

Kansas Ornithological Society

BULLETIN

PUBLISHED QUARTERLY

Vol. 66

DECEMBER, 2015

No. 4

SPRING SURVEYS (2011-2014) FOR AMERICAN GOLDEN-PLOVERS (*Pluvialis dominica*), UPLAND SANDPIPERS (*Bartramia longicauda*), AND BUFF-BREASTED SANDPIPERS (*Calidris subruficollis*) IN THE FLINT HILLS

Robert L. Penner¹, Brad A. Andres², James E. Lyons³, and Eugene A. Young⁴

¹The Nature Conservancy, 593 NE 130 Avenue, Ellinwood, KS 67526;

²U.S. Fish & Wildlife Service, 755 Parfet Street, Suite 235, Lakewood, CO 80215;

³U.S. Fish & Wildlife Service, 11510 American Holly Drive, Laurel, MD 20708;

⁴Agriculture, Science, and Engineering, Northern Oklahoma College, 1220 E. Grand, PO Box 310, Tonkawa, OK 74653-0310 (eugene.young@noc.edu).

Abstract — The Flint Hills ecoregion is an extensive, relatively intact grassland landscape in eastern Kansas and northeastern Oklahoma. The ecoregion provides breeding habitat for migratory grassland birds but also offers spring stopover habitat for upland shorebirds including the American Golden-Plover (*Pluvialis dominica*), Upland Sandpiper (*Bartramia longicauda*), and Buff-breasted Sandpiper (*Calidris subruficollis*). From 2011 to 2014, we conducted roadside surveys during the spring to determine migrant shorebird use throughout the Flint Hills and to assess the importance of the region as a stopover site for migratory shorebirds during spring migration. Surveys revealed that American Golden-Plovers and Buff-breasted Sandpipers were more abundant in the southern one-half of the Flint Hills, occurred in areas with a high proportion of native grassland, and primarily used grasslands that were recently burned. Additional surveys and further analyses to estimate migrant population size are planned to assess the importance of the Flint Hills for migratory species of upland shorebirds.

INTRODUCTION

Tallgrass prairie once stretched across 688 thousand km² (170 million acres) from Manitoba, Canada, south to Texas and east to Indiana (Samson and Knopf 1994). Since Euro-American settlement, the tallgrass prairie has been extensively modified and less than 4% remains intact today (Samson and Knopf 1994). The Flint Hills ecoregion of eastern Kansas and northeastern Oklahoma contains an extensive landscape that represents the continent's last significant and mostly unfragmented expanse of tallgrass prairie (Reichman 1988, Knapp and Seastedt 1998, Robbins *et al.*

2002); about three-quarters of the remaining tallgrass prairie in North America is in the Flint Hills (U.S. Fish and Wildlife Service, USFWS 2010). Grasslands in the core of the Flint Hills were mostly spared from crop conversion because of hilly topography and shallow, rocky soils (Steinauer and Collins 1996).

Like elsewhere in Kansas, land ownership in the Flint Hills is primarily private (98%; Middendorf *et al.* 2009). In 2001, The Nature Conservancy launched its “Flint Hills Initiative,” a community-based, multi-strategy conservation project, to help preserve the biological integrity of the region (see <http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/kansas/placesweprotect/flint-hills-initiative.xml>). Other organizations (Kansas Land Trust, Kansas Department of Wildlife, Parks & Tourism, Ranchland Trust of Kansas, Tallgrass Legacy Alliance, USDA Natural Resource Conservation Service, and USFWS) have worked with private landowners to secure easements and restore or enhance tallgrass prairie on more than 2,000 km² in the Flint Hills (USFWS 2010). The USFWS (2010) was recently authorized to purchase easements on 11,000 km² of grasslands in the central Flint Hills.

