

# RAPTOR MIGRATION ALONG THE MESOAMERICAN LAND CORRIDOR

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## Abstract

Each autumn (August-December), more than five million birds of prey (Order Falconiformes) migrate south from North America into Central and South America along the Mesoamerican Land Corridor, the most important raptor-migration flyway in the New World. The route, which extends for 4,000 km from the southwestern United States, in North America, to the Chocó region of northwestern Colombia in South America, hosts smaller numbers of northbound raptors in spring (February-May). Although reports of raptors moving along the corridor date from the 16<sup>th</sup> Century, the overall magnitude, geography, and timing of the migration only recently have come to light. The 32-species flight is dominated numerically by western North American breeding populations of Turkey Vultures (*Cathartes aura*) (>1.5 million individuals), together with world populations of Mississippi Kites (*Ictinia mississippiensis*) (>0.1 million), Broad-winged Hawks (*Buteo platypterus*) (>1.0 million), and Swainson's Hawks (*B. swainsoni*) (>0.5 million). The most important concentration points along the corridor are the Gulf of Mexico coastal plain of Veracruz, Mexico, the Caribbean coastal plain of southeastern-most Costa Rica, and the canal-zone region of Panama. Migration flyways branch elsewhere along the corridor. Autumn and spring movements are greatest in late September-mid-November and in mid-March-late April, respectively. The feeding and roosting ecology of raptors using the corridor remains largely unknown. A recently initiated cooperative monitoring effort, *Hawks Aloft Worldwide*, has identified more than 17 incipient and active raptor-migration watchsites in the region. Together with other possible watchsites in the region, the network offers considerable potential for long-term, multi-site monitoring and study of the flight, as well as a basis for community based conservation efforts in the region.

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## Introduction

Diurnal birds of prey, or raptors (Order Falconiformes), represent a diverse assemblage of approximately 295 highly-mobile predators that occur across a broad range of habitats on six continents. At least 183 raptors (62%) migrate seasonally. Unlike many smaller birds that fly by night using flapping flight, raptors are relatively large-bodied, lightly wing-loaded species that migrate almost exclusively by day and often engage in extended periods of slope- and thermal-soaring while traveling. Although some migrate across broad fronts, many concentrate along traditional migration corridors or flyways (Zalles and Bildstein 2000). Because most raptors are reluctant to cross even narrow bodies of water, migration corridors often funnel birds along isthmuses and across narrow straits that allow long-distance migrants to circumvent lengthy water crossings (Kerlinger 1989).

In the Old World, water avoidance by migrating raptors is best seen in the Mediterranean region, where European breeders overwintering in Africa funnel through the Strait of Gibraltar at the western end of the Mediterranean; the Bosphorus at the eastern end, or the Italian Peninsula, Sicily; and the Maltese archipelago in mid-Mediterranean. In the New World, it is best seen in Mexico and Central America where North American raptors overwintering in the region and in South America migrate overland along the intercontinental Mesoamerican isthmus that connects North and South America (Bildstein and Zalles 1998, Zalles and Bildstein 2000).

Used by populations of at least 32 species of migratory birds of prey, the Mesoamerican Land Corridor is the most important raptor migration flyway in the New World. The corridor consists of a series of inter-branching flyways that stretches for approximately 4000 km south-southeast from southern Gulf Coast Texas to northwestern Colombia (Smith 1980; 1985a,b; Bildstein and Zalles 1998; Sutton and Sutton 1999; Zalles and Bildstein 2000). Included in a conservatively estimated total of more than 5 million autumn migrants are near-world populations of Mississippi Kites (*Ictinia mississippiensis*), Broad-winged Hawks (*Buteo platypterus*), and Swainson's Hawks (*B. swainsoni*), along with many western North American populations of Turkey Vultures (*Cathartes aura aura* and *C. a. meridionalis*) (Bildstein and Zalles 1998, Sutton and Sutton 1999). Although several populations of raptors breeding in Central and South America also use portions of the corridor (Smith 1985a, Gerhardt et al. 1997, Angehr 1999), the overwhelming majority of the region's migrants are species that breed in North America and winter in Central and, especially, South America.

The best information regarding movements of North American breeders along the corridor comes from visual observations in eastern Mexico, particularly the state of Veracruz (e.g., Andrie 1968, Thiollay 1980, Tilly et al. 1990, Ruelas Inzunza 1992, Sutton and Sutton 1999, Zalles and Bildstein 2000), and along the Isthmus of Panama (Smith 1980, 1985a,b). Less detailed accounts of the flight also are available for Guatemala (Montejo Díaz and Ruelas Inzunza 1997) and Costa Rica (Hidalgo et al. 1995, Bildstein and Saborio 2000).

Although historic reports of raptor migration in the region date from the mid-16<sup>th</sup> Century (Bildstein and Zalles 1998), actual counts of significant portions of the flight did not occur until the late 1970s, when Neal Smith recorded movements of hundreds of thousands of raptors at Ancon Hill, Panama City, Panama (Smith 1980).

More recent counts from coastal-plain Veracruz, Mexico, place the southbound magnitude of the flight at >1.5 million Turkey Vultures, >1.0 million Broad-winged Hawks, >0.5 million Swainson's Hawks, and >0.1 million Mississippi Kites (Ruelas Inzunza in Sutton and Sutton 1999, Zalles and Bildstein 2000). Northbound counts of these species at the same site are about one order of magnitude lower (Ruelas Inzunza 1992).

By comparison, the greatest known movement of birds of prey in the Old World—several million raptors, representing 43 species of Asian and European breeders—funnels through the Middle East each spring and autumn, making that region an equally important intercontinental flyway (Shirihai 1996).

Here we provide excerpts and summaries of historical accounts of raptor migration along the Mesoamerican Land Corridor (i.e., ornithological observations published between 1550 and 1950), together with details from incipient and active raptor-migration watchsites that are monitoring movements of migrants along the corridor. We also detail outstanding questions regarding the ecology and geography of the flight,

and suggest ways in which a network of raptor migration watchsites could increase raptor-migration science and conservation in the region.

## Historical Ornithological Accounts

The oldest European account of raptor migration in the region is a mid-16<sup>th</sup> Century report by Spanish colonial historian and naturalist Gonzalo Fernández de Oviedo y Valdés, who described flights in the Darien of eastern Panama (Baughman 1947, Table 1). We have been unable to locate any 17<sup>th</sup> Century accounts and, except for a brief description of a flock of 50 southbound Broad-winged Hawks in southern Rio Grande Valley, Texas, in April 1878 (Sennett 1879, Table 2), most 18<sup>th</sup> and 19<sup>th</sup> century reports of raptor migration in the region consist of rather cursory accounts of what were believed to be anomalous and exceptional events.

The earliest ornithological records of large-scale raptor migration along the Mesoamerican Land Corridor appear to date from the early 20<sup>th</sup> Century (e.g., Carriker 1910, Chapman 1916, Wetmore 1943; Table 2). As is true of most accounts prior to 1950, Carriker (1910), Chapman (1916), and Wetmore (1943) provide brief, albeit compelling descriptions of the flight, focusing mainly on its magnitude and to some extent timing, with little in the way of detailed species-specific observations. Wetmore (1943) almost certainly misidentified high-flying Swainson's Hawks as White-tailed Hawks (*B. albicaudatus*), most likely because the former is a seldom-seen migrant in the region (Veracruz, Mexico), while the latter is a common and conspicuous year-round resident there. (Wetmore, apparently, was not alone in this mistake. W. H. Hudson appears to have committed the same misidentification on the Swainson's Hawk's wintering grounds in Argentina at about the same time [Hudson 1920]). Actual counts of significant portions of the flight did not occur until the late 1970s, when Neal Smith recorded movements of hundreds of thousands of Turkey Vultures, Broad-winged Hawks, and Swainson's Hawks, together with tens of thousands of Mississippi Kites, over Ancon Hill, Panama City, Panama (Smith 1980).

