6

Trends in Autumn Counts of Migratory Raptors in Western North America

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Abstract.—We analyzed counts from 10 watchsites in western North America. Average counts at watchsites ranged from 2,000 to 15,000 migrants each autumn, with as many as 21 species represented. Five species consistently made up more than 80% of the annual combined-site count totals: Sharp-shinned Hawk (*Accipiter striatus*), 25–30% of the total in a given year; Cooper's Hawk (*A. cooperii*), 15–22%; Red-tailed Hawk (*Buteo jamaicensis*), 13–20%, Golden Eagle (*Aquila chrysaetos*), 9–14%, and American Kestrel (*Falco sparverius*), 8–13%. We estimated geometric-mean rates of change in annual count indexes for 16 species. Turkey Vultures (*Cathartes aura*) increased significantly ($P \leq 0.10$) at three sites. Swainson's Hawks (*B. swainsoni*), Merlins (*F. columbarius*), and Peregrine Falcons (*F. peregrinus*) increased significantly at some but not all sites. Northern Goshawks (*A. gentilis*) and Northern Harriers (*Circus cyaneus*) declined significantly at two sites, and Golden Eagles declined significantly at five sites. Ospreys (*Pandion haliaetus*), Sharp-shinned Hawks, Cooper's Hawks, Broad-winged

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Hawks (*B. platypterus*), Red-tailed Hawks, American Kestrels, and Prairie Falcons (*F. mexicanus*) declined significantly at one or more sites. Bald Eagles (*Haliaeetus leucocephalus*; analyzed at three sites) and Rough-legged Hawks (*B. lagopus*; analyzed at two sites) showed no significant trends. For many species, trends were related to regional variation in precipitation and drought, especially in the Great Basin–Intermountain region since the late 1980s.

Introduction

Each autumn, more than 20 species of diurnal raptors migrate through western North America (Zalles and Bildstein 2000) where numbers of migrants are monitored at a network of traditional watchsites (e.g., Smith et al. 2001, Hoffman and Smith 2003, Sherrington 2003). We estimated trends for 16 species of migrating diurnal raptors across periods of various lengths between 1983 and 2005 at 10 watchsites along three major regional migration corridors in the region (*sensu* Hoffman et al. 2002; see Chapter 2). The Chelan Ridge Raptor Migration Project in the Cascade Mountains of Washington and Bonney Butte Raptor Migration Project in the Cascades of Oregon are in the Pacific Coast Corridor (Fig. 1). Boise Ridge in the Boise Mountains of western Idaho, the Goshute Mountains Raptor Migration Project in northeastern Nevada, and two sites, Lipan Point and Yaki Point, at the Grand Canyon in Arizona, are in the Intermountain Corridor. The Bridger Mountains Raptor Migration Project in Montana, the Wellsville Mountains Raptor Migration Project in Utah, the Manzano Mountains Raptor Migration Project in New Mexico, and Mt. Lorette in Alberta, are in the Rocky Mountain corridor (see Chapter 8 for details).

Annual mean counts ranged from 2,000 to 15,000 migrants per site. The analyses we present incorporate an additional four years of data for five watchsites reported in Hoffman and Smith (2003) together with data from five other sites.

Methods

Data Collection

Hourly counts were used to estimate trends. Site coverage ranged from 8 to 23 years (Table 1). Almost all counts were conducted annually throughout most of autumn migration, except during inclement weather. At all watchsites, trained observers used 7–10× binoculars to detect and identify migrating raptors. Spotting scopes sometimes were used to identify, but not to detect, raptors.

Most counts were conducted at a single traditional watchsite by two trained observers who worked throughout the season, with count teams varying across years. Most counters followed standardized count and data-recording protocols (cf. Hoffman and Smith 2003). All sites except those

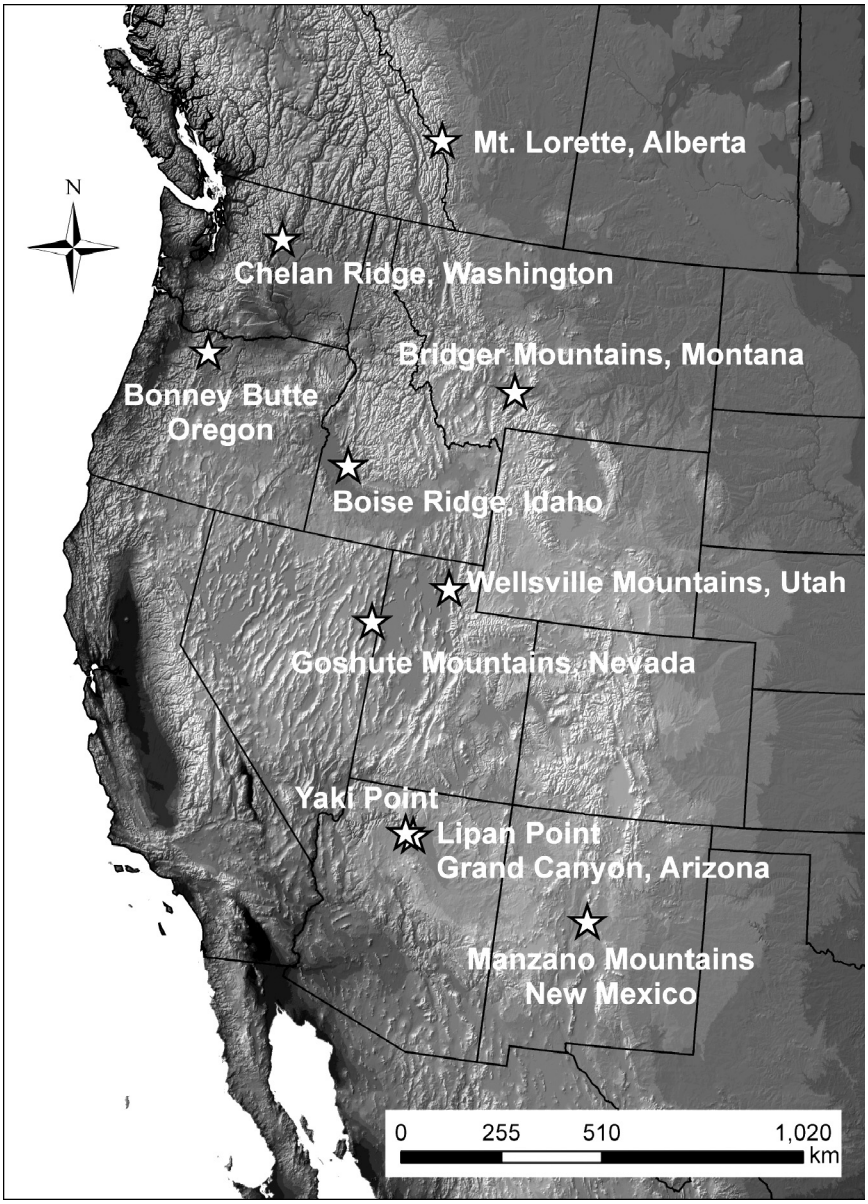

Fig. 1. Raptor-migration watchsites in western North America.

Table 1. Details of watchsites included in this analysis.

Location	Latitude	Longitude	Elevation (m)	Count years	Count season	Mean (range) days season^{-1}	Mean ± SD (h day^{-1})	Standardized daily window (n h)
Chelan Ridge, Washington [a]	48°01′13″N	120°05′38″W	1,729	1998–2005	24 Aug. to 27 Oct.	60 (53–67)	8.0 ± 2.3	0700–1700 (10)
Bonney Butte, Oregon [b]	45°15′47″N	121°35′31″W	1,754	1994–2005	27 Aug. to 31 Oct.	50 (38–59)	7.1 ± 2.0	0800–1700 (9)
Boise Ridge, Idaho [c]	43°36′19″N	116°03′37″W	1,799	1995–2005	25 Aug. to 31 Oct.	64 (59–68)	7.2 ± 1.6	0900–1800 (9)
Goshute Mountains, Nevada [d]	40°25′25″N	114°16′17″W	2,740	1983–2005	15 Aug. to 5 Nov.	78 (66–85)	8.6 ± 1.8	0700–1800 (11)
Lipan Point, Grand Canyon, Arizona [e]	36°01′59″N	111°51′12″W	2,125	1991–2005	27 Aug. to 5 Nov.	67 (57–71)	7.7 ± 1.4	0800–1700 (9)
Yaki Point, Grand Canyon, Arizona [e]	36°03′31″N	112°05′02″W	2,025	1997–2005	27 Aug. to 5 Nov.	69 (66–71)	7.8 ± 1.5	0800–1700 (9)
Mt. Lorette, Alberta [f]	50°52′36″N	115°09′25″W	1,440	1993–2005	late Aug. to late Nov.	86 (69–101)	9.9 ± 1.9	0700–1900 (12)
Bridger Mountains, Montana [g]	45°49′01″N	110°55′47″W	2,610	1992–2005	27 Aug. to 31 Oct.	51 (39–64)	6.5 ± 1.7	0800–1700 (9)
Wellsville Mountains, Utah [h]	41°41′18″N	112°02′54″W	2,617	1987–2004	late Aug. to 31 Oct.	54 (43–65)	7.1 ± 1.5	0900–1800 (9)
Manzano Mountains, New Mexico [i]	34°42′15″N	106°24′40″W	2,805	1985–2005	27 Aug. to 5 Nov.	64 (50–70)	7.9 ± 1.8	0800–1800 (10)

[a] Two full-time counters. Count period of 27 August to 31 October for 1998–2000, shifted earlier after that to account for early snowfall.

[b] Two full-time counters. Before 1999, start dates of 1–4 September and end dates of 25 October to 3 November.

[c] Two full-time counters.

[d] Single, full-time counter, 1983–1986; a second full-time counter during peak month, 1987–1989; two full-time counters, 1990–2005.

[e] Two observation points, one at each end of a 30-km, east–west transect. Two full-time counters per observation point; four counters rotate duties between points. Before 1996, start dates of 31 August to 8 September at Lipan Point.

[f] Rotating teams of one to four counters. Start dates of 27 August to 2 September, except for four years when start dates were 8–17 September. End dates of 29 November to 6 December, except for three years when end dates were 22 November, 12 December, and 17 December.

[g] Start dates of 1–13 September for 1992–1996. End date of 3 November in 1995.

[h] No counts conducted in 2002 or 2005. Single full-time counter, 1987–1991; two full-time counters, 1992–2004. Start dates of 3–7 September and end date of 20 October for 1987–1989; start dates of 22–28 August and end dates of 24–31 October for 1990–2004.

[i] Single full-time counter, 1985–1987; second full-time counter during peak 75% of the season, 1988–1989; two full-time counters,1990–2005. Start date of 27 August since 1995, 23 August to 6 September before then. End date of 5 November since 1991, 30 October to 8 November before then.

in the Grand Canyon and at Mt. Lorette were on north–south oriented ridgetops (elevations from 1,700 to 2,900 m above sea level). Migrants were counted as they crossed an east–west axis passing through the site.

Migrants cross the Grand Canyon along a *broad front*, descending into the canyon as they cross, before rising on thermals at the south rim. The use of a two-count transect (sites 30 km apart) at the Grand Canyon affords better sampling of this broad-frontal movement, which is subject to longitudinal shifting depending on the weather (cf. Ruelas 2005).

Ridgetop monitoring is impractical in western Alberta because of the stature of the Rocky Mountains and the region's climate. Thus, the Mt. Lorette count site is at a relatively low site in the Kananaskis Valley. Although data were recorded for many species at the site, we analyzed data only for Golden Eagles (*Aquila chrysaetos*), which is by far the most abundant migrant at the site.

Table 1 and Chapter 8 provide additional information for each site.

Trend Analysis

With one exception, our methods follow those in Chapter 5 (see also Chapter 4 and Farmer et al. 2007). We combined counts from the two Grand Canyon sites during the nine years that both sites were active and derived integrated annual count indexes for them following the methods of Hussell (1981) and Francis and Hussell (1998). Below, we present trends for the full 15-year Lipan Point data set as well as for the 9-year, two-site data set.

