

Urban Landscapes and Raptors: a Review of Factors affecting Population Ecology

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ABSTRACT

Many species of raptors occur in urban environments and recently some raptors have reinhabited many urban landscapes both as a result of purposeful reintroduction (e.g., Peregrine Falcon *Falco peregrinus*) and through recolonization (e.g., Cooper's Hawk *Accipiter cooperii*). Factors affecting use of urban environments are varied and raptors may use urban landscapes because of urbanization, in spite of urbanization, or because urban landscapes are indistinguishable from non-urban landscapes. To distinguish among these possibilities, we reviewed and summarized existing published information on use of urban landscapes by raptors, and found examples of all three conditions. In addition, we summarized published information dealing with survival, reproduction, and density of raptors in urban landscapes, and indicated where concurrent studies allowed direct comparison of these parameters in non-urban landscapes. Factors that affect population ecology of the same taxa in urban and non-urban landscapes can be different, and these differences need to be considered in conservation of raptors in urban landscapes.

INTRODUCTION

Many species of raptors (members of the order Falconiformes) occur in urban landscapes both during breeding (e.g., Bloom & McCrary 1996, Cade *et al.* 1996) and non-breeding (e.g., Sodhi *et al.* 1991) seasons. Considerable recent attention (e.g., Bird *et al.* 1996) has been afforded the occurrence of raptors in urban landscapes, yet reasons why raptors use urban landscapes, and whether raptors in urban landscapes are capable of maintaining their populations without augmentation through immigration, have not been thoroughly evaluated. By itself, occurrence of raptors in urban landscapes, often reported as anecdotal accounts of nesting (e.g., James 1992), does not equate to urban raptor populations that are self-sustaining.

Raptors may use urban habitats because of urbanization, in spite of urbanization, or because urban habitats are indistinguishable from non-urban habitats. In addition, whether contemporary urban populations result from persistence of raptor populations that pre-date urbanization, natural colonization of landscapes following urbanization, or purposeful introduction of raptors, may influence characteristics of raptor populations in urban landscapes. Similarly, whether raptors use urban landscapes for breeding, during migration, as winter habitat, or as non-breeding habitat may affect the relative importance of characteristics of urban landscapes that makes them suitable for raptors. Finally, the extent of direct persecution by humans of raptors in urban landscapes is likely to affect whether raptors use and persist in those habitats.

Our purpose herein is to summarize information on population ecology of raptors using urban landscapes. For the purposes of this paper, we define urban landscapes as those dominated by structures constructed to house the activities of humans, and supporting infrastructure such as roads, and urbanization as the conversion from some other landscape to one that is urban. For a more thorough discussion of what constitutes urban landscapes as related to raptors, we refer the reader to Cringan and Horak (1989). Further, we restrict the scope of this review to reports where the expected daily or seasonal activity range of the birds under consideration coincides geographically with the scale of landscapes (i.e., at the scale of 10s and 100s of km²). We present limited summaries of our own studies of Ferruginous Hawks *Buteo regalis* in eastcentral Colorado (Plumpton 1996; Plumpton & Andersen 1997, 1998), but primarily review published research pertaining to density, reproduction, survival, and habitat use of diurnal raptors in urbanized settings. We may unintentionally have emphasized North American species due to greater availability of these literature sources to us. However, we have attempted to include all published accounts without regard to geographic location.

In our review of literature pertaining to the impacts of human activity on raptor populations, we reviewed numerous accounts that addressed various human influences not related to urbanization (e.g., agriculture, forestry, and mining). Similarly, we encountered many published accounts that made reference to raptors and the effects of human disturbance. However informative, if these accounts failed to address the response of raptors specifically to urbanization, provided no basis for comparison with raptors inhabiting non-urban landscapes, or made no mention of quantifiable differences in ecology attributable to urbanization, we did not include them in this review. We note however, that it is important to realize that often urbanization is not the first anthropogenic influence affecting local raptor populations. Agriculture, silviculture, human infrastructure establishment (e.g., roads, electric transmission rights-of-way, mineral extraction, water impoundments) and other human changes to the landscape often precede urbanization, and may therefore exert an influence upon the fauna inhabiting an area before changes due strictly to urbanization are detected. For this reason, one must recognize the potential for gross changes in raptor populations that may have occurred because of various human pressures prior to urbanization.