In retrospect, misidentifications and the lack of species' details in early 20<sup>th</sup>-Century accounts are understandable. Modern field guides did not yet exist for Mesoamerica (Vuilleumier 1997), prismatic binoculars were not in widespread use there, and much of the flight took place high overhead (Bildstein and Zalles 1998). In addition, most early observations of raptor migration in the region were made by museum biologists, people more accustomed to viewing birds through the sights of collecting guns than through binoculars (see, for example, Anthony in Griscom 1932 [Guatemala], and Dickey and van Rossem 1938 [El Salvador], Table 2).

Not surprisingly, Ludlow Griscom, widely recognized as one of the most proficient birders of the first half of the 20<sup>th</sup> Century (Davis 1994), appears to have been the first to characterize the flight as one of the most spectacular of the continent's birding events (Griscom 1932 [Guatemala], Table 2). At the same time, Dickey and van Rossem (1938 [El Salvador], Table 2) appear to be the first to document night-time roosting on the part of the migrants, as well as the first to note widespread use of the Spanish vernacular name "asaquanes" (drought-bringers) to describe the birds whose autumn passage presaged the dry season in the region.

By far the most detailed pre-1950 report of raptor migration in Mesoamerica comes from Alexander Skutch (1945, Table 2) in Costa Rica. Skutch was the first to (1) suggest that the flight consisted of entire species populations moving largely en masse

**Table 1.** A 16<sup>th</sup>-Century account of raptor migration along the Mesoamerican Land Corridor.

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“I have seen [birds] passe over Darien and Nombre de Dios and Panama in divers years, in the Firme Land; so many that they cover the Skie; and this passage or march continueth a moneth or more about the moneth of March. ...from morning to night the aire is covered, and some flie so high that they cannot be seene, others lower yet higher than the mountain tops. The lowest are the Eaglets [sic hawks] and the Eagles, and all seeme Birds of Prey of many kinds and plumes.”

--Gonzalo Fernández de Oviedo y Valdés (1555, *Historia general y natural de las Indias*) in Baughman 1947.

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along traditional routes, (2) recognize that Broad-winged Hawks and Swainson's Hawks used different flyways, at least through portions of the corridor, and (3) understand that some raptors used different flyways in spring and in autumn. He also was the first to suggest the need for cooperative multi-site efforts to better understand the flight.

## **Ecogeography of the Corridor**

### ***Species and timing***

World populations of three species of North American raptors over-winter largely in both Central and South America (Mississippi Kite and Broad-winged Hawk), or in South America only (Swainson's Hawk) (del Hoyo et al. 1994). In addition to these three species of complete migrants (*sensu* Kerlinger 1989), populations of at least one other complete migrant (Osprey), together with 19 species of partial migrants also use the Mesoamerican Land Corridor on a regular basis, as do 11 other less-regular migrants (Table 3).

Overall, individuals of four species, Turkey Vulture, Mississippi Kite, Broad-winged Hawk, and Swainson's Hawk, dominate the flight numerically (Table 3).

Each autumn, >100,000 southbound Mississippi Kites begin entering the region in late August, followed by even larger numbers of Broad-winged Hawks in mid-September, and Turkey Vultures and Swainson's Hawks in early to mid-October. Most Mississippi Kites complete their autumn passage through the corridor by late September-early October. Most Broad-winged Hawks do so by early to mid-October, and most Turkey Vultures and Swainson's Hawks do so by late October-mid-November. In spring, the temporal pattern largely reverses itself, with Turkey Vultures entering the corridor in late February-early March, followed in several weeks by Swainson's Hawks and Broad-winged Hawks, and several weeks thereafter by Mississippi Kites. Overall, the migration chronology of the two hawks is more truncated than that of Turkey Vultures (Appendix 1; Smith 1980, 1985a,b; Zalles and Bildstein 2000).

**Table 2.** Pre-1950 accounts of raptor migration along the Mesoamerican Land Corridor.

Country	Accounts
Belize	No references found.
Costa Rica	<p data-bbox="255 332 1011 389">"One [<i>Buteo swainsoni</i>] was taken in [San Jose] in Nov. 25, 1889." (Cherrie 1890)</p> <p data-bbox="255 426 1011 789">"I have never met [<i>Buteo swainsoni</i>] except during April 1902, on the Volcan de Irazú [in the Cordillera Central], where they were quite numerous for about three weeks and then disappeared. I believe that they were migrating from some point further south and stopped on Irazú to rest and feed. During the early autumn of 1906 there passed over El Hogar [approximately 3 km west of Guacimo on the Caribbean Slope] at great height, an enormous flock of hawks, which I think were of this species, but they were too high to be certain of the identification. As nearly as I could estimate, there appeared to be at least a thousand of them. They came from the northwest, moving slowly in great circles, and after perhaps an hour disappeared toward the southeast." (Carriker 1910)</p> <p data-bbox="255 826 1011 974">"[<i>Buteo platypterus</i> is] the most abundant and widely spread of the migrant species of hawks in Costa Rica, being found in the lowlands of both the Caribbean and Pacific, and over the central plateau region. It seems quite partial to trees along the edges of streams and isolated patches of woodland." (Carriker 1910)</p> <p data-bbox="255 1011 1011 1192">"Except among the bird islands of Peru, I have never seen aggregations of birds so vast as those formed by the migrating Swainson's Hawks. Perhaps now that the Passenger Pigeon [<i>Ectopistes migratorius</i>] has passed into oblivion, these are the most spectacular mass movements of birds to be seen on the North American continent." (Skutch 1945)</p> <p data-bbox="255 1229 1011 1344">"Some of the flocks of Swainson's Hawks are so unbelievably vast that the watcher receives the impression that practically the whole of the species must be represented in that one immense aggregation of migrating birds." (Skutch 1945)</p> <p data-bbox="255 1381 1011 1491">"My earlier notes refer to all of these hawks that migrate as Broadwings; but from subsequent observations, I feel confident that the most spectacular [spring] flocks that I had witnessed [in the basin of El General, or the upper Terrabá Valley, along the Pacific drainage of</p>

southern Costa Rica] were made up chiefly of Swainson's Hawks." (Skutch 1945)

"[During six years of autumn observations in basin of El General] I have never seen a single individual of either kind traveling southward. ...Hence it appears that Swainson's Hawks migrate in autumn down the Pacific coast of northern Central America through Guatemala and doubtless also El Salvador, Honduras, and Nicaragua. Then they appear to cross over to the Caribbean side, probably over the belt of lowlands that traverse the isthmus in southern Nicaragua and northern Costa Rica." (Skutch 1945).