Besides estimating trends for all species–watchsite combinations, we also estimated trends before 1998 and after 1997. All sites were included in post-1997 analyses. Sites initiated on or before 1993 were included in pre-1998 analyses. We selected these periods for analyses because 1998 concluded a five-year period of high-moisture levels throughout much of the interior West associated with a strong *El Nino* that was followed by a lengthy period of severe and widespread drought (NOAA 2006; see also Hoffman and Smith 2003).

Results and Discussion

Sharp-shinned Hawks (*Accipiter striatus*; 25–30% of the annual total), Cooper's Hawks (*A. cooperii*; 15–22%), Red-tailed Hawks (*Buteo jamaicensis*; 13–20%), Golden Eagles (9–14%), and American Kestrels (*Falco sparverius*; 8–13%) (Table 2) were the most numerous migrants. The Northern Harrier (*Circus cyaneus*) was the only other migrant seen in sufficient numbers to be included in the analysis at all sites excluding Mt. Lorette. We were able to calculate trends at only one or two sites for Broad-winged Hawks (*B. platypterus*), Rough-legged Hawks (*B. lagopus*), and

Table 2. Average annual autumn migration counts (CV in parentheses) for 17 species of raptors at western watchsites in three migration corridors. (Counts of Ferruginous Hawks are included in this table, but were too low to permit trend analyses at any watchsite.)

	Rocky Mountain			
Species	Mount Lorette, Alberta (1993–2005)	Bridger Mountains, Montana (1992–2005)	Wellsville Mountains, Utah (1987–2005)	Manzano Mountains, New Mexico (1983–2005)
Turkey Vulture (*Cathartes aura*)	<1	<1	21 (65)	394 (62)
Osprey (*Pandion haliaetus*)	9 (60)	6 (77)	25 (45)	30 (59)
Bald Eagle (*Haliaeetus leucocephalus*)	383 (27)	82 (30)	4 (90)	3 (78)
Northern Harrier (*Circus cyaneus*)	21 (48)	49 (111)	277 (40)	58 (44)
Sharp-shinned Hawk (*Accipiter striatus*)	212 (28)	340 (35)	855 (20)	1,482 (30)
Cooper's Hawk (*A. cooperii*)	42 (19)	168 (47)	525 (31)	1,024 (36)
Northern Goshawk (*A. gentilis*)	58 (75)	35 (67)	24 (58)	16 (59)
Broad-winged Hawk (*Buteo platypterus*)	12 (72)	9 (106)	4 (90)	7 (65)
Swainson's Hawk (*B. swainsoni*)	1 (88)	2 (128)	142 (109)	553 (284)
Red-tailed Hawk (*B. jamaicensis*)	70 (45)	107 (51)	576 (45)	656 (27)
Ferruginous Hawk (*B. regalis*)	<1	2 (87)	10 (63)	13 (41)
Rough-legged Hawk (*B. lagopus*)	64 (25)	35 (59)	2 (87)	<1
Golden Eagle (*Aquila chrysaetos*)	3,897 (11)	1,463 (17)	182 (47)	117 (28)
American Kestrel (*Falco sparverius*)	9 (64)	76 (56)	812 (29)	562 (27)
Merlin (*F. columbarius*)	14 (42)	9 (62)	11 (51)	25 (57)
Peregrine Falcon (*F. peregrinus*)	6 (59)	8 (61)	9 (68)	49 (76)
Prairie Falcon (*F. mexicanus*)	3 (63)	13 (31)	16 (44)	20 (57)
Total raptors	4,804	2,112	3,602	5,208

Table 2. Continued.

Species	Intermountain			
	Boise Ridge, Idaho (1993–2005)	Goshute Mountains, Nevada (1983–2005)	Lipan Point, Arizona (1991–2005)	Grand Canyon combined, Arizona (1997–2005)
Turkey Vulture (*Cathartes aura*)	1,010 (51)	320 (51)	–[a]	–[a]
Osprey (*Pandion haliaetus*)	60 (32)	86 (48)	74 (32)	119 (24)
Bald Eagle (*Haliaeetus leucocephalus*)	6 (64)	13 (52)	19 (61)	35 (41)
Northern Harrier (*Circus cyaneus*)	231 (40)	170 (43)	80 (43)	108 (36)
Sharp-shinned Hawk (*Accipiter striatus*)	1,175 (30)	4,534 (44)	1,420 (29)	2,395 (18)
Cooper's Hawk (*A. cooperii*)	797 (44)	3,155 (46)	1,059 (39)	2,016 (34)
Northern Goshawk (*A. gentilis*)	41 (45)	103 (57)	9 (123)	10 (56)
Broad-winged Hawk (*Buteo platypterus*)	18 (51)	45 (80)	10 (104)	25 (53)
Swainson's Hawk (*B. swainsoni*)	65 (57)	222 (90)	42 (66)	91 (80)
Red-tailed Hawk (*B. jamaicensis*)	1,010 (29)	3,002 (31)	1,624 (37)	2,328 (19)
Ferruginous Hawk (*B. regalis*)	<1	16 (42)	6 (63)	11 (47)
Rough-legged Hawk (*B. lagopus*)	5 (59)	14 (78)	<1	<1
Golden Eagle (*Aquila chrysaetos*)	52 (22)	254 (26)	26 (64)	27 (63)
American Kestrel (*Falco sparverius*)	1,144 (20)	1,870 (46)	1,076 (23)	1,735 (21)
Merlin (*F. columbarius*)	31 (48)	38 (64)	11 (49)	22 (39)
Peregrine Falcon (*F. peregrinus*)	8 (80)	10 (84)	8 (42)	16 (38)
Prairie Falcon (*F. mexicanus*)	9 (39)	26 (55)	5 (55)	10 (26)
Total raptors	5,987	14,430	5,891	10,076

Table 2. Continued.

Species	Pacific Coast	
	Chelan Ridge, Washington (1998–2005)	Bonney Butte, Oregon (1994–2005)
Turkey Vulture (*Cathartes aura*)	31 (46)	302 (44)
Osprey (*Pandion haliaetus*)	42 (39)	66 (31)
Bald Eagle (*Haliaeetus leucocephalus*)	5 (92)	47 (25)
Northern Harrier (*Circus cyaneus*)	113 (36)	30 (46)
Sharp-shinned Hawk (*Accipiter striatus*)	796 (30)	1,119 (32)
Cooper's Hawk (*A. cooperii*)	212 (17)	341 (27)
Northern Goshawk (*A. gentilis*)	28 (47)	26 (41)
Broad-winged Hawk (*Buteo platypterus*)	5 (41)	8 (252)
Swainson's Hawk (*B. swainsoni*)	7 (88)	1 (136)
Red-tailed Hawk (*B. jamaicensis*)	302 (30)	607 (24)
Ferruginous Hawk (*B. regalis*)	<1	<1
Rough-legged Hawk (*B. lagopus*)	28 (59)	13 (59)
Golden Eagle (*Aquila chrysaetos*)	127 (27)	95 (35)
American Kestrel (*Falco sparverius*)	66 (40)	22 (33)
Merlin (*F. columbarius*)	38 (31)	67 (39)
Peregrine Falcon (*F. peregrinus*)	6 (72)	7 (77)
Prairie Falcon (*F. mexicanus*)	8 (65)	5 (67)
Total raptors	2,134	2,898

[a] Tallying of vultures ceased at these sites in 2001 because of difficulties in distinguishing migrants from residents.

Peregrine Falcons (*F. peregrinus*). We were able to calculate trends for at least three sites as well as for at least one site in each of the three corrdiors, for all other species except Swainson's Hawks (*B. swainsoni*), which were too uncommon for such analyses in the Pacific Northwest. Ferruginous Hawks (*B. regalis*) occurred in numbers too low to support analyses at any watchsite (but see Hoffman and Smith 2003).

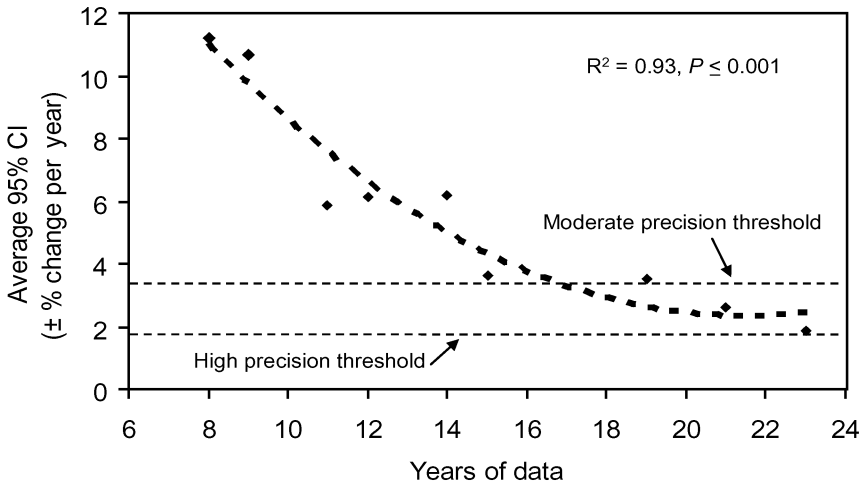

Fig. 2. Relationship between years of data collection and average 95% confidence intervals (CI) for species trend estimates. See Chapter 5 for explanation of moderate- and high-precision thresholds.

On average, confidence intervals (CI) for trend estimates decreased substantially as years of coverage increased (Fig. 2), particularly during the first 15 years of coverage. Thirty-six of 75 (48%) long-term trend estimates were of high or moderate precision. Low precision occurred primarily in data sets shorter than 15 years (Tables 3–5). Figure 2 suggests that confidence intervals of ±10% per year or less with 10–15 years of data yield at least moderate precision with 20–25 years of data. These results indicate the value of continued monitoring for long periods, as well as the value of comparing the results of short-term and long-term data sets.

We report annual percentage rates of change for each watchsite in Tables 3–5, and annual indexes and fitted trajectories for each species at each watchsite in Figures 4–19.

Regional Patterns and Trends

Long-term patterns.—Numbers of Turkey Vultures (*Cathartes aura*), Ospreys (*Pandion haliaetus*), Swainson's Hawks, Red-tailed Hawks, Merlins (*F. columbarius*), and Peregrine Falcons increased in the Goshutes, Manzanos, and Wellsvilles (Table 3 and Figs. 4–19). Long-term trend estimates for these species were significant in the Goshutes, both significant and nonsignificant in the Manzanos, and nonsignificant in the Wellsvilles. Broad-winged Hawks also increased significantly in the Goshutes, one of only two sites analyzed for this species. Northern Goshawks (*A. gentilis*),

Table 3. Trends (mean percentage of change per year ± 95% CI[a]) in autumn migration counts of 16 species of raptors at western watchsites in three migration corridors.

