CONSERVATION PLAN FOR THE BUFF-BREASTED SANDPIPER (*TRYNGITES SUBRUFICOLLIS*)

Version 1.1

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NOTE about Version 1.1:

The only difference between Version 1.1 (February 2010) and Version 1.0 (December 2009) is the addition of a Spanish executive summary.

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Front Cover Photo:

Buff-breasted Sandpiper (*Tryngites subruficollis*) performing a double wing-wave at a tundra lek site in the Prudhoe Bay Oil Field, Alaska, USA. This behavior is used by males to attract females and is a pre-cursor to copulation. Photo by Kevin Karlson.

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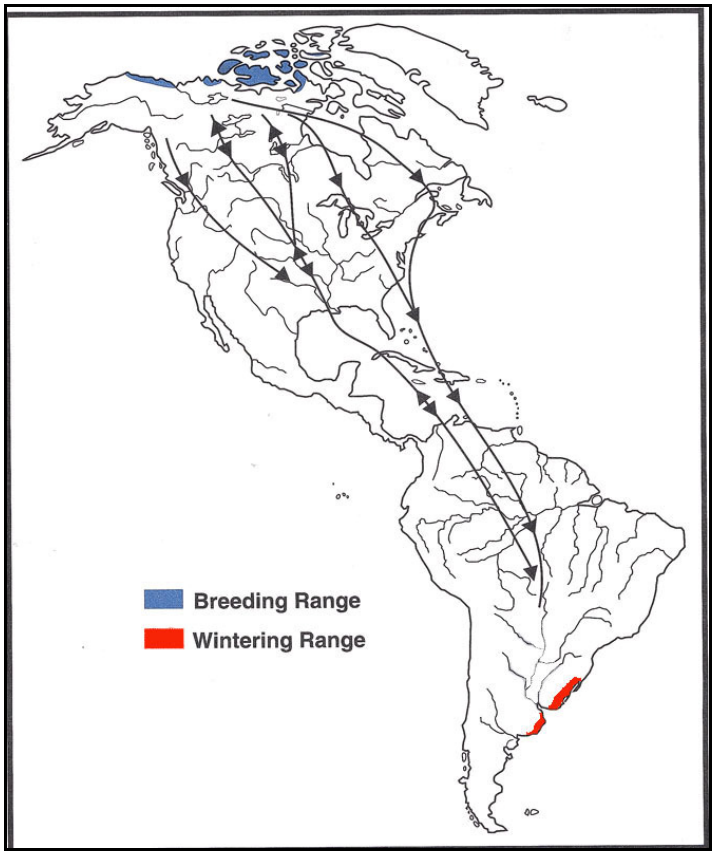
EXECUTIVE SUMMARY

The Buff-breasted Sandpiper (*Tryngites subruficollis*) is a medium-size shorebird that breeds sporadically (both temporally and spatially) along Arctic coasts in Russia, Alaska, and Canada (Lanctot and Laredo 1994). It spends the nonbreeding (wintering) season in South America on the pampas of Argentina, Uruguay, and Brazil where individuals frequent heavily grazed grasslands adjacent to wetlands. Northbound migration proceeds through central South America, across the Gulf of Mexico, and through the central United States and Canada before the birds reach the Arctic coast. Southbound migration follows a similar route, but over a much broader front with juveniles frequently seen on the Atlantic coast of North America. Much smaller numbers of birds are also seen along the Pacific coast of North America and in Western Europe (mainly Ireland and England).



Map 1. Buff-breasted Sandpiper migration routes and the location of breeding and nonbreeding (wintering) ranges. Source: R. Lanctot (modification of Birds of North America range map).

Buff-breasted Sandpipers are unique among North American shorebirds in having a lek mating system. Males defend relatively small territories (e.g., males flying vertically next to each other in photo at right) that are used to attract females (see wing display in photo below) for mating, but provide no resources for raising offspring. Females select a mate then leave to nest and raise the chicks elsewhere (Pruett-Jones 1988, Lanctot and Weatherhead 1997; Lanctot *et al*. 1997, 1998).


Ted Swem


Pavel Tomkovich

Once abundant, the population decreased substantially due to commercial harvests in the late 1800s and to loss of habitat along its migratory route in the central United States and its nonbreeding grounds in South America (Lanctot and Laredo 1994). The extreme approachability of the Buff-breasted Sandpiper and its tendency to return to a wounded flock member made this species especially vulnerable to mass shooting. Recent surveys on breeding, migration, and nonbreeding grounds suggest this species may still be declining, although more study is needed to accurately determine the actual population size and trend.

In 1999, the Buff-breasted Sandpiper was added to Appendix I and II of the Convention on the Conservation of Migratory Species of Wild Animals (http://www.cms.int/pdf/en/CMS1_Species_5lng.pdf) at the request of Argentina. The species is also categorized as Near Threatened by IUCN/BirdLife International, as a Bird of Conservation Concern by the U.S. Fish and Wildlife Service, as a Red species in the 2007 Audubon Watchlist, as a Highly Imperiled global species in the U.S. Shorebird Conservation Plan (2004), and as a species of High Concern in the Canadian Shorebird Conservation Plan (Donaldson *et al.* 2001). The species is also a high-priority bird in Argentina, Brazil, Paraguay, and Uruguay. Factors that led to these designations were a small and declining population, and a

relatively small nonbreeding area within which birds concentrate (CMS-UNEP 1999, Brown *et al.* 2001, Lanctot *et al.* 2002). These certifications mandate the study, management, and conservation of the species.

Unlike many other shorebird species, Buff-breasted Sandpipers rarely aggregate in large numbers during any part of their annual cycle (although flocks of hundreds to the low thousands of birds have been reported regularly along the Texas coast in recent years, likely due to an extended drought in the area). There are noteworthy locations, however, where the species can be found dependably. Few of these sites are protected. Most survey work for the species has been conducted during migration (Jorgensen *et al.* 2008; W. Norling, unpubl. data) and during the nonbreeding season in Argentina, Brazil, and Uruguay (Blanco *et al.* 1993, Lanctot *et al.* 2002; Isacch and Martínez 2003a,b; Isacch *et al.* 2005, Almeida 2009, Isacch and Cardoni 2009; D. Blanco and J. Aldabe, unpubl. data). Population estimates have also been made for coastal areas of Alaska within the Arctic PRISM (Program for Regional and International Monitoring) (Brown *et al.* 2007; J. Bart and P. Smith, unpubl. data). Recent work has focused on pesticide and herbicide contaminant exposure during migration and on nonbreeding grounds (Strum *et al.* 2008, 2010), site fidelity, movements, use of rice fields, and pasture management effects on the species during the nonbreeding season (Almeida 2009; D. Blanco and J. Aldabe, unpubl. data).

Based on recent survey work on migration sites in North America, we suggest revising the estimated population size of Buff-breasted Sandpipers from 30,000 (Morrison *et al.* 2006) to 56,000 individuals (range of 35,000 to 78,000). It is important to recognize that there is large uncertainty in this estimate, and we hope that colleagues consider using the range as opposed to the mean for the population estimate of this species. Further, all available evidence suggests the species is declining, thus there is still a need to be concerned about the status of this species.

We define key conservation sites as areas where at least 0.2% of the population (about 100 birds) occur regularly through time. Because the species rarely, if ever, occurs at these levels on the breeding grounds, we have indentified important breeding areas based on the abundance of the species at a landscape level. These include the 1002 Area of the Arctic National Wildlife Refuge (especially the Canning River corridor), and the Prudhoe Bay/Kuparuk oil field production areas (especially the Kuparuk, Sagavanirktok, and smaller river corridors) of Alaska, as well as Creswell Bay on Somerset Island and Banks Island in Canada. The limited number of

important sites on the breeding grounds is most likely a reflection of poor data availability rather than the absence of important sites.

Important northbound migratory sites include landscape-level sites such as the Eastern Rainwater Basin of Nebraska and the Coastal Prairie Ecoregion of Texas and Louisiana. The data available suggest human-altered habitats, especially newly planted fields of rice, soybeans, corn, and wheat, as well as sod farms, are used heavily by this species. It is unclear, however, whether Buff-breasted Sandpipers prefer to use these habitats or are forced to because their natural habitats are no longer available. Regardless, few of these sites have any protective status. Important southbound migratory sites include landscape-level sites such as the Coastal Prairie Ecoregion of Texas, as well as smaller sites such as select counties in Kansas and Oklahoma, the Beni Savanna in Bolivia, and Bahía de Asunción in Paraguay. Like the northbound migration sites, many of the preferred areas have been altered by humans and have no protective status. We are certain that important north- and southbound migration stopover sites are present in northern South America but they have yet to be identified.

Important nonbreeding sites include Estancia Medaland and southern Bahía Samborombón of Argentina; Ilha da Torotama and Lagoa do Peixe National Park in Brazil; and Laguna de Rocha and Laguna de Castillos in Uruguay. These sites have had temporally repeated observations of large numbers of birds.

Conservation threats faced by the species vary throughout the annual cycle. On the breeding grounds, habitat is being lost or degraded due to energy production and climate change. Climate change may also be affecting demographic parameters but the overall effects are unclear. Negative effects on Buff-breasted Sandpiper productivity may occur due to the decoupling of the apparent synchrony between the breeding chronology of the birds and food availability. Alternatively, climate change could lengthen the growing season, providing flexibility for birds to initiate or replace lost clutches (although this may be more common in Calidrids that do not have a lek mating system), as well as promote survival of chicks – enhancements that could provide an overall positive or neutral effect. During migration, Buff-breasted Sandpipers may be negatively impacted from wind field installations in the Great Plains/Midwest of the central United States and in coastal portions of the Gulf of Mexico; native grasslands that are managed for medium to tall vegetation; reduction in the size of intact grassland units; and the conversion of native grasslands or pastures to agriculture and other

human development. Agricultural conversion could lead to altered prey availability and increased exposure to pesticides and herbicides. However, little to no quantitative data are available to suggest birds using human-altered habitats have altered migration abilities, lower survival rates, or any other measurable demographic trait. Climate change may also affect the species during migration by increasing the severity of storms over the western Atlantic that could directly impact survival rates of juveniles, which predominately use this pathway during southbound migration. On the nonbreeding range, Buff-breasted Sandpipers are threatened by conversion of historic grasslands into agriculture, wood plantations, mines, and tourist locations. Pastures are also being "improved" by ranchers planting exotic vegetation with a different vegetation structure that appears to be less preferred. Such improvements frequently involve applications of fertilizer and other contaminants that may negatively affect the species. Buff-breasted Sandpipers are also vulnerable to changes in ranch management that reduce grazing levels and result in pastures with tall vegetation. Finally, climate change may result in sea-level rise and greater precipitation, which will inundate the many low-lying areas used by the species during the nonbreeding season.

We have identified high, medium, and ongoing priority action items that should be implemented at various scales: range-wide, breeding, migration, and nonbreeding. We list a few action items under each category below:

RANGE-WIDE

High-priority action items include documenting migratory connectivity and other aspects of the species's population biology using geolocators, molecular markers, and stable isotopes; protecting key conservation areas by developing partnerships and providing incentives to private landowners and stewards of public lands; and updating the Birds of North America species account. Ongoing priorities include strengthening mechanisms of cooperation and communication among interested parties across the species's range; and informing policy makers, managers, and landowners about the unique habitat requirements of the species. Medium-priority action items include assessing impacts of climate change on the species's habitat and migration abilities and documenting the presence of diseases.

BREEDING

High-priority action items include supporting broad-scale and focused surveys to better delineate the species's range and key conservation sites. Ongoing priorities include providing guidance to industry and environmental consultants to minimize impacts of any development. Finally, medium-priority action items include developing a habitat-selection model that can be used to predict breeding locations.

MIGRATION

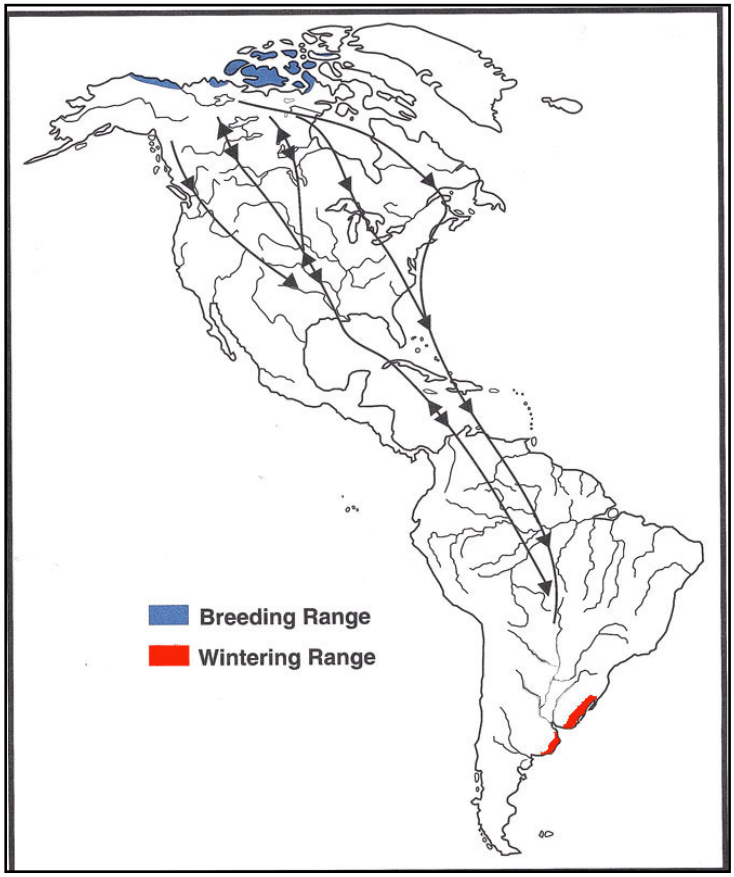
High-priority action items include establishing a long-term, statistically sound, monitoring program in the eastern Rainwater Basin and the Gulf Coastal Plain; assessing the species's compatibility with human-altered habitats; and investigating the effects of contaminants to the species. Ongoing priority action items include creating partnerships to better prioritize management actions that will be beneficial for the species; and updating existing databases on the species to detect changes in distribution and relative abundance. Medium-priority action items include assessing use of lesser known stopover sites in northern North America and southern and central South America; and constructing a migration model that summarizes the species's decision-making process during migration.

NONBREEDING

High-priority action items include conducting long-term demographic studies at key sites; supporting existing and establishing new statistically sound monitoring efforts; conducting detailed ecotoxicology studies; and investigating pasture use and impacts of various management actions on the species. Ongoing priorities include creating partnerships to better prioritize management actions and set habitat goals to sustain Buff-breasted Sandpipers. Medium-priority action items include using remote sensing technology to identify suitable habitat and then extrapolating density estimates over this area, and assessing use of secondary nonbreeding locations.

RESUMEN EJECUTIVO

El *Tryngites subruficollis* es un ave playera de mediano tamaño que se reproduce de manera esporádica (tanto temporal y espacialmente) en las costas árticas de Rusia, Alaska, y Canadá (Lanctot y Laredo 1994). Pasa la temporada no reproductiva (invierno) en Suramérica en la pampas de Argentina, Uruguay, y Brasil donde los individuos visitan las praderas pacidas adyacentes a los humedales. La ruta de migración hacia el norte es a través Suramérica central, a través del Golfo de México, y a través del centro de los Estados Unidos y Canadá antes de llegar a las aves a la costa del Ártico. La migración hacia el sur sigue una ruta similar, pero en un frente más amplio, con los juveniles vistos en la costa Atlántica de Norte América. En menor número, las aves también se ven a lo largo de la costa Pacífica de Norte América y en Europa occidental (principalmente Irlanda e Inglaterra).



Mapa 1. Las rutas de migración de *Tryngites subruficollis* y la ubicación de los rangos de reproducción (azul) y no reproducción (invierno; rojo). Fuente: R. Lanctot (modificación del mapa de distribución de las Aves de Norte América).

Los *T. subruficollis* son las únicos de las aves playeras de Norte América porque tienen un sistema de apareamiento "lek." Los machos defienden territorios relativamente pequeños (por ejemplo, los machos vuelan verticalmente uno cerca al otro, como la foto a la derecha) que se utilizan para atraer a las hembras (ver el muestro con ala en la foto de abajo) para el apareamiento, pero ellos no proporcionan recursos para criar hijos. Las hembras seleccionan a un compañero y luego lo dejan para anidar y criar a los polluelos en otro lugar (Pruett-Jones 1988, Lanctot Weatherhead 1997; Lanctot *et al.* 1997, 1998).


Ted Swem


Pavel Tomkovich

La población, una vez abundante, disminuyó considerablemente debido a las cosechas comerciales a finales de los 1800 y a la pérdida de hábitat a lo largo de su ruta migratoria por el centro de los Estados Unidos y en los sitios de no reproducción en Suramérica (Lanctot y Laredo 1994). Debido la accesibilidad extrema del *T. subruficollis* y su tendencia a regresar al miembro herido de la bandada, fue una especia especialmente vulnerable al tiroteo en gran números. Recientes estudios en los sitios de reproducción, migración, y no reproducción sugieren que esta especie todavía puede estar disminuyendo, aunque se necesitan más estudios para determinar con exactitud el tamaño real de la población y la tendencia.

En 1999, el *T. subruficollis* fue añadido al Apéndice I y II de la Convención de la Conservación de Especies Migratorias de Animales Silvestres (http://www.cms.int/pdf/en/CMS1_Species_5lng.pdf) por petición de Argentina. La especie también está clasificada como Casi Amenazado por la UICN / BirdLife Internacional, como un Ave de Preocupación para la Conservación del Servicio de Pesca y Vida Silvestre de los Estados

Unidos, como una especie Roja en la Lista de Audubon del 2007, como una especie global de Alta Peligro en el Plan de Conservación de Aves Playeras de Estados Unidos (2004), y como una especie de Gran Preocupación en el Plan de Conservación de Aves Playeras de Canadá (Donaldson *et al*. 2001). La especie también está considerado un ave de alta prioridad en Argentina, Brasil, Paraguay, y Uruguay. Los factores que llevaron a estas designaciones fueron su pequeña y decreciente población, y su área de no reproducción relativamente pequeña en el que se concentran las aves (CMS-PNUMA 1999, Brown *et al*. 2001, Lanctot *et al*. 2002). Estas afirmaciones requieren el estudio, manejo, y conservación de la especie.

A diferencia de muchas otras especies de aves playeras, el *T. subruficollis* rara vez se congrega en grandes cantidades durante algún parte de su ciclo anual (aunque las bandadas de cientos a miles de aves han sido reportadas regularmente a lo largo de la costa de Texas en los últimos años, probablemente debido a una extensa sequía en la zona). Hay lugares dignos de mencionar, sin embargo, donde la especie puede ser encontrada de forma fiable. Pocos de estos sitios están protegidos. La mayoría del trabajo de encuesta para la especie se ha realizada durante la temporada migración (Jorgensen *et al.* 2008; W. Norling, datos no publicados.) y durante la temporada de no reproducción en Argentina, Brasil, y Uruguay (Blanco *et al.* 1993, Lanctot *et al.* 2002; Isacch y Martínez 2003a, b; Isacch *et al.* 2005, Almeida 2009, Isacch y Cardoni 2009; D. Blanco y J. Aldabe, datos no publicados). Las estimaciones de población también se han hecho por las zonas costeras de Alaska como parte del Ártico PRISM (en sus siglas ingles; *Programa de Monitoreo Regional e Internacional de las Aves Playeras*) (Brown *et al*. 2007; Bart J. y P. Smith, datos no publicados). Trabajo reciente se ha enfocado en la exposición a contaminantes (pesticidas y herbicidas) durante la migración y en las áreas de no reproducción (Strum *et al.* 2008, 2010), la fidelidad al lugar, los movimientos, el uso de campos de arroz, y los efectos del manejo de pastizales sobre la especie durante la temporada de no reproducción (Almeida 2009, D. Blanco y J. Aldabe, datos no publicados)

Basado en los recientes trabajos de encuentra en los sitios de migración en Norte América, sugerimos la revisión del tamaño de la población estimada de *T. subruficollis* de 30.000 (Morrison *et al*. 2006) a los 56.000 individuos (rango de 35.000 a 78.000). Es importante reconocer que hay gran incertidumbre en esta estimación, y esperamos que los colegas consideren el rango de comparación con la media para la estimación de la población de esta

especie. Además, toda la evidencia disponible sugiere que la especie está disminuyendo, por lo que todavía hay una necesidad estar preocupado por el estatus de esta especie.

Definimos los sitios claves para la conservación como áreas donde al menos está el 0,2% de la población (alrededor de 100 aves) se encuentra regularmente al tiempo. Debido a que la especie rara vez o nunca se encuentra en estos niveles en las áreas de reproducción, hemos identificado importantes áreas de reproducción basada en la abundancia de la especie a la escala paisaje. Estos incluyen el Área 1002 en el Refugio Nacional de Vida Silvestre en el Ártico (especialmente el corredor Río Canning), y en las áreas de producción de los campos petroleros de la Bahía de Prudhoe/Kuparuk de Alaska (especialmente la Kuparuk, Sagavanirktok, y los corredores más pequeños de ríos), así como en la Bahía de Creswell en la Isla Somerset y la Isla Banks en Canadá. El número limitado de sitios importantes de reproducción es probablemente más un reflejo de la escasa disponibilidad de datos en lugar de la ausencia de sitios importantes.

Los sitios importantes a la migración hacia el norte incluyen los del nivel paisaje tales como el *Eastern Rainwater Basin* (Cuenca de Agua de Lluvia) en el este de Nebraska (EE.UU) y la Eco-región de la Pradera Costera de Texas y Louisiana (EE.UU.). Los datos disponibles sugieren que los hábitats alterados por humanos, especialmente los campos recién sembrados de arroz, soja, maíz, y trigo, así como granjas de césped, son utilizados en gran medida por esta especie.

No está claro, sin embargo, si los *T. subruficollis* prefieren utilizar estos hábitats o se ven forzados a causa que sus hábitats naturales ya no están disponibles. De todos modos, algunos de estos sitios tiene algún estatus de protección. Sitios importantes a la migración hacia el sur incluyen los del nivel paisaje tales como la Eco-región de la Pradera Costera de Texas, así como sitios más pequeños tales como ciertos municipios en Kansas y Oklahoma, la Sabana Beni en Bolivia, y la Bahía de Asunción en Paraguay. Al igual que los sitios de ruta de migración hacia el norte, muchas de las áreas preferidas han sido alterados por los seres humanos y no tienen ningún estatus de protección. Estamos seguros que los sitios importantes de paradas durante la migración tanto al norte y al sur se encuentran presentes en el norte de Suramérica, pero todavía no han sido identificados.

Importantes sitios de temporada no reproductiva incluyen a Estancia Medaland y el sur de la Bahía Samborombón en Argentina; Ilha da Torotama y el Parque Nacional Lagoa do Peixe

en Brasil, y Laguna de Rocha y la Laguna de Castillos en Uruguay. Estos sitios han tenido observaciones temporalmente repetidas de un gran número de aves.

Las amenazas para la conservación que enfrentan esta especie varían a lo largo del ciclo anual. En el los sitios de reproducción, el hábitat está siendo perdido o degradado debido a la producción de energía y cambio climático. El cambio climático global también puede afectar los parámetros demográficos, pero sus efectos generalmente no son claros. Los efectos negativos sobre la productividad de los *T. subruficollis* puede ocurrir debido a la disociación de la sincronía entre la cronología reproductiva de las aves y la disponibilidad de alimentos. Como alternativa, el cambio climático podría alargar la temporada, proporcionando flexibilidad a las aves de iniciar los huevos o reemplazar los perdidos (aunque esto puede ser más común en Calidrids que no tienen un sistema de apareamiento lek), así como promover la supervivencia de las crías - los mejoramientos que podrían proporcionar un efecto positivo o neutral. Durante la migración, los *T. subruficollis* puede tener un impacto negativo a causa de las instalaciones de los campos para la producción de energía de viento en las Grandes Llanuras/Medioeste del central de los Estados Unidos y en partes costeros del Golfo de México; las praderas nativas que están manejados hacia vegetación media o alta; la reducción del tamaño de áreas de praderas contiguas; y la conversión de praderas o pastizales nativos a la agricultura u otro desarrollo humano. La conversión agrícola podría llevar a modificar la disponibilidad de presas y el incremento de la exposición a las pesticidas y herbicidas. Sin embargo, hay pocos datos cuantitativos disponibles indicar que las aves usando hábitats que han sido alterados por humanos también tienen capacidades alteradas de migración, tasas más bajas de supervivencia, o cualquier otro característico demográfico de medido. El cambio climático global también puede afectar a las especies durante la migración por aumentando la severidad de las tormentas sobre el Atlántico occidental que podría afectar directamente las tasas de supervivencia de los jóvenes, los cuales utilizan principalmente esta vía durante la migración hacia el sur. En áreas de no reproducción, los *T. subruficollis* están amenazados por la conversión de las praderas históricas a la agricultura, las plantaciones de madera, las minas, y lugares turísticos. Los pastizales también están siendo "mejorados" por los ganaderos implantando vegetación exótica con una estructura diferente que parece ser menos preferido. Dichos mejoramientos implican con frecuencia el uso de fertilizantes y otros contaminantes que pueden afectar negativamente a la especie. Los *T. subruficollis* también son vulnerables a los cambios en el manejo del campo que disminuyan los niveles de

pasto que llevan a las pastizales con vegetación alta. Por último, el cambio climático puede resultar en el incremento del nivel del mar y mayor precipitación, que inundarán las muchas bajas áreas que utiliza esta especie durante la temporada de no reproducción.

