PROPOSED FINAL

Species at Risk Act
Management Plan Series

Management Plan for the Buff-breasted Sandpiper (*Tryngites subruficollis*) in Canada

Buff-breasted Sandpiper

2022

Government of Canada
Gouvernement du Canada

Canada

Recommended citation:

Environment and Climate Change Canada. 2022. Management Plan for the Buff-breasted Sandpiper (*Tryngites subruficollis*) in Canada. *Species at Risk Act* Management Plan Series. Environment and Climate Change Canada, Ottawa. v + 37 pp.

Official version

The official version of the recovery documents is the one published in PDF. All hyperlinks were valid as of date of publication.

Non-official version

The non-official version of the recovery documents is published in HTML format and all hyperlinks were valid as of date of publication.

For copies of the management plan, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry[1].

Cover illustration: Buff-breasted Sandpiper at Seal River Estuary Important Bird Area by © Christian Artuso

Également disponible en français sous le titre
« Plan de gestion du Bécasseau roussâtre (*Tryngites subruficollis*) au Canada »

ISBN
Catalogue no.

[1] www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of management plans for listed species of special concern and are required to report on progress within five years after the publication of the final document on the SAR Public Registry.

The Minister of Environment and Climate Change and Minister responsible for the Parks Canada Agency is the competent minister under SARA for the Buff-breasted Sandpiper and has prepared this management plan, as per section 65 of SARA. To the extent possible, it has been prepared in cooperation with other federal government departments, Provinces/Territories, Wildlife Management Boards, and Aboriginal organizations as per section 66(1) of SARA.

Success in the conservation of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this plan and will not be achieved by Environment and Climate Change Canada and the Parks Canada Agency, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this plan for the benefit of the Buff-breasted Sandpiper and Canadian society as a whole.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

[2] www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html#2

Acknowledgments

This document was prepared by Amelia R. Cox and Marc-André Cyr (Environment and Climate Change Canada, Canadian Wildlife Service [ECCC-CWS] – National Capital Region). Thanks are extended to Richard Lanctot (United States Fish and Wildlife Service [USFWS]) for providing advice on an earlier draft. Drafts were reviewed and helpful insight provided by numerous people: Catherine Geoffroy; Benoit Laliberté, Cynthia Pekarik, Christian Artuso, Megan Stanley and Angela Barakat (ECCC-CWS – National Capital Region), Pam Sinclair, Danica Hogan and Jennie Rausch (ECCC-CWS – Northern Region), Ann McKellar and Jeff Ball (ECCC-CWS – Prairie Region), Manon Dubé, Yves Aubry, and François Shaffer (ECCC-CWS – Québec Region), Scott Flemming and Ross Vennesland (ECCC-CWS – Pacific Region), Christian Friis and John Brett (ECCC-CWS – Ontario Region), Juan Pablo Isacch (Universidad Nacional de Mar del Plata-CONICET – Argentina), Brad Andres (USFWS), Véronique Connolly (private consultant), Joanna Wilson and Shirley Standafer-Pfister (Northwest Territories), Thomas Jung (Yukon), Tim Poole (Manitoba) and Gordon Court (Alberta).

Thanks are extended to David Fraser for facilitating the Buff-breasted Sandpiper IUCN-CMP threat assessment in June 2019 and to experts who participated in this assessment: Tjalle Boorsma (Armonía – Bolivia); Juliana Bosi de Almeida (SAVE Brasil – Brazil); Juan Pablo Isacch (Universidad Nacional de Mar del Plata-CONICET – Argentina); Isadora Angarita-Martínez (CAFF); Arne Lesterhuis (Manomet Inc.); Carlos Ruiz (Asociación Calidris – Colombia); as well as members of ECCC's Shorebird Technical Committee.

A draft of this management plan was presented during a workshop on October 10, 2019 in Ottawa, Canada. Thanks are extended to participants to this workshop: Isadora Angarita-Martínez (CAFF), Arne Lesterhuis and Rob Clay (Manomet Inc.), Brad Andres and Richard Lanctot (USFWS), as well as members of ECCC's Shorebird Technical Committee.

Acknowledgement and thanks are given to all other parties that provided advice and input used to help inform the development of this management plan including provincial and territorial governments, other federal departments (e.g., Department of National Defence), landowners, citizens, and stakeholders.

The development of this management plan was largely informed by the Conservation Plan for the Buff-breasted Sandpiper (*Tryngites subruficollis*) published in 2010 by Richard Lanctot and colleagues. On October 23, 2019, experts met in Panama City, Panama to lay the groundwork for a full life-cycle conservation plan for the Buff-breasted Sandpiper. The Panama City workshop was an opportunity to align conservation targets and strategies between the Management Plan for the Buff-breasted Sandpiper (*Tryngites subruficollis*) in Canada and the full life-cycle conservation plan.

Executive Summary

The Buff-breasted Sandpiper (*Calidris subruficollis,* formerly *Tryngites subruficollis*) is an arctic-breeding shorebird. The species nests on the upland coast of the Yukon, Northwest Territories, Nunavut and Alaska before migrating along the Midcontinental flyway to the coast of Argentina, Uruguay, and Brazil where birds stay during the boreal winter.

The species was assessed as Special Concern by COSEWIC in 2012 and listed under Schedule 1 of the *Species at Risk Act* in 2017. Globally, the IUCN Red List has categorized the species as Near Threatened since 2004. As a long-distance migrant, the Buff-breasted Sandpiper is protected under the *Migratory Birds Convention Act* in Canada and the *Migratory Bird Treaty Act* in the United States.

The Buff-breasted Sandpiper population is estimated at 56,000 individuals (range: 35,000–78,000; Lanctot et al. 2010), 75% of which are thought to breed in Canada (Donaldson et al. 2000). After massive declines during the early 1900s caused by hunting in Canada and the United States, the species appears to be still declining today. The scale of the decline is uncertain due to the challenges in surveying the species and the current lack of data.

The exact causes of this decline are unknown. A combination of factors resulting in habitat loss or poor habitat quality on the migratory and wintering grounds are likely driving the decline. Those factors include conversion of natural areas to agriculture, pesticide exposure, wind turbines, resource extraction, and climate change.

The management objective for the Buff-breasted Sandpiper is to maintain the population size of the species over a period of 10 years ranging from 2026 to 2036. The baseline for this management objective will be a more reliable and accurate population estimate obtained within the next 5 years (2021–2026).

The broad strategies identified in this management plan aim to conserve habitat, monitor the population and distribution of the species, and understand characteristics of non-breeding habitats through research. Much of this habitat is outside of Canada, so supporting international conservation and research efforts should play a key role in Canada’s conservation strategies for the species.

Table of Contents

1. COSEWIC* Species Assessment Information

Date of Assessment: May 2012

Common Name (population): Buff-breasted Sandpiper

Scientific Name: *Tryngites subruficollis***

COSEWIC 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.

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

COSEWIC Status History:
Designated Special Concern in May 2012.

* COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

** The scientific name of the Buff-breasted Sandpiper (*Calidris subruficollis*) changed in 2013 (Chesser et al. 2013), after COSEWIC assessment in May 2012. Documents developed under the *Species at Risk Act* (SARA) must follow the species nomenclature used in Schedule 1 of SARA.

2. Species Status Information

An estimated 75% of the global Buff-breasted Sandpiper population breeds in Canada (Donaldson et al. 2000). In Canada, the species was assessed as Special Concern by COSEWIC in 2012 and listed as Special Concern under Schedule 1 of the *Species at Risk Act* (S.C. 2002, c. 29) in 2017. The Buff-breasted Sandpiper is not listed under any provincial species at risk legislation. The species has been identified as a priority

species in four of the twelve Bird Conservation Regions[3]. A recently updated assessment of shorebirds in Canada deemed Buff-breasted Sandpiper to be of High Concern in Canada based on the probable decline and threats to the species (Hope et al. 2019).

Table 1. Summary of national and provincial or state NatureServe ranks for the Buff-breasted Sandpiper where it occurs in North America (NatureServe, 2019)

Global (G) Rank	National (N) Ranks	Sub-national (S) Ranks
G4	Canada N2N4B, N4N5M	Alberta (S3M), British Columbia (SUM), Labrador (SNA), Manitoba (S1S2M), Newfoundland Island (SNA), Northwest Territories (S2S4B), Nunavut (S3B, S3M), Ontario (SNA), Quebec (S3M), Saskatchewan (S4M), Yukon (S1B)
	United States N4B	Alabama (SNRM), Alaska (S2B), Arkansas (SNA), California (SNA), Colorado (SNA), Connecticut (SNA), Delaware (SNA), Florida (S2M), Georgia (SNRN), Illinois (SNA), Indiana (S3M), Iowa (S3N), Kansas (SNA), Kentucky (SNA), Louisiana (S3M), Maine (SNA), Maryland (SNA), Massachusetts (S1N), Michigan (SNRN), Minnesota (SNRM), Mississippi (SNA), Missouri (SNA), Nebraska (S2N), New Jersey (S4N), New York (SNRN), North Carolina (SNA), North Dakota (SNA), Ohio (SNA), Oklahoma (S3M), Pennsylvania (S2M), Rhode Island (S1N), South Carolina (SNA), South Dakota (SNA), Tennessee (S3N), Texas (S2S3), Virginia (SNA), Washington (SNA), Wisconsin (S3N), Wyoming (S4N)

National (N) and Subnational (S) NatureServe alphanumerical ranking: 1 – Critically Imperiled, 2 – Imperiled, 3 – Vulnerable, 4 – Apparently Secure, 5 – Secure, NR – Unranked, NA – Not Applicable, U – Unrankable. Occurrence definitions: B – Breeding, M – Migrant. The N2N4B range indicates the range of uncertainty about the status of the species.

The global NatureServe rank is G4 – Apparently Secure (reviewed in 2016; NatureServe 2019; see Table 1 for additional sub-rankings) and the IUCN Red List has categorized the species as Near Threatened since 2004 when its status was upgraded from Lower Risk (BirdLife International 2017). The species was listed in 1999 in Appendix I and II of the UN Convention on the Conservation of Migratory Species of Wild Animals, which prohibits hunting of the species in its wintering range[4]. The Buff-breasted Sandpiper is also protected under the *Migratory Birds Convention Act, 1994* which protects all individuals of the species as well as its nest and eggs on federal and non-federal lands.

[3] Those Bird Conservation Regions are the Arctic Plains and Mountains, the Lower Great Lakes/St. Lawrence Plain, the Prairie Potholes, and the Taiga Shield and Hudson Plains.

[4] This document refers to the wintering range as the species' range occupied during the northern hemisphere's winter months (December to March).

The Buff-breasted Sandpiper is a Species of High Concern in the United States. (USSCP, 2016). In South America, the species is considered Vulnerable in Brazil, Threatened in Paraguay (Ministerio de Ambiente y Desarrollo Sostenible, 2019), a Priority Species for Conservation in Uruguay, Threatened in Argentina, and Highly Threatened in Colombia (Johnston-González et al. 2010).

3. Species Information

3.1. Species Description

The Buff-breasted Sandpiper is a medium-sized, buff-coloured (light brownish yellow), arctic-breeding shorebird. Males weigh about 70 g and females weigh about 55 g (McCarty et al. 2017). They are marked with dark brown spots or streaks along the crown and sides of the breast, and narrow, teardrop shaped, dark-brown streaks edged in buff along the feather shafts on their back, scapulars[5], upper tail, and wing coverts[6] (COSEWIC 2012). Male, female, and juvenile plumage is similar, but the dark spots on the undersides of the outer primaries are larger in males than in females who have larger spots than juveniles (McCarty et al. 2017). The species has yellow legs and a black bill.

Buff-breasted Sandpipers are the only North American shorebird with an exploded lek[7] mating system (Lanctot et al. 1998). In an exploded lek, males are further away from one another than they would be in a classic lek. Because of density-dependent effects[8] associated with its unusual lek-mating system, further reductions in the species' abundance could accelerate population collapse if males and females cannot locate each other in their expansive breeding grounds. However, at present, there is no indication that genetic diversity declined as a result of historic reductions in population size (Lounsberry et al. 2013, 2014).

