in Alberta in mid June, which means that some birds probably fail to reach the breeding grounds (Lanctot *et al.* 2010).

Foraging and Diet

Knowledge of Buff-breasted Sandpiper diet is incomplete. Spring migrants feed on mainly terrestrial invertebrates, such as spiders and all insect life stages. Plant seeds are also consumed. In the fall, birds feed on copepods, crane-flies and gammarid crustaceans (Lanctot and Laredo 1994). Buff-breasted Sandpipers seem to prefer soybean fields to corn fields as foraging sites during migration in Nebraska. The reason for this preference is unclear, although it may be related to differences in availability of invertebrate prey and/or prior insecticide use (Jorgensen *et al.* 2007).

Interspecific Interactions

Buff-breasted Sandpipers associate with several other shorebird species throughout their range. In the Arctic, they have been observed nesting in close proximity to Black-bellied Plovers (*Pluvialis squatarola*), which may be an anti-predator strategy because the plovers are aggressive toward avian nest predators such as jaegers (*Stercorarius* spp.) and gulls (*Larus* spp.; Paulson and Erickmann 1985). Buff-breasted Sandpiper juveniles loosely associate with Semipalmated Plovers (*Charadrius semipalmatus*) and Baird's Sandpiper (*Calidris bairdii;* Lindström *et al.* 2002). On migration, Buff-breasted Sandpipers forage with at least 16 different shorebird species in dry upland crop fields in Nebraska, including large numbers of American Golden-Plover (*Pluvialis dominica*), Baird's Sandpiper and Pectoral Sandpiper (*Calidris melanotos*; Jorgensen *et al.* 2007).

On the wintering grounds, Buff-breasted Sandpipers form both intra- and interspecific flocks in response to avian predators (Myers 1980). They associate with American Golden-Plovers and Upland Sandpipers on migration through South America (Haverschmidt 1972). They are also commonly associated with American Golden-Plovers in Argentinean wintering grounds (Myers 1980).

Many animals prey on Buff-breasted Sandpipers. On the breeding grounds, potential nest predators include Arctic Fox (*Vulpes lagopus*), Red Fox (*Vulpes vulpes*), Short-tailed Weasel (*Mustela erminea*), Arctic Ground Squirrel (*Spermophilus parryii*), Common Raven (*Corvus corax*), gulls, and falcons (*Falco* spp.). Jaegers have been observed attacking adult males at leks (Lanctot and Laredo 1994). Snowy Owl (*Bubo scandiaca*) and Wolverine (*Gulo gulo*) also hunt the shorebird during the breeding season (Lanctot and Laredo 1994). On the wintering grounds, potential predators include Crested Caracara (*Caracara cheriway*), Swainson's Hawk (*Buteo swainsoni*), Barn Owl (*Tyto alba*), harriers (*Circus* spp.) and falcons (Lanctot and Laredo 1994).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

The Buff-breasted Sandpiper is difficult to survey on the breeding grounds. This is because it tends to have an unpredictable distribution (as a result of unpredictable environmental conditions), and because of its lek mating system, in which groups of displaying males and nesting females are not evenly distributed across the tundra landscape, but clumped in lekking areas (Pruett-Jones 1988). Population estimates have been based primarily on a limited number of surveys conducted on the wintering grounds and along the migratory route.

Lanctot *et al.* (2002) estimated abundance on the species' wintering grounds in Argentina, Brazil and Uruguay. The potential wintering range was first determined by plotting historical records onto base maps using GIS. Surveys were then concentrated within the small, but important, main portion of this range in areas having short vegetation. In most cases, surveys occurred within suitable habitat on randomly chosen plots. However, some sites in Uruguay were selected non-randomly based on road accessibility. Researchers used a variable circular plot method to sample the species, recording the number and radial distance to all birds detected over at least a 5-minute period. Density estimates were generated from these data by running a series of models and selecting the best one using Akaike's Information Criterion (AIC) and goodness of fit tests, then extrapolating to the entire study area within each country (Lanctot *et al.* 2002).