Hemos identificado las acciones de alta, media, y continua prioridad que deben ser aplicadas en diversas escalas: rango entero, reproducción, migración, y no reproducción. A continuación listamos algunas acciones para cada categoría:

EL RANGO ENTERO

Acciones de alta prioridad son la documentación de la conectividad migratoria y otros aspectos de la biología de la población de la especie utilizando geolocators, marcadores moleculares, e isótopos estables; la protección de áreas claves para conservación mediante el desarrollo de alianzas y proporcionar incentivos a los propietarios privados y administradores de tierras públicas; y la actualización del perfil de esta especie en las Aves de Norte América. Acciones de prioridad continua incluyen el fortalecimiento de los mecanismos de cooperación y comunicación entre las partes interesadas atrás el rango de la especie; y informar a los responsables políticos, administradores, y propietarios sobre los requerimientos únicos de hábitat para esta especie. Acciones de media prioridad incluyen la evaluación de los impactos del cambio climático global sobre el hábitat de la especie y su capacidades de la migración, y la documentación de la presencia de enfermedades.

REPRODUCCIÓN

Acciones de alta prioridad incluyen apoyar a los censos de gran escala y enfocados para definir mejor el rango de la especie y los sitios clave para la conservación. Acciones de prioridad continua incluyen guiar a la industria y los consultores ambientales para minimizar los impactos de cualquier desarrollo. Por último, acciones de media prioridad incluyen el desarrollo de un modelo de selección de hábitat que pueden ser utilizados para predecir sitios de reproducción.

MIGRACIÓN

Acciones de alta prioridad incluyen el establecimiento de un programa de monitoreo que es del largo plazo y seguro estadísticamente en el *Eastern Rainwater Basin* (Cuenca oriental de Agua de Lluvia) y la Llanura Costera del Golfo; la evaluación de la compatibilidad de la especie

con hábitats alterados por humanos; y la investigación de los efectos de los contaminantes a la especie. Acciones de prioridad continua incluyen la creación de redes de socios para priorizar mejor las acciones de manejo que sean beneficiosas para la especie; y la actualización de las bases de datos existentes sobre la especie para detectar cambios en la distribución y abundancia relativa. Acciones de media prioridad incluyen la evaluación de uso de los sitios de paradas menos conocidos en el norte del Norte América y en el sur y centro de Suramérica; y la construcción de un modelo de migración que explique el proceso para tomar las decisiones por la especie durante la migración.

NO REPRODUCCIÓN

Acciones de alta prioridad incluyen la realización de estudios demográficos del largo plazo en sitios claves; apoyar esfuerzos existentes y establecer nuevos para el monitoreo que es seguro estadísticamente; la realización de estudios detallados de ecotoxicología; e investigar los usos de los pastizales y los impactos de las acciones de manejo en la especie. Acciones de prioridad continua incluyen la creación de redes de socios para priorizar mejor las acciones de manejo y establecer metas para mantener el hábitat de *T. subruficollis*. Acciones de media prioridad incluyen el uso de la tecnología de teledetección para identificar a un hábitat adecuado, extrapolar las estimaciones de densidad en esta área, y evaluar el uso de lugares secundarios en la temporada de no reproducción.

PURPOSE

Once numbering in the hundreds of thousands, the Buff-breasted Sandpiper is currently estimated at approximately 30,000 (see revised population estimate and range below). Decreases are the results of commercial harvest in the late 1800s and loss of habitat along the migratory route in the central United States and nonbreeding grounds in South America. Recent surveys at breeding, migration, and nonbreeding (wintering) areas suggest the species may still be declining (Lanctot *et al.* 2002). Determining whether this decline is real and, if so, what is driving the decline, is just one issue that prompted the development of this conservation plan. Other issues of concern include 1) loss of suitable habitat on the breeding, migration, and nonbreeding grounds due to human alteration (direct and indirect) of land; and 2) exposure of the species to contaminants due to its frequent use of human-altered habitats on migration sites and nonbreeding grounds.

These concerns have led to the species being assigned special conservation status on international, national, and state lists. For example, the Buff-breasted Sandpiper is categorized as "Near Threatened" by IUCN (BirdLife International 2009), is included in Appendices I and II of the Convention on Migratory Species of Wild Animals (CMS website – http://www.cms.int/pdf/en/CMS1_Species_5lng.pdf), is included as a Bird of Conservation Concern by the U.S. Fish and Wildlife Service (USFWS 2009), and is a Red species (declining rapidly and/or have very small populations or limited ranges, and face major conservation threats) on the 2007 Audubon Watchlist (http://web1.audubon.org/science/species/watchlist/profile.php?speciesCode=bufsan). It is also categorized as High Concern in the U.S. and Canadian Shorebird Conservation Plans (Brown *et al.* 2001, Donaldson *et al.* 2001) and was increased to Highly Imperiled when the Population Trend rank of the species was revised (USSCP 2004). Argentina, Brazil, Paraguay, and Uruguay all consider the species as a priority (López-Lanús *et al.* 2008, Marques *et al.* 2002, Bencke *et al.* 2003, del Castillo *et al.* 2005, Brazeiro *et al.* 2006). This conservation plan is the first step to help understand and hopefully alleviate these concerns.

In this conservation plan, we provide information on the species's ecology and behavior, as well as the various conservation issues important to achieving population goals set forth in the U.S. Shorebird Conservation Plan (Brown *et al.* 2001). This plan includes information for the full annual cycle and draws on expertise from colleagues in all portions of the species's range.

We identify important sites (or landscapes) used by at least 0.2% of the species and describe major conservation threats and conservation actions needed at those sites. We have summarized information from the published literature, unpublished data, and personal communications with a variety of people with an interest in this species.

STATUS AND NATURAL HISTORY

The status of the Buff-breasted Sandpiper was little known prior to detailed studies of the species beginning in the late 1970s. At this time, anecdotal data indicated the species had undergone a dramatic decline in numbers due to commercial harvest and loss of habitat to development at migration and nonbreeding areas. During the past 30 years, studies have focused on: 1) breeding behavior (Prevett and Barr 1976, Myers 1979, Cartar and Lyon 1988, Pruett-Jones 1988, Lanctot and Weatherhead 1997; Lanctot *et al.* 1997, 1998); 2) nonbreeding territoriality and site tenacity (Myers 1980; Isacch and Martínez 1999, 2003a,b; Almeida 2009); 3) population numbers and distribution on migration stopover sites (Jorgensen *et al.* 2008, W. Norling, unpubl. data) and nonbreeding grounds (Blanco *et al.* 1993, Lanctot *et al.* 2002, Isacch *et al.* 2005, Blanco and Aldabe 2007, Almeida 2009, Isacch and Cardoni 2009); 4) risk of contaminant exposure (Blanco *et al.* 2006a, Strum *et al.* 2008, Strum *et al.* 2010); 5) food abundance and diet (Isacch *et al.* 2005); and 6) conservation and management of pasturelands (Blanco *et al.* 2006b, Blanco and Aldabe 2007, Isacch and Cardoni 2009). These studies have greatly improved the current state of knowledge on the species's status and natural history. However, much still remains to be learned.

Figure 1. Male Buff-breasted Sandpiper standing alert on tundra display area. Females are typically thinner but the two sexes are difficult to tell apart without noting typical male behaviors such as 1-wing and 2-wing waves (see cover and Executive Summary photos). Photo by Ted Swem.

MORPHOLOGY

The Buff-breasted Sandpiper is a medium-size, plover-like shorebird (Figure 1), with a length of: 18–20 cm; wing span: 43–47 cm; tarsus: average male 32.9 mm, average female 29.5 mm; culmen: average male 19.7 mm, average female 17.9 mm; weight on Alaskan breeding grounds: male 57–78 g, female 46–65 g; weight on nonbreeding grounds: male 48–76 g, female 41–64 g; weight on Nebraska migration: male 80–117 g, female 62–81 g (Lanctot and Laredo 1994; O'Brien *et al.* 2006; Almeida 2009, unpubl. data). The species's underparts are strongly buff in all plumages; they have bright yellow-ochre legs; a short, straight, black, pigeon-like bill; a plain buff-colored face with prominent dark eye; and a plain breast with spotting on the side. In flight, upperwings are buffish; underwing axillaries are gleaming white and contrast with buff-colored flanks and belly; and there is a dark bar at the tips of under primary coverts (Figure 2). The upperwing also has an indistinct buffy bar that poorly contrasts with the rest of upperparts.

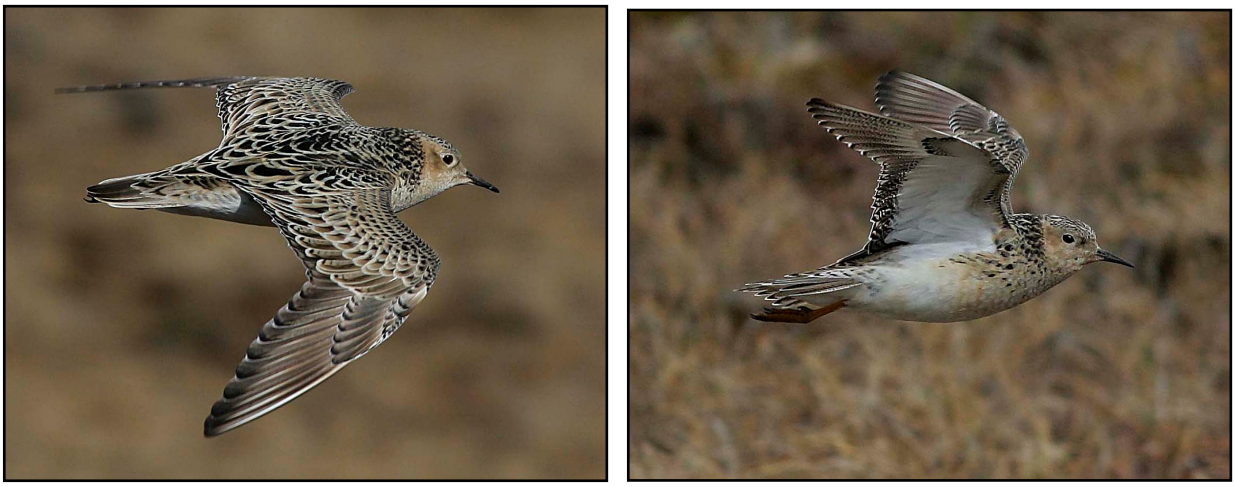


Figure 2. Flight profiles illustrating color patterns above and below the wings of the Buff-breasted Sandpiper. Photos by Ted Swem.

The two sexes are similar in plumage except that adult males have larger spots on the 9th and 10th under primary feathers than do females; females have larger spots than juveniles (Figure 3) (R. Lanctot, unpubl. data).

Figure 3. Left to right: underwing spotting of an adult male, adult female, and hatch year Buff-breasted Sandpiper. The sex of hatch-year birds can not be determined. Hatch-year birds molt their primaries during late January/early February and can no longer be differentiated at this time. Photos by Juliana Bosi de Almeida.

The males of the species are larger on average than females, especially for tarsus and head-to-bill lengths (Almeida 2009), although it is difficult to differentiate the two sexes in the field except during the display period. Adults are distinguishable from juveniles at close distance by their longer, more loosely arranged scapulars, coverts, and tertials, and by their buff, rather than white, fringes above on the coverts (Figure 4) (O'Brien *et al.* 2006). Juveniles have uniformly fresh plumage with relatively small, crisply pale-fringed scapulars, coverts, and

tertials. Juvenile Ruff (*Philomachus pugnax*) are similar to Buff-breasted Sandpipers, but Ruffs are much larger with dull-colored legs, longer bills, white wing bar, long tertials, and short primary projection. Upland Sandpipers (*Bartramia longicauda*) are also buff-colored but larger (28–32 cm long) with a longer neck and tail. Baird's Sandpipers (*Calidris bairdii*) have black legs with the buff of the breast sharply delineated from a white abdomen. In flight, the Buff-breasted Sandpiper is similar to the Eurasian Dotterel (*Charadrius morinellus*), but the dotterel has a conspicuous black-and-white tail tip and prominent pale supercilium (Hayman *et al.* 1986, Paulson 1993).

Figure 4. Buff-breasted Sandpiper plumages (left to right): breeding adult, nonbreeding (wintering) adult, and juvenile.

TAXONOMY

The Buff-breasted Sandpiper is in the Order Charadriiformes and the Family Scolopacidae. Its scientific name is *Tryngites subruficollis* (which means "somewhat reddish-necked sandpiper-like bird," www.deltadiscovery.com/ourlivingresources), but the species is also known by various common names such as hill grass-bird, grass-bird; Bécasseau roussâtre or Bécasseau rousset (French); Correlimos canelo, Correlimos ocraceo, Chorlito ocraceo, Playerito Canela, Chorlito canela (Spanish); Maçarico-acanelado or Pilrito-canela (Portuguese); Grasläufer (German); Aklaktak (or spotted bird, Nunamiut dialet); and Núdluayu (Eskimo) (Gotthardt and Lanctot 2002, CMS website – http://www.cms.int/pdf/en/CMS1_Species_5lng.pdf).

High site fidelity at some sites on the nonbreeding grounds supports the presence of distinct wintering populations (Almeida 2009). Kessel (1989) suggested a western population breeds in western Chukotka and migrates along the coast of the Pacific Ocean (in contrast to the

interior of North America). To date, only a limited number of banded birds have been resighted that allow connections among breeding, stopover, and nonbreeding areas to be made (R. Clay, J. Almeida, R. Lanctot, unpubl. data). Almeida (2009) found only small differences in morphology when comparing Buff-breasted Sandpipers breeding in Alaska and those captured on the nonbreeding grounds in Brazil. To date, no subspecies are recognized and no molecular studies have been conducted to define whether discrete populations exist. A molecular study to evaluate population subdivision is beginning in January 2010.

POPULATION ESTIMATE AND TREND

Estimates of the population size of the Buff-breasted Sandpiper have changed considerably during the past 15 years. Del Hoyo *et al*. (1992) list the total world population at a maximum of 25,000 birds. Within North America, Brown *et al*. 2001 estimated the population to be approximately 15,000, although this species is classified as a "difficult-to-count species," and population estimates may be too low (Morrison *et al*. 2001). Wayne Norling (unpubl. data) estimated that between 28,000 and 84,000 birds staged in rice fields on the Gulf Coastal Plain of Louisiana and Texas in 1997 and 1998, respectively, depending upon whether an assumption of a 5- or 15-day length of stay was used. Subsequent surveys in the Rainwater Basin of Nebraska in 2004 and 2005 estimated that between 16,000 and 32,000 birds may pass through this area each year (Jorgensen *et al.* 2006). Due to potential limitations of these studies (Lanctot *et al.* 2008), Morrison *et al.* (2006) conservatively revised the North American estimate to 30,000 or more.

A more complete analysis of the data presented by Jorgensen *et al.* (2006) produced extrapolations ranging from 13,000 to 78,000 Buff-breasted Sandpipers stopping in the Rainwater Basin during northbound migration (Figure 5) (Jorgensen *et al.* 2008). Each extrapolation was dependent on whether mean or 95% lower-confidence-level density estimates were used, as well as the size of the extrapolation area. Extrapolations using mean density and the entire study area ranged from 35,000 to 78,000 birds. Conservative estimates, based on 95% lower-confidence-level density estimates, were lower and ranged from 22,000 to 42,000 birds (Jorgensen *et al.* 2008). Additional—and probably overly conservative—extrapolations that used the lower confidence level and limited area ranged from 13,000 to 15,000 birds (Jorgensen *et al.* 2008). None of these estimates considered turnover rates. Additional research using radio transmitter-equipped birds suggests that stopover length is probably short (<2 days) in the

Rainwater Basin (i.e., a relatively quick turnover rate; J. Jorgensen, unpubl. data), suggesting the population size may be higher than originally thought. Although we recognize that many factors may influence turnover rates and that turnover rates may not be consistent through time (Ydenberg *et al.* 2004), we recommend revising the current population estimate to 56,000, with a stated range of 35,000 to 78,000, as a new population estimate for the species. We anticipate that this estimate will be changed as new data become available.

The Alaska Shorebird Group (2008) estimated that Alaska likely hosts <25% of the Western Hemisphere's breeding population of Buff-breasted Sandpipers. Morrison (1993/1994) estimated that 5,000–10,000+ Buff-breasted Sandpipers occur in Canada, although this number may be higher given recent population estimate changes. The species also breeds sporadically on the Russia mainland of Chukotka (no population estimate available) and Wrangel Island where "several tens of nesting birds" occur (Dorogoi 1983; P. Tomokovich, pers. comm.).

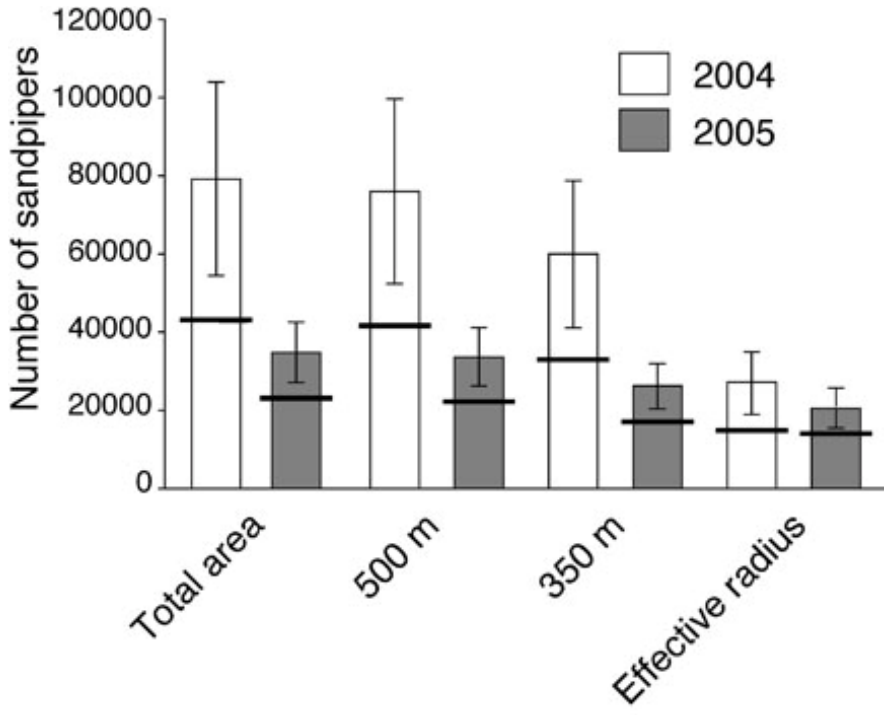


Figure 5. Mean estimates (± SE) and lower 95% confidence levels (solid bar) of the number of Buff-breasted Sandpipers in the eastern Rainwater Basin during spring migration in 2004 and 2005 using four area estimates. Estimates of the number of birds are based on the total area of the entire defined study area (849,028 hectares), the area in the 500- and 350-meter buffers around the roads along which surveys were conducted (813,977 ha and 643,009 ha, respectively), and the area using the effective radius calculated by program Distance for 2004 (292,101 ha) and 2005 (499,544 ha). Figure and legend excerpted from Jorgensen et al. (2008).

Historical Trend

Based on anecdotal sightings on the nonbreeding (wintering) grounds, the historic population was estimated to number in the hundreds of thousands (Hudson 1920, del Hoyo *et al*. 1992, Lanctot and Laredo 1994). The species was brought close to extinction at the turn of the 20th Century due to commercial harvest in the late 1800s and early 1900s in the central United States and, to a lesser degree, in southern South America (McIlhenny 1943, Myers 1980, Canevari and Blanco 1994). In addition, the species suffered from the widespread conversion of short-grass prairies to agriculture in the U.S. plains and in the pampas of Argentina, Uruguay, and Paraguay (Wetmore 1927, Lanctot and Laredo 1994). Observations from migration flyways and from breeding and nonbreeding areas confirm these declines. For example, McIlhenny (1943) reported this species was once plentiful during migration in Louisiana in August and September, but was completely absent by 1943 as a result of widespread commercial harvest. Forbush (1912) reported that Buff-breasted Sandpiper numbers were once vast in the Mississippi Valley, but were greatly reduced by 1925 due to spring shooting. In 1880 at Point Barrow, Alaska, this species was described as an abundant summer breeder (Murdoch 1885), although it is now rarely seen there (R. Lanctot, unpubl. data). In the nonbreeding areas in South America, numbers are also below historic levels. During the early 1900s, flock after flock of 200–500 birds were seen over a period of several days in the Buenos Aires Province during migration (Hudson 1920). In 1999, only 360 birds were detected during 13 days of surveys in Argentina (Lanctot *et al*. 2002).

Contemporary Trend

Several lines of evidence suggest the population of Buff-breasted Sandpipers is continuing to decline. A comparison of population numbers on the nonbreeding grounds at Estancia Medaland, Argentina, between 1973 and the 1990s suggests the species has greatly decreased. Myers (1980) estimated that up to 2,000 Buff-breasted Sandpipers used this area during the austral summers of 1973 and 1974, whereas Blanco *et al.* (1993) counted only 360 birds and Isacch and Martínez (2003a) rarely had counts over 100 during the nonbreeding seasons of 1996–2000. Information collected on the breeding grounds suggests a decline in population size is also occurring. A comparison of Buff-breasted Sandpiper densities at 38 plots near Creswell Bay, Somerset Island (Nunavut, Canada) showed a significant decrease in

densities from the mid 1990s (1995 and 1997) to 2001 (P. Latour and J. Bart, unpubl. data). Information from two migration sites also suggests that a decline is occurring. Lee Morris living near Benedict, Nebraska, reported thousands of Buff-breasted Sandpipers on his farm in the mid 1980s and now reports less than 100 each year (Morris 1995; L. Morris, pers. comm.). Dick Dekker reports a similar decline in observations of Buff-breasted Sandpipers from the 1970s to early 1990s near Beaverhill Lake, Edmonton, Alberta (D. Dekker, pers. comm.). Unfortunately, insufficient data are available from the broader Maritimes Shorebird Survey (covering sites in eastern Canada) and the International Shorebird Survey (covering sites in eastern and central United States) to test for an increase or decrease in Buff-breasted Sandpiper numbers (J. Bart, unpubl. data). It is possible that the decline in bird numbers described above during breeding, migration, and nonbreeding may not be real but simply a product of declining detection rates or a shift in the distribution of birds (Bart *et al.* 2007). In the case of migration sites, declines may also be due to birds changing their migration route (Bart *et al.* 2007) or spending less time in an area resulting in an apparent but not real decline (Ydenberg *et al.* 2004). Migratory sites in the U.S. Great Plains can be very wet or dry in any given year, especially those sites that depend on precipitation for their source of water (Skagen 2006), influencing bird use and, ultimately, population estimates. Thus it may be prudent to conduct long-term studies (>10 years) at any given site before announcing a large decline has occurred. In any event, these apparent negative trends suggest caution should be used when managing the species until additional trend data can be gathered.

Besides comparing counts of birds through time to determine population trends, it is also possible to use demographic parameters to indicate whether a population is able to sustain itself. The only information available on Buff-breasted Sandpipers comes from an intensive banding study conducted on the nonbreeding grounds at Lagoa do Peixe National Park in southern Brazil (Almeida 2009). Almeida reported adult apparent survival rates of 0.77; this is within the upper range of rates reported for *Calidris* sandpipers (see Appendix 1, Almeida 2009). This relatively high apparent survival rate suggests either the species is not declining or that poor adult survival is not responsible for the population decline (other factors may be responsible such as poor juvenile survival or productivity). However, it is important to consider that 1) this estimate comes from a single nonbreeding population that represents < 8% of the world population (based on density estimates reported in Almeida [2009] and population size of 56,000), and 2) because

of the short nature of her study, Almeida did not test for temporal (year) variation or include hatch year (HY) birds in her estimates of apparent annual survival, which may confound the interpretation of these results.

DISTRIBUTION

Breeding Range

Buff-breasted Sandpipers breed in the Arctic of Russia, Alaska, and western Canada (Figure 6) (Lanctot and Laredo 1994). Less than 25% of the Buff-breasted Sandpipers that occur in North America likely occur in Alaska (Alaska Shorebird Group 2008). In Alaska, this species breeds over most of the Beaufort Sea coast (Kessel and Gibson 1978, Johnson and Herter 1989, Gotthard and Lanctot 2002, Johnson *et al*. 2007), including the National Petroleum Reserve-Alaska, in the Kuparuk and Prudhoe Bay oil fields, and in the Arctic National Wildlife Refuge. Courtship has also been observed on the Seward Peninsula (at Cape Woolley) in western Alaska (Kessel 1989) and potentially at Demarcation Point (Brooks 1915).

