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Will increased storm-surge frequency impact food availability for Semipalmated Sandpipers *Calidris pusilla* at the beginning of fall migration?

Roy T. Churchwell[1,2], Steve Kendall[3], Stephen C. Brown[4] & Abby N. Powell[5,6]

[1]*Department of Biology and Wildlife, University of Alaska Fairbanks, Fairbanks, Alaska 99775, USA*
roy.churchwell@alaska.gov
[2]*Alaska Department of Fish and Game, Department of Wildlife Conservation, 802 3rd St. Douglas, Alaska 99824, USA*
[3]*Hakalau Forest National Wildlife Refuge, U.S. Fish & Wildlife Service, Hilo, Hawaii 96720, USA*
[4]*Manomet Inc., Manomet, Massachusetts 02345, USA*
[5]*U.S. Geological Survey, Alaska Cooperative Fish & Wildlife Research Unit, and Institute of Arctic Biology, University of Alaska Fairbanks, Fairbanks, Alaska 99775, USA*
[6]*Current Address: U.S. Geological Survey, Florida Cooperative Fish and Wildlife Research Unit, University of Florida, Gainesville, Florida 32611, USA*

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Hatch-year Semipalmated Sandpipers *Calidris pusilla* use river deltas along the Beaufort Sea coast of Alaska as their first stops during fall migration. However, these sites are subject to extreme changes in water levels that affect available foraging habitat. We examined relationships between timing of fall migration and storm surges, with respect to forage availability, using different water level scenarios to predict impacts on food availability for fueling migration at three river deltas. We compared available calories at observed water levels to modeled values derived from changes due to lunar (classic) tides (35% decline) and storm surges (58% decline). Peak use by shorebirds varied temporally among sites, while the peak in forage availability occurred late in the season, mismatched with the largest peak in migration at the most used river delta. Shifts in breeding phenology due to climate warming may allow shorebirds to migrate earlier and miss some storm surges, but this may create a mismatch between peak migration and greater food availability. Additionally, changes in climate will likely increase frequency and severity of storm surges that negatively impact availability of foraging habitat for migrant shorebirds.

Keywords

Beaufort Sea
foraging
mismatch
bottleneck
inundation
river delta
stopover
tides

INTRODUCTION

Coastal ecosystems are predicted to suffer significant climate impacts in the future including erosion and partial or complete inundation from storm surges (changes in water level caused by wind) and sea-level rise (Overpeck *et al.* 2006, Manson & Solomon 2007, Tebaldi *et al.* 2012). Sea-level rise has the potential for greater change in the Arctic Ocean basin compared to the global average due to more thermal expansion in arctic waters and increased freshwater inputs (Church *et al.* 2001). Furthermore, the number of storm surges will increase when sea-ice declines in extent and persistence due to increased arctic temperatures (Overeem *et al.* 2011, Rampal *et al.* 2011, Massonnet *et al.* 2012), because sea-ice dampens wave action (Reimnitz & Maurer 1979). Additionally, more storms will augment the number of storm surges that occur in a season (Walsh 2008, Overeem *et al.* 2011). The potential impacts storm surges may have on migrating shorebirds that use coastal mudflats as stopover sites is currently unknown. However, as shorebirds use these sites for foraging, increased water levels from storm surges may reduce the availability of invertebrate prey.

The energy reserves gained at stopover sites are a critical component of successful migration (McWilliams & Karasov 2001, Krapu *et al.* 2006, Maillet & Weber 2006, Hua *et al.* 2013). The energy gained may be particularly important for species like arctic-breeding shorebirds migrating long distances from breeding to wintering grounds (Galbraith *et al.* 2002, Skagen 2006, Iwamura *et al.* 2013). The quantity of food resources needed for migration are tied to a species' migration strategy; to refuel, long-distance migrants need more resources at a stopover site than do short-distance migrants (Choi *et al.* 2009).

The Beaufort Sea coast includes deltaic mudflats used as stopover sites by shorebirds as they move from their breeding grounds on the Arctic Coastal Plain and begin fall migration (Brown *et al.* 2007, 2012, Taylor *et al.* 2010). The majority of these shorebirds (83%; Brown *et al.* 2012) are hatch-year (recently fledged) Semipalmated Sandpipers *Calidris pusilla* preparing for their first migration. During this early portion of their migration, these sandpipers use a 'hop' (i.e. short-distance) migration strategy, foraging at a site for a day or so and then flying ~100 km to the next stop (Taylor *et al.* 2011). The invertebrate prey found within these mudflats varies temporally and spatially, and species composition is influenced by salinity and substrate type (Churchwell *et al.* 2016, 2017).

