Use of upland tundra habitats by Western and Rock Sandpipers during brood-rearing on the Yukon-Kuskokwim Delta, Alaska

MATTHEW JOHNSON[1] & BRIAN MCCAFFERY[2]

[1]Department of Biology, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, USA jedibirdnerd@yahoo.com; [2]Yukon Delta National Wildlife Refuge, United States Fish and Wildlife Service, PO Box 346, Bethel, AK 99559, USA.

Johnson, M. & McCaffery, B. 2004. Use of upland tundra habitats by Western and Rock Sandpipers during brood-rearing on the Yukon-Kuskokwim Delta, Alaska. *Wader Study Group Bull.* 103: 36–39.

We compared upland tundra habitat use patterns during brood-rearing in the Rock and Western sandpipers near Old Chevak, Yukon-Kuskokwim Delta, Alaska. During 2002, we surveyed six plots ranging in size from 100 to 200 ha every 3–5 days for a total of four surveys per plot. We observed differentiation of habitat use between the two species during the brood-rearing phase of reproduction. Rock Sandpiper broods were most often observed >20 m from the edge of upland tundra habitat, sedge-grass habitat, and open water, whereas Western Sandpiper broods were usually observed within 20 m of these habitat features. Over three-quarters of Western Sandpiper broods were observed in dwarf shrub-graminoid habitat, yet Rock Sandpiper brood observations were equally distributed between the two tundra classifications (dwarf shrub tundra, dwarf shrub-graminoid tundra). Given the high levels of chick mortality among most sandpiper species, patterns of habitat use during brood-rearing are almost certainly under strong selection pressure and warrant further investigation.

INTRODUCTION

Habitat use by arctic and subarctic sandpiper broods has been poorly studied (but see descriptive comments in Holmes 1966, 1971, 1972, Connors *et al.* 1979, Miller 1983, Tomkovich 1985, 1994, Tomkovich & Sorokin 1983, Smith & Connors 1993, Lanctot & Laredo 1994), in part due to the difficulty of tracking individual broods through both space and time. Given the high levels of chick mortality during this period (Norton 1973, Maher 1974, Safriel 1975, Miller 1983, Lanctot & Laredo 1994, Johnson & Connors 1996, Nol *et al.* 1997, Handel & Gill 2000), patterns of habitat use are almost certainly under strong selection pressure. In addition, other aspects of breeding behaviour, such as nest-site selection and parental investment, may affect and/or be constrained by habitat requirements during brood-rearing. Before specific hypotheses about the factors affecting habitat use by sandpiper broods can be adequately tested, it is first necessary to provide descriptions of this phenomenon.

Rock *Calidris ptilocnemis* and Western *C. mauri* Sandpipers breed sympatrically on the Yukon-Kuskokwim Delta, Alaska (YKD). Males of both species defend a nesting territory in hummocky upland tundra habitat and forage on their nesting territories as well as on riparian mudflats, in graminoid-dwarf shrub meadows, and along lakeshores (Tomkovich & Sorokin 1983, Tomkovich 1985, Wilson 1994). Rarely, Western Sandpipers nest in wet meadows dominated by *Carex ramenskii* on the YKD (C. Ely pers. comm.). Nests are initiated from mid-May to mid-June (Gill *et al.* 2002, Ruthrauff 2002). Both species commonly exhibit biparental care of eggs and young. However, either sex, usually the female, may desert its mate and brood shortly after hatching (Holmes 1971, Myers *et al.* 1982, Tomkovich 1994), and on the Chukotsky Peninsula, either Rock Sandpiper parent may desert its mate prior to hatching (Tomkovich 2003).

Data on habitat use by broods is scant for both species. Rock Sandpiper broods on the Chukotsky Peninsula often feed in forb-graminoid tundra (Tomkovich & Sorokin 1983), and Western Sandpipers rear dependent young along the margins of wetlands near Kanaryarmiut Field Station, Yukon Delta National Wildlife Refuge (D. Ruthrauff pers. comm.). On the YKD, both species typically select nest sites in upland tundra habitat, yet the extent to which either or both species continue to use upland tundra habitat during brood-rearing is unknown. In this paper, we compare upland tundra habitat use patterns during brood-rearing in the Rock and Western sandpipers.