"With the Broad-winged Hawk the picture is much the same, except that this species travels in far smaller flocks, and the situation is complicated by the presence of numerous individuals that winter in Central America." (Skutch 1945)

"It is evident that to obtain a complete picture of the migration of Swainson's Hawks through Costa Rica would require the efforts of cooperating observers scattered over a broad front." (Skutch 1945)

#### El Salvador

"[The Swainson's Hawk is an] abundant spring and fall migrant through the lowlands. ...On October 12 the first low-flying flock of migrating hawks passed directly over Divisadero. ...The lowest birds were about 500 feet above the hilltop, low enough for certain identification, but too high to secure specimens. The hawk migration reached its peak on October 21 in an enormous flight, or rather a series of flights, which occupied the greater part of the day. It was not possible to make any estimate of the flight that passed, but it must have been in the tens of thousands... The flight came in distinct waves... The hawks, so far as could be determined, were all Swainson's, about ninety percent being light phase [sic morph] adults, melanistic birds of varying degrees of darkness, but no streaked young of the year were present. No red-tails or other hawks were noticed, but there was an occasional sprinkling of turkey vultures, migrating as an integral part of the flight. ...Not the least remarkable part of the series of flights was the fact they invariably passed over the same hilltops, and residents told us that there was little variation from year to year." (Dickey and van Rossem 1938)

"Smaller flocks of from about 200 to well over 1,000 were seen daily until November 6, on which day the last flock of the season was noted. In all of these Swainson's Hawks predominated, and other species accompanying them were present only as a sprinkling. In the flight of November 4 were a good many streaked young of the year, the only occasion on which they were detected." (Dickey and van Rossem 1938)

“Spring collecting during the years of 1912, 1926, and 1927 was carried out in localities away from the migration route, and on only one date was a Swainson’s migration seen. On the foot of the north slope of Volcán de San Salvador is a new lava field, the result of the most recent eruption. ...On the evening of April 30, 1927, a few minutes after sunset, this field was white with roosting hawks, which had settled for the night. There were several thousand birds in sight from each side of the train, most of which paid little attention to its passing... The residents of Divisadero said that spring flights sometimes, but very rarely, stopped for the night on the lava butte north of town... (Dickey and van Rossem 1938)

“All migrating species of raptors are collectively known as asaquanes and, in popular superstition, they are supposed to usher in the dry and wet seasons which certainly commence, respectively, at about the time of the southbound and northbound migrations. It is not unlikely that the general dates for migration are advanced or retarded by unusual weather conditions.” (Dickey and van Rossem 1938)

Guatemala

“The remarkable flights of Swainson’s Hawk on migrations in Central America are one of the sights of the bird world, to the few who have been fortunate enough to see one. ...Apparently the great majority of individuals in existence pass over Central America in a comparatively few days in a few enormous flocks, which take hours to pass a given point. ...The birds alight only casually, and only three specimens have been collected in Central America.” (Griscom 1932).

“...The only chance that I had of observing this interesting migration was when it passed to the south, October 25, 1925. I happened to be hunting in the heavy growth of the coffee plantation, where it was well nigh out of the question to observe what was passing overhead, and it was only when I returned to the Hacienda, at noon, that I learned of the southward flight that took some three hours passing.” (Anthony in Griscom 1932)

“[The Broad-winged Hawk is] a fairly common winter visitant [in Guatemala], more numerous on migration.” (Griscom 1932)

Honduras

No references found.

Mexico

“In the spring, on the eastern slope of the mountains of Vera Cruz, Mexico, I have seen flocks containing thousands of hawks migrating northward. Although closely massed they did not move onward in a solid body like a flock of blackbirds, but, like a swarm of bees, circled about and among in the most remarkable and confusing manner. However, in spite of their wheeling they all passed rapidly northward and were soon out of sight.” (Chapman 1916)

“Migrant flocks of these hawks [identified by Wetmore as White-tailed Hawks *Buteo albicaudatus*], but almost certainly Swainson’s Hawks] were recorded near Tres Zapotes from March 30 to April 12, the number seen varying from a few to several hundred during one day. They appeared in bands of varying size that traveled to the north, occasionally turning in spirals but even then drifting steadily northward. They were seen usually early in the morning and at times were accompanied by a smaller species that was probably *B. p. platypterus*, though none of these passed sufficiently near for certain identification. The White-tailed Hawks were always high in the air, so that it was necessary to use field glasses to name them. They appeared white below, occasionally with a rusty wash on the lower breast, and were marked by a single broad band of black across the end of the white tail.” (Wetmore 1943).

Nicaragua No references found.

Panama No references found.

Texas George B. Sennett reported movements of a flock of at least 50 broadwings on spring migration in southern Texas (Hidalgo County) in early April 1878, which he described as “easy, graceful, and at times quite rapid.” (Sennett 1879).

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Other less-numerous, albeit regular migrants using the corridor include three species (Osprey, Merlin [*Falco columbarius*], and Peregrine Falcon [*F. peregrinus*]) of over-water, trans-Caribbean migrants, all of which are particularly evident along coastal and near-coastal portions of the corridor (Poole 1989, Hoffman and Darrow 1992, Hernández and Zook 1993); one species, (Swallow-tailed Kite [*Elanoides forficatus*]), most individuals of which join the Caribbean-slope branch of the main corridor in Guatemala (Figure 1) after departing southwestern Florida and traveling across northwestern Cuba, en route to the eastern Yucatan Peninsula of Mexico and Belize (K. Meyer, pers. comm.); seven species (Northern Harrier [*Circus cyaneus*], Sharp-shinned Hawk [*Accipiter striatus*], Cooper’s Hawk [*A. cooperii*]) Red-shouldered Hawk [*Buteo lineatus*], Zone-tailed Hawk [*B. albonotatus*], Red-tailed Hawk [*B. jamaicensis*], American Kestrel [*Falco sparverius*]), of land-based migrants that breed north of the region and overwinter largely within it (Andrle 1968; Thiollay 1980; Smith 1980, 1985a,b; Tilly et al. 1990; Ruelas Inzunza 1992; del Hoyo et al. 1994; Hidalgo et al. 1995; Montejo Díaz and Ruelas Inzunza 1997; Sutton and Sutton 1999; Zalles and Bildstein 2000; Bildstein and Saborio 2000); and one species, Hook-billed Kite (*Chondrohierax uncinatus*), which breeds within the region and is locally migratory in Texas, Mexico, and Guatemala (Zalles and Bildstein 2000).

Other, decidedly less common migrants reported at one or more watchsites in the corridor include Black Vulture (*Coragyps atratus*) (Texas and, possibly, El Salvador); White-tailed Kite (*Elanus leucurus*) (Texas and Costa Rica); Plumbeous Kite (*Ictinia plumbea*) (Mexico, Guatemala, and Panama); Bald Eagle (*Haliaeetus leucocephalus*)



**Table 3.** Species and numbers of raptors sighted along the Mesoamerican Land Corridor. (Numbers based on information in Zalles and Bildstein 2000.)

