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SPRING MIGRATION COUNTS OF RAPTORS AND NEW WORLD VULTURES IN COSTA RICA

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Abstract. In both spring and autumn, millions of migratory birds of prey that breed mainly in North America, and overwinter mainly in South America, travel between these two continents via the Mesoamerican Land Corridor, numerically the most important raptor-migration flyway in the world. Although the flight has been well documented at migration bottlenecks in Veracruz, Mexico, and the canal region of Panama, the choreography of raptor migration through most of the 4,000-km corridor is not well understood. Here we report the first counts, rather than estimates, of the spring raptor migration from ten sites in central and southeastern Costa Rica using protocols developed at well-established North American watchsites. *Buteo platypterus* made up 76%, *B. swainsoni* 14%, and *Cathartes aura* 10% of the nine-species, 13,853-bird flight. Our results, which largely confirm earlier estimates of the magnitude, timing, and location of the flight in Costa Rica, suggest that raptors are more likely to migrate in sub-optimal conditions in the tropics than in temperate regions. Although we offer no explanation for this difference, our limited time in the field suggests that both the timing and location of raptor migration are sufficiently well known in Costa Rica to permit the effective study of migrating raptor flight dynamics there, and the establishment of a countrywide monitoring program. *Accepted 17 March 2000.*

Resumen. Durante la primavera y el otoño, millones de aves rapaces migratorias que anidan principalmente en Norteamérica emigran a Sudamérica, viajan entre estos dos continentes a través del corredor de tierra mesoamericano, numéricamente la vía de migración de rapaces más importante en el mundo. Aunque este evento ha sido bien documentado en los cuellos de botella de la migración como Veracrúz, México y la región del Canal de Panamá, la coreografía de la migración de rapaces a través de los 4000 km del corredor no ha sido bien entendida. Reportamos los primeros conteos, mas que las estimaciones, de la migración de primavera de rapaces en diez localidades en el centro y sureste de Costa Rica mediante la utilización de protocolos desarrollados y establecidos por los sitios de conteo norteamericanos. *Buteo platypterus* representó el 76% de las observaciones, *Buteo swainsoni* el 14 %, *Cathartes aura* el 10 % de las nueve especies y de las 13.853 aves observadas. Nuestros resultados confirman los estimativos previos sobre la magnitud, época y ubicación de la migración en Costa Rica, lo que sugiere que las rapaces emigran bajo condiciones menos óptimas en los trópicos que en las regiones templadas. Aunque no podemos explicar el por que de esta diferencia, nuestro limitado tiempo en el campo sugiere que ambos, la época y ubicación de la migración de rapaces son suficientemente conocidas en Costa Rica para permitir un estudio de la dinámica de vuelo de la migración de rapaces y el establecimiento de un programa de monitoreo a nivel nacional.

Key words: Raptors, Falconiformes, vultures, migration, Costa Rica.

INTRODUCTION

Each year millions of Nearctic vultures and raptors breeding in the United States and Canada overwinter in South America. Most of the migrants travel to and from South America along the Mesoamerican Land Corridor, a 4,000-km route that stretches from the Gulf

