Transactions of the Illinois State Academy of Science
(2008), Volume 101, #3&4, pp. 217-224

received 1/28/08
accepted 7/20/08

Population Trends of Raptors Admitted to the Illinois Raptor Center, 1995-2006

Mallory R. Neese[1], Jane Seitz[2], Jacques Nuzzo[2], and David Joseph Horn[1,3]
[1]Department of Biology, Millikin University, 1184 W. Main St., Decatur, IL 62522, USA
[2]Illinois Raptor Center, 5695 W. Hill Rd., Decatur, IL 62522, USA
[3]Corresponding Author: Email: dhorn@millikin.edu

ABSTRACT

Raptor population status reflects overall environmental health with various species of hawks and owls responding differently to urbanization, agricultural intensification, and other anthropogenic factors. We examined the population trends of raptors admitted to the Illinois Raptor Center in Decatur, IL from 1995-2006. For the study, 929 raptors of six species admitted to the center were used including Cooper's Hawk (*Accipiter cooperii*), Red-tailed Hawk (*Buteo jamaicensis*), American Kestrel (*Falco sparverius*), Eastern Screech-Owl (*Otus asio*), Great Horned Owl (*Bubo virginianus*), and Barred Owl (*Strix varia*). Changes in the number of raptors admitted per year were examined over time, and compared with changes in land use and human population growth in three central Illinois counties. Except for Barred Owls, the number of raptors admitted changed over time. Observed trends corresponded with Christmas Bird Count data, and the appearance of West Nile Virus in central Illinois may have influenced the number of raptors admitted. We suggest that wildlife rehabilitation centers can be used as an early warning signal of raptor population status.

INTRODUCTION

As focal species, raptor populations can be used to monitor an ecosystem's health (Sanchez-Zapata et al., 2003) and changes in eagle, hawk, falcon, and owl counts may be an indicator of harmful effects that humans are contributing to the environment (Hoffman and Smith, 2003). Numerous studies have concluded that raptors are sensitive to environmental changes initiated by natural and anthropogenic causes (Rodriguez-Estrella et al., 1998). For example, in the 1960's and 1970's, pesticide use led to the decline in many species of raptors (Kirk and Hyslop, 1998). Currently, urbanization, agricultural intensification, human activity, and emerging diseases are threatening raptor species (Deem et al., 1998; Kirk and Hyslop, 1998; Joyner et al., 2006).

Berry et al. (1998) found several raptor species that avoid areas with as little as 5-7% urbanization. Leptich (1994) found that a majority of raptors exhibit decreased abundance and diversity in highly developed irrigated agriculture. Some raptors such as Cooper's Hawks, Red-tailed Hawks, and American Kestrels, however, show minimal sensitivity to urbanization and/or agricultural development (Berry et al., 1998; Boal and Mannan, 1999).

Diseases like West Nile Virus (WNV, Joyner et al., 2006) and changing prey densities (Steenhof et al., 1999) may cause fluctuations in raptor populations (although see Stout et al., 2005). Joyner et al. (2006) suggest a negative impact of WNV on local raptor populations due to decreased mean monthly admissions to the Wildlife Center of Virginia immediately following a WNV outbreak. Cyclical or numerical fluctuations in prey produce similar responses in raptor populations (Galushin, 1974; Kirk and Hyslop, 1998). Korpimäki and Norrdahl (1991) found that European Kestrel (*Falco tinnunculus*), Short-eared Owl (*Asio flammeus*), and Long-eared Owl (*Asio otus*) followed population trends in several species of voles (*Microtus)* simultaneously.

Many techniques are used to assess raptor populations such as the Breeding Bird Survey (BBS) and Christmas Bird Count (CBC) (Kirk and Hyslop, 1998); however, their effectiveness may be limited as raptors are secretive and widely distributed. Another possible way to assess population change may be to compare admissions of raptors to rehabilitation centers over time.

We studied raptor rehabilitations recorded at the Illinois Raptor Center (IRC) in Decatur, IL between 1995 and 2006 to measure population changes in central Illinois raptors. Trends in raptor rehabilitations were compared with land use change, human population growth, and the occurrence of WNV. To assess the accuracy of the IRC trends, population trends were compared with CBC data. Consistency between IRC and CBC data would provide support that wildlife rehabilitation centers may serve as an early warning of changes to local raptor populations.

