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MAGNITUDE AND TIMING OF AUTUMN OSPREY MIGRATION IN SOUTHEASTERN CUBA

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ABSTRACT.—From 2005–2008 we used counts of visible migrants at an inland watchsite (La Gran Piedra) 9 km from the coast and a coastal watchsite (Siboney) to describe the magnitude and timing of Osprey (*Pandion haliaetus*) autumn migration through southeastern Cuba from 1 August through 30 November. Counts of Ospreys at Siboney averaged 5283 (2006–2008) annually or roughly twice those tallied at other North American watchsites known for the concentration of this species during autumn migration. Nevertheless, simultaneous counts at both watchsites better represent the magnitude of its migration through southeastern Cuba, averaging more than 7000 Ospreys (3 yr). The mean seasonal passage window (95% of the flight) ranged from 78 to 83 d at La Gran Piedra and Siboney. The average peak at both sites occurred in early October, with more than 20 Ospreys/hr. The daily passage window (95% of the daily passage) was more protracted at Siboney, where birds migrated both early in the morning and late in the afternoon, than at the inland mountain site at La Gran Piedra, where Osprey numbers peaked at midday. We believe that Ospreys migrating in southeastern Cuba move from the coast to the mountains at midday in response to thermal convections along the mountains at that time. Osprey flocks observed at watchsites ranged between 2–52 individuals and one flock of 92 individuals was observed at a dam in central Cuba.

KEY WORDS: *Osprey*; Pandion haliaetus; *Cuba*; *flocking*; *migration*; *timing*; *watchsite*.

MAGNITUD Y RITMO DE LA MIGRACIÓN OTOÑAL DE *PANDION HALIAETUS* EN EL SURESTE DE CUBA.

RESUMEN.—Durante el periodo 2005–2008 utilizamos conteos de migrantes en un sitio de observación tierra adentro (La Gran Piedra) a nueve kilómetros de la costa y en un sitio de observación costero (Siboney) para describir la magnitud y ritmo de la migración otoñal de *Pandion haliaetus* a lo largo del sureste de Cuba desde el primero de agosto hasta el 30 de noviembre. Los conteos de *P. haliaetus* en Siboney promediaron 5283 individuos (2006–2008) anualmente, o aproximadamente el doble de los conteos de otros sitios de observación norteamericanos conocidos por la concentración de esta especie durante la migración otoñal. Sin embargo, conteos simultáneos en ambos sitios representan mejor la magnitud de la migración de *P. haliaetus* en el sureste de Cuba, promediando más de 7000 individuos (3 años). El paso promedio estacional (95% del total) fluctuó de 78 a 83 días en La Gran Piedra y Siboney. El pico promedio en ambos sitios ocurrió a principios de octubre con más de 20 águilas/hr. El paso diario (95% del paso diario) se prolongó más en Siboney, donde las águilas volaron preferentemente temprano en la mañana y a última hora en la tarde, que en el sitio montañoso en La Gran Piedra donde volaron preferentemente al mediodía. Sugerimos que los individuos migrantes de *P. haliaetus* en el sureste de Cuba se mueven desde la costa hacia las montañas al mediodía en respuesta a la concentración de corrientes termales en las cadenas montañosas a esta hora del día. Las bandadas de *P. haliaetus* observadas en los sitios de observación fluctuaron entre 2 y 52 individuos y se observó una bandada de 92 individuos en una presa en el centro de Cuba.

[Traducción del equipo editorial]

The Osprey (*Pandion haliaetus*) is a cosmopolitan raptor with four known subspecies (Prevost 1983) and populations migrating across all continents except Antarctica. Classified as a complete, long-distance, and partially trans-equatorial migrant (Bildstein 2006), the Osprey migrates in North America

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across a broad front (data from band returns, Henny and Van Velzen 1972, Poole and Agler 1987; data from satellite telemetry, Martell et al. 2001).

Although the majority of individuals fly alone or in small groups in North America, there is growing evidence that farther south, especially on the islands of Cuba and Hispaniola, Osprey migration is more concentrated, and larger flocks are common (Crouse and Keith 1999, Rodríguez Santana et al. 2002). Migrating Ospreys appear less likely to follow leading lines than other migrant raptors, although coastlines (Bildstein 2006) and landforms (Poole 1989) act to concentrate their migration.

The timing of Osprey migration along the eastern seaboard of North America has been summarized using analyses of band returns (Henny and Van Velzen 1972, Poole and Agler 1987), satellite-telemetry data (Martell et al. 2001), and counts from raptor migration watchsites (Zalles and Bildstein 2000). The lack of raptor migration studies in the West Indies prior to 2001 precluded similar analyses in this area, where the availability of quality roosting and feeding sites could be critical for birds preparing to cross the Caribbean Sea.

North America is thought to hold 50% of the approximately 100 000 estimated breeding Ospreys worldwide (Farmer et al. 2008); of these, up to 90% of the breeding population of the eastern seaboard of the United States and approximately 25% of birds nesting as far west as Minnesota likely travel through Cuba during autumn migration (Martell et al. 2001, Rodríguez Santana et al. 2001). The movement of this part of the North American Osprey population results in an unusual concentration of this raptor at certain localities where both coastlines and mountain ranges converge to funnel the migration of this otherwise broad-front migrant. Counts initiated in 2001 at La Gran Piedra watchsite, 9 km from the southern coast, in eastern Cuba (Rodríguez Santana et al. 2002) and other exploratory counts carried out countrywide (Rodríguez Santana et al. 2003) quickly revealed a promising opportunity for studying the migration of this species.