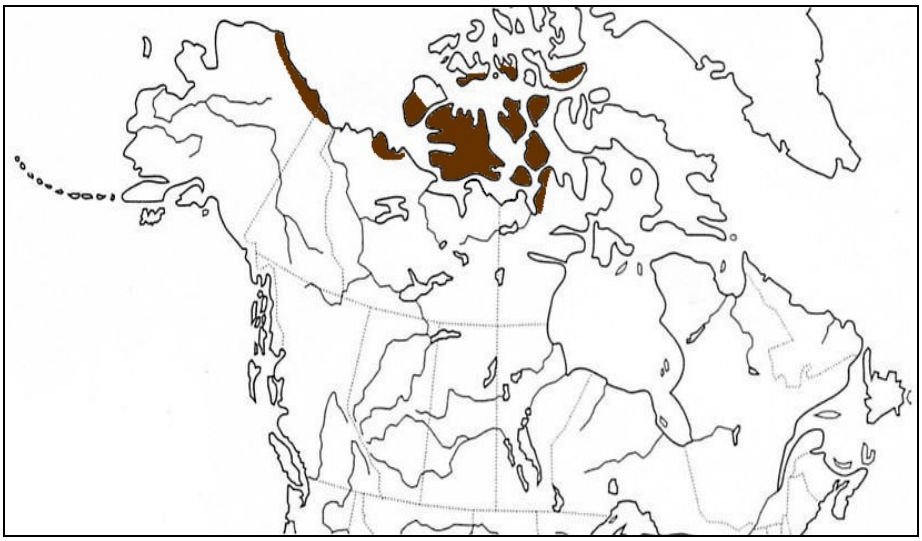


Figure 6. North American breeding range for the Buff-breasted Sandpiper. Source: Lanctot and Laredo 1994.

In Canada, Buff-breasted Sandpipers are known to breed in the western arctic, mostly on the mainland, from the Alaska boundary to Boothia Peninsula. It occurs as far north as Melville, Bathurst, and Devon Islands. Specific locations by province and territory follow. This species

occurs throughout the North Slope of the Yukon Territory from the Blow River to Clarence Lagoon (Salter *et al*. 1980). Birds have been observed nesting in nearby regions of the Mackenzie River Delta, although breeding has not been recorded (Martell *et al*. 1984 *in* Johnson and Herter 1989). Buff-breasted Sandpipers were uncommon nesters in the Anderson River area, Northwest Territories (Höhn 1959). Hussel and Holroyd (1974) reported Buff-breasted Sandpiper nests on the Truelove Lowlands of northeastern Devon Island, Northwest Territories. Breeding also occurs on Banks Island, Victoria Island (Cambridge Bay, Holman region, Prince Albert Sound, Richard Collinson Inlet), Jenny Lind Island, King William Island, Boothia Peninsula, and Somerset Island; probably in Melville Island (at Winter Harbor), Bathurst Island (near Cape Cockburn and Polar Bear Pass); and perhaps northern Yukon (Herschel Island; Manning *et al*. 1956, Parmelee *et al*. 1967, McLaren and Renaud 1977, Patterson and Alliston 1978, McLaren and Alliston 1981, Godfrey 1986, Lanctot and Laredo 1994). Parmelee *et al*. (1967) indicated the Buff-breasted Sandpipers were the second most abundant species on Jenny Lind Island in 1962 but were uncommon there in 1967 (one of the first clues about how irruptive the species's numbers can be – see "Density: Breeding Range" section of plan).

In Russia, Buff-breasted Sandpipers are known breeders on Wrangel Island and in western Chukotka, from Ayon Island east to the Ekvyvatan River Valley and the north coast of the Chukutskiy Peninsula (Portenko 1981, Cramp and Simmons 1983, Dorogoi 1983, del Hoyo *et al*. 1992, Lanctot and Laredo 1994).

Migration

During southbound migration (Map 1), Buff-breasted Sandpipers move south through the Central Flyway of Canada and the United States, although small numbers are also seen along the Atlantic coast of North America and, to a lesser degree, Western Europe and the Pacific coast of North America. In South America, the major migration route is thought to be the Central Amazonia/Pantanal flyway, which birds use to reach the pampas of Argentina, Brazil, and Paraguay.

Northbound migrants (Map 1) reverse their travels, again using the Central Amazonia/Pantanal flyway before crossing the Gulf of Mexico to reach coastal Texas and Louisiana in the United States. After stopping over, most birds then travel north via the Central Flyway, with few to any birds traveling along the Atlantic or Pacific Coasts.

Nonbreeding Range

Buff-breasted Sandpipers spend the nonbreeding season in South America, with the majority occurring in coastal areas of central Argentina, southeast Uruguay, and southeast Brazil (Figure 7) (Gabrielson and Lincoln 1959, Lanctot and Laredo 1994, Lanctot *et al*. 2002). The main nonbreeding range of this species is within the coastal sectors of the Rio de La Plata Grasslands, at the eastern portion of the Flooding Pampas of Argentina, and adjacent to large lagoon complexes in the coastal plain of Rio Grande do Sul of Brazil and Uruguay (Lanctot *et al*. 2002).

Smaller numbers of birds can be found in the Puna ecoregion of Argentina and in southwest Bolivia (Lanctot and Laredo 1994, Lanctot *et al.* 2002). The Basalto Grasslands in northwestern Uruguay also is an important area for the species during its nonbreeding season. A group of more than 100 birds was recorded in the Artigas Department in late March 2002, and 150 individuals were recorded in the Salto Department during austral spring and summers of 2006–2007 (P. Rocca and J. Aldabe, unpubl. data).

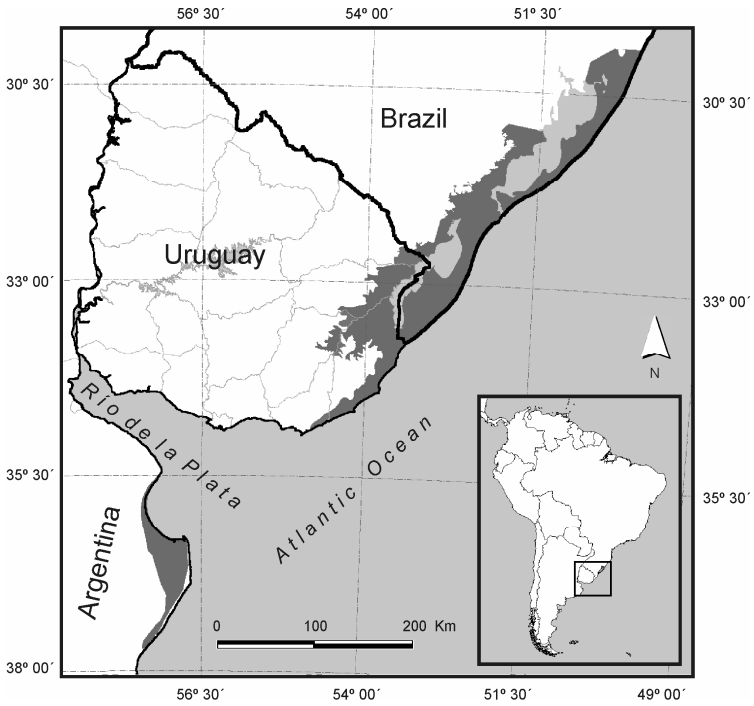


Figure 7. Primary nonbreeding range for the Buff-breasted Sandpiper in South America. Medium gray indicates inland lagoons. Source: Lanctot *et al.* 2004.

ABUNDANCE

The largest numbers of birds reported at a given site typically occur either during staging on migration or on the nonbreeding grounds. Migrant flocks of hundreds to thousands have been reported numerous times in the eastern Rainwater Basin of Nebraska and the Coastal Prairie Ecoregion of Texas and Louisiana (Table 2). The largest flock ever observed was an estimated 5,000 birds at Calallen, Corpus Christi, Texas, during southbound migration on 24 August 2009 (eBird 2009).

During the nonbreeding season in South America, flocks of 800 and 909 birds were observed at Ilha da Torotama, Brazil, on 4 December 2001 and on 8 January 2008 (Lanctot *et al.* 2002; J. Aldabe and P. Rocca, unpubl. data). Similarly, a flock of about 2,000 Buff-breasted Sandpipers was observed at nearby Lagoa do Peixe National Park in Brazil in February 2003 (J. Almeida, unpubl. data). This park is known for its consistently high numbers of this species (Almeida 2009). Other areas with consistently high numbers include Estancia Medaland in Argentina (Isacch and Martínez 2003a) and areas surrounding Laguna de Rocha in Uruguay (Lanctot *et al.* 2002, Blanco and Aldabe 2007).

Large aggregations are never found on the breeding grounds (groups of five or fewer birds are common, with occasional counts of up to 20 to 30; see e.g., Gotthardt and Lanctot 2002), although collectively a landscape-level breeding area may have sizeable numbers of birds. For example, Brown *et al.* (2007) estimated that 7,684 birds (range 0–17,812) were located on the 1002 Area of the Arctic National Wildlife Refuge of Alaska. This estimate was based on the observation of eight birds during rapid surveys of randomly located plots and extrapolated to the 674,000-hectare area. Unfortunately, the large confidence interval surrounding this estimate, especially because it includes the value 0, makes it rather meaningless.

DENSITY

Breeding Range

The numbers of adult Buff-breasted Sandpipers counted on breeding grounds vary dramatically on an annual basis (Lanctot and Laredo 1994, Lanctot and Weatherhead 1997). Breeding density (no./km^2) in Alaska varied from 0 to 10.0 at Storkensen Point between 1971 and 1974 (Bergman *et al*. 1977) and 0.5–14.0 (average = 5.2) at the Point McIntyre Reference Area (PMRA) near Prudhoe Bay between 1981 and 1991 (Troy 1996a). Breeding density from

an earlier study at Prudhoe Bay (1978) ranged from a high of 0.3 birds/ha in mid-June to 0 birds by mid-August (Jones 1980). Breeding season densities from a comparative study were 0–5 at Milne Point and 0–3.5 at Prudhoe Bay between 1994 and 1996 (Troy 1997). In Canada, Buff-breasted Sandpipers occur in a low-density pattern, similar to Alaska, over most of the Arctic bounded on the north by Melville, Bathurst, and Devon Islands (Johnston *et al.* 2000). Breeding densities include 1.9–3.1 birds/km^2 at Babbage River, Yukon; 3.9 birds/km^2 at S. Boothia Peninsula and Middle Lake; 0.5 birds/km^2 at Rasmussen Lowlands, and 0–4 birds/km^2 at Creswell Bay, Somerset Island (Latour *et al.* 2005).

Nesting densities of Buff-breasted Sandpipers also vary along the Alaska Arctic coast (Lanctot and Laredo 1994). Nest density in the PMRA from 1981–1991 ranged from 0.0–3.0 nests/km^2 (average = 1.0; Troy 1996a). Nest densities from a comparative study conducted at Milne Point and Prudhoe Bay oil fields from 1994–1996 ranged from 0–1.7 and 0–1, respectively (Troy 1997). Studies conducted in Inigok, National Petroleum Reserve-Alaska, in 1998 reported nest densities of 1.32±1.32 (SE) on tussock/ridge tundra within 29 survey plots located within a 7-kilometer radius (Cotter and Andres 2000). Nest densities at upland tundra sites along the Canning River Delta were 3.9 and 0 in 1978 and 1979, respectively, and 7.8 at mesic tundra sites in 1980 (Martin 1983).

Within Alaska, post-breeding-season densities in the PMRA (1984, 1987, 1989–1992) ranged from 0.0 to 4.0 birds/km^2 (avg. = 0.9; Troy 1993). Between 1994 and 1995, post-breeding-season densities at Milne Point were 0.0–3.3, and in PRMA were 1.4–2.4 (Troy 1996b). Densities of post-breeding, migrating Buff-breasted Sandpipers on the Colville River Delta were 0.2 birds/km^2 in 1987 and 1988 (Andres 1994).

In Russia, not more than several tens of birds likely nest on Wrangel Island, and the species occurs sporadically on the Chukotski Peninsula. Densities varied from 1–19 birds/km^2 on Wrangel Island, and 0–14 on Chukotka (M. Stishov, pers. comm.).

Migration

Buff-breasted Sandpipers are generally considered rare in mid-continental North America during migration (Thompson and Ely 1989, Kent and Dinsmore 1996, Skagen *et al.* 1999, Tallman *et al.* 2002), but may be locally numerous (see list of sightings >99 birds in Table 2). Jorgensen *et al.* (2008) estimated densities of 0.09 birds/ha in 2004 and 0.04 birds/ha in 2005 in

agricultural fields in the Rainwater Basin, Nebraska, during northbound migration. Lesterhuis and Clay (2001) recorded a high single count of 140 birds and a total of 539 individuals in the 375-hectare Bahía de Asunción, Paraguay, during 27 surveys between August and December 2000 (average # observed = 28.6 ± 6.7 [SE]). Because approximately 50 hectares of the bay contain suitable habitat, these numbers would yield a density of 1.7 birds/ha during any given survey. Similar counts and densities were observed when 36 visits were made to Bahía de Asunción between August and December 2004 (A. Lesterhuis and R. Clay, unpubl. data). Single counts of 250 and 200 birds were observed at the same site in 2001 and 2009, respectively, during southbound migration (R. Clay and H. del Castillo, unpubl. data). During October 2004, observations along the Paraguay River indicated linear densities of 0.3 birds/km of river traveled. This density extrapolated to the 1,212 kilometers of river suggests 364 birds were present.

Nonbreeding range

Densities on Estancia Medaland in the southern pampas of Argentina ranged from 8–15 birds/ha between October and November 1973, and from 0.25–2.7 birds/ha during repeated surveys in November 1992 (M. Martínez, pers. comm. *in* Lanctot and Laredo 1994). Between 1996 and 1999, Isacch and Martínez (2003a) counted a maximum of 56, 72, 130, and 133 birds on this same 650-hectare estancia (ranch), yielding density estimates between 0.09 and 0.20 birds/ha. At a more northern portion of the pampas of Argentina, a maximum density of 8.6 birds/ha (mean = 2.79, SD = 2.33) was recorded at the southern edge of Samborombón Bay during a survey between October and February 2009 (Las Tijeras Ranch; Isacch and Cardoni 2009). In northwest Argentina, Buff-breasted Sandpiper densities averaged 1.8 birds/ha (± 1.1 SD, range 0.3–4.3) between November 1992 and February 1993 (Laredo 1993). A total of 899 Buff-breasted Sandpipers were counted in Argentina and Uruguay from August 1992 to March 1993 (within 11,534 kilometers of surveys; Blanco *et al*. 1993).

Brazil had the highest population densities of Buff-breasted Sandpipers during surveys conducted on South American nonbreeding grounds in 1999 and 2001, followed by Uruguay then Argentina (Lanctot *et al*. 2002). Population densities (birds/ha) of Buff-breasted Sandpipers were 0.11 (C.I. = 0.04–0.31) in Argentina; 1.62 (C.I. = 0.67–3.93) in Brazil; and 1.08 (C.I. = 0.37–3.18) in Uruguay. During 1999, the highest concentration of Buff-breasted Sandpipers in Argentina was in southern Bahía Samborombón (General Lavalle District) and areas north of

Mar Chiquita coastal lagoon. During 2001, the highest concentrations in Brazil were at Ilha da Torotama and Lagoa do Peixe National Park. During 1999 and 2001, the highest concentrations of Buff-breasted Sandpipers in Uruguay were found along three lagoons (Laguna de Rocha, Laguna de Castillos, and Laguna Garzón) bordering the Atlantic Ocean.

Surveys conducted during the austral winters of 2002/2003 and 2004/2005 in southern Brazil recorded maximum densities of 15 ± 13, 19 ± 7, and 16 ± 7 individuals/ha at Lagoa do Peixe National Park, Ilha da Torotama, and Taim Ecological Station, respectively (Almeida 2009). These densities are between 9 and 12 times higher than that reported in Lanctot *et al*. (2002) for Brazil overall; these densities, besides being over-inflated because they are maximum densities, likely reflect differences in geographic coverage, methodological survey approach (point counts versus double-observer strip censuses), and timing. Indeed, these three sites also had some the highest number of birds recorded during the Lanctot *et al.* (2002) surveys. Almeida (2009) further found that densities varied seasonally, with increases from October until mid-December or early January, and decreases thereafter. There was also considerably inter-annual variability at some sites, with the Taim Ecological Station having few birds present in two of the three years when water levels were low (i.e., less precipitation).

Recent transect-line surveys at Estancia La Rinconada located on the southern edge of Laguna de Rocha, Uruguay, revealed a mean density of 0.76 birds/ha between October and December 2007. When extrapolated to suitable habitat areas surrounding Laguna de Rocha, an estimated population of 3,700 individuals was present (J. Aldabe and D. Blanco, unpubl. data). Similar surveys on other ranches near Laguna de Rocha between October 2008 and February 2009 revealed a mean density of 3.25 birds/ha (range of 0.3–5.5) (J. Aldabe and P. Rocca, unpublished data). A similar extrapolation of density data in Brazil would yield 1,900–3,420 birds in the 760-hectare Lagoa do Peixe National Park and 354–556 birds in the 101-hectare Ilha da Torotama (derived from Figure 2 in Almeida 2009).

MIGRATION

Buff-breasted Sandpipers are gregarious during migration, typically flying in small flocks (≤ 5 birds; Lanctot and Laredo 1994) or joining flocks of other shorebirds. During migration and during the nonbreeding season, Buff-breasted Sandpipers are usually found at traditional sites from year to year, often in the company of American Golden-Plovers (*Pluvialis dominica*) and

Upland Sandpipers (*Bartramia longicauda*). Favorite stopovers are short-grass pastures, sod farms, agricultural fields with emerging crops (corn, soybeans, rice), dry to moist ponds, recently planted rice fields, airports, lawns, and other grasslands (e.g., grass-covered sandbars) (Cramp and Simmons 1983; R. Clay and A. Lesterhuis, unpubl. data). This species is probably a nocturnal migrant and can be very approachable during migration (del Hoyo *et al*. 1992).

Southbound Migration

Males and non- or failed-breeding females depart from breeding grounds during mid-June to early July (Lanctot and Laredo 1994) whereas females that breed successfully and their broods depart during late July to early September (del Hoyo *et al*. 1992; Lanctot and Laredo 1994; R. Lanctot, unpubl. data). Adults usually depart before juveniles. Buff-breasted Sandpipers have been recorded within their breeding range in Alaska as late as 21, 22, and 27 August (Johnson and Herter 1989). Little is known about whether Buff-breasted Sandpipers stage in the Arctic prior to migrating or how they reach the Central and Mississippi Flyways. The little evidence available on post-breeding Buff-breasted Sandpipers in the Arctic comes from Lindström *et al.* (2002) who suggested the relatively low weights of the birds (although relatively fat) likely indicated they followed a time-minimizing strategy for migrating through the Arctic (i.e., migrate in short hops with small fuel stores). Whether this short-hop migration continues through North America is unclear, but seems likely, given the lack of any major stopover sites. Buff-breasted Sandpipers move south between the Mississippi River Valley and the eastern edge of the Rocky Mountains, utilizing a much broader front than during northbound migration (extending across Canada, from British Columbia to Nova Scotia), although still concentrated in the interior corridor (Figures 8 and 9a, 9b) (Johnson and Herter 1989, Forster 1991, Lanctot and Laredo 1994). Migration through North America occurs over a longer period of time during southbound migration, occurring from late July through late September, although records exist outside this time period (Oring and Davis 1966, Jorgensen 2004, 2007b, 2008). Small numbers of Buff-breasted Sandpipers have been reported moving east before flying south along the west side of Hudson Bay (14 July–17 August; Jehl and Smith 1970), across the Great Lakes, and through the New England states (1 August–1 November; Palmer 1967, Campbell and Gregory 1976, Cramp and Simmons 1983; B. Harrington, pers. comm.). Based on collection location and age of museum specimens, adults and most juveniles are thought to migrate south

via the Central Flyway, whereas a small number of juveniles may use the East Coast (>200 birds/year) and, to a lesser degree, the Pacific coast of North America (25–100 birds/year; Campbell and Gregory 1976; J. Strauch and R. Russell, pers. comm.). The species is also regularly seen in Western Europe, principally in Ireland and England (25–100 birds/year; R. Russell, pers. comm.). Adults are also thought to precede juveniles through the Prairie Provinces (last 3 weeks of August versus September) (Rowan 1927).

Migration distance from the U.S. mainland to South America indicates a staging area should exist in northern South America (J. Strauch, pers. comm.). Indeed, there are records of Buff-breasted Sandpipers in Colombia during southbound migration (i.e., October) along a rather broad front, including records in the Atlantic Coast (Magdalena department), the Andes (Cauca Department) and Isla Mocagua (Amazonas department) (R. Johnston-Gonzalez, unpubl. data).

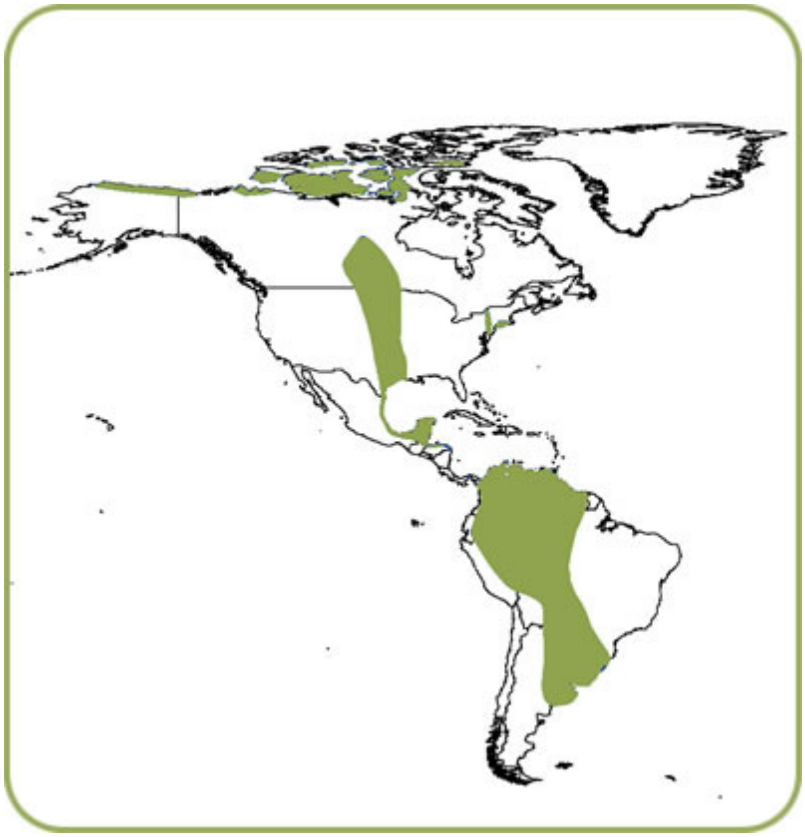


Figure 8. General migration corridor followed by Buff-breasted Sandpipers during northbound (exclusively mid-Americas) and southbound (mid-Americas and Atlantic coast) migration. Courtesy of Southern Cone Grassland Alliance website: http://www.pastizalesdelconosur.org/ficha_playeritocanela.html

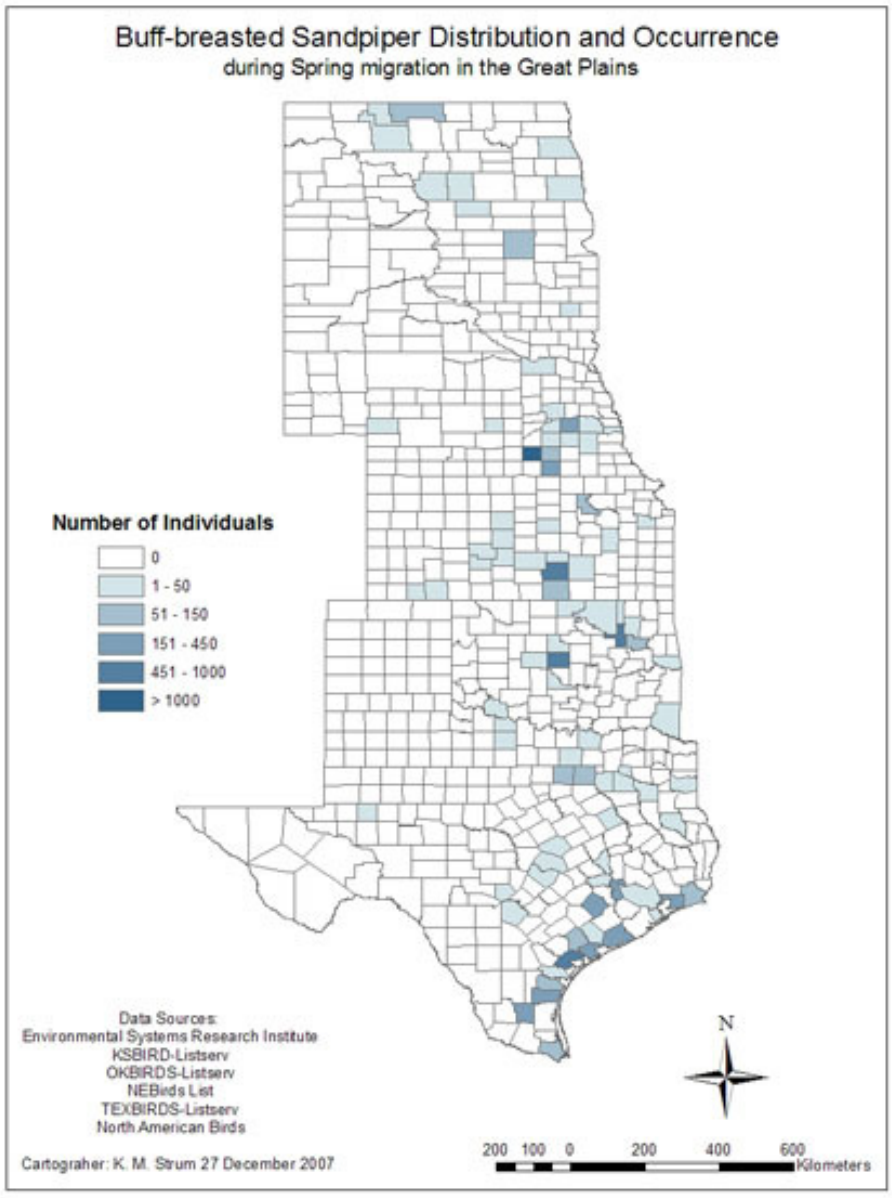


Figure 9a. Distribution and occurrence of Buff-breasted Sandpipers during northbound migration through the central United States. Compiled by K. Strum.