3.2. Species Population and Distribution

Distribution

The Buff-breasted Sandpiper breeds in low densities in the tundra along the coastline of Alaska and Canada from Point Barrow, Alaska through the Northwest Territories and to the Boothia Peninsula, Nunavut and as far north as Melville, Bathurst, and Devon Islands, Nunavut (Figure 1; COSEWIC 2012; McCarty et al. 2017). There are also small populations (280-650 individuals) breeding in Russia on Wrangel Island and the

[5] Scapulars are the feathers at the top of the wing when the bird is at rest.
[6] Wing coverts are the feathers that cover the wing's flight feathers.
[7] A lek is an aggregation of male animals gathered to engage in competitive displays, lekking, to entice visiting females, which are surveying prospective partners to mate.
[8] Density-depended effects occur when a change in the size of a group influences, either positively or negatively, the conditions of habitat available for individual. For example, a lower number of Buff-breasted Sandpipers (lower density) might result in a decreased ability of individuals to find a mate in a given area, especially if the mating area is widespread.

Chukotski Peninsula (Lappo et al. 2012). The Buff-breasted Sandpiper breeds in low densities; their local distribution is patchy and variable both between and within years—one Alaskan study found only 10% of leks to be present in all three consecutive years of the study (Lanctot and Weatherhead 1997). There is little to no breeding site fidelity (less than 10% of adults return; Pruett-Jones 1988; Lanctot and Weatherhead 1997) and males may display at multiple leks across the entire breeding range (Lanctot et al. 2016).

The Buff-breasted Sandpiper migrates south mainly following the Midcontinental flyway, through the prairies and plains, where they make multiday stops in locations such as southern Saskatchewan, in the Kansas Flint Hills, southcentral Texas and the Gulf of Mexico coast in the United States (Lanctot et al. 2016; Lyons et al. 2019; Tibbitts et al. 2019). Some juveniles frequent the Atlantic coast during southbound migration, with vagrant birds also migrating on the Pacific and Atlantic coasts (McCarty et al. 2017; see Figure 1). Then, they follow the Midcontinental Amazonia/Pantanal flyway, stopping in Bolivia and Paraguay (Lanctot et al. 2016; Tibbitts et al. 2019) before arriving on their wintering grounds on the coast of central Argentina, southeast Uruguay, and southeast Brazil (Lanctot et al. 2002; McCarty et al. 2017). The wintering grounds overlap with the Southern Cone Grasslands, also known as the pampas. On their northbound migration, birds stop in the Llanos plains of Colombia and Venezuela before crossing the Gulf of Mexico. This region therefore represents an important stopover site on migration. Fall and spring migrants take similar routes, but in the fall, juveniles migrating south may follow the Atlantic and Pacific coasts leading to a more dispersed route in the fall than spring (COSEWIC 2012). In contrast to the breeding grounds, birds show fairly high wintering site fidelity (55% to 64% return rate), with males being somewhat more likely to emigrate than females (Almeida 2009).

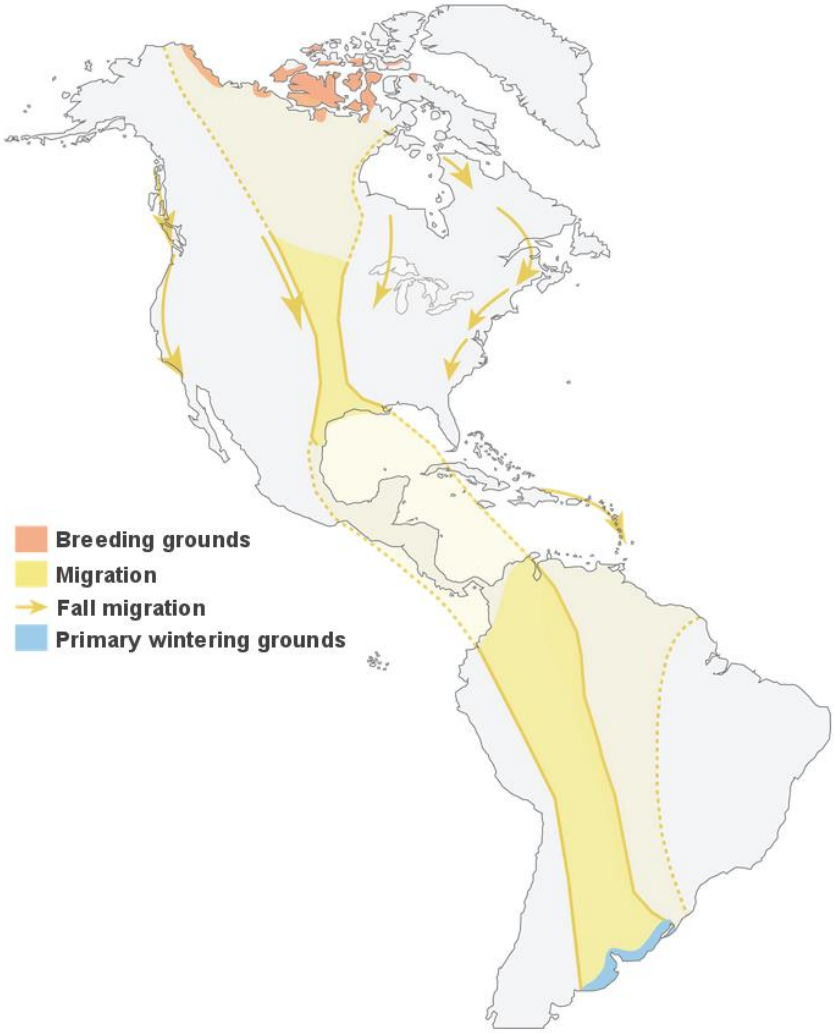

Figure 1. Distribution of the Buff-breasted Sandpiper in the Americas. Shaded yellow areas are migration corridors where the species is found at low densities; the species funnels through areas represented in dark yellow (from Cornell Lab - Birds of North America's Website, McCarty et al. 2017).

Population Size and Trends

Based on surveys done on stopover sites in the United States, the Buff-breasted Sandpiper population is estimated to include 56,000 individuals (range of 35,000 to 78,000; Lanctot et al. 2010); earlier estimates were between 15,000 and 30,000 (Morrison et al. 2006), but likely were underestimates (Lanctot et al. 2010). The current estimate of 56,000 individuals is based on counts in the Rainwater Basin, Nebraska, an important stopover location[9] during northbound migration (Jorgensen et al. 2008). The uncertainty of the current population estimate depends on turnover rates estimated at stopover sites. Stopover duration at the Rainwater Basin is now known to be 48 hours

[9] Lanctot et al. (2010) defined key conservation sites as areas where at least 0.2% of the population (about 100 birds) occur regularly through time.

or less (McCarty et al. 2015), suggesting actual population size may be higher than previously estimated (Farmer and Durbian 2006). In addition, recent tracking data suggests that some birds bypass the Rainwater Basin, again potentially increasing population size estimates (R.B. Lanctot pers. comm. 2020). It should be noted that surveys of Buff-breasted Sandpipers on wintering grounds do not cumulatively support a population estimate of more than 50,000 birds. This suggests either a smaller population than estimated at the Rainwater Basin, or the existence of unknown wintering sites with large concentrations of birds (A.J. Lesterhuis, pers. comm. 2020; see Appendix B for a summary of population estimates).

Arctic Program for Regional and International Shorebird Monitoring (PRISM) surveys conducted between 1997 and 2007 across parts of Arctic Alaska yielded a population size estimate of 42,839 individuals for the areas surveyed at that time (95% range = 5,856–79,260; Bart and Smith, 2012). PRISM surveys conducted on the breeding grounds in Arctic Canada between 2010 and 2017 yielded much higher densities than expected based on conventional assumptions of the species' distribution and abundance. The population estimates arising from these surveys are many times larger than the currently proposed range-wide estimate of 56,000 (Lanctot et al. 2010). At the time of developing this management plan, these results are being carefully evaluated to ensure that they are accurate (P.A. Smith, pers. comm. 2020). PRISM estimates for the Buff-breasted Sandpiper present unique challenges because the species breeds at highly variable densities, due to its lek mating system, and they inhabit dry upland areas that are surveyed less intensively than the wetlands area used by many species (Lanctot et al. 2010; COSEWIC 2012). These new PRISM analyses will provide important information on abundance, distribution and habitat use for Buff-breasted Sandpipers. Surveys such as the North American Breeding Bird Survey (BBS) and Audubon Christmas Bird Count (CBC) provide very limited insight on this species.

Estimating trends is difficult because the species occurs in unpredictable locations on the breeding grounds, and appears to adjust when, where and how long it uses sites on both the migration and wintering grounds depending on environmental conditions (Lanctot et al. 2010). Historically, the Buff-breasted Sandpiper numbered in the hundreds of thousands. By the end of the 19th century, extensive commercial hunting during migration, and to a lesser extent on the wintering grounds, resulted in population numbers approaching dangerously low levels (McCarty et al. 2017; Lanctot et al. 2002, 2010). When the *Migratory Birds Convention Act* in 1917 and *Migratory Bird Treaty Act* in 1918 came into force, hunting pressure on the population declined, likely slowing the dramatic population decline (Lanctot et al. 2002, 2010; COSEWIC 2012).

Following hunting regulations, it is unknown whether the Buff-breasted Sandpiper population recovered or remained at low levels between the 1920s and the 1970s. The population is thought to have continued to decline in the recent decades (Lanctot et al. 2002, 2010). Observers on the migratory and wintering grounds alike have anecdotally reported declining numbers since at least the 1980s (Lanctot et al. 2002, 2010; COSEWIC 2012). For example, on the wintering grounds, there were 1,000 to 2,000 individuals during the winters of 1973 and 1974, with roosts of 600 to 1,000 individuals at Estancia Medaland, Argentina (Myers 1980). When the survey was

repeated in 1996–2000, there were rarely more than 100 birds sighted and never more than 94 individuals together (although there was a flock of ~300 sighted outside the study area) (Isacch and Martínez 2003a, 2003b). Estancia Medaland was declared a Western Hemisphere Shorebird Reserve Network (WHSRN) site of Regional Importance in 2018, in part based on counts of 1,010 Buff-breasted Sandpipers recorded at the site in 2017 (Martínez-Curci et al. 2018). The extent to which birds move between sites within a year is unknown but their numbers often vary substantially between years and even within the season, so short-term studies should be interpreted with caution (Myers 1980; Pruett-Jones 1988; Lanctot and Weatherhead 1997; Lanctot et al. 2002, 2016; but see Almeida 2009).

3.3. Needs of the Buff-breasted Sandpiper

Breeding

The Buff-breasted Sandpiper is an upland species, preferring to breed on the drier, elevated ridges of the tundra, rather than the wet, polygon lowlands as is common for many other shorebirds. In the spring, males begin foraging and displaying on the first snow-free areas, usually along bluffs and ridges bordering rivers (Pruett-Jones 1988; Lanctot and Weatherhead 1997). As the snow melts, males display on leks in moist graminoid meadow with many clumps of grasses (20 cm tall, 25-50 cm diameter; Lanctot et al. 2010; COSEWIC 2012; McCarty et al. 2017). Display areas typically are non-patterned ground, with few of the geometric patterns created by permafrost that are common in many arctic areas. Buff-breasted Sandpipers have an exploded lek mating system, with groups of 2-20 (average 2.6) males displaying together in a lek (Lanctot and Weatherhead 1997). Males typically display at one lek for only a short time, apparently moving between leks based on the number of available females (Lanctot and Weatherhead 1997). This causes lek location to be unstable within and across years. Solitary males may also display near the nest while females are fertile; this may be a more reliable tactic later in the season when there are fewer available females (Prevett and Barr 1976; Pruett-Jones 1988; but see Lanctot and Weatherhead 1997). Males leave breeding grounds following the initiation of nesting by females (Sutton 1967; Pitelka et al. 1974; McCarty et al. 2017).

Females nest away from lek sites (270-830 m; Pruett-Jones 1988), in well-drained grassy tundra with sedge grass clumps or moss-willows or moist sedge–graminoid meadows (Sutton 1967; Prevett and Barr 1976; Lanctot et al. 2010; McCarty et al. 2017). During incubation breaks, females forage in areas with little vegetation, often along streams. They may also use habitats with a distinct net-like pattern across the ground caused by permafrost freeze/thaw cycle. After their eggs hatch, females forage with their brood in wetter areas, often along streams in emergent vegetation (Lanctot et al. 2010). Unlike many other species, the Buff-breasted Sandpiper remains in the uplands throughout brood rearing (McCarty et al. 2017).