METHODS

The IRC is a wildlife rehabilitation and educational facility in Decatur, IL. The IRC admits raptors on a case-by-case basis by appointment, and occasionally admits birds from other rehabilitation centers and the University of Illinois Wildlife Medical Center. Information on each raptor is collected including: date, species, injury or reason for admission, and the city and/or county where the raptor was found. The data are compiled annually into a wildlife report and submitted to the Illinois Department of Natural Resources. The wildlife report data collected by the IRC from 1995-2006 were examined in this study.

Population trends were only examined for species admitted to the IRC >30 times between 1995 and 2006. To examine population trends, we conducted two analyses. Because raptor populations fluctuate (Korpimäki and Norrdahl, 1991), we used chi-square tests to determine if the number of raptors admitted each year was equivalent. If the number of raptors admitted each year was not equivalent, we used linear regression to determine if trends in raptor admittance were positive or negative.

The raptor species admitted to the IRC came from at least 31 Illinois counties and Missouri. Seventy-five percent of the raptor admissions to the IRC originated from Macon (34%), Sangamon (22%), and Champaign (19%) counties. To investigate how changes in land use and human population influence raptor populations, only data from these three counties were used. Data from the U.S. Department of Agriculture National Agricultural

Statistics Service (www.nass.usda.gov) were collected on the acres of soybeans and corn for grain planted in 1995-2006. We used soybeans and corn as indicators for changes in land use since they are the most abundant land cover types found in central Illinois. Total acreage of each crop for each county was combined, and linear regression was used to determine how acreage changed over time. Intercensal county population estimates for 1995-2004 were obtained through the U.S. Census Bureau (www.census.gov). Human population was combined by county and linear regression was used to examine changes over time. Linear regression was also used to examine the relationships between the number of raptors admitted and both changes in corn and soybean acreage combined and human population.

To examine the effects WNV had on raptor populations of central Illinois, two periods were established: 1995-2002 (the years prior to the arrival and spread of WNV) and 2003-2006 (the years after WNV had spread through Illinois) (http://diseasemaps.usgs.gov). Yearly numbers of raptors admitted to the IRC were compared for the 1995-2002 and 2003-2006 time periods using *t*-tests assuming unequal variance.

To examine the accuracy of IRC trends, we compared trends to CBC data. CBC data were obtained from the National Audubon Society (http://www.audubon.org). Count data for three circle counts: Champaign County, IL, Decatur, IL, and Springfield, IL were retrieved for the time periods 1994-95 to 2005-06. These three circle counts were used because they are the only circles within the three counties producing 75% of raptors admitted to the IRC. The number of sightings for each species at all three count circles combined was divided by the number of hours at the count circles combined. Linear regression was then used to determine whether raptor populations, as measured by the number per hour from the three count circles combined, changed from 1995-2006. Comparison between IRC and BBS data were not made because no BBS routes were completed within the three major counties from which IRC received raptors from 1995-2006. For all analyses, results were considered significant if $P<0.05$.

RESULTS

From 1995-2006, the IRC treated 986 raptors of 21 species comprising most of the eagle, hawk, falcon, and owl species found in central Illinois. The number of raptors admitted ranged from 50 in 2003 to 140 in 1999 with a median of 82 (95% confidence limits ranged from 67– 97). Six species were admitted >30 times to the IRC, Cooper's Hawk (n=57), Red-tailed Hawk (n=163), American Kestrel (n=268), Eastern Screech-Owl (n=165), Great Horned Owl (n=191), and Barred Owl (n=85), and accounted for 94% of the raptors admitted to the center.

Annual admissions fluctuated for Red-tailed Hawk ($X^2=27.9$, $P=0.0019$) and American Kestrel ($X^2=32.7$, $P=0.0003$) between 1995-2006 (Fig. 1). Population fluctuations were not calculated for Cooper's Hawk due to an expected frequency below 5 for the chi-square test (Zar 1984). Cooper's Hawk had a significant increase in number of admissions over time ($F_{1,10}=15.3$, $P<0.005$, $r^2=0.60$). No increase or decrease was found for Red-tailed Hawk ($F_{1,10}=0.0$, $P=0.97$) or American Kestrel ($F_{1,10}=0.2$, $P=0.69$).