METHODS

Shorebird brood surveys were conducted in and around Old Chevak (61°26'N, 165°27'W), Yukon-Kuskokwim Delta, Alaska. Old Chevak is located on Yukon Delta National Wildlife Refuge between the Kashunuk and Keoklevik rivers; surrounding habitat is a complex of lakes, sloughs, wetlands, and upland tundra. Upland tundra vegetation surrounding Old Chevak is dominated by lichens, *Sphagnum* spp., *Betula nana*, *Salix fuscescens*, *Ledum decumbens*, *Empetrum nigrum*, *Rubus chamaemorus*, *Eriophorum* spp., and *Poa eminens*, and wetland and lakeshore margin vegetation is predominately characterized by sedges (*Carex mackenziei*, *C. rariflora*), and grasses (*Poa eminens*, *Calamagrostis* spp., *Eriophorum* spp.; Ely & Raveling 1984). Upland tundra vegetation surrounding Old Chevak corresponds to the "lowland moist low scrub" community described by Jorgenson & Ely (2001). This vegetation community is a mosaic of patches, some of which contain graminoid species (dwarf shrub-graminoid tundra) and some of which do not (dwarf shrub tundra). To clarify sandpiper use of upland tundra habitats during brood-rearing, we subdivided the lowland moist low scrub community into these two classes of tundra.

Upland tundra habitat within a 4-km radius of Old Chevak was subdivided into six survey plots ranging in size from 100 to 200 ha each (Table 1). Plot delineation was based on habitat features to minimise potential brood movement between plots (e.g. rivers and wide sloughs were used as plot boundaries). Between two adjacent plots (south lake, fish camp B), there was no natural barrier to inhibit brood movement. These two plots were simultaneously surveyed to reduce the potential for double-counting broods. During 25 June–10 July 2002, plots were surveyed every 3–5 days for a total of four surveys per plot (n = 24 total surveys, Table 1). During plot surveys, observers walked all upland tundra habitat within the plot boundary, scanning for shorebird broods (mean time per plot survey ± SD, 6.0±0.6h). Upon finding a brood, observers recorded the location, time, and number of attending parent(s), distance from parent(s) to nearest chick, number of chicks, brood age (<5d, 5–10d, >10d), habitat type (dwarf shrub tundra, dwarf shrub-graminoid tundra), distance to open water, distance to sedge-grass habitat, and distance to edge of upland tundra habitat. Distances were categorized as <5 m, 5–20 m, >20 m.

The parents and brood from a known Rock Sandpiper nest on the south lake plot were observed intensively for 2½ hours per day for five days. We were able to identify and differentiate each parent of this brood based on plumage. This clutch hatched on 16 June 2002 and observations were conducted between 1200 and 1500 on 17–20 and 27 June. During observation of this brood, the behaviour of parents and chicks, their locations, and habitats occupied were continuously recorded.

ANALYSIS

We compared Western and Rock Sandpiper use of upland tundra habitat using contingency tables. Although survey plots were delineated to minimise brood movement between plots and thus avoid double counting of broods, we are unable to exclude the possibility of double counting broods during consecutive surveys on a given plot. To overcome this difficulty and maintain adequate samples of Rock Sandpiper broods, brood data from the one survey per plot recording the largest number of broods were selected *a priori* and used in analysis. Because there were four Western Sandpiper broods observed during two different surveys of plot fish A, the data from 29 June were randomly selected (Table 1). This method of data selection resulted in 30 Western and 13 Rock Sandpiper brood observations that served as independent data points for analysis. Although this analysis does not rigidly adhere to central limit theory (i.e. the log-likelihood employed is not a sum of all log-likelihoods), our method of data selection essentially deals with problems associated with double counting.

RESULTS

Rock Sandpiper broods utilised dwarf shrub tundra and dwarf shrub-graminoid tundra habitat equally, whereas Western Sandpiper broods were observed more often in dwarf shrub-graminoid tundra habitat ($\chi^2_1 = 3.85$, n = 43, $p < 0.05$; Fig. 1). Western Sandpiper broods were closer to the edge of upland tundra habitat compared to Rock Sandpipers ($\chi^2_2 = 12.02$, n = 43, $p < 0.001$; Fig. 1), and Western Sandpiper broods were closer to sedge/grass habitat compared to Rock Sandpipers ($\chi^2_2 = 6.47$, n = 43, $p < 0.05$; Fig. 1). Western Sandpiper broods also were closer to open water compared to Rock Sandpipers ($\chi^2_2 = 6.08$, n = 43, $p < 0.05$; Fig. 1).