A similar approach was used by Jorgensen *et al.* (2008) to estimate abundance of Buff-breasted Sandpipers passing through the Eastern Rainwater Basin, Nebraska during spring migration. Surveys were conducted using distance sampling at point transects along county roads, recording birds over a 5-minute period at each point. Density estimates were derived by fitting detection data as a function of distance to a set of models. The best model was selected using AIC and goodness of fit tests. Density estimates were subsequently extrapolated to generate an estimate of the total number of Buff-breasted Sandpipers occurring in the Rainwater Basin stopover area (Jorgensen *et al.* 2008).

Population estimates have also been derived from observations of birds staging in rice fields on the Gulf Coastal Plain of Louisiana and Texas, although details on the methodology are not available (Norling *et al*. unpubl. data as cited in Lanctot *et al.* 2010).

Abundance

Population estimates for the Buff-breasted Sandpiper are based primarily on data gathered from outside the breeding season. Estimates have varied considerably over the last two decades. Del Hoyo *et al.* (1996) suggested that the maximum global population was 25,000 birds. The Canadian Shorebird Conservation Plan estimated the total Canadian (and North American) population at 15,000 individuals (Donaldson *et al.* 2000), derived from calculations by Morrison *et al.* (2001a; Table 1). The U.S. Shorebird Conservation Plan indicated that this estimate had low confidence, because it was calculated from broad-scale surveys, but was likely in the right order of magnitude (Brown *et al.* 2001). Morrison *et al.* (2006) subsequently revised this estimate to 30,000 or more birds as a result of surveys in the U.S. Midwest (Rainwater Basin, Nebraska) and Gulf Coastal Plain (Louisiana and Texas). These U.S. surveys reported ranges of 16,000- 32,000 and 28,000- 84,000 individuals respectively, based on extrapolations from density estimates (Jorgensen *et al.* 2006; Norling *et al.* unpublished manuscript; Table 1). The Midwest estimates were likely conservative, because they were based on the lower confidence levels of densities calculated using the distance-sampling method, and did not factor in turnover rates (Morrison *et al.* 2006). Radio-telemetry research in the Rainwater Basin suggests that Buff-breasted Sandpipers have a relatively short stopover length (< 2 days), indicating that population estimates from there may be higher than previously reported (Lanctot *et al.* 2010). The relatively large range of the Gulf Coastal Plain numbers, meanwhile, reflected estimates generated depending on whether an assumption of a 5- or 15-day length of stay was used (Norling *et al.* unpublished manuscript).

Table 1. Abundance estimates for Buff-breasted Sandpiper on breeding grounds and migratory stopover sites.

Abundance Estimate* (number of individuals)	Survey Area	Estimate Method	Density*(birds/ha)	Area (ha)	Source
15,000- 20,000	Prince Charles Island, Nunavut; Northeast Alaska lagoons	?	0.0009 (Nunavut observations)	7,356,000	Morrison *et al.* 2001a
78,960 (2004) 35,000 (2005)	Rainwater Basin, Nebraska	Density x Area	0.09±0.03 (2004) 0.04±0.01 (2005)	849,028	Jorgensen *et al.* 2008
43,300 (2004) 22,924 (2005)	Rainwater Basin, Nebraska	Lower 95% confidence limit of density x Area	0.05 (2004) 0.03 (2005)	849,028	Jorgensen *et al.* 2008
28,058-84,174	Coastal rice prairies, Texas and Louisiana	Density x Area	0.1-0.3	6031	Norling *et al.* unpubl.

*includes ±SE if provided

Jorgensen *et al.* (2008) produced a series of population estimates derived from density estimates at the Rainwater Basin stopover area. Depending on whether the mean density or 95% lower confidence level of density estimates was used in calculations, and varying the size of the extrapolation area, led to a population estimate ranging from about 23,000- 79,000 individuals (Jorgensen *et al.* 2008; Table 1). Minimum estimates for the entire Eastern Rainwater Basin were 43,300 and 22,924 birds in 2004 and 2005, respectively (Jorgensen *et al.* 2008; Table 1).

