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Continental-Scale Decline of the American Kestrel--North America's Smallest Falcon

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Some unequivocal signs of trouble for North America's smallest falcon have emerged recently: New Jersey's Cape May Bird Observatory reported a seasonal total of 5,255 American Kestrels (*Falco sparverius*) for the autumn migration season (September - November) of 2006. This count is more than 40% below the 30-year site average of 9,271 migrating kestrels. A similar pattern occurred at other eastern hawkwatches. For example, Hawk Mountain Sanctuary in Pennsylvania had 412 kestrels while Holiday Beach, Ontario, recorded 2,113 kestrels in 2006; in both cases, roughly 30% less than the 40 and 30-year averages for the two sites. We could present a similar picture for many of the other monitoring sites across the continent.

What is Happening to American Kestrel Populations?

The red flags have been raised for several years now, but the scope of the issue was recently magnified based on a new 30-year continental-scale assessment presented in *The State of North America's Birds of Prey* (SNABP), a new book prepared by the Raptor Population Index (RPI) Project team (see http://rpi-project.org) and just published in June 2008 (see page 5). The challenge now is to determine the reasons for the species' decline, with four primary hypotheses currently being evaluated.

Is the American Kestrel Declining?

The answer is a sound yes. Available data on kestrel populations come from several different data sources: migration counts, the Breeding Bird Survey (BBS), Christmas Bird Counts (CBC), and regional nest-box programs.

The validity of information originating from different survey types to support this statement varies. Migration counts have been used in the past to determine population trends of this and other species of migratory raptors (e.g., Bednarz et al. 1990, The Auk 107:96-109; Hoffman and Smith 2003, The Condor 105:397-419). In contrast, for most raptor species, BBS data are considered unreliable; however, the American Kestrel is one of the few raptor species for which this is not true, because they tend to inhabit open habitats, are relatively abundant, and are therefore easily detected along BBS survey routes.

Because the American Kestrel is a partial migrant (a species whose winter range overlaps largely with its breeding range) whose winter range falls largely within the well-sampled area of southern Canada and the United States, there also is significant value in using

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CBC data to support these statements.

Raptor Population Index Project Data

Here we use migration count data recently published in the SNABP book to present a more accurate picture of the current status of the American Kestrel.

In the East, data originate from seven long-term monitoring sites in five U.S. states and Canadian provinces. The time series analyzed included counts spanning 30 years (1974-2005), in which a long-term 'reference' of those declines is presented. However, the sharpest declines in kestrel populations have been reported within the last 10 years, so a second estimate of change is presented to represent the most recent decade (Table 1).

Table 1. Percentage of annual change (decrease [-] or increase [+]) in counts of American Kestrels at seven migration monitoring sites in eastern North America. Statistically significant trends are marked with an asterisk.

Raptor Migration Monitoring Site	Annual Change 1974-2004	Annual Change 1994-2004
Lighthouse Point, CT	-3.1*	-9.2*
Cape May, NJ	-4.5*	-4.5*
Montclair, NJ	-3.3*	-3.3*
Hawk Mountain, PA	-1.6*	-4.8*
Waggoner's Gap, PA	-0.3	+0.9
Holiday Beach, ONT	-0.4	-4.1*
Hawk Ridge, MN	+3.2*	-0.7

The 30-year trend estimates from eastern migration sites are robust (statistically precise), except for Hawk Ridge, Minnesota (an indication of high inter-annual variation in counts). However, a look at the most recent decade showed significant declines at most sites, including Hawk Ridge. The single exception was Waggoner's Gap, Pennsylvania, which showed a slight but statistically non-significant increase during the recent decade.

If such widespread declines reflect a true population change, then one might expect a strong correspondence with the demographic "signals" detected in other surveys from the American Kestrel's breeding or winter ranges. Data from BBS routes in Connecticut, Massachusetts, Maine, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, New Brunswick, Nova Scotia, Ontario, and Québec, the relevant northeastern breeding range of kestrels, showed a negative trend of 1.4% per year from 1976-2003 (see http://www.mbr-pwrc.usgs.gov/bbs/bbs.html). An even higher rate of decline of 4.6% per year was shown in CBC winter data from the same states and for the same period (see http://www.audubon.org/bird/cbc), whereas an identical 1.4% per year decline was shown farther south in the heart of the kestrel's eastern winter range in Delaware, Florida, Georgia, Kentucky, Maryland, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia.

Western migration counts offer a more complex picture, in part because the coverage is shorter (only two sites have data that extend beyond 20 years of continuous monitoring), but also because the region is geographically more complex and extensive. The data come from eight sites in seven states, with common coverage at all sites only during the most recent decade (Table 2). The results emerge with a similar general pattern: Declines at most sites (especially recently), mostly of a larger magnitude than in the East, and with statistically significant trends at five sites. Exceptions to the general pattern of decline include a long-term increase in the northern Great Basin (Nevada), but a sharp downturn in the recent decade, and no long-term or recent trend in the southern Rocky Mountains (New Mexico).