The large and relatively intact area of tallgrass prairie in the Flint Hills is important to grassland obligate nesting birds, such as Upland Sandpiper (*Bartramia longicauda*), Grasshopper Sparrow (*Ammodramus savannarum*), Henslow’s Sparrow (*Ammadramus henslowii*), Dickcissel (*Spiza americana*), and Eastern Meadowlark (*Sturnella magna*) (Zimmerman 1988, 1993, Ribic *et al.* 2009). Because of its vast extent, the Flint Hills also harbors one of the continent’s largest populations of the Greater Prairie-Chicken (*Tympanuchus cupido*) (Baker 1953, Westemeier and Gough 1999, Rahmig *et al.* 2009, McNew *et al.* 2012). The significance of the Flint Hills ecoregion to many of these species has been well documented and an overview of habitat conditions, management, and the ecological importance for sensitive grassland birds can be found in Zimmerman (1993, 1997), Robbins *et al.* (2002), Reinking (2005), With *et al.* (2008), and McNew *et al.* (2011, 2012).

The Flint Hills also provides an important north-south migration corridor and wintering habitat for grassland songbirds (ex. Sprague’s Pipit, *Anthus spragueii*; Smith’s Longspur, *Calcarius pictus*), raptors (ex. Northern Harrier, *Circus cyaneus*; Rough-legged Hawk, *Buteo lagopus*; Swainson’s Hawk, *Buteo swainsoni*), and shorebirds, such as the American Golden-Plover (*Pluvialis dominica*), Upland Sandpiper, and Buff-breasted Sandpiper (*Calidris subruficollis*). Historically, these three shorebird species, and the possibly extinct Eskimo Curlew (*Numenius borealis*), relied on central North American grasslands during spring migration (Gill *et al.* 1998, Thompson *et al.* 2011), with virtually their entire populations passing through a narrow band stretching from coastal Texas to prairie Canada (Skagen *et al.* 1999). However, the extent to which these species depend on the remaining intact grasslands versus modified habitat isn’t well known.

Jorgensen *et al.* (2008) documented large numbers of Buff-breasted Sandpipers using the Rainwater Basin, Nebraska, which was at one time a tall to mid-grass prairie dominated by warm season grasses (ex. Big Bluestem, *Andropogon gerardii*; Little

Bluestem, *Schizachyrium scoparium*; Western Wheatgrass, *Pascopyrum smithii*) and wetlands (Jorgensen *et al.* 2007, Jorgensen 2012). Ninety percent of the current land-use is in agriculture, including 80% row crops, primarily corn and soybeans (Jorgensen *et al.* 2008, Jorgensen 2012).

In Kansas, most shorebird studies have focused on wetland habitats from the central region: Cheyenne Bottoms (Barton County), Quivira National Wildlife Refuge (Stafford County), and Slate Creek Wetlands (Sumner County) (Thompson *et al.* 2011). However, few comprehensive studies have documented shorebird migration through eastern Kansas, particularly for upland species, for which habitat requirements are less well known (Hands 2008, Thompson *et al.* 2011). Robbins (2007) and Strum *et al.* (2010) studied use of sod farms by fall-migrating Buff-breasted Sandpipers at Lawrence, and Young (2007) provided observations of Buff-breasted Sandpiper flocks in the southern Flint Hills during spring migration. Robbins (2007) and Young (2007) recommended increased monitoring to determine abundance and habitat use during migration.

In 2011, we began a survey of upland shorebird use of the Flint Hills region during spring migration to document the importance of the ecoregion as a shorebird stopover for the American Golden-Plover, Upland Sandpiper, and Buff-breasted Sandpiper, and secondarily as a core nesting area for the Upland Sandpiper. The American Golden-Plover and Buff-breasted Sandpiper were designated as needing management attention in the recent conservation assessment of North American-breeding shorebirds (U.S. Shorebird Conservation Plan Partnership 2015). Our surveys were also designed to determine if the Flint Hills would meet the criteria for designation as a Landscape of Hemispheric Importance to shorebirds within the Western Hemispheric Shorebird Reserve Network, specifically, by having a minimum of 30% of the biogeographic population of Buff-breasted Sandpipers (see <http://www.whsrn.org/selection-criteria>). Information collected on abundance, distribution, and habitat use of upland migrant shorebirds will enable better decision-making for shorebird conservation in the Flint Hills and will assist in developing a more effective survey design. Herein, we report on the distribution, habitat use, and phenology of spring-migrant American Golden-Plovers and Buff-breasted Sandpipers, and to a lesser extent Upland Sandpipers, in the Flint Hills.