Migration

Historically, during the North American portion of migration, Buff-breasted Sandpipers would have congregated in the short-grass prairies, where fire and grazing bison kept

vegetation short (Jorgensen et al. 2007). These prairies are now largely taken over by agriculture. Currently, migrating Buff-breasted Sandpipers congregate in surrogate short-grass areas, like newly planted crops, pastures, plowed fields, sod farms, golf courses, cemeteries, airports, freshly cut hayfields, lawns, and fallow or short-growth agricultural fields (Lanctot et al. 2010; COSEWIC 2012; McCarty et al. 2017). The species is attracted to “relatively moist” fields and, especially in drier year, to recently watered fields (Lanctot et al. 2010 citing D. Newstead). In the Rainwater Basin, Nebraska, an important stopover site, migrating birds congregate in corn or soybean fields, with a strong preference for fields where soybean had been harvested on the previous year (Jorgensen et al. 2007). Buff-breasted Sandpipers tend to use cornfields where stalks are cut at the base and less than 10 cm in height (Jorgensen et al. 2007). The birds spend about 50% of their time at migratory stopover sites foraging (McCarty et al. 2009) and prefer the foraging site to be near (but not in) a wetland (Jorgensen et al. 2007), which they use for bathing and drinking (McCarty et al. 2009). On the Gulf Coast, staging Buff-breasted Sandpipers rely heavily on commercial sod and other forms of agriculture to a lesser extent (Stone et al. 2019). In South America, migrating Buff-breasted Sandpipers primarily use short-grass areas along rivers and wetlands. They are also found in harvested or newly planted agricultural fields (particularly sugar cane and rice), sand bars, or other short-grass habitats (Lanctot et al. 2002, 2010).

Non-breeding

Buff-breasted Sandpipers winter in the Pampas biome and show high fidelity to previous wintering sites (Isacch and Martinez 2003b). As during migration, they prefer grasslands where vegetation is 2 to 5 cm tall (Lanctot et al. 2002, 2004). Over winter, the birds rely primarily on intensively grazed pastureland or areas with flooding events, high salinity, and naturally short vegetation (Isacch and Martínez 2003b). Alternatively, the species relies on soybean or rice agricultural fields (Lanctot et al. 2002, 2004). Habitat tracking of wintering birds in the Samborombón Bay shows they rely on a combination of Pampas grassland (day) and salt-tolerant coastal (night) areas in Argentina (Castresana et al. 2019). In the Estancia Medaland, Buff-breasted Sandpipers move to freshwater swamps at night (J.P. Isacch, pers. comm. 2019)

Diet

Buff-breasted Sandpipers feed on insects, with some seeds and plant material. They also eat aquatic zooplankton, particularly during the fall after brood-rearing (McCarty et al. 2017). Their exact diet is poorly documented and likely varies between sites. However, on the wintering grounds, birds preferentially eat adult and larval beetles, ants, flies, spiders and earthworms (Isacch et al. 2005). Although most other arctic shorebirds eat worms, insect larvae, and marine zooplankton during brood rearing in the wet lowlands, the Buff-breasted Sandpiper remains in the uplands throughout brood rearing and therefore does not feed heavily on these aquatic invertebrates (McCarty et al. 2017).

4. Threats

4.1. Threat Assessment

The Buff-breasted Sandpiper threat assessment is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system (Salafsky et al. 2008). This threat assessment was conducted in June 2019. Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational). Limiting factors are not considered during this assessment process. Historical threats, indirect or cumulative effects of the threats, or any other relevant information that would help understand the nature of the threats are presented in the Description of Threats section.

Table 2. Threat calculator assessment.

Threat #	Threat Description	Impact[a]	Scope[b]	Severity[c]	Timing[d]
1	Residential and commercial development	Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)
1.1	Housing and urban areas	Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)
1.3	Tourism and recreation areas	Unknown	Small (1-10%)	Unknown	High (Continuing)
2	Agriculture and aquaculture	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)
2.1	Annual and perennial non-timber crops	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)
2.2	Wood and pulp plantations	Not Calculated (outside assessment timeframe)	Negligible (<1%)	Negligible (<1%)	Low (Possibly in the long term, >10 yrs)
2.3	Livestock farming and ranching	Not a Threat	Large (31-70%)	Neutral or Potential Benefit	High (Continuing)
3	Energy production and mining	Medium-Low	Large - Restricted (11-70%)	Moderate (11-30%)	High (Continuing)
3.1	Oil and gas drilling	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)
3.2	Mining and quarrying	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)
3.3	Renewable energy	Medium - Low	Large - Restricted (11-70%)	Moderate (11-30%)	High (Continuing)
4	Transportation and service corridors	Negligible	Large - Restricted (11-70%)	Negligible (<1%)	High (Continuing)
4.2	Utility and service lines	Negligible	Large - Restricted (11-70%)	Negligible (<1%)	High (Continuing)

Threat #	Threat Description	Impact[a]	Scope[b]	Severity[c]	Timing[d]
5	Biological resource use	Negligible	Negligible (<1%)	Extreme (71-100%)	Moderate (Possibly in the short term, < 10 yrs)
5.1	Hunting and collecting terrestrial animals	Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)
7	Natural system modifications	Low	Pervasive-Large (31-100%)	Slight (1-10%)	High (Continuing)
7.1	Fire and fire suppression	Low	Pervasive - Large (31-100%)	Slight (1-10%)	High (Continuing)
7.2	Dams and water management/use	Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)
7.3	Other ecosystem modifications	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)
8	Invasive and problematic species, pathogens and genes	Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)
8.1	Invasive non-native/alien plants and animals	Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)
8.2	Problematic native plants and animals	Not a Threat	Restricted (11-30%)	Neutral or Potential Benefit	High (Continuing)
9	Pollution	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)
9.3	Agricultural and forestry effluents	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)
11	Climate change	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)
11.1	Ecosystem encroachment	Not Calculated (outside assessment timeframe)	Large (31-70%)	Unknown	Low (Possibly in the long term, >10 yrs)
11.4	Changes in precipitation and hydrological regimes	Unknown	Pervasive (71-100%)	Unknown	Moderate (Possibly in the short term, <10 yrs)
11.5	Severe / Extreme Weather Events	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)

[a] **Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment timeframe (e.g., timing is insignificant/negligible or low as threat is only considered to be in the past); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.

[b] **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%; Negligible < 1%).

[c] **Severity** – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%; Negligible < 1%; Neutral or Potential Benefit ≥ 0%).

[d] **Timing** – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.

4.2. Description of Threats

The exact causes of the decline of Buff-breasted Sandpipers are unknown. Multiple factors likely reduce the suitability or availability of stopover and wintering sites, including fire suppression, resource extraction, conversion of short-grass prairies to agricultural land, and pesticide contamination. Habitat loss as a result of these factors likely are the most immediate threat to the species. Habitat loss from wind farm encroachment and direct mortality from collisions with wind turbines at important stopover and wintering sites are significant threats to the Buff-breasted Sandpiper. A large proportion of the population is exposed to threats occurring on the Midcontinental flyway as the species uses this narrow migration corridor in spring and fall. Most of the threats to the species, and their underlying factors, are ongoing. The species faces few threats on its breeding grounds, but an expansion of industrial activities in the Arctic could cumulatively result in impacts on the species. In the coming years, climate change will likely play a larger role in the decline of the species. Threats likely to affect the species within the next ten years are described below from highest to lowest impact and certainty (Table 4).

IUCN-CMP Threat 3.3 Renewable energy (Medium to Low Impact)

The development of wind farms is thought to have a medium to low impact on Buff-breasted Sandpipers, though there is uncertainty in both the scope and severity of this threat. Wind farms may kill birds if they enter the rotor sweep zone or cause birds to avoid historic staging areas (Lanctot et al. 2010). Pre-construction surveys in Indiana found that more than 20% of staging American Golden-Plovers (*Pluvialis dominica*), who often migrate with Buff-breasted Sandpipers, flew in the proposed rotor sweep zone (West Inc., unpublished report, described in Lanctot et al. 2010). Wind energy production has grown substantially in Canada and the United States with more growth projected (Statistics Canada 2017; U.S. Energy Information Administration 2019). Most wind farms in the United States are located along the Midcontinental flyway, where birds migrate both in the fall and in spring. This biannual use of the migration corridor increases the risk of negative interaction with wind farms. In Canada, wind energy installations are mostly found outside of the Buff-breasted Sandpiper's breeding and migration ranges (Canadian Wind Energy Association 2019). There are at least 10 wind farms in development in southern Alberta (Dowdell and Patel 2020), but they also seem to be outside of the main migration corridor (McCarty et al. 2015, 2017). However, northern regions and the Prairies show high wind energy potential (Canadian Geographic Enterprises 2009). Extensive windfarm development is projected in the grassland and coastal areas of Brazil, Uruguay and Argentina. As of 2018, the Global Wind Energy Council ranks Brazil as having the 8th largest wind power capacity in the world and the largest in South America, while Uruguay has the 3rd largest capacity in South America. In Brazil, ongoing windfarm development overlaps with important wintering areas for Buff-breasted Sandpipers, where flocks of 200 to 300 birds have been reported (J.B. Almeida, pers. comm. 2019).

IUCN-CMP Threat 7.1 Fire and fire suppression (Low Impact)

Buff-breasted Sandpipers seem to prefer grassland that has been recently burned (Penner et al. 2015). The species may have benefitted from indigenous people's practices of burning the grasslands in the Midwestern United States and on the wintering grounds (R.B. Lanctot pers. comm. 2019a). Current fire suppression allows woody vegetation to encroach into grasslands, reducing habitat availability (Brockway et al. 2002), particularly as this species prefers areas without nearby trees or other obstructions (Jorgensen et al. 2007). In the Kansas' Flint Hills, new management techniques are starting to use fire for prairie conservation. Fire suppression was deemed to have a low impact on Buff-breasted Sandpipers.

IUCN-CMP Threat 11.5 Severe weather events (Low Impact)

Because of climate change, severe storms are increasing, and this increase is linked to declines in songbirds, particularly those that migrate over the Atlantic, as they cannot seek shelter (Butler 2000). Buff-breasted Sandpipers' migration across the Gulf of Mexico may become increasingly perilous. Similarly, juvenile mortality may increase with storm number and severity. Unlike adults, juveniles often migrate along the Atlantic Coast (Lanctot et al. 2010) and are therefore more likely to encounter storms or hurricanes. On the breeding grounds, extreme weather may cause nest failure, but losses to nests and chicks have not yet been studied in detail (J. Rausch, pers. comm. 2019). Overall, the impact of severe weather events is likely low.

IUCN-CMP Threat 3.1 Oil and gas drilling (Low Impact)

Buff-breasted Sandpipers have been documented breeding in the National Petroleum Reserve, Kuparuk and Prudhoe Bay oil fields and the Arctic National Wildlife Refuge in Alaska, where oil and gas drilling is either already occurring or proposed (Lanctot et al. 2010). The infrastructure associated with arctic oil and gas projects (e.g. roads, runways, buildings) is usually built in the drier upland areas where Buff-breasted Sandpiper males display. Building in these areas may lead to habitat loss and disturbance during the breeding season, possibly causing females to abandon nests if they are repeatedly flushed, or to increased predator numbers due to the presence of artificial food sources.

Since 2007, oil drilling, particularly horizontal drilling and hydraulic fracturing (fracking) has increased across the prairies in both Canada and the United States (National Energy Board 2013). Horizontal drilling may reduce the amount of land affected by oil and gas development. Many grassland species avoid these sites and their surroundings to varying degrees (Thompson et al. 2015). On the wintering grounds, Colombian grasslands are seeing an increase in habitat loss due to drilling (C. Ruiz-Guerra, pers. comm. 2019). Given the limited extent of oil and gas development, their impact is likely low.