Lanctot *et al.* (2010) recommended updating the current global population estimate to 56,000 (range: 35,000-78,000) in light of Jorgensen *et al.*'s (2008) extrapolations using mean density and the entire Rainwater Basin study area (Table 1), and the more recent information on high turnover rate. About 75% of the Western Hemisphere breeding population is believed to occur in Canada (Alaska Shorebird Group 2008). Assuming Lanctot *et al.*'s (2010) global estimate is presently the most accurate population assessment (because it is based on the most current survey information), then this yields a current Canadian population estimate of about 42,000 birds (range: 26,250-58,500). Even so, it is acknowledged that large areas of the Arctic have not been surveyed, so this may be an underestimate (see Bart and Smith in press).

Attempts to estimate global population numbers of the Buff-breasted Sandpiper have several limitations. Lanctot *et al.* (2002) conducted a large-scale survey on the South American wintering grounds, but were unable to generate accurate population estimates due to weak habitat-bird associations and because key habitats could not be identified in satellite images (Lanctot *et al.* 2008). Surveys on migration (in the U.S. Midwest and Gulf Coastal Plain) were conducted from roads, which may bias observations if birds either avoid or are attracted to them (Jorgensen *et al.* 2008). Furthermore, information on turnover rates is missing from Rainwater Basin estimates.

Finally, the particular life history traits of the Buff-breasted Sandpiper on migration may hinder accurate estimates of population numbers. The species tends to be sparsely distributed during migration, but may aggregate in flocks, whose detection, or non-detection, may artificially inflate or deflate population density estimates (Lanctot *et al.* 2008).

Fluctuations and Trends

Buff-breasted Sandpiper population numbers have undoubtedly declined significantly since the late 1800s, and ongoing contemporary declines are strongly suspected by most authorities (Brown *et al.* 2001; Lanctot *et al.* 2002, 2010). Anecdotal observations on the wintering grounds set historical population numbers to be in the hundreds of thousands to millions at the beginning of the 20th century (Lanctot and Laredo 1994). The species is believed to have come to the brink of extinction in the early 1920s primarily because of intensive commercial hunting in the late 1800s and early 1900s (Lanctot *et al.* 2010). Contemporary observations along migratory flyways and from breeding and non-breeding areas suggest that populations have continued to decline over recent decades (Lanctot *et al.* 2002; Table 2). However, lack of long-term systematic monitoring of the species makes it difficult to statistically prove whether populations are really in decline, and if so, its magnitude and rate (Lanctot *et al.* 2010).

Table 2. Patterns in Buff-breasted Sandpiper abundance at sites on the breeding, stopover and wintering grounds.

Site	Historical Population Numbers	Contemporary Population Numbers	Type of Information	Reference
Point Barrow, Alaska	Abundant summer breeder (1880)	Rarely seen (2010)	Anecdotal field observations	Murdoch (1885) [1] ; Lanctot and Weatherhead (1997)
Creswell Bay, Nunavut	Significant decrease between 1995-1997 and 2001		Systematic field surveys	P. Latour and J. Bart (unpubl. data)[2]
Yukon[3]	35 records (1970s); 23 records (1980s)	11 records (1990-1998)	Anecdotal field observations	Sinclair *et al.* (2003)
Eastern Rainwater Basin, Nebraska	Thousands of birds (mid-1980s)	Less than 100 per year (2002); ~600 birds (2004, 2005)	Anecdotal field observations and systematic field surveys	Lanctot *et al.* (2002); Jorgensen *et al.* 2008
Beaverhill Lake, Alberta	Similar trend as in Nebraska		Anecdotal field observations	Lanctot *et al.* (2002)
Argentina	Numerous flocks with 100-300 birds over several days in Buenos Aires province (1868)	360 birds observed over 13 days at 32 sites across main Argentinean wintering range (1999)	Anecdotal field observations (historical); systematic field surveys (contemporary)	Hudson (1920) [1]; Lanctot *et al.* (2002)
Estancia Medaland, Argentina	~2000 (1973, 1974)	200 (1996-2000)	Systematic field surveys	Myers (1980); Isacch and Martinez (1999) [1]

[1] As reported in Lanctot *et al.* (2002).
[2] As reported in Lanctot *et al.* (2010).
[3] Sinclair *et al.* (2003) noted that the reduced frequency of Yukon sightings could represent a decline in the number of birds or could be caused by a combination of uneven field coverage and sporadic breeding distribution.