The corresponding BBS data from the presumed breeding range of western American Kestrels (Arizona, California, Idaho, Nevada, Oregon, Utah, Washington, Montana, Wyoming, Colorado, New Mexico, and British Columbia) also indicate an overall declining trend of 1.7% per year from 1983-2004. Similarly, CBC data for 1983-2005 show a decrease of 1.5% per year for the region encompassed by Alaska, Arizona, California, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming, Alberta,

Table 2. Average annual percentage change (decrease [-] or increase [+]) in counts of American Kestrels at eight migration monitoring sites in western North America. Statistically significant trends are marked with an asterisk.

Raptor Migration Monitoring Site	Annual Change Long-term	Annual Change 1995-2005
Goshute Mountains, NV (1983-2005)	+3.4*	-5.9*
Manzano Mountains, NM (1985-2005)	+0.1	+0.1
Wellsville Mountains, UT (1987-2004)	-3.6*	-8.6*
Lipan Point, AZ (1991-2005)	-4.1*	-4.1*
Grand Canyon, AZ (Lipan Pt. + Yaki Pt.: 1997-2005)	--	-2.8
Bonney Butte, OR (1994-2005)	--	-7.9*
Boise Ridge, ID (1995-2005)	--	-1.9
Chelan Ridge, WA (1998-2005)	--	-11.7*

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British Columbia, Northwest Territories, and the Yukon Territory. The CBC trend for this region for the recent decade (1995-2005) decreased at an even higher rate of 2.3% per year.

Four Hypotheses to Explain Kestrel Declines

There is no simple answer to the question of why American Kestrels are declining. These widespread declines were the subject of a special symposium organized by renowned kestrel specialist Dr. David Bird of McGill University in Québec and convened last autumn at a joint meeting of the Raptor Research Foundation and Hawk Migration Association of North America in Pennsylvania. One of the objectives of this symposium was to discuss the extent and nature of American Kestrel declines as reported by different surveys, and to explore the possible reasons of such declines. In the recent conservation status report for kestrels included in SNABP, Farmer and colleagues highlight four possibilities.

Contamination. The effects of DDT on the reproductive success of American Kestrels have been widely discussed and documented in the literature (e.g., Porter and Wienemeyer 1969, Science 165:199-200; Lincer 1975, Journal of Applied Ecology 12:781-793). As Farmer and colleagues wrote, these effects may have been carried into the late 1970s, and although DDT has been banned for use within the United States, other sources of contamination also may be having negative effects (e.g., witness the latest and growing fervor over widespread contamination from PBDEs associated flame retardants by visiting http://www.epa.gov/oppt/pbde/).

Habitat Change. The American Kestrel occupies a wide variety of open and semi-open habitats. In many areas of North America, the availability of such habitats grew enormously during the first half of the 20th century as widespread logging and suburban/urban development opened up extensive forested areas previously unsuited to kestrels. During the past several decades, however, this trend has reversed in many areas as regrowth of forests has occurred. Especially in the East, open habitats have undergone a dramatic change over the last few decades, resulting in a net loss at a regional scale (Hall et al. 1991, Ecology 72:628-640). The replacement of open habitats by more shrubby or forested habitats, a process known as secondary succession, has been responsible for declines of other species of birds (e.g., the Eastern Towhee [Pipilo erythrophthalmus]; Hagan 1993, The Auk 110:863-874), and it has been hypothesized to be responsible at least in part for kestrel declines. In the West, widespread, long-term drought also appears to have played a major role in recent declines in migration counts of several raptor species, including the kestrel (Smith et al. 2008, SNABP).

Increased Predation. According to Farmer et al. (2008, SNABP), population growth of the larger Cooper's Hawk (*Accipiter cooperii*) may be contributing to kestrel declines in many regions, because "studies at Hawk Mountain and elsewhere have demonstrated that this species regularly preys upon American Kestrels."

West Nile Virus. This introduced virus has had impacts on populations of several bird species, including several common raptors. Although researchers do not yet know if exposure to WNV has ultimate fitness consequences for American Kestrels, some regional studies have demonstrated high exposure rates for kestrels based on nest-monitoring programs. For example, nest productivity in southeastern Pennsylvania decreased 57% between 2000 and 2004, with 95% of the adults using nest boxes exposed to the virus (Rusbuldt et al. 2006, Pennsylvania Birds 20:112-117).

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Migration count data from multiple sites analyzed as part of the RPI Project and presented in the SNABP book have made an important contribution to document and quantify the decline of kestrels across much of the species' range in North America. Moreover, unlike for most other raptor species, other long-term monitoring data from the BBS and CBC programs also provide robust trend data for kestrels and corroborate the negative indicators from the migration-monitoring network. Use of this strong combination of monitoring data as an early warning system promotes action in the conservation community to formulate research hypotheses concerning possible causal factors behind the declines. Although clarifying the answers may still require a considerable amount of effort, fortunately the call-to-action has emerged while we still have a chance to help maintain the American Kestrel as one of our most common North American raptors (Sullivan and Wood 2005, North American Birds 59:20-30).