METHODS

Pilot Surveys (2011)

To survey migrant shorebirds in 2011, a total of nine road-based surveys were opportunely established on fairly good roads in ten Flint Hills counties in Kansas (Butler, Chase, Chautauqua, Cowley, Elk, Geary, Greenwood, Lyons, Morris, and Wabaunsee) that appeared to contain large amounts of open grasslands (Figure 1).

Stops were placed along the routes at 0.8 km (0.5-mile) intervals, although stops were adjusted by up to 0.4 km (0.25 miles) to optimize views of suitable habitat (e.g.,

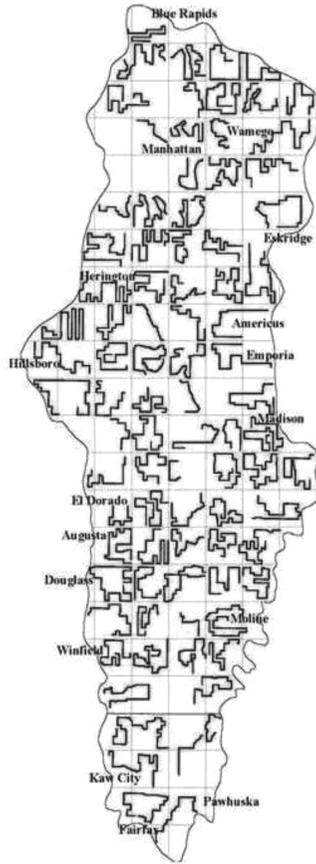


Figure 2. General locations of randomly selected roadside routes surveyed for migrant shorebirds in the Flint Hills of Kansas and Oklahoma, 2012–2014.

Random Surveys (2012 and 2013)

Based on pilot data obtained in 2011, we developed new survey methods for the 2012 and 2013 seasons that introduced an element of randomization into the spatial sampling design and increased coverage of the entire Flint Hills ecoregion (Figure 2). The region was first divided into 86 cells of 16.09 x 16.09 km (10 x 10 miles) in size, and a randomly selected driving route was established in each cell. Each route was assigned to a weekly survey period, to account for migration timing from south to north, between 10 March and 11 May in 2012. In 2013, the first surveys were conducted in the second week of March and continued into the first week of May. Observers drove predetermined routes at a speed of 32 km per hour (20 mph). When shorebirds were encountered, the following information was recorded: GPS coordinates (decimal latitude and longitude, NAD83), species, flock size, distance to the center of the flock using a range finder, dominant land cover type based on the National Land Cover Database (NLCD; Table 1), and whether birds were in burned

Table 1. National Land Cover Database types recorded on roadside shorebird survey routes in the Flint Hills of Kansas and Oklahoma, 2012-2014.

Type	Description
Open Water	Generally <25% cover of vegetation or soil.
Developed, Open Space	Areas with a mixture of some constructed materials but mostly vegetation in the form of lawn grasses. Impervious surfaces account for <20% of cover. Large-lot, single-family housing units, parks, golf courses, vegetation planted in developed settings for recreation, erosion control or aesthetics.
Developed, Low Intensity	Areas with mixture of constructed materials and vegetation. Impervious surfaces account for 20-49% of total cover. Single-family housing units.
Developed, Medium Intensity	Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50-79% of total cover. Single-family housing units.
Developed, High Intensity	Highly developed areas where people reside or work in high numbers. Impervious surfaces account for >80% total cover. Apartment complexes, row houses, commercial/industrial.
Barren Land (Rock/Sand/Clay)	Bedrock, desert pavement, scarpus, talus slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, other accumulations of earthen material. Vegetation accounts for <15% of total cover.
Deciduous Forest	Areas dominated by trees > 5m tall and > 20% of total vegetation cover, >75% of species are deciduous.
Evergreen Forest	Areas dominated by trees > 5m tall and > 20% of total vegetation cover, >75% of species are evergreens.
Mixed Forest	Areas dominated by trees > 5m tall and > 20% of total vegetation cover. Neither deciduous nor evergreen species are >75% of total tree cover.
Shrub/Scrub	Areas dominated by shrubs < 5 m tall with shrub canopy >20% of total vegetation. True shrubs, young trees in an early successional stage, or trees stunted from environmental conditions.
Grassland/ Herbaceous	Areas dominated by graminoid or herbaceous vegetation, generally > 80% of total vegetation; not subject to intensive management such as tilling, but can be utilized for grazing. Indicate burn condition and grass height by % cover.
Hay/Pasture	Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for >20% of total vegetation. Indicate height of hay crop.
Cultivated Crops	Areas used for production of annual crops (corn, soybeans, vegetables, tobacco, cotton) and perennial woody crops (orchards, vineyards) and all land being actively tilled. Crop vegetation accounts for >20% of total vegetation. Indicate density and height of crops.
Woody Wetlands	Areas where forest or shrubland vegetation accounts for >20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
Emergent Herbaceous Wetlands	Areas where perennial herbaceous vegetation accounts for >80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