In general, foraging habitat at these river deltas is reliably available to shorebirds because there is minimal tidal influence along the Beaufort Sea coast, and the amplitudes of lunar high tides are not high enough to inundate the mudflats. The maximum lunar (high spring) tide results in water level change of only 30 cm and averages 10.5 cm (NOAA 2010). On the Beaufort Sea, storm surges are the product of an interaction between the Beaufort Gyre that flows from east to west along Alaska's north coast, and atmospheric pressure, wind speed, and wind direction (Norton & Weller 1984). Strong winds from the west create an increasing storm surge, while strong winds from the east cause water levels to drop (Crane 1974, Norton & Weller 1984). These storm surges can completely inundate delta mudflats at random times (Crane 1974, Marsh & Schmidty 1993, Pisaric *et al.* 2011, Vermaire *et al.* 2013). Because shorebirds migrate through this region from mid-July through mid-September, while the Beaufort Sea is ice-free, the impact of an increasing number of annual storm surges on forage availability during this critical period of their life history is of concern.

Herein, we examine the relationships between timing of fall migration of Semipalmated Sandpipers and storm surges with respect to forage availability. First, we determined the phenology of fall migration for hatch-year Semipalmated Sandpipers at three major river deltas on the Beaufort Sea coast. We expected storm surges would overlap with the use of the river deltas by migrating shorebirds, and the timing of these events would be stochastic. Next, we estimated the calories available to foraging shorebirds derived from systematic sampling of invertebrates at these sites. Finally, we determined changes in available calories based on several different water level scenarios, including seasonal variation, lunar tides, and storm surges, to better understand the importance of these stopover sites and the potential impacts of increased frequency of storm surges due to climate change. To our knowledge, this work is the first to investigate tidal and storm-surge impacts on foraging habitat at stopover sites. Previous research on the effects of storm surges have focused on impacts to nesting birds (Fienup-Riordan 1999, van de Pol *et al.* 2010, Craik *et al.* 2015), and the impacts of sea-level rise at shorebird stopover sites (Galbraith *et al.* 2002, Austin & Rehfisch 2003, Iwamura *et al.* 2013).

METHODS

As part of a large-scale study on the ecology of shorebirds using Alaskan stopover sites during fall migration, we sampled invertebrates and counted Semipalmated Sandpipers at three river deltas (Canning, Okpilak/Hulahula, and Jago) on the coast of the Arctic National Wildlife Refuge (Fig. 1). Jago is the farthest east and approximately 650 ha, Okpilak/Hulahula is 20 km to the west (740 ha), and the smallest site, Canning, is another 60 km west (290 ha). The mudflats where shorebirds fed consisted of sand, silt, and clay sediments; no gravels were observed (Churchwell *et al.* 2016). While it is typical for coastal deltas to have regular inputs of seawater, Jago and Okpilak/Hulahula mudflats were characterized by freshwater (zero salinity) due to constant river flows and minimal tidal activity, except for small areas on their western ends. In contrast, about 25–50% of Canning's perimeter was saline (12–20‰), depending on the prevailing ocean currents (Churchwell *et al.* 2016).

Phenology of migration

We counted shorebirds at each delta starting the third week of July through the third week of August in 2010 and 2011. The timing encompassed the end of the breeding season and most of the migration period; by the end of our surveys most shorebirds had left the Beaufort Sea area. We first deployed a count grid of 100 x 100 m cells delineated by wooden lathes on each delta. When we counted shorebirds in the grid, the species, number, and age (hatch-year or adult) of birds were recorded in each cell. Surveys were conducted on a three-day schedule at each delta, and the entire grid was counted during each survey. Even though we had 24-hr daylight for much of the survey period, we counted birds starting mid-morning (around 09:00 hrs) until we covered the survey area, which took 6–8 hrs on the larger deltas. We did not count birds later in the evening because shorebird activity declined (Andres 1989).

We present total daily counts for Semipalmated Sandpipers as an estimate of the number of birds on each delta on a given survey day to describe use through the migration period. We cannot discount double counting some birds, but we were conscious of bird movement throughout the day and did not recount birds that we knew were counted previously. We did not account for detection probability because detection rates for shorebirds in this habitat using a similarly scaled line-transect method were estimated to be 0.99 (Brown *et al.* 2012).

Invertebrate sampling

To determine spatial and temporal patterns of invertebrate abundance, we used a stratified sampling framework with a grid of 250 x 250 m cells. The scale of the grid used to collect invertebrate samples was larger than the scale of the grid for surveying shorebirds because it was not