The highest counts of migrating Ospreys in North America occur along the Atlantic coast at Cape May, New Jersey, in the Gulf of Mexico region in Veracruz, Mexico, and in the Florida Keys (Goodrich and Smith 2008). Therefore, given that the majority of migrating Ospreys coming from the eastern seaboard use Cuba and Hispaniola as stepping stones to South America (Martell et al. 2001), we expected that counts in our two sites in Cuba would yield sufficient numbers, presumably, from the eastern-seaboard population of North American Ospreys (Martell et al. 2001, Rodríguez Santana et al. 2001), to allow assessment of Osprey migration abundance, timing, and trends.

We herein describe the autumn migration of Ospreys at La Gran Piedra and Siboney watchsites, Cuba, for four and three consecutive years, respectively. The primary objective of our study was to describe the Osprey migration magnitude and timing through southeastern Cuba. We also compared the magnitude of the Osprey migration at both watchsites with that observed at some important concentration points of this species at other watchsites in North America. Finally, we also report Osprey flock size at both sites.

METHODS

Autumn counts of Ospreys were performed at La Gran Piedra from 2005–2008 and at Siboney from 2006–2008. Raptor counts at the Gran Piedra watchsite (Fig. 1) failed to include Ospreys moving along the coast, especially early and late in the day. Because of this, in 2006 we initiated a second monitoring effort in a coastal watchsite at Siboney, 9 km southwest of La Gran Piedra (Fig. 1), to document Osprey movements along the southeastern coast.

The La Gran Piedra watchsite was 9 km from the coast at the summit of La Gran Piedra (Fig. 1; 20°0.68′N, 75°37.62′W; elevation 1234 masl) in the eastern part of the Sierra Maestra, a range that extends for close to 300 km parallel to the coast of southeastern Cuba. Counts were performed atop a large, 17-m high boulder that afforded a 360° view of the sky. As at Siboney, observers faced west during counts, scanning the western horizon from 180° to 360°.

The Siboney watchsite (Fig. 1; 19°57.53′N, 75°42.15′W; elevation 17 masl), was at the top of a wall of a 19th century Spanish fort, 9 km southwest of La Gran Piedra. The site afforded a 180° view of the western horizon and observers scanned the western horizon from 180° to 360° as at La Gran Piedra.

We carried out counts from 1 August to 30 November during all years. We also visited the two watchsites before and after these dates in an attempt to determine the earliest and latest migrating Ospreys. Counts started at 0600 H and lasted through 1800 H (EST) at Siboney and from 0700 H through

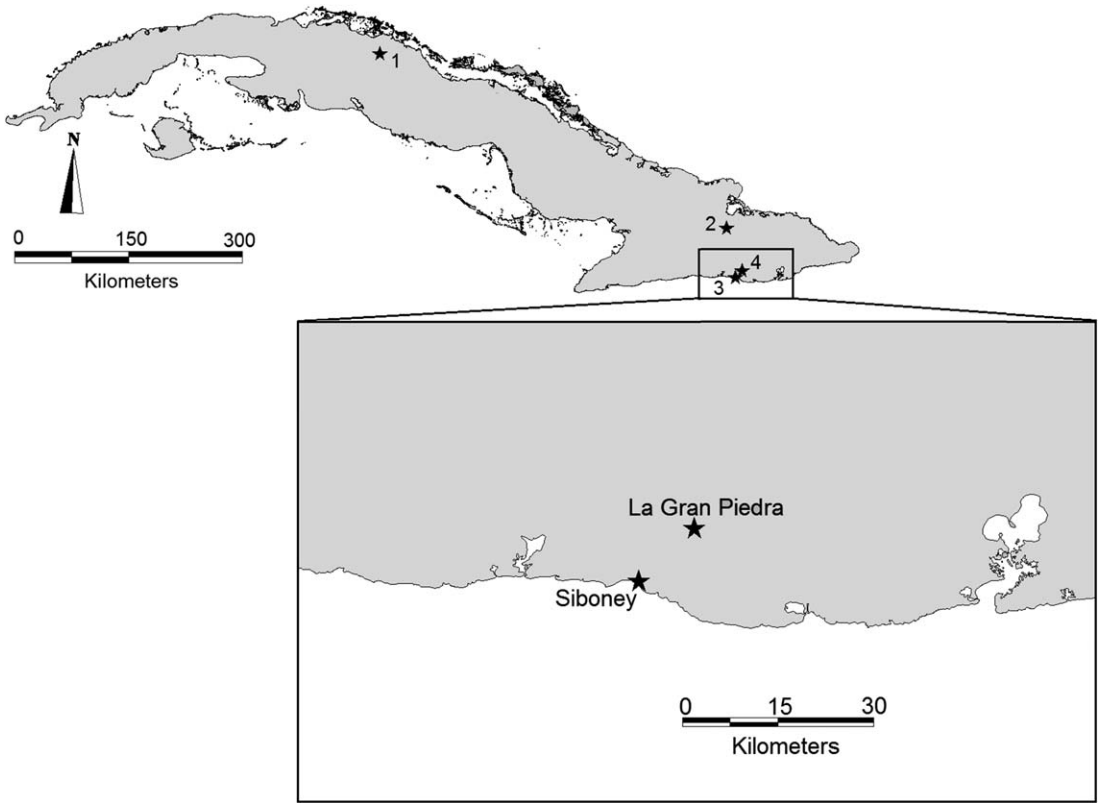

Figure 1. Location of the study areas in Cuba referenced in the text. 1 = Alacranes Reservoir; 2 = Pinares de Mayarí; 3 = Siboney; 4 = La Gran Piedra. Inset map shows the location of La Gran Piedra and Siboney watchsites.