	Rocky Mountain			
Species	Mount Lorette, Alberta (1993–2005)	Bridger Mountains, Montana (1992–2005)	Wellsville Mountains, Utah (1987–2004)	Manzano Mountains, New Mexico (1985–2005)
Turkey Vulture	–	–	0.3 ± 3.5	2.3 ± 3.8
Osprey	–	–	0.7 ± 2.7	3.8 ± 2.2*
Bald Eagle	–	0.4 ± 3.6	–	–
Northern Harrier	–	–2.4 ± 9.9	0.3 ± 3.9	–1.3 ± 2.2
Sharp-shinned Hawk	–	–1.1 ± 4.6	–1.7 ± 2.0†	2.2 ± 2.0‡
Cooper's Hawk	–	–4.4 ± 4.9†	–1.7 ± 2.7	4.5 ± 1.9*
Northern Goshawk	–	–4.6 ± 9.0	–0.2 ± 3.6	–
Broad-winged Hawk	–	–	–	–
Swainson's Hawk	–	–	2.0 ± 6.1	3.9 ± 6.1
Red-tailed Hawk	–	–1.7 ± 6.3	1.5 ± 4.1	2.1 ± 1.6‡
Rough-legged Hawk	–	–1.1 ± 7.4	–	–
Golden Eagle	–2.2 ± 2.5†	–2.3 ± 2.8†	0.6 ± 3.6	–1.9 ± 1.6‡
American Kestrel	–	–4.2 ± 7.3	–3.6 ± 2.8†	0.1 ± 1.6
Merlin	–	–	–	5.6 ± 2.9*
Peregrine Falcon	–	–	–	9.6 ± 2.9*
Prairie Falcon	–	–	–	2.0 ± 2.6

	Intermountain			
Species	Boise Ridge, Idaho (1995–2005)	Goshute Mountains, Nevada (1983–2005)	Lipan Point, Arizona (1991–2005)	Grand Canyon combined, Arizona (1997–2005)
Turkey Vulture	18.3 ± 2.6*	4.3 ± 1.6*	–	–
Osprey	4.4 ± 5.0†	4.4 ± 1.3*	0.3 ± 2.5	–4.4 ± 5.6†
Bald Eagle	–	–	–	–1.2 ± 9.6
Northern Harrier	0.3 ± 6.7	0.4 ± 1.7	–5.3 ± 4.0‡	–10.6 ± 7.8‡
Sharp-shinned Hawk	0.7 ± 6.1	1.7 ± 1.8†	–3.4 ± 3.1‡	–5.6 ± 7.7§
Cooper's Hawk	2.1 ± 6.5	1.6 ± 1.6†	–8.7 ± 2.8*	–16.0 ± 8.3*
Northern Goshawk	–3.9 ± 8.7	–4.7 ± 2.9*	–	–
Broad-winged Hawk	–	6.8 ± 2.4*	–	–11.9 ± 9.4‡
Swainson's Hawk	–2.3 ± 10.2	5.4 ± 2.1*	5.5 ± 3.9*	8.7 ± 15.5§
Red-tailed Hawk	7.3 ± 3.7*	2.0 ± 1.5‡	–6.0 ± 4.2*	–6.2 ± 11.4§
Rough-legged Hawk	–	–	–	–
Golden Eagle	1.2 ± 4.2	–2.4 ± 1.3*	–10.0 ± 5.8*	–11.6 ± 17.8§
American Kestrel	–1.9 ± 4.3	3.4 ± 1.5*	–4.1 ± 2.5*	–2.8 ± 9.8
Merlin	6.3 ± 6.7†	9.1 ± 2.5*	–	–5.7 ± 14.3§
Peregrine Falcon	–	–	–	–
Prairie Falcon	–	–2.1 ± 2.3‡	–	–

Table 3. Continued.

Species	Pacific Coast	
	Chelan Ridge, Washington (1998–2005)	Bonney Butte, Oregon (1995–2005)
Turkey Vulture	5.0 ± 13.0	5.5 ± 6.7†
Osprey	–6.0 ± 13.8	2.2 ± 4.1
Bald Eagle	–	2.0 ± 3.0
Northern Harrier	–10.1 ± 11.6†	–3.3 ± 8.9
Sharp-shinned Hawk	–12.8 ± 9.7‡	–0.1 ± 6.1
Cooper's Hawk	–6.3 ± 7.3†	–0.9 ± 6.0
Northern Goshawk	–12.9 ± 14.8†	–2.3 ± 8.7
Broad-winged Hawk	–	–
Swainson's Hawk	–	–
Red-tailed Hawk	–5.0 ± 10.5	–1.7 ± 6.8
Rough-legged Hawk	–2.2 ± 10.5	–
Golden Eagle	4.5 ± 8.3	–3.8 ± 5.5
American Kestrel	–11.7 ± 13.5†	–7.9 ± 3.7*
Merlin	–0.4 ± 10.3	2.1 ± 8.1
Peregrine Falcon	–	–
Prairie Falcon	–	–

[a] §$P \leq 0.50$, †$P \leq 0.10$, ‡$P \leq 0.05$, *$P \leq 0.01$.

Golden Eagles, and Prairie Falcons (*F. mexicanus*) declined significantly at one or more of the sites and did not increase significantly at any site. Sharp-shinned Hawks, Cooper's Hawks, and American Kestrels showed a mix of significant increases and decreases at the three sites. Northern Harriers showed no significant trends at the three sites.

Pacific Coast Migration Corridor.—Bonney Butte and Chelan Ridge, which lie within the Pacific Coast corridor, monitor a relatively distinct collection of migrants for most species (Hoffman et al. 2002; Chapter 2). Although the drought that began in the interior West in the late 1990s (e.g., Fig. 3) extended into many areas along the eastern Cascades, moisture generally remained more favorable in the Pacific Northwest (NOAA 2006). Thus, one might expect common patterns at these two sites as well as significant differences between them and sites farther east. Indeed, trends for the two sites were similar for many species, with six species declining at both and similar increases at both for Turkey Vultures (Table 3 and Figs. 4–19). American Kestrels declined significantly at Bonney Butte, whereas Northern Harriers, all three accipiters, and American Kestrels, declined significantly at Chelan Ridge. Variation in all-species counts was positively correlated from 1998 to 2000, but negatively correlated thereafter. Although band encounters and satellite tracking clearly link the two sites

Table 4. Trends (mean percentage of change per year ± 95% CI[a]) in autumn migration counts of 16 species of raptors at western watchsites in two migration corridors before 1998.

	Rocky Mountain			Intermountain	
	Bridger Mountains, Montana (1992–1997)	Wellsville Mountains, Utah (1987–1997)	Manzano Mountains, New Mexico (1985–1997)	Goshute Mountains, Nevada (1983–1997)	Lipan Point, Arizona (1992–1997)
Turkey Vulture	–	0.3 ± 3.5	10.4 ± 5.9*	6.2 ± 2.6*	–
Osprey	–	7.6 ± 4.8*	6.8 ± 3.8*	8.1 ± 2.0*	10.9 ± 5.8*
Bald Eagle	0.4 ± 3.6	–	–	–	–
Northern Harrier	–2.4 ± 9.9	0.3 ± 3.9	3.0 ± 3.8§	5.5 ± 2.5*	–5.3 ± 4.0‡
Sharp-shinned Hawk	5.9 ± 11.3§	0.8 ± 3.6	2.2 ± 2.0‡	7.0 ± 3.0*	–3.4 ± 3.1‡
Cooper's Hawk	9.0 ± 15.5§	6.4 ± 4.9‡	4.5 ± 1.9*	7.4 ± 2.6*	2.2 ± 6.5§
Northern Goshawk	–4.6 ± 9.0§	–0.2 ± 3.6	–	3.0 ± 4.0§	–
Broad-winged Hawk	–	–	–	10.6 ± 4.0*	–
Swainson's Hawk	–	11.6 ± 11.1‡	13.7 ± 10.2*	5.4 ± 2.1*	5.5 ± 3.9*
Red-tailed Hawk	–2.2 ± 6.3	6.4 ± 7.4†	2.1 ± 1.6‡	2.0 ± 1.5*	3.6 ± 9.8§
Rough-legged Hawk	–1.1 ± 7.4	–	–	–	–
Golden Eagle	–7.1 ± 6.8‡	3.6 ± 7.1§	1.2 ± 2.6	1.3 ± 1.9§	–10.0 ± 5.8*
American Kestrel	8.7 ± 18.2§	0.8 ± 5.0	0.1 ± 1.6	9.6 ± 2.3*	–4.1 ± 2.5*
Merlin	–	–	10.1 ± 5.0*	20.1 ± 4.1*	–
Peregrine Falcon	–	–	14.4 ± 4.8*	–	–
Prairie Falcon	–	–	6.1 ± 4.0*	6.3 ± 3.2*	–

[a] §$P \leq 0.50$, †$P \leq 0.10$, ‡$P \leq 0.05$, * $P \leq 0.01$.

Table 5. Trends (mean percentage of change per year ± 95% CI[a]) in autumn migration counts of 16 species of raptors at 10 western watchsites in three migration corridors during the drought years of 1998–2005.

	Rocky Mountain			
	Mount Lorette, Alberta	Bridger Mountains, Montana	Wellsville Mountains, Utah	Manzano Mountains, New Mexico
Turkey Vulture	–	–	0.3 ± 3.5	–12.9 ± 12.0†
Osprey	–	–	–10.0 ± 6.7‡	–1.1 ± 5.7
Bald Eagle	–	0.4 ± 3.6	–	–
Northern Harrier	–	–2.4 ± 9.9	0.3 ± 3.9	–8.2 ± 5.8‡
Sharp-shinned Hawk	–	–6.3 ± 8.8§	–5.7 ± 5.2†	2.2 ± 2.0†
Cooper's Hawk	–	–5.6 ± 9.9§	–14.3 ± 7.0‡	4.5 ± 1.9‡
Northern Goshawk	–	–4.6 ± 9.0§	–0.2 ± 3.6	–
Broad-winged Hawk	–	–	–	–
Swainson's Hawk	–	–	–13.1 ± 14.9†	–7.3 ± 20.1§
Red-tailed Hawk	–	–2.2 ± 6.3	–6.1 ± 10.3§	2.1 ± 1.6†
Rough-legged Hawk	–	–1.1 ± 7.4	–	–
Golden Eagle	–2.2 ± 2.5§	1.3 ± 5.5	–5.3 ± 11.0§	–9.6 ± 5.0*
American Kestrel	–	–13.8 ± 13.9†	–10.5 ± 7.0‡	0.1 ± 1.6
Merlin	–	–	–	–1.7 ± 7.4
Peregrine Falcon	–	–	–	–2.1 ± 8.8
Prairie Falcon	–	–	–	–9.1 ± 8.1†

	Intermountain			
	Boise Ridge, Idaho	Goshute Mountains, Nevada	Lipan Point, Arizona	Grand Canyon combined, Arizona
Turkey Vulture	18.3 ± 2.6*	2.3 ± 3.0	–	–
Osprey	4.4 ± 5.0†	–2.3 ± 3.4§	–9.0 ± 5.0‡	–4.4 ± 5.6†
Bald Eagle	–	–	–	–1.2 ± 9.6
Northern Harrier	0.3 ± 6.7	–10.6 ± 6.2‡	–5.3 ± 4.0†	–10.6 ± 7.8‡
Sharp-shinned Hawk	0.7 ± 6.1	–8.3 ± 4.7*	–3.4 ± 3.1†	–5.6 ± 7.7§
Cooper's Hawk	2.1 ± 6.5§	–9.3 ± 4.5‡	–18.2 ± 5.8‡	–16.0 ± 8.3*
Northern Goshawk	–3.9 ± 8.7§	–13.9 ± 10.5‡	–	–
Broad-winged Hawk	–	–0.4 ± 6.5	–	–11.9 ± 9.4‡
Swainson's Hawk	–2.3 ± 10.2	5.4 ± 2.1‡	5.5 ± 3.9‡	8.7 ± 15.5§
Red-tailed Hawk	7.3 ± 3.7*	2.0 ± 1.5†	–14.3 ± 8.7‡	–6.2 ± 11.4§
Rough-legged Hawk	–	–	–	–
Golden Eagle	1.2 ± 4.2	–12.6 ± 4.7‡	–10.0 ± 5.8‡	–11.6 ± 17.8§
American Kestrel	–1.9 ± 4.3§	–8.2 ± 4.1‡	–4.1 ± 2.5‡	–2.8 ± 9.8
Merlin	6.3 ± 6.7†	–11.6 ± 6.4‡	–	–5.7 ± 14.3§
Peregrine Falcon	–	–	–	–
Prairie Falcon	–	–17.1 ± 7.7‡	–	–

Table 5. Continued.

	Pacific Coast	
	Chelan Ridge, Washington	Bonney Butte, Oregon
Turkey Vulture	5.0 ± 13.0§	5.5 ± 6.7†
Osprey	–6.0 ± 13.8§	2.2 ± 4.1§
Bald Eagle	–	2.0 ± 3.0§
Northern Harrier	–10.1 ± 11.6†	–3.3 ± 8.9§
Sharp-shinned Hawk	–12.8 ± 9.7‡	–0.1 ± 6.1
Cooper's Hawk	–6.3 ± 7.2†	–0.9 ± 6.0
Northern Goshawk	–12.9 ± 14.8†	–2.3 ± 8.8
Broad-winged Hawk	–	–
Swainson's Hawk	–	–
Red-tailed Hawk	–5.0 ± 10.5§	–1.7 ± 6.8
Rough-legged Hawk	–2.2 ± 10.5	–
Golden Eagle	4.5 ± 8.3§	–3.8 ± 5.5§
American Kestrel	–11.7 ± 13.5†	–7.9 ± 3.7‡
Merlin	–0.4 ± 10.3	2.1 ± 8.1
Peregrine Falcon	–	–
Prairie Falcon	–	–

[a] §$P \leq 0.50$, †$P \leq 0.10$, ‡$P \leq 0.05$, *$P \leq 0.01$.