As Lanctot *et al.* (2010) suggest, it is possible that observed declines could be confounded by other factors, such as declining detection rates, shifts in distribution, a change of migratory routes and/or birds spending less time in a given area. For example, in the U.S. Great Plains, occupation of stopover sites can fluctuate from year to year depending on how wet the habitat is (Lanctot *et al.* 2010). Large variations in annual densities of the species are common in staging areas and on the breeding grounds and may reflect changes in local food abundance and conditions along the migratory route (Lanctot and Laredo 1994).

Sightings of Buff-breasted Sandpipers have become less common in Manitoba over the past 10-15 years, especially in the southern part of the province (C. Artuso pers. comm. 2010). Less frequent sightings in areas where the species used to regularly occur may be related to the temporary loss of suitable stopover habitat, while birds could also simply have switched to other stopover sites elsewhere. For example, Whitewater Lake in western Manitoba once provided good stopover habitat, but in recent years high-water levels have restricted the availability of suitable habitat for the species to use (C. Artuso pers. comm. 2010). The Oak Hammock Marsh area also was a regular stopover site until recent years. The northern section of the marsh contained sod farms, and, until recently, pastureland, which has now been converted to crops (C. Artuso pers. comm. 2010).

Data from the Northwest Territories/Nunavut Bird Checklist Survey (1971-2009) show no significant changes in habitat occupancy for Buff-breasted Sandpiper over the last 40 years in the checklist region (C. Machtans pers. comm. 2010). On the Yukon coastal plain, observations of Buff-breasted Sandpipers have become less frequent. Surveys of tundra breeding shorebirds produced 35 observations of this species in the 1970s, 23 in the 1980s, 11 in the 1990s, and none in the 2000s, although methods and effort differed (Sinclair *et al.* 2003; P. Sinclair pers. comm. 2011).

Rescue Effect

Most of the Buff-breasted Sandpiper's breeding range occurs in Canada, and about 75% of the North American population is believed to breed here. Consequently, sources of immigrants to repopulate the Canadian population, should it disappear or decline, are limited. The remaining North American breeding population occurs in Alaska, where the species is considered of high conservation concern because it is known or thought to be declining (Andres and Gill 2000). Less than 25% of the North American breeding population (or fewer than 14,000 individuals, range: 8750-19,500) is found in Alaska (Alaska Shorebird Group 2008). Birds that breed in Alaska likely migrate along the same north-south route as birds from the western Canadian Arctic, and presumably mix with them in migration and on the wintering grounds. However, it is unknown whether movement between U.S. and Canadian breeding areas occurs (i.e., movement of individuals within a breeding season or between seasons). Given the strong migratory abilities of the Buff-breasted Sandpiper, and the unpredictable nature of its breeding distribution, it seems probable that exchange of individuals between western Arctic Canada and Alaska breeding sites occurs (Lanctot and Weatherhead

1997). Any individuals dispersing into Canada from Alaskan breeding grounds would likely be well-adapted to survive and reproduce here because the habitat and environmental conditions are similar.

There are relatively few birds that breed in Russia (e.g., less than a hundred on Wrangel Island, and breeding is only sporadic on the Chukotski Peninsula; Lanctot *et al.* 2010). No information is available on whether Russian populations exchange individuals with breeding populations in North America. The distance between Canadian and Russian breeding grounds likely would not be a physical obstacle to dispersal, but whether behavioural differences or other obstacles exist remains unanswered.