These results are unlikely to be biased as a result of number of attending adults or brood age. There was no statistical difference between the two species in the number of attending adults per brood ($\chi^2_1 = 1.1$, n = 43, $p > 0.25$). Fifty-four percent of Rock Sandpiper broods were tended by a single adult (n = 13), and 37% of Western Sandpiper broods were associated with a single adult (n = 30). There also was no difference in the number of broods per age class between the species ($\chi^2_2 = 4.45$, n = 43, $p > 0.25$).

During 12.5h of observation of a single Rock Sandpiper brood over five days, the brood left upland tundra habitat on two occasions for total of 0.6h. On one occasion, the brood entered sedge/grass habitat along the edge of a lake to drink. During the other occasion, sedge/grass habitat between two lakes was traversed while moving from one patch of upland tundra to another. Both parents tended the brood during the first five days after hatching; however, one of the parents deserted its mate and brood on or before 12 days post hatching. A single parent typically tended the brood (i.e. maintained parent chick distances of 0–10m), while the other parent remained alert approximately 20 m away. During brood observations when both parents were present (n = 4), the tending parent (<10 m from the chicks) was on duty for approximately two hours (1.83–2.25 h). Tending parents appeared to "herd" the brood across upland tundra habitat allowing chicks to forage at a given location for 10–30 minutes before calling chicks to a new location roughly 20 m away. Four days post-hatching, the brood was 200 m south of the nest site. Twenty-four hours later, the brood was 700 m south of the nest site, and when the brood was last observed, 12 days post-hatching, it was 1 km south of the nest site.

Table 1. Western *Calidris mauri* and Rock *C. ptilocnemis* Sandpiper broods observed during surveys of upland tundra habitat at Old Chevak, AK (number of WESA broods/number of ROSA broods).

Plot (size, hours surveyed)	June					July								Total
	25	26	27	29	30	1	3	5	6	7	8	9	10	
Old Chevak (100 ha, 26.8 h)		10/–			9/–			6/1				1/–		26/1
between rivers (120 ha, 22.2 h)		4/–			6/–			2/–				4/–		16/–
fish camp A (200 ha, 21.9 h)	2/–			4/–			2/2				4/–			12/2
north lake (100 ha, 21.3 h)	1/–			–/–			1/1			2/–				4/1
fish camp B (150 ha, 25.3 h)			6/4			1/–			2/1				2/2	11/7
south lake (200 ha, 25.3 h)			2/5			6/2			5/3				2/2	15/12