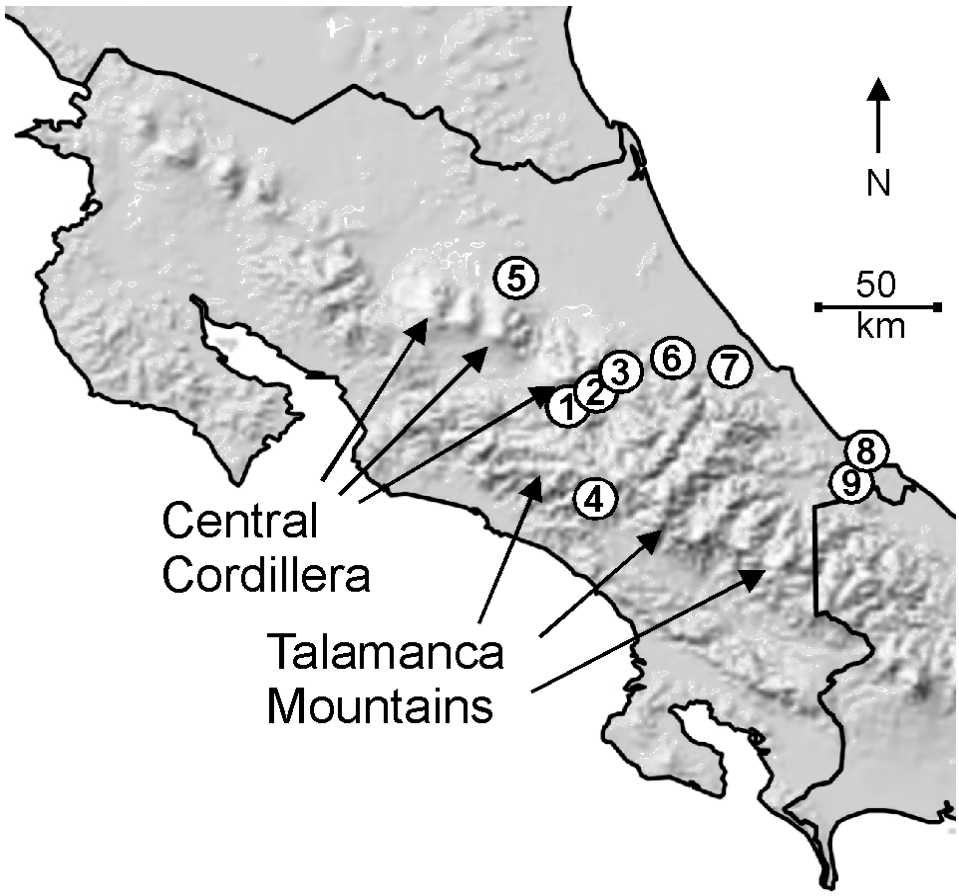

FIG. 1. Location of 10 raptor migration watchsites in Costa Rica (1, Pacayas; 2, Capellades; 3, Santa Cruz; 4, Cerro La Muerte; 5, Puerto Viejo, Sarapiqui; 6, EARTH; 7, Matina; 8, Ocean View Park Mirador; 9, Bribri One and Bribri Two). See Table 1 for site descriptions and Table 2 for counts results for each watchsite.

Coast of Texas along the mountains and coastlines of Mexico and seven Central American countries to northern Colombia (Bildstein & Zalles 1998), and that ranks, numerically, as the most important raptor migration flyway in the world (Zalles & Bildstein 2000). Although at least 18 species of New World vultures and raptors are known to use this corridor, the overwhelming majority of the flight consists of individuals of three soaring species, Turkey Vulture (*Cathartes aura*), Broad-winged Hawk (*Buteo platypterus*), and Swainson's Hawk (*B. swainsoni*) (Smith 1980, Zalles & Bildstein 2000).

Raptor migration along the corridor has been studied in greatest detail in southern and eastern Mexico (Andrle 1968, Thiollay 1980, Tilly *et al*., 1990, Sutton & Sutton 1999) and along the Isthmus of Panama (Smith 1980, 1985a, 1985b), where multi-year counts of migrants have revealed movements of millions and hundreds of thousands of autumn

TABLE 1. Descriptions of raptor-migration watchsites in Costa Rica, 24–31 March 1999.