1800 H at La Gran Piedra. However, we rarely counted after 1500 H at La Gran Piedra watchsite due to low clouds, fog, and rains that reduced visibility, thus preventing counts. The same often occurred during attempted observations before 0900 H.

Observers counted migrants at Siboney during 6-hr shifts from 0600 to 1200 H and from 1200 to 1800 H, switching periods of observation each day. At La Gran Piedra only one observer counted daily as weather rarely allowed counts longer than 7 hr. We used 8–10× binoculars to scan for Ospreys and a 60-mm 15–45× spotting scope as an optical aid during all counts.

Count data were recorded on field forms similar to those suggested by the Hawk Migration Association of North America (HMANA 2009a). Observers also recorded hourly meteorological data (humidity, temperature, and wind speed) with a Kestrel 3500 pocket weather meter (KestrelMeters.com, Sylvan Lake, Michigan). Other data recorded included cloud cover (%), wind direction, visibility, flight direction, duration of observations, and notes about flock size.

Statistical Analyses. We described the seasonal passage window of the Osprey migration at each watchsite as the period during which 95% of migrants were observed at each watchsite. We also described the daily passage window as the hours of the day during which 95% of the individuals were counted at each watchsite (see Farmer et al. 2008 for a similar treatment). We determined the median date of passage at both watchsites as the date by which half of 95% of the season's flight had occurred. We performed all statistical analyses with the 95% of the total flight (Titus and Mosher 1982, Hall et al. 1992, Smith et al. 2008). A Shapiro-Wilk *W*-test for normality (Zar 1999) was performed to test whether the middle 95% of the season's flight at each watchsite was normally distributed for the period 2006–2008.

Because total hours of observation varied from day to day among years, we averaged the number

of Ospreys seen per each hour of observation at each watchsite and divided by the average hours counted at each hour interval during the 95% of daily passage window to describe the daily migration pattern at each watchsite. We used chi-square tests to compare hourly migration rates during the daily passage window between watchsites. We performed the same analysis to describe the Osprey seasonal migration timing at both watchsites within 95% of the seasonal passage window, but using average Ospreys counted per day divided by the average hours counted per day instead.

Comparison with other areas. North American watchsites are known for the concentration of Ospreys during autumn migration; thus, we statistically compared the average count of La Gran Piedra (2005–2008) and Siboney (2006–2008) with the average obtained at other watchsites in North America (2006–2008).

Comparison of the two Cuban watchsites. Because weather often hindered raptor counts at La Gran Piedra, we selected days when counts at this site lasted six or more hours to compare number of Ospreys seen at both Cuban watchsites. We made the comparisons using Mann-Whitney *U*-test for years 2006–2008. We also chose these days to determine if Osprey numbers at the two watchsites were correlated with each other (by month) and to determine possible association of flock size with temperature using Spearman's rank correlation analysis. We did not test for correlation between flock size and wind direction and speed, as during the autumn migration, prevailing winds almost always come from the southeast in a fairly predictable pattern, with low speed winds dominating early and late hours and higher winds around noon (Montenegro 1991).

Flock size. We compared Osprey flock size observed at each hour during the daily passage window at the two watchsites using the Kruskal-Wallis test. We also combined all years and compared flock size at both watchsites during the daily passage window seen at La Gran Piedra. Because the daily passage window at Siboney is longer, we used the Mann-Whitney *U*-test to compare only the hours from 0900–1500 H. We also choose days when rainstorms formed along the mountain range to compare Osprey numbers counted at Siboney at one hour after a rainstorm with the same hour during days where no rainstorms were reported using Mann-Whitney *U*-test. We present results as mean ± SD unless otherwise noted. We consider statistical tests significant at $P \leq 0.05$.

RESULTS

Numbers of Ospreys were not normally distributed at either watchsite for all years ($P < 0.001$ for each case). At La Gran Piedra, the mean number of hours (±SD) of observation ranged from 4.6 ± 1.5 hr/d in 2005 ($n = 96$ d) to 5.7 ± 1.9 hr/d in 2008 ($n = 84$ d), with a 4-yr average of 5.1 ± 1.6 hr/d. At Siboney, mean number of hours of observation ranged from 9.1 ± 2.7 hr/d in 2007 ($n = 116$ d) to 10.0 ± 1.9 hr/d in 2006 ($n = 100$ d), with a three-year average of 9.5 ± 2.2 hr/d. Osprey autumn migration at La Gran Piedra and Siboney was unidirectional west to east during all years analyzed (2005–2008).

We started sporadic counts on 21 July and stopped on December 14. The earliest migrating Osprey was recorded on 23 July and the latest on 13 December. Overall, Osprey migration rates observed at both watchsites were similar (*U*-test = 49825.5, $P > 0.1$) with a mean of 4.8 ± 8.4 Ospreys/hr (range 0–76.2, $n = 4$ yr) at La Gran Piedra and 6.0 ± 8.1 Ospreys/hr, (range 0–52.4, $n = 3$ yr) at Siboney.