The specific objectives of our review then, were to: (1) provide a summary of published information on density, reproduction, survival, and habitat use by raptors in urban landscapes; (2) categorize existing descriptions of urban raptor populations based on factors such as when during the year raptors occur in those habitats and the likely source of the urban population, and; (3) suggest conditions under which raptors occur in urban landscapes in spite of, because of, or without regard to urbanization.

METHODS

We reviewed published literature by searching electronic databases and recent overviews of the potential impacts of human activity on raptors (e.g., Bird *et al.* 1996), and through our own familiarity with the literature. Based on manuscript titles and keywords, we selected those manuscripts that may have included information about population ecology of raptors in urban landscapes. One or both of us then evaluated the original manuscript to determine whether it was pertinent for this review.

We then categorized those manuscripts that included information about population ecology of raptors in urban landscapes based on (1) the nature of the study (anecdotal observation or descriptive or comparative study), (2) season (breeding or non-breeding), and (3) the likely source of the population (persistence from pre-urbanized landscape, colonization, or introduction). Based on this review and any other pertinent information included in the published account, we then assessed whether raptors described in the study were likely using a specific landscape in spite of, because of, or without regard to urbanization. For studies that included estimates of density, survival, or reproduction, we summarized comparisons of these parameters from populations in non-urban landscapes, based either on concurrent study of non-urban populations or comparison with previous studies, as reported in published manuscripts.

RESULTS AND DISCUSSION

1. Summary of Published Literature

We reviewed > 150 published manuscripts that reported on raptors or owls (owls are often included within the definition of raptors, and were sometimes included in the results of electronic literature searches) in human-modified landscapes, or the impacts of human activity on birds of prey, based on key words and titles. The majority of these were removed from further consideration, as they did not address raptor ecology in urban landscapes (we also excluded manuscripts that dealt solely with owls), leaving approximately 50 manuscripts for further consideration. Upon careful review of these, only 36 reported information on density, reproduction, survival, or habitat use of raptors in urban landscapes. Of these 36 manuscripts, we classified 6 (17%) as anecdotal descriptions of nesting by raptors in urban habitats (Stahlecker & Beach 1979, Hull 1980, Newton 1986, Murphy *et al.* 1988, James 1992, Bell *et al.* 1996; for an overview of nesting of raptors in urban habitats, we refer the reader to Love and Bird [this volume]), leaving 30 published studies of raptor ecology in urban landscapes (Tables 1-3). Several manuscripts included in these 30 resulted from a single research programme (e.g., Plumpton 1996; Plumpton & Andersen 1997, 1998). In those instances, we considered manuscripts together that resulted from the same study and reported related results, reducing the number of studies considered further from 30 to 21.

Fifteen (71%) of these 21 published studies reported on nesting success and productivity of raptors nesting in urban landscapes (Table 1), and emphasized breeding-season population ecology. Thirteen (62%) of these were primarily descriptive, in that they presented results from studies of raptors in urban landscapes without providing comparative information from non-urban raptor populations. The remaining 8 (38%) compared characteristics of ≥ 2 populations, at least one of which was located in an urban landscape. Only five studies included habitat use and behaviour as a primary component (Table 2) and in only three were raptor populations studied primarily outside of the breeding season (Table 2). Five (including several incorporated into previous categories) reported on nest site selection as the sole or a significant component (Table 3).

