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## Trends in Autumn Counts of Migratory Raptors Around the Gulf of Mexico, 1995–2005

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ABSTRACT.—We estimated trends in autumn counts of migrating diurnal raptors collected at four watchsites around the Gulf of Mexico: Florida Keys Raptor Migration Project at Curry Hammock State Park in the Florida Keys (1999–2005); Smith Point Raptor Migration Project and Corpus Christi Raptor Migration Project, Texas (1997–2005); and Veracruz River of Raptors, Mexico (a two-site transect, 1995–2005) (Chapter 8). Four species—Turkey Vulture (*Cathartes aura*; 35–40%), Broad-winged Hawk (*Buteo platypterus*; 35–40%), Swainson's Hawk (*B. swainsoni*; 15–20%), and Mississippi Kite (*Ictinia mississippiensis*; 2–5%)—make

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up >90% of the Texas and Veracruz totals. We estimated geometric-mean rates of change in annual count indexes for 17 species. Seven species—Turkey Vulture, Osprey (*Pandion haliaetus*), Swallow-tailed Kite (*Elanoides forficatus*), Mississippi Kite, Swainson's Hawk, Zone-tailed Hawk (*B. albonotatus*), and Peregrine Falcon (*Falco peregrinus*)—increased significantly at one or more sites. Northern Harriers (*Circus cyaneus*) and Sharp-shinned Hawks (*Accipiter striatus*) were the only species that declined at all sites. Both declined significantly ( $P \leq 0.10$ ) in Florida, and Northern Harriers also declined significantly in Veracruz. American Kestrels (*F. sparverius*) and Merlins (*F. columbarius*) declined significantly in Florida. Red-shouldered Hawks (*B. lineatus*) were stable at Smith Point but declined at Corpus Christi. No trends were detected for Black Vultures (*Coragyps atratus*) in Texas, for Red-tailed Hawks (*B. jamaicensis*) in Texas and Veracruz, and for Cooper's Hawks (*A. cooperii*) at any site. Precision of trend estimates was low because of brief monitoring periods (i.e.,  $\leq 11$  years) and relatively high interannual variability in counts.

## INTRODUCTION

Each autumn, more than 30 species of diurnal raptors migrate around or across the Gulf of Mexico on their way to wintering grounds farther south (Zalles and Bildstein 2000). Most can be readily observed as they migrate past traditional watchsites, where trained observers monitor their numbers (e.g., Smith et al. 2001, Ruelas 2005, Lott 2006).

We analyzed migration counts spanning periods of different lengths between 1995 and 2005 from four migration watchsites around the Gulf of Mexico, from the Florida Keys west to Veracruz, Mexico (Table 1 and Fig. 1). The conservation status of species and the implications of trends are discussed in Chapter 9.

The Veracruz River of Raptors watchsite in southeastern Mexico monitors the world's largest known concentration of migratory raptors, with 4–6 million migrants passing each autumn (Ruelas et al. 2000, Bildstein 2006). Flights there include most of the world populations of Mississippi Kites (*Ictinia mississippiensis*), Broad-winged Hawks (*Buteo platypterus*), and Swainson's Hawks (*B. swainsoni*), all of which winter in Central and South America (Bildstein 2006). The Veracruz flight also includes a large proportion of the western North American population of Turkey Vultures (*Cathartes aura*), which, together with Broad-winged Hawks, are the most abundant raptors counted there.

The largest concentrations of migrating raptors in the United States and Canada appear at the Corpus Christi Raptor Migration Project (Smith et al. 2001, Bildstein 2006). Turkey Vultures, Mississippi Kites, Swainson's Hawks, and, especially, Broad-winged Hawks typically comprise >98% of the flight.

The Florida Keys Raptor Migration Project monitors the largest known migratory concentration of Peregrine Falcons (*Falco peregrinus*) in the United States and Canada, with an average annual total exceeding 1,800 birds (Lott 2006).

Table 1. Details of watchsites included in this analysis.

Watchsites	Latitude	Longitude	Count years	Count season	Mean (range) days season <sup>-1</sup>	Mean $\pm$ SD h day <sup>-1</sup>	Standardized daily window ( <i>n</i> h)
Curry Hammock State Park, Florida <sup>a</sup>	24°44'N	80°59'W	1999–2005	15 Sept.–13 Nov. <sup>b</sup>	54 (37–60)	7.5 $\pm$ 1.3	0800–1600 (8)
Smith Point, Texas <sup>c</sup>	29°31'N	94°45'W	1997–2005	15 Aug.–15 Nov.	91 (86–94)	8.2 $\pm$ 2.0	0600–1500 (9)
Corpus Christi, Texas <sup>d</sup>	27°52'N	97°38'W	1997–2005	15 Aug.–15 Nov.	90 (83–93)	7.4 $\pm$ 2.0	0700–1500 (8)
Veracruz River of Raptors, Mexico <sup>e</sup>	19°22'N	96°22'W	1995–2005	20 Aug.–20 Nov.	92 (90–93)	9.3 $\pm$ 1.3	0800–1700 (9)

<sup>a</sup> Counts were made from second-story balcony of a building.

<sup>b</sup> 23 September to 30 October 1999; 15 September to 7 November 2005 (purposeful adjustment of ending date).

<sup>c</sup> Counts made from 7-m tower.

<sup>d</sup> Two count sites. Given coordinates are for site at Cardel, where counts were made from atop a five-story hotel in the middle of the city. In Chichicaxtle (19°21'N, 96°28'W), counts were made from a 7-m tower near a soccer field.

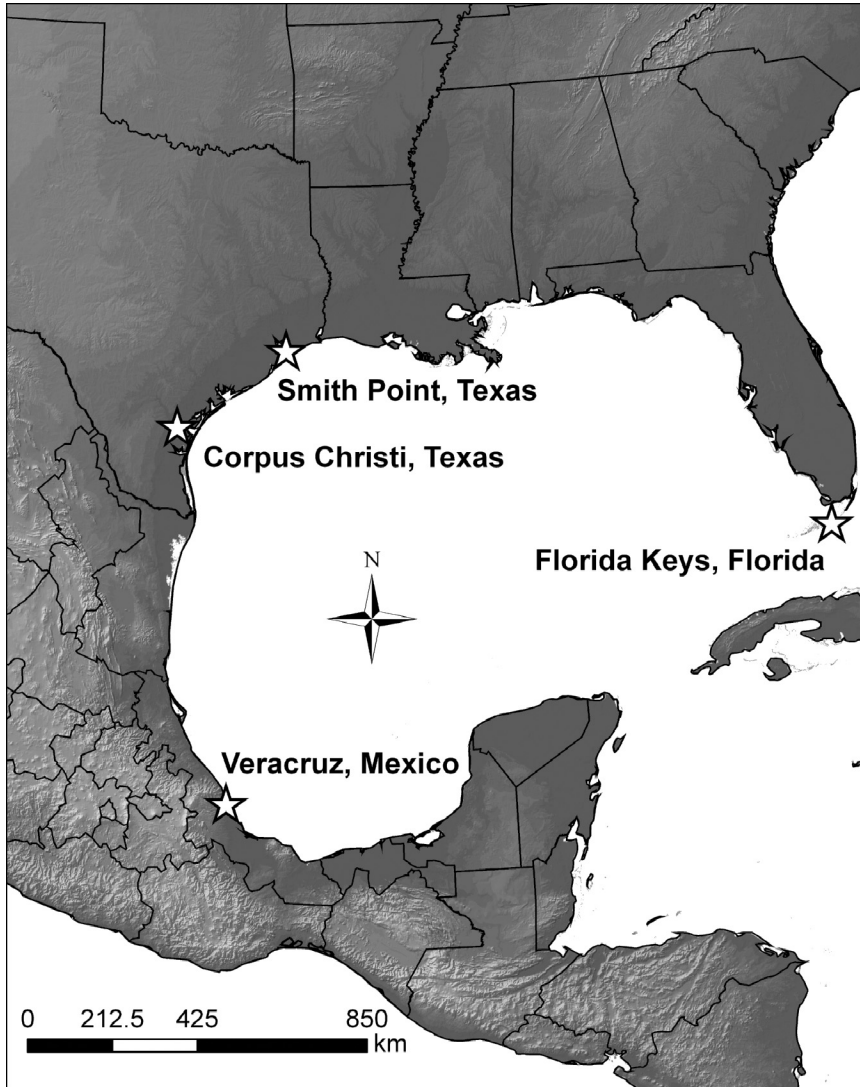


Fig. 1. Autumn raptor-migration monitoring sites around the Gulf of Mexico.