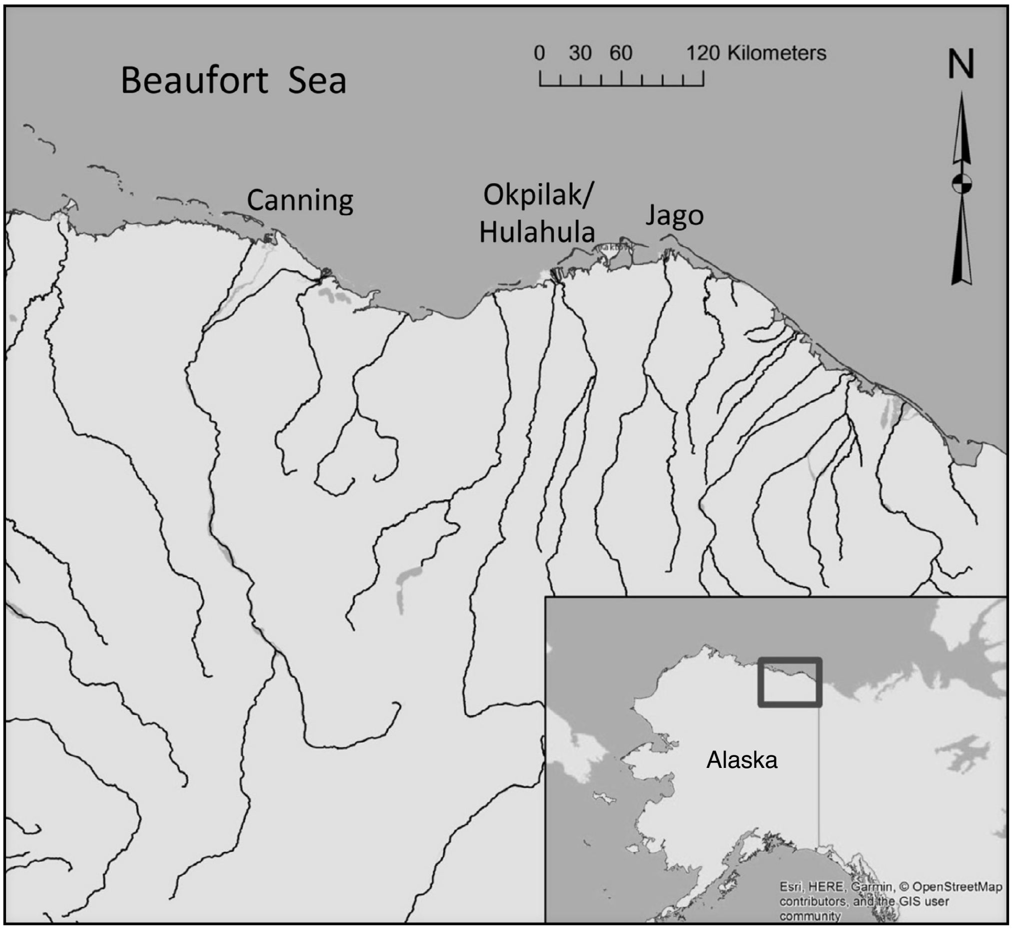

Fig. 1. Location of three river deltas along the Beaufort Sea, Alaska sampled for shorebird use (2009–2011) and invertebrate abundance and density (2010–2011).

possible to visually quantify shorebirds within the larger invertebrate grid, and sampling invertebrates on the smaller shorebird grid would have been unmanageable because of the large number of samples that would need to be collected. Similar invertebrate sampling schemes have been used on other projects (Kraan *et al.* 2009, 2010). To capture temporal patterns of invertebrate abundance and distribution, we collected samples at each delta during three time periods corresponding with fall migration along Alaska's North Slope: early- (21–31 Jul), mid- (1–9 Aug), and late-season (10–20 Aug). The time periods were unequal in length due to complications in scheduling data collection; however, all deltas were sampled once during each period. The area of the delta sampled during these survey events included all available shorebird feeding habitat, which included the entire dry mudflat plus water-covered mudflat ≤5 cm in depth. Water depths ≤5 cm, were determined to be accessible to feeding shorebirds based on mean bill length of the suite of species (ranging in bill length from Semipalmated Plover *Charadrius semipalmatus* to Stilt Sandpiper *Calidris himantopus*) using the deltas during fall migration.

At each survey event, invertebrates were sampled from a random location within each grid cell. If water depth at a sample location was >5 cm, that location was not sampled, and a second random location within each grid square was evaluated for water depth and sampled instead. If both locations were >5 cm then the grid cell was not considered foraging habitat and was not sampled during that period. Invertebrate sampling included collecting a sediment core and, when water was present, we recorded water depth to the nearest cm at each sample location. We used a PVC corer (1/100 m^2) pushed 5 cm into the sediment (volume = 501.2 cm^3) to sample invertebrates. We sifted the core through a 500-μm sieve in the field and stored preserved invertebrates and residual sediment in a plastic jar with 70% alcohol.