Watchsite name	Location and description
Central Cordillera sites	
Pacayas	09°54'30"N, 83°48'54" W. At a Catholic shrine along the road from San Rafael to Pacayas, on the southeastern slope of Volcán Irazú. Skies were scanned to the east and south.
Capellades	09°56'00"N, 83°46'40"W. 50 m north of the Santa Teresa restaurant, on the eastern edge of Capellades along the road from Pacayas to Santa Cruz, on the eastern slope of Volcán Irazú. Skies were scanned to the east and south.
Santa Cruz	c. 09°55'N, 83°45'W. From a 4-m tower on the eastern slope of Volcán Irazú, 200 m east of Santa Cruz. Skies were scanned to the east and south.
Talamanca Mountains site	
Cerro La Muerte	09°33'17"N, 83°45'16" W. Along the ridge at the eastern end of the communications-towers parking lot at the top of Cerro La Muerte, along Ruta 2 from Cartago to San Isidro de El General. Skies were scanned to the southeast in the direction of Cerro Chirripo.
Eastern (Caribbean) slope sites	
Puerto Viejo, Sarapiqui	10°27'06"N, 84°03'11"W. An isolated hilltop north of Ruta 4, between Guaria and Chilamate, approximately 3 km west of Puerto Viejo, Sarapiqui. Skies were scanned to the southeast.
EARTH	c. 10°11'N, 83°37'W. An open area at a faculty residence 400 m east of the cafeteria at the EARTH (Escuela Agricultura Region Tropical Humeda) campus north of Ruta 32 between Guácimo and Siquirres. Skies were scanned to the south.
Matina	10°03'39"N, 83°18'04"W. Several km north of Ruta 32 on a bridge along the road between the Rio Barbilla and Matina. Skies were scanned to the south.
Ocean View Park Mirador	c. 09°40'N, 82°50'W. Several lookouts at Ocean View Park Finca Mirador 100–500 m west of Ruta 36 between Cahuita and Hone Creek. Skies were scanned to the south, east, and west.
Bribri One and Two	09°38'0"N, 82°48'34" W (Bribri One); 09°37'30"N, 82°49'30"W (Bribri Two). Two sites, both along Ruta 34 between Hone Creek and Bribri. Bribri One is a hilltop south of the road, approximately 2 km west of Hone Creek. Bribri Two is along the road 2 km southeast of Bribri overlooking Delicias, Panama. At both sites skies were scanned to south, east, and west.

migrants, respectively, along with decidedly smaller movements in spring (Zalles & Bildstein 2000). In contrast, relatively little is known regarding movements of raptors in spring in Costa Rica, and actual counts, rather than estimates, of passage rates have yet to be performed there (Carriker 1910, Skutch 1945, Stiles & Skutch 1989, Hernandez & Zook

1993, Hidalgo *et al.*1995).

Here, we report our observations, including the first actual counts of migrating New World vultures and raptors in Costa Rica, at suspected migratory bottlenecks in the Central Cordillera, Talamanca Mountains, and eastern (Caribbean) slope and coastal plain of Costa Rica in late March 1999, and offer suggestions regarding how these and other sites in Costa Rica might be used as part of a regional network for counting migratory raptors in Central America, and for studying their migratory ecology there.

METHODS

We gathered preliminary data during 15 visits to 10 potential raptor-migration watchsites on eight days from 24 to 31 March 1999. Watchsites were chosen based on a series of previous visits over several years by MS, as well as on their relative accessibility by road. Watchsites included three locations in the Central Cordillera along the southeastern slopes of Volcán Irazú, approximately 25 km east of San José, a single location in the Talamanca Mountains along the country's continental divide, and six locations along the eastern (Caribbean) slope and coastal plain in northeastern to southeastern-most Costa Rica (Fig. 1, Table 1).

All counts were made between 07:45 h and 16:45 h local time by two individuals (KLB & MS) who scanned the skies from open areas along and overlooking roads. Most counts were made from the ground. At one watchsite (Santa Cruz), counts were made from a 4-m tower. At another site (Bribri Two), counts were made from the top of a parked minivan. We used 8x and 10x binoculars to detect and identify migrants. Raptors were included in counts if they were engaged in directed soaring or flapping flight toward the north (see Bildstein & Zalles 1995 for additional details concerning the count and record-keeping protocols used.)