We treated the four sites together because of their common geographic location around the Gulf of Mexico. This is not meant to imply that the four sites necessarily draw from the same source populations.

For species such as the Broad-winged Hawk, which breed mainly in the eastern half of the continent and move into Central and South America for

the winter (Goodrich et al. 1996), the progression of migrants from Smith Point to Corpus Christi to Veracruz (Fig. 1) probably results in replication of sampling. Similarly, Mississippi Kites and Swainson's Hawks accumulate along the principal flight-line during their southbound migrations (England et al. 1997), so that hundreds pass Smith Point, thousands pass Corpus Christi, and hundreds of thousands pass Veracruz (Fuller et al. 1998). All three species also are seen in the Florida Keys in relatively low numbers.

Satellite tracking and band recoveries indicate that Peregrine Falcons passing through the Florida Keys include those breeding in western Canada and Alaska as well in Greenland and eastern North America (Fuller et al. 1998; Chapter 2). Satellite tracking also indicates that some Ospreys (*Pandion haliaetus*) from the upper Midwest travel through the Florida Keys before crossing to Cuba on their way south, whereas others travel through Texas and around the western Gulf Coast (Martell et al. 2001). Most other species reported around the Gulf Coast are short- or moderate-distance partial migrants whose winter ranges overlap some or all of the four sites (e.g., Sharp-shinned Hawks [*Accipiter striatus*], Bildstein and Meyer 2000).

The Texas and Veracruz sites are on broad coastal plains where thermals provide lift for migrating raptors. In such cases, obligate-soaring migrants (*sensu* Alerstam 1992) travel in narrow-front migrations following *thermal pathways* (Schüz et al. 1971, Berthold 2001), the distribution of which changes depending on the weather (Kerlinger 1989, Bildstein 2006). Shifts in flight-line locations can be important when monitoring obligate "super-flocking" species (*sensu* Bildstein 2006), such as Turkey Vultures, Mississippi Kites, Broad-winged Hawks, and Swainson's Hawks, which are the most abundant migrants in Texas and Veracruz. Because such species generally travel in large flocks, any significant shift in the predominant flight line can dramatically affect counts and increase annual variability, potentially making it difficult to determine long-term trends. The presence of such sources of extrinsic variation unrelated to population change may require longer time series (20–25 years) to provide adequate statistical power for detecting underlying population trends (Lewis and Gould 2000; Chapter 8).

## METHODS

### DATA COLLECTION

We used hourly counts to develop annual indexes and trend estimates. Site coverage ranged from 7 to 11 years (Table 1). Counts were conducted as described in Chapters 5 and 6. Daily monitoring for eight to nine hours between early to mid-morning and mid- to late afternoon was the standard

target at all sites. Inclement weather sometimes reduced daily coverage, whereas large flights sometimes resulted in expanded daily coverage. We truncated data as described in Chapter 5 to reduce the effect of such variability.

Data-collection protocols are described in Lott (2006) for the Florida Keys, Smith et al. (2001) for the two sites in Texas, and Ruelas (2005) for Veracruz. Counts in Florida and Texas occurred at single observation points. Veracruz counts were made at two observation points 11 km apart (see Chapter 8).

Counts in Florida and at Smith Point were conducted by two primary observers, with local volunteers assisting as substitutes at Smith Point and others opportunistically assisting at both sites. Counts in Corpus Christi were conducted by three, full-season observers, with local volunteers assisting. Counts in Veracruz were conducted by a rotating group of six primary observers and three recording assistants, with two primary counters and one assistant working each site daily on a two-day-on, one-day-off work shift.

#### TREND ANALYSIS

We used analytical methods outlined in Chapter 5, with one exception. We followed a special approach outlined in Hussell (1981) and Francis and Hussell (1998) to combine counts from the two Veracruz sites to derive integrated annual count indexes. Because of irregularities in the data, we excluded the 1997 counts at Veracruz for four large-volume, obligate-flocking migrants (i.e., Turkey Vultures, Broad-winged Hawks, Swainson's Hawks, and Mississippi Kites).

#### RESULTS AND DISCUSSION

Approximately 5 million raptors of 20 species were counted each year at the four watchsites from 1995 to 2005 (e.g., see Table 2). They included nearly the entire North American populations of Mississippi Kites, Broad-winged Hawks, and Swainson's Hawks. Precision was low for all trend estimates, at least in part because of the short durations of all monitoring records (Table 3). Even so, 29 of 53 (55%) cases had 95% confidence intervals (CI) of  $\pm 10\%$  per year or less, which suggests a high likelihood that 20–25 years of data will produce at least moderate-precision estimates (see Chapter 6).

#### REGIONAL PATTERNS IN TRENDS

*Species with declining trends.*—Only Northern Harriers (*Circus cyaneus*) and Sharp-shinned Hawks declined at all four sites. Both showed significant declines in the Florida Keys. Harriers also declined significantly at

Table 2. Average autumn migration counts (coefficient of variation [CV]) for 17 species of raptors seen at Gulf Coast watchsites.

Species	Florida Keys, Florida	Smith Point, Texas	Corpus Christi, Texas	Veracruz, Mexico
Black Vulture ( <i>Coragyps atratus</i> )	– <sup>a</sup>	177 (81)	551 (79)	–
Turkey Vulture ( <i>Cathartes aura</i> )	– <sup>a</sup>	1,529 (56)	20,996 (57)	1,988,826 (23)
Osprey ( <i>Pandion haliaetus</i> )	1,154 (24)	65 (20)	167 (30)	2,969 (28)
Hook-billed Kite ( <i>Chondrohierax uncinatus</i> )	–	<1	<1	177 (34)
Swallow-tailed Kite ( <i>Elanoides forficatus</i> )	10 (75)	82 (54)	30 (69)	167 (34)
Mississippi Kite ( <i>Ictinia mississippiensis</i> )	19 (92)	4,320 (51)	7,020 (40)	155,651 (46)
Northern Harrier ( <i>Circus cyaneus</i> )	533 (33)	330 (40)	159 (47)	407 (55)
Sharp-shinned Hawk ( <i>Accipiter striatus</i> )	2,971 (47)	2,913 (40)	1,076 (33)	4,542 (55)
Cooper's Hawk ( <i>A. cooperii</i> )	536 (54)	1,125 (14)	663 (45)	2,529 (33)
Red-shouldered Hawk ( <i>Buteo lineatus</i> )	14 (96)	47 (42)	52 (51)	10 (56)
Broad-winged Hawk ( <i>B. platypterus</i> )	3,737 (28)	38,643 (73)	609,719 (45)	1,919,949 (13)
Swainson's Hawk ( <i>B. swainsoni</i> )	81 (60)	298 (98)	6,209 (77)	915,104 (32)
Zone-tailed Hawk ( <i>B. albonotatus</i> )	–	–	3 (105)	137 (41)
Red-tailed Hawk ( <i>B. jamaicensis</i> )	2 (109)	141 (76)	173 (38)	192 (35)
American Kestrel ( <i>Falco sparverius</i> )	2,596 (41)	1,334 (28)	506 (38)	8,252 (95)
Merlin ( <i>F. columbarius</i> )	524 (33)	57 (36)	31 (38)	174 (48)
Peregrine Falcon ( <i>F. peregrinus</i> )	1,826 (28)	89 (20)	155 (37)	745 (42)
Total raptors	13,981 (19)	51,275 (57)	639,551 (41)	5,260,871 (19)

<sup>a</sup> Vultures were not counted at this site.