Species	Migration status	Estimated numbers of migrants based on autumn watchsite counts
<b>Complete migrants<sup>a</sup></b>		
Osprey ( <i>Pandion haliaetus</i> )	Regular	<10,000
Mississippi Kite ( <i>Ictinia mississippiensis</i> )	Regular	<200,000
Broad-winged Hawk ( <i>Buteo platypterus</i> )	Regular	1-2 million
Swainson's Hawk ( <i>B. swainsoni</i> )	Regular	½ - 1 million
Rough-legged Hawk ( <i>B. lagopus</i> )	Irregular	<20
<b>Partial migrants</b>		
Black Vulture ( <i>Coragyps atratus</i> )	Regular	<500
Turkey Vulture ( <i>Cathartes aura</i> )	Regular	1-2 million
Swallow-tailed Kite ( <i>Elanoides forficatus</i> )	Regular	<2,000
White-tailed Kite ( <i>Elanus leucurus</i> )	Regular	<500
Plumbeous Kite ( <i>Ictinia plumbea</i> )	Regular	<2,000
Bald Eagle ( <i>Haliaeetus leucocephalus</i> )	Irregular	<10
Northern Harrier ( <i>Circus cyaneus</i> )	Regular	<2,000
Sharp-shinned Hawk ( <i>Accipiter striatus</i> )	Regular	<20,000
Cooper's Hawk ( <i>A. cooperii</i> )	Regular	<10,000
Northern Goshawk ( <i>A. gentilis</i> )	Irregular	<20
Gray Hawk ( <i>Asturina nitida</i> )	Regular	<100
Common Black Hawk ( <i>Buteogallus anthracinus</i> )	Irregular	<100
Harris' Hawk ( <i>Parabuteo unicinctus</i> )	Irregular	<100
Red-shouldered Hawk ( <i>Buteo lineatus</i> )	Regular	<100
White-tailed Hawk ( <i>B. albicaudatus</i> )	Regular	<100
Zone-tailed Hawk ( <i>B. albonotatus</i> )	Regular	<500
Red-tailed Hawk ( <i>B. jamaicensis</i> )	Regular	<1000
Ferruginous Hawk ( <i>B. regalis</i> )	Irregular	<20
Golden Eagle ( <i>Aquila chrysaetos</i> )	Regular	<50
American Kestrel ( <i>Falco sparverius</i> )	Regular	<30,000
Aplomado Falcon ( <i>F. femoralis</i> )	Irregular	<20
Merlin ( <i>F. columbarius</i> )	Regular	<2,000
Prairie Falcon ( <i>F. mexicanus</i> )	Regular	<50
Peregrine Falcon ( <i>F. peregrinus</i> )	Regular	<4,000

## Local or irruptive migrants

Hook-billed Kite ( <i>Chondrohierax uncinatus</i> )	Regular	<500
Roadside Hawk ( <i>Buteo magnirostris</i> ) <sup>b</sup>	Irregular	<100
Short-tailed Hawk ( <i>Buteo brachyurus</i> )	Irregular	<100
Crested Caracara ( <i>Polyborus plancus</i> )	Irregular	<100

<sup>a</sup>Complete migrants are species in which >90% of all individuals leave the breeding ground outside of the breeding season; partial migrants are species in which ≤90% of all individuals do so; irruptive or local migrants are species whose movements are associated with less predictable environmental fluctuations and whose migratory habits are less regular than those of complete or partial migrants (based on Kerlinger 1989 and Zalles and Bildstein 2000).

<sup>b</sup>Not usually considered migratory.

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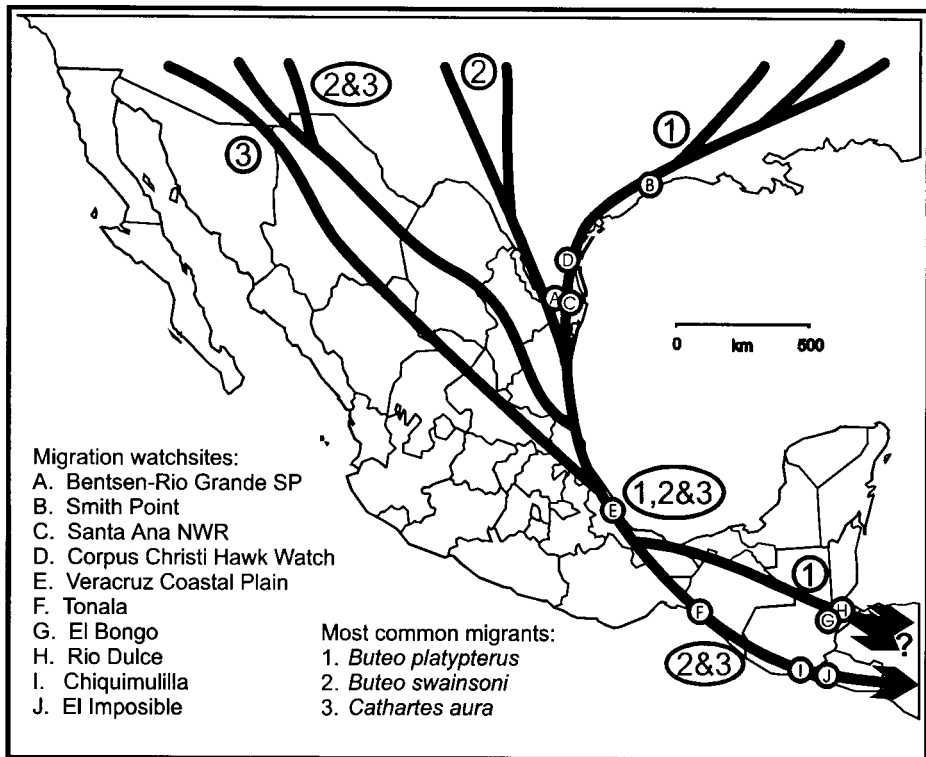
(Texas); Northern Goshawk (*Accipiter gentilis*) (Texas); Common Black Hawk (*Buteogallus anthracinus*) (Texas, Guatemala, and Costa Rica); Harris' Hawk (*Parabuteo unicinctus*) (Texas and Mexico); Gray Hawk (*Asturina nitida*) (Texas and Costa Rica); Roadside Hawk (*Buteo magnirostris*) (Texas), Short-tailed Hawk (*B. brachyurus*) (Guatemala); White-tailed Hawk (*B. albicaudatus*) (Texas); Rough-legged Hawk (*B. lagopus*) (Texas); Ferruginous Hawk (*B. regalis*) (Texas); Golden Eagle (*Aquila chrysaetos*) (Texas and Mexico); Crested Caracara (*Polyborus plancus*) (Texas and Costa Rica); Aplomado Falcon (*Falco femoralis*) (Texas); and Prairie Falcon (*F. mexicanus*) (Texas) (Appendix 1).

### **Geography of the corridor**

Autumn.—Although broad-frontal migration occurs through much of Mesoamerica, most raptors traveling overland between North and South America do so along a series of traditional interbranching flyways in the region that together form the Mesoamerican Land Corridor (Zalles and Bildstein 2000) (Figures 1 and 2).

Migration geography is best understood for the three most numerically dominate migrants using the corridor: Turkey Vulture, Broad-winged Hawk, and Swainson's Hawk (Smith 1980, 1985a,b, Hidalgo et al. 1995, Zalles and Bildstein 2000). Most Turkey Vultures using the corridor breed in the western United States and Canada (i.e., *C. aura aura* and *C. a. meridionalis*) and enter the region via the intermontane west (Kirk and Mossman 1998). Most Broad-winged Hawks—a species whose breeding range is centered in the northeastern United States and southeastern Canada—enter the corridor in coastal southeastern Texas (Goodrich et al. 1996, Bildstein 1999). Swainson's Hawks—a species whose breeding range is centered in the western United States and Canada—enter the corridor both east of the Rocky Mountains via the Great Plains in the vicinity of 100<sup>th</sup> meridian, and west of the Rocky Mountains via the Great Basin (Fuller et al. 1998) (Figure 1).