RESULTS

We detected and identified 13,853 migrating vultures and raptors during 27 h and 50 min of counts at 10 watchsites on eight days (24–31 March 1999) (Table 2). Broad-winged Hawks, which were seen at all watchsites, comprised 76% of the flight. Swainson's Hawks, which were seen at all but one watchsite (Santa Cruz), comprised 14% of the flight. Turkey Vultures, which were not seen at any of the Central Cordilleran watchsites, comprised 10% of the flight. Other species seen migrating at one of more of the 10 watchsites included Osprey (*Pandion haliaetus*) (27 at four sites in the Talamanca Mountains and eastern slope and coastal plain), Swallow-tailed Kite (*Elanoides forficatus*) (eight at two sites in the Central Cordillera and Talamanca Mountains), Northern Harrier (*Circus cyaneus*) (one in the Central Cordillera), Sharp-shinned Hawk (*Accipiter striatus*) (one in the Central Cordillera), American Kestrel (*Falco sparverius*) (two at two sites in the Central Cordillera), and Peregrine Falcon (*F. peregrinus*) (one on the eastern coastal plain).

In addition to sightings at the 10 potential watchsites, we counted 108 Turkey Vultures and 120 Swallow-tailed Kites departing northbound from a coastal-plain forest roost east of Ruta 36, and approximately 5 km northwest of Cahuita, between 08:15 h and 08:30 h local time on the morning of 27 March. We also saw a single adult male Merlin (*Falco columbarius*) depart a beach-side roost at Puerto Vargas at 09:40 h on the same day.

Most of the birds we watched, particularly the three most common species, soared in and glided between thermals; some engaged in slope soaring. Most migrated in single-species flocks of from a few individuals to several hundred individuals, although many larger

TABLE 2. Numbers of Turkey Vultures (*Cathartes aura*) (TUVU), Ospreys (*Pandion haliaetus*) (OSPR), American Swallow-tailed Kites (*Elanoides forficatus*) (ASTK), Broad-winged Hawks (*Buteo platypterus*) (BWHA), and Swainson's Hawks (*B. swainsoni*) (SWHA) seen at 10 raptor migration watchsites in Costa Rica, 24–31 March 1999.

Watchsite name	Absolute numbers (birds/h)				
Date (time of day, weather)	TUVU	OSPR	ASTK	BWHA	SWHA
Central Cordillera sites					
Pacayas					
24 March (07:50–09:30 h, overcast)	0	0	0	372 (223)	1 (0.6)
30 March (10:55–13:05 h, overcast, intermittent mist, ended in rain)[1]	0	0	0	1037 (479)	28 (12.9)
31 March (07:45–10:05 h, partly cloudy)[2]	0	0	0	1779 (534)	387 (116)
31 March (14:35–16:30 h, partly cloudy)[1]	0	0	0	152 (79.3)	55 (28.7)
Capellades					
24 March (09:50–11:45 h, partly cloudy)[3]	0	0	1 (0.5)	157 (81.9)	14 (7.3)
Santa Cruz					
31 March (12:45–14:00 h, partly cloudy)	0	0	0	70 (56)	0
Talamanca Mountains site					
Cerro La Muerte					
25 March (07:50–10:40 h, partly cloudy, ended in ground fog)	1 (0.4)	0	7 (2.5)	565 (199)	116 (40.9)
Eastern (Caribbean) slope sites					
Puerto Viejo, Sarapiqui					
29 March (14:00–15:00 h, partly cloudy)	0	0	0	8 (8)	1 (1)
EARTH					
26 March (12:30–13:35 h, overcast, ended in rain)	37 (34)	10 (9.2)	0	186 (172)	7 (6.5)
29 March (09:15–10:30 h, overcast)	2 (1.6)	0	0	24 (19.2)	0
Matina					
26 March (16:30–17:25 h, overcast)	168 (183)	3 (3.3)	0	734 (801)	13 (14.1)
Ocean Park Finca Mirador					
27 March (10:35–12:50 h, partly cloudy)[4]	413 (184)	0	0	415 (184)	46 (20.4)
Bribri One					
27 March (13:30–16:45 h, overcast)	212 (65.2)	12 (3.7)	0	3378 (1039)	206 (63.4)
28 March (12:00–13:30 h, heavy overcast)	234 (275)	1 (0.7)	0	504 (336)	307 (205)
Bribri Two					
28 March (13:40–15:10 h, heavy overcast)	281	1 (0.7)	0	1194 (796)	714 (476)

TABLE 2. Continuation.