Veracruz (Tables 3 and 4). Red-shouldered Hawks (*B. lineatus*), American Kestrels (*Falco sparverius*), and Merlins (*F. columbarius*) also declined at one or more sites.

*Species with increasing trends.*—Swainson's Hawks increased significantly at both Texas sites and in Veracruz (Tables 3 and 4). Mississippi Kites increased at Veracruz and Smith Point, most clearly so at Veracruz. Interannual fluctuations in vulture counts were too great at Smith Point and Corpus Christi to yield reasonably precise trend estimates (Table 3). Overall, Ospreys increased from 2.8% to 9.0% per year at all four sites (Fig. 4). Ospreys increased at Veracruz until the late 1990s and declined thereafter. Swallow-tailed Kites (*Elanoides forficatus*) increased at all three sites at which they were analyzed (Table 3). Peregrine Falcons increased at Smith Point but not at other sites. Zone-tailed Hawks (*B. albonotatus*) increased at Veracruz, which was the only site analyzed for the species (Table 3).

Numbers of Sharp-shinned Hawks, Cooper's Hawks (*A. cooperii*), Broad-winged Hawks, American Kestrels, Merlins, and Peregrine Falcons fluctuated similarly at Veracruz, which suggests that a factor or factors other than population change was involved.

Table 3. Trends (mean percentage of change per year  $\pm$ 95% confidence interval <sup>a</sup>) in autumn migration counts of 17 species of raptors at Gulf Coast watchsites, 1995–2005.

Species	Florida Keys, Florida (1999–2005)	Smith Point, Texas (1997–2005)	Corpus Christi, Texas (1997–2005)	Veracruz, Mexico (1995–2005)
Black Vulture	–	0.3 $\pm$ 21.2	1.9 $\pm$ 12.9	–
Turkey Vulture	–	0.0 $\pm$ 18.8	16.9 $\pm$ 25.6 <sup>§</sup>	5.7 $\pm$ 5.9 <sup>†</sup>
Osprey	9.0 $\pm$ 7.6 <sup>‡</sup>	4.7 $\pm$ 4.3 <sup>‡</sup>	7.2 $\pm$ 8.2 <sup>†</sup>	2.8 $\pm$ 6.5 <sup>§</sup>
Hook-billed Kite	–	–	–	3.3 $\pm$ 6.1
Swallow-tailed Kite	–	7.6 $\pm$ 5.9 <sup>‡</sup>	13.1 $\pm$ 17.5 <sup>§</sup>	7.3 $\pm$ 4.2 <sup>*</sup>
Mississippi Kite	–	10.0 $\pm$ 10.2 <sup>†</sup>	5.4 $\pm$ 21.7	15.4 $\pm$ 11.5 <sup>‡</sup>
Northern Harrier	–8.4 $\pm$ 10.4 <sup>†</sup>	–6.2 $\pm$ 12.0 <sup>§</sup>	–2.9 $\pm$ 9.5 <sup>§</sup>	–8.4 $\pm$ 8.2 <sup>‡</sup>
Sharp-shinned Hawk	–12.8 $\pm$ 7.9 <sup>*</sup>	–4.2 $\pm$ 10.0 <sup>§</sup>	–2.6 $\pm$ 13.8	–7.5 $\pm$ 9.3 <sup>†</sup>
Cooper's Hawk	7.3 $\pm$ 22.7 <sup>§</sup>	–1.0 $\pm$ 5.8	3.2 $\pm$ 14.2	1.9 $\pm$ 6.2
Red-shouldered Hawk	–	1.4 $\pm$ 7.5	–8.6 $\pm$ 9.7 <sup>†</sup>	–
Broad-winged Hawk	6.1 $\pm$ 15.8 <sup>§</sup>	8.2 $\pm$ 14.2 <sup>§</sup>	–6.7 $\pm$ 20.1 <sup>§</sup>	3.1 $\pm$ 9.5 <sup>§</sup>
Swainson's Hawk	–	10.0 $\pm$ 7.1 <sup>‡</sup>	18.5 $\pm$ 12.8 <sup>*</sup>	13.6 $\pm$ 12.2 <sup>‡</sup>
Zone-tailed Hawk	–	–	–	15.7 $\pm$ 7.2 <sup>*</sup>
Red-tailed Hawk	–	–0.4 $\pm$ 14.7	–2.6 $\pm$ 4.8 <sup>§</sup>	–3.3 $\pm$ 5.6 <sup>§</sup>
American Kestrel	–8.8 $\pm$ 9.6 <sup>†</sup>	–2.9 $\pm$ 6.8 <sup>§</sup>	6.7 $\pm$ 13.4 <sup>§</sup>	0.0 $\pm$ 7.3
Merlin	–13.4 $\pm$ 10.7 <sup>‡</sup>	4.6 $\pm$ 11.4 <sup>§</sup>	2.3 $\pm$ 8.7	0.4 $\pm$ 7.4
Peregrine Falcon	6.9 $\pm$ 12.0 <sup>§</sup>	5.8 $\pm$ 4.6 <sup>‡</sup>	3.2 $\pm$ 11.3	3.2 $\pm$ 6.5 <sup>§</sup>

<sup>a</sup>  $^{\$}P \leq 0.50$ ,  $^{\dagger}P \leq 0.10$ ,  $^{\ddagger}P \leq 0.05$ ,  $^*P \leq 0.01$ .



Table 4. Summary trends for Gulf Coast watchsites, 1995–2005.

Species	Florida Keys, Florida	Smith Point, Texas	Corpus Christi, Texas	Veracruz, Mexico	Summary
Black Vulture	–	Unclear	Unclear	–	No significant trends, high variability, very low precision estimates
Turkey Vulture	–	Unclear	Unclear	Increase	Increasing at Veracruz; no significant trends, high variability, and very low precision estimates in Texas
Osprey	Increase	Increase	Increase	No trend	Positive rates of change at all sites, significant in Florida and Texas; comparatively high precision
Hook-billed Kite	–	–	–	No trend	No trend but slight positive rate of change; fair precision
Swallow-tailed Kite	–	Increase	Unclear	Increase	Positive rates of change at all sites, significant at Smith Point and Veracruz; fair precision except at Corpus Christi
Mississippi Kite	–	Increase	Unclear	Increase	Positive rates of change at all sites, significant at Smith Point and Veracruz; low precision at all sites, especially Corpus Christi
Northern Harrier	Decrease	Unclear	No trend	Decrease	Negative rates of change at all sites, significant in Florida and Veracruz; marginal precision at all sites but should improve with time
Sharp-shinned Hawk	Decrease	No trend	Unclear	No trend	Negative rates of change at all sites, significant in Florida; low precision at Corpus Christi
Cooper's Hawk	Unclear	No trend	Unclear	No trend	No significant trends but positive rates of change except at Smith Point; low precision for Corpus Christi and especially Florida
Red-shouldered Hawk	–	No trend	Decrease	–	Decreasing at Corpus Christi; no trend at Smith Point; fair precision

Table 4. Continued.