or unburned grasslands. Observers assessed habitats at stops located every 1.6 km (1 mile) along each route; at each stop, observers recorded the four dominant NLCD cover types within 0.40 km (0.25 miles) of the road. For grass cover types, the burn condition was recorded as the percentage of unburned, black (recently burned), new green, or full green-up. Crop cover types were similarly evaluated as tilled, sprouted, or full green-up. Cover type data were collected to determine land cover composition of the routes relative to remotely sensed categories, assess habitat use by migrant shorebirds, and develop more precise estimates of abundance.

Legacy Area Surveys (2014)

Field survey methods were similar in 2014, except that Kansas routes were adjusted to lie more completely within the U.S. Fish and Wildlife Service’s Flint Hills Legacy Conservation Area boundary or to lie more completely outside of the boundary. Based on previous information on the use of grass cover types by migrant upland shorebirds, more effort was targeted on routes with a high proportion of their length within the easement boundary. Based on previous experience, measurements of grass and crop cover type conditions were also changed (Table 2), and burn state of grass was recorded as “yes” or “no”.

Table 2. Categories of grass, hay, and crop conditions recorded on roadside surveys for migrant shorebirds in the Flint Hills, Kansas in 2014. Burned grass was recorded as “yes” or “no”.

Grass and hay heights		Crop density and height	
Low	vegetation 0-1” high	Sparse Low	vegetation <30% cover and 0-4” high
Medium	vegetation 1-4” high	Sparse High	vegetation <30% cover and 0-4” high
High	vegetation >4”high	Dense Low	vegetation ≥30% cover and 0-4” high
		Dense High	vegetation ≥30% cover and >4” high

To determine area and proportional representation of land cover types in 2014, routes were buffered by 350 m (0.22 mile) on each side, a distance that captured all American Golden-Plover and Buff-breasted Sandpiper detections and 99% of all Upland Sandpiper detections. Using ArcMap® 10.1, we determined the proportion of each route that fell within the U.S. Fish and Wildlife Service’s Flint Hills Legacy Conservation Area boundary. Regression tree procedures were used to examine the effect of proportional land cover, as measured from route stops, on shorebird occurrence (Venables and Ripley 2003).

RESULTS

2011

During the pilot study, 2011, all nine routes were surveyed and observers recorded 20,660 American Golden-Plovers, 2,129 Buff-breasted Sandpipers, 7,372 Uplands Sandpipers, and 1,991 Killdeer. Migrants were more numerous in the southern Kansas counties of the Flint Hills. Of the ten Flint Hills counties surveyed, the five counties with the most observations of American Golden-Plovers were Butler, Elk, Chautauqua, Cowley and Lyons. Four of the five counties with the most golden-plovers also had the most Buff-breasted Sandpiper observations: Cowley, Butler, Elk, Chase, and Greenwood counties.

The majority of American Golden-Plover and Buff-breasted Sandpiper observations in 2011 were made in recently burned grasslands. Habitat conditions in these fields ranged from completely blackened ground (burned as recently as within one day of the survey) to varying degrees of regrowth following a prescribed fire. As the season progressed, shorebirds were also recorded in areas where the vegetation was nearly 15 cm (6 inches) in height. Upland Sandpipers also favored burned areas, but were also found in taller vegetation and unburned fields as the nesting season began.

American Golden-Plovers were first detected during the first week of April in 2011, and large numbers were recorded during the second week of April into the second week of May. The majority of birds were recorded between 20 April and 5 May, with the peak recorded between 26 and 28 April. American Golden-Plover flocks consisted mainly of winter-plumaged birds during the early part of spring migration, but individuals molting into breeding plumage were observed more frequently as migration progressed. By the end of migration, flocks consisted mostly of birds in breeding plumage.