Two owl species exhibited fluctuations in number of admissions per year, Eastern Screech-Owl (df=10, X^2=45.4, P<0.0001) and Great Horned Owl (X^2=37.3, P<0.0001, Fig. 2). Barred Owl had no change in admittance over time (X^2=4.9, P=0.89). Eastern Screech-Owl had a significant decline in the number of admissions over time ($F_{1,10}$=11.4, P=0.007, r^2=0.53), whereas no relationship was found for Great Horned Owl indicating population fluctuations ($F_{1,10}$=2.1, P=0.17).

Regression analysis showed that corn acreage increased by approximately 6,000 acres per year ($F_{1,10}$=20.8, P=0.001, r^2=0.70), and soybean acreage decreased by about 8,000 acres per year ($F_{1,10}$=11.6, P=0.006, r^2=0.56). Human population increased by approximately 800 residents annually ($F_{1,9}$=172.3, P<0.001, r^2=0.96). No species exhibited a relationship between the number of admissions and the combined acreage of corn and soybeans. The Cooper's Hawk exhibited a positive relationship between the number of admissions and human population ($F_{1,9}$=6.5, P=0.03, r^2=0.45), and the Eastern Screech-Owl exhibited a negative relationship ($F_{1,9}$=8.8, P=0.02, r^2=0.53).

We found that there were significantly fewer American Kestrels (t=3.0, P=0.02), Eastern Screech-Owls (t=3.7, P=0.004) and Great Horned Owls (t=3.2, P=0.01) between 1995-2002 and 2003-2006 (means=26 and 16 for American Kestrel, 17 and 7 for Eastern Screech-Owl, and 19 and 10 for Great Horned Owl, respectively).

CBC data exhibited similar population trends to raptors admitted to the IRC for three of the six species compared. Regression analysis using CBC data showed an increase in abundance of Cooper's Hawk ($F_{1,10}$=18.08, P=0.001, r^2=0.64), and a decrease in both American Kestrel ($F_{1,10}$=6.72, P=0.03, r^2=0.40) and Great Horned Owl ($F_{1,10}$=6.05, P=0.03, r^2=0.38). No change was observed in Red-tailed Hawk ($F_{1,10}$=0.58, P=0.46), Eastern Screech-Owl ($F_{1,10}$=1.32, P=0.28), and Barred Owl ($F_{1,10}$=4.49, P=0.06).

DISCUSSION

Rehabilitation centers like the IRC offer a variety of services including treatment of dozens of raptors each year and educational programs (Fix and Barrows, 1990). Furthermore, we suggest that data collected by the IRC are valuable in indicating population trends, and may serve as an early warning signal of environmental change. If the data collected by the IRC are representative of other wildlife rehabilitation centers throughout the country, data from these centers could be combined, and collectively serve as a way to monitor raptor population status on a national scale.

Five of the six species studied show population changes over time. In general, population change can be attributed to changes in land use, human population growth, WNV, and fluctuating prey abundance (Deem et al., 1998; Kirk and Hyslop, 1998; Joyner et al., 2006). Differences in land use are less likely to have resulted in the population trends we observed. For example, the net loss in acreage of corn and soybeans totaled 22,000 acres during our study period (0.2%), and no species exhibited a relationship with corn and soybean acreage combined.

The human population increased by 9,306 (0.2%) during our study. Eastern Screech-Owls exhibited a negative relationship with human population, while Cooper's Hawks

had a positive relationship. Suitable nesting areas and prey abundance are both factors reported to limit Eastern Screech-Owl populations (Gelhbach, 1995). Curtis et al. (2006) indicated that Cooper's Hawks are moving into urban environments because these areas maintain higher prey numbers. Small birds are often attracted to backyard bird feeders providing a plentiful food source for these raptors (Klem, 1981).