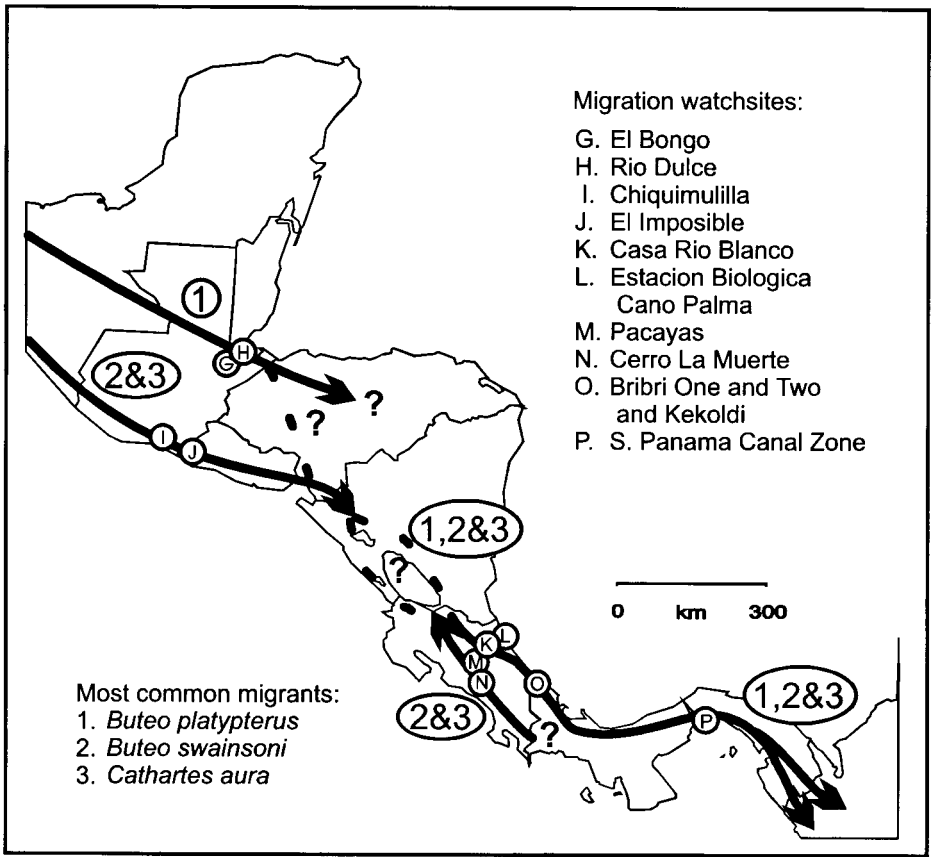
The flight lines of the three principal species converge in the state of Veracruz, Mexico, just north of where the Sierra Manuel Diaz, an eastern extension of the largely north-south Sierra Madre Oriental, creates a <20-km wide migration bottleneck along the region's Gulf of Mexico coastal plain (Figure 1). From there the corridor continues southeast, before again branching west of the Isthmus of Tehuantepec into two major



**Figure 1.** Northern flyways and watchsites in the Mesoamerican Land Corridor from the southern United States southeast through Guatemala and El Salvador. The Veracruz Coastal Plain watchsite (E) records higher numbers of migrating raptors each autumn than any other raptor-migration watchsite in the world (Zalles and Bildstein 2000).

flyways, one that is dominated by Broad-winged Hawks, which continues east along the Caribbean slope via the Tuxtlas Mountains of northern Chiapas, Mexico, and the southern Petén of central Guatemala, into northwestern Honduras; and another that is dominated by Turkey Vultures and Swainson’s Hawks, which continues southeast across the lowlands of Tehuantepec, en route to the Pacific slope of Chiapas, Guatemala, and El Salvador (Figure 1).

Although the geography of the corridor is not well known in Honduras and Nicaragua, anecdotal reports suggest that two flight lines coalesce on the Pacific slope of southern Honduras in the vicinity of the Gulf of Fonseca near the border with Nicaragua, and that the flight continues southeast from there through the Gap of Nicaragua, an extensive Pacific Coast lowland that includes lakes Managua and Nicaragua (Monroe 1968, Zalles and Bildstein 2000) (Figure 2). South of Nicaragua, most of the flight continues southeast along the Caribbean slope and coastal plain of northeastern Costa Rica. From there, southbound migrants proceed southeast between



**Figure 2.** Southern flyways and watchsites in the Mesoamerican Land Corridor from Guatemala southeast through Panama. Although the Southern Panama Canal Zone watchsite (P), potentially, is the most significant bottleneck in this portion of the corridor, the Kekoldi watchsite (O) in coastal Costa Rica reported more than one million migrants in autumn 2000. Overall, the geography of raptor migration is less well understood in southern Mesoamerica than it is farther north.

northwestern Panama (Hidalgo et al. 1995; P. Porras and J. McNicoll, pers. comm.). Once in Panama, the flight continues eastward, largely along the Caribbean slope and across the southern Canal Zone, before again branching near the Serrania de Majé, en route to the Darién lowlands of eastern Panama and, eventually, the Chocó of northwestern Colombia (Smith 1980, 1985a,b) (Figure 2).

The migration geography of other migrants that use the corridor in large numbers, including Ospreys, Mississippi Kites, Sharp-shinned Hawks, Cooper's Hawks, and American Kestrels, is less well understood. Many, and perhaps most of the Ospreys migrating in the region apparently breed in the western United States, and overwinter largely in Central America and northwestern South America (Poole and Agler 1987, Poole 1989). The extent to which Ospreys from the eastern United States and Canada

join the corridor south of Mexico after crossing the Gulf of Mexico and portions of the Caribbean is unknown. Presumably, most of the Mississippi Kites seen in Veracruz, Mexico, follow the corridor south through Panama, with some individuals apparently taking a more Caribbean coastal route in Nicaragua and Costa Rica (Hidalgo et al. 1995). The extent to which Sharp-shinned Hawks and Cooper's Hawks seen in Veracruz, Mexico, represent western and eastern North American populations also is not well known, although counts from coastal Texas suggest an eastern origin for many of the birds. Anecdotal observations along the Sierra Madre south of Monterrey, in southern Nuevo Leon, Mexico, implicate significant movements of western populations as well (K. Bildstein, pers. obs.). Counts of >10,000 American Kestrels in coastal Veracruz, Mexico, are more difficult to interpret, as the species is far less common at coastal Texas watchsites to the north, as well as farther south along the corridor. In eastern North America north of Texas, the species is more common at coastal than at inland watchsites (Zalles and Bildstein 2000), which may, in part, explain its scarcity along other inland portions of the main corridor.

Spring.—Although several of the earliest historical accounts of migration in Mesoamerica involved detailed springtime movements (Table 2), overall, the geography of springtime migration is far less well understood than is that of autumn (Zalles and Bildstein 2000). In Panama, most spring migration occurs north of the country's continental divide, although at least some northbound Buteos meander back and forth between the Pacific and Caribbean slopes (Smith 1980, 1985a,b). As a result, many Swainson's Hawks, as well as smaller numbers of Turkey Vultures and Broad-winged Hawks apparently enter Costa Rica from Panama along the Pacific, rather than along the Caribbean slope (Skutch 1945, Hidalgo et al. 1995) (Figure 2). The two flight lines (Pacific and Caribbean) eventually converge in central Costa Rica, as northbound individuals from both coalesce along the eastern slopes of Cordillera Central in the vicinity of Volcan Irazu before following the Caribbean slope north into Nicaragua (Bildstein and Saborio 2000).

Presumably, the flight reverses itself northbound through Nicaragua, Honduras, and El Salvador, although a lack of observations in the area precludes confirmation (Zalles and Bildstein 2000). In Guatemala, and in southeastern Mexico at least north to Veracruz, the flight does indeed appear to reverse itself, with Turkey Vultures and Swainson's Hawks following the Pacific slope flyway before crossing to the Caribbean slope at the Isthmus of Tehuantepec, and with Broad-winged Hawks following the Caribbean slope across northern Chiapas into southern Veracruz (Thiollay 1980, Tilly et al. 1990, Montejo Díaz and Ruelas Inzunza 1997) (Figure 1). Springtime movements along the corridor north of Veracruz are little studied, although Broad-winged Hawks apparently tract close to their southbound flight at least as far north as southern-most Texas, despite their diverging elliptical corridor farther north (Kerlinger 1989, Zalles and Bildstein 2000).