Species	Florida Keys,		Smith Point,		Corpus Christi,		Veracruz,		Summary
	Florida	Unclear	Texas	Unclear	Texas	Unclear	Mexico	No trend	
Broad-winged Hawk	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear	No trend	No trend	No significant trends but positive rates of change except at Corpus Christi; very low precision except at Veracruz
Swainson's Hawk	-	Increase	Increase	Increase	Increase	Increase	Increase	Increase	Uniformly increasing; precision highest at Smith Point with lowest count
Zone-tailed Hawk	-	-	-	-	-	-	Increase	Increase	Increasing in Veracruz; fair precision
Red-tailed Hawk	-	Unclear	Unclear	Unclear	Unclear	Unclear	No trend	No trend	No significant trends but slight negative rates of change at all sites; fair precision for Veracruz and Corpus Christi, low for Smith Point
American Kestrel	Decrease	No trend	No trend	Unclear	Unclear	Unclear	No trend	No trend	Decreasing in Florida; no significant trends elsewhere; fair precision except at Corpus Christi
Merlin	Decrease	Unclear	Unclear	Unclear	No trend	No trend	No trend	No trend	Decreasing in Florida; no significant trends elsewhere; fair precision for Corpus Christi and Veracruz, lower for Florida and Smith Point
Peregrine Falcon	Unclear	Increase	Increase	Unclear	Unclear	Unclear	No trend	No trend	Positive rates of change at all sites, significant at Smith Point; fair precision for Smith Point and Veracruz, lower for Florida and Corpus Christi

Notes: Decrease = significant at  $P \leq 0.10$ ; increase = significant at  $P \leq 0.10$ ; no trend = not significant at  $P \leq 0.10$  and with a 95% CI of less than or equal to  $\pm 10\%$  per year; unclear = no significant trend and a 95% CI greater than  $\pm 10\%$  per year (i.e., precision of estimate outside the threshold expected to yield at least moderate precision [95% CI less than or equal to  $\pm 3.5\%$  per year] with 20–25 years of data).

*Stable species.*—Black Vulture (*Coragyps atratus*; Texas only), Hook-billed Kite (*Chondrohierax uncinatus*; Veracruz only), Cooper's Hawk, Broad-winged Hawk, and Red-tailed Hawk (*B. jamaicensis*; Texas and Veracruz only) appeared to be stable over the periods analyzed (Tables 3 and 4).

#### SPECIES TRENDS

*Black Vulture.*—We calculated trends for this species at two watchsites. Black Vultures were recorded in moderate numbers (hundreds) at Smith Point and Corpus Christi (Table 2). We did not detect significant trends at either site (Tables 3 and 4; Fig. 2). Annual variability was high, especially at Smith Point. The species is a partial, short-distance migrant in the region (Buckley 1999), and separating migrants from wandering residents is challenging. Consequently, migration counts may be misleading indicators of regional population trends.

*Turkey Vulture.*—We calculated trends for this species at three watchsites. Turkey Vultures were recorded in high numbers at Smith Point, Corpus Christi, and, especially, at Veracruz (Table 2). The species was not monitored in the Florida Keys. Increases occurred at Veracruz, where a large portion of the western North American population migrates (Table 2), and at Corpus Christi (Tables 3 and 4; Fig. 3).

*Osprey.*—We calculated trends for this species at four watchsites. Low numbers of Ospreys ( $\leq 200$ ) were recorded in Texas (Table 2). Counts exceeded 1,000 individuals in the Florida Keys and at Veracruz. The species increased significantly at all sites at rates of 2.8–9.0% per year (Tables 3 and 4; Fig. 4).

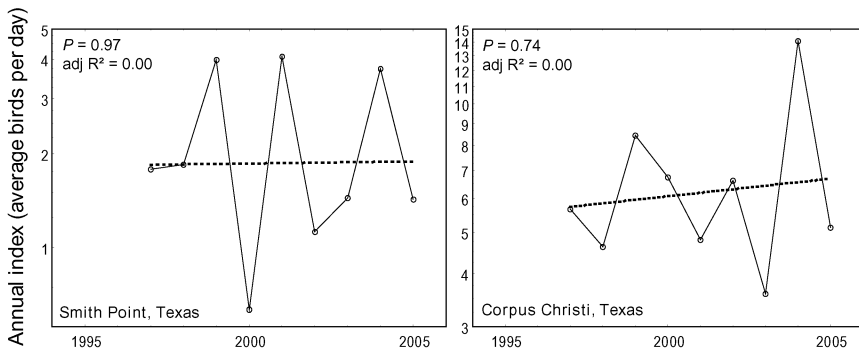


Fig. 2. Trends in autumn passage rates of Black Vultures (*Coragyps atratus*) at watchsites on the Texas Gulf Coast since 1997. Dashed lines illustrate nonsignificant ( $P > 0.10$ ) best-fit models.

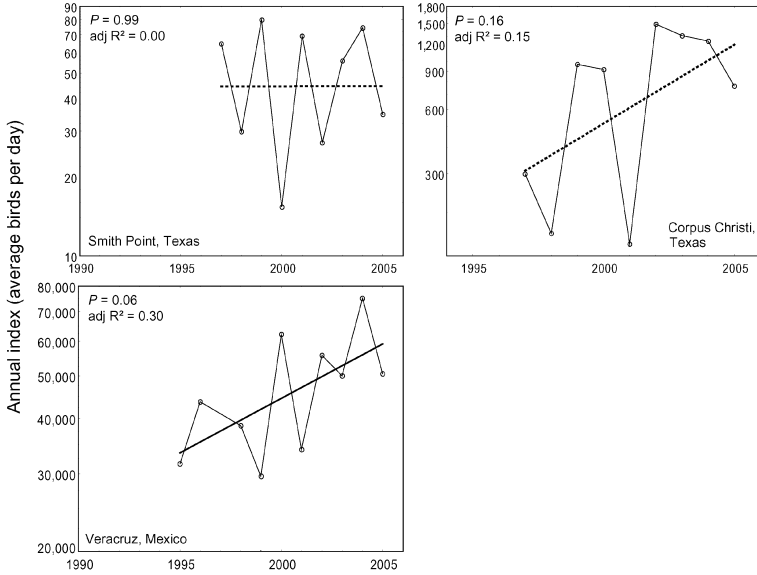


Fig. 3. Trends in autumn passage rates of Turkey Vultures (*Cathartes aura*) at Gulf Coast watchsites since the mid-1990s. Solid lines illustrate significant ( $P \leq 0.10$ ) regression models; dashed lines illustrate nonsignificant ( $P > 0.10$ ) best-fit models.

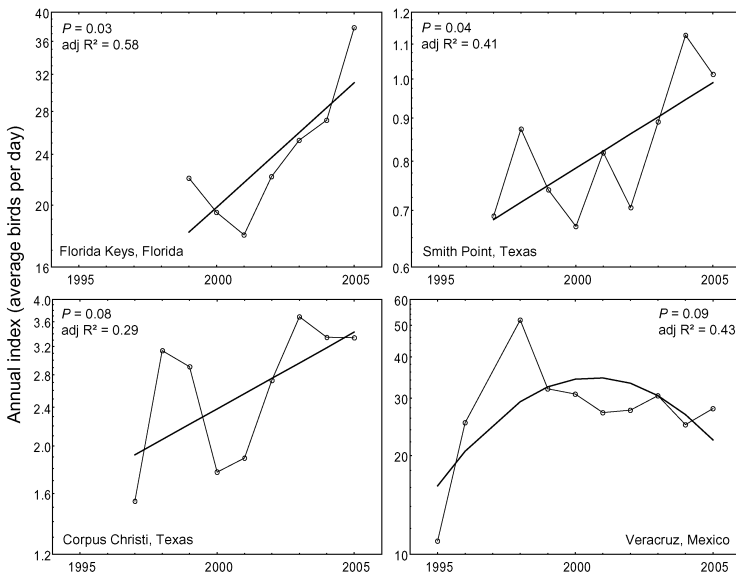


Fig. 4. Trends in autumn passage rates of Ospreys (*Pandion haliaetus*) at Gulf Coast watchsites since the mid-1990s. Solid lines illustrate significant ( $P \leq 0.10$ ) regression models.