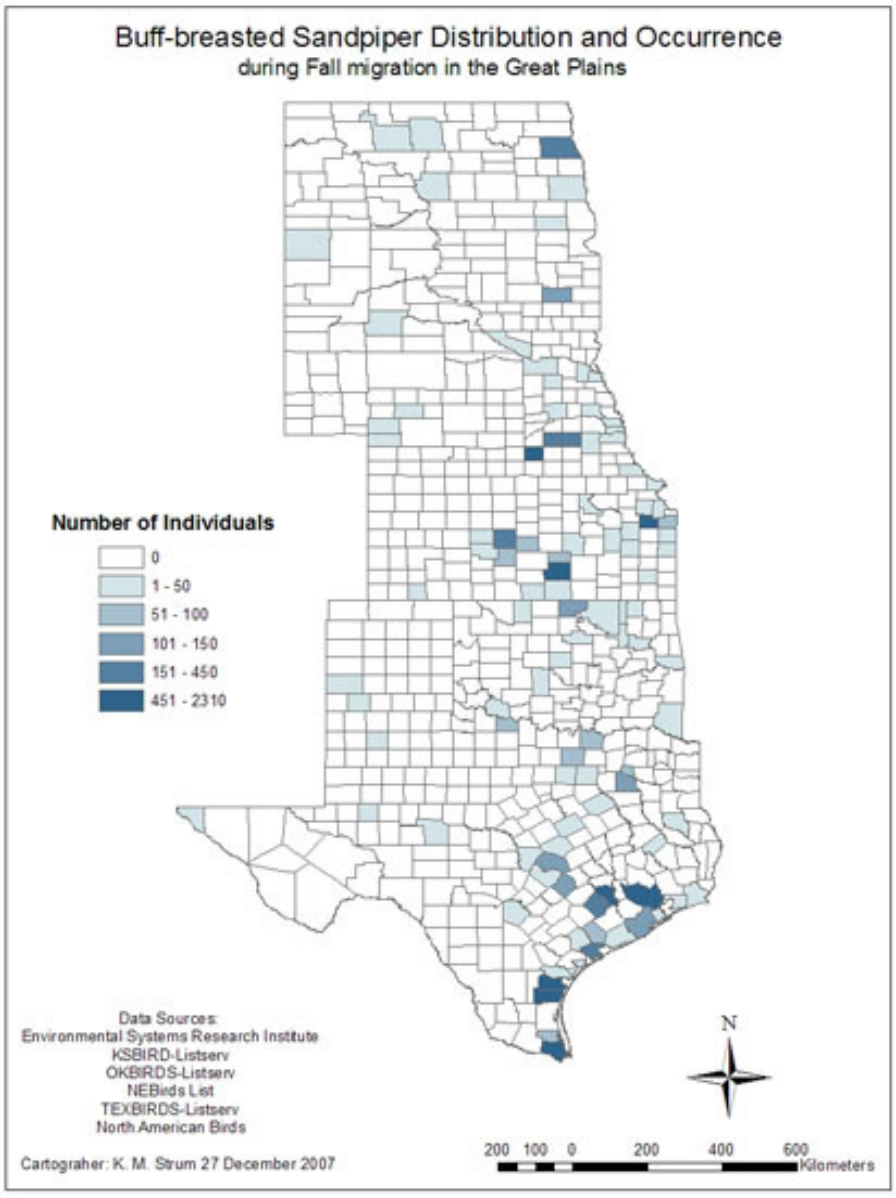


Figure 9b. Distribution and occurrence of Buff-breasted Sandpipers during southbound migration through the central United States. Compiled by K. Strum.

During southbound migration in South America, Buff-breasted Sandpipers have been reported from every country except for Chile (Wetmore 1927, Myers and Myers 1979, Rappole *et al*. 1983, Thomas 1987, Hayes *et al*. 1990, Bolster and Robinson 1990, Stotz *et al*. 1992, Lanctot and Laredo 1994, see Lanctot *et al*. 2002 for summary), although major migration routes are thought to be through the Central Amazonia/Pantanal Flyway (Figures 8 and 10) (Cramp and Simmons 1983). Preliminary survey data in the Barba Azul Nature Reserve in the Beni Savanna

of Bolivia indicate this may be the first major stopover for Buff-breasted Sandpipers flying south over the Central Amazon (B. Hennessey, pers. comm.). Buff-breasted Sandpipers are also reliably counted at Bahía de Asunción in Paraguay (61 of 92 surveys between August and December 2000–2004) with peak observations occurring in September and October (A. Lesterhuis and R. Clay, unpubl. data). Counts of shorebirds along the sandbanks of the Paraguay River (south of Asunción to Paso de Patria) indicate that this may be used as a corridor for southbound migration during years with low water levels. A total of 113 individuals were counted at nine separate locations on 14 and 15 October 2004. A week later (26, 27 October) a separate survey from Concepción to Asunción yielded one flock of 25 birds (A. Lesterhuis and R. Clay, unpubl. data). Three adults banded at Bahía de Asunción, Paraguay, in mid-September 2004 were later resighted at Lagoa do Peixe National Park in southern Brazil in early November (1 bird) and from October 2004 through January 2005 (2 birds; J. Almeida, unpubl. data). Birds begin arriving at nonbreeding grounds in late August, with the majority arriving from mid-September to mid-October (del Hoyo *et al*. 1992, Lanctot and Laredo 1994). The numbers of nonbreeding birds continue to increase until January before beginning to decline (Myers and Myers 1979, Lanctot and Laredo 1994, Isacch *et al.* 2003a, Almeida 2009, Isacch and Cardoni 2009).

Northbound Migration

Buff-breasted Sandpipers depart nonbreeding grounds in early February through mid- to late March (Palmer 1967, Myers and Myers 1979, Almeida 2009). At Lagoa do Peixe National Park in southern Brazil, monthly apparent survival rates suggests males leave about 1 month earlier than females (Almeida 2009). Northbound migration is via the central Amazonia/Pantanal Flyway (Figures 8 and 10), crossing over Brazil, Venezuela, Guyana, and Suriname (Haverschmidt 1972, Lanctot and Laredo 1994), across the Gulf of Mexico, and arriving in coastal Texas and Louisiana between mid-March and early April (Lanctot and Laredo 1994, Lanctot 1995). Considering the distances involved and the body condition of birds when first captured in the United States and before northbound migration at a nonbreeding site in Brazil, a staging area in northern South America is to be expected, but has not been documented (del Hoyo *et al*. 1992, Almeida 2009). Buff-breasted Sandpipers use Bahía de Asunción in Paraguay far less frequently during northbound migration when compared to southbound migration. The

species was observed during only 12 of 95 surveys conducted between January and July of 2001–2005, and the largest count was 25 birds (A. Lesterhuis and R. Clay, unpubl. data). No observations of birds are available for the Beni Savanna in Bolivia during northbound migration. Flocks of 500 and 100 birds have been observed in the Department of Meta, Colombia, in spring 1977 and 2007, respectively (Hilty and Brown 1986, Murillo and Bonilla 2008). Birds are also recorded regularly in Popayán Plateau of the Andes Mountains in Colombia (Hacienda Corocora, Hacienda Proviedencia in the Meta Department) (Negret 1994; Ayerbe-Quiñones *et al.* 2008, 2009; F. Ayerbe-Quiñones and R. Johnston-Gonzalez, unpubl.data).

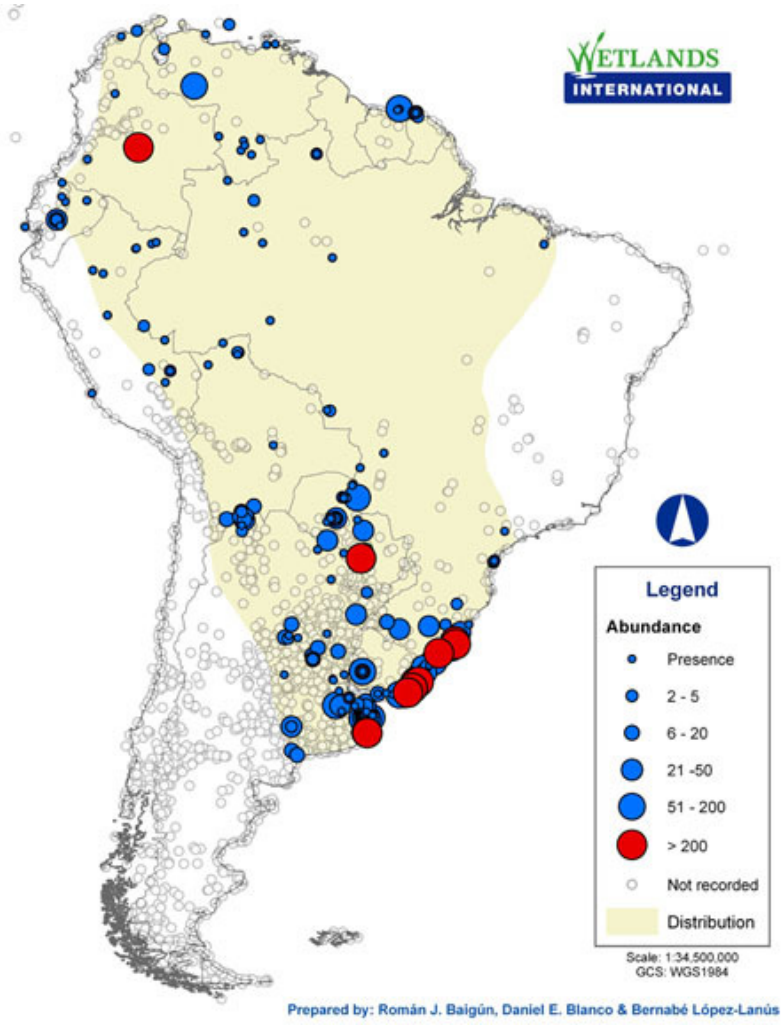


Figure 10. Observations of Buff-breasted Sandpipers during north- and southbound migration in South America based on abundance categories. Very large concentrations along the southeast coast of South America represent birds observed on the nonbreeding grounds. Note: empty circles represent counts where no Buff-breasted Sandpipers were observed. Courtesy of Daniel Blanco and Wetlands International.

Birds leave Texas and Louisiana coastal sites and migrate north in May, mostly through the interior of the continent (94–100°W longitude) (Figures 9a, 9b) (Lanctot and Laredo 1994). Oring and Davis (1966) indicated peak migration in Oklahoma was 4–17 May. Generally but consistently, peak migration in the Rainwater Basin, Nebraska, has been observed during the period 9–17 May (Morris 1978; Jorgensen 2004, 2007b, 2008; Jorgensen *et al.* 2008). Sightings of birds in Saskatchewan throughout the summer (1 May–5 October) (H.L. Dickson, pers. comm.) and at Beaverhill Lake, Alberta, into mid-June (D. Dekker, pers. comm.) suggest some birds have a "short-stop" migration and fail to reach the breeding grounds. Information on these individuals is needed. Birds arrive on the southern edge of their Arctic breeding grounds during late May or early June and more northern areas during mid-June, having completed a 13,000+ kilometer journey (Palmer 1967, Johnson and Herter 1989, R. Lanctot, unpubl. data). Males typically precede females in departing from the nonbreeding grounds (Myers and Myers 1979, Almeida 2009), yet both sexes arrive simultaneously on the breeding grounds (Lanctot and Laredo 1994). Buff-breasted Sandpipers have been recorded as early as 26 May at Demarcation Bay, Alaska (Brooks 1915 *in* Johnson and Herter 1989), and 28 May at the Colville River Delta (Simpson *et al*. 1982 *in* Johnson and Herter 1989). Buff-breasted Sandpipers are virtually unseen on Atlantic or Pacific Coasts during the spring (Bent 1927, Campbell and Gregory 1976).

MAJOR HABITATS

Breeding Range

Breeding is restricted to the tundra ecoregion (Bailey 1980), and habitat use differs according to gender and breeding stage. Males display in the first snow-free areas available, typically along barren ridges, creek banks, and raised, well-drained areas with reticulate-patterned ground and scant vegetation (e.g., *Dryas* sp.) (Parmelee *et al*. 1967, McWhorter *et al*. 1986, Pruett-Jones 1988). Within 3–5 days of arriving, most males display together although solitary display may occur in areas with lower bird densities (Prevett and Barr 1976). As snow melt occurs, displays occur in moister areas, typically graminoid meadows with *Carex aquatilis* and *Eriophorum angustifolium* as dominant vegetation types. Landform types at display areas are dominated by non-patterned ground with closely spaced tussocks about 20 centimeters high and 25–50 centimeters in diameter (Prevett and Barr 1976; R. Lanctot, unpubl. data), often with dwarf willow thickets (*Salix glauca* and *S. lanata*; Dorogoi 1983). Within 1–2 weeks, most

males abandon these sites and begin displaying around individual nest sites or leave the area altogether. Nests are on dry slopes with numerous sedge tussocks (Prevett and Barr 1976), on moss-willow-varied grass tundra (Dorogoi 1983), and in moist or wet sedge-graminoid meadows on non-patterned or strangmoor (series of aligned tussocks) ground. Females on incubation breaks can be found feeding primarily in non- and reticulate-patterned ground with scant vegetation. Such vegetation is frequently found along stream banks. Females with broods are seen primarily in moist and emergent vegetation along or in stream beds (R. Lanctot, pers. obs.). This species is also one of the few shorebirds that does not show a pronounced seasonal shift toward lowland, wet (ponded) sites during brood-rearing (Jones 1980, R. Lanctot, unpubl. data). Presence and interconnectiveness of these habitats may affect suitability of area for breeding.

Migration

In North America, birds frequent short-grass areas such as pastures, sod farms, golf courses, cemeteries, airports, freshly cut hayfields, and lawns (Campbell and Gregory 1976; Paulson 1993; Robbins 2007; K. Strum, pers. obs.); damp margins of freshwater lakes, ponds, and lagoons (Campbell and Gregory 1976; Hayman *et al*. 1986; H.L. Dickson, pers. comm.); and fields of recently planted rice, recently cut alfalfa, cotton, and potatoes (Sutton 1960, T. Collins and J. Strauch, pers. comm.). Jorgensen (2007a) reported that the species primarily used row-crop agricultural fields and, to a lesser degree, wetland habitats within the Rainwater Basin of eastern Nebraska (Figure 11). The species was five times more likely to occur in fields planted to soybeans than to corn—the two principal crops grown in the Rainwater Basin—with respect to each habitat's availability in the landscape (Jorgensen *et al*. 2007). Buff-breasted Sandpipers also preferred open areas free from human obstructions (such as farm buildings, cities, hedgerows), and areas that had historically high densities of wetlands (Jorgensen *et al.* 2007). In coastal counties of Texas, B. Ortega and M. Ealy (unpubl. data) observed Buff-breasted Sandpipers primarily in short sod grass farms and newly emerging rice fields (>2,800 hectares surveyed at 548 stops in late April and May of 2005).

Figure 11. Example of agricultural fields used by Buff-breasted Sandpipers in the eastern Rainwater Basin, Nebraska. Photos by Joel Jorgensen.

In South America, Buff-breasted Sandpipers use recently harvested and burned sugar cane fields of Suriname (Haverschmidt 1972); short grass habitats in the Popayán Plateau in the Andes of Colombia; rice fields in the Llanos-Orinoco region of Colombia; sand bars in Amazonas river of Colombia (R. Johnston-Gonzalez unpubl. data); in open, dry fields with short grasses in Brazil (Sick 1981); and on dry, sparsely vegetated sand bars in rivers in southeast Peru (Bolster and Robinson 1990) and Paraguay (A. Lesterhuis, unpubl. data). Interestingly, the species was not reported on sand bars lacking vegetation in Paraguay. Buff-breasted Sandpapers were also recorded, albeit in low numbers (<10), at saline lagoons in the Central Paraguay Chaco (Lesterhuis and Clay 2001).

Nonbreeding Range

Overall, the species depends primarily on the pampas biome of South America (Figures 12 and 13). Buff-breasted Sandpipers were located at 122 (20.9%) of 584 randomly located survey points in Argentina, Brazil, and Uruguay in 1999 and 2001 (Lanctot *et al.* 2002). The points containing birds were primarily pasturelands (85.8%), with a smaller percentage in agricultural (6.7%) and abandoned (7.5%) fields. Ninety percent of the survey points containing birds had livestock present, and most survey points were intensively grazed – 62% of points had vegetation 2–5 centimeters tall as the dominant cover type (Lanctot *et al*. 2002).

In Argentina, Buff-breasted Sandpipers were positively associated with halophytic and hydrophytic plant species (Lanctot *et al*. 2004, Blanco *et al.* 2004, Isacch and Martínez 2003b), and were found exclusively in wet pasturelands (Lanctot *et al*. 2002). Unlike Brazil and Uruguay, these lowland pastures were part of large ranches and were not restricted to lagoon

Figure 12. Typical grassland habitat used by Buff-breasted Sandpipers in Lagoa do Peixe National Park in southern Brazil. Photo by Richard Lanctot.

Figure 13. Close-up of Buff-breasted Sandpipers foraging in intensively grazed grasslands at Lagoa do Peixe National Park in southern Brazil. Photo by Juliana Bosi de Almeida.

margins. The predominant vegetation in the pastures includes *Distichlis* sp. and *Stenotaphrum secundatum* (Blanco *et al*. 1993, 2004; Isacch and Martínez 2003b), and vegetative communities dominated by *Spartina densiflora* and *Salicornia ambigua* (Isacch *et al.* 2006). The species is also found in shrub- and grassland areas adjacent to wetlands in Altiplano of northwest Argentina and southwest Bolivia (C. Laredo, unpubl. data).

In Uruguay, Buff-breasted Sandpipers were positively associated with humid prairies and halophytic steppes, and negatively associated with the mesophytic prairies. Agricultural conversion of mesophytic prairies typically results in rice fields or sown pasture. In a recent study at Estancia La Rinconada, the species was almost exclusively recorded in lowland fields with natural vegetation (as opposed to pastures planted by ranchers to non-native grasses), and more frequently in fields adjacent to the Rocha Lagoon where the average grass height varied between 3 and 7 centimeters (Blanco and Aldabe 2007). Blanco *et al.* (2006a) found few birds in growing-flooded rice fields in eastern Uruguay, and a small group of 30 individuals was seen feeding in northern Uruguayan rice fields (J. Aldabe and P. Rocca, unpubl. data). In Brazil, Buff-breasted Sandpipers were positively associated with halophytic steppes and negatively associated with rice fields. In both countries, Buff-breasted Sandpipers were found almost exclusively in

heavily grazed grasslands along the margins of salt and freshwater lagoons, although occasionally in agricultural or abandoned fields (Lanctot *et al*. 2002, 2004).

CONSERVATION STATUS

The Buff-breasted Sandpiper is categorized as "Near Threatened" by IUCN (BirdLife International 2009), is included in Appendices I and II of the Convention on Migratory Species of Wild Animals (http://www.cms.int/pdf/en/CMS1_Species_5lng.pdf), is a Bird of Conservation Concern by the U.S. Fish and Wildlife Service (USFWS 2009), and is a Red species (declining rapidly and/or have very small populations or limited ranges, and face major conservation threats) in the 2007 Audubon Watchlist (http://web1.audubon.org/science/species/watchlist/profile.php?speciesCode=bufsan). This species was categorized as High Concern in the U.S. and Canadian Shorebird Conservation Plans (Brown *et al.* 2001, Donaldson *et al.* 2001) and was increased to Highly Imperiled after its Population Trend rank was revised from a "4" to a "5" (USSCP 2004). Individual states within the breeding or migration range of the species categorize the Buff-breasted Sandpiper in the following way in their State Wildlife Action Plans:

U.S. State	Wildlife Action Plan Status
Alaska	Featured Species (1 of 7 shorebirds)
Arkansas	Bird Species of Greatest Conservation Need
Iowa	Migratory Bird of Greatest Concern
Kansas	Tier I, "Species of Greatest Conservation Need"
Louisiana	Tier I, "Species of Greatest Conservation Need"
Minnesota	Tier I, "Species of Greatest Conservation Need"
Missouri	Tier I, "Species of Greatest Conservation Need"
Nebraska	Tier I, "At-Risk" Species
North Dakota	Tier I, "At-Risk" Species
Oklahoma	Tier I, "Species of Greatest Conservation Need"
South Dakota	Tier I, "Species of Greatest Conservation Need"
Texas	High Priority Species
Wisconsin	"S3N" rare or uncommon during nonbreeding

In Argentina, the species is categorized as "Threatened" in its Red List (López-Lanús *et al.* 2008). Rio Grande do Sul, Brazil, categorizes the Buff-breasted Sandpiper as "vulnerable" on its state-level Endangered Species List; "vulnerable" is one of the three IUCN categories of

"Threatened" (Marques *et al.* 2002, Bencke *et al.* 2003). In Uruguay, the species is considered a Priority Species for Conservation through the National System of Protected Areas (Brazeiro *et al.* 2006). In Paraguay, the species is included in the national Red List and is listed as Near Threatened (del Castillo *et al.* 2005).

POPULATION GOAL(S)

Given that historically the population of Buff-breasted Sandpipers was suspected to number in the hundreds of thousands, the species has suffered a dramatic decline in population size (Lanctot and Laredo 1994). Recent evidence suggests the species may still be declining although trend data are anecdotal and fragmented. The estimated population size of the species was revised after intensive surveys were conducted during migration (Jorgensen *et al.* 2008), with the most recent population estimate at 56,000 individuals (range of 35,000 to 78,000). With this background, it is prudent to set a minimum goal of no net loss in the current population, and ideally to increase the current population size to at least 100,000 to offset expected future decreases from habitat loss, exposure to contaminants, climate change, and other threats faced by the species (see below).

CONSERVATION SITES

We define key conservation sites as those areas which support 1% or more of the biogeographic population of the species at any given time. As no subspecies have been described for the Buff-breasted Sandpiper (nor are there any known significantly large discrete breeding populations), 1% of the biogeographic population is taken to be 1% of the global population, estimated at 56,000 birds. Thus, any site holding 560 or more Buff-breasted Sandpipers qualifies as a site of global conservation importance for the species according to Birdlife International's Important Bird Area (IBA) criteria, and as a Site of Regional Importance per WHSRN criteria. Because Buff-breasted Sandpipers rarely aggregate in groups this large, we included individual sites that have at least 0.2% of the global population (or about 100 birds); we also identified "landscape areas" that collectively have at least 560 individuals. We should also point out that large aggregations of Buff-breasted Sandpipers can occur, apparently when suitable habitat conditions are limited, and thus inclusion of these sightings in our summary tables may over-exaggerate how important a given site is through time. Because of this apparently unpredictable

aggregation behavior, we have identified key conservation sites as those areas with temporally repeated observations of large numbers of birds.

BREEDING SITES

The species breeds sporadically across the Arctic Coastal Plain of Alaska and western Canada, and is typically found along river bluffs and river terraces where males establish leks for courtship display (Lanctot and Laredo 1994). They are most common near the coast and are rare visitors to inland river valleys (Johnson and Herter 1989). The species may vary dramatically in density from year to year (Lanctot and Weatherhead 1997). Historic data indicate Buff-breasted Sandpipers are relatively uncommon nesters throughout the western Canadian Arctic (bounded to the north by Melville, Bathurst, and Devon Islands) (Johnston *et al.* 2000). Contemporary data from Alaska indicate the species is frequently found along the shores of the Aichilik, Canning, Hulahula, Ikpikpuk, Kuparuk, Sadlerochit, and Sagavanirktok Rivers near the coast (Gotthardt and Lanctot 2002, Johnson *et al*. 2007). A search of the electronic database eBird revealed no sightings greater than 20 birds throughout the Canadian and U.S. Arctic regions. Similarly, of the 104 checklist records located in the Northwest Territories and Nunavut Provinces of Canada, no single site had more than 31 birds recorded (retrieved 31August 2009, Canadian Wildlife Service, Prairie and Northern Region 2008). A few statistical extrapolations indicate a fairly large number of birds occur in Alaska, although these are based on low numbers of observations and have large confidence intervals/SE/CVs (Table 1).

Based on the limited data available (Table 1, see also breeding-season density estimates above), relatively few breeding sites of importance stand out. On a landscape level, important areas may include the 1002 Area of the Arctic National Wildlife Refuge (especially the Canning River corridor), the Prudhoe Bay/Kuparuk oil field production areas (especially the Kuparuk, Sagavanirktok, and smaller river corridors), Creswell Bay on Somerset Island, Banks Island, and Jenny Lind Island. Only a limited amount of this area has any protection status (Table 1). Clearly more survey work needs to be conducted, especially in Canada, to better document key conservation sites on the breeding grounds.