### **Ongoing Efforts to Monitor the Flight**

Although Ancon Hill, Panama, was active for at least 11 years in the 1970s and early 1980s (Smith 1980, 1985a,b), by far the most significant current monitoring efforts in Mesoamerica are in southern Gulf Coast Texas, with four active watchsites, coastal-plain Veracruz, Mexico, and coastal Limon (Talamanca) Costa Rica, where hundreds of thousands to millions of migrating raptors are counted annually (Appendix

1). The Veracruz Coastal Plain watchsite has been particularly important in creating a better understanding of the magnitude and timing of the flight, as well as in highlighting its importance to local residents (Ruelas Inzunza 1992, Bildstein et al. 1993, Sutton and Sutton 1999, Zalles and Bildstein 2000). The more-recently established Kekoldi, Costa Rica watchsite promises to do the same (P. Porras and J. McNicoll, pers. comm.)

Additional active and incipient spring and autumn watchsites of note include from north to south, Tónalá, in Pacific slope Chiapas, Mexico; El Bongo and Rio Dulce-Cerro San Gil on the Caribbean slope of Guatemala; Chiquimulilla, on the Pacific slope of Guatemala; El Imposible National Park, on the Pacific slope of El Salvador; Pacayas, in the Central Cordillera, Cerro La Muerte, in the Talamanca Mountains, and Casa Río Blanco, Estación Biológica Caño Palma, Matina, and Bribri, on the Caribbean coastal plain of Costa Rica; and Ancón Hill-Bahai Hill in the Southern Panama Canal Zone, Panama (Smith 1980, Zalles and Bildstein 2000, Bildstein and Saborio 2000) (Appendix 1).

### **Future Directions**

In spite of recent monitoring efforts in Mexico, Guatemala, and Costa Rica (Ruelas Inzunza 1992, Hidalgo et al. 1995, Montejo Diaz and Ruelas Inzunza 1997, Sutton and Sutton 1999, Bildstein and Saborio 2000, P. Porras and J. McNicoll, pers. comm.), much remains to be learned regarding the geographical ecology of raptor migration in the region. This is particularly true for those portions of the corridor that pass through El Salvador, Honduras, and Nicaragua, where active watchsites do not exist (Figure 2). The extent to which the relative use of individual flyways within the corridor changes within or among years remains an unanswered question, as is the extent to which migrants feed while migrating through the region (Smith 1980, Smith et al. 1986). Also unexplored is the roosting ecology of migrants, particularly the types of habitats used for roosting sites, and the extent to which individual sites serve as traditional roosting areas. Overall, 19% of the raptors that migrate along the corridor (6 of 32 species) depend upon closed canopy forest for at least a portion of their life cycle. This, together with estimates indicating that human populations in South America, Central America, and the Caribbean will double within the next 50 years, suggest that migrants using the corridor are likely to face continued loss of natural habitats in the region (Zalles and Bildstein 2000). Learning more about migrant feeding and roosting ecology in the region should help focus habitat-conservation concerns on areas in need of particular protection.

Recent evidence suggests that atmospheric warming is affecting cloud cover and evapo-transpiration along portions of the corridor (Still et al. 1999, Pounds et al. 1999). The extent to which these and other climatic changes are likely to affect the movements of soaring migrants that depend upon thermals and orographic updrafts to complete their journeys is yet another area in need of critical review.

Satellite-telemetry work suggests that at least some raptors migrate considerably faster in the tropics than in temperate regions (Fuller et al. 1998). Why this is so is unclear. It may be that raptors are less likely to feed while migrating in the tropics (Smith et al. 1986), or that soaring conditions there permit faster travel. Visual observations at watchsites along the Mesoamerican Land Corridor could help determine which, if either or both, of these explanations is responsible for the change in speed.

In addition to these and other relatively general questions regarding the migration ecology of raptors using the corridor, a number of species-specific questions also remain unanswered. For example, why do most Broad-winged Hawks remain on Caribbean slope portions of the corridor in both autumn and spring, while many Turkey Vultures and Swainson's Hawks crossover to the Pacific slope at several points in both seasons? Although possible, it seems unlikely that differences in the timing of the three species flights are responsible for differences in routes chosen. Much more likely, but as yet untested, is the possibility that flyway choice is related to habitat choice, particularly roosting habitat, with the two more open-habitat species (Turkey Vulture and Swainson's Hawk) choosing less-forested branches in the corridor, and the more forest-dwelling Broad-winged Hawk choosing the more forested flyways (cf. Heckadon-Moreno 1997).

Finally, the value of the region's existing and incipient migration watchsites as monitoring centers for continental populations of Western Hemisphere raptors, and as education centers for local and regional conservation issues, is difficult to overstate. Indeed, the same attributes that make raptors vulnerable to shooting and trapping along the Mesoamerican Land Corridor (Ramos 1986, Bildstein et al. 1993) also make them especially attractive as watchable wildlife (Bildstein 1998, 1999). Enormous flocks of charismatic birds of prey migrating past traditional watchsites in the region provide an outstanding, yet largely unrealized opportunity for introducing local inhabitants to these normally secretive birds.

One of the best examples of the power of this conservation approach is the Veracruz Coastal Plain (or River-of-Raptors) watchsite in Veracruz, Mexico. Established in 1991 by local conservationists working with Pronatura-Veracruz in collaboration with two conservation organizations in the United States (Hawk Mountain Sanctuary in Pennsylvania, and HawkWatch International in Utah), each year the site monitors the southbound movements of >90% of the world's Mississippi Kites and Broad-winged Hawks, and >80% of the world's Swainson's Hawks. The value of such counts was highlighted recently when massive pesticide poisoning of Swainson's Hawks on the species Argentinean winter grounds heightened conservation concerns for the species (Woodbridge et al. 1995, Goldstein et al. 1996).

Together with its monitoring efforts, the Veracruz Coastal Plain watchsite has developed an active environmental education program for students in primary schools that includes workshops for local teachers. The site also has held an international workshop for raptor biologists interested in improving raptor monitoring elsewhere along the corridor (Zalles and Bildstein 2000). The early successes of this watchsite suggest a promising future for regional and community supported, locally-based conservation efforts that focus on protecting raptors along this critically important, yet little-studied international migration corridor.

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**Appendix 1.** Selected active and incipient hawk migration watchsites along the Mesoamerican Land Corridor. (Based largely on information in Zalles and Bildstein 2000, and Bildstein and Saborio 2000.)

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Location

Site name: geography and flight characteristics

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Texas

**Bentsen-Rio Grande State Park:** 26°15'N, 98°30'W; altitude, 40 m; 180 km southeast of Laredo, 230 km southwest of Corpus Christi, southern Texas, southwestern United States. A river-valley watchsite in Bentsen-Rio Grande State Park. An average 32,800 raptors, representing 20 regular and 7 irregular migrants was seen in spring 1987-1993. Species seen included *Coragyps atratus* (av. ann. count: 133), *Cathartes aura* (3160), *Pandion haliaetus* (32), *Elanoides forficatus* (2), *Ictinia mississippiensis* (334), *Haliaeetus leucocephalus* (2), *Circus cyaneus* (13), *Accipiter striatus* (81), *A. cooperii* (125), *A. gentilis* (4), *Asturina nitida* (irregular), *Buteogallus anthracinus* (irregular), *Parabuteo unicinctus* (irregular), *Buteo lineatus* (4), *B. platypterus* (23,500), *B. swainsoni* (3230), *B. albicaudatus* (2), *B. albonotatus* (irregular), *B. jamaicensis* (18), *B. regalis* (irregular), *Aquila chrysaetos* (4), *Polyborus plancus* (irregular), *Falco sparverius* (78), *F. femoralis* (irregular), *F. columbarius* (4), *F. mexicanus* (2), and *F. peregrinus* (7).