In the lab, we sorted invertebrate samples by taxa to the family level when possible. We identified samples to a higher taxonomic level than family when individuals were difficult to identify, were rare, or the taxonomic level met the ecological level of interest as a shorebird food item (for example it is unlikely that shorebirds differentiated amphipod families that were in similar habitat and of a similar size). We counted individuals within each core and extrapolated to biomass using published length-weight regressions specific to each taxon. The taxa-specific biomass measurements were then converted to calories m^{-2} by multiplying by 5,400 $cal \cdot g^{-1}$ invertebrate dry weight (Table 1). This value for calories per gram of dry weight is an estimate based on an average for Chironomidae, Oligochaeta, Amphipoda, and Polychaeta (Wissing & Hasler 1971, Wacasey & Atkinson 1976, Steimle & Terranova 1985), and is very similar to a commonly used estimate for all invertebrates of 5,500 cal·g^{-1} invertebrate dry weight (van de Kam *et al.* 2004). All of the taxa in our study were soft-bodied invertebrates and easily digested, thus we did not consider digestibility in our analyses. Calorie estimates for each sample location and period were then used as the basis for our analysis of available feeding habitat and potential fuel for migration.

Water levels

We used water levels to calculate the boundaries of available feeding habitat for shorebirds. We mapped water levels every three days by recording the water's edge during each shorebird count. We then took the mean water levels from the maps to represent water levels for the early-, mid-, and late-season periods. These water-level maps became the baseline mudflat/waterline boundaries used in our analyses.

We created a second set of maps to represent the influence of lunar tides by delineating new boundaries using GIS, which depicts the impact of an average lunar tide in addition to our baseline water level. These boundaries accounted for a 10.5 cm (the mean lunar tide, Mean High Water Datum; NOAA 2010) increase in water level and represented the additional horizontal distance in water inundation calculated from the average slope of our deltas. We used an average slope of 0.000741 m·m^{-1} based on measurements we made from Jago and observations that slopes were similar among deltas, but we were unable to survey all three deltas for slope. When we considered slope in addition to increased water level from an average lunar tide, there was a change of about 140 m of horizontal distance above the baseline water level (habitat lost under water) across each mudflat.

Finally, we created a third set of maps to estimate the amount of foraging habitat available during a storm surge. We measured water depths with a barometric pressure data logger deployed in each lagoon. We defined a surge as changes in water level greater than a maximum lunar tide (>30 cm). We calculated surge water levels by subtracting 30 cm from water depth measurements obtained from the barometric pressure data loggers, but then added these positive values that remained after subtraction to the regional average lunar tide (+10.5 cm) for analysis. This method normalized the surge effect around an average lunar tide and provided a conservative estimate of surge impacts. These calculations resulted in average yearly estimates of surge effect (the surge plus lunar effect) values of about 208 m and 321 m horizontal distance across each mudflat in 2010 and 2011, respectively.

We deployed barometric pressure data loggers in 2009, but we did not have data on invertebrate biomass that year, and so we did not include 2009 in most of our analyses. However, we included 2009 water level data in a graphic of surge water levels to display the annual and seasonal variability in surge effect.

Analyses

We used exponential kriging to determine the distribution of invertebrate calories on the delta using the R package *geoR* (Ribeiro & Diggle 2013). Kriging is a geostatistical technique that uses the spatial variance between pairs of sample points to model the predicted values from each sample location, which are then extrapolated across the study area (Fortin & Dale 2005; Fig. 2). In the kriging

Table 1. Caloric totals of the most common invertebrate taxa for three Beaufort Sea, Alaska, river deltas during early- (21–31 Jul), mid- (1–9 Aug), and late-season (10–22 Aug) sample periods in 2010 and 2011. Blank cells indicate no samples were collected and two stars (**) indicate that taxon was not found in the samples. For Canning, early- and mid-season samples are missing because invertebrates were too scarce to quantify during that sampling period.

Year/Taxa	Canning		Okpilak/Hulahula			Jago		
	Mid	Late	Early	Mid	Late	Early	Mid	Late
2010								
Amphipoda		93,268	10,730	**	**	6,873	5,908	20,780
Chironomidae		**	65,692	26,689	70,444	54,308	25,052	97,813
Oligochaeta		73,546	26,522	22,477	29,182	49,935	8,888	61,968
2011								
Amphipoda	**	151,426	106	9,380	48,041	300	1,109	19,227
Chironomidae	**	**	34,038	89,898	115,409	25,573	89,060	72,240
Oligochaeta	231,551	298,834	206,292	488,689	1,177,222	107,710	146,198	146,424
Spionidae	9,522	76,176	**	**	42,849	**	**	**

analysis, we created a variogram using an exponential model, and projected the model as a predictive map for each delta. These kriging maps of calories m^{-2} were created to evaluate differences in potential forage availability for each year, delta, period, and water level combination. From each map, we then calculated total calories available across each delta, which was the sum of values of the 250 x 250 m predictive raster grid cells from the output of each kriging analysis. We compared observed, tidal, and surge estimates using percent change, and conducted a three-factor ANOVA to test for a significant difference among the three water levels. Factors included water level, delta, and periods, which were nested within year. We were unable to create maps for Canning in early- and mid-season periods for 2010 and early-season in 2011 because there were too few invertebrates collected during those sample periods for the kriging models to converge on an estimate, and so ANOVA sample sizes were unequal but the unbalanced design was accounted for.