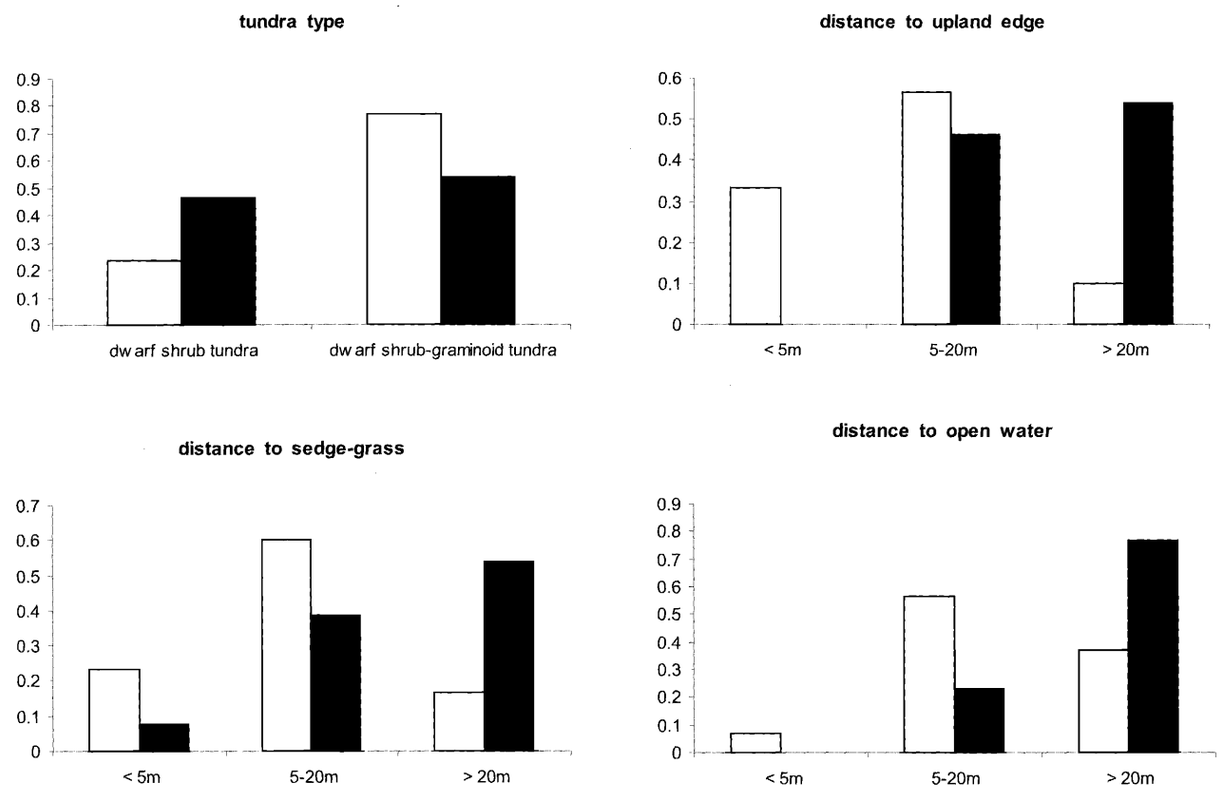

Fig. 1. Brood-rearing habitat used by Western (*Calidris mauri*, open bars, n = 30) and Rock (*C. ptilocnemis*, solid bars, n = 13) Sandpipers during 2002 near Old Chevak, AK. Differences in habitat use between the two species are statistically significant (all chi-square tests $p < 0.05$).

DISCUSSION

Rock and Western sandpipers sympatrically nest on hummocky upland tundra habitat on the YKD, often with overlapping territories. Yet, we observed differentiation of habitat use between the two species during the brood-rearing phase of reproduction. Rock Sandpiper broods were most often observed >20 m from the edge of upland tundra habitat, sedge-grass habitat, and open water, whereas Western Sandpiper broods were usually observed within 20 m of these habitat features. Further, over three-quarters of Western Sandpiper broods were observed in dwarf shrub-graminoid tundra habitat, yet Rock Sandpiper brood observations were equally distributed between the two tundra classifications (dwarf shrub tundra, dwarf shrub-graminoid tundra). Concentrated use of upland tundra habitat by Rock Sandpiper broods was supported through intensive observation of a single brood, as less than five percent of observations for this brood were not in upland tundra habitat.

Differences in prey base and/or chick diet may explain the segregated pattern of habitat use we observed between the two species. Concomitantly, use of microhabitats with more complex vegetative structure may offer a thermoregulatory environment more critical to the smaller species relative to the larger (mean chick mass at hatching: Western Sandpiper 5.0 g, Rock Sandpiper 9.7 g, Wilson 1994, Gill *et al.* 2002). Differences in adult body size between the two species (Western Sandpiper 22–35 g, Rock Sandpiper 72–78 g) also may explain why Western Sandpiper broods were observed closer to potential cover. If chicks are well concealed from potential predators, tending parents may be freer to forage and thereby meet energetic requirements associated with a high surface-area to volume ratio. These hypotheses are not necessarily exclusive and require experimental evaluation.

Repeated observation of a single Rock Sandpiper brood during the first 12 days post-hatching found the brood to be at increasing distances from the nest with age (1 km from nest during last observation). These observations are consistent with previous studies of Rock Sandpiper broods on the Chukotsky Peninsula (mean distance from the nest during the third week post-hatching: 747 m, n = 6, Tomkovich 1985). Extensive brood movement complicates study of Rock Sandpiper habitat use, and movement patterns among Western Sandpiper broods are yet to be described. Our comparison of upland tundra habitat use during brood-rearing in the Rock and Western sandpipers found differential habitat use. Given the high levels of chick mortality among most sandpiper species, patterns of habitat use during brood-rearing are almost certainly under strong selection pressure and warrant further investigation.

ACKNOWLEDGEMENTS

We thank Bob Gill and Craig Ely for comments on an earlier draft of our manuscript. We also thank Marin Sardy and the staff of the Yukon Delta National Wildlife Refuge for assistance in the field.

REFERENCES

Connors, P.G., J.P. Myers & F.A. Pitelka. 1979. Seasonal habitat use by arctic Alaskan shorebirds. *Studies in Avian Biology* 2: 101–111.

Ely, C.R. & D.G. Raveling. 1984. Breeding biology of Pacific white-fronted geese. *J. Wildlife Management* 48: 823–837.