**Smith Point:** 29°32'N, 94°45'W; altitude, sea level-5 m; 25 km north of Galveston, 65 km southeast of Houston, southeastern Texas, southwestern United States. A peninsula watchsite at the w tip of Smith Point in w Galveston Bay, 16 km northwest of the Gulf of Mexico. An average 25,900 raptors, representing 16 regular and 3 irregular was seen in autumn 1992-1993. Species seen included *Coragyps atratus* (av. ann. count: 22; period of peak passage: early Oct), *Cathartes aura* (236; mid-Oct), *Pandion haliaetus* (24; late Sep), *Elanoides forficatus* (4; Sep), *Elanus leucurus* (6; Sep), *Ictinia mississippiensis* (935; Sep), *Haliaeetus leucocephalus* (irregular), *Circus cyaneus* (59; late Sep), *Accipiter striatus* (958; late Sep), *A. cooperii* (586; late Sep), *Buteo lineatus* (28; late Sep), *B. platypterus* (17,200; late Sep), *B. swainsoni* (20; early Oct), *B. jamaicensis* (25; late Sep), *B. regalis* (irregular), *Polyborus plancus* (irregular), *Falco sparverius* (427; early Oct), *F. columbarius* (22; Oct), and *F. peregrinus* (10; early Oct).

**Santa Ana-Lower Rio Grande Valley National Wildlife Refuge:** 26°07'N, 98°18'W; altitude, 20 m; 200 km south-southwest of Corpus Christi, 220 km southeast of Laredo, southern Texas, southwestern United States. A river-valley watchsite on the n bank of the lower Rio Grande, 90 km w of the Gulf Coast. An average 30,600 raptors, representing 21 species of regular migrants was seen in spring 1992-1995. Species seen included *Coragyps atratus* (av. ann. count: 24), *Cathartes aura* (1100), *Pandion haliaetus* (7), *Chondrohierax uncinatus* (12), *Elanoides forficatus* (2), *Elanus leucurus* (42), *Ictinia mississippiensis* (263), *Circus cyaneus* (4), *Accipiter striatus* (39), *A. cooperii* (37), *Asturina nitida* (1), *Parabuteo unicinctus* (16), *Buteo magnirostris* (irregular), *B. lineatus* (9), *B. platypterus* (28,200), *B. swainsoni* (516), *B. albicaudatus* (irregular), *B.*

*jamaicensis* (33), *Polyborus plancus* (irregular), *Falco sparverius* (20), and *F. peregrinus* (1).

**Corpus Christi Hawk Watch at Hazel Bazemore Park:** 27°50'N, 97°30'W; altitude, 20 m; outside Corpus Christi, 240 km southeast of San Antonio, southern Texas, southwestern United States. A coastal-plain watchsite near the Gulf of Mexico in Hazel Bazemore County Park. An average 230,467 raptors, representing 17 regular and 6 irregular migrants, was seen in autumn 1988-1996 (Economidy 1997). Species seen included *Coragyps atratus* (av. ann. count: 20), *Cathartes aura* (34), *Pandion haliaetus* (40), *Elanoides forficatus* (irregular) (1), *Elanus leucurus* (12), *Ictinia mississippiensis* (3102), *Haliaeetus leucocephalus* (irregular) (4), *Circus cyaneus* (28), *Accipiter striatus* (102), *A. cooperii* (59), *Parabuteo unicinctus* (4), *Buteo lineatus* (27), *B. platypterus* (226,535), *B. swainsoni* (382), *B. albicaudatus* (13), *B. jamaicensis* (19), *B. regalis* (irregular) (6), *B. lagopus* (irregular), *Polyborus plancus* (irregular), *Falco sparverius* (63), *F. columbarius* (4), *F. mexicanus* (irregular) (3), and *F. peregrinus* (14).

In 1995, observers counted 7468 raptors on 20 days in spring (Economidy 1996). Species seen included *Coragyps atratus* (88), *Cathartes aura* (364), *Pandion haliaetus* (4), *Ictinia mississippiensis* (20), *Circus cyaneus* (5), *Accipiter striatus* (6), *A. cooperii* (10), *Buteo platypterus* (6816), *B. swainsoni* (128), *B. jamaicensis* (20), and *Falco sparverius* (7).

## Mexico

**Veracruz Coastal Plain:** 19°20'N, 96°15' to 97°00'W; altitude, 30-1450 m; in and around Cardel and Chichicaxtle, Gulf of Mexico coastal-plain Veracruz, southeastern Mexico. A coastal-plain watchsite south of Sierra Manuel Diaz, an eastern extension of the Sierra Madre Oriental that creates a <20-km-wide migration bottleneck along the Gulf of Mexico. The site reports the most concentrated movements of migrating raptors in the world. Fifteen species are recorded as regular migrants in both seasons; four additional species are irregular migrants in autumn. An average 612,000 and 2,100,000 raptors, representing 15 regular and 4 irregular migrants, was seen in spring 1991 and 1994 and autumn 1992-1994, respectively. Species seen in spring included *Cathartes aura* (av. ann. count: 163,000; period of peak passage: late Mar), *Pandion haliaetus* (810; Apr), *Chondrohierax uncinatus* (< 92), *Elanoides forficatus* (3), *Ictinia mississippiensis* (11,110; late Apr), *Circus cyaneus* (86; no peak), *Accipiter striatus* (1840; early Apr), *A. cooperii* (660; no peak), *Buteo lineatus* (32; no peak), *B. platypterus* (317,000; early Apr), *B. swainsoni* (107,000; early Apr), *B. albonotatus* (13; no peak), *B. jamaicensis* (107; no peak), *Falco sparverius* (2100; mid-Apr), *F. columbarius* (25; no peak), and *F. peregrinus* (96; no peak).

Species seen in autumn 1991-1993 included *Cathartes aura* (844,000; mid-Oct), *Pandion haliaetus* (1180; late Sep), *Chondrohierax uncinatus* (<116), *Elanoides forficatus* (23; late Aug), *Ictinia mississippiensis* (29,500; early Sep), *Circus cyaneus* (77; no peak), *Accipiter striatus* (2430; early to mid-Oct), *A. cooperii* (939; late Oct), *Buteo lineatus* (31; no peak), *B. platypterus* (912,000; late Sep-early Oct), *B. swainsoni* (365,000; early Oct), *B. albonotatus* (15; no peak), *B. jamaicensis* (92; no peak), *Falco sparverius* (2780; mid- to late Oct), *F. columbarius* (63; no peak), and *F. peregrinus* (260; no peak). 3.3 million raptors

were recorded at the site in one month in autumn 1994, including *Cathartes aura* (1,230,000), *Pandion haliaetus* (493), *Chondrohierax uncinatus* (67), *Elanoides forficatus* (1), *Ictinia plumbea* (1), *I. mississippiensis* (118), *Circus cyaneus* (120), *Accipiter striatus* (1530), *A. cooperii* (424), *Parabuteo unicinctus* (1), *Buteo lineatus* (2), *B. platypterus* (1,480,000), *B. swainsoni* (448,000), *B. albonotatus* (4), *B. jamaicensis* (33), *Aquila chrysaetos* (1), *Falco sparverius* (10,000), *F. columbarius* (17), and *F. peregrinus* (177).