IUCN-CMP Threat 3.2 Mining and quarrying (Low Impact)

As with oil and gas drilling, infrastructure associated with arctic mines (e.g. roads, runways, buildings) is usually built on the drier upland areas where Buff-breasted

Sandpipers display and occasionally nest. There has been increased mining in Brazil on the wintering grounds (COSEWIC 2012), but biologists negotiated the movement of an 8,000-hectare mine project south of Lagoa do Peixe away from Buff-breasted Sandpiper habitats (Lanctot et al. 2010). Similar to oil and gas development, the limited footprint of mining and quarrying resulted in this threat's low impact score.

IUCN-CMP Threat 7.3 Other ecosystem modifications (Unknown Impact)

Buff-breasted Sandpipers may be exposed to a wide array of pesticides because they rely on agricultural habitat when migrating and during the winter (Strum et al. 2008, 2010). Although attractive to the Buff-breasted Sandpiper because of their physical characteristics, surrogate short-grass habitat with intensive pesticides use could represent ecological traps for the species from direct or indirect contamination (Lanctot et al. 2010). Direct effects of pesticides are discussed under "Description of Threats: 9.3 Agricultural and forestry effluents". Insect abundance is also likely lower on cropland that has been treated with insecticides, reducing food availability for insectivorous birds, including this species (Hart et al. 2006; Bellavance et al. 2018). Poor insect abundance in these areas may reduce survival because Buff-breasted Sandpipers rely heavily on those insects to provide energy for migration. The impact on the population is unknown.

IUCN-CMP Threat 9.3 Agricultural and forestry effluents (Unknown Impact)

The Buff-breasted Sandpiper may be exposed to pesticides during migration and the wintering period because they rely mainly on human-altered habitat (such as cropland, sod fields and golf courses) sprayed with pesticides. Carbamate insecticides like Furadan F4 have been linked to Buff-breasted Sandpiper mortality during migration (Flickinger et al. 1986; Lanctot et al. 2010). Buff-breasted Sandpipers wintering in rice fields and cattle pastures in Argentina and Uruguay have shown evidence of being exposed to contaminants that altered the birds' nervous system (Strum et al. 2010). Effects of the increasing use of neonicotinoid, the most widely used insecticide known to be highly detrimental for seed eating birds (Goulson 2013, Gibbons et al. 2015), remain undocumented for the Buff-breasted Sandpiper (McCarthy et al. 2017). Since 2016, Brazil has approved the usage of more than 1200 pesticides, many of which are banned elsewhere, which creates a concern of further negative effects on the species. Because of the species' habitat use, a large proportion of the Buff-breasted Sandpiper population might be exposed to pesticides and contaminants; however, population effects have not been quantified. The overall impact of agricultural contaminants on the Buff-breasted Sandpiper population is unknown, but likely is significant and in need of study.

IUCN-CMP Threat 2.1 Annual and perennial non-timber crops (Unknown Impact)

Most of the native, short-grass prairie historically used as stopover habitat has been converted to agricultural fields, resulting in a profound loss of natural stopover habitat. Short-grass prairies managed under cattle grazing provide suitable habitat for Buff-breasted Sandpipers, but those areas are increasingly converted to agricultural cropland. Conversion to agricultural cropland across Canada, the United States and Mexico is ongoing, driven by the need to feed growing human populations, demands for biofuel, and increasing crop irrigation in traditionally dry areas as electricity becomes

available (Meeting of the Canada/Mexico/United States Trilateral Committee for Wildlife and Ecosystem Conservation and Management 2019; Agenda item 24). Similar agricultural expansions are happening in South America in both migratory and wintering habitat. Farmers are converting traditional rangeland into cropland in fertile areas (Lanctot et al. 2010). Important migratory stopovers during northern migration in the savannahs of Los Llanos, Colombia (Lanctot et al. 2016) have rapidly been converted for palm oil and rice cultivation since 2000 (Romero-Ruiz et al. 2011). Illegal drainage canals to irrigate rice and drain areas for cultivation threaten Brazilian wintering habitat around coastal lagoons (Lanctot et al. 2010).

Because there is little unaltered short-grass habitat, Buff-breasted Sandpipers have adopted some types of croplands as alternative habitat during migration and over the winter. It is unclear whether agricultural areas are high-quality substitutes—there may simply be no natural habitat available. Some types of fields are preferable to others (e.g., soy is preferable to corn; Jorgensen et al. 2007). In Saskatchewan and Manitoba, two important staging areas during northern migration (Tibbitts et al. 2019), pasture land has decreased between 2011 and 2016 by 5% and 7%, respectively (Statistics Canada 2020). The increased agricultural production discussed above may provide habitat, depending on which crops are planted. Some agricultural practices, increasingly used for other conservation purposes, may be at odds with Buff-breasted Sandpiper conservation (e.g., no-till agriculture conserves soil and water but may reduce insect abundance in fields; Lanctot et al. 2010). No-till agriculture and monocultures, such as sod fields, require increased chemical application, discussed under *7.3 Other ecosystem modifications*. Since the conversion of native areas to cropland both destroys traditional habitat and creates an alternative—albeit likely inferior—habitat, the overall impacts of non-timber crops are unknown.

IUCN-CMP Threat 11.4 Changes in precipitation and hydrological regimes (Unknown Impact)

Conditions on the breeding ground may get drier as precipitation regimes shift, permafrost thaws, and drainage increases (Hinzman et al. 2005), which may change the insect prey available to Buff-breasted Sandpipers. Along the migratory route, more frequent severe droughts are predicted in the Great Plains, which will reduce wetland habitat (Johnson et al. 2005). These areas are currently used by Buff-breasted Sandpipers for resting and maintenance (McCarty et al. 2009). However, the large, shallow lakes in the Parkland regions of Alberta (such as Beaverhill Lake and North Cooking Lake) have been at extremely low water levels since the late 1990s (G. Court, pers. comm. 2020). Those historical staging areas for Buff-breasted Sandpipers are now used less frequently by the species (G. Court, pers. comm. 2020). Increasing precipitation in the wintering range may contribute to flooding and displacement (Nuñez et al. 2008). Important sites for the species, such as Asuncion Bay and Estancia Medaland, are regularly flooded, which temporarily reduces the amount of available habitat locally, yet overall effects on the wintering population are unknown (A. Lesterhuis, pers. comm. 2019). It is ultimately unknown how changing precipitation regimes will impact Buff-breasted Sandpiper populations.

IUCN-CMP Threat 1.3 Tourism and recreational areas (Unknown Impact)

Because this species prefers short grass habitat, birds use airports, golf courses, and other large landscaped areas during their migration as short-term resting sites (Lanctot et al. 2010; COSEWIC 2012; McCarty et al. 2017). These sites may represent poor habitat—golf courses use large amounts of pesticides, and airport managers harass birds to prevent bird strikes on planes (R.B. Lanctot pers. comm. 2019a). Those surrogate habitats may be attractive to the species, but could result in poor foraging conditions compared to natural habitat. The impact of tourism and recreation is unknown.

IUCN-CMP Threat 7.2 Dams & water management/use (Negligible Impact)

Ground water pumping and surface drainage can result in drier fields, reducing the suitability of short-grass habitat for Buff-breasted Sandpipers. Surface and ground water management is a common practice in agricultural fields to optimize crop production. Those practices likely influence the suitability of a large portion of the Buff-breasted Sandpiper's non-breeding range, given that the species relies almost exclusively on crops as stopover and wintering sites. The impact of dams and water management has been considered as negligible for the species. This impact score could be revised following further investigation on the permanent effects of drainage on the species' habitat.

IUCN-CMP Threat 1.1 Housing and urban areas (Negligible Impact)

While the North American prairies that the Buff-breasted Sandpiper historically relied on during migration have overwhelmingly been converted for agricultural use (Gauthier and Wiken 2003), housing and urban areas expansion has likely been negligible. Evidence from Nebraska suggests that while migrating the species prefers areas without obstructions, such as buildings, trees, and other structures associated with human settlements (Jorgensen et al. 2007). On the wintering grounds, the species is no longer found surrounding Buenos Aires, Argentina after heavy urban development and habitat destruction (Lanctot et al. 2002). The impact of this threat has been deemed negligible.

IUCN-CMP Threat 8.1 Invasive non-native/alien plants and animals (Negligible Impact)

Non-native plant species may spread into the remaining native grassland. This is particularly true given that the Prairie Farm Rehabilitation Administration's Community Pasture Program ended in 2012 and federally managed grassland was returned to the provinces by 2018, decreasing resources for pasture management in Canada. Fire suppression may also contribute to the spread of non-native plants that are not as fire-resistant as their native competitors (Brockway et al. 2002). Finally, grasslands on the wintering grounds are often modified by planting non-native grasses that can increase forage levels for livestock (R.B. Lanctot pers. comm. 2019b). It is unclear whether this modification will affect the use of the areas by Buff-breasted Sandpipers. On wintering grounds, feral pigs alter vegetation where the Buff-breasted Sandpiper occurs, but effects on the species have not been assessed. Despite the potential

negative effects, non-native species invasion poses a negligible threat to the Buff-breasted Sandpiper.

IUCN-CMP Threat 4.2 Utility and service lines (Negligible Impact)

Although there have been instances where Buff-breasted Sandpipers collide with powerlines, generally the species seems to coexist with powerlines without population-level impacts, so the impact has been deemed negligible (Lanctot et al. 2010).

IUCN-CMP Threat 5.1 Hunting and collection of terrestrial animals (Negligible Impact)

Though historically commercial hunting was prevalent in North America, Buff-breasted Sandpipers have been protected under the *Migratory Birds Convention Act* in Canada and the *Migratory Bird Treaty Act* in the United States since 1917 and 1918, respectively. The species is listed in Appendix I and II of the UN Convention on the Conservation of Migratory Species of Wild Animals, which prohibits hunting of the species in its wintering range. Presently, there is little risk of hunting throughout their range. Small amounts of legal and illegal shorebird harvesting do occur in parts of Latin America (the Guianas, the Caribbean, along the northern coast of South America, and potentially other areas) but these areas are not along the main migratory route (Wege et al. 2014). Currently, it is estimated that no more than 1371 +/- 282 Buff-breasted Sandpipers could be sustainably harvested annually (Watts et al. 2015). This level of hunting is unlikely to be occurring and hunting was deemed a negligible threat to the population.

IUCN-CMP Threat 11.1 Ecosystem encroachment (Outside of Assessment Timeframe)

Buff-breasted Sandpipers are expected to lose about 50% of their potential suitable breeding habitat by 2070 because of climate change (Wauchope et al. 2017). Warming is allowing shrub growth to expand northward across the tundra (Sturm et al. 2001). Melting permafrost may affect the shallow tundra wetlands, preferred for foraging. Coastal erosion has accelerated as the permafrost melts and there are more ice-free days with heavy wave action, even flooding some freshwater areas with saltwater (Jones et al. 2009). Rising sea levels may also flood breeding sites and salinize freshwater wetlands used for foraging (Lanctot et al. 2010). Buff-breasted Sandpipers have low breeding site fidelity and ample breeding habitat, providing them some flexibility in adjusting where they breed (Lanctot et al. 2016). Thus, the species may be able to cope with changes in the near term but may struggle if habitat becomes more limiting.

Additionally, in response to earlier spring thaws in the Arctic, the arthropods that shorebirds feed on are emerging earlier. Some other shorebirds are responding to these changes by breeding earlier. However, many species are no longer able to synchronize the hatching of their eggs with peak insect emergence (i.e., phenological mismatch is occurring; McKinnon et al. 2012; Tulp and Schekkerman 2008). It is unknown whether Buff-breasted Sandpipers are able to adjust to these changes.

Climate change is projected to shift the location of suitable migratory stopover habitat along the Midcontinental flyway (Wauchope et al. 2017).

Most Buff-breasted Sandpiper wintering habitat is coastal and could be flooded as a result of the projected rise in sea levels. The species may be forced to move inland to hillier, drier habitats or agricultural areas, which long-term suitability have not been assessed. While the impact of ecosystem encroachment was not calculated because these impacts are outside the timeframe of the threat assessment, rising sea levels on the wintering ground may pose the largest threat to the species.