Gill, R.E., P.S. Tomkovich & B.J. McCaffery. 2002. Rock Sandpiper (*Calidris ptilocnemis*) in *The Birds of North America*, No. 686 (A. Poole and F. Fill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Handel, C.M. & R.E. Gill, Jr. 2000. Mate fidelity and breeding site tenacity in a monogamous sandpiper, the black turnstone. *Anim. Behav.* 60: 471–481.

Holmes, R.T. 1966. Breeding ecology and annual cycle adaptations of the red-backed sandpiper (Calidris alpina) in northern Alaska. *Condor* 68: 3–46.

Holmes, R.T. 1971. Density, habitat, and the mating system of the western sandpiper (Calidris mauri). *Oecologia* 7: 191–208.

Holmes, R.T. 1972. Ecological factors influencing the breeding schedule of western sandpipers (Calidris mauri) in subarctic Alaska. *Am. Midland Nat.* 87: 472–491.

Johnson, O.W. & P.G. Connors. 1996. American Golden-Plover (*Pluvialis dominica*), Pacific Golden-Plover (*Pluvialis fulva*). in *The Birds of North America*, No. 201–202 (A. Poole and F. Fill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Jorgenson, T. & C. Ely. 2001. Topography and flooding of coastal ecosystems on the Yuko-Kuskokwim Delta, Alaska: implications for sea-level rise. *J. Coastal Res.* 17: 124–136.

Lanctot, R.B. & C.D. Laredo. 1994. Buff-breasted Sandpiper (*Tryngites subruficollis*). in *The Birds of North America*, No. 91 (A. Poole and F. Fill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Maher, W.J. 1974. Ecology of Pomarine, Parasitic, and Long-tailed Jaegers in northern Alaska. *Pacific Coast Avifauna* 37.

Miller, E.H. 1983. Habitat and breeding cycle of the Least Sandpiper (*Calidris minutilla*) on Sable I., Nova Scotia. *Can. J. Zool.* 61: 2880–2898.

Myers, J.P., O. Hilden, & P. Tomkovich. 1982. Exotic *Calidris* species of the Siberian tundra. Ornis Fenn. 59: 175–182.

Nol, E., M. Sullivan Blanken & L. Flynn. 1997. Sources of variation in clutch size, egg size, and clutch completion dates of Semipalmated Plovers in Churchill, Manitoba. *Condor* 99: 389–396.

Norton, D.W. 1973. Ecological energetics of Calidrine sandpipers breeding in northern Alaska. PhD thesis, University of Alaska, Fairbanks.

Ruthrauff D.R. 2002. Seasonal and age-related trends in the reproductive output of western sandpipers *(Calidris mauri*) at Kanaryaraq, Alaska. MS thesis. Humbolt State University, Humbolt CA.

Safriel, U.N. 1975. On the significance of clutch size in nidifugous birds. *Ecology* 56: 703–708.

Smith, K.G. & P.G. Connors. 1993. Postbreeding habitat selection by shorebirds, waterbirds, and land birds at Barrow, Alaska: a multivariate analysis. *Can. J. Zool.* 71: 1629–1638.

Tomkovich, P.S. 1985. Territoriality of some monogamous species of Calidridinae sandpipers. Acta XVIII Cong. Intern. Ornithol. Vol. 2 (V.D. Iiyichev and V.M. Garilov, Eds.). Nauka Publ., Moscow.

Tomkovich, P.S. 1994. Site fidelity and spatial structure of population in the Rock Sandpiper *Calidris ptilocnemis* and Dunlin *Calidris alpina* on Chukotsky Peninsula. *Russ. J. Ornithol.* 3:13–30.

Tomkovich, P.S. 2003. Parental care in the Rock Sandpiper Calidris ptilocnemis on Chukotsky Peninsula, Russia. *Russ. J. Ornithol.* 12: 179–183.

Tomkovich, P.S. & A.G. Sorokin. 1983. Fauna of birds in Eastern Chuotka. Archives Mus. Moscow State Univ. 21: 77–159.

Wilson, W.H. 1994. Western Sandpiper (*Calidris mauri*) in *The Birds of North America*, No. 90 (A. Poole and F. Fill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Calidris ptilocnemis (incubating left) and *C. mauri* (standing right) photographed at Kanaryarmiut Field Station, Yukon Delta National Wildlife Refuge, Alaska (photos by Jesse Conklin).