Given the lower number of American Kestrel, Eastern Screech-Owl and Great Horned Owl admissions in 2003-2006, WNV may have had a negative impact on central Illinois raptor species after its spread throughout the state in 2002. These species, and the Red-tailed Hawk, have all been previously identified as susceptible to WNV (Joyner et al., 2006; Nemeth et al., 2006). At the Wildlife Center of Virginia, Joyner et al. (2006) found an increase in admissions in August and September followed by a decline in raptor admittance between October and December of 2003 after the outbreak of WNV compared to the previous ten years. Similar to the Wildlife Center of Virginia, the IRC saw an increase in admissions followed by a decline. Between the months of June through September of 2003, the IRC admitted 54 raptors including 11 for WNV. In the following fall and winter months, October through December, the IRC only reported 9 raptor admissions. Moreover, the three years immediately after the outbreak were the three lowest years in the total number of admissions at the IRC. Not all studies, however, have concluded that WNV influences raptor populations. Stout et al. (2005) concluded WNV had no apparent adverse effects on populations of Cooper's Hawk, Red-tailed Hawk, and Great Horned Owl in Wisconsin.

If admittance to wildlife rehabilitation centers can be used as an indicator of changes in raptor populations, then the number of raptors admitted to rehabilitation centers should be consistent with population trends using CBC data. We observed equivalent population trends using CBC and IRC data for three species: a positive increase for Cooper's Hawk, and no change in Red-tailed Hawk and Barred Owl. Data collected from CBC counts indicated a negative change in populations of American Kestrel and Great Horned Owl. While we did not find a significant negative relationship in the number of admissions over time, the number of admissions of both species to the IRC decreased, and we found lower numbers of both species in 2003-2006 compared to 1995-2002. In only one species was there a difference in the direction of the trend between IRC and CBC data. Analysis of Eastern Screech-Owl using CBC data showed no change in population, whereas IRC admissions of screech-owl declined over time.

One possible shortcoming of this study is the lack of prey abundance data available. Getz et al. (2001) studied population fluctuations of two species of vole (*M. ochrogaster* and *M. pennsylvanicus*) in Champaign County, Illinois from 1972-1997. However, we lack equivalent data from Macon and Sangamon counties, and data after 1997. During the 11-year study period, we also assumed that the pattern of raptor admission did not change (e.g., the number of admissions did not increase with increased awareness of the IRC to the general public).

ACKNOWLEDGMENTS

We thank the contributors of the Illinois Raptor Center who have donated time, money, and effort to support the rehabilitation and education efforts of the center since its incep-

tion. We thank R. Boehmer, R. N. Rosenfield, R. Stiehl, and an anonymous referee for reviewing previous versions of the manuscript.

LITERATURE CITED

Berry, M. E., C. E. Bock, and S. L. Haire. 1998. Abundance of diurnal raptors on open space grasslands in an urbanized landscape. Condor 100:601-608.

Boal, C. W. and W. R. Mannan. 1999. Comparative breeding ecology of Cooper's Hawks in urban and exurban areas of southeastern Arizona. Journal of Wildlife Management 63:77-84.

Curtis, O. E., R. N. Rosenfield, and J. Bielefeldt. 2006. Cooper's Hawk (*Accipiter cooperii*). The Birds of North America, Number 75.

Deem, S. L., S. P. Terrell, and D. J. Forrester. 1998. A retrospective study of morbidity and mortality of raptors in Florida: 1988-1994. Journal of Zoo and Wildlife Medicine 29:160-164.

Fix, A. S. and S. Z. Barrows. 1990. Raptors rehabilitated in Iowa during 1986 and 1987: a retrospective study. Journal of Wildlife Diseases 26:18-21.

Galushin, V. 1974. Synchronous fluctuations in populations of some raptors and their prey. Ibis 116:127-134.

Gehlbach, F. R. 1995. Eastern Screech-Owl (*Otus asio*). The Birds of North America, Number 165.

Getz, L. L., J. E. Hofmann, B. McGuire, and T. W. Dolan. 2001. Twenty-five years of populations fluctuations of *Microtus ochrogaster* and *M. pennyslvanicus* in three habitats in east-central Illinois. Journal of Mammalogy 82:22-34.

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

Joyner, P. H., S. Kelly, A. A. Shreve, S. E. Snead, J. M. Sleeman, and D. A. Pettit. 2006. West Nile Virus in raptors from Virginia during 2003: clinical, diagnostic, and epidemiologic findings. Journal of Wildlife Diseases 42:335-344.

Kirk, D. A. and C. Hyslop. 1998. Population status and recent trends in Canadian raptors: a review. Biological Conservation 83:91-118.