The bulk (95% of the flight) of the seasonal passage window passed over La Gran Piedra during a mean of 78 ± 16 d ($n = 4$ yr), and over Siboney in a mean of 83 ± 5 d ($n = 3$ yr; Table 2). The average peak day ($n = 3$ yr) at both watchsites occurred in early October with a passage rate of more than 20 Ospreys/hr (Fig. 2, 3). Osprey migration measured as the days during which 95% of the flight passed and the median day of passage were variable at La Gran Piedra, but less so at Siboney (Table 2).

The daily passage window also differed between the two watchsites. The daily passage window at La Gran Piedra was 0900–1500 H, compared with 0700–1800 H at Siboney (Fig. 4, 5, respectively).

Ospreys did not fly in equal numbers throughout the daily passage window at either watchsite. At La Gran Piedra, Osprey numbers peaked around noon ($X^2 = 2023.2$, df = 5, $P < 0.001$, Fig. 4), whereas at Siboney, Osprey numbers peaked early in the morning and again late afternoon ($X^2 = 3147.2$, df = 10, $P < 0.001$, Fig. 5).

Seasonal Osprey counts at Siboney were twice those at La Gran Piedra from 2006–2008. They also were higher at Siboney than at any other watchsite in North America during the autumn migration (Table 1).

During days in which raptor counts at La Gran Piedra lasted six or more hours, numbers of Ospreys were significantly higher at Siboney in 2007 (mean

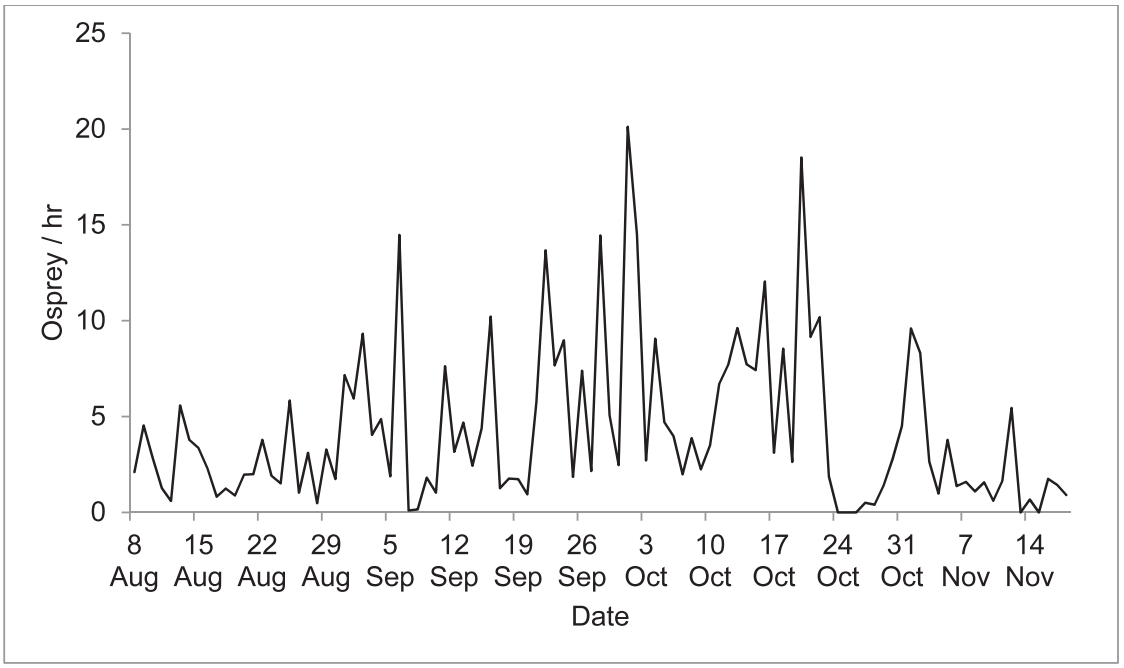

Figure 2. Mean seasonal passage window (95% of the seasonal flight) measured as birds per hour during autumn migration at La Gran Piedra, eastern Cuba, during years 2005–2008.