THREATS AND LIMITING FACTORS

The Buff-breasted Sandpiper was heavily harvested in commercial hunts during the late 1800s and early 1900s. Birds were hunted primarily during migration through the central United States, and to a lesser extent on the South American wintering grounds (Lanctot *et al.* 2002). With the exception of some birds and/or their eggs that might be taken for subsistence by aboriginal peoples on the breeding grounds (R. Jeppesen pers. comm. 2012), it is now illegal to hunt the species in the United States and Canada. However, hunting of the species still occurs in Latin America, although it is probably fairly minor (Lanctot *et al.* 2010). For example, the Buff-breasted Sandpiper is an irregular visitor to Guadeloupe, where it is known to be hunted (Boyé *et al.* 2009).

Like many other shorebirds, Buff-breasted Sandpipers are sensitive to environmental disturbance because of several key life-history traits, namely their long-distance migration, the periodic concentration of large numbers of individuals at a restricted number of sites, and their use of habitats that are targeted for certain kinds of human activity, such as crop production and industrial development (Morrison *et al.* 2001b).

A recent broad-scale analysis of North American shorebirds found that species that migrate through the interior of the continent are more susceptible to decline than those that migrate along the coast or over ocean (Thomas *et al.* 2006). This pattern of decline may be linked to large-scale changes to upland and wetland habitat (i.e., annual crop production, grazing regimes, human settlement) that continental migrants depend on in migration (Thomas *et al.* 2006).

The Buff-breasted Sandpiper is susceptible to a suite of threats. One or more stochastic events (e.g., a large-scale shift in agricultural landuse, a series of hurricanes during peak migration, a series of cold-snaps during the breeding season causing repeated nest failures) could have severe impacts on the Buff-breasted Sandpiper's already small population size. Moreover, because of density-dependent effects associated with its peculiar lek-mating system, further reductions in abundance could accelerate population collapse.

Habitat Loss

In the case of the Buff-breasted Sandpiper, habitat loss, fragmentation and degradation appear to be primary threats, especially at stopover sites and elsewhere in the non-breeding range (Lanctot *et al.* 2010).

Breeding Habitat

In the Arctic, the distribution of Buff-breasted Sandpipers overlaps with mineral, oil and gas exploration and development projects. On the Canadian breeding grounds, development is mostly associated with mining and coal exploration (Environment and Natural Resources 2011). Most oil and gas development in the north occurs in Alaska. For example, the species is known to breed within the National Petroleum Reserve, Kuparuk and Prudhoe Bay oil fields and the Arctic National Wildlife Refuge in Alaska – all sites of either active or proposed oil and gas drilling (Lanctot *et al.* 2010).

Although the impact of development activities on Buff-breasted Sandpipers is not yet clear, the necessary infrastructure to support development projects (e.g., buildings, runways, roads) tends to be located in the drier upland habitat that represents prime courtship-display habitat for the species. Such projects may thus result in direct habitat loss and increased disturbance during the breeding season (e.g., repeated flushing of incubating females, nest abandonment). Furthermore, garbage that accumulates around development sites and Arctic communities likely attracts increased numbers of predators that prey on eggs and young, including Arctic Fox, Red Fox, Glaucous Gull (*Larus hyperboreus*), and Common Raven. This could be a particular problem in oil fields where trapping and hunting of predators is prohibited (Lanctot *et al.* 2010). Liebezeit *et al.* (2009) failed to find any correlation between infrastructure development and nest survival, but their study had high variability in environmental conditions, nest survivorship, and predator numbers between years and sites, which confounded the results.

Non-breeding Habitat: Migration

Away from the breeding grounds, much of the species' historical native grassland habitat for staging and wintering has been converted to cropland and human settlement in North and South America. What native habitat remains for staging may no longer be suitable for Buff-breasted Sandpipers, because it tends to be small and fragmented, and evidence from Nebraska suggests birds prefer open areas free from human obstructions (Jorgensen *et al.* 2007). Furthermore, native short grasslands in North America are increasingly under threat by oil and gas development and associated road infrastructure (Primm *et al.* 2001).The remaining native grassland is largely represented by tallgrass systems, which do not maintain the short vegetative structure favoured by the species (Lanctot *et al.* 2010), in the absence of grazing regimes.