Although the first observation of Buff-breasted Sandpiper was made during the first week of April, most birds were recorded during the last week of April into the second week of May, with the highest numbers recorded between 26 April and 10 May. Upland Sandpipers were first recorded during the first week of April, and the highest numbers occurred between 20 and 30 April, with a portion of the population remaining in the area to breed.

2012

Seventy-one routes (82.6%) were surveyed in 2012. Observers counted 7,936 American Golden-Plovers, 50 Buff-breasted Sandpipers, and 493 Upland Sandpipers. Shorebird flocks were encountered almost exclusively on native grass cover types; few birds were detected in tame pastures or crops. Drought conditions severely limited the number of shorebirds observed on the 71 routes that were surveyed (see <http://www.climate.gov/maps-data>) and our ability to address ecological questions about effects of land cover type on shorebird populations was limited.

2013

The number of volunteer surveyors in 2013 was reduced from the previous year, and poor weather conditions during the first half of the survey period resulted in fewer routes being completed relative to 2012. Of the 86 available survey routes, only 57 (66 %) were completed, this includes six routes in Oklahoma. Observers recorded 836 American Golden-Plovers, 23 Buff-breasted Sandpipers, and 3,293 Upland Sandpipers. The drought conditions in the Flint Hills in 2011 and 2012 resulted in unfavorable habitat conditions for shorebird stopover during spring of 2013. Little burning occurred in the Flint Hills in 2013, but lower stature grass resulting from drought may have increased detectability of Upland Sandpipers.

2014

In 2014, 66 of 78 (84.6%) scheduled routes were completed in Kansas and five of six (83.3%) routes were surveyed in Oklahoma. However, effort was not distributed proportionately across the entire survey period. Heavy rain during the latter half of the growing season in 2013 resulted in more grass (fuel) to burn in 2014, and landowners took advantage of the situation with a significant increase in burned grasslands compared to 2012 or 2013. During 2014, a total of 4,908 shorebirds were counted, which included 2,135 American Golden-Plovers, 1,515 Buff-breasted Sandpipers, and 621 Upland Sandpipers. Combining Kansas observations from 2013 and 2014, approximately 90% of the American Golden-Plover and Buff-breasted Sandpiper flocks were recorded in the southern half of the Flint Hills and within the Flint Hills Legacy Conservation Area boundary (Figure 3).

In 2014, Kansas routes that had $\geq 53\%$ of their buffered length within the Flint Hills Legacy Conservation Area boundary (Figure 4) had significantly more records of American Golden-Plover flocks ($P = 0.0029$, Fisher's Exact Test) and marginally more occurrences of Buff-breasted Sandpiper flocks within the boundary ($P = 0.0809$). Because the Flint Hills Legacy Conservation Area boundary in Kansas is derived from a criteria of containing 95% native grass, there was a high correlation (Pearson's $r = 0.68$) between the proportion of native grass occurring along routes and the proportion of the route within the Flint Hills Legacy Conservation Area boundary.

Proportional land cover was also examined to explain additional variation among routes with a high proportion of area within the Flint Hills Legacy Conservation Area boundary. On these routes, low levels of development ($\leq 20\%$) had significantly higher frequencies of American Golden-Plover flocks ($P = 0.0202$, Fisher's Exact Test) and marginally higher frequencies of Buff-breasted Sandpiper flocks ($P = 0.1267$) than routes with $> 20\%$ development (Figure 5).