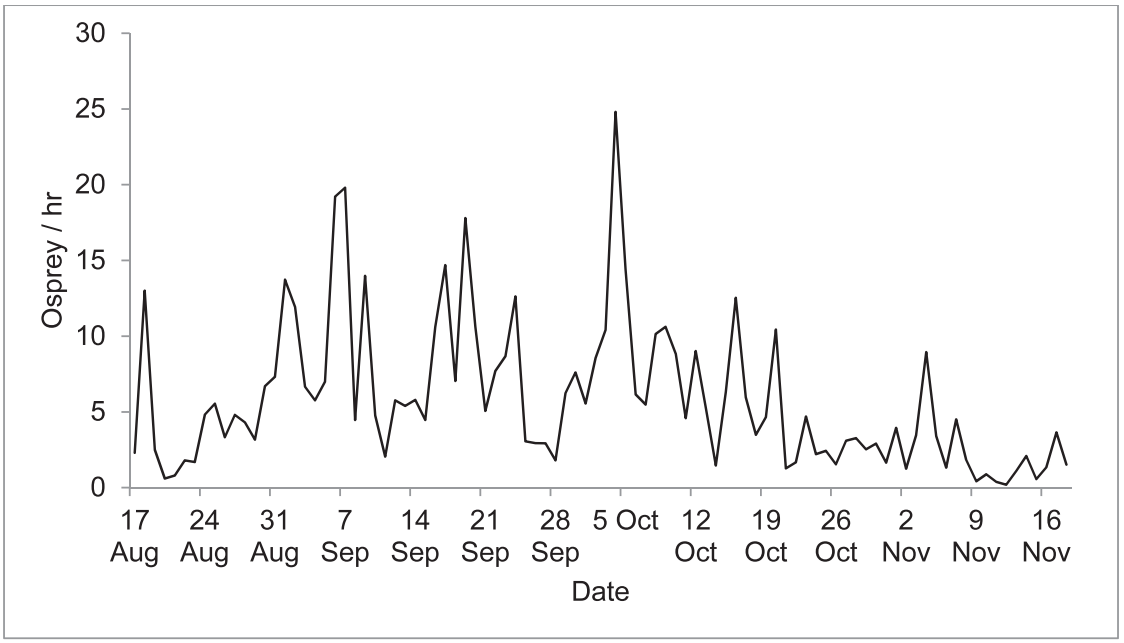

Figure 3. Mean seasonal passage window (95% of the seasonal flight) measured as Ospreys per hour during autumn migration at Siboney, eastern Cuba, during years 2006–2008.

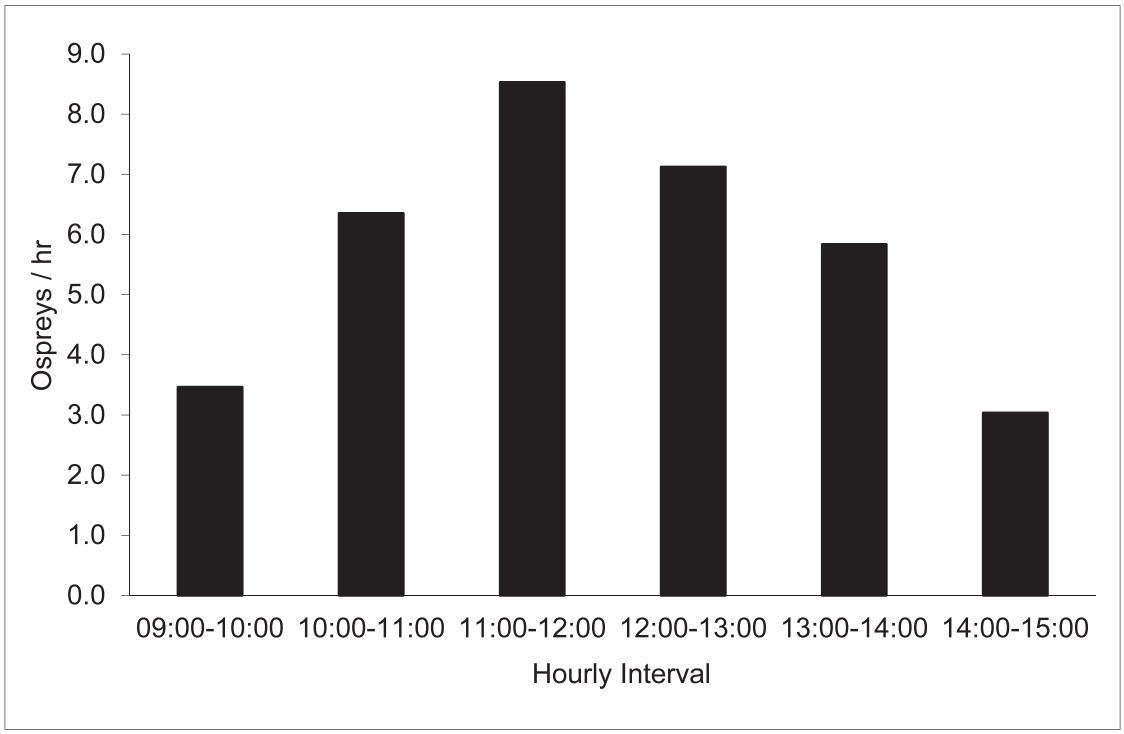

Figure 4. Mean daily passage window (95% of the daily flight) of the Ospreys autumn migration at La Gran Piedra, eastern Cuba, from 2005–2008.

= 73.2 ± 102.7) than at La Gran Piedra (mean = 34.5 ± 39.6; Mann-Whitney *U*-test = 618, $P = 0.01$) and in 2008 (mean = 65.5 ± 76.2 vs. 44.3 ± 71.8, respectively; Mann-Whitney *U*-test = 289, $P = 0.04$). We did not find differences in Osprey numbers between both observatories in 2006 (mean = 91.6 ± 85.1 vs. 71.78 ± 60.5; Mann-Whitney *U*-test = 323, $P = 0.25$).We did not find any correlation between Osprey numbers at the two watchsites except during the month of October in 2006 (Spearman rank correlation; $r_s = 0.52$, $P = 0.03$, $n = 23$ d) and 2007 (Spearman rank correlation; $r_s = 0.67$, $P = 0.005$, $n = 21$ d).