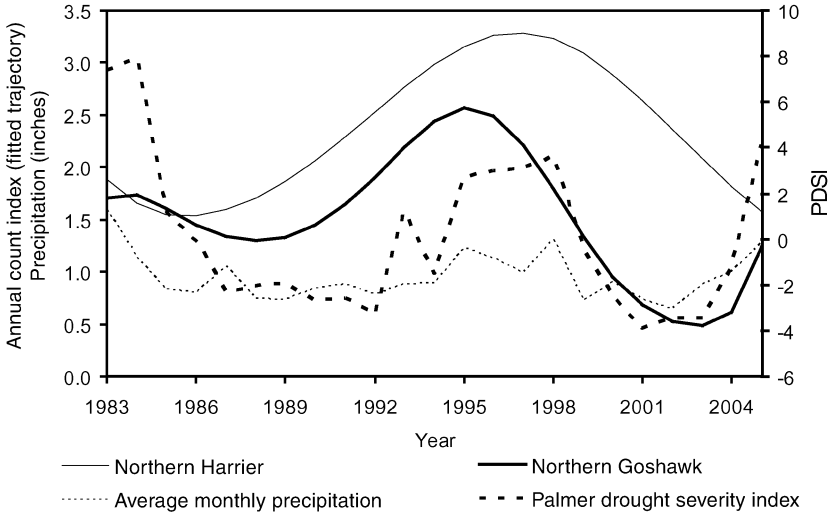

Fig. 3. Fitted trajectories of annual count indexes for selected species of migrating raptors in the Goshute Mountains, Nevada in relation to annual variation in regional drought severity and precipitation levels in the northern Great Basin since the 1980s (NOAA 2006; data represent the Nevada Division 2 geographic realm).

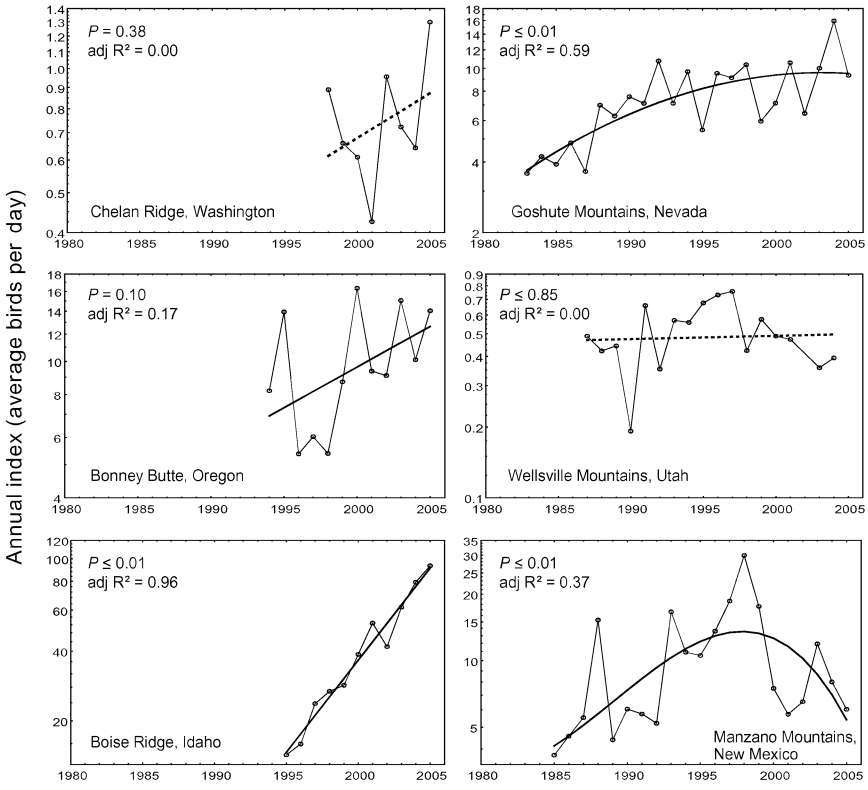

Fig. 4. Trends in annual count indexes of Turkey Vultures (*Cathartes aura*) at western migration sites since the early 1980s. Solid lines illustrate significant ($P \leq 0.10$) regression models; dashed lines illustrate nonsignificant ($P > 0.10$) best-fit models.

for some species (HawkWatch International [HWI] unpubl. data), the two appear to draw migrants of many species from different ranges. For many species, trends at Bonney Butte are more similar to those at Boise Ridge than to those at Chelan Ridge (Figs. 4–19). In particular, counts at both Bonney Butte and Boise Ridge remained high during the recent drought, whereas counts declined at Chelan Ridge and the Goshutes, which suggests that some intermountain migrants began flying southwest across Oregon and then down the Sierra Nevada–Cascade range at the onset of drought in the northern Great Basin.

Intermountain Migration Corridor.—At the Goshutes, the common pattern of change included low to moderate counts in the early 1980s, increases through about 1998, and stable or declining counts thereafter (Tables 4–5 and Figs. 4–19). Other watchsites in the corridor showed

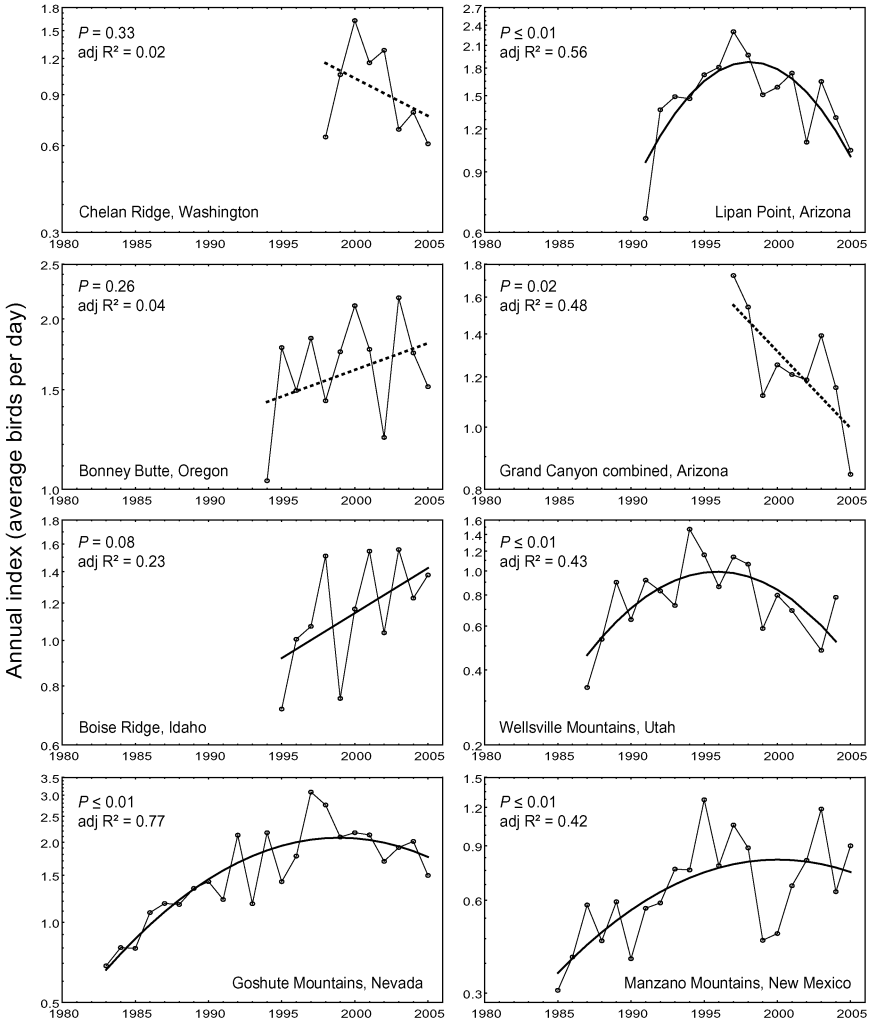

Fig. 5. Trends in annual count indexes of Ospreys (*Pandion haliaetus*) at western migration sites since the early 1980s. Solid lines illustrate significant ($P \leq 0.10$) regression models; dashed lines illustrate nonsignificant ($P > 0.10$) best-fit models.

similar patterns, which, since the early 1990s, parallel variation in drought severity in the region (e.g., see Fig. 3).

Rocky Mountain Migration Corridor.—For many species, patterns at the Manzanos and Wellsvilles were similar to those at the Goshutes (Figs. 4–19). That said, numbers of Sharp-shinned Hawks, Cooper's Hawks, American Kestrels, and Merlins decreased after the late 1990s in

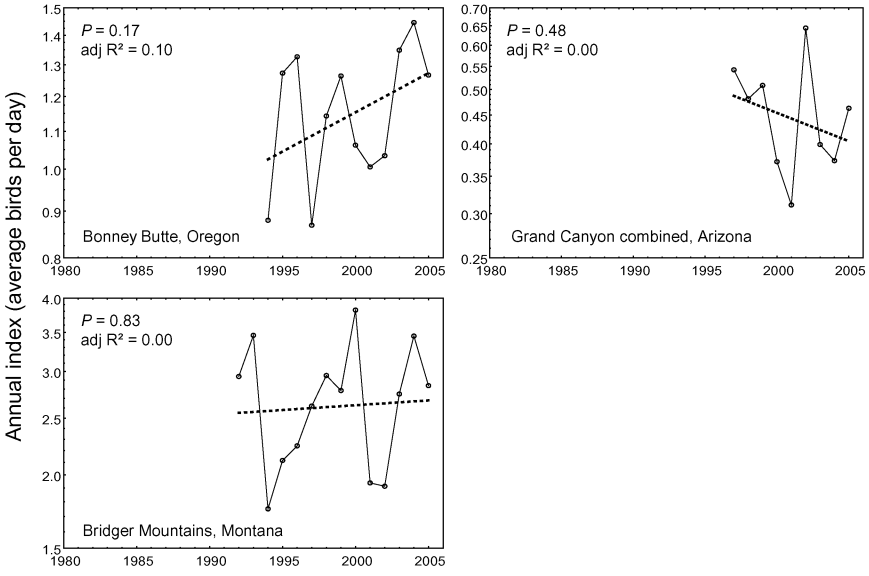

Fig. 6. Trends in annual count indexes of Bald Eagles (*Haliaeetus leucocephalus*) at western migration sites since the early 1980s. Dashed lines illustrate nonsignificant ($P > 0.10$) best-fit models.

the Goshutes and Wellsvilles, but were stable or increasing at the same time in the Manzanos (Figs. 8, 9, 16, and 17). Counts of Turkey Vultures remained relatively stable in the Goshutes, but declined significantly in the Manzanos and nonsignificantly in the Wellsvilles after 1997 (Fig. 4). Prairie Falcons declined significantly in the Goshutes and increased nonsignificantly in the Manzanos (Fig. 19). Other watchsites that began in the 1990s, including the Bridger Mountains and Mt. Lorette (Golden Eagles), showed patterns similar to those seen in the Wellsvilles and Manzanos.