MIGRATION SITES

A summary of locations where at least 100 Buff-breasted Sandpipers were recorded at migration sites over the past 50 years are provided in Table 2. This represents only a partial list of locations, as not all data are entered into paper or electronic databases such as eBird and new sightings are constantly occurring. We also include information on the habitat conditions and the protective status of these areas when available.

Northbound Migration

Based on sheer numbers and repeated observations of birds through time, the most important stopover sites identified during northbound migration include the eastern Rainwater Basin of Nebraska, especially Butler, Clay, Fillmore, Thayer, Seward, Saline and York Counties; and the Texas Gulf Coastal Plain, especially portions of Chambers, Harris, Kleberg, Nueces, and Refugio Counties; and coastal parishes of Louisiana (Table 2). B. Ortego reports that the birds frequent the entire Coastal Prairie Ecoregion of Texas and Louisiana with highest concentrations occurring in the lower coastal plain physical province. This province is generally very flat, poorly drained, has numerous depressional wetlands, and a higher preponderance of rice production. The data suggest human-altered habitats are critically important to this species, especially newly planted fields of rice, soybeans, and corn, as well as sod farms. Few of these sites have any protective status. The eastern Rainwater Basin was recently recognized as the first WHSRN Landscape of Hemispheric Importance. Insufficient data are available to identify a likely stopover site in northern South America or in southern Canada.

Table 1. List of sites (or complexes of sites) and number of Buff-breasted Sandpipers observed during **breeding**. Data limited to sites where at least 100 birds were detected.

Site	Province/State	Country	Numbers	Date	Site Designation	Source
674,000 ha "1002 Area," Arctic National Wildlife Refuge	Alaska	United States	7,684, range of 0–17,812 (8)[1]	June 2002 and 2004	National Wildlife Refuge	Brown *et al.* 2007
16-km^2 study site between east and west branch of Sagavanirktok River Delta	Alaska	United States	>40 males/survey and 36 and 29 nests in 1993 and 1994, respectively, equates to ~5 birds/km^2	June 1993 and 1994	Part of Prudhoe Bay Oil Field Complex; limited access to area by people, no hunting allowed	Lanctot and Weatherhead 1997
437 km^2, Creswell Bay, Somerset Island	Nunavut	Canada	908 ± 1,169	June and July, 1995–1997	None	Latour *et al.* 2005
139 km^2, Creswell Bay, Somerset Island	Nunavut	Canada	2.97 birds/km^2, estimate of 280 birds (5)[1]	2001	None	PRISM database; J. Bart and P. Smith, unpubl. data
Banks Island	Nunavut	Canada	2,000 (62)[1]	May–June 1952, May–August 1953	Portions protected	Manning *et al.*1956
1,200 km^2, near big Snow Goose Colony, Banks Island	Nunavut	Canada	3.4 birds/km^2 near colony and 1.1 birds/km^2 >10 km from colony (16)[1]	June 2000 and 2001	Banks Island Bird Sanctuary No. 1	P. Latour, Canadian Wildlife Service Occasional Paper (in prep)
Alaska Coastal Plain: Point Lay to Demarcation Point	Alaska	United States	42,558 ± 18,846 (SE), CV = 0.44 (25)[1]	June 1998–2004	Portions protected as National Wildlife Refuge, 10-year no development protection on Teshekpuk Lake Special Area	PRISM database; J. Bart and P. Smith, unpubl. data

[1] Numbers in parentheses refer to actual number of birds observed during surveys that were extrapolated to generate population estimates.

Table 2. List of sites (or complexes of sites) and the number of Buff-breasted Sandpipers observed during **southbound migration (SM) and northbound migration (NM)**. Data limited to sites where at least 100 birds were detected. Site designation criteria: BIRE = Biosphere Reserve, NP = National Park; NWR = National Wildlife Refuge, EE = Ecological Station, IBA = Important Bird Area, IBP = International Biological Programme, RAMSAR = Ramsar site, PR = Provincial Reserve, TNC = The Nature Conservancy, WPA = Waterfowl Production Area, WHSRN = Western Hemisphere Shorebird Reserve Network Site, WMA = Wildlife Management Area.

Site	Province/State/ Department	Country	SM Numbers	NM Numbers	Date	Habitat	Site Designation	Source[1]
Suffolk Co., Sagaponack, East Long Island	New York	United States	100		9 September 1997	Potato fields		NAB 32 (2)
Accomack Co., Chincoteague National Wildlife Refuge	Virginia	United States	105, 117, 211, 340		11, 14, 15, 20 September 1980		NWR, WHSRN (partial)	NAB 35 (2)
Vancouver Island, Alberni-Clayoquot Regional District, Tofina	British Columbia	Canada		200	24 May 1974			NAB 28 (4)
Essex Co., Pelee	Ontario	Canada	142		10 Sept. 1977			NAB 32 (2)
Beaver Co., Tofield	Alberta	Canada		300	21 May 1973			NAB 27 (4)
Beaver and Lamont Co., Beaverhill Lake	Alberta	Canada		700	28 May 1984		WHSRN (Beaverhill)	NAB 38 (5)
Quill Lakes	Saskatchewan	Canada	125		July – December		RAMSAR, IBP, WHSRN, IBA	Skagen *et al.* 1999
Saskatoon Co., Saskatoon	Saskatchewan	Canada		2,200, 137	25 May 1985, 25 May 1968			NAB 22 (4), NAB 39 (3)
Buffer Lake, NE of Saskatoon	Saskatchewan	Canada		200	January – June		IBA	Skagen *et al.* 1999
Oak Hammock Marsh, 30 km N of Winnipeg	Manitoba	Canada	100, 100		11 Aug. 1984, 8 Aug. 1996		RAMSAR, IBA, WMA	NAB 39 (1), NAB 51 (1)
Dakota Co., Castle Rock	Minnesota	United States	250		11 August 2002			NAB 57 (1)
Dakota Co., Empire	Minnesota	United States	164		6 August 2001			NAB 56 (1)
Big Stone Co., Big Stone	Minnesota	United States	162		8 August 2001			NAB 56 (1)

Site	Province/State/ Department	Country	SM Numbers	NM Numbers	Date	Habitat	Site Designation	Source[1]
Dane and Columbia Co.	Wisconsin	United States	235		August – September 1980	Sod farms, sheep pastures		NAB 35 (2)
Grand Forks Co., Grand Forks Sewage Lagoons	North Dakota	United States	130		31 July 1982	Fallow field		NAB 36 (6)
Brown Co.	South Dakota	United States		100	16 May 1998			NAB 52 (3)
Kingsbury Co., W of Oldham	South Dakota	United States	100		27 July 1996			NAB 50 (5)
Red Rock Reservation	Iowa	United States	135		1 September 1998		Red Rock Native American Reservation	NAB 53 (1)
Fremont Co., Riverton Wildlife Management Area	Iowa	United States	257		2 August 1987		WMA	NAB 42 (1)
Clay Co., Clay Airport	Missouri	United States	100		30 August 2000			NAB 55 (1)
849,028 hectares, eastern Rainwater Basin	Nebraska	United States		78,960 ± 26,000 (SE) (660)[2], 35,000 ± 6,000 (SE) (602)[2]	5–23 May 2004, 4–21 May 2005	Primarily corn and soybean fields	IBA, WHSRN Landscape	Jorgensen *et al.* 2008
Antelope Co., SE side of RDS 868 and 532	Nebraska	United States		321	15 May 2006			NEBirds
Butler Co, mile NE of Garrison	Nebraska	United States		200	16 May 2005	Flooded field		NEBirds
Clay Co.	Nebraska	United States		266, 115, 312, 300, 346	28 May 2001, 19 May 2002, 11 May 2003, 10 May 2004, 14 May 2006			NEBirds

Site	Province/State/ Department	Country	SM Numbers	NM Numbers	Date	Habitat	Site Designation	Source[1]
Clay Co., Sandpiper WMA	Nebraska	United States		300	7 May 2004		WMA	NEBirds
Seward Co.	Nebraska	United States		125	17 May 2007	1		NEBirds
Clay Co., Field W of Sutton	Nebraska	United States		216	14 May 2005	Agricultural field		Jorgensen 2007b
Clay Co., Hruska Mean Animal Research Center, 5 miles N of Smith WPA	Nebraska	United States	317		30 July 2003	hayfield		Jorgensen 2007b
Fillmore Co., Wilkins WPA	Nebraska	United States		140	20 May 2005		WPA	Jorgensen 2007b
Fillmore Co., Field 3 miles S of Miller's Pond WPA	Nebraska	United States		116	17 May 1997	Agricultural field		Jorgensen 2007b
Seward Co., Field near Utica	Nebraska	United States		264, 255	15 May 2006, 21 May 2006	Agricultural field		Jorgensen 2007b
Seward Co., Field N of North Lake Basin WMA	Nebraska	United States		259	10 May 2003	Agricultural field	WMA	Jorgensen 2007b
Seward Co. Goehner	Nebraska	United States	151		2 Aug 2003	Hayfield		Jorgensen 2007b
Thayer Co., Northern	Nebraska	United States		226	11 May 2007	Field		Jorgensen 2007b
York Co., NW corner	Nebraska	United States	172		27 July 2003			NEBirds
York Co., Kirkpatrick Basin South WMA	Nebraska	United States		700	10 May 2006		WMA	Jorgensen 2007b
York Co., Field near Houston	Nebraska	United States		622	17 May 2008	Agricultural field		Jorgensen 2008
York Co., Freeman Lake	Nebraska	United States		162, 312, 322	10 May 1997, 17 May 2003, 21 May 2006			Jorgensen 2007b

Site	Province/State/ Department	Country	SM Numbers	NM Numbers	Date	Habitat	Site Designation	Source[1]
Cheyenne Co., Cheyenne Bottoms SWA	Kansas	United States	182		10 September 1982		WMA and TNC; WHSRN	eBird 2009
Douglas Co., Pine Sod Farm, N and S of US highway 40 on 1500E	Kansas	United States	201		27 August 2000	Sod Farm		KSBirds
Sedgwick Co., Cranmer Sod Farm, 183rd St W and S. of 69th N	Kansas	United States	350, 150		22 and 29 August 2000	Sod Farm		KSBirds
Sedgwick Co., Cranmer Sod Farm, 1 mile N of 61st N and 183 St W	Kansas	United States	270		17 August 2000	Sod Farm		KSBirds
Sedgwick Co., Cranmer Sod Farm, ½ mile N of Colwich	Kansas	United States	119		3 August 2002	Sod Farm		KSBirds
Sedgewick Co., Sedgewick	Kansas	United States	157		7 August 2002			NAB 57 (1)
Canadian Co.	Oklahoma	United States		175	January – June			Skagen *et al.* 1999
Tulsa Co., Tulsa	Oklahoma	United States	115, 179		11 Aug. 2001, 17 Aug. 1997			NAB 56 (1), NAB 52 (1)
Tulsa Co., Haskell Sod Farms	Oklahoma	United States		377	21 May 2001	Sod Farm		OKBirds
Tulsa Co., Arkansas River at Bixby	Oklahoma	United States	160		July – December			Skagen *et al.* 1999
Kay Co., sod farm near Tonkawa exit on I-35	Oklahoma	United States	137		16 August 2003	Sod Farm		OKBirds
Oklahoma Co., Oklahoma City	Oklahoma	United States		200, 250	10 May 1986, 12 May 1979			NAB 40 (3), NAB 33 (5)
Wagoner Co.	Oklahoma	United States	120, 200, 337		3 Sept. 1992, 17 Sept. 1996, July – Dec.			NAB 47 (1), NAB 51 (1), Skagen *et al.* 1999
Wagoner Co., Coweta Sod Farms	Oklahoma	United States	281		July – December	Sod Farm		Skagen *et al.* 1999

Site	Province/State/ Department	Country	SM Numbers	NM Numbers	Date	Habitat	Site Designation	Source[1]
Cross Co., Baldwin	Arkansas	United States	172		9 September 2000			NAB 55 (1)
Baldwin Co., Gulf Shores	Alabama	United States	153		14 September 1996	Sod Farm		NAB 51 (1)
Calcasieu Parish, Calcasieu and Cameron Parish, Cameron	Louisiana	United States		170	26 April 2003			NAB 57 (3)
Jefferson Davis Parish	Louisiana	United States		137	21 April 2001			NAB 55 (3)
Lafayette Parish, Duson to Vermilion Parish, Kaplan	Louisiana	United States		222	28 March 1986			eBird 2009
Lafayette Parish, Duson to Acadia Parish, Crowley	Louisiana	United States		355	January–June			Skagen *et al.* 1999
Orleans Parish, New Orleans	Louisiana	United States	115		20 September 1980			NAB 35 (2)
Vermilion Parish, Rayne	Louisiana	United States		112	17 April 1987	Rice Field		NAB 41 (3)
279,364 hectares, Gulf Coastal Plain between Lafayette and Victoria, and up to 160 km inland	Louisiana and Texas	United States		28,058–84,174 (606)[2]	March – May 1998			W. Norling., unpubl. data
Austin Co., Horizon Sod Farms	Texas	United States	900, 750		31 Aug. 2004, 1 Sept. 2004	Sod farm		Texas Birds, eBird 2009
Bastrop Co., Barton Ranch	Texas	United States	117		9 August 1999	Ranch		Texas Birds
Brazoria Co., Brazoria National Wildlife Refuge	Texas	United States	100		10 September 1970		NWR, WHSRN	NAB 25 (1)
Brooks Co., Falfurrias	Texas	United States		250	17 April 1993			NAB 47 (3)
Burleson Co., Brazos River Bottoms	Texas	United States	900, 100		Sept. 2004, 26 Aug. 2009	Sod farm, Sod farm		NAB 59 (1), eBird 2009

Site	Province/State/ Department	Country	SM Numbers	NM Numbers	Date	Habitat	Site Designation	Source[1]
Calhoun Co., near Port Lavaca	Texas	United States	400		6 September 1997			NAB 52 (1)
Calhoun Co.	Texas	United States		1,800	30 April 1998	Rice fields		NAB 52 (3)
Cameron Co., Laguna Atascosa	Texas	United States	175		1 September 1960			NAB 15 (1)
Cameron Co., Harlingen, 1561 extension	Texas	United States	200		28 August 2006			Texas Birds
Cameron Co., La Feria Sod Farm	Texas	United States	100		30 August 2006	Sod Farm		Texas Birds
Cameron Co., by highway 803 & 1561	Texas	United states	1,001		27 August 2006	Sourghum grain stubble		Texas Birds
Chambers Co.; Cove and rice fields	Texas	United States		200, 500	28 April 1963, 15 April 1998			NAB 17 (4), NAB 52 (3)
Colorado Co., Attwater Prairie-Chicken NWR	Texas	United States	200	400	20 April 2000; 3 Aug. 2003	Grassland	NWR	Texas Birds
Galveston Co., Anahuac National Wildlife Refuge	Texas	United States		1,000	24 April 1979		NWR, WHSRN	NAB 33 (5)
Harris Co., Cedar Bayou E of Houston, west edge of Col, and Crosby	Texas	United States	300, 173, 300	825, 100, 750	30 Apr1961, 5 May 1974, 27 Apr1987, 10 May 1981, 27 Aug. 2006, 2 Sept. 2006	Last 2 sightings: Sod farms		NAB 15 (4), NAB 28 (4), eBird 2009 NAB 35 (5), ShoreTox
Hunt Co., Lake Tawakoni	Texas	United States	120		12 September 1996			NAB 51 (1)
Jefferson Co., Beaumont	Texas	United States		200	25 April 1976			NAB 30 (4)
Kleberg Co., Riviera, Ricardo	Texas	United States	300, 600		1 Aug. 1985 1 Sept. 1990			NAB 40 (1) NAB 45 (1)

Site	Province/State/ Department	Country	SM Numbers	NM Numbers	Date	Habitat	Site Designation	Source[1]
Kleberg Co., pond in S. Kleberg	Texas	United States	300		27 August 1994			NAB 49 (1)
Kleberg Co.,CR 3010	Texas	United States	300		28 August 1994			Texas Birds
Kleberg Co., Laguna Larga	Texas	United States		500	24 April 1967			NAB 21 (4)
Liberty and Chambers Co., E of Houston	Texas	United States		500	5 May 2006			Texas Birds
Matagorda Co., Bay City and East	Texas	United States		151	28 April 1996			Texas Birds
Matagorda Co.	Texas	United States	600+	400	1 May 2009, 25 Aug. 2007	800-acre Sod Farm		Texas Birds
Nueces Co., Corpus Christi	Texas	United States	110, 100, 200, 200, 1,000		22 Aug. 1963, 24 Aug. 1973, 25 Aug. 1978, 4 Sept. 1983, 11 Aug. 2001	100 and 200 in plowed fields, 100 in flooded fields		NAB 18 (1), NAB 28 (1), NAB 33 (2), NAB 38 (2), Texas Birds
Nueces Co., near Corpus Christi	Texas	United States		100, 5,000	7 April 1985 24 Aug. 2009			NAB 39 (3), eBird 2009
Nueces Co., Petronilia	Texas	United States		130	24 April 1993			Texas Birds
Refugio Co., Bayside, Rockport Area	Texas	United States		200, 400, 100	3 May 1963, 7 May 1967, 28 April 1968			NAB 17 (4), NAB 21 (4), NAB 22 (4)
Victoria Co.	Texas	United States		150	January – June			Skagen *et al.* 1999
Waller Co., Katy Prairie, Pattison Road	Texas	United States		200, 100	1 May 2005, 9 May 2009,			Texas Birds
Hacienda La Corocora	Meta	Colombia		500	February, March 1977	Pasturelands		Hilty and Brown 1986
Hacienda La Providencia	Meta	Colombia		100	Spring 2007	Rice fields		Murillo and Bonilla 2008

Site	Province/State/ Department	Country	SM Numbers	NM Numbers	Date	Habitat	Site Designation	Source[1]
Hata El Cedral	Apure	Venezuela		200	April, May 2000			Lanctot *et al*. 2002
One site in Barba Azul Nature Reserve and nearby ranch	Beni	Bolivia	850		21–25 September 2009	Dry river beds and lagune edges	IBA, Nature Reserve	G. Sanchez and B. Hennessey, unpubl. data
Bahía de Asunción	Central	Paraguay	Min of 539		12 September to 15 Dec 2000	Mudflats to grasslands	WHSRN, Ecological Reserve, IBA	Lesterhuis and Clay 2001

[1] S. Norland compiled sightings from the North American Birds/Audubon Field notes journals. This is referenced as NAB # (#) which refers to journal volume and number. K. Strum compiled information from the following references: KSBirds: Archives of the Kansas Birding Listserv, Horned Lark: Newsletter of the Kansas Ornithological Society, ShoreTox: staff of Shorebird Toxicology Project at Kansas State University, NDBirds: Birding listserv archives of North Dakota, Jorgensen (2004), NEBirds: Birding listserv archives of Nebraska, OKBirds: Archives of the birding listserv of Oklahoma, SDBirds: Birding listserv archives of South Dakota, Texas Birds: Birding listserv archives of Texas. eBird observations checked by state or province through 28 August 2009.

[2] Numbers in parentheses refer to actual number of birds observed during surveys that were extrapolated to generate population estimates.

Southbound Migration

Using the same criteria as for northbound migration, the most important stopover sites identified during southbound migration include Sedgwick County, Kansas; Wagoner County, Oklahoma; Cameron, Harris, Kleberg, and Nueces Counties in Texas; the Beni Savanna in Bolivia; and Bahía de Asunción in Paraguay (Table 2). Like the northbound migration sites, many of the preferred areas have been altered by humans and have no protective status. Insufficient data are available to identify a likely post-breeding staging in northern Canada or stopover site(s) in northern South America.

NONBREEDING SITES

In Argentina, Estancia Medaland in the southern pampas stands out as a site that has and remains to be important to nonbreeding Buff-breasted Sandpipers (Table 3). Surveys conducted on the nonbreeding grounds in 1999, 2001, and 2009 identified the importance of pasturelands in southern Bahía Samborombón. Vast ranches within the latter area accounted for 63% of the total number of Buff-breasted Sandpipers detected in Argentina. In Uruguay and Brazil, the most important areas appear to be intensively grazed pasturelands near several of the brackish lagoon systems along the Atlantic coast. Indeed, some of the largest groups of Buff-breasted Sandpipers ever recorded were detected at Ilha da Torotama and Lagoa do Peixe National Park in Brazil and at Laguna de Rocha and Laguna de Castillos in Uruguay (Table 3). Unlike the majority of breeding and stopover sites, most of the identified important sites in South America have some official designation that provides some protection from urban/agricultural development although current land management (i.e., intensively grazing) that favors Buff-breasted Sandpipers may be at odds with the management guidelines of the park or ecological station. Ilha da Torotama does not have any legal protection and the area most used by the Buff-breasted Sandpipers is a field near the Torotama Cemetery that is not officially owned by anyone. This common ownership results in constant and permanent grazing by multiple users, which favors the maintenance of low vegetation height (Santos and Braga 2007).

Table 3. List of sites (or complexes of sites) and number of Buff-breasted Sandpipers observed during the **nonbreeding** season. Data limited to sites where at least 100 birds were detected. Site designation criteria: BIRE = Biosphere Reserve, NP = National Park; EE = Ecological Station, IBA = Important Bird Area, RAMSAR = Ramsar site, PR = Provincial Reserve, WHSRN = Western Hemisphere Shorebird Reserve Network Site.

Site	Province/State /Department	Country	Numbers	Date	Habitat	Site Designation	Source
Bahía Samborombón pasturelands	Buenos Aires	Argentina	Several thousand (estimate)	Oct.– Dec. 1992 Nov. 1999, Nov.–Dec. 2001	Pastureland	RAMSAR, PR, IBA	Blanco *et al.* 1993; Lanctot *et al.* 2002; D. Blanco, pers. comm.
Bahía Samborombón pasturelands	Buenos Aires	Argentina	Max count of 115	Sept. 2008 – March 2009	Pastureland	RAMSAR, PR, IBA	Isacch and Cardoni 2009
Estancia Medaland	Buenos Aires	Argentina	2,000	1973	Pastureland	IBA	Myers and Myers 1979
Estancia Medaland	Buenos Aires	Argentina	Max counts of 262	December 1992	Pastureland	IBA	Blanco *et al.* 1993
Estancia Medaland	Buenos Aires	Argentina	Max counts of 56, 72, 130 and 133	1996–1999	Pastureland	IBA	Isacch and Martínez 2003a
Lagoa do Peixe National Park	Rio Grande do Sul	Brazil	1,900– 3,420 yearly	2002/2003 – 2004/2005	Pastureland	NP, WHSRN, RAMSAR, BIRE, IBA	Bencke *et al.* 2003, 2006; Almeida 2009
Taim Ecological Station	Rio Grande do Sul	Brazil	up to 500	2002/2003	Pastureland	EE	Bencke *et al.* 2003, 2006; Almeida 2009
Ilha da Torotama	Rio Grande do Sul	Brazil	354–556 yearly	2001, 2002/2003 – 2004/2005	Pastureland	Part of IBA Estuário da Laguna dos Patos	Lanctot *et al*. 2002; Bencke *et al.* 2003, 2006; Almeida 2009
Laguna de Rocha	Rocha	Uruguay	Max counts of 225	November 1992	Pastureland	BIRE, IBA, NP, WHSRN candidate	Blanco *et al.* 1993
Laguna de Rocha	Rocha	Uruguay	3,700 (min.estimate, including ca. 850 at Estancia La Rinconada)	October– December 2007	Pastureland	BIRE, IBA, NP, WHSRN candidate	D. Blanco and J. Aldabe, unpubl. data

Site	Province/State /Department	Country	Numbers	Date	Habitat	Site Designation	Source
Laguna de Castillos	Rocha	Uruguay	541	12 December 2001	Pastureland	BIRE, RAMSAR	Lanctot *et al.* 2002
Laguna Garzón	Maldonado	Uruguay	Hundreds	2007–2008	Pastureland	IBA	J. Aldabe, pers. comm.
Bañados de la India Muerta y San Miguel	Rocha	Uruguay	Hundreds	2007–2008	Pastureland and wetland	RAMSAR, IBA, BIRE	J. Aldabe, pers. comm.
Basalto Grasslands	Paysandú, Salto and Artigas	Uruguay	Hundreds (estimate)	2007–2008	Pastureland	IBA	J. Aldabe and P. Rocca, pers. comm.

CONSERVATION THREATS

This section presents a synthesis of the known and hypothesized threats that Buff-breasted Sandpipers may experience throughout their range. This assessment follows the nomenclature of the *Unified Classifications of Direct Threats and Conservation Actions* created by the World Conservation Union (IUCN) and the Conservation Measures Partnership (see http://www.iucn.org/about/work/programmes/species/red_list/resources/technical_documents/new_classification_schemes/).

BREEDING RANGE

Energy Production and Mining: Oil & Gas Drilling

Infrastructure development, such as building of gravel areas used to site buildings, runways, and roads needed to extract oil and gas resources in northern Alaska and Canada, may have negative effects on the Buff-breasted Sandpiper. These developments are frequently sited in drier upland habitats to avoid impacting wetlands, but as a result they alter habitats typically used by the species during the display period (Lanctot and Laredo 1994).