The widespread loss and alteration of grassland habitat undoubtedly explains why Buff-breasted Sandpipers are frequently associated with cultivated agricultural lands (such as corn, soybean and rice fields) over much of their migratory range today. Even then, it seems that the suitability of some of these human-altered habitats may themselves be declining for the species, owing to widely-adopted changes in agricultural practices that yield widely-recognized, alternative conservation benefits. For example, the increased use of no-till agriculture (as a conservation alternative to deep plowing) in Nebraska may decrease prey availability for Buff-breasted Sandpipers (Lanctot *et al.* 2010).

In the future, increased demand for biofuel crops could also lead to the introduction of non-indigenous tall grasses in crop land now used by migrating Buff-breasted Sandpipers in the United States and Canada (Mabee 2006; Lanctot *et al.* 2010).

The development of wind energy projects along the North American migratory route of the Buff-breasted Sandpiper could be a potential future threat for the species (Lanctot *et al.* 2010). Little is known about the effects of wind turbines on shorebirds. Wind farms could cause direct mortality if birds fly within the rotor sweep zone (as has been found with American Golden-Plovers, which associate with Buff-breasted Sandpipers on migration; Lanctot *et al.* 2010). Indirect effects could include the avoidance of traditional staging areas in the United States and Canada. Currently, several large wind energy projects are planned for areas used by Buff-breasted Sandpipers in the Great Plains and the Gulf Coastal Plain (Lanctot *et al.* 2010). Thirty-one wind energy projects currently operate in Alberta and Saskatchewan, the main migratory corridor for Buff-breasted Sandpipers in Canada. An additional 47 are planned within these provinces by 2015 (CANWEA 2011).

Non-breeding Habitat: Wintering

Although not entirely clear, the most significant threats to the species appear to occur on the wintering grounds and/or at the yet to be discovered major staging area that is believed to be located somewhere in northern South America. Losses in the extent and quality of wintering habitat are primary concerns.

On the present-day wintering grounds, Buff-breasted Sandpipers are highly dependent on livestock grazing to maintain short-grass habitat structure. But ranching practices may not always promote the habitat conditions required by the species. For instance, if cattle and sheep are moved frequently (i.e., to minimize overgrazing), introduced late in the austral summer, or removed completely (e.g., when land is acquired by conservation agencies), the amount of short-grass cover that is associated with moderate to heavy levels of grazing diminishes or disappears altogether (Lanctot *et al.* 2010). A recent assessment of Buff-breasted Sandpiper habitat use under a range of cattle-grazing management practices in South America revealed that birds used pastures only where short-grass cover was close to 100% (Isacch and Cardoni 2009). Lanctot *et al.* (2010) suggested that changes to livestock grazing patterns could have a strong influence on the distribution and abundance of Buff-breasted Sandpipers.

More importantly, ranchland also is rapidly being converted to cropland in the fertile grasslands of South America. For example, more than 60% of the rangelands have disappeared from the Argentine Pampas since the 1880s, with much of the loss occurring in recent decades (Lanctot *et al.* 2010). The rising demand for biofuels derived from soybeans is partly responsible, and future development of other biofuel crops may lead to even greater loss of grassland habitat (Lanctot *et al.* 2010). Other potential threats to the wintering habitat of Buff-breasted Sandpiper include mines and pine plantations (which may disperse seeds into adjacent grasslands), subdivision of ranches, and tourism development (e.g., roads, buildings; Lanctot *et al.* 2010).

In Brazil, wintering habitat around coastal lagoons may also be threatened by the illegal construction of drainage canals to irrigate rice fields, or to drain areas for cultivation (Lanctot *et al.* 2010).

Environmental Contaminants

The Buff-breasted Sandpiper's present-day reliance on a variety of human-altered habitats along its migratory route and on the wintering grounds (e.g., croplands, sod fields, golf courses, airport runways, cemeteries) potentially exposes it to high levels of pesticides. Indeed, Strum *et al.* (2010) found that Buff-breasted Sandpipers showed exposure to organophosphorus and carbamate pesticides at agricultural sites in South America (i.e., rice fields and cattle pastures). However, exposure was not evident at stopover sites in North American agricultural habitat (i.e., organic rice fields and turf grass farms; Strum *et al.* 2010).