RESULTS

We present data from 2009–2012 for Jago to describe phenological use of the sites by foraging shorebirds, and data from 2011 for the other deltas to describe variation among study sites (Fig. 3) because patterns were similar among years. The number of Semipalmated Sandpipers using Jago peaked in the early- or mid-season period, on average around 1 August (range = 26 Jul–5 Aug; Fig. 3a). Peak counts at Jago were 3,000–4,000 birds, and the highest peak occurred for just one count day before numbers declined by 1,500 birds. A second peak, of 1,000–2,000 fewer birds than the highest peak, was observed some years, usually later in migration. In contrast, peak counts at the other two deltas were observed during the late period; at Okpilak/Hulahula a peak of 4,000 birds was counted on 12 August, and about 1,000 birds at Canning during the same count period (Fig. 3b). However, our surveys did not capture the peak count at the Canning delta where many more birds were observed the two days prior to the survey day. Our previous research also indicated that the number of shorebirds was positively associated with the abundance of invertebrates at these sites (Churchwell *et al.* 2017).

The amount of available food resources, expressed as total calories m^{-2}, varied among the three sites, with the most calories available at Jago (160,376 total calories averaged across periods), and the least overall at Okpilak/Hulahula (95,523 total calories; Fig. 4). Patterns of seasonal variability also differed by site. At Okpilak/Hulahula, the amount of available foraging habitat did not vary much among periods. In contrast, the Canning and Jago deltas had more available foraging habitat in the late period than the two earlier periods (Fig. 4). When compared to bird use, the peak in forage availability was later than the greatest bird use at Jago, but coincided at Okpilak/Hulahula and Canning. The count of 250 x 250 m grid cells representing available foraging habitat was, respectively, 17 and 25 mid- and late-season at Canning, 50, 18, and 45 early-, mid-, and late-season at Okpilak/Hulahula, and 43, 41, and 78 early-, mid-, and late-season at Jago. We found Chironomidae contributed as many calories as Oligochaeta in 2010 across all sites, although this taxon was not found at the Canning delta

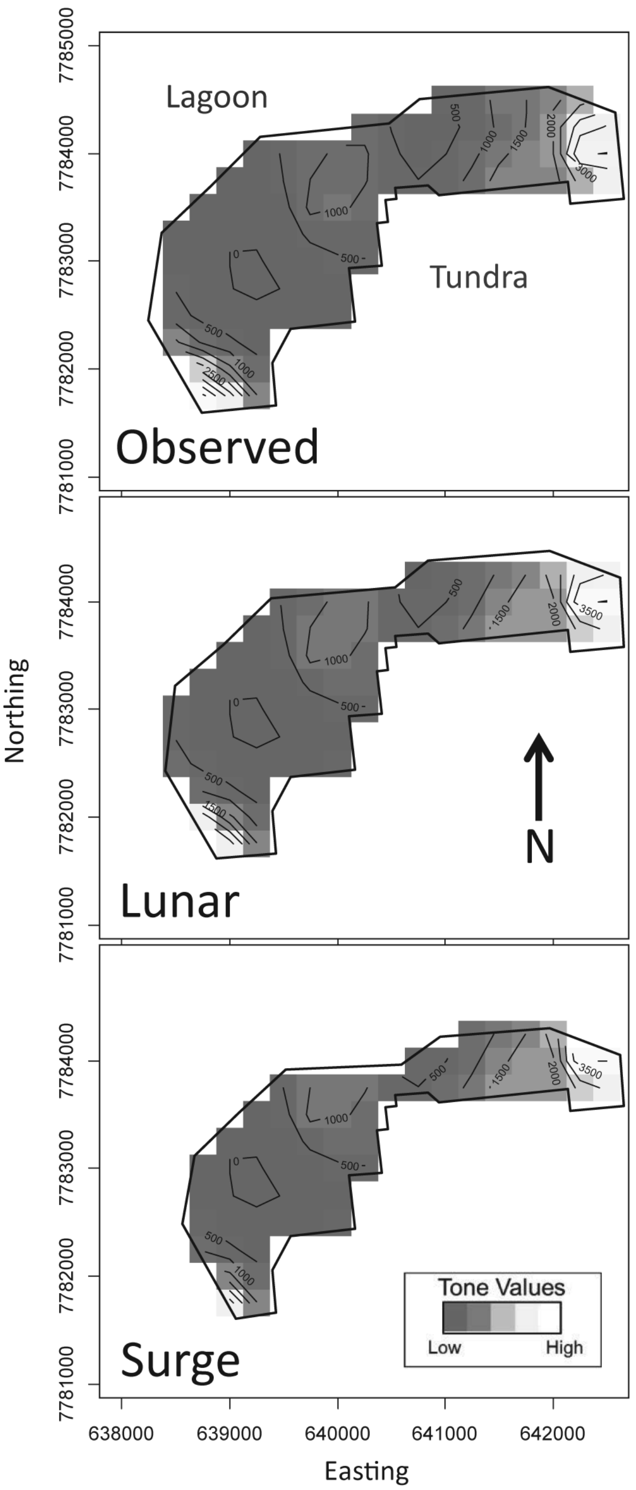

Fig. 2. An example of the kriging layers for the Jago River delta during the late-season period (10–22 Aug), 2011. Layers reflect the changes in water levels from observed water levels and models of lunar tides and an average storm surge.