Watchsite name	Absolute numbers (birds/h)				
Date (time of day, weather)	TUVU	OSPR	ASTK	BWHA	SWHA
All sites combined (27 h 50 min of observation on 8 days)	1348 (49.5)	27 (1.0)	8 (0.3)	10,575 (380)	1895 (68.1)
Percent of overall flights	10%	0.2%	< 0.1%	76%	14%

[1]Count included one American Kestrel (*Falco sparverius*).
[2]Count included one Sharp-shinned Hawk (*Accipiter striatus*).
[3]Count included one Northern Harrier (*Circus cyaneus*).
[4]Count included one Peregrine Falcon (*Falco peregrinus*).

flocks (i.e., > 100 birds), consisted of members of two and, in some instances, three species flying together. When flying in mixed-species flocks, Broad-winged Hawks and, to a lesser extent, Swainson's Hawks, glided at faster speeds between thermals, and ascended more rapidly in thermals, than did Turkey Vultures. Although we did not record the circumstances of the several dozen in-flight collisions we observed, most, if not all, involved members of different species.

Local weather conditions appeared to influence migration behavior. On the afternoon of 28 March, a day with heavy overcast skies and isolated bands of rain, thousands of migrating Broad-winged Hawks, Swainson's Hawks, and Turkey Vultures migrating past Bribri Two, appeared to struggle to remain aloft while rising unusually slowly in weak, low altitude (< 500-m) thermals over a series of banana (*Musa* sp.) plantations. Indeed, one group of several hundred individuals observed at the time took > 25 min to travel less than 3 km while soaring and gliding among three weak thermals. Also, two days later at midday on 30 March, a group of 30 Broad-winged Hawks migrating past Pacayas abruptly shifted their flight direction 150° to bypass an isolated band of rain showers. In spite of such behavior, many vultures and raptors were seen migrating on relatively still, overcast, and rainy days, when conditions for both thermal and slope soaring appeared marginal, and when few if any raptors would have been expected to migrate in more temperate regions (K. L. Bildstein, pers. observ.).

DISCUSSION

Our counts of spring raptor migration in Costa Rica confirm and quantify earlier accounts of the flight (Carriker 1910, Skutch 1945, Stiles & Skutch 1989, Hernandez & Zook 1993, Hidalgo *et al.*1995).

The interspecies differences in flight behavior and limited intermingling we observed among the three species of principal migrants appear to be typical for these species in the tropics (Andrle 1968). Several authors (Hagar 1988, Tilly *et al.* 1990, Hidalgo *et al.* 1995, Montejo Díaz & Ruelas Inzunza 1997) have suggested that Turkey Vultures and Swainson's Hawks take a more westerly (i.e., Pacific slope) route through the region, while Broad-winged Hawks take a more easterly (i.e., Caribbean slope) route. Whether differences in flight behavior, or other differences in migration ecology, such as roosting requirements, timing of migration, or all of these factors, are responsible for species differences in migration paths remains unclear and in need of further investigation.