The effects of agrochemicals on shorebirds may range from death to physiological impairment. For example, three adult Buff-breasted Sandpipers were killed from feeding on rice seed treated with Furadan 4F in Texas (Flickinger *et al.* 1986) and mortality from Furadan was similarly reported in Nebraska in the 1970s (Lanctot *et al.* 2010). Other sandpiper species have died from exposure to closely-related rice pesticides. Although Furadan products are now banned in the U.S., they may still be permitted in Brazil and Uruguay (Lanctot *et al.* 2010). Sublethal effects of cholinesterase-inhibiting pesticides (i.e., organophosporus and carbamate) include reduced body mass, loss of migratory orientation and decreased flight speed (Strum *et al.* 2010), although to date these impacts have not been studied in Buff-breasted Sandpipers.

Climate Change

Climate change is predicted to affect Buff-breasted Sandpipers in multiple ways throughout their range. For example, rising sea levels in low-lying coastal areas may flood Arctic breeding sites and South American wintering sites and degrade freshwater habitat by increasing salinity levels (Morrison *et al.* 2001b; Lanctot *et al.* 2010). The increased frequency and severity of droughts forecast for the Canadian Prairies and the United States Great Plains will negatively impact wetland and seasonal pond habitat used by the species for maintenance and rest, and will likely result in decreased food availability on migration (Barnett *et al.* 2005; Karl *et al.* 2009). Increased frequency of severe storms over the western Atlantic raises the risk of mortality for birds migrating south in the fall (Lanctot *et al.* 2010).

Many effects of climate change are already manifesting themselves across the Buff-breasted Sandpiper's range, particularly in the Arctic, which has experienced rapid warming since the 1950s (Arctic Climate Impact Assessment 2004). In the Arctic, warmer temperatures have led to an advancement in spring phenology, potentially decoupling the synchrony between breeding chronology and food availability (Tulp and Schekkerman 2006). Likewise, warming is resulting in the northward advancement of shrub cover into the tundra (Sturm *et al.* 2001). On the wintering grounds, recent increases in severe droughts and flooding are believed to have affected the species' habitat use in Paraguay (Lanctot *et al.* 2010), and a rise in periods of heavy rainfall has been documented over the past 50 years in the sandpiper's Argentinean range (Berbery *et al.* 2006).

PROTECTION, STATUS, AND RANKS

Legal Protection and Status

Outside Canada, the Buff-breasted Sandpiper is listed in Appendices I and II of the Convention on Migratory Species of Wild Animals. It is protected under Canada's federal *Migratory Birds Convention Act* (1994). The species is also protected under provincial/territorial legislation, such as Alberta's *Wildlife Act* (2000), Saskatchewan's *Wildlife Act* (1998), and Nunavut's *Wildlife Act* (2003). None of the existing protections extend to conservation of the species' habitat.

Non-Legal Status and Ranks

The species is considered 'Near Threatened' in the IUCN Red List of Threatened Species and as a Red Species in the 2007 Audubon Watchlist (meaning that it is declining rapidly and/or has very small populations or limited ranges, and faces major conservation threats; Audubon 2007). The Canadian and U.S. Shorebird Conservation Plans designated the Buff-breasted Sandpiper as a species of high concern (Brown *et al.* 2001; Donaldson *et al.* 2001). More recently, the U.S. rank has been revised to 'highly-imperiled' (USCCP 2004). According to NatureServe, the species' Global (G) rank is G4, apparently secure (uncommon but not rare, some cause for long-term concern due to declines or other factors), while its National (N) rank is N4B, apparently secure, in both Canada and the United States (NatureServe 2010).

In Canada, the species is ranked nationally as 'sensitive' (not believed to be at risk of immediate extirpation or extinction but may require special attention or protection to prevent it from becoming at risk; CESCC 2011). Provincial and territorial rankings are provided in Table 3. The U.S. Fish and Wildlife Service considers the Buff-breasted Sandpiper as a species of high conservation concern (USFWS 2009).