Relatively few species were represented in published studies of raptors in urban landscapes; 2 accipitrine hawks (Cooper's Hawk *Accipiter cooperii*, Sparrowhawk *A. nisus*), 4 buteonine hawks (Red-tailed Hawk *Buteo jamaicensis*, Red-shouldered Hawk *B. lineatus*, Swainson's Hawk *B. swainsoni*, and Ferruginous Hawk), 3 falconids (Merlin *Falco columbarius*, Peregrine Falcon *F. peregrinus*, Lesser Kestrel *F. naumanni*), 1 New World kite (Mississippi Kite *Ictinia mississippiensis*), and 1 sea eagle (Bald Eagle *Haliaeetus leucocephalus*) (Tables 1-3). In addition, the majority of published studies that we reviewed were of North American raptors. We located only three descriptions of raptors in urban landscapes from Europe (Newton 1986, Tella *et al.* 1996; Frimer 1989a, 1989b), and none from South America, Asia, Africa, or Australia. The reason(s) for our inability to locate published accounts of raptor ecology in urban habitats from outside of North America is unclear. If such literature exists, it does not appear to be readily accessible in electronic literature databases, nor cited in English-language scientific journals.

In most instances, it was not possible to discern whether raptor populations described in the published accounts we reviewed had colonized urban landscapes, or whether they had persisted in landscapes that had undergone urbanization. The nature of urbanization differs geographically (e.g., North American and European landscapes; Cringan & Horak, 1989), and thus the likely source of urban raptor populations may also vary geographically. In at least some accounts, however, authors speculated that raptors had colonized urban landscapes as nesting habitat. Colonization seemed most likely for Cooper's Hawks (Rosenfield *et al.* 1995, 1996; Boal 1997, Boal & Mannan 1998), Sparrowhawks (Frimer 1989a, 1989b), Merlins (Oliphant & Haug 1985, Warkentin & James 1988), Swainson's Hawks (England *et al.* 1995), and Mississippi Kites (Gennaro 1988, Parker 1996) (Table 1). Introduction into urban landscapes was an important consideration for Peregrine Falcons (Cade & Bird 1990, Cade *et al.* 1996, Tordorff & Redig 1997). For Red-tailed Hawks (Speiser & Bosakowski 1988, Stout *et al.* 1996), Red-shouldered Hawks (Bloom & McCrary 1996), and Lesser Kestrels (Tella *et al.* 1996), some combination of persistence and colonization probably resulted in populations

Table 1. Published studies of breeding raptors in urban landscapes that report estimates of nesting success, productivity, or both nesting success and productivity.

<i>Study</i>	<i>Years</i>	<i>Location</i>	<i>Species</i>	<i>Study Type</i>	<i>Population Source</i>	<i>Parameters Reported</i>	<i>Sample Size and Type</i>
Parker 1996	1977-1980 1979-1980 1982-1987	Kansas	<i>Ictinia mississippiensis</i>	Comparative	Colonization Persistence	Nesting density	<i>n</i> = 34-41 nests
						Hatching success	
						Nesting success Productivity	
Gennaro 1988	1982-1984 1994-1997	Clovis, New Mexico Tucson, Arizona	<i>Ictinia mississippiensis</i> <i>Accipiter cooperii</i>	Descriptive Descriptive Comparative	Colonization Persistence Colonization Persistence	Productivity	<i>n</i> = 124 nests
						Productivity Nest site selection Clutch size Productivity	
Boal 1997 Boal and Mannan 1998	1984-1997	Tucson, Arizona	<i>Accipiter cooperii</i>	Descriptive Comparative	Colonization Persistence	Nest site selection Clutch size Productivity	<i>n</i> = 51 territories <i>n</i> = 275 banded birds
						Nesting survival Adult survival	
Rosenfield <i>et al.</i> 1995, 1996	1993	Central Wisconsin	<i>Accipiter cooperii</i>	Descriptive	Colonization Persistence	Nesting density Nesting density Clutch size	<i>n</i> = 13 nests
						Productivity	
Frimer 1989a, 1989b	1979-1987	Denmark	<i>Accipiter nisus</i>	Comparative	Colonization	Nesting density Productivity	<i>n</i> = 48 breeding attempts
						Productivity	
Stout <i>et al.</i> 1996	1987-1993	Milwaukee, Wisconsin	<i>Buteo jamaicensis</i>	Comparative	Colonization Persistence	Nesting success Nest site selection Nesting density Productivity	<i>n</i> = 99 nests
						Productivity	
Minor <i>et al.</i> 1993	1980-1989	Central New York	<i>Buteo jamaicensis</i>	Descriptive	Persistence	Productivity	<i>n</i> = 134 nests
						Nesting density	
Rottenborn <i>In preparation</i>	1994-1995	Central California	<i>Buteo lineatus</i>	Descriptive	Persistence Colonization	Nesting success Productivity	<i>n</i> = 85 nests
						Productivity	
England <i>et al.</i> 1995	1990-1994	Central Valley, California	<i>Buteo swainsoni</i>	Descriptive Comparative	Colonization Persistence	Nesting success Nest site characteristics	<i>n</i> = 65 nesting attempts
						Productivity	
Bloom and McCrary 1996	"25 years"	Southern California	<i>Buteo lineatus</i>	Descriptive	Colonization Persistence	Nesting success Productivity	<i>n</i> = 86 nests
						Nesting success	
Oliphant and Haug 1985	1971-1982	Saskatoon, Saskatchewan	<i>Falco columbarius</i>	Descriptive	Colonization	Nesting success Nesting density Productivity	<i>n</i> = 82 nests
						Productivity	