IUCN-CMP Threat 2.2 Wood and pulp plantations (Outside of Assessment Timeframe)

In Brazil, and to a lesser extent Argentina, tree plantations may affect Buff-breasted Sandpipers wintering habitat. Ten percent of the grasslands in Rio Grande do Sul, Brazil have been converted to pine, eucalyptus, and acacias plantations (Gautreau and Vélez 2011), though much of this grassland is not coastal. These plantations are avoided by Buff-breasted Sandpipers (Dias et al. 2013). Pine plantations are particularly concerning because their seeds may disperse into adjacent grassland habitat, altering even greater areas than the plantations themselves, and ecological restoration is challenging (Simberloff et al. 2010; Lanctot et al. 2010). In fact, invasions of non-native pines into native habitat have already occurred around the world, resulting in varying degrees of habitat loss (Simberloff et al. 2010). This threat's impact is negligible to the species. This impact score could be revised following further investigation on the species' range overlap with tree plantation areas.

IUCN-CMP Threat 8.2 Problematic native plants and animals (Not a Threat)

Expanding Snow Goose (*Anser caerulescens*) populations cause habitat degradation in agricultural fields in Saskatchewan and to a lesser extent Manitoba and Alberta where geese grub for food on migratory staging grounds (Mowbray et al. 2000). Since Snow Geese stage in Saskatchewan earlier than the Buff-breasted Sandpiper in the spring and later in the fall, Snow Geese are not expected to impact Buff-breasted Sandpipers on migration (Mowbray et al. 2000; McCarty et al. 2017). Grubbing may even be beneficial if it exposes soil and invertebrates for Buff-breasted Sandpiper foraging (C. Artuso, pers. comm. 2019). In two studies performed on the breeding grounds, the presence of goose colonies were shown to increase predation risk to nesting shorebirds; however, Buff-breasted Sandpipers were not specifically included in these studies (Lamarre et al. 2017; Flemming et al. 2019).

Nest predators such as the Arctic Fox (*Vulpes lagopus*) and the Red Fox (*V. vulpes*), whose range's has expanded northward over the last decades (Stickney et al. 2014, Elmhagen et al. 2017), are expected to have a higher impact on nest survival through changes in distribution, increased densities, and adapted behavior (Kubelka et al. 2018). Oil and gas development is thought to increase the number of avian and mammalian predators due to the presence of artificial food sources and additional denning and nesting sites. However, according to two studies, there is no evidence that the infrastructure reduces nest survival of shorebirds as a group, although both studies included only a small number of Buff-breasted Sandpiper nests (10 and 3, respectively; Liebezeit et al. 2009; Bentzen et al. 2017). In general, predation risk has increased over the last 70 years in the Northern Hemisphere, especially in the Arctic (Kubelka

et al. 2018). Problematic native plants and animals are deemed not a threat to this species.

IUCN-CMP Threat 2.3 Livestock farming and ranching (Not a Threat)

Buff-breasted Sandpipers extensively use tame pastures during the winter and, to a lesser extent, during migration (Lanctot et al. 2004; Jorgensen et al. 2007; Isacch and Cardoni 2011; Aldabe et al. 2019). Tame pastures might provide similar amount of food as in natural grasslands if grazing conditions are similar, and therefore adequate wintering and stopover habitat. Pastures with suboptimal grazing conditions for the species might still be used, as those may simply be the dominant habitat in the area. Though this species prefers to forage in overgrazed areas, grazing to that intensity year-round might be detrimental to the soil (Lanctot et al. 2004; Aldabe et al. 2019) and can degrade the quality of the forage and increase erosion (Bement 1969, Cingolani et al. 2005). Instead, Buff-breasted Sandpipers may benefit from seasonal rotations in grazing intensity that maintain vegetation height from 2 to 5 cm while birds are present (Isacch and Cardoni 2011; Aldabe et al. 2019). In Canada, the Prairie Farm Rehabilitation Administration's Community Pasture Program ended in 2012, and federally managed grassland was returned to the provinces by 2018. This may lead to overgrazing, soil erosion, and damage in some areas where Buff-breasted Sandpipers stopover depending on how the areas are managed going forward. On the balance, livestock farming and ranching are not a threat to Buff-breasted Sandpipers.

5. Management Objective

The management objective for the Buff-breasted Sandpiper is to maintain the population size of the species over a period of 10 years ranging from 2025 to 2035 using new stopover sites estimates provided by 2025.

Accounts of historical population sizes are limited and the trend of the population is unknown. The species is difficult to survey given its sparse distribution on breeding grounds and the difficulty to detect individuals in the field. Surveys at key stopover areas currently provide the most reliable estimates of population size and will contribute in measuring progress towards the management objective. A tracking study revealed that the Flint Hills, located in Oklahoma and Kansas, and the Texas Gulf Coast are the two main stopover areas for the Buff-breasted Sandpiper in the U. S., the latter likely being the most important (Lanctot et al. 2016). From 2016 to 2019, the United States Fish and Wildlife Service (USFWS), the United States Geological Survey (USGS), and the University of Nebraska Omaha, working with citizen scientists, conducted spring ground surveys for the Buff-breasted Sandpiper on the Texas Gulf Coast. Those surveys will yield a more reliable population estimate[10] for the species, which should be available by 2026, and will provide a baseline for the long-term management objective.

[10] The current estimates did not take turnover rates into account, which are known to be relatively high (see *Population Size and Trends* in section 3.2). This could lead to an underestimation of the population count. New estimates are expected to be more reliable as specific effort was put in assessing turnover rates at the Texas stopover sites throught radio-tracking of individuals.

Progress towards meeting the management objective will be evaluated as new population estimates become available.

The Buff-breasted Sandpiper was designated as Special Concern because of ongoing threats related to habitat loss and degradation on the non-breeding grounds (COSEWIC 2012). Since hunting of the species was banned in North America in the early 1900s, its population has grown, but numbers remain much lower than they were before hunting began. The Buff-breasted Sandpiper population appears to be limited by the availability of habitat on migration and non-breeding areas. Hence, the long-term management objective will be achieved by ensuring a no net loss of suitable sites at the landscape level on migration and wintering grounds. Considering the extent of non-breeding habitat found outside Canada, achieving this goal will only be possible through strong collaboration with Canada's international partners.

The United States Conservation Plan for the Buff-breasted Sandpiper sets the goal to increase the population by more than 90% to at least 100,000 individuals (Lanctot et al. 2010). This goal aims to build resiliency in the population of the species to offset future threats (Lanctot et al. 2010). In contrast, this management plan's objective seeks to address the risk of the species to become endangered or threatened, which led COSEWIC to assign a Special Concern status to the Buff-breasted Sandpiper.

6. Broad Strategies and Conservation Measures

6.1. Actions Already Completed or Currently Underway

In Canada, there has been little conservation work specifically targeting the Buff-breasted Sandpiper. The following list is not exhaustive, but is meant to illustrate the main areas where work has been completed or is already underway, to give context to the broad strategies outlined in section 6.3. Actions completed or underway include the following:

- Broad-scale initiatives which benefit the conservation and management of the species:
  - The Buff-breasted Sandpiper is one of the focal species for the Americas Flyway Action Plan of the Arctic Migratory Birds Initiative (AMBI). This designation focuses efforts at understanding the factors limiting this species and ways to improve its conservation throughout the flyway (CAFF 2019).
  - The USFWS is leading work, with contribution from the Canadian Wildlife Service (CWS), to update the full life-cycle conservation plan for the Buff-breasted Sandpiper.
  - Many organizations and programs provide financial incentives to farmers and ranchers for conserving or restoring grassland and wetland habitats along the migratory route. Examples include the United States and Canada Joint Ventures, MultiSAR in Alberta, South of the Divide Conservation Action Program, the United States Department of Agriculture's Conservation Reserve Program, and the Sustainable Grazing Network in Mexico.

- Research identifying key breeding, stopover, and wintering locations using satellite and GPS tracking technology is ongoing. See section 3. Species Information.

- Conservation and management of the species in Canada:
  - Buff-breasted Sandpiper breeding habitat is conserved in the national parks, migratory bird sanctuaries, national wildlife areas of the Canadian Arctic, as well as through the Inuvialuit community conservation plans.
  - The Ahiak Migratory Bird Sanctuary Management Plan (2018) outlines a plan for the co-management of Buff-breasted Sandpipers and other species by Environment and Climate Change Canada (ECCC) and local Inuit in the sanctuary (ECCC 2018).
  - The Arctic PRISM, a joint effort between ECCC, the USGS, and the USFWS, has been surveying the Arctic for shorebirds from 2002 to 2018 to determine population sizes and trends, and clarify distribution and habitat usage of all species, including the Buff-breasted Sandpiper. At the time of developing this management plan, new estimates of population size and breeding distribution for the species are being carefully evaluated to ensure accuracy.
  - Land from the former Prairie Farm Rehabilitation Administration's Community Pasture Program had been returned by 2018 to provinces for management and is in large part still being managed for conservation by different groups in a way that benefits the Buff-breasted Sandpiper.

- Conservation and management of the species outside Canada:
  - Some of the identified key stopover sites have been designated as sites of importance by the WHSRN, including Rainwater Basin in Nebraska (2009) and the Flint Hills in Kansas and Oklahoma (2016) as sites of hemispheric importance, as well as Asuncion Bay in Paraguay (2008) and Barba Azul Nature Reserve in Bolivia (2015) as sites of regional importance.
  - Following habitat destruction from construction in Asuncion Bay (Paraguay) in 2010, the CWS and the United States' *Neotropical Migratory Birds Conservation Act* (NMBCA) have supported the local government in restoring habitat for Buff-breasted Sandpiper and other impacted shorebirds.
  - In 2018, a grant from NMBCA was awarded to fund the purchase of an additional 681 hectares of grassland and the management of 15,000 hectares of Buff-breasted Sandpiper habitat at the Barba Azul Nature Reserve, Bolivia (U.S. Fish and Wildlife Program 2018). Starting October 2019, the reserve will be experimenting with beneficial management practices for cattle ranching to create and maintain Buff-breasted Sandpiper staging habitat. Long-term monitoring of the species will also be conducted at the site (Asociación Armonía 2019).
  - The Southern Cone Grassland Alliance, supported in part by CWS, has helped guide the development of beneficial management practices for sustainable land-use in Argentina, Paraguay, Uruguay, and Brazil. Through this project, ranching practices were improved on 116,479 hectares of grasslands and other beneficial management practices implemented on 25,371 hectares (Rosenberg et al. 2016).

- Four sites of importance for the Buff-breasted Sandpiper on the wintering grounds have been designated under WHSRN, namely Lagoa do Peixe in Brazil (1990) and Bahía Samborombón in Argentina (2011) as sites of international importance, and Laguna de Rocha in Uruguay (2010) and Estancia Medaland in Argentina (2018) as sites of regional importance. These sites include both publicly and privately-owned land.
- Biologists in several countries within the Southern Cone Grassland Alliance have conducted surveys for Buff-breasted Sandpipers with the goal of providing a winter-based population estimate and trend for the species.