**Tonalá:** 16°07'N, 93°47'W; altitude, 100 m; in and around the city of Tonalá, 90 km southwest of Tuxtla Gutiérrez, state of Chiapas, southeastern Mexico. A Pacific Ocean coastal-plain watchsite in southern Mexico, east of the Isthmus of Tehuantepec. Fifteen species seen during 13 9-h days of counts in 1997, appear to be regular migrants at the site. Species seen included *Cathartes aura* (season count: 134,100), *Pandion haliaetus* (35), *Chondrohierax uncinatus*, *Ictinia plumbea*, *Circus cyaneus* (27), *Accipiter striatus* (189), *A. cooperii* (38), *Buteo lineatus*, *B. platypterus* (4100), *B. swainsoni* (98,470), *B. albonotatus*, *B. jamaicensis*, *Falco sparverius* (890), *F. columbarius*, and *F. peregrinus* (19).

## Guatemala

**El Bongo:** 15°36'N, 89°11'W; altitude, 200m; 20 km northeast of El Estor, 300 km northeast of Guatemala City, department of Izabal, eastern Guatemala. A lowland watchsite between the Santa Cruz Mountains and Lake Izabal. Three species, *Pandion haliaetus*, *Buteo platypterus* (max. 1-day count: 1000), and *B. swainsoni*, were seen during several weeks of observations in October 1990.

**Rio-Dulce-Cerro San Gil:** 15°45'N, 88°59'W; altitude, <80 m; the bridge south of Rio Dulce, at the northeastern edge of Lake Izabal, 300 km northeast of Guatemala City, in eastern Guatemala. A bridge-top watchsite spanning the Rio Dulce in the lowlands between the Sierra de Santa Cruz and the Montañas del Mico. More than 36,000 raptors, overwhelmingly *Buteo platypterus*, but including small numbers of *Ictinia mississippiensis* and *Buteo swainsoni*, were seen during 15 days of observation in early October 1997.

**Chiquimulilla:** 14°10'N, 90°20'W; altitude, 200 m; 250 km southeast of Escuintla, 70 km south-southeast of Guatemala City, southern Guatemala. A mountainside watchsite in the town of Chiquimulilla, on the s edge of the Sierra Madre de Chiapas, 20 km n of the Pacific Ocean. More than 91,000 raptors, representing 18 species, were counted in autumn 1997; >85,000 were counted in autumn 1998, including *Cathartes aura* (>60,000 in 1997), *Pandion haliaetus*, *Chondrohierax uncinatus*, *Rostrhamus sociabilis*, *Ictinia mississippiensis*, *Circus cyaneus*, *Accipiter striatus*, *A. cooperii*, *Buteogallus anthracinus*, *Buteo lineatus*, *B. platypterus* (>85,000 in 1998, including two 1-day counts of >40,000 on 17 and 18 Oct), *B. brachyurus*, *B. swainsoni* (>2000 in 1997), *B. albicaudatus*, *B. albonotatus*, *Falco sparverius*, *F. columbarius*, and *F. peregrinus*. *Coragyps atratus*, *Sarcoramphus papa*, *Elanus caeruleus*, *Parabuteo unicinctus*, *Buteo magnirostris*, *Polyborus plancus*, and *Herpethotes cachinnans* occur at the site.

## El Salvador

**El Imposible:** 13°50'N, 89°58'W; altitude, 200-1400 m; 90 km west of San Salvador, southern El Salvador. A mountainside watchsite on the Pacific slope of the Cordillera Apaneca in El Imposible National Park. In March and April 1999, 5000 raptors, representing six species, were counted at the site, including *Cathartes aura*, *Coragyps atratus*, *Accipiter striatus*, *Buteo platypterus*, *B. swainsoni*, *B. jamaicensis*. *Ictinia mississippiensis* also is thought to migrate at the site.

## Costa Rica

**Casa Río Blanco:** 10°15'N, 83°46'W; altitude, 150 m; 8 km from Guapiles, 40 km northeast of San José, province of Limón, eastern Costa Rica. A river-valley watchsite on the eastern (Caribbean slope) foothills of the Cordillera Central. Sporadic observations in 1994-1996 suggest that 13 species are regular migrants at the site, including *Pandion haliaetus*, *Elanoides forficatus*, *Elanus leucurus*, *Ictinia mississippiensis*, *Circus cyaneus*, *Asturina nitida*, *Buteogallus anthracinus*, *Buteo platypterus*, *B. swainsoni*, *B. albonotatus*, *B. jamaicensis*, *Polyborus plancus*, and *Falco peregrinus*.

**Estación Biológica Caño Palma:** 10°25'N, 83°25'W; altitude, 5 m; 75 km northwest of Puerto Limón, eastern Costa Rica. A coastal-plain watchsite 1 km from the Caribbean Sea that provides an excellent spring-time venue for counting migrating *Falco peregrinus*.

**Pacayas:** 9°55'N, 83°49'W; altitude, 1800 m; 30 km east of San Jose, central Costa Rica. A mountain slope watchsite at a Catholic shrine on the road from San Rafael to Pacayas, on the southeastern slope of Volcán Irazú. A total of 3814 raptors, representing five species, was seen during three partial days of observation in late March 1999, including *Circus cyaneus* (1), *Accipiter striatus* (1), *Buteo platypterus* (3340), *B. swainsoni* (471), and *Falco sparverius* (1).

**Cerro La Muerte:** 9°33'N, 83°45'W; altitude, 3450 m; on the ridge at the eastern end of the communications-towers parking lot at the top of Cerro La Muerte, on Ruta 2 between Cartago and San Isidro de El General. 565 *Buteo platypterus* and 116 *B. swainsoni* were seen during three hours of observation on 25 March 1999.

**Bribri One and Two:** 9°38'N, 82°49'W and 9° 38'N, 82°50'W; altitude, 100-150 m; two sites along Ruta 34 between Hone Creek and Bribri, southeastern Costa Rica. Bribri One is a hilltop south of the road, 2 km west of Hone Creek. Bribri Two is along the road 2 km southeast of Bribri overlooking Delicias, Panama. A total of 7044 raptors, representing four species, was seen during two partial days of observations in late March 1999, including 727 *Cathartes aura*, 14 *Pandion haliaetus*, 5076 *Buteo platypterus*, and 1227 *B. swainsoni*.

**Kéköldi:** 9°38'N, 82°48'W; altitude, 150 m; 1.0 km southeast of Hone Creek, Talamanca, southeastern Costa Rica. A ridge-top watchsite in an indigenous reserve, one kilometer south of the road between Hone Creek and Puerto Viejo; southeast of the Fila Carbon and north of the Fila Kaskicha coastal foothills. More

than one million raptors, including >400,000 Turkey Vultures, >40,000 Mississippi Kites, >300,000 Broad-winged Hawks, >200,000 Swainson's Hawks, and >1,400 Peregrine Falcons, were seen during the site's first full season (September-November) count in autumn 2000.

## Panama

**Southern Panama Canal Zone:** 08°58'N, 79°32'W; altitude, sea level-525 m; immediately n of and including Panama City, central Panama. A coastal-plain watchsite in the hills and lowlands of the southern Isthmus of Panama. At least five species are regular migrants at the site. Species seen during photographic and visual counts in 1970-1981 (Smith 1980; 1985a, b) include *Cathartes aura* (av. ann. count: 296,000; migratory period: late Oct), *Ictinia plumbea* (flocks of 70-100; early Aug), *I. mississippiensis* (12,100; late Sep), *Buteo platypterus* (252,000; early Oct), and *B. swainsoni* (227,000; late Oct).

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