Our data suggested that the flight line of migrating Ospreys in the area changes throughout the day, with a greater number of birds passing along the coast early and late in the day, and the main flight line moving inland toward the mountains at midday, possibly in response to local weather patterns such as differential daily warming between the coast and the mountains (Fig. 4, 5). Osprey numbers migrating through Siboney increased in the hour following rainstorms in the mountain range (Mann-Whitney *U*-test = 5.5, $P = 0.005$). This pattern was evident during days when, due to the daily warming, local storms formed along Sierra Maestra mountain range; thus, Osprey flight increased at Siboney even at midday, when lulls at this site were expected (Fig. 5).

Flocks of Ospreys observed at both watchsites ranged from 2 to 52 individuals. We found statistically significant differences in flock size during different hourly intervals at Siboney (Kruskal-Wallis test $H = 40.6$, $P \leq 0.001$), but not throughout the day at La Gran Piedra (Kruskal-Wallis test $H = 12.8$, $P = 0.07$; Tables 3, 4). When we compared flock size observed at La Gran Piedra to that at Siboney in the same hourly interval, flocks were significantly larger at Siboney during the hour from 1000–1100 H than in La Gran Piedra (Mann-Whitney *U*-test = 2555, $P = 0.01$). Flocks also were significantly larger at Siboney than at La Gran Piedra at 1200–1300 H (Mann-Whitney *U*-test = 2743, $P = 0.006$). However, flocks were significantly larger at La Gran Piedra than in Siboney during 1400–1500 H (Mann-Whitney *U*-test = 994, $P = 0.03$; Tables 3, 4).

We found statistical significant correlation between temperature and flock size at La Gran Piedra

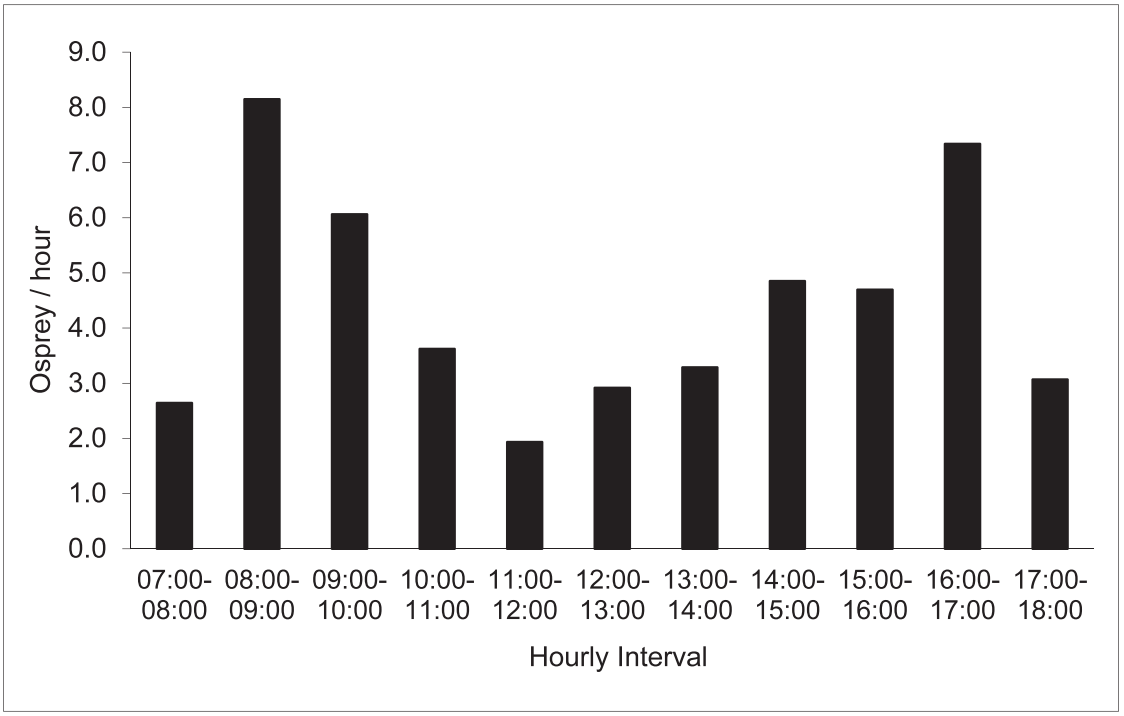

Figure 5. Mean daily passage window (95% of the daily flight) of the Ospreys autumn migration at Siboney, eastern Cuba, from 2006–2008.

($r_s = 0.74$, $P = 0.03$) but not at Siboney ($r_s = 0.49$, $P = 0.10$). This suggests that concentration of thermal convections at mountain sites such as La Gran Piedra could also account for some flocking, especially during large flights.

DISCUSSION

Autumn migration counts at the La Gran Piedra and Siboney watchsites in southeastern Cuba suggest that these sites are important concentration points for migrating Ospreys. Unlike at other rap-

Table 1. Ospreys totals (2005–2008), mean ± SD and coefficient of variation (CV) for four of the most important raptor migration watchsites in North America known for concentrations of Ospreys during autumn migration compared with counts at La Gran Piedra and Siboney in southeastern Cuba.