6.2. Broad Strategies

The broad strategies for the Buff-breasted Sandpiper have been developed to address the threats this species is facing across its range, primarily focusing on mitigating the most pressing threats and gathering the information needed to address the remaining threats. While renewable energy development received the highest impact score in the threat assessment and this impact score could rapidly increase, wintering and stopover habitat loss from a combination of factors (see section 4.2) remain the most immediate threat to the Buff-breasted Sandpiper. Strategies fall under the following broad categories[11]:

- Livelihood, Economic & Moral Incentives
- Conservation Designation & Planning
- Institutional Development
- Research and Monitoring

6.3. Conservation Measures

Table 3. Conservation Measures and Implementation Schedule

Conservation Measure	Priority[e]	Threats or Concerns Addressed	Timeline
Broad Strategy: Livelihood, Economic & Moral Incentives			
Market-based Incentives • Provide resources to landowners through stewardship programs to consider Buff-breasted Sandpiper habitat needs (such as short-grass, adequate soil moisture, and vital dry Arctic uplands in danger of flooding as sea levels rise) when managing their lands.	High	IUCN Threats 2.1, 2.3, 7.1, and 7.2	Ongoing

[11] The broad strategy categories follow the International Union for Conservation of Nature – Conservation Measures Partnership (IUCN-CMP) Conservation Actions Classification v 2.0 (http://cmp-openstandards.org/tools/threats-and-actions-taxonomies/),

Conservation Measure	Priority[e]	Threats or Concerns Addressed	Timeline
Better Products & Management Practices • Encourage the wind energy sector to develop, implement, and promote beneficial management practices to mitigate threats to the Buff-breasted Sandpiper and its habitats where the species is known to occur.	High	IUCN Threat 3.3	2021–2031
Better Products & Management Practices • Assist landowners to implement and promote beneficial management by providing or helping to develop written and digital resources to strengthen stewardship programs, which directly contribute to creating and maintaining Buff-breasted Sandpiper habitat and an appreciation of its value.	Moderate	IUCN Threats 2.1, 2.3, 7.1, and 7.2	2026–2036
Broad Strategy: Conservation Designation & Planning			
Protected Area Designation &/or Acquisition • Conserve habitat at key sites.	Moderate	IUCN Threats 2.1, 2.3, 3.1, 3.2 and 3.3	Ongoing
Broad Strategy: Institutional Development			
Alliance & Partnership Development • Develop new international partnerships for conservation and maintain existing ones.	High	All	Ongoing
Broad Strategy: Research and Monitoring			
Basic Research & Status Monitoring • Centralize data from past surveys and complete the analysis of tracking studies that identify sites with high densities of Buff-breasted Sandpipers.	High	Knowledge gap	2021–2026
Basic Research & Status Monitoring • Monitor the species at known and potential key sites during southbound and northbound migration; • Establish a list of key sites where at least 0.2% of the population (about 100 birds) occur regularly through time.	High	Knowledge gap	2021–2026
Basic Research & Status Monitoring • Develop a more reliable and accurate population estimate within the next 5 years	High	Knowledge gap	2021–2026

Conservation Measure	Priority[e]	Threats or Concerns Addressed	Timeline
Basic Research & Status Monitoring • Determine fine-scale landscape features that predict habitat usage both on breeding and non-breeding grounds	High	IUCN Threats 3.1, 3.2, 11.1, and 11.4	2021–2026
Basic Research & Status Monitoring • Identify the natural processes that created and maintained suitable habitats to develop land-use practices beneficial for the species	High	IUCN Threats 2.1, 2.3, 7.1, and 7.2	2021–2026
Basic Research & Status Monitoring • Continue to monitor the species and its habitat on the breeding ground as part of the Arctic PRISM survey.	High	Knowledge gap	2021–2031
Basic Research & Status Monitoring • Determine level of exposure of the species to pesticides and effects of those contaminants on survival, fitness and food availability.	Medium	IUCN Threats 7.3 and 9.3	2021–2026
Basic Research & Status Monitoring • Evaluate current and past population monitoring methods and identify the most appropriate methods to assess progress towards the management objective.	Medium	Knowledge gap	2021–2026
Basic Research & Status Monitoring • Determine the fall migration route, survival rates and potential threats to juveniles of the Buff-breasted Sandpiper population.	Low	Knowledge gap	2026–2031
Basic Research & Status Monitoring • Assess the severity of the effects of climate change on demographics and distribution	Low	Threats 11.1, 11.4, and 11.5	2026–2031

[e] "Priority" reflects the degree to which the measure contributes directly to the conservation of the species or is an essential precursor to a measure that contributes to the conservation of the species. High priority measures are considered those most likely to have an immediate and/or direct influence on attaining the management objective for the species. Medium priority measures may have a less immediate or less direct influence on reaching the management objective but are still important for the management of the population. Low priority conservation measures will likely have an indirect or gradual influence on reaching the management objective but are considered important contributions to the knowledge base and/or public involvement and acceptance of the species.

6.4. Narrative to Support Conservation Measures and Implementation Schedule

Institutional Development

Considering the extent of non-breeding habitat found outside Canada, implementing broad strategies that benefit the Buff-breasted Sandpiper will only be possible through strong collaboration with Canada's international partners. In addition, collaboration with the wind energy sector is required to mitigate threats to the species and its habitat at key sites.

As such, Canada and international partners created the Midcontinental Shorebird Conservation Initiative (MSCI), which aims to deliver full life-cycle conservation for the Buff-breasted Sandpiper and other species. The Buff-breasted Sandpiper is recognized as high conservation concern in many countries because it occupies several locations relevant to shorebird conservation that are prioritized as part of the MSCI.

Livelihood, Economic & Moral Incentives, and Conservation Designation & Planning

Wintering and stopover habitat used by the Buff-breasted Sandpiper is predominantly privately owned and used as agricultural cropland or pastureland, so the involvement of private landowners is critical. Stewardship programs can support and incentivize landowners to manage their land for short-grass habitat and shorebird conservation. Where appropriate and after consideration of a range of ecological targets, this may involve using livestock or fire to maintain short-grass habitat, as well as appropriate soil moisture in sod fields. Support could also be given to sod farm owners, where housing development exerts pressure on agricultural lands. Further research is need to determine if this type of habitat provides adequate conditions to support the recovery of Buff-breasted Sandpiper. Conservation managers and landowners of key migratory and wintering sites should be educated about Buff-breasted Sandpiper's unusual habitat requirements (shortgrass rather than the taller coastal wetland grasses preferred by most shorebirds and waterbirds) so that these requirements are not overlooked when implementing management practices for shorebirds more broadly.

Appropriate buffers and mitigation measures for renewable energy developments must be put in place in locations where there is high density of Buff-breasted Sandpiper. *Standards for monitoring nonbreeding shorebirds in the Western Hemisphere* (PRISM 2018) provide a comprehensive protocol for *ad hoc* assessments of habitat use by shorebirds.

Research and Monitoring

Buff-breasted Sandpipers should be monitored to determine habitat usage, population size and trends. By 2025, this monitoring effort should inform a more reliable and accurate baseline population size towards the management objective. Surveys on staging or wintering grounds may be more effective in determining population sizes and trends than arctic surveys because the species does not congregate in large numbers or show site fidelity on the breeding grounds. This is particularly important as population

trends have not been quantified. At the same time, arctic breeding ground surveys and GPS-tracking can provide important information about micro-scale habitat use, which is needed to identify areas sensitive to industrial development and to climate change. Arctic PRISM may provide some of this information as upland habitats are included in the surveys (COSEWIC 2012). Surveys along the migratory route and in the wintering grounds can provide similar information about habitat use during these stages.

Monitoring of habitat use and research on suitable habitat characteristics are key steps in shaping conservation actions for the species. By 2025, key wintering and migratory stopovers sites that cumulatively support 80% of the current population estimate of 56,000 individuals should be identified. Canada will collaborate with its international partners to work towards a no net loss of suitable habitat at those sites. Tracking Buff-breasted Sandpipers using technology such as isotopes, genetics, radio-telemetry, geolocators, and satellite telemetry provides a wealth of information, including the location of sites with high densities of the species. Once identified, high-density locations can be conserved and managed cooperatively with landowners. Much of the species monitoring work is already in progress, but the analysis of the data is ongoing (R.B. Lanctot pers. comm. 2019b). Additionally, to most effectively use this technology, the potential effects of geolocators and telemetry units on movement and survival must be assessed (identified as High priority by the ECCC Shorebird Technical Committee in 2016).

Various threats to the Buff-breasted Sandpiper require further investigation to understand their impact. The species' reliance on agricultural areas during the non-breeding period puts individuals at risk of pesticide contamination. While there has been some research into the effects of pesticides, multiple unknowns remain, such as the extent of exposure to various chemicals; the direct effects of those chemicals on the species, and; the indirect effects on the invertebrates eaten by the species.

Climate change may become one of the greatest threats facing this species but the severity of its current and projected effects on the Buff-breasted Sandpiper requires more research. As average temperatures increase in the Arctic, the northern limit of shrub vegetation is advancing into the Buff-breasted Sandpiper's breeding habitat. On the wintering grounds, habitat is expected to be lost from coastal erosion and rising sea levels. It is unclear whether the species is adjusting its breeding schedule to match earlier insect emergence in the Arctic. Along migration, habitat and weather patterns are expected to shift and it is unknown whether the species will adapt to these changes. The population-level effect of these threats is unknown. Some changes, like more frequent and severe storms, may have strong impacts on individual survival, but more study is needed to determine whether birds are able to survive such situations. During fall migration, juveniles following the Atlantic coast might be disproportionally vulnerable to increased frequency and severity of storms compared to adults who migrate inland. Overall, more research into the effects of climate change on Buff-breasted Sandpiper demographics and distribution is needed.

7. Measuring Progress

The performance indicators presented below provide a way to measure progress towards achieving the management objective and monitoring the implementation of the management plan.

- By 2026, a more accurate population estimate from stopover sites is available.
- By 2026, key wintering and migratory stopovers sites that cumulatively support 80% of the current population estimate are identified. Key sites are defined as areas where at least 0.2% of the population (about 100 birds) occur regularly through time.
- By 2036, the Buff-breasted Sandpiper population is maintained at the 2026 level detected from stopover surveys.

8. References

Aldabe, J., R.B. Lanctot, D. Blanco, P. Rocca, and P. Inchausti. 2019. Managing grasslands to maximize migratory shorebird use and livestock production. Rangeland Ecology and Management 72:150–159.

Almeida, J.B. 2009. Wintering ecology of Buff-breasted Sandpipers (*Tryngites subruficollis*) in southern Brazil. Ph.D. dissertation, University of Nevada, Reno, USA. 201 pp.

Almeida, J.B., pers. comm. 2019. Standardized threat assessment workshop. June 2019. Project Manager, BirdLife/SAVE Brasil, Sao Paulo, Brasil.

Andres, B.A., P.A. Smith, R.G. Morrison, C.L. Gratto-Trevor, S.C. Brown, and C.A. Friis. 2012. Population estimates of North American shorebirds, 2012. Wader Study Group Bulletin 119:178-194.

Artuso, C., pers. comm. 2019. In-person meeting. September 2019. Wildlife Biologist, Migratory Birds Conservation Unit, Environment and Climate Change Canada, Gatineau, Quebec.

Asociación Armonía. 2019. Barba Azul Nature Reserve Report: July 2019. 13 pp.

Bart, J., and P.A. Smith. 2012. Summary. Pp. 213–238 in J. Bart and V.H. Johnston (eds.). Arctic shorebirds in North America: a decade of monitoring. Studies in Avian Biology Monograph Series No. 44, University of California Press, Berkley, CA.

Bellavance, V., M. Bélisle, J. Savage, F. Pelletier, and D. Garant. 2018. Influence of agricultural intensification on prey availability and nestling diet in Tree Swallows (*Tachycineta bicolor*). Canadian Journal of Zoology 96(9): 1053-1065.

Bement, R. E. 1969. A stocking-rate guide for beef production on blue-grama range. Journal of Range Management 22:83-86.

Bentzen, R., S. Dinsmore, J. Liebezeit, M. Robards, B. Streever, and S. Zack. 2017. Assessing development impacts on Arctic nesting birds using real and artificial nests. Polar Biology 40(8):1527-1536.

BirdLife International. 2017. *Calidris subruficollis*. In: The IUCN Red List of Threatened Species 2018 [online]. Available at www.iucnredlist.org. (Accessed November 2019).

Brockway, D.G., R.G. Gatewood, and R.B. Paris. 2002. Restoring fire as an ecological process in shortgrass prairie ecosystems: Initial effects of prescribed burning during the dormant and growing seasons. Journal of Environmental Management 65:135–152.

Butler, R.W. 2000. Stormy seas for some North American songbirds: Are declines related to severe storms during migration? Auk 117:518–522.

CAFF. 2019. Arctic Migratory Birds Initiative (AMBI): Workplan 2019-2023. Page CAFF Strategies Series No. 30. Akureyi, Iceland. 56 pp.

Canadian Geographic Enterprises. 2009. Wind energy in Canada. Available at https://www.nrcan.gc.ca/energy/renewable-electricity/wind/7323 (Accessed May 2020).

Canadian Wind Energy Association. 2019. Wind energy in Canada. Data from December 2019. Available at https://canwea.ca/wind-energy/installed-capacity/ (Accessed May 2020).

Castresana, G., M. Lunardelli, P. Rojas, A. Fletcher, and D. Blanco. 2019. Habitat use of *Calidris subruficollis* in Samborombon bay, Argentina: Detection using GPS Argos Pinpoint tags. Buff-breasted Sandpiper Conservation Workshop.