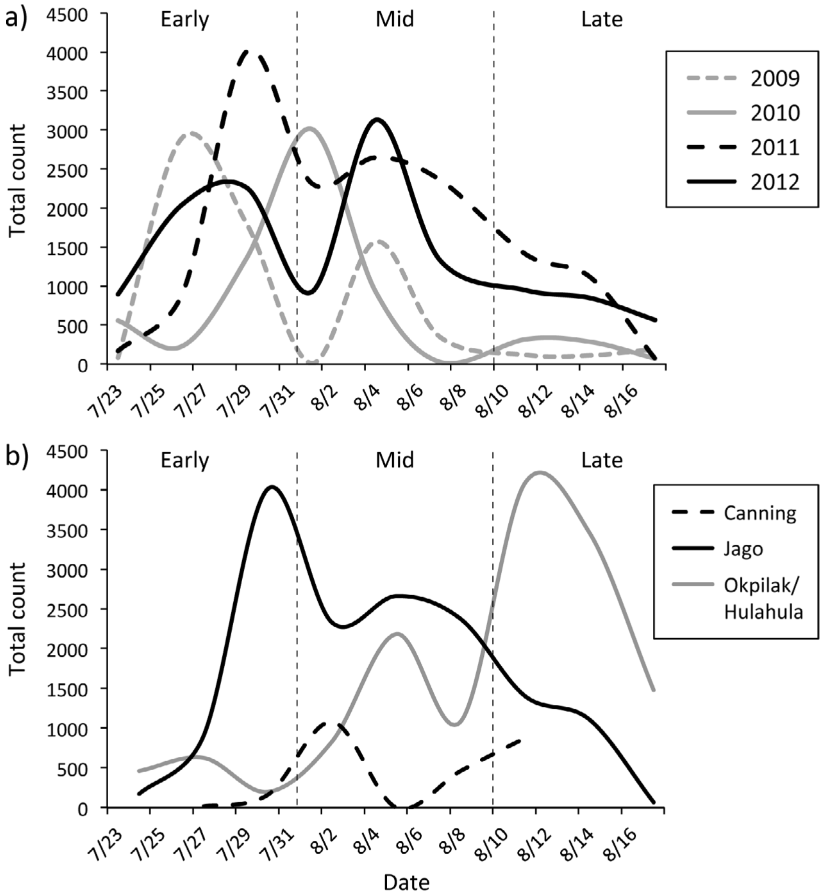

Fig. 3. Phenology of fall migration for hatch-year Semipalmated Sandpipers at river deltas along the Beaufort Sea, Alaska coast. **a)** Counts at Jago 2009–2012. **b)** Counts at Jago, Okpilak/Hulahula, and Canning, 2011. Numbers are raw counts of Semipalmated Sandpipers during each survey day.

(Table 1). In 2011, the majority of calories came from Oligochaeta, and this taxon was commonly found at all deltas. During both years marine invertebrates contributed more calories at Canning compared to marine contributions at the other two deltas (Table 1).

In our models, lunar tides reduced by 35% (range 19–64%) the available calories calculated for observed baseline water levels. The estimated effect of surge events on available calories was a 58% (range 0–75%) reduction in available calories across the delta compared to baseline water levels. The estimated reduction in available calories from a storm surge was 37% (range 0–98%) greater than the reduction from lunar tides. Accounting for the error across years and periods within a year, we found significant differences in the available forage calories among deltas ($df = 2$, $F = 8.2$, $P = 0.001$) and water levels ($df = 2$, $F = 8.3$, $P = 0.001$) we tested. Of our modeled effects, a surge event occurring mid-season at Canning was the only one that would have completely inundated the entire mudflat, resulting in no available foraging habitat for shorebirds. In fact, actual observations at Canning indicated there was complete inundation of the delta during two days for about a four-hour period due to the combination of a storm surge occurring at a maximum lunar (~30 cm) tide.

Actual storm surges were relatively common and unpredictable in 2009–2011 (Fig. 5). However, they were less frequent during the early period of migration. Many storm surges occurred for 24 hours or less, but there were multi-day events on 8–11 August 2009 and 15–17 August 2010. There was only one surge that resulted in water levels >1 m, which occurred at all three deltas in 2009 and completely inundated all foraging habitat (R. Churchwell pers. obs.). All other surge events in 2009–2011 resulted in changes in water levels similar to, or less than, a maximum lunar tide (<30 cm).