WATCHSITE	2005	2006	2007	2008	MEAN ± SD	CV
Lighthouse Point[a]	1130	1810	1137	1509	1396.5 ± 327.6	23
Veracruz, Mexico[b]	2712	2533	2635	2859	2684.7 ± 137.3	5
Cape May, New Jersey[c]	2447	1010	1632	2510	1899.7 ± 715.3	3
Kiptopeke[d]	2772	1911	2200	2190	2268.2 ± 361.5	2
La Gran Piedra	2312	2967	1924	1583	2196.5 ± 593.7	27
Siboney	–	6132	5097	4621	5283.3 ± 772.5	1
La Gran Piedra and Siboney[e]	–	9099	7021	6204	7441.3 ± 1492.5	20

[a] Data used with permission of Steve Mayo from Lighthouse Point.
[b] Data used with permission of Ernesto Ruelas Inzunza.
[c] Data used with permission of David Mizrahi and NJ Audubon Society, Cape May Bird Observatory.
[d] Data used with permission of Coastal Virginia Wildlife Observatory.
[e] La Gran Piedra and Siboney combined for the years 2006–2008.

Table 2. Seasonal passage window of the Osprey migration (95% of the flight) at the Siboney and La Gran Piedra watchsites in southeastern Cuba.

SITE	YEAR	95% FLIGHT (d)	TOTAL DAYS	MEDIAN DAY	PEAK DAY (TOTAL)	% ON PEAK DAY
Gran Piedra	2005	8 August–18 November (102)	119	28 September	1 October (212)	9
	2006	13 August–23 October (71)	98	17 September	2 October (238)	8
	2007	13 August–21 October (69)	84	16 September	21 September (143)	7
	2008	9 August–18 October (70)	120	13 September	6 September (341)	22
Siboney	2006	23 August–8 November (77)	120	30 September	9 September (438)	7
	2007	17 August–10 November (85)	114	28 September	19 September (552)	11
	2008	23 August–18 November (87)	121	5 October	24 September (337)	7

tor-migration sites, where Ospreys account for a small percentage of the seasonal totals, in eastern Cuba, Ospreys dominate the raptor flight. At La Gran Piedra, Ospreys represented 97 ± 2.6% of the total flight (range 93.0%–98.8%, $n = 4$ yr), whereas at Siboney Ospreys represented the 89 ± 3.4% of the total flight (range 85.8%–92.7%, $n = 3$ yr; F. Rodríguez-Santana unpubl. data). The nearest North American watchsite, in the Florida Keys, reported the Osprey as the fifth most common autumn migrant (Lott 2006), accounting for close to 8% of the flight. However, we note the count period at the Keys site began on 15 September, 46 d later than in Cuba; thus, at the Florida Keys, the first part of the Osprey migration was not tallied. The other four most common raptors migrating through the Florida Keys, Broad-winged Hawk (*Buteo platypterus*), Sharp-shinned Hawk (*Accipiter striatus*), American Kestrel (*Falco sparverius*) and Peregrine Falcon (*Falco peregrinus*) have different migration strategies, including migrating through Caribbean Islands *en route* to South America, overwintering in the Caribbean Islands (see White et al. 2002, Goodrich et al. 1996, Bildstein and Meyer 2000, and Smallwood and Bird 2002, for summaries on these species), and even retracing their flights to mainland North America during autumn migration in the Florida Keys (i.e., Broad-winged Hawk; Lott 2006).

The flight direction observed at both La Gran Piedra and Siboney watchsites was consistently unidirectional west to east. La Gran Piedra is 9 km inland in the Sierra Maestra range, which parallels the coast (Fig. 1), and no Ospreys at Siboney were seen flying toward La Gran Piedra; instead, they followed the coastline. Similarly, no Ospreys were seen at La Gran Piedra flying southwest toward the coastal watchsite at Siboney; thus, it was unlikely that we double-counted birds at our two watchsites. Because of this, simultaneous counts at both watchsites better represent the magnitude of the migration of this species through the southeastern part

Table 3. Osprey flock size by hour and number of flocks observed during the daily passage window (95% of the daily flight) at La Gran Piedra in southeastern Cuba from 2005–2008.

TIME (H)	NUMBER OF OSPREYS PER FLOCK MEAN ± SD	NUMBER OF FLOCKS OBSERVED (RANGE)
0800–0900	2.7 ± 0.8	10 (2–4)
0900–1000	2.5 ± 1.0	30 (2–6)
1000–1100	2.6 ± 1.0	82 (2–7)
1100–1200	3.1 ± 2.0	132 (2–19)
1200–1300	3.1 ± 2.0	87 (2–13)
1300–1400	3.2 ± 1.7	31 (2–7)
1400–1500	4.8 ± 4.9	28 (2–22)

Table 4. Osprey flock size by hour and number of flocks observed during the daily passage window (95% of the daily flight) at Siboney in southeastern Cuba from 2006–2008.

TIME (H)	NUMBER OF OSPREYS PER FLOCK MEAN ± SD	NUMBER OF FLOCKS OBSERVED (RANGE)
0700–0800	2.9 ± 1.7	98 (2–15)
0800–0900	3.0 ± 1.8	210 (2–13)
0900–1000	3.4 ± 3.5	148 (2–30)
1000–1100	3.8 ± 2.5	81 (2–12)
1100–1200	3.2 ± 2.7	66 (2–20)
1200–1300	4.7 ± 5.8	83 (2–52)
1300–1400	2.7 ± 1.3	70 (2–7)
1400–1500	3.1 ± 2.1	97 (2–15)
1500–1600	4.0 ± 3.6	115 (2–31)
1600–1700	3.5 ± 2.1	98 (2–12)
1700–1800	3.2 ± 2.7	70 (2–17)

of Cuba (Table 1). Ospreys observed at La Gran Piedra during autumn migration typically followed the west-to-east ridgeline of the Sierra Maestra range (Fig. 1) and when they were first spotted, they always came from the west. Similarly, Ospreys at Siboney always came from the west but, in this case, they followed the contour of the southern coast.