Table 3. Provincial and territorial general status ranks for the Buff-breasted Sandpiper (based on CESCC 2011).

Jurisdiction	General Status Ranking	Definition
Yukon	2: May be at risk	Potentially at risk of extirpation or extinction
Northwest Territories, Nunavut, Manitoba, Quebec	3: Sensitive	Not believed to be at risk of immediate extirpation or extinction but may require special attention or protection to prevent it from becoming at risk
British Columbia, Alberta, Saskatchewan, Prince Edward Island	4: Secure	Not believed to be at risk. This category includes some species that show a trend of decline in numbers but remain relatively widespread or abundant
Ontario	5: Undetermined	Insufficient data, information, or knowledge is available with which to reliably evaluate status.
New Brunswick, Nova Scotia, Newfoundland and Labrador	8: Accidental	Occurs infrequently and unpredictably, outside its usual range

Buff-breasted Sandpipers are classified as threatened in Argentina (López-Lanús *et al.* 2008) and as vulnerable in the Brazilian state of Rio Grande do Sul (Marques *et al.* 2002). The species is identified as a priority species for conservation in Uruguay and is listed as near-threatened in Paraguay (del Castillo *et al.* 2005; Brazeiro *et al.* 2006).

Habitat Protection and Ownership

A relatively small proportion of the Buff-breasted Sandpiper's total habitat is legally protected. On the breeding grounds, some habitat is protected by the State Nature Preserve on Wrangel Island, Russia and the Arctic National Wildlife Refuge, Alaska (Lanctot and Laredo 1994). However, U.S. Congress can authorize oil and gas development along the north coast of the Arctic National Wildlife Refuge at any time (USFWS 2011). In Canada, birds have been documented breeding in Queen Maud Gulf Migratory Bird Sanctuary, Nunavut (J. Rausch unpubl. data). The species is reported as regularly breeding in Aulavik National Park, Northwest Territories and Ivvavik National Park, Yukon, and as regularly occurring during migration in Wapusk National Park, Manitoba (Parks Canada 2010). Buff-breasted Sandpipers are recorded as accidental/nonregular transients in Prince Edward Island National Park, Prince Edward Island, and Gros Morne National Park, Newfoundland and Labrador (Parks Canada 2010).

On the North American stage of migration, Buff-breasted Sandpipers pass through areas designated as National Wildlife Refuges, Western Hemisphere Shorebird Reserve Network Sites (WHSRN), RAMSAR wetlands, Important Bird Areas, and Wildlife Management Areas (Lanctot *et al.* 2010). However, the majority of sites visited by birds on migration are human-altered private lands and have no protection status.

On the wintering grounds, some sites known to provide important habitat for Buff-breasted Sandpipers receive some degree of protection from development. Some habitat occurs in areas designated as WHSRN sites, RAMSAR wetlands, Important Bird Areas, biosphere reserves, national parks, and provincial reserves. For example, large numbers of birds have been recorded at Lagoa do Peixe National Park (Brazil) and Laguna de Rocha Biosphere Reserve (Uruguay). Nonetheless, most of the non-breeding habitat occurs on privately-owned land having no legal protection (Lanctot *et al.* 2010). The species' dependence on heavily-grazed grassland for wintering habitat may put it at odds with conservation projects seeking to restore such habitat for other native wildlife species (Lanctot *et al.* 2010).

The Buff-breasted Sandpiper's unusual habitat requirements (compared with other shorebirds) have likely led to inadequate protection of habitat across its range. On its Arctic breeding grounds, the species' preference for drier uplands conflicts with existing policies that focus on wetlands protection. With the exception of native pasture, many of the human-altered habitats now used by the species on migration tend to be viewed as being of low conservation value for most other species. Similarly, heavily-grazed grasslands on the wintering grounds are not deemed a high conservation priority. Furthermore, because information is lacking on the Buff-breasted Sandpiper's

distribution and use of specific sites on the breeding and wintering grounds, as well as on migration, key sites used by the species are currently unknown (e.g., suspected migration stopover sites have yet to be identified in northern South America; Lanctot *et al.* 2010).

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