Chesser, R.T., R.C. Banks, F.K. Barker, C. Cicero, J.L. Dunn, A.W. Kratter, I.J. Lovette, P.C. Rasmussen, J.V. Remsen Jr., J.D. Rising, D.F. Stotz, et al. 2013. Fifty-Fourth Supplement to the American Ornithologists' Union Check-list of North American Birds. The Auk 130(3). doi.org/10.1525/auk.2013.130.3.1.

Cingolani, A. M., I. Noy-Meir, and S. Diaz. 2005. Grazing effects on rangeland diversity: A synthesis of contemporary models. Ecological Applications 15:757-773.

COSEWIC. 2012. COSEWIC assessment and status report on the Buff-breasted Sandpiper Tryngites subruficollis in Canada. Ottawa. x + 44 pp.

Court, G., pers. comm. 2020. Email correspondence to M.-A. Cyr. February 2020. Provincial Wildlife Status Biologist, Government of Alberta, Edmonton, Alberta.

Dias, R.A., V.A.G. Bastazini, M.S.S Gonçalves, F.C. Bonow, and S.C. Müller. 2013. Shifts in composition of avian communities related to temperate-grassland afforestation in southeastern South America. Iheringia. Série Zoologia 103:12–19.

Donaldson, G.M., C. Hyslop, R.I.G. Morrison, and I. Davidson. 2000. Canadian Shorebird Conservation Plan. Canadian Wildlife Service. Ottawa, Ontario. i + 27 pp.

Dowdell E., and S. Patel. 2020. Canadian Renewable Energy Project Map. Edmonton, AB: Future Energy Systems, University of Alberta. Web site: https://www.futureenergysystems.ca/resources/renewable-energy-projects-canada# [accessed December 2020].

Elmhagen, B. et al. 2017. Homage to Hersteinsson and Macdonald: climate warming and resource subsidies cause red fox range expansion and Arctic fox decline. Polar Research 36:3.

Environment and Climate Change Canada. 2018. Ahiak (Queen Maud Gulf) Migratory Bird Sanctuary Management Plan [Proposed]. v + 65 pp.

Farmer, A., and F. Durbian. 2006. Estimating shorebird numbers at migration stopover sites. The Condor 108(4):792–807.

Flemming, S.A., P.A. Smith, J. Rausch, and E. Nol. 2019. Broad-scale changes in tundra-nesting bird abundance in response to hyperabundant geese. Ecosphere 10(7):e02785.

Flickinger, E.L., C.A. Mitchell, D.H. White, and E.J. Kolbe. 1986. Bird poisoning from misuse of the carbamate Furadan in a Texas rice field. Wildlife Society Bulletin 14:59–62.

Gauthier, D.A., and E.B. Wiken. 2003. Monitoring the conservation of grassland habitats, Prairie Ecozone, Canada. Environmental Monitoring and Assessment 88:343–364.

Gautreau, P., and E. Vélez. 2011. Strategies of environmental knowledge production facing land use changes: Insights from the Silvicultural Zoning Plan conflict in the Brazilian state of Rio Grande do Sul. Cybergeo: European Journal of Geography.

Gibbons, D., C. Morrissey, and P. Mineau. 2015. A review of the direct and indirect effects of neonicotinoids and fipronil on vertebrate wildlife. Environmental Science and Pollution Research 22:103-118.

Goulson, D. 2013. An overview of the environmental risks posed by neonicotinoid insecticides. Journal of Applied Ecology 50:977-987.

Hart, J.D., T.P. Milsom, G. FIsher, V. Wilkins, S.J. Moreby, A.W.A. Murray, and P.A. Robertson. 2006. The relationship between yellowhammer breeding performance, arthropod abundance and insecticide applications on arable farmland. Journal of Applied Ecology 43:81–91.

Hinzman, L.D. et al. 2005. Evidence and implications of recent climate change in northern Alaska and other arctic regions. Climatic Change 72:251–298.

Hope, D.D. et al. 2019. Shorebirds of conservation concern in Canada – 2019. Wader Study 126: in press.

Isacch, J.P., pers. comm. 2019. Email correspondence to M.-A. Cyr. December 2019. Researcher, Instituto de Investigaciones Marinas y Costeras, CONICET, Mar del Plata, Argentina.

Isacch J.P., and Cardoni D.A. 2011. Different grazing strategies are necessary to conserve endangered grassland birds in short and tall salty grasslands of the flooding Pampas. Condor 113: 724-734.

Isacch, J.P., C.A. Darrieu, and M.M. Martínez. 2005. Food abundance and dietary relationships among migratory shorebirds using grasslands during the non-breeding season. Waterbirds 28: 238-245.

Isacch, J.P., and M.M. Martínez. 2003a. Temporal variation in abundance and the population status of non-breeding Nearctic and Patagonian shorebirds in the flooding pampa grasslands of Argentina. Journal of Field Ornithology 74:233–242.

Isacch, J.P., and M.M. Martínez. 2003b. Habitat use by non-breeding shorebirds in flooding pampas grasslands of Argentina. Waterbirds 26:494–500.

Johnson, W.C., B.V. Millett, T. Gilmanov, R.A. Voldseth, G.R. Guntenspergen, and G.E. Naugle. 2005. Vulnerability of northern prairie wetlands to climate change. BioScience 55:863–872.

Johnston-González, R., C.J. Ruiz-Guerra, D. Eusse-González, L.F. Castillo-Cortés, Y. Cifuentes-Sarmiento, P. Falk-Fernández y V. Ramírez De Los Ríos. 2010. Plan de Conservación para aves Playeras en Colombia. Asociación Calidris, Cali, Colombia.

Jones, B.M., C.D. Arp, M.T. Jorgenson, K.M. Hinkel, J.A. Schmutz, and P.L. Flint. 2009. Increase in the rate and uniformity of coastline erosion in arctic Alaska. Geophysical Research Letters 36:L03503.

Jorgensen, J.G., J.P. Mccarty, and L.L. Wolfenbarger. 2007. Landscape and habitat variables affecting Buff-breasted Sandpiper *Tryngites subruficollis* distribution during migratory stopover in the Rainwater Basin, Nebraska, USA. Wader Study Group Bulletin 112:45–51.

Jorgensen, J.G., J.P. Mccarty, and L.L. Wolfenbarger. 2008. Buff-breasted Sandpiper density and numbers during migratory stopover in the Rainwater Basin, Nebraska. Condor 110:63-69.

Kubelka, V., M. Šálek, P. Tomkovich, Z. Végvári, R. P. Freckleton, and T. Székely. 2018. Global pattern of nest predation is disrupted by climate change in shorebirds. Science 362:680-683.

Lamarre, J. F., P. Legagneux, D. Gauthier, E. T. Reed, and J. Bêty. 2017. Predator-mediated negative effects of overabundant snow geese on arctic-nesting shorebirds. Ecosphere 8:e01788.

Lanctot, R.B., pers. comm. 2019a. Standardized threat assessment workshop. June 2019. Alaska Shorebird Coordinator, Migratory Bird Management, US Fish and Wildlife Service, Anchorage, Alaska.

Lanctot, R.B., pers. comm. 2019b. Email correspondence to A. Cox. September 2019. Alaska Shorebird Coordinator, Migratory Bird Management, US Fish and Wildlife Service, Anchorage, Alaska.

Lanctot, R.B., pers. comm. 2020. Email correspondence to M.-A. Cyr. October 2020. Alaska Shorebird Coordinator, Migratory Bird Management, US Fish and Wildlife Service, Anchorage, Alaska.

Lanctot, R.B., J. Aldabe, J.B. Almeida, D. Blanco, J.P. Isacch, J. Jorgensen, S. Norland, P. Rocca, and K.M. Strum. 2010. Conservation Plan for the Buff-breasted Sandpiper (*Tryngites subruficollis*), Version 1.1. Anchorage, AL, and Manomet, MA, USA.

Lanctot, R.B., D.E. Blanco, R.A. Dias, J.P Isacch, V.A. Gill, J.B. Almeida, K. Delhey, P.F. Petracci, G.A. Bencke, and R.A. Balbueno. 2002. Conservation status of the Buff-breasted Sandpiper: Historic and contemporary distribution and abundance in South America. Wilson Bulletin 114:44–72.

Lanctot, R.B., D.E. Blanco, M. Oesterheld, R.A. Balbueno, J.P. Guerschman, and G. Piñeiro. 2004. Assessing habitat availability and use by Buff-breasted Sandpipers (*Tryngites Subruficollis*) wintering in South America. Ornitologia Neotropical 15:367–376.

Lanctot, R.B., and P.J. Weatherhead. 1997. Ephemeral lekking behavior in the Buff-breasted Sandpiper, *Tryngites subruficollis*. Behavioral Ecology 8:268–278.

Lanctot, R.B, P.J. Weatherhead, B. Kempenaers, and K.T. Scribner. 1998. Male traits, mating tactics and reproductive success in the Buff-breasted Sandpiper,*Tryngites subruficollis*. Animal Behaviour 56:419–432.

Lanctot, R.B., S. Yezerinac, J. Aldabe, J.B. Almeida, G. Castresana, S. Brown, P. Rocca, S.T. Saalfeld, and J.W. Fox. 2016. Light-level geolocation reveals migration patterns of the Buff-breasted Sandpiper. Wader Study 123:29–43.

Lappo, E.G., P.S. Tomkovich, and E. Syroechkovskiy. 2012. Atlas of breeding waders in the Russian Arctic. UF Ofsetnaya Pechat: Moscow, Russia. 448 pp.

Lesterhuis, A.J., pers. comm. 2019. Email correspondence to M.-A. Cyr. January 2020. Conservation Specialist, Western Hemisphere Shorebird Reserve Network (WHSRN) Executive Office, Manomet, Asuncion, Paraguay.

Liebezeit, J.R. et al. 2009. Influence of human development and predators on nest survival of tundra birds, Arctic Coastal Plain, Alaska. Ecological Applications 19:1628–1644.

Lounsberry, Z.T., J.D. Almeida, T. Grace, R.B. Lanctot, J. Liebezeit, B.K. Sandercock, K.M. Strum, S. Zack, and S.M. Wisely. 2013. Range-wide conservation genetics of Buff-breasted Sandpipers (*Tryngites subruficollis*). Auk 130:429–439.

Lounsberry, Z.T., J.B. Almeida, R.B. Lanctot, J.R. Liebezeit, B.K. Sandercock, K.M. Strum, S. Zack, and S.M. Wisely. 2014. Museum collections reveal that Buff-breasted Sandpipers (*Calidris subruficollis)* maintained mtDNA variability despite large population declines during the past 135 years. Conservation Genetics 15:1197–1208.

Lyons, J.E., pers. comm. 2020. Email correspondence to M.-A. Cyr. December 2020. Research Ecologist, Patuxent Wildlife Research Center, United States Geological Survey, Laurel, Maryland.

Lyons, J.E., B.A. Andres, and F.F. Rivera-Milán. 2016. Modeling Abundance of Buff-breasted Sandpipers in the Flint Hills Ecoregion using Hierarchical Distance Sampling. Unpublished Report.

Lyons, J.E., B.A. Andres, R.L. Penner, K. Stone, and L. Wolfenbarger. 2019. Migration of Buff-breasted Sandpipers at two key regions in Central North America: Stopover in the Gulf of Mexico and Flint Hills ecoregions. Buff-breasted Sandpiper Conservation Workshop. October 23, 2019. Panama City, Panama.

Martínez-Curci N, Loredo A, Isacch J.P., Pretelli M, Cavalli M, García G, Chiaradia N. 2018. Relevamiento de la abundancia y distribución de aves playeras realizado para evaluar la importancia de la Estancia Medaland (Pdo. de General Madariaga) en el contexto de la Red Hemisférica de Reservas de Aves Playeras. Report to Manomet Center for Conservation Sciences – Western Hemisphere Shorebird Reserve Network. 18 pp.

McCarty, J., J. Jorgensen, J. Michaud, and L. Wolfenbarger. 2015. Buff-breasted Sandpiper stopover duration in the Rainwater Basin, Nebraska, in relation to the temporal and spatial migration patterns in the Great Plains of North America. Wader Study 122:243–254.