DISCUSSION

We found that foraging habitat, in terms of calories available for Semipalmated Sandpipers, varied among deltas and time periods due to changes in water levels during fall migration along the Beaufort Sea coast. The greatest amount of foraging habitat at all sites was available late in migration (mid–late August). Water levels within these lagoons are low in August corresponding to declining river discharges (USGS 2012) due to minimal snow and glacial melt in the Brooks Range corresponding with increasingly colder temperatures in the mountains (R. Churchwell pers. obs.). Available foraging habitat also varied by year; estimates

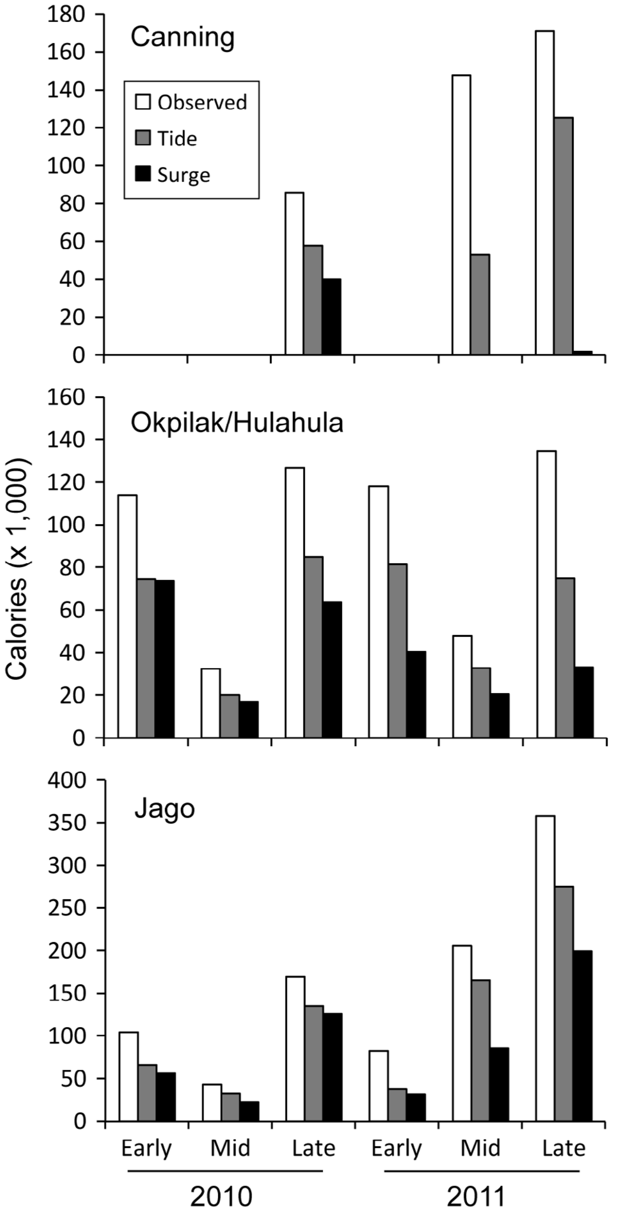

Fig. 4. Changes in calories derived from invertebrate prey among three Beaufort Sea, Alaska, river deltas under three scenarios: observed water levels, modeled lunar tides, and modeled surge events, 2010–2011. The only model that completely inundated the delta occurred at Canning during a mid-period (1–9 August) as the result of a storm-surge event.

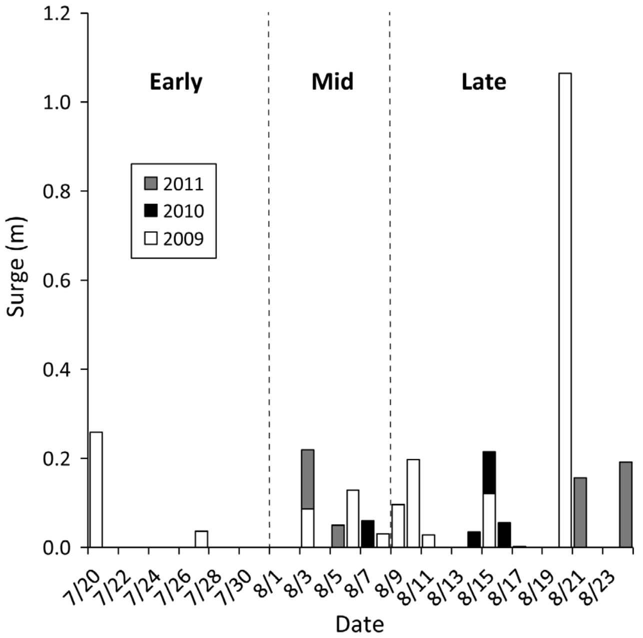

Fig. 5. Date and heights of actual storm surges along the Beaufort Sea, Alaska, coast during fall migration of Semipalmated Sandpipers, 2009–2011. Surges were observed at all three river deltas (Canning, Okpilak/Hulahula, and Jago).

were more similar among the different time periods and deltas in 2010 than 2011 (Fig. 4), and the timing of maximum shorebird use did not always correspond with periods of greatest food availability.