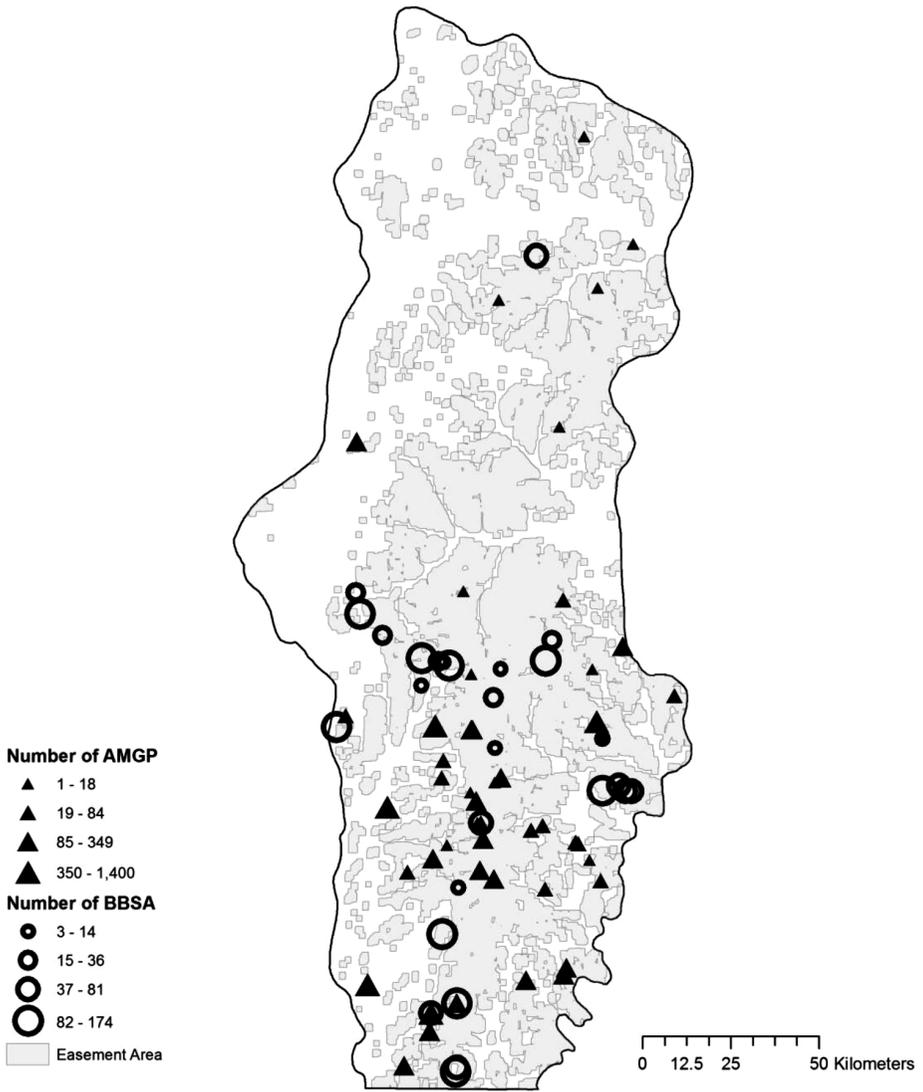


Figure 3. Locations of American Golden-Plover and Buff-breasted Sandpiper flocks observed on roadside surveys of the Flint Hills, Kansas, in 2013 and 2014. Shaded area is the boundary of the U.S. Wildlife Service's Flint Hills Legacy Conservation Area.

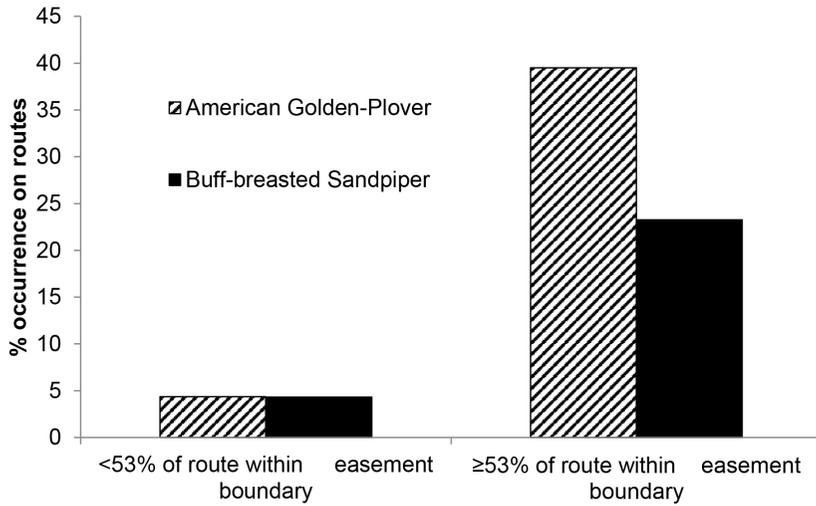


Figure 4. Occurrence of flocks of American Golden-Plover (*Pluvialis dominica*) and Buff-breasted Sandpiper (*Calidris subruficollis*) migrants in 2014 on roadside routes (n = 66) in the Flint Hills, Kansas, relative to the proportion of the route that fell within the easement boundary (either <53% or ≥53% of the route determined from regression tree procedures) of the U.S. Fish and Wildlife Service’s Flint Hills Legacy Conservation Area.