*Hook-billed Kite*.—We calculated trends for this species at one watchsite. Single Hook-billed Kites were recorded at Smith Point and Corpus Christi. At least 100–300 individuals are counted at Veracruz each year (Table 2), where their numbers increased significantly (Tables 3 and 4; Fig. 5).

*Swallow-tailed Kite*.—We calculated trends for this species at three watchsites. Swallow-tailed Kites were recorded in low to moderate numbers at all sites (Table 2), primarily because they begin to migrate earlier than the operation dates of watchsites (Meyer 1995). Individuals satellite tracked from Georgia suggest a tendency for the species to follow the perimeter of the Gulf rather than cross it (K. Meyer pers. comm.), as is likely true for birds from a small and growing population in southeastern Texas and southwestern Louisiana (e.g., Brown et al. 1997, Shackelford and Simons 2000). Peninsular Florida birds, however, cross the Gulf beginning in July.

Swallow-tailed Kites increased from 7.3% to 13.1% per year at all three analyzed sites (Tables 3 and 4; Fig. 6). Patterns of variation at Smith Point and Corpus Christi were roughly similar (Fig. 6), but the estimated rate of change—albeit relatively imprecise—was almost twice as high at the latter site (Table 3). Overall, there is a common pattern of increase since the mid- to late-1990s.

*Mississippi Kite*.—We calculated trends for this species at three watchsites. Mississippi Kites were recorded in high to very high numbers in Texas and Veracruz, whereas small numbers in Florida precluded analysis there (Table 2). The Veracruz count likely monitors passage of most of the world population of the species (Parker 1999, Ruelas et al. 2000). Mississippi

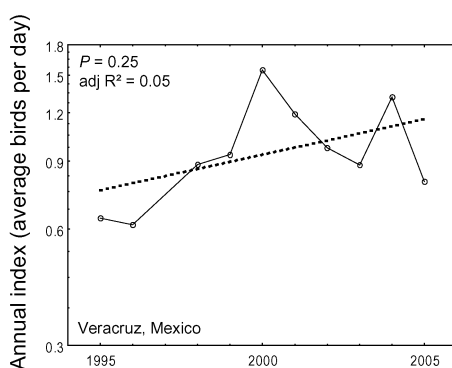


Fig. 5. Trends in autumn passage rates of Hook-billed Kites (*Chondrohierax uncinatus*) in Veracruz, Mexico since 1995. The dashed line illustrates a nonsignificant ( $P > 0.10$ ) best-fit model.

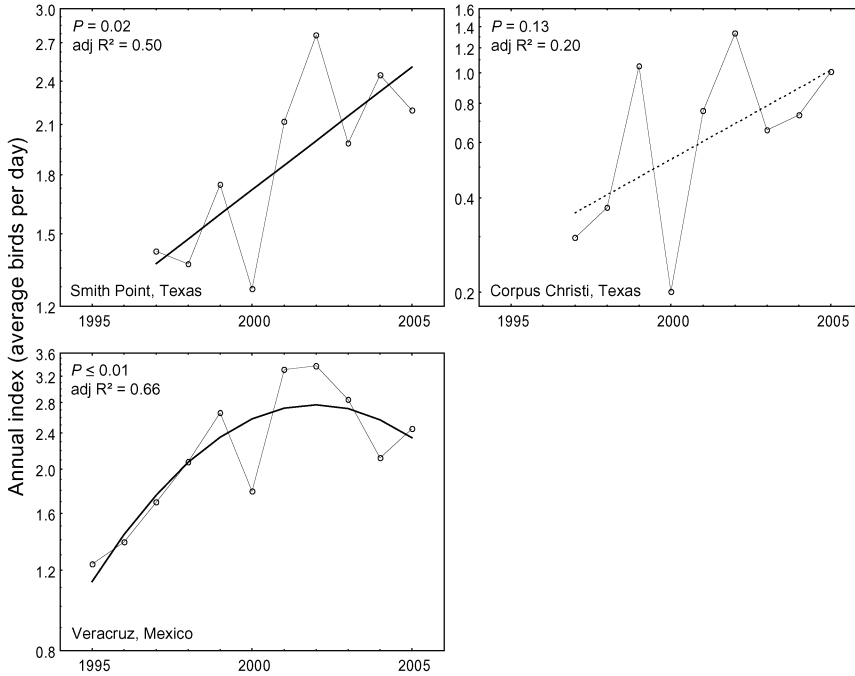


Fig. 6. Trends in autumn passage rates of Swallow-tailed Kites (*Elanoides forficatus*) at Gulf Coast watchsites since the mid-1990s. Solid lines illustrate significant ( $P \leq 0.10$ ) regression models; dashed lines illustrate nonsignificant ( $P > 0.10$ ) best-fit models.

Kites increased significantly in Veracruz (Tables 3 and 4), where the average count is more than an order of magnitude higher than in Texas (Table 2). Annual variation at the three sites was similar, which suggests that all three counts may monitor essentially the same population (Fig. 7).

*Northern Harrier*.—We calculated trends for this species at four watchsites. Recorded in moderate numbers at all four sites (Table 2), Northern Harriers declined throughout the region, most clearly so at Veracruz (Tables 3 and 4). The four sites also shared roughly similar patterns of annual variation (Fig. 8).

*Sharp-shinned Hawk*.—We calculated trends for this species at four watchsites. Sharp-shinned Hawks occurred in high numbers at all four sites (Table 2). Annual declines of  $-2.6\%$  to  $-12.8\%$  were recorded, with recent declines in Florida and Veracruz most pronounced (Tables 3 and 4; Fig. 9).

*Cooper's Hawk*.—We calculated trends for this species at four watchsites and detected no significant, overall trends (Tables 2–4; Fig. 10).

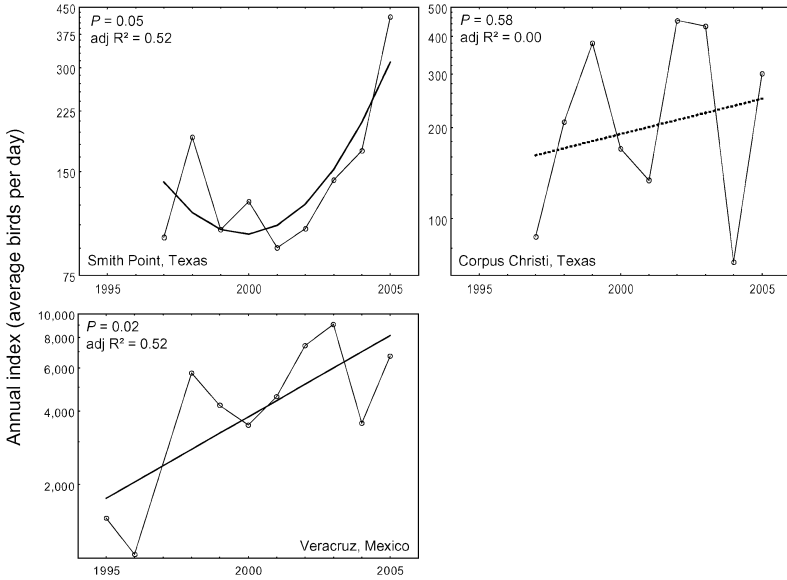


Fig. 7. Trends in autumn passage rates of Mississippi Kites (*Ictinia mississippiensis*) at Gulf Coast watchsites since the mid-1990s. Solid lines illustrate significant ( $P \leq 0.10$ ) regression models; dashed lines illustrate nonsignificant ( $P > 0.10$ ) best-fit models.