Effects of drought.—There were 19 exchanges of banded accipiters between Boise Ridge and the Goshutes since 1995, and Red-tailed Hawks satellite tracked from the Goshutes passed through western Idaho (see Chapter 2). Nevertheless, the distribution of Boise Ridge band returns is decidedly more southwesterly (i.e., leading to primary winter ranges in southern California and northwestern Mexico; Idaho Bird Observatory [IBO] unpubl. data) than is that for the Goshutes (i.e., primary winter ranges from northwest to southwest Mexico; Hoffman et al. 2002). Moreover, 73% ($n = 14$) of Boise Ridge winter band returns from outside of Idaho since the drought began came from the west coast (Washington

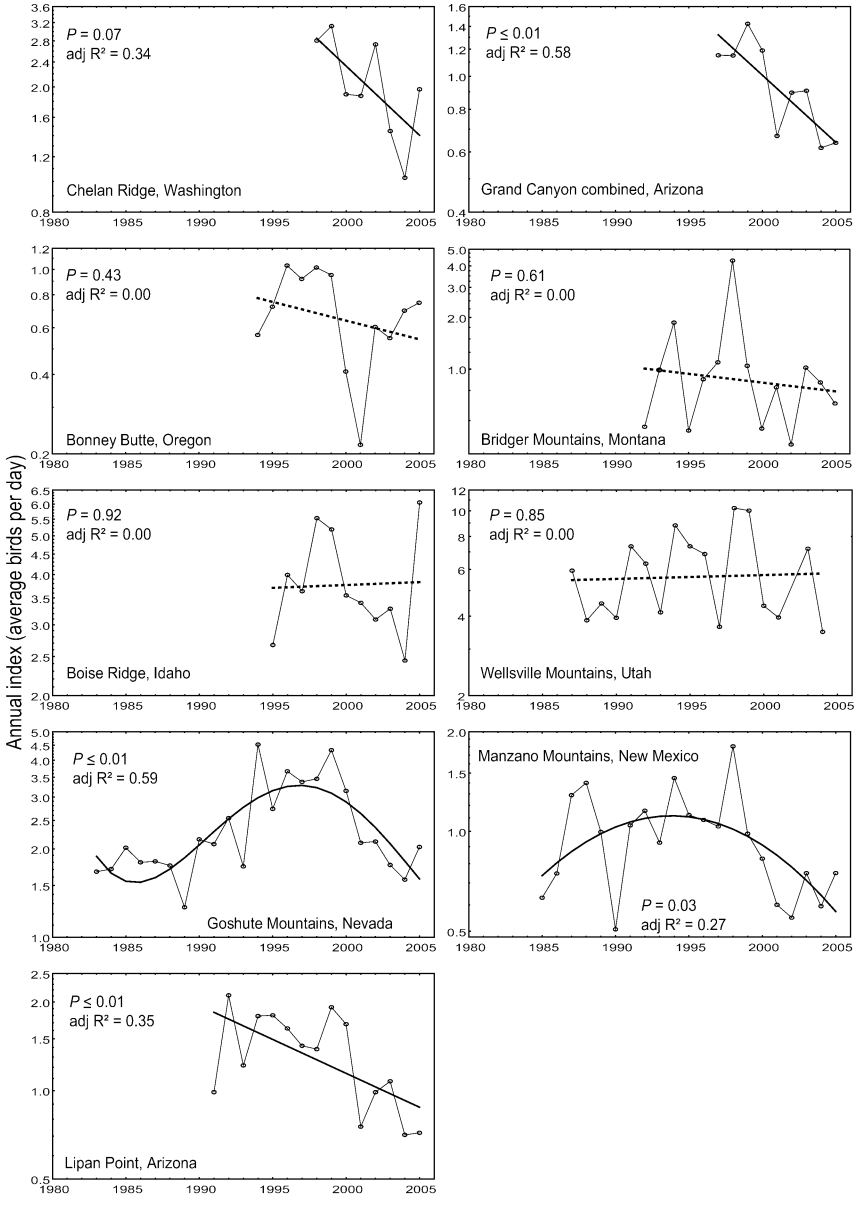

Fig. 7. Trends in annual count indexes of Northern Harriers (*Circus cyaneus*) at western migration sites since the early 1980s. Solid lines illustrate significant ($P \leq 0.10$) regression models; dashed lines illustrate nonsignificant ($P > 0.10$) best-fit models.

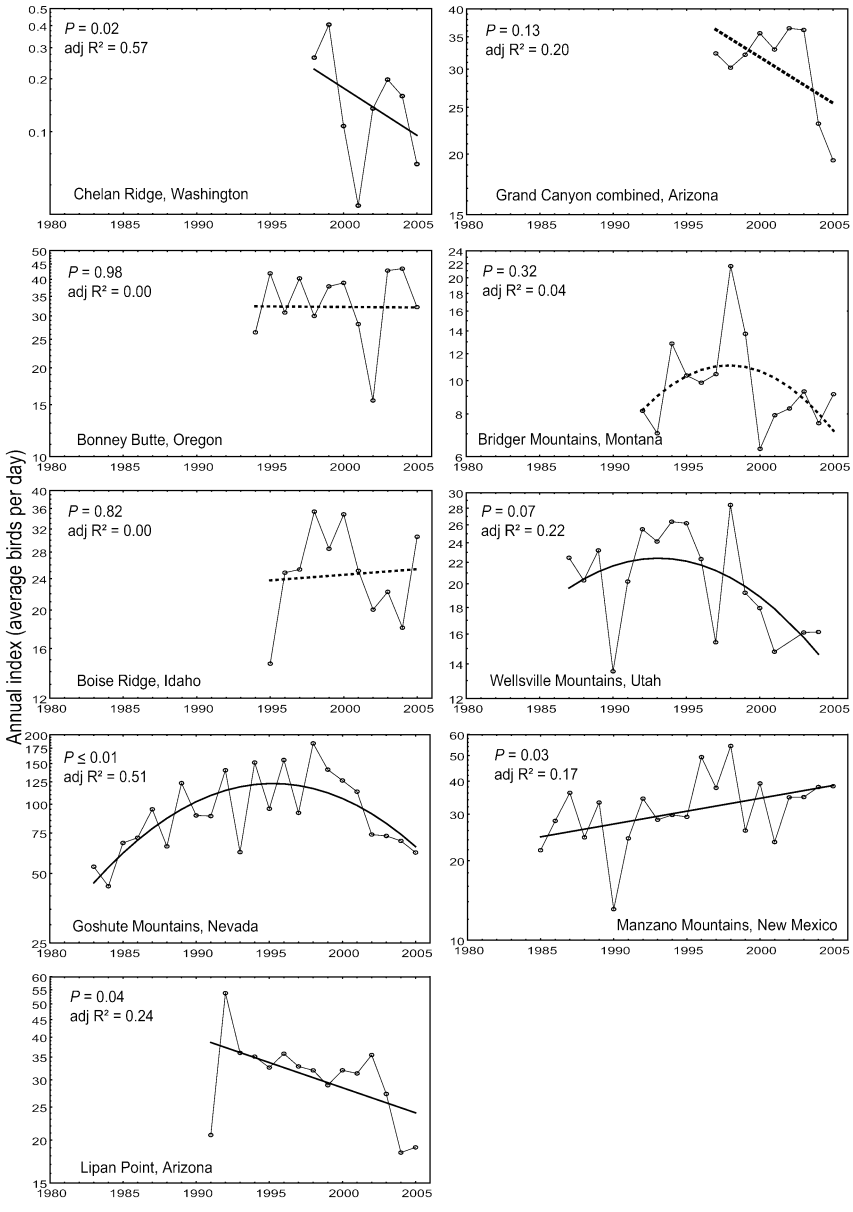

Fig. 8. Trends in annual count indexes of Sharp-shinned Hawks (*Accipiter striatus*) at western migration sites since the early 1980s. Solid lines illustrate significant ($P \leq 0.10$) regression models; dashed lines illustrate nonsignificant ($P > 0.10$) best-fit models.

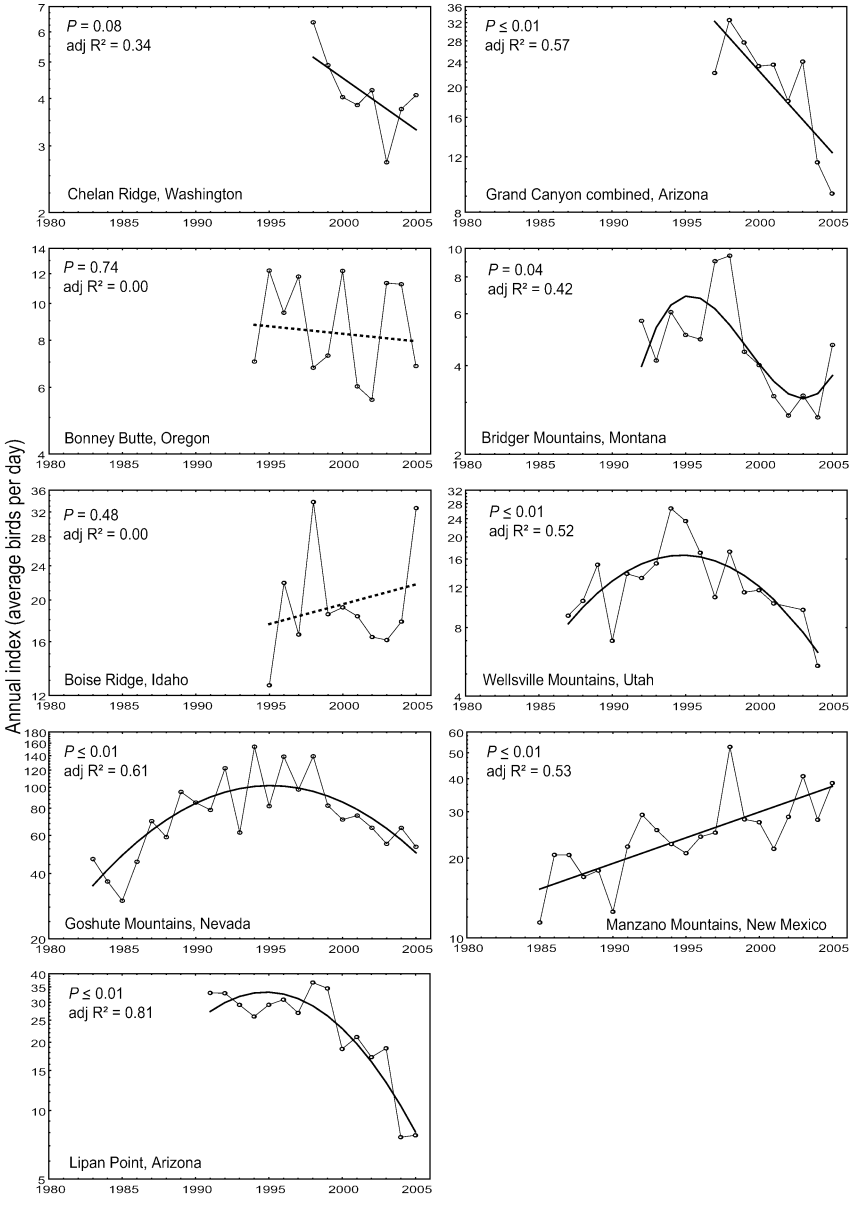

Fig. 9. Trends in annual count indexes of Cooper's Hawks (*Accipiter cooperii*) at western migration sites since the early 1980s. Solid lines illustrate significant ($P \leq 0.10$) regression models; dashed lines illustrate nonsignificant ($P > 0.10$) best-fit models.

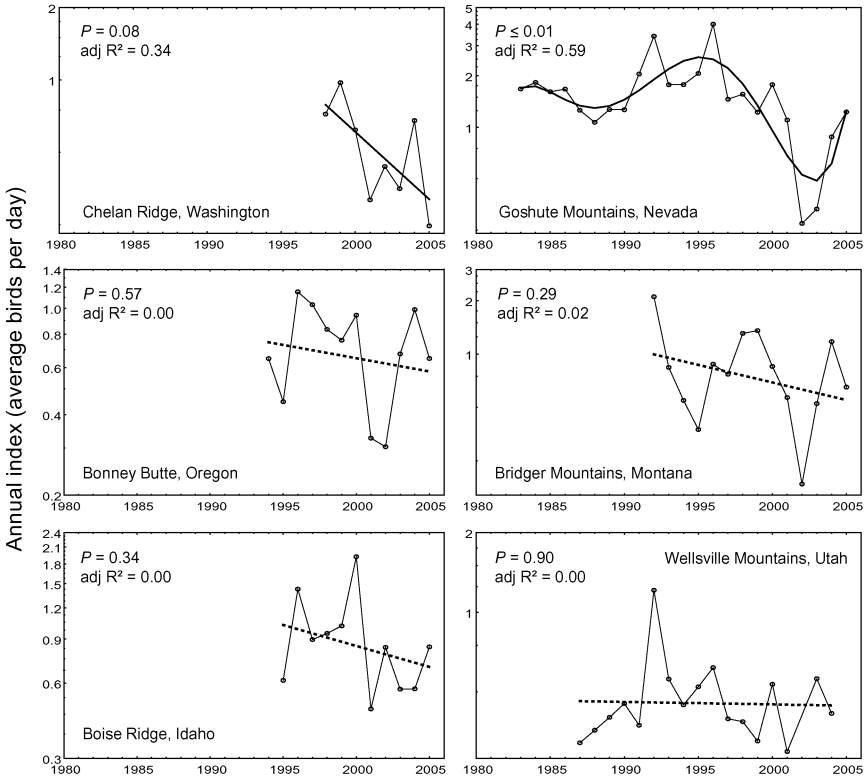

Fig. 10. Trends in annual count indexes of Northern Goshawks (*Accipiter gentilis*) at western migration sites since the early 1980s. Solid lines illustrate significant ($P \leq 0.10$) regression models; dashed lines illustrate nonsignificant ($P > 0.10$) best-fit models.

to Baja California), whereas only 38% ($n = 9$) of predrought returns came from this region. This suggests that Idaho migrants may have diverted west during the drought, presumably along other pathways to the Sierra–Cascade range.