The tendency for Ospreys to spend the night along the coast in the mouth of rivers, bays, and other wetlands probably explains the peaks in numbers observed at the coastal watchsite of Siboney in the morning and late in the afternoon. As they depart from these sites in southeastern Cuba, the most likely flight bearing is eastward along the coast, which may also explain the observed lull in the early morning and late afternoon hours at La Gran Piedra.

The averages over 3 yr of approximately 7400 Ospreys per year (when we pooled the data from La Gran Piedra and Siboney watchsites [Table 1]) represented an estimated 12 to 14% of the breeding population of the entire United States (16 000–19 000 pairs in 2001) and Canada (10 000–12 000 pairs during late 1980s) reported by Poole et al. (2002) or 15% of the breeding North American population of the species estimated by Farmer et al. (2008). This and the relatively low coefficient of variation for the 3-yr average (Table 1) suggest that long-term monitoring efforts at this watchsite can contribute to the monitoring of population trends of this species in eastern and central North America.

Although our data suggested that there is a tendency for Ospreys to funnel along the southeastern part of Cuba, there is also a considerable Osprey autumn migration north of the Sierra Maestra Mountain range, along the west-to-east Nipe-Sagua-Baracoa mountain range. A total of 118 Ospreys were counted on 4 October 2002 in Pinares de Mayarí (Fig. 1; E. Reyes pers. comm.) and Rodríguez Santana et al. (2001) also reported movements of Ospreys along and through this mountain range. Additionally, all 12 GPS satellite-tagged Ospreys tracked by R. Bierregaard (pers. comm.) passed between 13 and 50 km north of La Gran Piedra, and thus were uncounted by the observers at La Gran Piedra.

Osprey migration from North America has broad temporal variation (Martell et al. 2001), which was reflected in the length of the passage of 95% of the flight, which ranged from 69 to 102 d at both watchsites (Table 2). The overall seasonal passage (158 d) most likely reflects the broad geographical nature of the population migrating through Cuba (Poole and Agler 1987, Martell et al. 2001) and the differences in migration timetables among populations and between sexes; for example, birds from the east coast may stay up to 23 d in Cuba before continuing south (Rodríguez Santana et al. 2001) and may travel short distances by day while in stopover sites (Martell et al. 2001). Alternatively, cold fronts and foul weather, including tropical waves, tropical depressions, low pressure areas, and hurricanes may delay and protract flights at both sites (F. Rodríguez-Santana unpubl. data).

Migration timing and abundance appear to be less variable at Siboney; however, that may be because fewer observation days were missed due to rains and fog there than at La Gran Piedra (F. Rodríguez-Santana unpubl. data). The lost days of observation in La Gran Piedra also may account for the greater variability observed in Osprey numbers at La Gran Piedra versus Siboney (Table 1).

As far as we are aware, there are no studies describing the flocking behavior of Ospreys during migration. Our data suggest that at least in Cuba, Ospreys typically travel in flocks larger than previously reported (Poole 1989, Poole et al. 2002). For example, on September 2001, a flock of 92 individuals formed at 0830 H at the Alacranes Reservoir (Fig. 1; F. Rodríguez-Santana unpubl. data). This water reservoir was built in 1972 and is close to the north-central coast of Cuba where Ospreys usually make landfall in Cuba during the autumn migration (Martell et al. 2001). The 92 birds, which presumably had stopped over at the reservoir, soared up to heights >500 m and headed southeast toward eastern Cuba, while another 52 Ospreys remained roosting near one part of the dam. This suggests that the number of Ospreys concentrating at feeding sites upon arrival in Cuba may facilitate the flocking behavior we observed. During the last 50 yr, Cuban reservoirs have increased from 13 reservoirs containing 48×10^6 m^3 of water to 239 reservoirs containing 8700×10^6 m^3 (Hernández 2007); an increase of 18 and 181 times in the number of reservoirs and their surface area, respectively. Most of these reservoirs are devoted either to human water consumption or fish farms, the latter unquestionably increasing the probabilities for concentration of Ospreys.

Presumably, the flocking behavior of Ospreys in southeastern Cuba is linked to the fact that the birds

are preparing to make a flight of approximately 85 to 140 km across open water to Hispaniola (R. Bierregaard pers. comm.), during which they will engage in flapping as well as soaring flight, the latter assisted by ''sea thermals'' related to the trade winds (*sensu* Augstein 1980 and Pennycuick 1983) in the Caribbean region. Flocking behavior has been linked to increased success in locating thermals (Kerlinger 1989, Bildstein 2006), and finding thermals over water is likely to be of particular importance to migrating raptors (Bildstein 2006). The flocking of Ospreys observed at La Gran Piedra and Siboney watchsites in eastern Cuba not only brings an opportunity to study this poorly known behavior for the species, but also offers a good chance to monitor Osprey breeding populations east of the Mississippi River.

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