Klem, Jr., D. 1981. Avian predators hunting birds near windows. Proceeding of the Pennsylvania Academy of Science 55:90-92.

Korpimäki, E. and K. Norrdahl. 1991. Numerical and functional responses of Kestrels, Short-Eared Owls, and Long-Eared Owls to vole densities. Ecology 72:814-826.

Leptich, D. J. 1994. Agricultural development and its influence on raptors in southern Idaho. Northwest Science 68:167-171.

Nemeth, N., D. Gould, R. Bowen, and N. Komar. 2006. Natural and experimental West Nile Virus infection in five raptor species. Journal of Wildlife Diseases 12:1-13.

Rodriguez-Estrella, R., J. A. Donazar, and F. Hiraldo. 1998. Raptors as indicators of environmental change in the scrub habitat of Baja California Sur, Mexico. Conservation Biology 12:921-925.

Sanchez-Zapata, J. A., M. Carrete, A. Gravilov, S. O. Ceballos, J. A. Donazar, and F. Hiraldo. 2003. Land use changes and raptor conservation in steppe habitats of eastern Kazakhstan. Biological Conservation 111:71-77.

Steenhof, K., M. N. Kochert, L. B. Carpenter, and R. N. Lehman. 1999. Long-term Prairie Falcon population changes in relation to prey abundance, weather, land uses, and habitat conditions. Condor 101:28-41.

Stout, W. E., A. G. Cassini, J. K. Meece, J. M. Papp, R. N. Rosenfield, and K. D. Reed. 2005. Serologic evidence of West Nile virus infection in three wild raptor populations. Avian Diseases 49:371-375.

Zar, J. H. 1984. Biostatistical Analysis. Second edition. Prentice-Hall, Englewood Cliffs, NJ. 718 pp.

Figure 1. Using admissions data from the Illinois Raptor Center from 1995-2006, Cooper's Hawk showed an increasing population trend in central Illinois while both Red-tailed Hawk and American Kestrel exhibited population fluctuations.

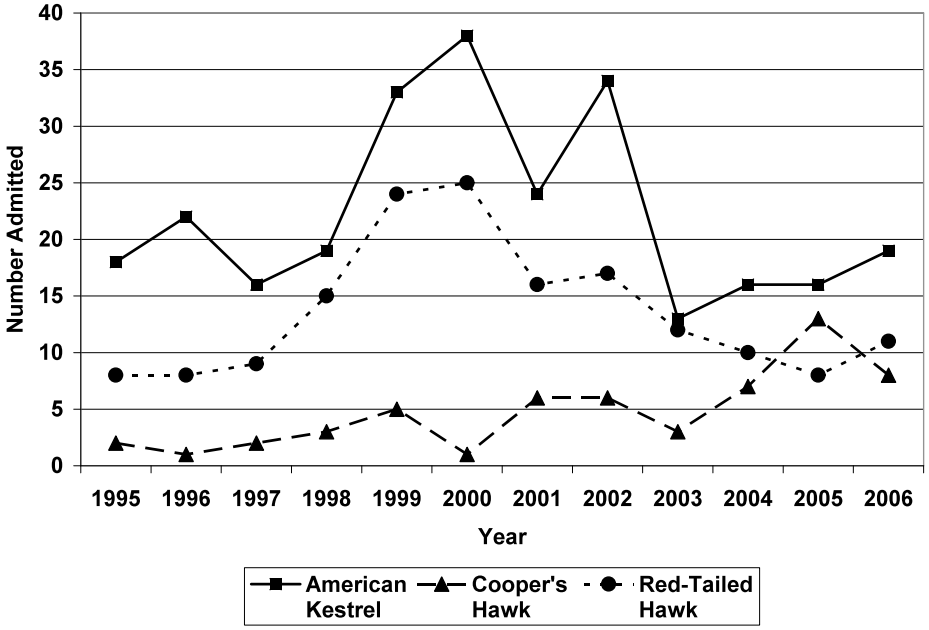

Figure 2. Using admissions data from the Illinois Raptor Center from 1995-2006, Eastern Screech-Owl decreased over time in central Illinois. Great Horned Owl exhibited population fluctuations, while Barred Owl showed no change.