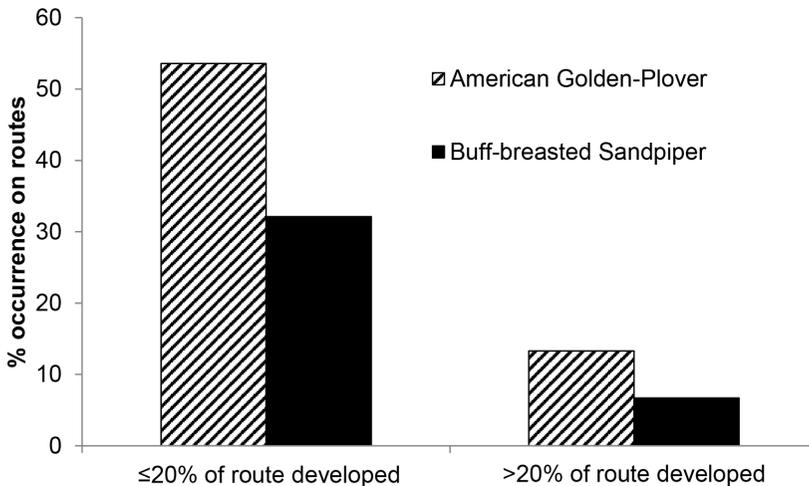


Figure 5. Occurrence of flocks of American Golden-Plover (*Pluvialis dominica*) and Buff-breasted Sandpiper (*Calidris subruficollis*) migrants in 2014 on roadside routes that had >53% of their length included within the U.S. Fish and Wildlife Service’s Flint Hills Legacy Conservation Area boundary in Kansas (n = 43) relative to the proportion of the route that is developed (≤20% or >20% of the route determined from regression tree procedures).

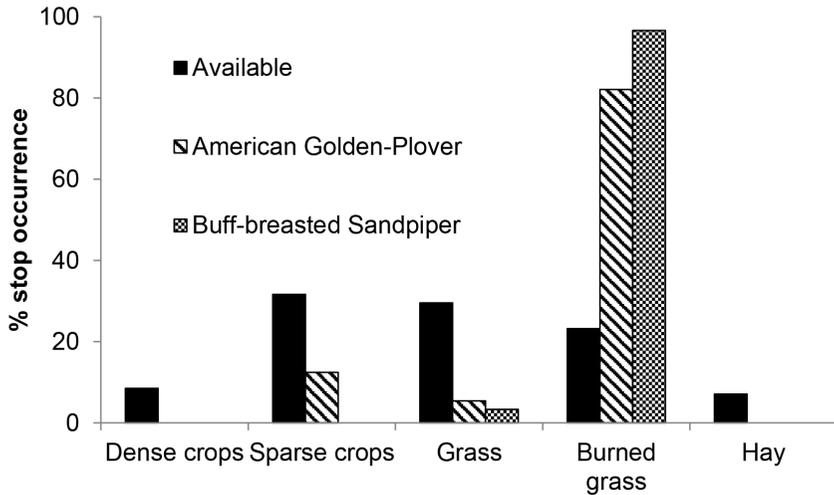


Figure 6. Availability and use of low stature (<1 inch) grass and hay and low stature (<4 inches) crop cover types (n = 1,130 stop occurrences) by American Golden-Plovers (n = 2,121 individuals) and Buff-breasted Sandpipers (n = 1,346 individuals) along roadside routes in the Kansas and Oklahoma Flint Hills during spring 2014.