The availability of garbage around development sites and Arctic communities may increase predator populations and be indirectly responsible for higher predation of nests and juveniles by species such as Arctic Fox (*Vulpes lagopus*), Red Fox (*Vulpes vulpes*), Glaucous Gull (*Larus hyperboreus*), and Common Raven (*Corvus corax*; Murphy *et al*. 1987, Day 1998, Leibezeit and Zack 2008; R. Lanctot, unpubl. data). This may be particularly true in oil fields, where trapping or hunting of animals is prohibited. However, a recent study that sought to address this issue could not find any effect from human infrastructure on nest survival of shorebirds (Liebezeit *et al*. 2009). Despite this finding, the study's authors indicate high variability in environmental conditions, nest survivorship, and predator numbers between sites and years which may have compromised their ability to detect subtle effects of infrastructure on shorebirds if they occurred.

Climate Change: Habitat Shifting & Alteration

The Arctic has warmed rapidly over the past 50 years and is predicted to experience striking changes in climate conditions (Arctic Climate Impact Assessment 2004). Climate

models predict longer growing seasons and warmer temperatures, which are already thought to be responsible for advancement of spring phenology (Durant *et al.* 2007) and increasing density and northward advancement of shrubs (Sturm *et al.* 2001). In addition, accelerated ice wedge degradation and accompanying thermokarst pond development have increased the proportion of land covered with surface water (Shur *et al.* 2003). Beyond direct effects on habitat conditions, earlier snowmelt may decouple the apparent synchrony between the breeding chronology of birds and food availability (MacLean 1980, Durant *et al.* 2007, Tulp and Schekkerman 2008). For example, the timing and availability of surface-active insects is critical to shorebirds for egg production (Klaassen *et al.* 2001) and chick growth (Schekkerman *et al.* 2003). Decoupling of these events could negatively affect shorebird productivity and survival. Alternatively, longer growing seasons, which are predicted to occur primarily during the latter part of the summer, could lengthen the time insects are available for consumption, providing more flexibility for birds to initiate or replace lost clutches (Naves *et al.* 2008) and for chicks to develop – such changes would increase productivity. However, these longer growing seasons may also allow other species to expand northward (Thomas and Lennon 1999), resulting in more competition for resources. How Buff-breasted Sandpipers will cope with these changes is unknown.

Species Stresses: Disease

Considerable effort and finances have been expended recently to assess Buff-breasted Sandpipers and other shorebirds and waterbirds for the presence of avian influenza (e.g., Ip *et al.* 2006). Funds have been appropriated specifically to capture and sample Buff-breasted Sandpipers on the Arctic breeding grounds (2006–2009) and during migration (2006) (R. Lanctot and B. Sandercock, unpubl. data). To date, scientists are aware of no cases where either high or low pathogenic avian influenza has been detected. Other potential deseases that might be worth testing for include malaria, West Nile virus, and Newcastle disease.

MIGRATION

Thomas *et al.* (2006) conducted a comparative study of North American shorebirds to elucidate factors that make some shorebird species more prone to decline than others. They tested migratory behavior (route and distance), biogeography (population size and range), life history (body size, clutch size), and sexual selection (social mating system and testis size) on

population trends in North American breeding shorebirds. Trend scores were based on data presented in U.S. Shorebird Conservation Plan (2004). Using phylogenetic comparative methods, they showed that species that migrate across continental North America are more prone to decline than species that do not. Below we present some threats that Buff-breasted Sandpipers face while traveling along the Central Flyway of North America and the Amazonia/Pantanal Flyway in South America.

Agriculture: Annual non-timber crops, Livestock Farming, & Ranching

Conversion of native grasslands or pastures to agriculture and suburbs along the migration corridor has resulted in an enormous loss of habitat for upland shorebirds (Lanctot 1995). Grassland areas that have been preserved in the United States are frequently very small and few are managed to make them appropriate for Buff-breasted Sandpipers (i.e., short vegetation). Large blocks of grasslands may be favored by the species given data from migratory birds in Nebraska indicating they occurred more frequently in open areas free from human obstructions (Jorgensen *et al.* 2007). Historically, the tall-grass prairie ecosystem was maintained by natural fires and grazing by large herds of ungulates. These disturbances resulted in a mixture of short- and mixed-grass prairies that provided short vegetated areas that were beneficial to the Buff-breasted Sandpiper. Efforts should be made to mimic historic disturbances by incorporating prescribed burning and grazing into grassland management plans.

Currently, the overall loss and alteration of existing grasslands appears to have led Buff-breasted Sandpipers to use cultivated agricultural lands (primarily corn, soybean, and rice fields). Although birds appear to use such areas frequently (Table 2), the quality of some of the sites may be declining. Lee Morris (pers. comm.) suggested that the declines he observed on his farm in the eastern Rainwater Basin of Nebraska may have been a result of changing agricultural practices that lessened the attractiveness of actively planted cornfields. He pointed out that the recent practice of using no-till agriculture, as opposed to deep plowing, may reduce the number of invertebrates available to sandpipers to feed upon. Even if agricultural areas remain viable habitat for Buff-breasted Sandpipers, they may pay a cost for using these areas. Potential threats may include decreased prey diversity and availability, and exposure to pesticides and herbicides (see below, Jorgensen 2007a, Strum *et al.* 2008). Future threats to existing agricultural areas may include conversion to exotic "tall" grasses (e.g., canary grass) that can be used in cellulosic

ethanol development. Agricultural practices may also change if droughts forecasted for the Great Plains (see Climate Change: Storms, Flooding, and Droughts section) become a reality. The lack of water may preclude or at least limit water intensive crops such as rice and sod farms.

Pollution: Agriculture

Exposure to pesticides and herbicides used on lands frequented by Buff-breasted Sandpipers during migration may pose a threat to the species (Flickinger *et al.* 1986; Blanco *et al.* 2006a; J. Strauch unpubl. data). Such lands include agricultural fields (e.g., rice and alfalfa), sod and stubble fields, golf courses, airport runways, and cemeteries. Pesticide exposure has been implicated in the decline of other upland species in South America (White 1988 *in* Lanctot and Laredo 1994). Such chemical exposure may cause individuals to die, and sublethal doses of pesticides can reduce birds' survival, growth, and reproduction rates as well as negatively impact their prey. Three adult Buff-breasted Sandpipers died from feeding on planted rice seed treated illegally with Furadan 4F in Calhoun County, Texas, in 1983 (Flickinger *et al.* 1986), and die-offs from the granular form of Furadan were observed in Nebraska in the 1970s (L. Morris, pers. comm.). Death of other sandpiper species (Western [*Calidris mauri*] and Pectoral [*Calidris melanotos*]) has been attributed to exposure to Furadan 3G, a rice pesticide closely related to Furadan 4F (Flickinger *et al.* 1986). The U.S. Environmental Protection Agency recently ruled that Furadan could no longer be used in the United States, thus these impacts should lessen throughout the country. Furadan 4F and Furadan 5G can still be legally sold in Uruguay (and likely Brazil) as of 15 July 2009 (www.mgap.gub.uy/DGSSAA). Strum *et al.* (2010) found that Buff-breasted Sandpipers sampled in agricultural fields of Argentina in 2006 had plasma acetyl cholinesterase and butyryl cholinesterase activity levels indicative of exposure to organophosphorus and carbamate pesticides typically used to control agricultural pests. Unexpectedly, Buff-breasted Sandpiper samples from agricultural sites in North America did not show exposure to such chemicals. While the reason for this disparity is unknown, it is clear that Buff-breasted Sandpipers in Argentina are being exposed to pesticides and, as such, may suffer from direct mortality and sub-lethal effects such as loss of migratory orientation and decreased flight speed (Strum *et al.* 2010).

Biological Resource Use: Shooting

Buff-breasted Sandpiper numbers declined dramatically in the late 1800s and early 1900s due to commercial harvesting (Lanctot and Laredo 1994). This species was harvested most heavily in the central United States and, to a lesser degree, on the South American wintering grounds (Blanco *et al.* 1993). Since 1918, Buff-breasted Sandpipers have been protected by the Migratory Bird Treaty Act in the United States and Canada (Lanctot and Laredo 1994). Currently, shooting of Buff-breasted Sandpipers is thought to be minimal or non-existent throughout their range (Lanctot and Laredo 1994, Lanctot 1995), although birds are occasionally taken for scientific purposes (e.g., museum specimens, avian influenza testing) (R. Lanctot, pers. obs.) and at commercial airports to prevent accidents (R. Russell, pers. comm.) under the U.S. Fish and Wildlife Service permit process.

Climate Change: Storms, Flooding, & Droughts

Climate change is also expected to affect broad-scale climatology; most notable is change in the position, frequency, and seasonality of storm tracks, especially in the Northern Hemisphere (Brayshaw 2005, Bengtsson *et al.* 2006, Yin 2006). How Buff-breasted Sandpipers will be affected by this during migration is unknown but the increase in severe (hurricane-force) storms over the western Atlantic in late summer will likely lead to direct and indirect increases in mortality of juveniles (that tend to migrate along the Atlantic Coast during fall migration) due to difficulties in successfully completing migration over open oceans and altered coastal habitats (Michener *et al.* 1997). Global warming is also projected to cause severe droughts within the Great Plains of the United States, resulting in the extensive loss of temporary wetlands (Woodhouse and Overpeck 1998). Loss of these wetlands may also result in less foraging habitat for shorebirds (Skagen 2006), although the fact that Buff-breasted Sandpipers use upland areas now may buffer them from this negative effect. Severe droughts and flooding have also led to changes in how Buff-breasted Sandpipers use Asunción Bay and nearby river corridors in Paraguay (R. Clay and A. Lesterhuis, pers. comm.).

Energy Production and Mining: Renewable Energy (Wind Fields)

The United States ranked second in the world in highest cumulative wind capacity as of the end of 2007 and development of wind power increased by 46% in 2007 (USDOI 2007). Wind development is expected to continue, and perhaps accelerate, due to the emphasis of the United States' energy policy on expanding energy development into areas that reduce dependence on foreign oil and promote a reduction in carbon emissions. Indeed, wind energy development is booming in the Great Plains (e.g., Oklahoma, Minnesota) (Pruett *et al.* 2009, R. Russell, pers. comm.) and the coastal regions of Texas and Louisiana (B. Howe, pers. comm.), and studies designed to evaluate the possible environmental impacts of wind fields on bird species cannot keep pace with the erection of towers (Pruett *et al.* 2009). [*Note*: we prefer the term wind "fields" as opposed to wind farms as the word "farms" sounds innocuous]. Studies conducted to date generally indicate a negative impact to raptors (see e.g., de Lucas *et al.* 2008, Farfán *et al.* 2009) and prairie-grouse (see e.g., Robel *et al.* 2004), and less so for smaller, non-migratory passerine species (see e.g., Devereux *et al.* 2008, Farfán *et al.* 2009). To our knowledge, there has been little to no studies done on shorebirds. A pre-construction study conducted by West Inc. (unpubl. report) found that >20% of American Golden-Plovers (*Pluvialis dominica*) staging in Indiana were flying within the rotor sweep zone when moving between foraging fields. Rather than having direct mortality, large wind fields might also cause grassland shorebirds to avoid historic staging areas. We suggest studies be conducted to assess, avoid, minimize, and mitigate for potential impacts. This is particularly important given 1) impacts of wind turbines appear to vary depending on species, turbine size and height, number of turbines, and topographical and geographical location (Barclay *et al.* 2007, de Lucas *et al.* 2008, Desholm 2009, Rothery *et al.* 2009); and 2) large development projects are planned for staging areas used by Buff-breasted Sandpipers and other shorebirds on the U.S Gulf Coastal Plain and Great Plains. Further, we recommend following guidelines put forth by the U.S. Fish and Wildlife Service's Wind Turbine Guidelines Advisory Committee (USDOI 2007; see draft guidelines at: http://www.fws.gov/habitatconservation/windpower/Wind_FAC_Synthesis_Workgroup_Draft_v6_for_Release_Oct_26_2009.pdf).

NONBREEDING RANGE

Agriculture: Annual non-timber crops

The nonbreeding area has undergone extensive agricultural development during the past century (Soriano *et al.* 1991), with cropland replacing native grasslands in most of the region (León *et al.* 1984). For example, more than 60% of the rangelands in the Argentine Pampas have disappeared over the period 1880–2000 (Viglizzo and Frank 2006). Loss has been particularly rapid in recent decades with a shift from cattle/sheep ranching to crops in the most fertile grassland areas (Viglizzo *et al*. 2005). This shift has been, in part, the result of increasing demand (and high prices) for biofuels derived from soybean. In the future, the development of second- and third-generation biofuels, potentially combined with the cultivation of exotic grasses, could lead to the loss of additional areas of grassland habitat. Remaining grasslands are conserved because flooding and saline soils constrain agricultural development (León *et al.* 1984), although the amount of land in agriculture varies with rainfall, livestock prices (meat, wool), and other factors that affect the economics of ranching and agriculture. Indeed, Oesterheld (1993) reported large fluctuations in the proportion of land devoted to cropping and animal husbandry in the Rio de la Plata Grassland of Argentina during the past 20–30 years. These changes appear to be directly related to the price of beef and grain.

In Laguna de Rocha and Laguna de Castillos, Uruguay, cattle pastures (termed paddocks in Uruguay) historically used by Buff-breasted Sandpipers could be transformed to agriculture (such as potato crops, but also soybean and artificial prairies). For example, in Bañados de la India Muerta and San Miguel regions of Uruguay, cattle pastures have been changed to rice fields and, to a lesser extent, soybean fields. In Brazil, an additional threat associated with expanding rice farms is the building of illegal drainage canals within the lagoon basins to irrigate rice fields or to drain areas to expand farming (Bencke *et al.* 2006). Such canals are prevalent at Taim Ecological Station, outside of Lagoa do Peixe National Park, and the Várzea do Canal São Gonçalo in Brazil, as well as in the pampas of Argentina. These canals are particularly problematic in dry years when farmers may pump water legally (or illegally) from the lagoons, reducing the water levels in pastures near the lagoon's edge, making them less suitable for Buff-breasted Sandpipers (Blanco *et al.* 2006b).

Agriculture: Livestock Ranching

The value of livestock pastures to Buff-breasted Sandpipers is dependent on appropriate ranch management (Lanctot *et al.* 2002, Aldabe and Blanco 2009, Isacch and Cardoni 2009). The introduction and movement of livestock at a local and regional level may indirectly have strong within- and among-year effects on the distribution and abundance of Buff-breasted Sandpipers. For example, pastures where grazing has only recently begun may not be suitable for Buff-breasted Sandpipers, but in a few months these same pastures might be of the correct vegetation height (i.e., 2–5 centimeters tall) (Lanctot *et al.* 2004). Observations at a limited number of sites visited in multiple years confirmed this. Areas with intensive grazing in 1999 had Buff-breasted Sandpipers present but these same areas had no birds when the grass was higher in 2001 (and vice versa) (Isacch 2001; R. Lanctot, pers. obs.). Additionally, pastures may never become suitable if livestock are moved too quickly among pastures (i.e., to minimize overgrazing), are introduced too late in the austral summer, or are removed altogether. Researchers recently experimentally tested how Buff-breasted Sandpipers and American Golden-Plovers responded to three cattle-grazing management options in the Bahía Samborombón pasturelands of Argentina (Isacch and Cardoni 2009). Treatments included continuous grazing, rotational grazing, and winter grazing. Both species used grasslands where the percentage of short grass cover was near 100%. This was most common in the continuous-grazing and rotational-grazing management options (Isacch and Cardoni 2009).

The removal of cattle may occur when land is acquired by conservation agencies and the livestock are removed to allow vegetation to grow for the benefit of other wildlife species. While advocating protection of areas for all wildlife, we believe a portion of these areas should be managed to maintain intensely grazed pasturelands. Ideally, these areas should be managed so that parcels of land with short vegetation are available throughout the austral summer (i.e., to accommodate early- , mid- , and late-arriving nonbreeding Buff-breasted Sandpipers). Such a grassland management plan will benefit other Nearctic (e.g., American Golden-Plovers) and Patagonian migratory shorebirds (e.g., Rufous-chested Dotterel [*Charadrius modestus*] and Tawny-throated Dotterel [*Oreopholus ruficollis*]) that also use these areas (Isacch and Martínez 2003b). Buff-breasted Sandpipers and American Golden-Plovers are frequently together in the nonbreeding areas (Blanco *et al.* 1993, Lanctot *et al.* 2002; Isacch *et al.* 2003a,b).

Removal of cattle is of particular concern at Lagoa do Peixe National Park and Taim

Ecological Station in Brazil. Federal law requires that cattle be removed once the properties are bought from local ranchers; at the moment, these sites are federally mandated conservation sites but most of the land has not been purchased by the government. Thus, ranchers currently have permission to live at their properties as well as to conduct ranching and farming operations, although some restrictions have been imposed. For example, at Taim Ecological Station landowners are restricted from cleaning the fields (burning and mowing of pastures), in the number of cattle that can be put on pastures, and from planting certain crops (Santos and Braga 2007). It seems possible that the management plans of the park and ecological station may be revised to include intensive grazing in some areas, given studies are conducted to verify Buff-breasted Sandpipers no longer use an area once cattle are removed (Santos and Braga 2007).

In Argentina, Brazil, and Uruguay, the "improvement" of cattle pastures by planting non-native grasses (e.g., rye grass, clover, trefoil, millet, pangola, oats, aruana) may also be detrimental to Buff-breasted Sandpipers, although some evidence suggests the species still uses these areas under particular conditions (Blanco *et al.* 2006b, Santos and Braga 2007). For example, in January 2008, under very windy conditions, 50% of Buff-breasted Sandpipers observed at Estancia La Rinconada, located in the pampas of Uruguay, were found in improved grassland paddocks. Typically, almost 100% of the birds are in paddocks with native pasture plants (Aldabe and Blanco 2009). In Laguna de Rocha, Uruguay, natural grasslands are also being substituted by other plant species, such as *Juncus acutus*, that decreases habitat suitability in paddocks located along the lagoon margin (J. Aldabe and D. Blanco, unpubl. data). Management of this fast-growing plant species may need to be conducted.

Other Forms of Development: Wood Plantations, Mining, & Tourism

Other forms of development such as mines and pine plantations in Brazil, construction of roads and buildings for tourism in Brazil and Uruguay, and the subdivision of ranches in Argentina may also have a negative effect on the species (Sagrera 1999, Blanco *et al.* 2006b; G. Maurício, G.A. Bencke, and J.P. Isacch, pers. comm.). Pine plantations are particularly problematic around Brazil's Lagoa do Peixe National Park, where some 15,000 hectares of trees have been planted. The dispersal of seeds, driven by wind and water, is causing wild populations to begin growing inside the park boundaries (Santos and Braga 2007). In addition, government policies that promote cattle ranching in the interior of Brazil and the conversion of pasturelands

to timber production in southern Brazil may soon result in more planned and unplanned (via seed dispersal) forests.

Biologists have been able to guide mining activities away from Buff-breasted Sandpiper habitat in Brazil. Several years ago, they were able to negotiate the location of an 8,000-hectare mine project south of Lagoa do Peixe to habitats not being used by Buff-breasted Sandpipers. Further, this mine site is to be approved under the condition that the Capão da Areia Marsh be protected and added to the Lagoa do Peixe National Park (G.A. Bencke, unpubl. data). Both areas are currently used extensively by Buff-breasted Sandpipers.

Of particular concern is the building of a bridge that would span the mouth of Laguna Garzon, Uruguay. Completion of this project would substantially increase urban development and the number of people visiting Laguna de Rocha, Uruguay.

Pollution: Agriculture

Buff-breasted Sandpipers may be exposed to organochlorines in rice fields on the nonbreeding grounds in Brazil, Uruguay, and Argentina (Lanctot *et al*. 2002, Blanco *et al.* 2006a, Strum *et al.* 2010). Furthermore, natural grasslands in the Rio de La Plata Grassland are being increasingly ploughed and replaced by sown pastures that are supplemented with imported fertilizers and other agrochemicals (Lanctot *et al*. 2002). Agrochemicals such as fungicides, insecticides, and herbicides are used regularly in rice fields of southern Brazil (Santos and Braga 2007). *See similar section under Migration for more information*.

Pollution: Garbage & Solid Waste

The dumping of garbage in open pasturelands and near lagoon systems is not that uncommon in portions of the species's nonbreeding range (Santos and Braga 2007). The decomposition of this trash can lead to contamination of small streams and eventually uptake within the flora and fauna of the area.

Species Stresses: Disease

Because of the large influx of Nearctic migrants into South America each year and the highly contagious nature of highly pathogenic H_5N_1 avian influenza (HPAI) that might result in

large numbers of domestic poultry dying, virtually all countries in South America, including those in the nonbreeding range of the Buff-breasted Sandpiper, have been concerned about the spread of this disease into South America. The Wild Bird Global Avian Influenza Network for Surveillance (GAINS) has operated in most countries in South America. Through this network, studies have been conducted to document the distribution and abundance of waterfowl and shorebirds (see e.g., Blanco *et al.* 2007) and capture birds. Although many birds have been captured, no positive-result occurrences of HPAI have occurred.

Climate Change: Habitat Shifting & Alteration

Climate change is expected to result in sea levels rising, inundating many low-lying coastal and intertidal areas. This could have important implications for the coastal areas used by Buff-breasted Sandpipers during the nonbreeding season, such as along the Samborombón Bay, Lagoa do Peixe, and Laguna de Rocha, three of the main nonbreeding areas in Argentina, Brazil, and Uruguay, respectively. Low-lying areas are heavily used by the species because they have remained largely intact due to the salinity of the soils. Sea-level rise may flood areas or result in higher salt levels, which may result in areas no longer being available or suitable. Another consequence of global climate change in the nonbreeding range is the increase in heavy rainfalls (Viglizzo *et al.* 1995, Collischonn *et al.* 2001). Such rains will flood the lowland areas heavily used by shorebirds (Figure 14). Indeed, during the last four decades the rainfall regime has been higher than the historic mean in east-central Argentina (Viglizzo *et al.* 1995, Berbery *et al.* 2006), with 10 to 30% increases over the last 50 years, and an associated increase in the occurrence of heavy rainy periods (Berbery *et al.* 2006). In this area, rainfall regime is also affected by the El Niño Southern Oscillations (ENSO), which cyclically result in an increase in precipitation from southern Brazil to central Argentina (Viles and Goudie 2003). The ENSO has led to higher water levels in estuaries associated with lagoons like the Argentina's Mar Chiquita coastal lagoon (Reta *et al.* 2001, Canepuccia *et al.* 2007).

Figure 14. Taim Ecological Station in southern Brazil in February 2003 (left) and December 2004 (right), showing the large disparity in water levels associated with heavy rainfalls. Photos by Juliana Bosi de Almeida.

CONSERVATION STRATEGIES AND ACTIONS

GENERAL OVERVIEW

Over the past two decades we have learned a considerable amount about Buff-breasted Sandpipers. Perhaps most striking are the recent population estimates that indicate the species is more numerous than previously thought. These estimates are very preliminary and efforts are needed to refine them (e.g., using turnover rates at migration sites), and to generate additional estimates in other areas of their annual cycle. Despite these slightly higher estimates, the large historic decline of the species and the fact that all information to date shows the species is still declining should give us pause, should efforts be made to delist the species. Of equal value has been the considerable amount of information learned about the habitat use by the species, especially given that the Buff-breasted Sandpiper uses human-altered habitats to such a great extent. This information allows managers ample opportunity to alter habitats in ways that benefit the species; it could also be detrimental to the species because it suggests the species may be exposed to agrochemicals frequently used on such human-altered habitats. Much of the conservation strategies and actions listed below are geared toward obtaining better population estimates and working with local people to promote suitable habitat conditions throughout the species's migration and nonbreeding areas.

COMMUNICATION/COORDINATION OF CONSERVATION STRATEGIES/ACTIONS

Much of the information present in this conservation plan came from members of the Buff-breasted Sandpiper Working Group, which was established shortly before the Shorebird Science in the Western Hemisphere meeting in 2006. This informal working group has become less active as many studies have been concluded, although clearly much remains to be learned and investigated about this species. Field studies on Buff-breasted Sandpipers are continuing in the Southern Cone of South America as biologists there strive to understand how cattle management practices influence the species. A conservation molecular study will be initiated in January 2010, which will require extensive coordination and collaboration to gather relevant tissue samples from Buff-breasted Sandpipers by individual researchers and institutions throughout the species's range. We encourage past members and interested parties to continue to communicate with one another using the active biologist list in Appendix 1, or via the Western Hemisphere Shorebird Group Forum (http://www.eco-index.org/forums/nmbc_topic.cfm?id=shorebird_waterbird).

CONSERVATION OF IMPORTANT HABITATS

Breeding Range

Generally, information on the distribution and abundance of Buff-breasted Sandpipers from the breeding grounds is dated and fragmented (Lanctot and Laredo 1994). Recent data from Alaska (e.g., Brown *et al.* 2007; Johnson *et al.* 2007; J. Bart and P. Smith, unpubl. data) indicate the species rarely occurs in high numbers and can be quite variable in abundance from year to year. Given that the species's breeding range is so poorly known, support should be put towards surveying coastal areas within the historic range of Alaska and Canada, and if funds are limited, to revisit areas previously identified as having high densities. Such support is likely to be best applied via the PRISM survey efforts underway in the Arctic. Doing so will help identify additional key conservation sites for this species—a first step in designating areas that warrant protection. Currently, we know of only a few sites that have consistent numbers of birds on a yearly basis (see above).