McCarty, J.P., J.G. Jorgensen, and L.L. Wolfenbarger. 2009. Behavior of Buff-breasted Sandpipers (*Tryngites subruficollis*) during migratory stopover in agricultural fields. PLoS ONE 4:e8000.

McCarty, J.P., L.L. Wolfenbarger, C.D. Laredo, P. Pyle, and R.B. Lanctot. 2017. Buff-breasted Sandpiper (*Calidris subruficollis*), version 2.0. Pp. in P. G. Rodewall (ed.). Birds of North America. Cornell Lab of Ornithology, Ithaca, NY, USA.

McCarty, J.P., L.L. Wolfenbarger, C.D. Laredo, P.Pyle, and R.B. Lanctot. 2020. Buff-breasted Sandpiper (Calidris subruficollis), version 1.0. Pp. in P. G. Rodewald (ed.). Birds of the World. Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.bubsan.01

McKinnon, L., M. Picotin, E. Bolduc, C. Juillet, and J. Bêty. 2012. Timing of breeding, peak food availability, and effects of mismatch on chick growth in birds nesting in the High Arctic. Canadian Journal of Zoology 90:961–971.

Ministerio de Ambiente y Desarrollo Sostenible. 2019. Listado de especies protegidas de la vida silvestre amenazada de extinción. Resolución 254/19 del Gobierno Nacional. República del Paraguay.

Morrison, R.I.G., B.J. McCaffery, R.E. Gill, S. Skagen, S.L. Jones, G.W. Page, C.L. Gratto-Trevor, and B.A. Andres. 2006. Population estimates of North America shorebirds, 2006.Wader Study Group Bulletin 111:67–85.

Mowbray, T.B., F. Cooke, and B. Ganter. 2000. Snow Goose (*Anser caerulescens*), version 2.0. Pp. in P. G. Rodewall (ed.). Birds of North America. Cornell Lab of Ornithology, Ithaca, NY, USA.

Myers, J.P. 1980. Territoriality and flocking by Buff-breasted Sandpipers: Variations in non-breeding dispersion. Condor 82:241-250.

National Energy Board. 2013. Canada's Energy Future 2013 - Energy supply and demand projections to 2035 - An Energy Market Assessment. x + 87 pp.

NatureServe. 2019. NatureServe Explorer: An online encyclopedia of life, version 7.1 [online]. NatureServe, Arlington, Virginia. Available at: http://explorer.natureserve.org. (Accessed September 16, 2019).

Nuñez, M.N., H.H. Ciapessoni, A. Rolla, E. Kalnay, and M. Cai. 2008. Impact of land use and precipitation changes on surface temperature trends in Argentina. Journal of Geophysical Research 113:D06111.

Penner, R. L., B. A. Andres, J. E. Lyons and E. A. Young. 2015. Spring surveys (2011-2014) for American Golden-Plovers (Pluvialis dominica), Upland Sandpipers (Bartramia longicauda), and Buff-breasted Sandpipers (Calidris subruficollis) in the Flint Hills. Kansas Ornithological Society Bulletin 66: 37–52.

Pitelka, F. A., R. T. Holmes and S. F. Jr. MacLean. 1974. Ecology and evolution of social organization in arctic sandpipers. American Zoologist 14:185-204.

Prevett J.P., and J.F. Barr. 1976. Lek behavior of the Buff-breasted Sandpiper. Wilson Bulletin 88:500–503.

Program for Regional and International Shorebird Monitoring (PRISM). 2018. Standards for Monitoring Nonbreeding Shorebirds in the Western Hemisphere. Unpublished report, Program for Regional and International Shorebird Monitoring (PRISM). Available at: https://www.shorebirdplan.org/science/program-for-regional-and-international-shorebird-monitoring/. (Accessed December 20, 2019).

Pruett-Jones, S.G. 1988. Lekking versus solitary display: temporal variations in dispersion in the Buff-breasted Sandpiper. Animal Behaviour 36:1740–1752.

Rausch, J., pers. comm. 2019. Standardized threat assessment workshop. June 2019. Shorebird Biologist, Wildlife Habitat and Assessment, Environment and Climate Change Canada, Yellowknife, Northwest Territories.

Romero-Ruiz, M.H., S.G.A. Flantua, K. Tansey, and J.C. Berrio. 2011. Landscape transformations in savannas of northern South America: Land use/cover changes since 1987 in the Llanos Orientales of Colombia. Applied Geography 32:766–776.

Rosenberg, K.V. et al. 2016. 2016 Revision for Canada and Continental United States. Partners in Flight. 119 pp.

Ruiz-Guerra, C., pers. comm. 2019. Standardized threat assessment workshop. June 2019. Biologist, Asociación Calidris, Cali, Colombia.

Salafsky, N., D. Salzer, A.J. Stattersfield, C. Hilton-Taylor, R. Neugarten, S.H.M. Butchart, B. Collen, N. Cox, L.L. Master, S. O'Connor, and D. Wilkie. 2008. A standard lexicon for biodiversity conservation: unified classifications of threats and actions. Conservation Biology 22:897–911.

Simberloff, D. et al. 2010. Spread and impact of introduced conifers in South America: Lessons from other southern hemisphere regions. Austral Ecology 35:489–504.

Smith, P.A., pers. comm. 2020. Email correspondence to M.-A. Cyr. December 2020. Research Scientist, National Wildlife Research Centre, Environment and Climate Change Canada, Ottawa, Ontario.

Statistics Canada. 2017. Table 25-10-0022-01 Installed plants, annual generating capacity by type of electricity generation. Ottawa, QC. Available from https://doi.org/10.25318/2510002201-eng.

Statistics Canada. 2020. Table 32-10-0406-01 Land Use. Ottawa, QC. Available from https://doi.org/10.25318/3210040601-eng.

Stickney, A. A., T. Obritschkewitsch, R. M. Burgess, and N. Giguère. 2014. Shifts in fox den occupancy in the greater Prudhoe Bay area, Alaska. Arctic 67:196-202.

Stone, K.L., L.L. Wolfenbarger, J.E. Lyons, and K.L. Kruse. 2019. Buff-breasted Sandpiper habitat use during spring migration along the Gulf Coast of Texas and Louisiana, United States. Buff-breasted Sandpiper Conservation Workshop.

Strum, K.M. et al. 2008. Plasma cholinesterases for monitoring pesticide exposure in nearctic-neotropical migratory shorebirds. Ornitologia Neotropical 19:641–651.

Strum, K.M., M.J. Hooper, K.A. Johnson, R.B. Lanctot, M.E. Zaccagnini, and B.K. Sandercock. 2010. Exposure of nonbreeding migratory shorebirds to cholinesterase-inhibiting contaminants in the western hemisphere. Condor 112:15–28.

Sturm, M., C. Racine, and K. Tape. 2001. Increasing shrub abundance in the arctic. Nature 411:546–547.

Sutton, G.M. 1967. Behaviour of the Buff-breasted Sandpiper at the nest. Arctic 20:2–7.

Thompson, S.J., D.H. Johnson, N.D. Niemuth, and C.A. Ribic. 2015. Avoidance of unconventional oil wells and roads exacerbates habitat loss for grassland birds in the North American great plains. Biological Conservation 192:82–90.

Tibbitts, L., R. Lanctot, J. Aldabe, J. Almeida, G. Castresana, R. McGuire, B. Ortego, S. Saalfeld, and K. Stone. 2019. Year-round satellite tracking of Buff-breasted Sandpipers identifies important sites for this species of conservation concern. Buff-breasted Sandpiper Conservation Workshop.

Tulp, I., and H. Schekkerman. 2008. Has prey availability for Arctic birds advanced with climate change? Hindcasting the abundance of tundra arthropods using weather and seasonal variation. Arctic 61:48–60.

U.S. Energy Information Administration. 2019. Electric Power Monthly with Data for May 2019. Washington, D.C.

U.S. Fish and Wildlife Program. 2018. Neotropical Migratory Bird Conservation Act Approved Grants 2018. 19 pp.

U.S. Shorebird Conservation Plan Partnership. 2016. U.S. Shorebirds of Conservation Concern – 2016. Available from http://www.shorebirdplan.org/science/assessment-conservation-status-shorebirds/.

Watts, B.D., E.T. Reed, and C. Turrin. 2015. Estimating sustainable mortality limits for shorebirds using the Western Atlantic Flyway. Wader Study 122:37–53.

Wauchope, H.S., J.D. Shaw, Ø. Varpe, E.G. Lappo, D. Boertmann, R.B. Lanctot, and R.A. Fuller. 2017. Rapid climate-driven loss of breeding habitat for arctic migratory birds. Global Change Biology 23:1085–1094.

Wege, D.C., W. Burke, and E.T. Reed. 2014. Migratory shorebirds in Barbados :hunting, management and conservation. 26 pp.

Appendix A: Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[12]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[13] (FSDS) goals and targets.

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

The Buff-breasted Sandpiper is an arctic shorebird, breeding in the coastal uplands and relying on short-grass habitat on migratory stopover sites and wintering grounds. Conservation measures aiming to preserve short-grass habitats and manage pasturelands for Buff-breasted Sandpipers are expected to provide habitat for other shorebirds migrating and wintering with them, including but not limited to the Semipalmated Plover (*Charadrius semipalmatus*), Baird's Sandpiper (*Calidris bairdii*), American Golden-Plover (*Pluvialis dominica*), Pectoral Sandpiper (*Calidris melanotos*), and Upland Sandpiper (*Bartramia longicauda*). On the breeding ground, other species also nest in the upland coastal habitat including Black-bellied Plover (*Pluvialis squatarola*) and American Golden-Plover so conservation measures on the breeding ground (e.g., managing development, climate action) may be of broad benefit.

[12] www.canada.ca/en/impact-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html
[13] www.fsds-sfdd.ca/en#/en/goals/

Appendix B: Summary of Buff-breasted Sandpiper Population Estimates

Life Cycle Stage	Location	Year	Estimation (thousands)	Scope	Particularities	Reference
Spring migration	Rainwater Basin	2004–2005	56 (35–78, 95%CI)	Global	- Stopover duration (2 days) not considered; possible high underestimation - Assumes that all individuals stop there but they don't; possible underestimation	Jorgensen et al. 2008; Lanctot et al. 2010; McCarty et al. 2015.
Spring Migration	Flint Hills ecoregion	2014	20.7 (11.7–35,4, 95%CI)	Surveyed area	- Surveys performed from a moving vehicle - Stopover duration not considered; possible high underestimation	Lyons et al. 2016.
Spring Migration	Flint Hills ecoregion	2015	12.7 (5–28.9, 95%CI)	Surveyed area	- Difference with 2014 could be that fewer birds stopped in the study area or could be due to timing of surveys	Lyons et al. 2016.
Spring migration	Coastal Texas	2016–2019	Not yet available	Global	- Stopover duration obtained through tagging data and considered for estimation	J.E. Lyons, pers.comm, 2020; Lanctot et al. 2016.
Breeding grounds	Canadian Arctic	2010–2017	550 (293–719, 85%CI) (358–654, 95%CI)	Canada	- Currently being reviewed to evaluate accuracy - Effects of deviation from random site selection unknown; possible positive bias - Small sample size in marginal habitats; possible unstable estimates - Many of the PRISM estimates are much higher than estimates based on summed winter counts, because for widely dispersed species, there are always birds wintering in low numbers in areas that aren't surveyed	P.A. Smith, pers. comm. 2020; CWS, unpublished data.
Breeding grounds	Arctic Alaska	1997–2007	42.5 (5.8–79, 95%CI)	Surveyed area	- Estimation based on only 60 observations; high uncertainty	Andres et al. 2012; McCarty et al. 2020; Bart and Smith 2020.

Life Cycle Stage	Location	Year	Estimation (thousands)	Scope	Particularities	Reference
Wintering grounds	Argentina, Uruguay, Brazil	1999 & 2001	None provided but could be 100–200	Global	- Not provided for statistical reasons associated with the use of unsupervised satellite image classification	R.B. Lanctot, pers. comm. 2020; Lanctot et al. 2004.
Wintering grounds	South America	-	Less than 50	Global	- Most likely missing important wintering sites or birds too dispersed	A.J. Lesterhuis, pers. comm. 2019.

1342