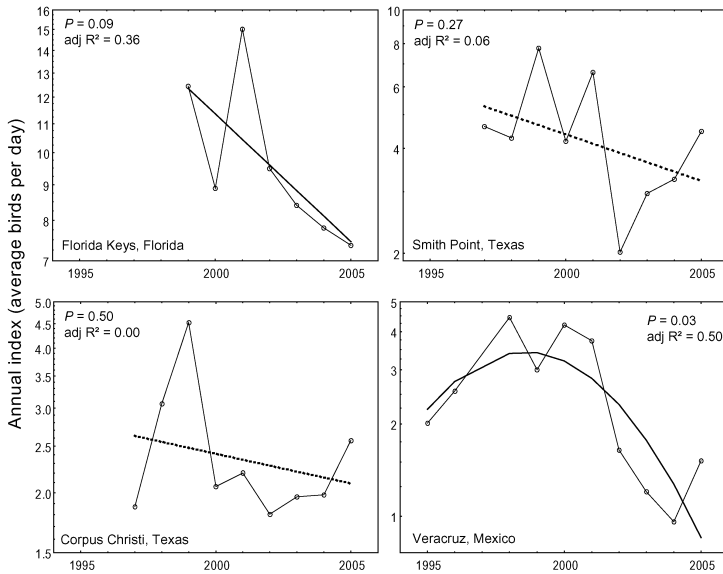


Fig. 8. Trends in autumn passage rates of Northern Harriers (*Circus cyaneus*) at Gulf Coast watchsites since the mid-1990s. Solid lines illustrate significant ( $P \leq 0.10$ ) regression models; dashed lines illustrate nonsignificant ( $P > 0.10$ ) best-fit models.

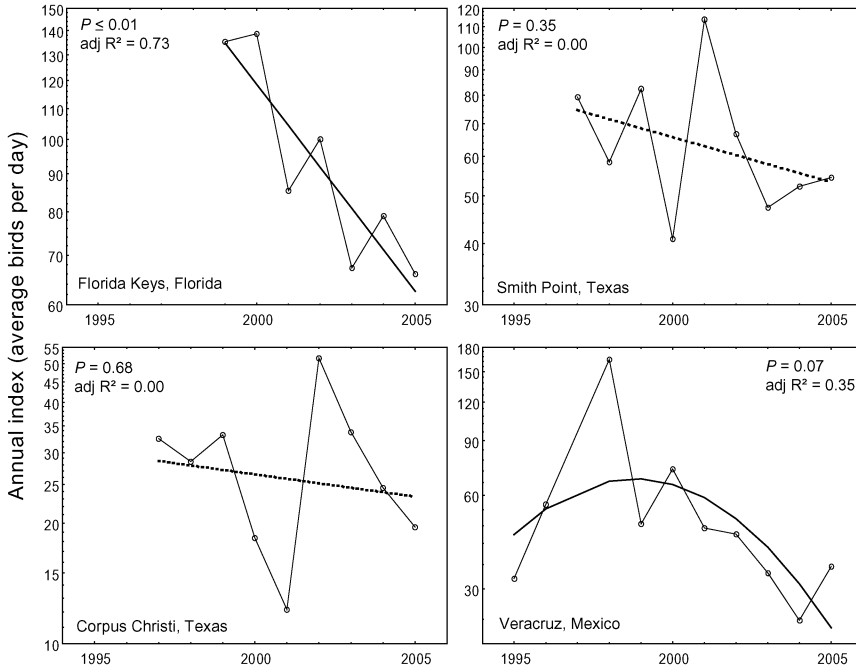


Fig. 9. Trends in autumn passage rates of Sharp-shinned Hawks (*Accipiter striatus*) at Gulf Coast watchsites since the mid-1990s. Solid lines illustrate significant ( $P \leq 0.10$ ) regression models; dashed lines illustrate nonsignificant ( $P > 0.10$ ) best-fit models.

*Red-shouldered Hawk*.—We calculated trends for this species at two watchsites. About 50 Red-shouldered Hawks are recorded each year at Smith Point and Corpus Christi (Table 2). Numbers declined significantly at Corpus Christi, particularly after 2003 (Tables 3 and 4). Patterns of variation at Corpus Christi and Smith Point were almost mirror images of each other after 2000 (Fig. 11). Low counts at the Florida Keys and Veracruz precluded analyses there (Table 2). The species is a partial, short- and intermediate-distance migrant in the region (Crocoll 1994), and counts may reflect movements of regional residents rather than birds from farther north.

*Broad-winged Hawk*.—We calculated trends for this species at four watchsites. Broad-winged Hawks were recorded in high to very high numbers at all four sites (Table 2). Inter-annual variation in count indexes was high at all sites and, consequently, no significant long-term trends were detected (Tables 3 and 4; Fig. 12).



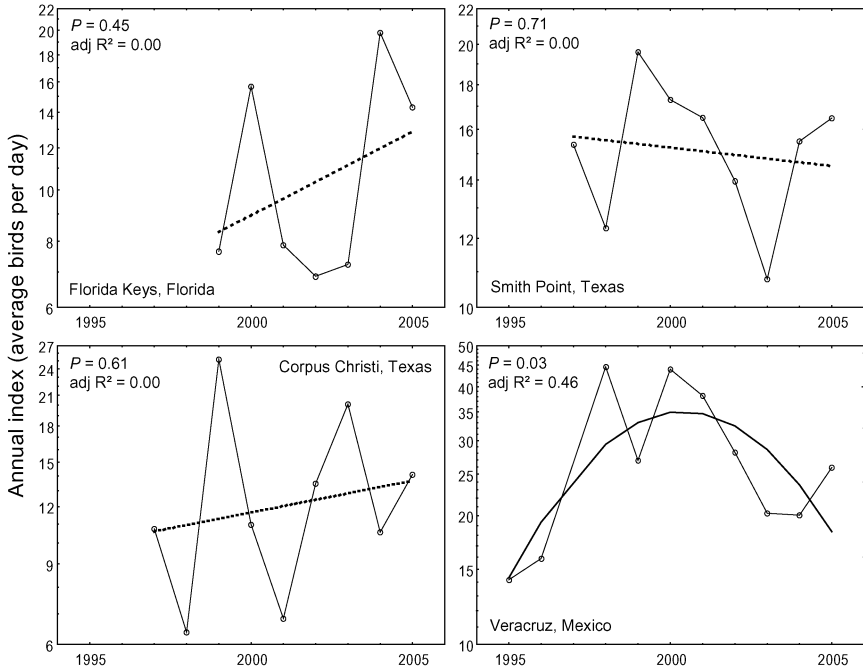


Fig. 10. Trends in autumn passage rates of Cooper's Hawks (*Accipiter cooperii*) at Gulf Coast watchsites since the mid-1990s. Solid lines illustrate significant ( $P \leq 0.10$ ) regression models; dashed lines illustrate nonsignificant ( $P > 0.10$ ) best-fit models.

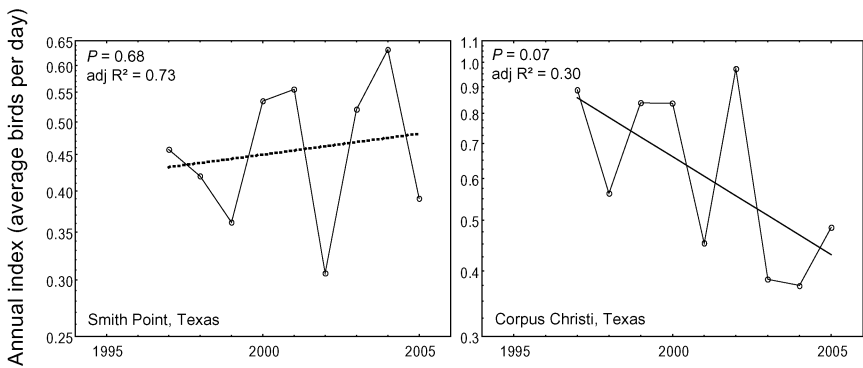


Fig. 11. Trends in autumn passage rates of Red-shouldered Hawks (*Buteo lineatus*) at Gulf Coast watchsites since the mid-1990s. Solid lines illustrate significant ( $P \leq 0.10$ ) regression models; dashed lines illustrate nonsignificant ( $P > 0.10$ ) best-fit models.