Based on the timing of spring raptor migration in Mexico (Thiollay 1980, Tilly *et al.* 1990) and Panama (Smith 1980), our observations appear to have been made at or near the peak of Broad-winged Hawk and Swainson's Hawk movements in the region, and probably towards the end of Turkey Vulture movements. Thus, the relatively large numbers of Broad-winged Hawks seen at the watchsites we used may reflect either the location (central mountain and Caribbean slope) or timing of our observations, or both. Although most Swainson's Hawks and Broad-winged Hawks funnel through relatively narrow common bottlenecks in coastal Veracruz, Mexico, and the canal region of Panama, northwest and southeast of Costa Rica, the extent to which the principal routes of these two species overlap elsewhere in Mesoamerica remains unclear (Zalles & Bildstein 2000). Although the two species are known to use both Caribbean and Pacific slope flyways between these two bottlenecks, Swainson's Hawks appear to follow more westerly (i. e., drier and more open-habitat Pacific slope) routes, overall, while Broad-winged Hawks appear to follow more easterly (i.e., moister and more forested Caribbean slope) routes (Zalles & Bildstein 2000). Swainson's Hawks breed and overwinter in decidedly drier and more open habitats than do Broad-winged Hawks (Johnsgard 1990), and differences in the species migratory routes through Mesoamerica may reflect these general habitat preferences. Clearly, additional observations both on the Pacific slope, and earlier and later in the season (i.e., early and mid-March, and early and mid-April) are needed to determine the extent to which timing and location affect the species composition of the flight in the Costa Rican portion of the corridor.

Although relationships between weather patterns and raptor migration, as well as other aspects of raptor flight dynamics, are well studied at temperate latitudes in North America (Kerlinger 1989, Allen *et al.* 1996, and references therein), such is not the case in the Neotropics (but see Smith 1985b). Our observations, limited as they are, suggest that soaring migrants are more likely to migrate on still, overcast and rainy days in Costa Rica than in more temperate areas. Recent satellite telemetry studies of Swainson's Hawks migrating between wintering areas in Argentina and breeding grounds in North America indicate that the birds traveled 42% faster in the tropics than in the temperate portions of their journeys (Fuller *et al.* 1998). Taken together, these observations suggest that raptor flight dynamics differ considerably in tropical versus temperate areas. The extent and explanation for such differences merits additional study.

Evidence suggests that recent global warming is affecting Costa Rica's climate. Parameters involved include changes in local rates of evapo-transpiration and cloud cover and the altitudinal locations of orographic clouds (Pounds *et al.* 1999, Still *et al.* 1999), all of which are linked to thermal and orographic updraft formation. The extent to which changes in soaring conditions in the region will affect raptor migration there, although unclear, merits considerable additional attention, since many raptors, including the three principal species seen by us, depend on soaring to complete their intercontinental journeys (Smith 1980, Bildstein 1999).

Raptors are secretive, area-sensitive predators whose populations are frequently difficult and expensive to survey and monitor. Recent evidence suggests that at least some populations of as many as 54% of all Neotropical raptors are threatened by habitat loss, environmental contaminants, or direct persecution, or by two or more of these factors (Bildstein *et al.* 1998). Concentrations of thousands of birds of prey at traditional migration bottlenecks along major regional

corridors provide an opportunity both to study and monitor regional populations, and to introduce the public to these evocative birds (Bildstein 1998, Zalles & Bildstein 2000).

Given our limited time in the field, our successes in finding and counting large numbers of birds of prey suggest that the timing and location of raptor migration is sufficiently well known in Costa Rica for conservationists working there to consider establishing a countrywide series of raptor-migration watchsites. Once established, this network could (1) monitor both north- and south-bound movements – and presumably populations – of the three principal Nearctic migrants (i.e., Turkey Vulture, Broad-winged Hawk, and Swainson's Hawk), (2) study raptor-migration ecology in the tropics and compare it with temperate-zone migration ecology, and (3) introduce local residents both to phenomenon of long-distance migration and to populations of local endemic raptors.

Although the Nearctic migrants that pass through Costa Rica represent but a small portion of the country's raptor diversity (Stiles & Skutch 1989), the spectacular nature of their movements offers considerable opportunity for increasing regional and international ecotourism and, more importantly, local conservation community-based efforts (Bildstein & Zalles 1995, Sutton & Sutton 1999).

Finally, a recent gap analysis of protected areas in Costa Rica suggests that the raptor-migration watchsites we identified will be useful to those working to establish "linkage zones" designed to enhance the "ecological connectivity" of existing protected areas in the country (Powell *et al.* 2000).

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