The evidence above suggests that the relatively wet *El Nino* years of the early 1980s and early- to mid-1990s, interspersed with multiyear droughts in the late 1980s and, especially, since 1999, influenced the long-term patterns of migration across much of the interior West. The strongest correlations between regional moisture patterns and migration occurred in the central Intermountain corridor within the xeric Great Basin (e.g., see Fig. 3), in the Wellsville Mountains along the eastern edge of the Great Basin, and in the rain-shadow of the northeastern Cascade Mountains of Washington at the western edge of the Columbia Basin.

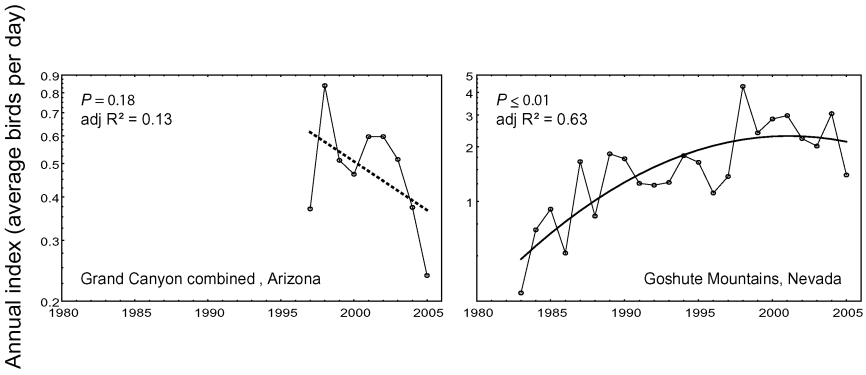

Fig. 11. Trends in annual count indexes of Broad-winged Hawks (*Buteo platypterus*) at western migration sites since the early 1980s. Solid lines illustrate significant ($P \leq 0.10$) regression models; dashed lines illustrate nonsignificant ($P > 0.10$) best-fit models.

Apparent declines since 1998 often were less pronounced or less prolonged at the Manzanos in the southern Rocky Mountains compared with those at the Goshutes in northern Nevada (e.g., compare patterns for Sharp-shinned Hawks and Cooper's Hawks; Figs. 8 and 9). This suggests either that Rocky Mountain populations of several species were relatively unaffected by the drought, or that there was a shift in migration away from the Great Basin that augmented counts in central and southern Rocky Mountain, masking any declines. Finally, certain species, including Turkey Vulture, were less affected by regional moisture patterns than were others, including Ospreys, Northern Harriers, Sharp-shinned Hawks, and Cooper's Hawks.

Species Trends

Turkey Vulture.—We calculated trends for this species at six watchsites (Tables 3–5). Numbers increased either significantly or not significantly at all six sites (Tables 3–5).

Osprey.—We calculated trends for this species at eight watchsites (Tables 3–5). Overall, numbers followed the drought pattern mentioned above (Fig. 5). Long-term increases occurred at the Goshutes and the Manzanos (Tables 3–5). After 1997, numbers declined significantly at both the Wellsvilles and the combined Grand Canyon sites (Table 5).

Bald Eagle.—We calculated trends for Bald Eagles (*Haliaeetus leucocephalus*) at three watchsites (Bonney Butte, Bridger Mountains, and combined Grand Canyon) (Tables 3–5). No significant trends were detected (Tables 2–5 and Fig. 6). Late-season snowfall limits full-season mountaintop counts of this species (cf. Buehler 2000).

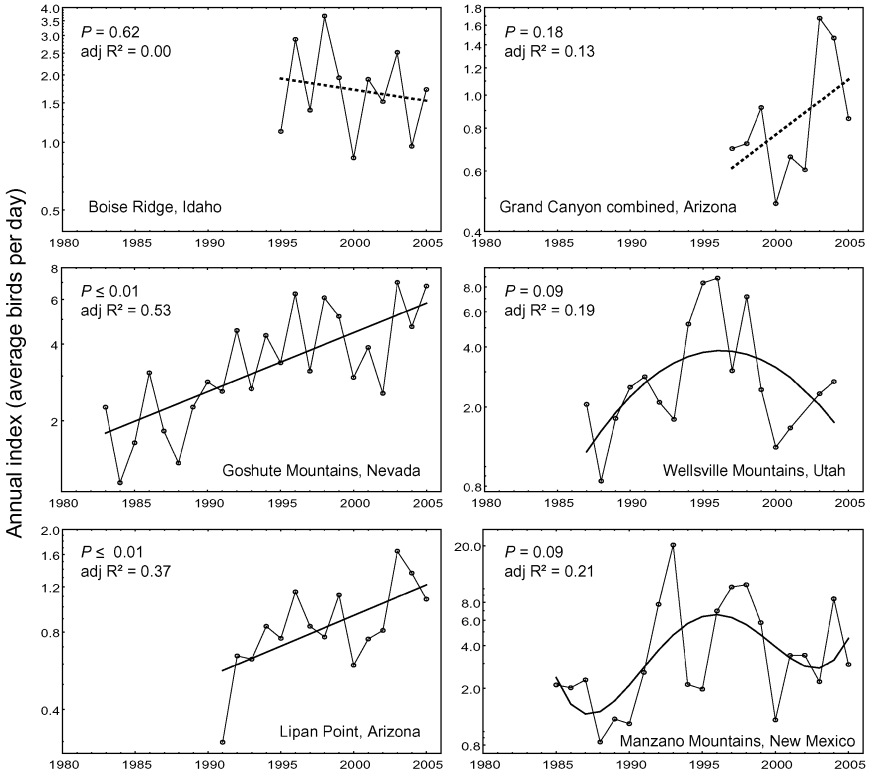

Fig. 12. Trends in annual count indexes of Swainson's Hawks (*Buteo swainsoni*) at western migration sites since the early 1980s. Solid lines illustrate significant ($P \leq 0.10$) regression models; dashed lines illustrate nonsignificant ($P > 0.10$) best-fit models.

Northern Harrier.—We calculated trends for this species at eight watchsites (Tables 3–5). Numbers at the Goshutes and Manzanos followed the drought pattern of increases before 1998 and declines thereafter, with no long-term trends (Fig. 7). No long-term trend occurred at the Wellsvilles, where there was a somewhat cyclical pattern of abrupt increases every three to four years followed by two to three years of gradual decline. After 1998, harriers declined significantly at five sites (Table 5).

Sharp-shinned Hawk.—We calculated trends for this species at nine watchsites (Tables 3–5). Counts of at the three longest-term sites followed the drought pattern, at least through 2001 (Fig. 8). Counts at the Goshutes continued to decline after 2001, whereas those at the Manzanos increased, and those at the Wellsvilles remained stable. Overall, there were significant

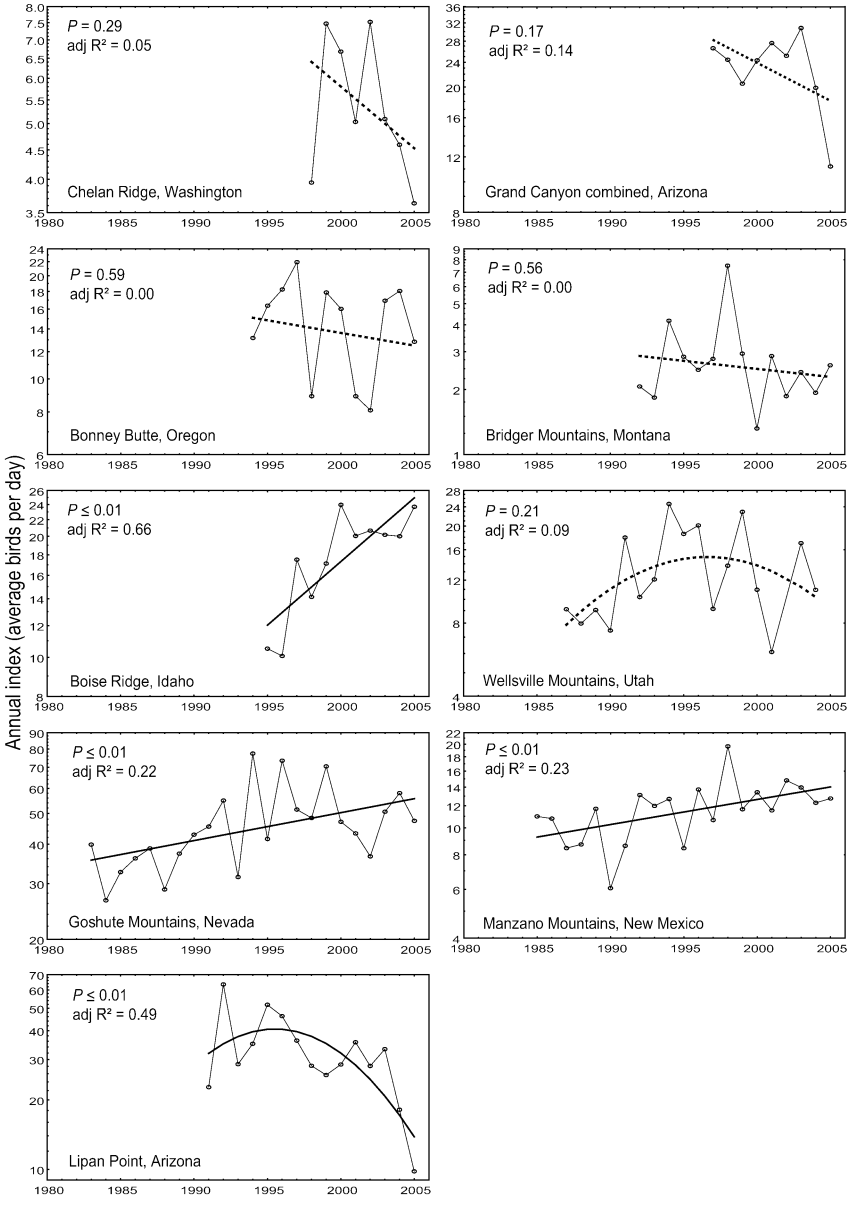

Fig. 13. Trends in annual count indexes of Red-tailed Hawks (*Buteo jamaicensis*) at western migration sites since the early 1980s. Solid lines illustrate significant ($P \leq 0.10$) regression models; dashed lines illustrate nonsignificant ($P > 0.10$) best-fit models.

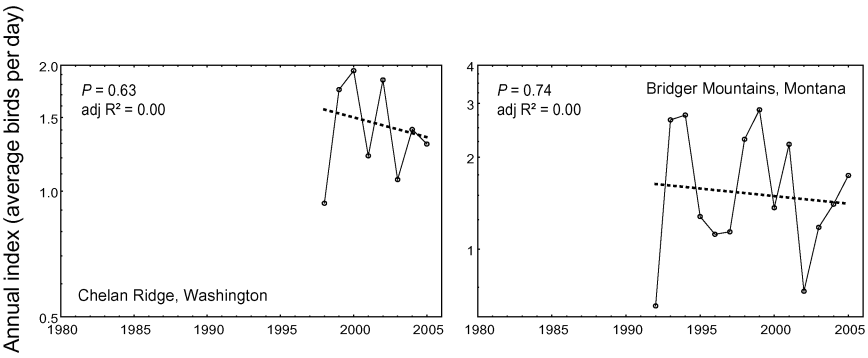

Fig. 14. Trends in annual count indexes of Rough-legged Hawks (*Buteo lagopus*) at western migration sites since the early 1980s. Dashed lines illustrate non-significant ($P > 0.10$) best-fit models.

declines at four of eight sites since 1998, but a significant increase in the Manzanos (Table 5).