Table 1. continued

Tella <i>et al.</i> 1996	1993	Southern Spain	<i>Falco naumanni</i>	Comparative	Colonization Persistence	Adult survival Nestling survival Clutch size Productivity Nesting success Nesting success Productivity Survival (introduction)	<i>n</i> = 465 nests <i>n</i> = 16 colonies
Cade and Bird 1990	1988	North America	<i>Falco peregrinus</i>	Comparative	Introduction Colonization		<i>n</i> = 24 nests
Cade <i>et al.</i> 1996	1993	North America	<i>Falco peregrinus</i>	Descriptive	Introduction Colonization	Occurrence Nesting	<i>n</i> = 88 nests
Tordoff and Redig 1997	1982-1995	Central North America	<i>Falco peregrinus</i>	Descriptive	Introduction	Survival Dispersal Reproduction Fidelity	<i>n</i> = 747 released birds <i>n</i> = 493 wild birds

Table 2. Published literature reporting behaviour and habitat use of raptors using urban landscapes.

Study	Years	Location	Species	Study Type	Season	Population Source	Parameters Reported	Sample Size and Type
Bloom <i>et al.</i> 1993	1979-1981 1986-1988 1992-1995	Southern California Eastcentral Colorado	<i>Buteo lineatus</i>	Descriptive	Breeding	Persistence	Habitat use	<i>n</i> = 2 radio-marked birds
Plumpton 1996			<i>Buteo regalis</i>	Comparative	Non-breeding (winter)	Persistence	Behaviour	<i>n</i> = 38 radio-marked birds
Plumpton and Andersen 1997, 1998							Home range size	
Warkenton <i>et al.</i> 1991, 1992	1985-1990	Saskatoon Saskatchewan	<i>Falco columbarius</i>	Descriptive	Breeding	Colonization	Associative mating Site fidelity	<i>n</i> = 149 pairs <i>n</i> = 120 nesting attempts
Warkenton and James 1988, 1990							Nest site characteristics	<i>n</i> = 58 nest sites <i>n</i> = 41 roosts
Sodhi <i>et al.</i> 1991	1987-1990	Saskatoon Saskatchewan	<i>Falco columbarius</i>	Descriptive	Breeding Non-breeding (winter)	Colonization	Mate switching Hunting behaviour	<i>n</i> = 27 radio-marked birds
Buehler <i>et al.</i> 1991	1985-1989	Virginia and Maryland	<i>Haliaeetus leucocephalus</i>	Descriptive	Non-breeding (winter)	Persistence	Habitat use	<i>n</i> = 75 radio-marked birds

in urban landscapes (Tables 1 and 3). In contrast, published accounts of urban Ferruginous Hawks (Plumpton 1996; Plumpton & Andersen 1997, 1998), Bald Eagles (Buehler *et al.* 1991), and at least some Red-shouldered Hawks (Bloom *et al.* 1993) were likely based on raptors that persisted in landscapes that had become urbanized.