Hatch-year Semipalmated Sandpipers used Beaufort Sea delta mudflats as stopover sites mostly around the first few weeks of August. The timing of fall migration is partially dependent on spring snowmelt and the initiation of nesting (Newton 2008) that occurs in mid-June. After fledging, birds move to the coast in mid-July to start their west-to-east migration along the Beaufort Sea coast (Taylor *et al.* 2011). Climate warming has the potential to impact the timing of nesting by shifting nest initiation earlier in the breeding season (Grabowski *et al.* 2013, Liebezeit *et al.* 2014), which could lead to earlier departure from the breeding grounds by adults and juveniles. An earlier departure would correspond with current periods of low frequencies of storm surges (Overeem *et al.* 2011), potentially minimizing the risk of birds encountering a storm-surge event. Currently, peak migration occurs about the time that storm surges become more frequent. Alternatively, the phenology of invertebrate prey available on the mudflats may preclude any advantage of earlier arrival of shorebirds at these sites; we found that the greatest invertebrate abundance, biomass, and available calories for fattening were found at the end of the migratory season (Fig. 4; Churchwell *et al.* 2016). However, none of these processes are static, and climate-warming predictions also suggest that storm surges (Overeem *et al.* 2011) and invertebrate emergence could occur earlier in the future.

Although peak shorebird use was not closely tied to maximum available habitat, there are several reasons to believe that Beaufort Sea deltas are important as stopover sites for hatch-year Semipalmated Sandpipers. First, based on observed undeveloped feather tracks, short wing chords, and low weights, some juvenile birds were still growing when they began their migration (R. Churchwell unpubl. data). In addition, the majority of adult birds seemed to leave the breeding grounds by a different route, based on the few adults observed in our study and others (Taylor *et al.* 2010, Brown *et al.* 2012). Handel & Gill (2010) suggested juvenile Sharp-tailed Sandpipers *C. acuminata*, which also take a different migration route than adults, might need more food resources than adults to complete a successful migration. If juveniles migrating along the Beaufort Sea coast do not have competition from adults, it is possible this route provides ample feeding opportunities to allow for continued growth and migratory fattening. Second, migratory strategies include 'hops', short-distance migrations of hundreds of kilometers and stops of 1–2 days (~100 km for Semipalmated Sandpiper), 'jumps' where birds travel long distances and stop for several weeks to refuel, and 'skips', which have intermediate migration distances and stopover times (Piersma 1987, Warnock 2010). Juvenile Semipalmated Sandpipers may be showing an adaptation to variable resources by using a 'hop' migration strategy along the Beaufort Sea coast since short flights with many feeding stops (Warnock 2010) would allow for adjustments to changing conditions and food availability.

We observed highly variable and unpredictable storm surges (Fig. 5), including a storm surge that completely inundated the Canning delta for a few hours on two days. Furthermore, we observed complete inundation events across the study areas that lasted ≥24 hours in 2008 and 2009. In future, the severity of storm surges will likely increase with decreasing sea ice coverage (Overeem *et al.* 2011, Perovick *et al.* 2014) as ice can dampen wave action (Reimnitz & Maurer 1979, Overeem *et al.* 2011). It is also expected that the frequency of storms in the Beaufort Sea will increase during the summer open-water period (Atkinson 2005, Walsh 2008, Hinzman *et al.* 2013). In addition to impacts on availability of overall shorebird feeding habitat, storm surges can also negatively affect the composition of the invertebrate community (Pisaric *et al.* 2011, Vermaire *et al.* 2013). Benthic invertebrates have specific salinity and sediment requirements (Yates *et al.* 1993, Kraan *et al.* 2010), and storm surges can increase the salinity of deltas via seawater inundation, and change the particle size of sediments (Vermaire *et al.* 2013) by washing away fine sediments. Some important food resources, such as Chironomidae, inhabit sediments with fine particle size and low salinity (Churchwell *et al.* 2016); increased storm surges could negatively impact their abundance and distribution within delta mudflats.

In conclusion, Beaufort Sea deltas might be a 'bottleneck' (bottleneck stopover sites are critical to population survival for migratory shorebird species; Piersma 2002, Buehler & Piersma 2008) for hatch-year Semipalmated Sandpipers produced in Alaska because a significant proportion of their population may use these deltas to fuel their southern migration. Events such as storm surges that reduce forage opportunities for juvenile Semipalmated Sandpipers using Beaufort Sea deltas as stopover sites could cause a population decline if they lead to lower survival of this age class. However, recognizing these impacts on a population level would be difficult because a decline in recruitment into the adult population would not be detected for several years. Nevertheless, predicted increases in frequency and intensity of storm surges along the Beaufort Sea coast during this critical stage of life history for migratory sandpipers merits conservation concern.

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