Cooper's Hawk.—We calculated trends for this species at nine watchsites (Tables 3–5). In general, trends for Cooper's Hawks were similar to those for Sharp-shinned Hawks (Tables 3–5). At the Bridger Mountain site and at Lipan Point in the Grand Canyon, Cooper's Hawks declined more steeply than Sharp-shinned Hawks since 1998 (Fig. 9), whereas the reverse was true at Chelan Ridge. In the Manzanos, Cooper's Hawks increased at twice the rate of Sharp-shinned Hawks.

Northern Goshawk.—We calculated trends for this species at six watchsites (Tables 3–5). Northern Goshawks are relatively sedentary across most of North America, with dispersal and migration generally restricted to <200 km, and irruptive movements largely limited to northern populations (Mueller et al. 1977, Squires and Reynolds 1997, Sonsthagen et al. 2006). This suggests that migration counts typically reflect local rather than regional population trends. Numbers of the species declined significantly at the Goshutes and at Chelan Ridge (Tables 3–5 and Fig. 10). Irruptive movements peaking in 1992–1993 occurred at the Goshutes, Wellsvilles, and Bridger Mountains (Hoffman and Smith 2003). Even so, the species clearly exhibited drought-related patterns at the Goshutes, Chelan Ridge, and, possibly, the Bridgers.

Broad-winged Hawk.—Broad-winged Hawks are less common in western North America than in eastern North America (Goodrich et al. 1996). The highest average counts in the West, a long-term average of slightly more than 100 birds, occur at the Golden Gate Raptor Observatory on the Marin Headlands of central California (A. Fish pers. comm.).

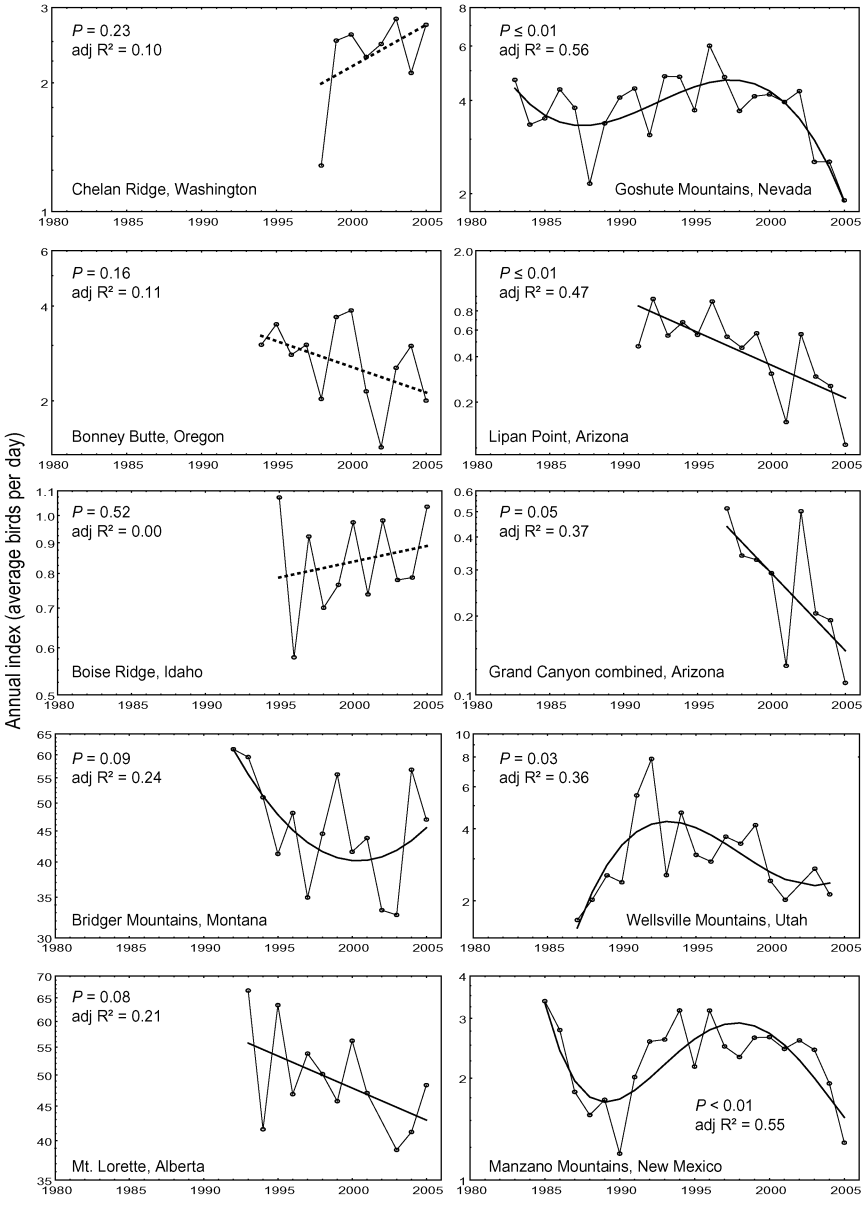

Fig. 15 Trends in annual count indexes of Golden Eagles (*Aquila chrysaetos*) at western migration sites since the early 1980s. Solid lines illustrate significant ($P \leq 0.10$) regression models; dashed lines illustrate nonsignificant ($P > 0.10$) best-fit models.

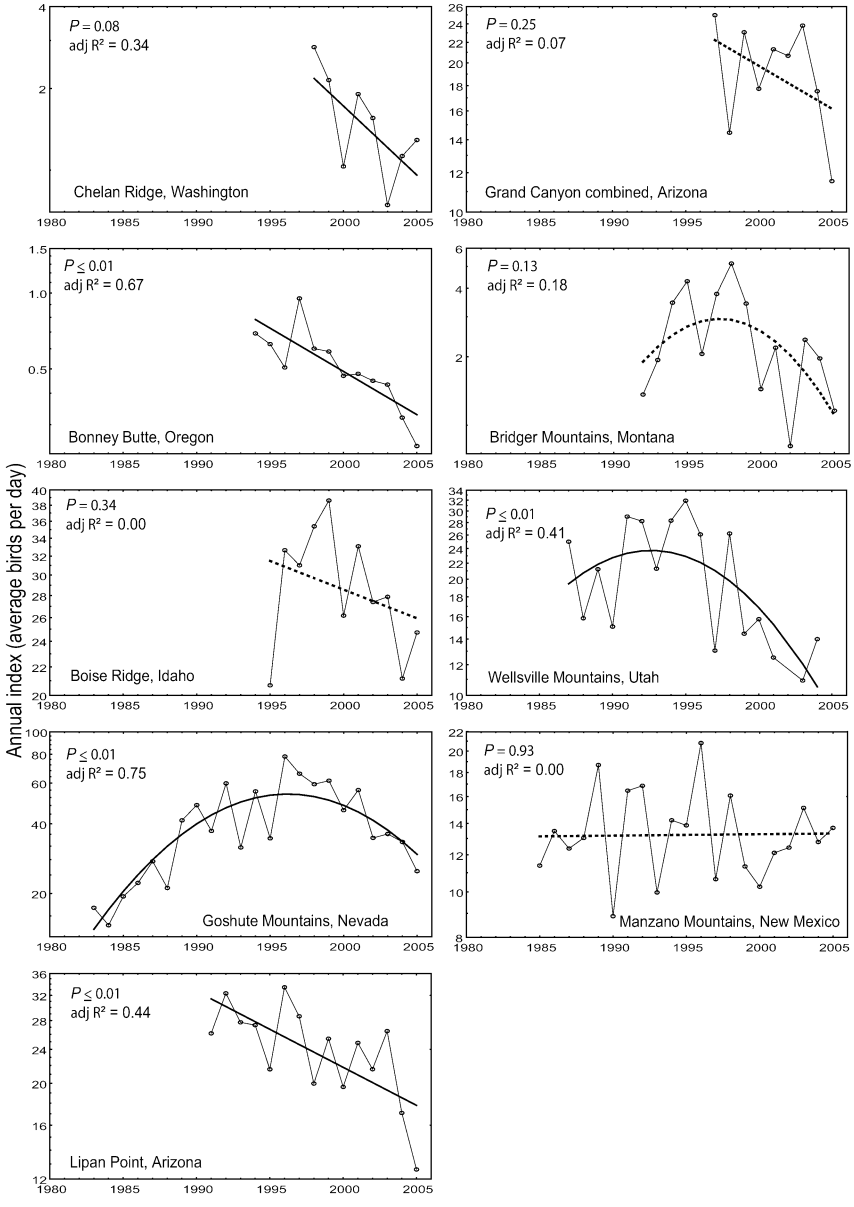

Fig. 16. Trends in annual count indexes of American Kestrels (*Falco sparverius*) at western migration sites since the early 1980s. Solid lines illustrate significant ($P \leq 0.10$) regression models; dashed lines illustrate nonsignificant ($P > 0.10$) best-fit models.

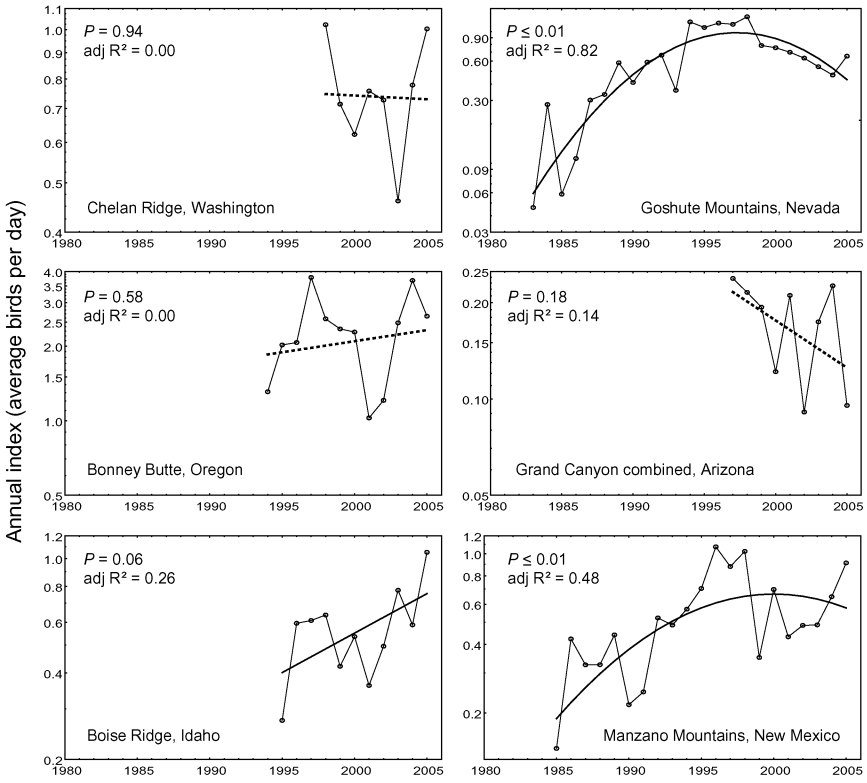

Fig. 17. Trends in annual count indexes of Merlins (*Falco columbarius*) at western migration sites since the early 1980s. Solid lines illustrate significant ($P \leq 0.10$) regression models; dashed lines illustrate nonsignificant ($P > 0.10$) best-fit models.

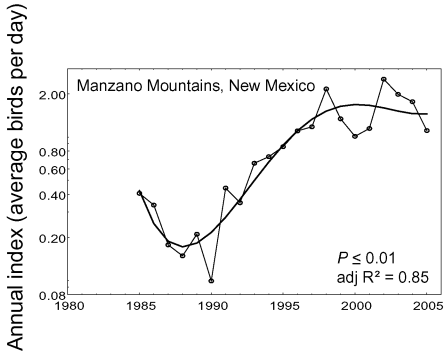

Fig. 18. Trends in annual count indexes of Peregrine Falcons (*Falco peregrinus*) at western migration sites since the early 1980s. The solid line illustrates a significant ($P \leq 0.10$) regression model.