Given the paucity of data on breeding locations, pre-development surveys of upland habitats should be conducted to prevent construction of resource facilities in areas with large

numbers of birds (e.g., lek locations) (Lanctot 1995). Such surveys should be conducted during the first week of display (typically 7–14 June but later at higher latitudes) to ensure breeding birds are detected (R. Lanctot, unpubl. data) and, if possible, surveys should be conducted over several years as the presence of Buff-breasted Sandpipers may vary from year to year (Lanctot and Weatherhead 1997). Pre-development field surveys are critically needed to refine our knowledge of the density and distribution of Buff-breasted Sandpipers in the National Petroleum Reserve-Alaska and in the Arctic National Wildlife Refuge—two currently identified key conservation landscape areas where oil and gas development is occurring or may occur in the future.

Surveys during late summer (i.e., July–September) will also be useful for determining whether post-breeding aggregation sites exist in the Alaskan or Canadian Arctic. Very little is known about the species during these months; observations typically occur during the breeding season and then again during southbound migration in lower portions of Canada or the lower 48 U.S. states. This post-breeding but pre-migratory period of time may be a particularly difficult one for juvenile or brood-rearing adult Buff-breasted Sandpipers as they attempt to acquire resources for their southbound migration. The use of geolocators to track adults might be one option for locating any staging sites initially.

Migration

The fact that Buff-breasted Sandpipers rely on human-altered lands (e.g., sod farms; soybean, corn, and stubble fields; and newly flooded rice fields) during much of their migration makes protecting these areas difficult. Indeed, the unusual habitats and the way farmers manage these lands make them attractive to the species. Therefore, placing these lands into some form of protective status could be counter-productive. Instead, efforts must be made to first identify relevant landowners, assess their current management practices, and encourage them to continue managing their lands for the benefit of the Buff-breasted Sandpiper while minimizing any detrimental effects (e.g., pesticide application). Conservation easements or other collaborative arrangements should be made to ensure some land is available and is being managed properly for the species in major stopover sites (e.g., Texas coast, Nebraska Rainwater Basin). Such management may be particularly important in drought years when ephemeral fresh water is limited. For example, a few recently watered sod fields near Corpus Christi, Texas, attracted

approximately 5,000 Buff-breasted Sandpipers during the 2009 fall migration when other areas were dry (D. Newstead, pers. comm.). Efforts must also be made to work with state and federal offices to manage currently protected areas to benefit the species. Additional research on the species's habitat needs, which from a superficial level appear straightforward, may allow the establishment of a few wildlife refuges in these key areas that would be geared toward managing habitat for the Buff-breasted Sandpiper.

Nonbreeding Range

Although Buff-breasted Sandpipers occur over a large area of the pampas of Argentina (Lanctot *et al.* 2002), much of this area, despite having apparently suitable vegetation cover, does not have any birds. This suggests that the landscape (e.g., spatial arrangement of wetlands and grasslands) or other environmental conditions (e.g., soil moisture and compaction; fire frequency) may be inappropriate for the species. It is also possible that the available nonbreeding habitat in Argentina greatly surpasses the amount of land needed by the current number of Buff-breasted Sandpipers, and other factors outside of the nonbreeding grounds are preventing the species from increasing to previous levels. At the moment additional studies are needed to unravel why much of this area is not used (see Research Actions below).

In contrast to Argentina, suitable habitat in Brazil and Uruguay is more limited and restricted geographically. Although lower densities of Buff-breasted Sandpipers can be found inland (and in that sense the area is not restricted geographically), Buff-breasted Sandpipers are found predominantly along a very narrow zone of recent terrain at ocean shores and around some coastal lagoons. While generally grazed by livestock, the natural vegetation in some areas (e.g., *Distichlis* spp.; J. Isacch, pers. comm.) appears to have evolved a low structural profile due to the frequent flooding and saline conditions (i.e., height may not be dictated by grazing alone). This habitat specialization, in contrast to the more general habitat use exhibited by other upland shorebirds, may have led the Buff-breasted Sandpiper to evolve high site fidelity within and across years. Observations across years from Estancia Medaland (Isacch and Martínez 1999, 2003a, b) and Bahía Samborombón (D. Blanco and M. Beade, unpubl. data) in Argentina, Laguna de Rocha and Laguna de Castillos in Uruguay (Lanctot *et al*. 2002, Aldabe and Blanco 2009), and Banhado do Taim, Ilha do Torotama, and Lagoa do Peixe in Brazil (Resende and Leeuwenberg 1987, Resende 1988, Lanctot *et al*. 2002, Almeida 2009), suggest particular

nonbreeding sites are used consistently from year to year. Resightings of marked birds across years at Lagoa do Peixe further support this idea (Almeida 2009). This information should be used to promote nominations for WHSRN sites of regional, international, or hemispheric importance where appropriate or needed. Efforts are currently underway to nominate portions of the Laguna de Rocha in Uruguay and Bahía Samborombón in Argentina.

Most of the sites identified as being key nonbreeding areas are privately owned, although many are officially recognized as important sites under a variety of designations (e.g., IBA, Ramsar, Biosphere Reserve, National Park, Provincial Reserve). Unfortunately, many of these designations do not legally protect the areas. In some places, identification of the legal owners is difficult, and complex legal rules make it further difficult to negotiate easements or other forms of land protection. Fortunately, these areas are, in general, unlikely to be converted to agriculture because of flooding and saline conditions at their location near the coast, but other human activities described above still pose threats to Buff-breasted Sandpiper habitat. Therefore, efforts should be made to legally protect and manage areas known to be used repeatedly by the species, while taking into account these areas may change as sea levels rise due to climate change.

IMPLEMENTATION OF BENEFICIAL MANAGEMENT PRACTICES

Site and Habitat Management

Although adequate habitat-preference studies have not been conducted for the Buff-breasted Sandpiper throughout its range, it seems clear that the species likes specific habitats during migration and on the nonbreeding grounds. On migration, the species is frequently found on terrestrial short-grass habitats, margins of natural wetlands, recently tilled or planted soybean and corn fields, and the interface of dry dirt and water in agricultural fields flooded for rice culture. During the nonbreeding season, native grasslands and pastures that are relatively moist and grazed intensively by livestock are commonly used (see Major Habitats above). A concerted effort should be made to ensure that these habitats are available in sufficient quantity and quality (i.e., pesticide- and herbicide-free) throughout the migration period and nonbreeding season. Such a recommendation was made by the Gulf Coast Joint Venture (GCJV) when making fall habitat objectives in Bird Conservation Region 37 (i.e., the Gulf Coastal Prairie in Texas, Louisiana, and Mississippi) in 2007 (Vermillion 2007). Indeed, managers set a habitat goal to provide approximately 271 hectares of short-grass habitat and/or bare soil-water interface habitat

on a continuous basis from 15 July to 5 November for the estimated 68,400 Buff-breasted Sandpipers likely to migrate through the area (adult population estimated to be 38,000 and juveniles to make up the remainder). They went further to indicate that, ideally, this habitat should not be subject to pesticide and/or herbicide application. Such detailed habitat goals are rare, but should be replicated on other staging and nonbreeding areas, and evaluated to assess success. Given the propensity of shorebirds to use different migration pathways in very wet and very dry years (Skagen 2006), it seems prudent that land managers scatter suitable patches of habitat spatially over the migration corridor.

To accomplish habitat goals like those proposed by the GCJV, partnerships that cross federal, state, and private jurisdictions need to be forged. Joint Ventures are an excellent vehicle to do just that as their mandate is to promote partnerships to conserve habitats and wildlife. Similar ventures exist in South America such as the Alliance for the Grasslands, which holds workshops with ranching organizations and government agricultural institutes to encourage ranchers to keep grazing their cattle in particular ways. Beneficial practices include continuing intensive grazing in some locations to keep grass short throughout the nonbreeding season while applying minimal levels of agrochemicals in appropriate ways. The former could be accomplished through certification schemes (for beef raised on natural grasslands) and technical assistance regarding best practice grazing systems, use of water resources, etc. (e.g., Marino 2008). To maintain short-grass pastures, farmers have to essentially overgraze them (Isacch and Cardoni 2009). This can cause pastures to degrade (e.g., loss of plant genetic diversity) – a problem that may be overcome by rotating which paddocks are kept intensively grazed or by removing cattle during the austral fall and winter when Buff-breasted Sandpipers are absent. In general, providing technical assistance to land managers is a key part of ensuring that optimal management practices are carried out to benefit the species. Assistance on the following practices would be particularly helpful: water drawdown and rice planting at appropriate times for the anticipated arrival of migrants; grazing regimes; burning of natural grasslands to foster appropriate vegetation height during migratory periods; and minimal or at least prescribed agrochemical application.

Socio-economic studies conducted recently in Argentina and Uruguay (Blanco *et al*. 2006b) and Brazil (Santos and Braga 2007) have indicated a large number of landowners are willing to collaborate on projects that lead to the conservation of Buff-breasted Sandpipers—as

long as their involvement does not hamper developments on their property. Because many of the current land management techniques provide suitable Buff-breasted Sandpiper habitat, this restriction does not appear to be a problem. In all three countries, landowners were in favor of a financial incentive that would lower their taxes on their lands in exchange for maintaining suitable Buff-breasted Sandpiper habitat on their ranch. For many landowners located within parks or ecological stations, this compensation would be their first financial gain from the opening of the park or station. Most landowners saw a devaluation of their properties when parks and ecological stations were decreed and generally disliked the presence of declared ecological areas. Such incentives seem the best approach given the high cost of land (approximately USD $12,000/hectare in the region of Taim, USD$3,000/hectare on the island of Torotama, and USD$6,000/hectare in the region of Lagoa do Peixe in Brazil)(Santos and Braga 2007) and given the cost associated with necessary management actions should the land be purchased.

EDUCATION

Overall there is a great need to inform policy makers, managers, and landowners about the unusual habitat requirements of this species. On the breeding grounds, the species's preference for drier habitats puts them at odds with current policies to protect wetlands. During migration, the species frequents human-altered habitats (e.g., sod farms, tilled crops) that are frequently overlooked by biologists as having value for wildlife conservation. On the nonbreeding range, intensely grazed pastures are the area of choice but are another often dismissed area for conservation actions. Fortunately there are other species that use these same habitats during all stages of their annual cycle, so encouraging managers to maintain these unusual but essential habitats is feasible and potentially tractable. In the Arctic, policy makers should be informed of the need to maintain uplands along with wetlands, especially in locations where wetlands predominate. Along migration and on the nonbreeding grounds, farmers and ranchers should be encouraged to continue land management practices that are beneficial to Buff-breasted Sandpipers. This encouragement should come in the form of technical advice about providing essential habitat during critical times (e.g. late April along the Texas coast when Buff-breasted Sandpipers are arriving after flying over the Gulf of Mexico; early to mid-May in Nebraska's eastern Rainwater Basin) and throughout the nonbreeding season. Provisioning of

suitable habitat is particularly important during periods of droughts or floods when the species's preferred nonbreeding sites may be unavailable.

RESEARCH AND MONITORING NEEDS

The Buff-breasted Sandpiper has had a limited amount of research conducted on it throughout its annual cycle. In contrast to most shorebirds, more knowledge of the species is available from the nonbreeding range than during breeding or on migration. Indeed, only a few intensive studies have been conducted on the breeding grounds (Pruett-Jones 1988, Lanctot and Weatherhead 1997, Lanctot *et al.* 1997, 1998) and on the migration corridor (Jorgensen 2007a, W. Norling, unpubl. data). Nonbreeding studies include several site-specific winter ecology studies (Myers 1980, Isacch 2001, Almeida 2009), range delineation and distribution (Blanco *et al.* 1993, Lanctot *et al.* 2002, Blanco *et al*. 2004), and habitat use (Lanctot *et al.* 2004, Aldabe and Blanco 2009, Isacch and Cardonoi 2009). An additional study investigated the potential for the species to be exposed to contaminants during migration and in the nonbreeding season (Strum *et al.* 2008, 2010). Most of these studies have only recently been completed.

RANGE-WIDE PRIORITY ACTIONS

Migration and Connectivity Between Breeding, Stopover, & Nonbreeding Areas

The limited studies conducted to date indicate that Buff-breasted Sandpipers have low breeding-site fidelity (Lanctot and Weatherhead 1997) but rather high nonbreeding-site fidelity (Almeida 2009). This is in sharp contrast to many other shorebird species that exhibit the opposite pattern (i.e., high breeding-site fidelity and low nonbreeding-site fidelity). These patterns indicate that the species may show population structuring that may result in distinct management units (Avise 1994) that will require development of conservation strategies for discrete populations. To evaluate population structure and connectivity, molecular markers (e.g., Haig *et al.* 1997) should be analyzed using contemporary and historic samples collected on breeding, migration, and nonbreeding areas. Investigations of population structure based on molecular markers such as microsatellites in the nuclear genome and mitochondrial DNA provide a useful alternative to count surveys because molecular information allows estimation of effective population size (*N*e). Information on current and historical levels of genetic diversity

should also be evaluated to test the potential effects of genetic bottlenecks on future population viability. Birds with lek-mating breeding systems are vulnerable to extinction because a high skew in male mating success and female nesting success can reduce effective population size and genetic diversity (Höglund 1996, Stiver *et al.* 2007). Comparisons of current and historical levels of genetic diversity of Buff-breasted Sandpipers will be essential for assessments of population vulnerability and conservation planning in the future. Drs. Samantha Wisely and Brett Sandercock of Kansas State University recently received funding to conduct this study through a grant agreement with the U.S. Fish and Wildlife Service.

An alternative approach for investigating migratory connectivity involves the use of stable isotope signatures (e.g., Hobson and Wassenaar 1997). This approach relies on the fact that 1) a bird's body tissues, including feathers, carry chemical markers that reflect its diet and habitat use (Mizutani *et al.* 1990), and 2) that these chemical markers vary spatially across the surface of the earth according to well-defined geological processes. These two factors provide the ability to predict a feather's geographic origin, and thus the bird's movements, by analyzing the chemical content of particular feathers. This approach has been used successfully to link breeding and nonbreeding grounds of other Neotropical migrants (Hobson and Wassenaar 1997, Kelly and Finch 1998). Buff-breasted Sandpipers are an ideal candidate for this methodology because the species 1) appears to be philopatric to particular nonbreeding areas where they molt their flight feathers (Almeida 2009) and 2) occurs across a large geographic area during the nonbreeding season where stable isotope markers are known to vary. Thus by collecting a few flight feathers from individuals on the breeding grounds or migration stopover sites, it may be possible to determine where these individuals spend the nonbreeding season. Information on migratory connectivity will yield additional information on the presence of distinct management units. Additional study is needed to first document the stable isotope distinctiveness of the nonbreeding sites in Argentina, Brazil, and Uruguay (e.g., Torres-Dowdall *et al.* 2009); if the approach seems plausible, feathers will need to be collected from museum specimens and live birds originating from areas away from the nonbreeding grounds.

Finally, efforts should be made to use light-level geolocators to document migratory connectivity (e.g., Stutchbury *et al.* 2009). Light levels recorded by the geolocators can be analyzed to estimate daily sunrise and sunset times throughout the annual cycle allowing us to estimate geographic locations to within 100 to 150 kilometers. This is sufficient resolution given

that Buff-breasted Sandpipers travel many thousands of kilometers during their annual migrations. These data can be used to reconstruct migration routes, allowing stopover sites to be identified and length of stay at each site to be quantified. This knowledge is essential for other conservation and research needs identified in this plan. Geolocator technology requires birds be recaptured at some interval after being initially tagged (usually at least 1 year so a complete annual migration can be documented). Given the high nonbreeding-site fidelity exhibited by Buff-breasted Sandpipers in Brazil, this seems the most logical location to conduct such a study. At present, Lagoa do Peixe is the only location where the species has been shown to exhibit site fidelity across years, allowing the use of this technology.

With the recent development of 0.75-gram geolocator (see http://www.birdtracker.co.uk/geolocators_2.html), it seems plausible to incorporate this into an enlarged flag attached to the leg. Such an approach has been used successfully on Pacific Golden-Plovers (*Pluvialis fulva*) by W. Johnson and his colleagues (pers. comm.) and is currently being tested on Red Knots (*Calidris canutus*) (H. Sitters, pers. comm.).

Factors Affecting Survival and Population Dynamic

A primary focus of the Shorebird Research Group of the Americas (SRGA) is to investigate factors that may be limiting the population size of shorebird species (see http://www.shorebirdresearch.org/). As a species that has declined dramatically over the past century, the Buff-breasted Sandpiper is an obvious species on which to study causes of decline. Due to the lack of site fidelity on the breeding grounds, estimates of survival rate are difficult to acquire there. The only apparent annual survival rates of Buff-breasted Sandpipers have been reported by Almeida (2009) for the population spending the nonbreeding season at Lagoa do Peixe National Park, Brazil. Based on mark-recapture analyses (Figure 15), she reports that the species survival falls within the upper range of rates reported for *Calidris* sandpipers. Almeida noted however that this estimate was for a single population that represented < 8% of the world population (based on this paper's population increase and Almeida's density estimates) and that temporal and age effects were not tested. Additional long-term studies of survival are needed to assess variation in survival rates across years and age groups (especially for first-year birds) at Lagoa do Peixe National Park and in other portions of the species's range. Having an adult survival rate is not significant in and of itself. Information on juvenile survival, hatching success,

year of first breeding, and other demographic parameters are needed to build population viability models. In addition, the identification of stressors that influence demographic parameters such as adult survival are needed throughout the annual cycle to direct management actions.

Figure 15. Uniquely color-banding birds allows any observer to note where it was banded and which individual it is. The latter is important for studies of site fidelity and survival. All countries in the Pan-American Flyway have their own color code. Pictured here (left to right), the dark blue flag indicates Brazil and the dark green flag indicates the United States. Photos by Juliana Bosi de Almeida.

BREEDING RANGE

Range Delineation and Identification of Important Habitats

Currently there are no species-specific surveys for Buff-breasted Sandpipers on the breeding grounds—only surveys that are multi-species based, which may not adequately address the range delineation and habitats used by Buff-breasted Sandpipers. Recent data collected as part of Arctic PRISM (e.g., Johnson *et al.* 2007, Brown *et al.* 2007, R. Lanctot, unpubl. data) and Canada (V. Johnston, J. Rausch, and P. Smith, unpubl. data) indicate the species is rare and, when seen, occurs in very small groups. For example, Buff-breasted Sandpipers were detected on

only 5% of 144 survey clusters (3 survey plots/cluster) on the Arctic Coastal Plain (Johnson *et al.* 2007). These low numbers may be a reflection of the species's very specific habitat preferences, such as river bluffs and terraces, which make it unlikely to be detected if survey locations are selected randomly. Further, the species's disruptive breeding behavior (Lanctot and Weatherhead 1997) may cause the species to go undetected in years when birds are absent. Nevertheless, the Arctic PRISM surveys provide some location information. We suggest combining these data with new, badly needed species-specific surveys in historically good locations (e.g., Banks Island, Jenny Lind Island) (Manning *et al.* 1956, Parmelee *et al.* 1967). The merging of such information would permit development of a more refined breeding range for the species. As a start, Gotthardt and Lanctot (2002) provide a summary of the number, location, and date Buff-breasted Sandpipers were recorded in Alaska between 1883 and 2001 (see also Table 1). Information on habitat use and availability needs to be collated or collected to construct a testable habitat-selection model for the species.

Species Stresses: Indirect Species Effects

The large decline in the Buff-breasted Sandpiper population during the past century may have indirect consequences on the ability of the population to sustain itself by decreasing the ability of individuals to find and attract mates. This may be especially problematic for this species given its lek-mating system, in which males clump together to attract females and females only visit the leks to mate before leaving to lay eggs and raise young on their own (Lanctot *et al.* 1997). Given the vast size of the species's breeding range (Wrangel Island, Russia, to Devon Island, Canada) (Lanctot and Laredo 1994), individual birds may have difficulty finding each other or, at a minimum, may decrease the size of leks to make it less likely for females to mate. Males have been shown to join leks with larger males, perhaps to mate with females attracted to these larger males (Lanctot *et al.* 1998). This finding suggests that male quality and indirectly lek size may influence a female's likelihood of mating. While monitoring the likelihood of females successfully mating under different density regimes may be difficult, we suggest monitoring the genetic diversity of offspring in areas with varying densities. Lack of genetic diversity after population bottlenecks has been implicated in population declines of other lek-mating species (Westemeier *et al.* 1998, Briskie and MacIntosh 2004).

MIGRATION

Identification of Important Stopover Sites

To date, relatively few sites of importance have been identified for the Buff-breasted Sandpiper's migration route. In Nebraska, the species was found primarily in small flocks that averaged 11.5 birds (± 0.9 [SE], range 1–95) (McCarty et al. 2009). On occasion, however, very large flocks are observed (hundreds to thousands); this appears to occur when habitat conditions constrain the species to a few, select, suitable areas. For this reason, consistent and important stopover sites may not exist except on rare occasions where habitat suitability remains relatively consistent through time. The Gulf Coastal Plain of Texas and Louisiana and the Rainwater Basin of Nebraska appear to be such sites. Jorgensen *et al.* (2008) documented the importance of the Rainwater Basin to Buff-breasted Sandpipers. Based on the number of birds they observed (along with other bird species), they successfully nominated the area as a WHSRN Landscape of Hemispheric Importance—the first of its kind. Wayne Norling (unpubl. data) also counted relatively large numbers of Buff-breasted Sandpipers in rice fields of the Texas and Louisiana Gulf Coastal Plain. Fair to good numbers of birds have also been recorded at the Upper Bay of Panama (Watts 1998), Beni Savanna in Bolivia (B. Hennessey, pers. comm.), and the Asunción Bay in Paraguay (Lesterhuis and Clay 2001). The one priority action item for this species within the Quebec Shorebird Conservation Plan is to identify and characterize habitats used during spring and fall migrations and to implement a monitoring program based at staging areas during fall migration (Aubry and Cotter 2007). Additional study is needed to document annual and inter-annual use of these sites, understand how use relates to local and regional habitat conditions, and determine if particular sites warrant WHSRN nomination based on the number of Buff-breasted Sandpipers they host.

Birds leaving the nonbreeding grounds in southern Brazil (Almeida 2009) are much leaner than birds captured during spring migration in Oklahoma and Nebraska (Oring 1964; J. Jorgensen, pers. obs.). This suggests that either 1) major stopover sites in northern South America have not been located, 2) birds stop frequently and acquire fat while they migrate, or 3) birds acquire fat reserves in southern Texas prior to traveling to Oklahoma and Nebraska. Additional investigation of areas used during northbound migration (e.g., surveys in Paraguay, Bolivia, and Colombia) and the quality of those sites (based on duration of stay and fat accumulation) is needed to determine whether particular stopover sites are more important than

others. Attachment of geolocators in combination with fat metabolism measurements could provide this information. Such site-quality data will help biologists to determine which areas are best to include in any conservation strategy.

Use of Natural and Human-altered Habitats

Although ample observations suggest Buff-breasted Sandpipers frequently use human-altered habitat (e.g., sod and other agricultural lands, airport runways, cattle pastures) (Lanctot and Laredo 1994, Robbins 2007, Jorgensen *et al.* 2008, McCarty *et al.* 2009, Strum *et al.* 2010), little research has been conducted on whether the species prefers altered habitats over native grasslands, what makes optimal habitat conditions, and whether areas can be actively managed to attract the species. Where native grasslands (or at least pastures) are present, surveys should be conducted to inventory this species. Anecdotal observations suggest that short-grass sod farms or moist, recently tilled fields with low-stature vegetation are attractive. Given the practice of wildlife refuge managers to create areas that include both upland and wetland areas in order to provide cover and foraging and brood-rearing opportunities for nesting waterfowl, it seems feasible that some portion of these upland areas could also be managed for short vegetation. If possible, experimental habitat modifications should be conducted over a suite of areas within the species's migration corridor to test the efficacy of attracting Buff-breasted Sandpipers and determine optimal habitat conditions.

Determine the Population Size and Status of Buff-breasted Sandpipers

Efforts have been made to estimate the population size of the Buff-breasted Sandpiper during migration on the Rainwater Basin of Nebraska (Jorgensen *et al.* 2008) and coastal areas of Texas and Louisiana (W. Norling, unpubl. data). These studies were limited by 1) a potential bias due to conducting surveys from roads, 2) the fact that sightings during migration indicate that the species is sparsely distributed and can aggregate in large flocks for which detection (or nondetection) could increase or decrease population density estimates, and 3) a lack of available information on turnover rate (Lanctot *et al.* 2008). Data recently collected by Jorgensen on turnover rates indicates individuals usually remain in the Rainwater Basin area for less than one day (i.e., a very high turnover rate), suggesting the population is larger than the current estimate

of 30,000 (Morrison *et al.* 2006). Population modeling that takes into account this new turnover information should be conducted to estimate the population size of the species. To compliment this work, studies designed to monitor numbers and document turnover rates should be conducted along the Texas and Louisiana coasts where large numbers of Buff-breasted Sandpipers have been detected making landfall. Further efforts are needed to determine whether individuals use both the Rainwater Basin and the Gulf Coastal Plain on an annual basis (i.e., are the same birds being counted twice). An ongoing monitoring program at these two stopover areas would help to provide population size estimates (Lanctot *et al.* 2008) and may be a viable option for detecting population trends of this species. Such a monitoring program should include a statistically and biologically sound survey approach that accounts for detection probability, enumerates and incorporates turnover rate, and if possible, ascertains the frequency at which very large aggregations occur. This program could serve as one of the primary mechanisms for estimating population size and trend, and should be used to update population estimates as needed. If warranted, appropriate federal and non-federal entities should be notified of changes in status.