To determine the value of burned grasslands as a stopover habitat, we examined shorebird use of low stature land cover type condition relative to their availability, which should minimize the effects of vegetation height on detectability (Figure 6). In 2014, American Golden-Plovers and Buff-breasted Sandpipers used burned grasslands disproportionately to their availability on routes in Kansas and Oklahoma ($P = 0.0001$, Fisher's Exact Test). We did not attempt to address differences in detectability of Upland Sandpipers related to vegetation height because of difficulty of determining migrants from resident breeding individuals.

DISCUSSION

During 2011, it appeared that the Flint Hills was an important migration stopover area for American Golden-Plovers and Buff-breasted Sandpipers and was also a prime stopover and nesting area for the Upland Sandpiper. Overall, the four-year project resulted in four major findings. Migrant American Golden-Plovers and Buff-breasted Sandpipers: 1) are more common in the southern portion of the Flint Hills; 2) use areas with a high proportion of native grass; 3) occur more often in grassland landscapes that are less developed; and 4) primarily use grasslands that have been recently burned over other low stature habitats. Variation in migration stopover use among years was influenced indirectly by precipitation and subsequent grass growth and directly by the amount of burning. Frequent burning of native grasslands can negatively affect habitat for some breeding bird species (Robbins *et al.*

2002, Powell 2008, Rahmig *et al.* 2008), but migrant American Golden-Plovers and Buff-breasted Sandpipers benefit from this practice in the Flint Hills.

American Golden-Plover and Buff-breasted Sandpiper use of low-stature fields and artificial grasslands has been documented in soybean stubble fields in the Rainwater Basin, Nebraska (Jorgensen *et al.* 2007, 2008); sod farms in northeastern Kansas (Robbins 2007) and northeastern Oklahoma (based on archives from OKBirds E-mail List-Serv, <https://lists.ou.edu>); and soybean fields and fields with standing water in Indiana (Stodola *et al.* 2014). All of Young's (2007) observations of Buff-breasted Sandpipers in the southern Flint Hills were made on burned grasslands. Jorgensen *et al.* (2007) also found that Buff-breasted Sandpipers were more abundant in Nebraska fields where development was minimal. Thus, management activities for migrant American Golden-Plovers and Buff-breasted Sandpipers should target large, undeveloped grassland tracts in the southern half of the Flint Hills with management favoring heterogeneity, since some disturbance is desirable (ex. burning).

Information gained in this study is being used to develop an optimal survey design for monitoring upland, grassland shorebirds in the Flint Hills. Except for work in the Rainwater Basin (Jorgensen *et al.* 2007, 2008, Jorgensen 2012), we are unaware of other studies attempting to survey migrant shorebirds in non-wetland habitats at a landscape scale. However, long-term studies have been conducted on the avifauna in the northern Flint Hills at Konza Prairie (Zimmerman 1993) and the southern region, the Tallgrass Prairie Preserve in Oklahoma (Reinking and Hendricks 1993, Rohrbaugh *et al.* 1999, Reiking *et al.* 2002, Reinking 2005), though not specifically on shorebird migration. Because of the dynamics of migration, it is important that survey effort is distributed across the period of interest and that observers adhere to a systematic survey schedule. Further analysis is underway to generate estimates of the migrant population size, which will provide an evaluation of the importance of the Flint Hills to American Golden-Plovers and Buff-breasted Sandpipers.

ACKNOWLEDGMENTS

We thank the following observers for participating in the survey: Matt Blacely, Ken Brunson, Lee Ann Brunson, Jim Denning, Melina Droege, Dwayne Elmore, Mike Estey, Dave Evans, Suzanne Fellows, Denise Hall, Jim Hays, Torre Hovick, Pete Janzen, Tim Menard, Cheryl Miller, Carol Morgan, Brian Obermeyer, Jimmy Rutledge, Brian Smith, Max Thompson, and E. Young's students from Northern Oklahoma College. Mike Estey, Suzanne Fellows, Murray Laubhan, and Brian Smith contributed to the development of the survey methods and Brian Obermeyer contributed to the editing. Brett Sandercock, and two anonymous reviewers reviewed the manuscript, and their comments greatly enhanced the final product. Funding for the survey work was provided by The Nature Conservancy and Region 6 Migratory Bird Program, U.S. Fish and Wildlife Service. The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service or The Nature Conservancy.

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