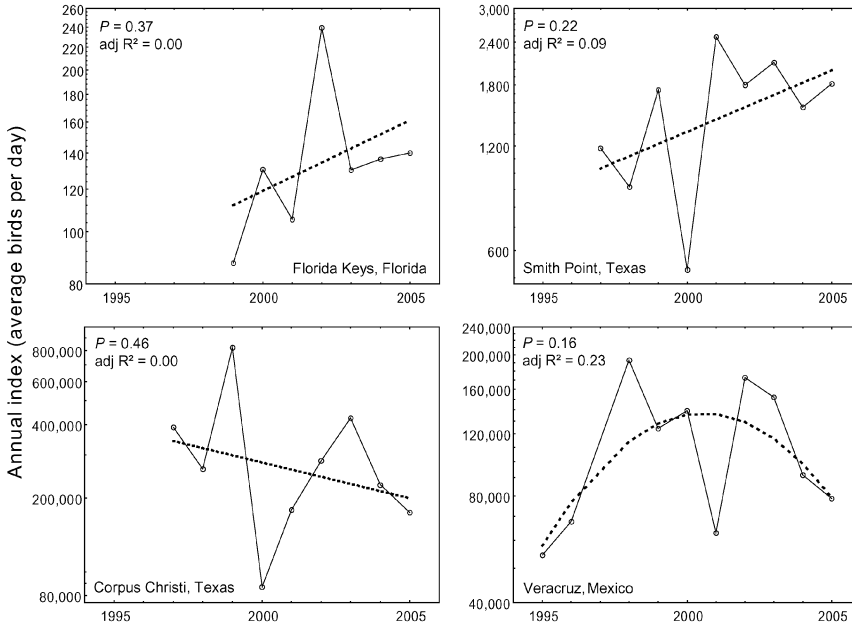


Fig. 12. Trends in autumn passage rates of Broad-winged Hawks (*Buteo platypterus*) at Gulf Coast watchsites since the mid-1990s. Dashed lines illustrate nonsignificant ( $P > 0.10$ ) best-fit models.

*Swainson's Hawk.*—We calculated trends for this species at three watchsites. Swainson's Hawks were recorded in moderate to very high numbers at Veracruz and the Texas watchsites, where they increased by 10–18% per year (Tables 3 and 4; Fig. 13). We did not calculate trends for Florida, where counts were comparatively low (Table 2).

*Zone-tailed Hawk.*—We calculated trends for this species at one watchsite. Veracruz records >100 Zone-tailed Hawks each year. The species is recorded in most years at Corpus Christi, but low numbers precluded analysis there (Table 2). Overall, Zone-tailed Hawks increased significantly at Veracruz, at an average rate of 16% per year; however, numbers remained relatively stable between 1999 and 2003 (Table 3; Fig. 14).

*Red-tailed Hawk.*—We calculated trends for this species at three watchsites. Red-tailed Hawks were recorded in moderate numbers at both Texas sites and at Veracruz, but were too uncommon in Florida for analysis (Table 2). Numbers varied considerably among years at all analyzed sites, and no long-term trends were detected (Tables 3 and 4; Fig. 15).

*American Kestrel.*—We calculated trends for this species at four watchsites. American Kestrels occurred in moderate to high numbers at all sites

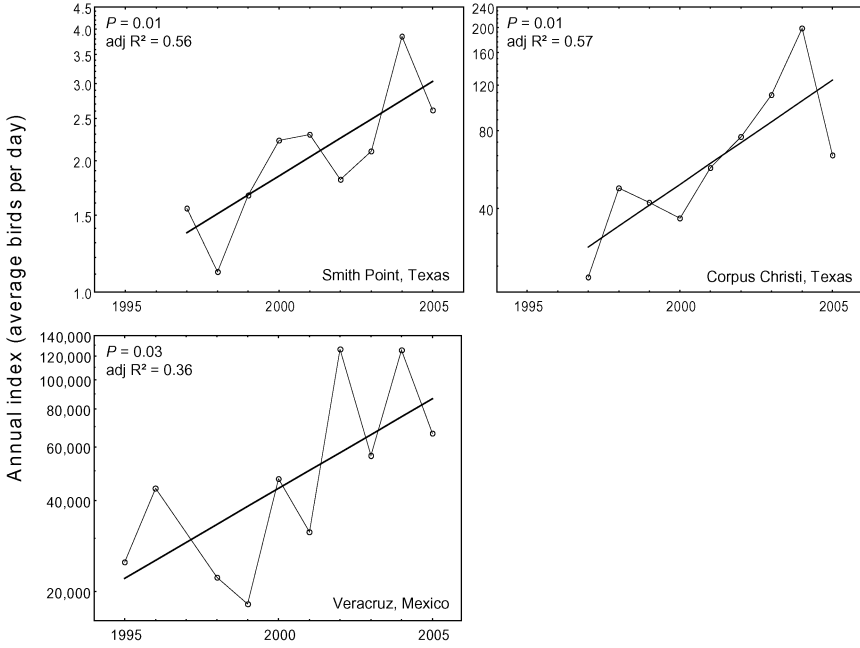


Fig. 13. Trends in autumn passage rates of Swainson's Hawks (*Buteo swainsoni*) at Gulf Coast watchsites since the mid-1990s. Solid lines illustrate significant ( $P \leq 0.10$ ) regression models.

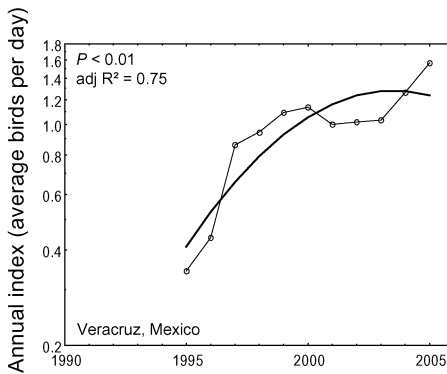


Fig. 14. Trends in autumn passage rates of Zone-tailed Hawks (*Buteo albonotatus*) in Veracruz, Mexico since 1995. The solid line illustrates a significant ( $P \leq 0.10$ ) regression model.

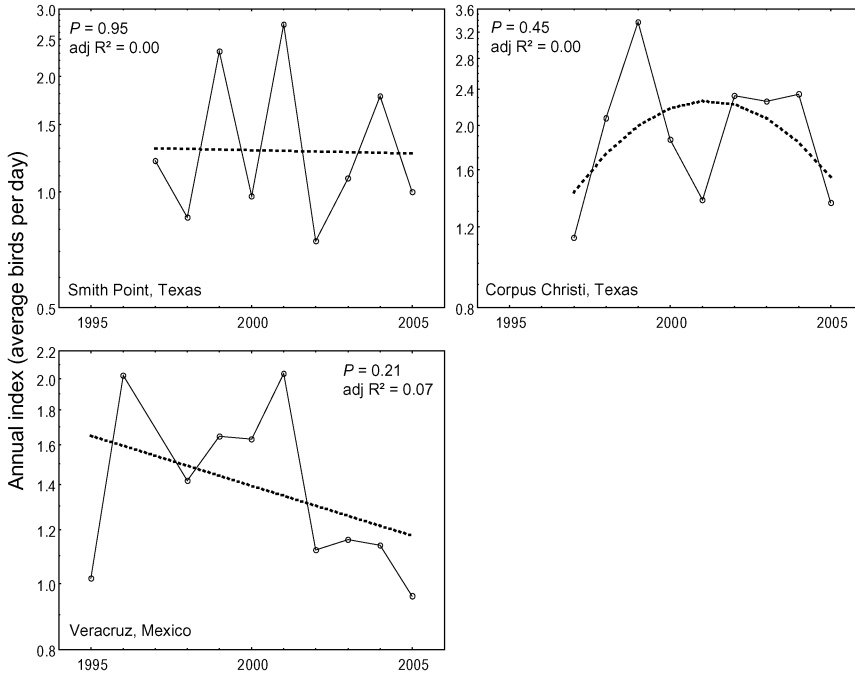


Fig. 15. Trends in autumn passage rates of Red-tailed Hawks (*Buteo jamaicensis*) at Gulf Coast watchsites since the mid-1990s. Dashed lines illustrate non-significant ( $P > 0.10$ ) best-fit models.