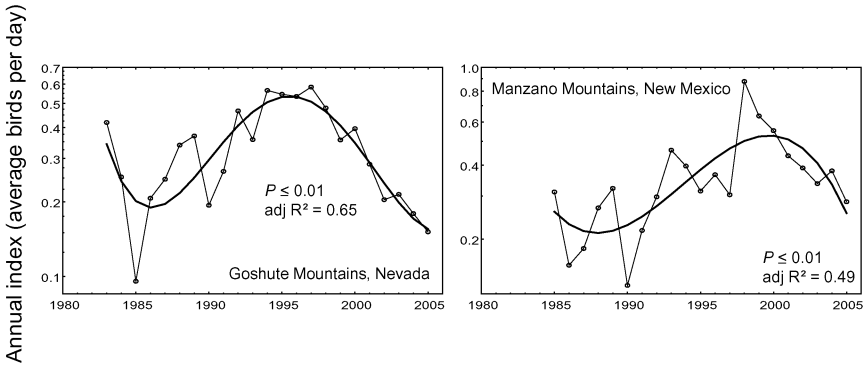

Fig. 19. Trends in annual count indexes of Prairie Falcons (*Falco mexicanus*) at western migration sites since the early 1980s. Solid lines illustrate significant ($P \leq 0.10$) regression models.

We calculated trends for this species at two watchsites (Tables 2–5). There was a significant long-term increase at the Goshutes, with numbers stabilizing after 1999 (Tables 3–5 and Fig. 11). Counts at the Grand Canyon declined significantly after 1997 (Table 5).

Swainson's Hawk.—We calculated trends for Swainson's Hawks at five watchsites (Tables 3–5). Significant long-term increases occurred at the Goshutes and Lipan Point. The Wellsvilles, Goshutes, Manzanos, and Lipan Point indicated increases through the late 1990s, and brief declines thereafter (except at Lipan Point) followed by increases (Fig. 12).

Red-tailed Hawk.—We calculated trends for this species at nine watchsites (Tables 3–5). Significant long-term increases in counts occurred at the Goshutes and Manzanos, with a significant short-term increase at Boise Ridge since 1995 (Fig. 13). A significant long-term decline occurred at Lipan Point. Numbers at the combined Grand Canyon and Wellsville sites followed the drought pattern (Tables 3–5).

Rough-legged Hawk.—We calculated trends for Rough-legged Hawks at two watchsites (Table 3 and Fig. 14). There were no significant trends at either Chelan Ridge or the Bridger Mountains sites. Late-season snowfall limits full-season mountaintop counts of this species (cf. Bechard and Swem 2002).

Golden Eagle.—We calculated trends for Golden Eagles at 10 watchsites. Numbers declined significantly at five sites and were stable or increasing at five sites (Fig. 15). The Goshutes and Manzanos showed significant long-term declines of similar magnitude (Table 3). Farther south, the combined Grand Canyon count exhibited a similar trend (Table 5). Mt. Lorette and Bridger Mountains, both of which count thousands of individuals annually (Table 2), exhibited trends similar to

those seen at most other sites (Fig. 15), with declines beginning in the early 1990s (Table 3).

American Kestrel.—We calculated trends for American Kestrels at eight watchsites. Long-term trends were mixed, but numbers declined at seven of the sites since 1997 (Tables 3–5). Counts at the Goshutes and Boise ridge followed the drought pattern (Table 5 and Fig. 16), but long-term trends were increasing (Table 3). Trends at the combined Grand Canyon were similar, but the post-1997 decline there was less steep than at the Goshutes (Table 5). Numbers at the Manzanos were stable. Numbers at the Wellsvilles and Bridgers tracked the drought, and long-term trends at the two sites were negative, significantly so at the Wellsvilles. Declines also occurred at Bonney Butte and Chelan Ridge in the Pacific Coast corridor.

Merlin.—We calculated trends for this species at six watchsites. Numbers increased at the Goshutes and at Boise Ridge but declined at the combined Grand Canyon (Tables 3–5 and Fig. 17). Numbers at the Manzanos tracked the drought, but increased significantly in the long-term. There were no significant trends at Bonney Butte or Chelan Ridge (Table 5). Recent declines at the Goshutes and Grand Canyon, but not at Boise Ridge, combined with the fact that Merlins do not breed in the Great Basin, suggest that birds shifted their movements geographically in response to the drought.

Peregrine Falcon.—We calculated trends for this species at one watchsite. Numbers increased 9.6% annually at the Manzanos (Table 3 and Fig. 18), with numbers following the drought pattern. Nearly identical patterns of long-term variation were evident at the Goshutes and Wellsville sites (see Hoffman and Smith 2003).

Prairie Falcon.—We calculated trends for this species at two watchsites (Tables 3–5). Numbers at the Goshutes and Manzanos sites followed the drought pattern similar to Northern Goshawks and Golden Eagles (Fig. 19). Numbers declined significantly at the Goshutes over the long term, whereas recent counts at the Manzanos are above those from the 1980s.

Summary of Trends

Western counts of six species increased since the early 1980s, whereas those of three species declined. Three species showed mixed trends, and counts of Northern Harriers were relatively stable (Table 6). Counts of 13 species appear to have been affected by a regional drought, with increases up to 1998, and declining or stable numbers thereafter.

Acknowledgments

The analyses presented here could not have been accomplished without the efforts of hundreds of volunteer migration counters. Each migration

Table 6. Summary of trends at western watchsites.

Species	1980s to 2005 (three sites)	1980s to 1997 (five sites)	1998–2005 (nine sites)	Overall pattern
Turkey Vulture	Stable–Increase	Stable–Increase	Variable	Uniformly stable to increasing, except for a decline in New Mexico since 1998.
Osprey	Increase	Increase	Variable	Long-term and pre-1998 increases at most pre-mid-1990s sites; declines common since 1998.
Bald Eagle	–	Stable	Stable	No trends in Montana, Arizona, and Oregon.
Northern Harrier	Stable	Variable	Decrease	No long-term or 1980s to 1997 trends at most pre-mid-1990s sites; declines common since 1998.
Sharp-shinned Hawk	Variable	Variable	Variable	Increases common pre-1998; declines common since.
Cooper's Hawk	Increase	Increase	Variable	Long-term and 1980s to 1997 increases at most pre-mid-1990s sites; declines common since 1998.
Northern Goshawk	Stable–Decrease	Stable	Stable–Decrease	Uniformly stable or slight declines except for long-term decline in Nevada and a recent decline in Washington.
Broad-winged Hawk	Increase	Increase	Stable–Decrease	Long-term increase in Nevada, but stable there since 1998; recent decline in Arizona.
Swainson's Hawk	Stable-Increase	Increase	Variable	Uniformly increasing 1980s to 1997; mixed trends since 1998.
Red-tailed Hawk	Increase	Increase	Variable	Mostly long-term and 1980s to 1997; mostly stable or slight declines since 1998.
Rough-legged Hawk	–	Stable	Stable	Stable or slight declines in Montana since 1992 and in Washington since 1998.
Golden Eagle	Decrease	Stable–Decrease	Stable–Decrease	Declines at most long-term and at both high-volume northern Rockies sites; declines common since 1998.

Table 6. Continued.

Species	1980s to 2005 (three sites)	1980s to 1997 (five sites)	1998–2005 (nine sites)	Overall pattern
American Kestrel	Variable	Variable	Decrease	Variable long-term and 1980s to 1997 trends; declines common since 1998.
Merlin	Increase	Increase	Variable	Uniformly increasing long-term and pre-1998; mostly stable to decreasing after 1997.
Peregrine Falcon	Increase	Increase	Stable	Long-term and 1980s to 1997 increases in New Mexico; stable or slight declines since 1998.
Prairie Falcon	Stable–decrease	Increase	Decrease	Long-term decline in Nevada; long-term stable or slight increase in New Mexico, with increases at both sites before 1998, then declines.

Notes: Decrease = significant ($P \leq 0.10$) decreases at most sites and no significant increases; Increase = significant increases at most sites and no significant decreases; Stable–Decrease = most of trends nonsignificant, but at least one significant decrease and no significant increases; Stable-Increase = most trends nonsignificant, but at least one significant increase and no significant decreases; Variable = at least one significant decrease and one significant increase; Stable = no significant trends.

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Literature Cited

Bechard, M. J., and T. R. Swem. 2002. Rough-legged Hawk (*Buteo lagopus*). *In* The Birds of North America, no. 641 (A. Poole and F. Gill, Eds.). Birds of North America, Philadelphia.

Buehler, D. 2000. Bald Eagle (*Haliaeetus leucocephalus*). *In* The Birds of North America, no. 506 (A. Poole and F. Gill, Eds.). Birds of North America, Philadelphia.

Farmer, C. J., D. J. T. Hussell, and D. Mizrahi. 2007. Detecting population trends in migratory birds of prey. Auk 124:1047–1062.

Francis, C. M., and D. J. T. Hussell. 1998. Changes in numbers of land birds counted in migration at Long Point Bird Observatory, 1961–1997. Bird Populations 4: 37–66.

Goodrich, L. J., S. C. Crocoll, and S. E. Senner. 1996. Broad-winged Hawk (*Buteo platypterus*). *In* The Birds of North America, no. 218 (A. Poole and F. Gill, Eds.). Academy of Natural Sciences, Philadelphia, and American Ornithologists' Union, Washington, D.C.

Hoffman, S. W., and J. P. Smith. 2003. Population trends of migratory raptors in western North America, 1977–2001. Condor 105:397–419.

Hoffman, S. W., J. P. Smith, and T. D. Meehan. 2002. Breeding grounds, winter ranges, and migratory routes of raptors in the Mountain West. Journal of Raptor Research 36:97–110.

Hussell, D. J. T. 1981. The use of migration counts for monitoring bird population levels. Pages 92–102 *in* Estimating Numbers of Terrestrial Birds (C. J. Ralph and J. M. Scott, Eds.). Studies in Avian Biology, no. 6.

Mueller, H. C., D. D. Berger, and G. Allez. 1977. The periodic invasions of goshawks. Auk 94:652–663.

National Oceanographic and Atmospheric Administration (NOAA). 2006. National climatic data center. [Online.] Available at www.ncdc.noaa.gov/oa/climate/research/monitoring.html.

Ruelas Inzunza, E. 2005. Raptor and wading bird migration in Veracruz, Mexico: Spatial and temporal dynamics, flight performance, and monitoring applications. Ph.D. dissertation, University of Missouri, Columbia.

Sherrington, P. 2003. Trends in a migratory population of Golden Eagle (*Aquila chrysaetos*) in the Canadian Rocky Mountains. Bird Trends Canada 9:34–39.

Smith, J. P., and S. W. Hoffman. 2000. The value of extensive raptor migration monitoring in western North America. Pages 597–615 *in* Raptors at Risk (R. D. Chancellor and B.-U. Meyburg, Eds.). World Working Group on Birds of Prey and Owls, Berlin, and Hancock House Publishers, Surrey, British Columbia.

Smith, J. P., P. Grindrod, and S. W. Hoffman. 2001. Migration counts indicate Broad-winged Hawks are increasing in the West: Evidence of range expansion? Pages 93–103 *in* Hawkwatching in the Americas (K. L. Bildstein and D. Klem, Jr., Eds.). Hawk Migration Association of North America, North Wales, Pennsylvania.

Sonsthagen, S. A., R. L. Rodriguez, and C. M. White. 2006. Satellite telemetry of Northern Goshawks breeding in Utah—I. Annual movements. Pages 239–251 *in* The Northern Goshawk: A Technical Assessment of Its Status, Ecology, and Management (M. L. Morrison, Ed.). Studies in Avian Biology, no. 31.

Squires, J. R., and R. T. Reynolds. 1997. Northern Goshawk (*Accipiter gentilis*). *In* The Birds of North America, no. 298 (A. Poole and F. Gill, Eds.). Academy of Natural Sciences, Philadelphia, and American Ornithologists' Union, Washington, D.C.

Zalles, J. L., and K. L. Bildstein, Eds. 2000. Raptor Watch: A Global Directory of Raptor Migration Sites. Birdlife International, Cambridge, United Kingdom, and Hawk Mountain Sanctuary Association, Kempton, Pennsylvania.