Given difficulties in ascertaining population trends at migratory sites (Bart *et al.* 2007), any trend data acquired in Nebraska or the Gulf Coastal Plain should be verified from data collected elsewhere during the annual cycle. For example, population modeling that uses demographic parameters acquired at breeding and nonbreeding sites can also generate likely trends in the population (as well as the reason for the decline, such as low productivity, low adult survival, etc.).

Ecotoxicology Studies

During northbound migration, large numbers of Buff-breasted Sandpipers stopover in sod farms and rice fields of coastal Texas and Louisiana (Table 2), and row crop fields in the Rainwater Basin region of Nebraska (Jorgensen *et al.* 2008). Behavioral observations in Nebraska suggest Buff-breasted Sandpipers forage in the row crops and rest and conduct maintenance behaviors in the nearby wetlands (McCarty *et al.* 2009). Because of the high potential for Buff-breasted Sandpipers to be exposed to chemicals while visiting agricultural fields, Strum *et al.* (2010) investigated exposure of Buff-breasted Sandpipers to organophosphorus and carbamate (anti-cholinesterase) pesticides on migration sites in the United

States and nonbreeding sites in Paraguay, Argentina, and Uruguay. These environmental contaminants are known to have adverse effects in other migratory species that use agricultural habitats on the nonbreeding grounds. Surprisingly, they did not find strong evidence of these chemicals on agricultural sites used during migration in the United States but did document cholinesterase activity levels of Buff-breasted Sandpipers indicative of exposure to anti-cholinesterase pesticides in Argentina. Tests to document exposure to many other types of agro-chemicals (i.e., organocholorines, pyrethroids) are needed. Further research is needed to determine on a regional basis which chemicals are used on each of the land types used by the species (e.g., various crops, sod farms). Collaboration with landowners is needed to document direct exposure by identifying when and which chemicals are applied, and where. Further testing is needed on most chemicals to identify lethal and sublethal effects to the species.

NONBREEDING RANGE

Monitoring and Population Size Estimation via Habitat Modeling

Extensive surveys were conducted on the nonbreeding grounds in the early 1990s (Blanco *et al.* 1993) and the later 1990s and early 2000s (Lanctot *et al.* 2002). The later study provided rough population density estimates for the species in Argentina, Brazil, and Uruguay. Efforts to extrapolate these densities to the entire nonbreeding range proved difficult due to problems associating bird distribution with both vegetation heterogeneity and unsupervised classifications (where image pixels are correlated directly with bird presence and no human-generated habitat type is assigned) of satellite imagery (Lanctot *et al.* 2004). Particularly problematic was defining appropriate habitat using GIS technology due to difficulties associated with differentiating managed (sown with non-native species) and native pastures, and differentiating the moisture level and grass heights within pastures. An additional confounding factor is the apparent excess of suitable habitat in Argentina. Contemporary surveys have failed to find Buff-breasted Sandpipers in areas that appeared to be quite good. It seems likely that either our ability to identify suitable sites is poor or the historic declines in Buff-breasted Sandpiper numbers have resulted in suitable habitats being vacant. It is not necessary to completely understand this problem as long as habitat-based population estimate studies include all areas apparently suitable and select survey areas randomly.

Other factors that have been shown to be important in predicting the presence of Buff-breasted Sandpipers include proximity to the coast (possibly because of the presence of low-stature, salt-loving plants [see Lanctot *et al.* 2002]), halomorphic soils, and grasslands dominated by *Distichlis* spp. (Blanco and Canevari 1992, Lanctot and Laredo 1994). All of these factors strongly influence habitat use by the species and, if not taken into account, would likely over-exaggerate the potential nonbreeding area. Studies should be developed and conducted that will enhance opportunities to use remote-sensing technology to identify suitable nonbreeding habitat. Future attempts to estimate population size on the nonbreeding ground using habitat modeling will need to be able to resolve land-type misclassifications and include as many relevant explanatory variables as possible so that relatively refined, predictive landscape availability maps can be generated. Once accomplished, these land-type suitability maps should be paired with contemporary surveys to generate population estimates for the species. This would provide an alternative way to estimate the size, and eventually trends, of the species.

Since Buff-breasted Sandpipers may form very large flocks on the nonbreeding grounds (800 to 2,000 at one location, see above), attempts to estimate population size might be biased if such flocks are missed or detected too frequently (how detection of such flocks would affect density estimates needs to be resolved). Understanding how often these aggregations occur and how long they stay together is a central and critical issue in need of further study.

Although these monitoring efforts provided a much better understanding of the species's core nonbreeding range, surveys away from the coast are also needed to document the relative importance of these less important, secondary nonbreeding areas. Such survey areas should include the Puna Ecoregion in western Argentina and southern Bolivia; the grasslands of Paysadnú, Salto, and Artigas Departments and the Merín Lagoon basin in Uruguay; and the Rio Grande do Sul's central trough in Brazil (Blanco *et al.* 1993, Lanctot and Laredo 1994, Lanctot *et al.* 2002). In addition, little is known about how the number of birds varies within and among austral summers at any location, and what mechanisms are behind any differences observed. A multi-year study by Almeida (2009) in southern Brazil found that two of three sites visited repeatedly had consistent and high densities of Buff-breasted Sandpipers, while a third site was lower and less consistent (although all three sites had higher densities than that reported by Lanctot *et al.* 2002). Changes in water levels of the nearby lagoons (due to rainfall and flooding from the ocean) is likely responsible for differences in habitat availability that ultimately affect

the number of birds using each area. Isacch and Martínez (2003b) also reported consistent use of grasslands by Buff-breasted Sandpipers in the pampas of Argentina, noting that the birds used pastures with short grass and high water content. With this information in mind, we encourage future survey efforts to work closely with a new program for monitoring grassland shorebirds in Argentina, Brazil, Paraguay, and Uruguay. This program is being developed within the framework of the Grasslands Alliance (http://www.pastizalesdelconosur.org), led by BirdLife International with technical support from Wetlands International.

Despite these challenges, nonbreeding range-based surveys would provide a second estimate of population size and trends. Such surveys should include a statistically sound approach that accounts for detection probability and enumerates and incorporates turnover rate. These surveys would augment the others being conducted during migration in the central United States, and serve to sound alarms should surveys during migration differ.

Comparable efforts to estimate population size on the breeding grounds via the Arctic PRISM double-sampling protocol have proved difficult due to low numbers of birds, low site fidelity, and the species's nomadic nature during this lifecycle phase.

Pasture Use and Management

The use of pastures by Buff-breasted Sandpipers is likely affected by the size of the pasture, grass height and plant composition, soil wetness, and a variety of other factors. Aldabe and Blanco (2009) illustrated the importance of these factors in attracting Buff-breasted Sandpipers during a recent study at Estancia La Rinconada, a ranch in the pampas of Uruguay, (Figure 16). Isacch and Cardoni (2009) investigated how different grazing regimes influenced Buff-breasted Sandpiper numbers. Studies such as these should be replicated at other areas within the nonbreeding range to better understand the species's habitat requirements and management needs.

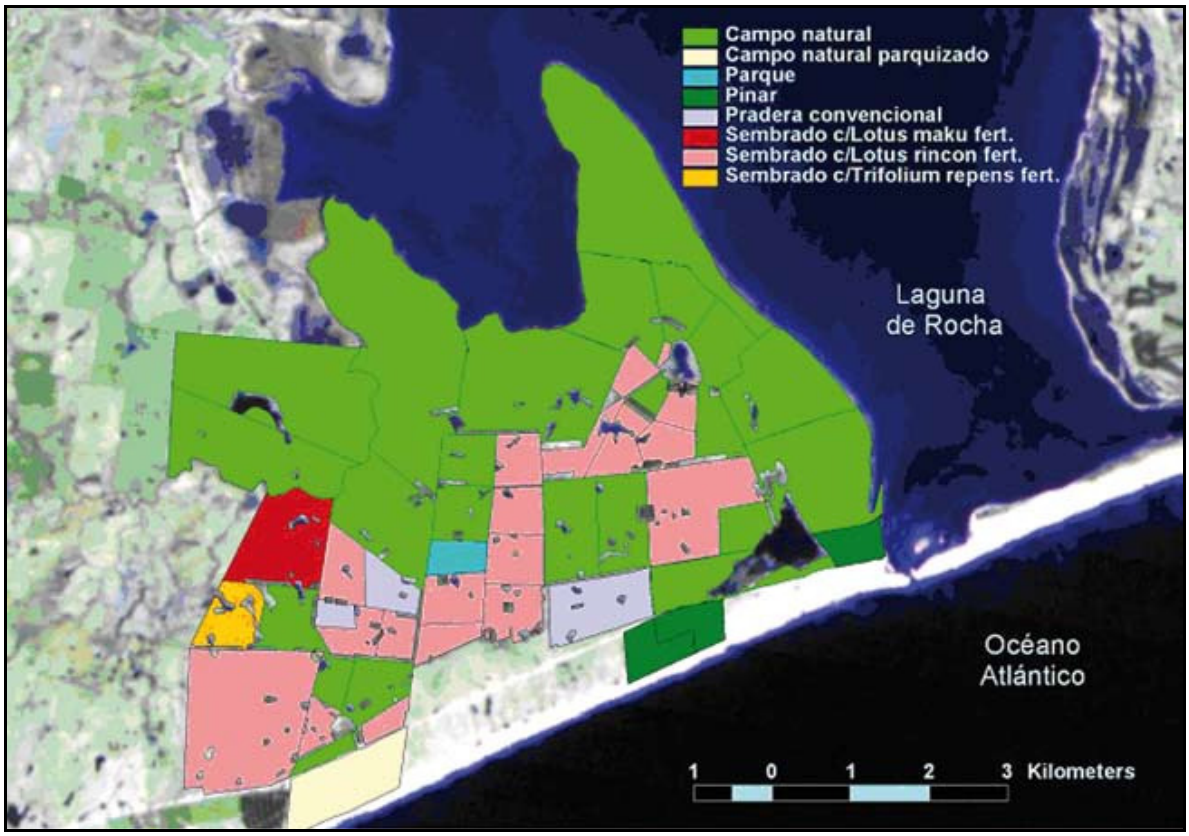


Figure 16. Map indicating the variety of conditions encountered by Buff-breasted Sandpipers visiting paddocks at Estancia La Rinconada on the southern edge of Laguna de Rocha in the pampas of Uruguay. Key: Campo natural = natural field; Campo natural parquizado = landscaped natural field; Parque = park; Pinar = pine trees; Pradera convencional = conventional grasslands; Sembrado = grasslands sown with three types of plant species and fertilizer (last three items in key). Source: Figure 2 in Blanco and Aldabe 2007.

Ecotoxicology Studies

Exposure and the potential for exposure of Buff-breasted Sandpipers to agricultural chemicals during the nonbreeding season are indisputable. Strum (2008) found evidence that Buff-breasted Sandpipers were exposed to ChE-inhibiting pesticides in Argentina. Blanco *et al.* (2006a) also documented a high potential for exposure on rice fields; Buff-breasted Sandpipers are detected with some regularity in such fields and large numbers of agrochemicals (as much as 30 at a single site) can be used during rice production. Strum suggests continued cooperation and collaboration with investigators and universities in Argentina to conduct surveys and gather information on the species's habitat use and plasma ChE activity levels. Information on the type and timing of chemical application relative to use by Buff-breasted Sandpipers is also needed.

Buff-breasted Sandpipers might experience another indirect negative effect from chemical applications. Chemicals that are applied to cattle to reduce parasites ultimately leach off into pasturelands and may kill macro-invertebrates used for food by the birds. We know of no studies conducted on this to date.

Sexual Segregation

Almeida (2009) reported a female bias in the sex ratio of Buff-breasted Sandpipers captured in Lagoa de Peixe National Park and suggests that a latitudinal segregation in sexes exists, with males spending the nonbreeding season further south. Similarly, K. Strum (unpubl. data) documented a female bias (6:1) when capturing birds at Anahuac National Wildlife Refuge in coastal Texas during northward migration. This suggests the potential for differential migration or sexual segregation at migratory stopover sites. Additional study on the spatial segregation of males and females at other sites within the nonbreeding range and at stopover sites is needed to verify this hypothesis. Morphological measurements, pictures of wings, blood, feather or other needed tissue samples should be collected from captured individuals when possible. These data/samples will allow birds to be sexed and possibly aged, and can provide material for ecotoxicology, molecular, and stable isotope studies (see previous Priority Actions).

Should sexual segregation exist, it will be essential to incorporate this knowledge when deciding what stopover and nonbreeding sites to protect. Lanctot *et al.* (1997) argued that it was unlikely that the species's sex ratio deviated from 1:1, thus we do not think these biased sex ratios indicate a lack of males in the population.

CONSERVATION TIMELINE

(Action items are not listed in any particular order within each subcategory)

RANGE-WIDE

HIGH PRIORITY (to be initiated or completed within the next 2–5 years)

- Equip Buff-breasted Sandpipers with state-of-the-art, light-level geolocators at appropriate locations to ascertain migration patterns and concentration areas and to link breeding and nonbreeding locations.
- Evaluate population structure and connectivity, effective population size (an alternative to count surveys), and evidence of genetic bottlenecks using molecular markers (*project currently funded through Kansas State University*).
- Investigate the potential to use stable isotope signatures to assess the isotopic distinctiveness of nonbreeding sites; if present, assess the ability to link birds that breed in particular Arctic locations with unique nonbreeding areas.
- Promote the permanent protection of key conservation areas (or portions thereof) through government or private procurement of lands or long-term landowner commitments.
- Develop partnerships with private landowners (e.g., farmers and ranchers) and public-land stewards (e.g., refuges, parks, ecological stations), and actively promote land management practices that provide appropriate habitat conditions for the Buff-breasted Sandpiper.
- Generate funds and develop mechanisms to offer incentives to private landowners to manage lands for Buff-breasted Sandpipers
- Develop a workshop to exchange experiences between North and South American conservationists regarding habitat conservation on private lands for Buff-breasted Sandpiper and other grassland species.
- Nominate asWHSRN, Ramsar, and other site designations 50% of the important sites identified in this plan.
- Implement the WHSRN Site Assessment Tool at 50% of the important Buff-breasted Sandpiper sites in the Western Hemisphere. Compare and collectively analyze the rankings for each site's condition, threats, and trends for an overall status of important sites range-wide.

- Revise Cornell's "Birds of North America" species account for Buff-breasted Sandpiper.

***ON-GOING HIGH PRIORITY* (to be done on a continual basis)**

- Establish new and strengthen existing mechanisms of cooperation and communication between shorebird conservationists/researchers in the Western Hemisphere, as well as among all relevant governments, private groups, and communities throughout the species's range.
- Educate and inform policy makers, managers, and landowners about the unique habitat requirements and threats facing Buff-breasted Sandpipers in different parts of its range. Utilize the Shorebird Sister Schools program and other education/outreach activities to also raise public awareness.
- Create and maintain a GoogleEarth placemark file (map) of important breeding, migration, and nonbreeding sites for Buff-breasted Sandpipers, indicating sites known to be of higher priority/importance. WHSRN Executive Office and plan authors proactively distribute this map to conservation partners.
- Promote input of Buff-breasted Sandpiper survey data to public databases such as WorldBirds or eBird.
- Maintain coordinated, hemisphere-wide, color-banding efforts that allow investigations of demography (e.g., survival, fidelity), local and regional movement, and migratory routes.

***MEDIUM PRIORITY* (to be initiated or completed within the next 5–10 years)**

- Assess changes in habitat availability due to potential effects of climate change, habitat degradation due to human alteration, and other factors at key conservation sites throughout the species's range.
- Establish new research studies to determine potential limiting factors on population growth through the identification and measurement of stressors to demographic parameters (e.g., adult survival, year of first breeding, productivity at key breeding locations).
- Develop models to evaluate potential effects of climate change on migration behavior/success.

- Evaluate the existence of a latitudinal segregation of males and females at migration and nonbreeding sites by conducting a large-scale capture effort at numerous sites.
- Document the prevalence of avian influenza and other diseases (e.g., malaria, West Nile virus, Newcastle Disease) in the Buff-breasted Sandpiper, and their potential impacts.
- Update the Buff-breasted Sandpiper Conservation Plan (i.e., Version 2.0) at five-year intervals to revise information and action items as needed.

BREEDING

HIGH PRIORITY (to be initiated or completed within the next 2–5 years)

- Direct funds and available personnel towards broad-scale, multi-species and species-specific surveys at potential Buff-breasted Sandpiper hotspots in the Arctic via PRISM and other survey efforts, to evaluate the importance of known key conservation areas and identify new ones.
- Promote an expedition to Jenny Lind Island and other key conservation sites to determine if Buff-breasted Sandpiper numbers are as large as historically reported.

ON-GOING HIGH PRIORITY (to be done on a continual basis)

- Provide guidance to industry and environmental consultants involved in extracting mineral resources in the Arctic to ensure adequate upland habitat surveys are conducted pre-development to enumerate the presence of large concentrations of Buff-breasted Sandpipers (e.g., lek locations) and other birds. Use survey information to mitigate or relocate proposed development sites if necessary.

MEDIUM PRIORITY (to be initiated or completed within the next 5–10 years)

- Collate existing count or presence/absence data from prior surveys to determine a more refined breeding range; construct a testable habitat-selection model that can predict breeding locations and thereby decrease potential impacts from future development.

MIGRATION

HIGH PRIORITY (to be initiated or completed within the next 2–5 years)

- Establish a long-term monitoring program at key conservation sites, including at a minimum, the eastern Rainwater Basin and the Gulf Coastal Plain of Texas and Louisiana; the statistically sound surveys should address detection probability, turnover rates, and frequency and duration of large aggregations.
- Conduct research that assesses the species's compatibility (i.e., continued use or avoidance of an area; direct and indirect impacts) with human-altered habitats such as agricultural fields, sod farms, and wind fields.
- Assess the timing and numbers of Buff-breasted Sandpipers using areas of Colombia, the Beni Savanna in Bolivia, the Paraguay River and Bahía de Asunción in Paraguay, and other sites along the central Amazonia/Pantanal Flyway.
- Continue investigating Buff-breasted Sandpipers' and other shorebirds' exposure to contaminants (agrochemicals) on rice fields and sod farms in Nebraska, Kansas, Texas, and Louisiana; assess how the type and timing of agrochemical applications influences exposure and consequences.

ON-GOING HIGH PRIORITY (to be done on a continual basis)

- Throughout the species's main migration corridor, establish diverse public-private partnerships that will prioritize management actions and set habitat goals to sustain the numbers of Buff-breasted Sandpipers migrating through an area.
- Retrieve summaries of Buff-breasted Sandpiper observations on migration (see Table 2) from birding journals, electronic listserves, professional birding trips and other new sources, and incorporate them into one master database; also incorporate negative observational data to determine the species's absence from locations.

***MEDIUM PRIORITY* (to be initiated or completed within the next 5–10 years)**

- Support survey efforts in northern North America and northern South America to locate potential staging areas for the species; investigate sightings in Saskatchewan and Alberta between June and August to determine whether birds have a short-stop migration.
- Using data obtained from geolocators and contemporary data from breeding, stopover, and nonbreeding areas, construct a detailed migration model identifying temporal movements, relative site use, stopover length, body condition, fat-deposition rates, and acute and migration-wide threats.

NONBREEDING

***HIGH PRIORITY* (to be initiated or completed within the next 2–5 years)**

- Reinitiate previous long-term demographic studies at Lagoa do Peixe, Brazil, and establish new ones at key conservation sites in Brazil, Uruguay, and Argentina, investigating site fidelity, length of stay, local movements, and annual and over-winter adult survival.
- Support existing monitoring efforts (e.g., Annual Monitoring of Grassland Nearctic Shorebirds in the Southern Cone of South America) and establish/implement new ones at key conservation sites, including at a minimum, Bahía Samborombón pasturelands and Estancia Medaland in Argentina; Lagoa do Peixe National Park, Taim Ecological Station, and Ilha da Torotama in Brazil; and Laguna de Rocha, Laguna de Castillos, and Laguna Garzón in Uruguay.
- Conduct a detailed ecotoxicology study at rice fields in Argentina where Buff-breasted Sandpipers' exposure to chemicals was previously detected; assess the type and timing of agrochemical applications, likelihood of exposure, and consequences.
- Conduct additional studies on pasture use and how different livestock grazing regimes affect Buff-breasted Sandpipers; through experiments, assess how Buff-breasted Sandpiper use relates to pasture size, grass height and composition, and soil wetness.
- Investigate the potential negative consequences of parasite-controlling chemicals applied to livestock on the macro-invertebrate populations eaten by Buff-breasted Sandpipers.

- Promote incorporating key conservation areas within Uruguay into the National System of Protected Areas.

***ON-GOING HIGH PRIORITY* (to be done on a continual basis)**

- Implement strategies and action items generated from socio-economic studies conducted in Argentina, Uruguay (Blanco *et al.* 2006b), and Brazil (Santos and Braga 2007) designed to conserve Buff-breasted Sandpipers.

***MEDIUM PRIORITY* (to be initiated or completed within the next 5–10 years)**

- Develop and conduct studies that will enhance opportunities to use remote-sensing technology to identify suitable nonbreeding habitat and generate refined, predictive landscape-availability maps; pair the maps with contemporary surveys to generate population estimates.
- Conduct surveys to assess the timing and numbers of Buff-breasted Sandpipers using apparent secondary nonbreeding locations, such as the Puna Lakes in Argentina and the grasslands of Paysadnú, Salto and Artigas Departments, and the Merín Lagoon basin in Uruguay.
- Throughout the species's nonbreeding range, establish diverse public-private partnerships that will prioritize management actions and set habitat goals to sustain the numbers of Buff-breasted Sandpipers that winter in an area.

EVALUATION

The Buff-breasted Sandpiper Working Group should monitor the implementation and revision of the plan's conservation strategies and actions, as well as monitor the effectiveness of the action items in achieving their prescribed goals. To do so, members should plan on meeting during each bi-annual Western Hemisphere Shorebird Group meeting to discuss this topic. These sessions should be held in an open forum and be announced to encourage participation by all interested parties. At these sessions, participants can also highlight new findings, challenges, and tasks, thereby ensuring the plan's action items are constantly being evaluated and updated (i.e.,

ensuring this plan is a living document). Throughout all evaluation efforts, working group members should search for and demand that action items be able to have some measurable effect, and if feasible be implemented in a hypothesis-driven, adaptive framework. As specific action items are addressed, the results will help steer future questions and assist land and resource managers toward the most effective conservation strategies. This adaptive approach is an iterative process through which conservation and management actions are constantly evaluated and adjusted to more efficiently address explicit objectives.

An example of how this might work relates to the proposed habitat promotion and manipulations designed for migration sites in the United States and nonbreeding areas in southern South America. If land managers make efforts to attract Buff-breasted Sandpipers, then an effort should be made to quantify the actions and their results. This evaluation process, especially if done over a series of sites, will allow managers to modify their approach to habitat management until a proven means of generating suitable habitat is developed. One means for automating this process is to use the WHSRN Site Assessment Tool. This tool, which can be used for any site of importance for shorebirds (i.e. not only recognized WHSRN sites), permits changes in threats, shorebird populations, and conservation responses to be tracked over time and correlated, both at individual sites and across networks of sites. Implementation of the tool will require participation from a site's landowners/managers and stakeholders, and a network of appropriately trained conservation practitioners, local conservation groups, birdwatchers, and professional ornithologists contributing information about Buff-breasted Sandpipers.

Other measures of more general indicators of success will be important for communicating progress to a wider audience. Among potential metrics are:

- Number of members within the Buff-breasted Sandpiper Working Group, their geographic distribution, and the frequency with which the group meets.
- Number of national/subnational/regional threatened species (Red List) assessments undertaken that take into consideration corresponding Buff-breasted Sandpiper populations.
- Number of hectares of land transformed or managed, at least in part, to provide Buff-breasted Sandpiper habitat.

- Number of hectares of Buff-breasted Sandpiper habitat newly incorporated within public or private protected areas systems and/or under international designations (WHSRN, Ramsar, World Heritage).
- Number of new sites of international importance (regional or global) with site conservation plans developed, at least in part, for Buff-breasted Sandpipers.
- Number of sites of regional, international, and hemispheric importance being recognized as a result of new information becoming available on Buff-breasted Sandpipers.
- Number of surveys conducted at each stage of the annual cycle that locate new breeding, migratory stopover, and nonbreeding sites, as well as aid in the assessment of the population size and trends of the species.
- Number of unique research studies conducted using molecular markers, stable isotopes, and light-level geolocators that increase our understanding of the species's migratory connectivity, and identification of key stopover sites.
- Number of unique research studies conducted to evaluate exposure and impacts from agrochemicals.
- Number of education and outreach programs which have incorporated information regarding the conservation of Buff-breasted Sandpiper.
- Number of identified tasks within each stage of the annual cycle completed.
- Number of funded projects to work at least partially on Buff-breasted Sandpipers.
- Number of population size estimates and trend in population size that helps to inform the status of the species.
- Amount of money generated and spent on studies related to this species.

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