(Table 2). A significant 8.8% annual decline occurred in Florida (Tables 3 and 4; Fig. 16). Data from all sites except Corpus Christi suggested declines after 1998 or 1999 (Fig. 16).

*Merlin*.—We calculated trends for this species at four watchsites. Merlins were recorded in low numbers in Texas, and in moderate numbers in Veracruz and Florida (Table 2). Numbers declined by 13% per year in Florida (Tables 3 and 4; Fig. 17).

*Peregrine Falcon*.—We calculated trends for this species at four watchsites. The average of ~1,800 individuals per year in Florida (Table 2) is the largest for any watchsite in the United States or Canada (Lott 2006). Estimated rates of increase ranged from 3% to 7% per year at all sites, but the trend was significant only at Smith Point (Tables 3 and 4; Fig. 18).

#### SUMMARY OF TRENDS

Numbers of seven species increased since 1995, whereas those of three species declined. Three additional species showed mixed trends and the

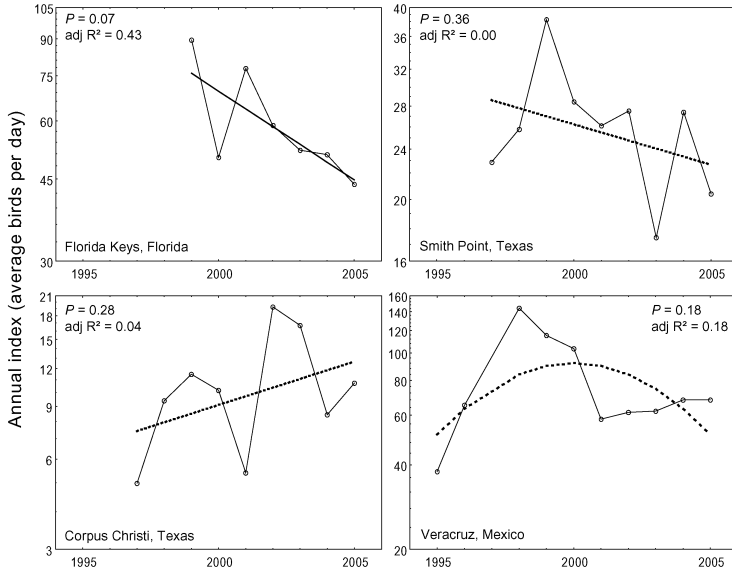


Fig. 16. Trends in autumn passage rates of American Kestrels (*Falco sparverius*) at Gulf Coast watchsites since the mid-1990s. The solid line illustrates a significant ( $P \leq 0.10$ ) regression model; dashed lines illustrate nonsignificant ( $P > 0.10$ ) best-fit models.

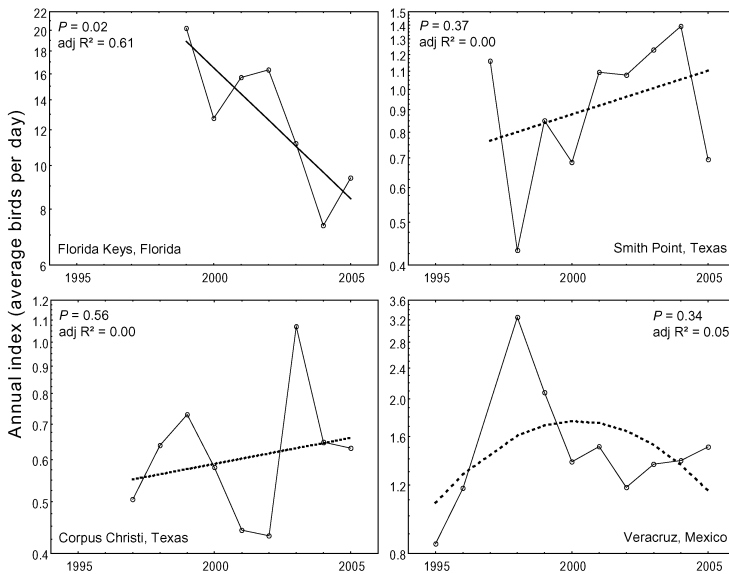


Fig. 17. Trends in autumn passage rates of Merlins (*Falco columbarius*) at Gulf Coast watchsites since the mid-1990s. The solid line illustrates a significant ( $P \leq 0.10$ ) regression models; dashed lines illustrate nonsignificant ( $P > 0.10$ ) best-fit models.

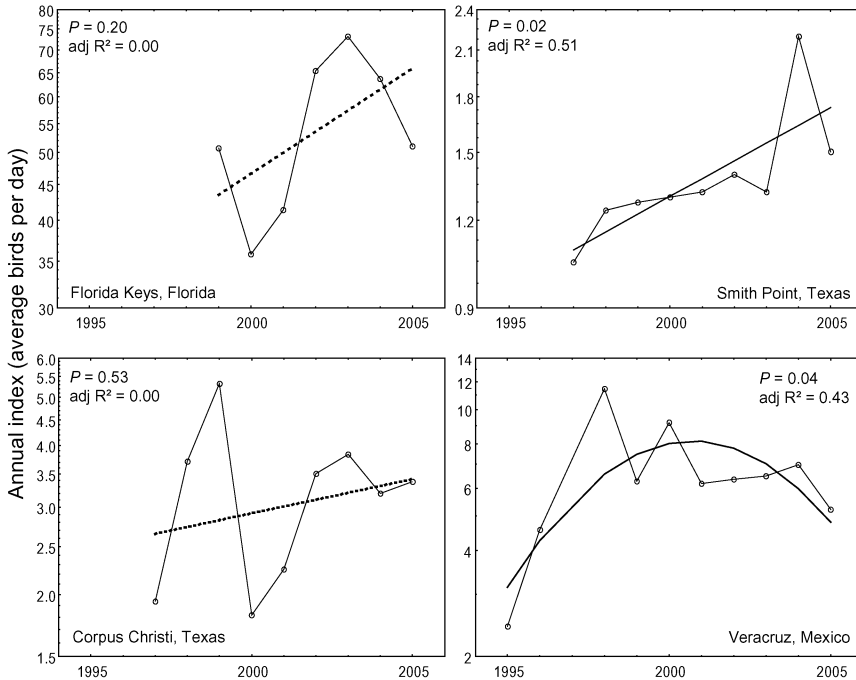


Fig. 18. Trends in autumn passage rates of Peregrine Falcons (*Falco peregrinus*) at Gulf Coast watchsites since the mid-1990s. Solid lines illustrate significant ( $P \leq 0.10$ ) regression models; dashed lines illustrate nonsignificant ( $P > 0.10$ ) best-fit models.

status of two species was uncertain (Table 4). Three species for which watchsites in this region monitor near entire world populations either increased uniformly (Mississippi Kite, Swainson's Hawk) or showed no detectable trends (Broad-winged Hawk). Watchsites in the region monitor a large part of the western North American population of Turkey Vultures, and counts of this species increased over the last decade.

Four species, Hook-billed Kite, Swallow-tailed Kite, Mississippi Kite, and Zone-tailed Hawk, are not monitored by other watchsites in North America, making counts along the Gulf Coast especially important in monitoring their populations.

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