Few studies addressed aspects of population dynamics (reproduction, survival, and density) of urban raptors, and most addressed only nesting success and/or productivity (Table 1). We located only four studies of breeding urban raptors that included discussion of survival rates (Cade & Bird 1990, Tella *et al.* 1996, Boal 1997, Tordoff & Redig 1997), and only two of these (Boal 1997, Tordoff & Redig 1997) estimated population growth rates based on schedules of fecundity and survival. Several authors compared reproductive success in urban and non-urban raptor populations (e.g., Boal 1997), and examples of both higher and lower nesting success and productivity in urban landscapes (compared with non-urban) were reported. Similarly, estimates of nesting density in urban landscapes have been reported as higher compared with that in non-urban landscapes (e.g., Cooper's Hawks; Rosenfield *et al.* 1995, 1996), and lower than in adjacent non-urban areas (e.g., Red-tailed Hawk, Stout *et al.* 1996). We note, however, that nesting density has only infrequently been estimated for breeding raptors concurrently in both urban and non-urban populations.

We found few published accounts of habitat use and behaviour. Characteristics of nest sites have been measured concurrently in breeding urban and non-urban raptor populations in only a few instances (e.g., Red-tailed Hawk, Stout *et al.* 1996), but more commonly as part of study of urban-nesting raptors (e.g., Swainson's Hawk, England *et al.* 1995). We found relatively little information regarding habitat use and behaviour of urban raptors based on marked birds during the breeding season -- home range (e.g., Bloom *et al.* 1993; Boal & Mannan 1998) mating strategies (e.g., Warkentin & James 1988, 1990; Warkentin *et al.* 1991, 1992), and hunting behaviour (e.g., Sodhi *et al.* 1991) have been described for only a few urban raptors. Outside the breeding season, even less information is available regarding habitat use and behaviour. Plumpton (1996) and Plumpton and Andersen (1998) compared behaviour and habitat use of Ferruginous Hawks in urban and non-urban habitats in east-central Colorado, Buehler *et al.* (1991) documented avoidance of urban landscapes by wintering Bald Eagles in the Chesapeake Bay, and Sodhi *et al.* (1991) described hunting behaviour of wintering Merlins in Saskatoon, Saskatchewan.

2. Comparison with non-urban raptor populations

We found very few examples of published studies that compared urban and non-urban raptor populations, where data from both populations were collected coincident in time. Most studies that compared characteristics of urban and non-urban raptor populations reported reproductive parameters, usually nesting success and productivity. Boal (1997) reported larger clutches and more nestlings for Cooper's Hawks in urban than non-urban landscapes, but higher nestling mortality resulted in lower net productivity in urban landscapes. He also reported on potential differences in nesting phenology and breeding-season diet between Cooper's Hawks in urban and non-urban habitats. In contrast, Tella *et al.* (1996) reported lower nesting success and productivity for urban-nesting Lesser Kestrels, compared with kestrels nesting in non-urban landscapes. Predation of adult kestrels at the nest was lower, as were prey delivery rates to nests in urban landscapes, suggesting higher adult survival but poorer prey availability. England *et al.* (1995) reported lower nesting success and productivity of urban-nesting Swainson's Hawks compared with rural-nesting hawks in central California. Stout *et al.* (1996) presented nearest-neighbour distances for nesting Red-tailed Hawks in urban, suburban, and rural landscapes, indicating higher breeding densities in more rural landscapes. Conversely, in a correlative study of Red-shouldered Hawks in California, Rottenborn (in preparation) found no evidence for an effect of extent of urbanization on nesting success and productivity. Similarly, Cade and Bird (1990) reported comparable productivity of urban versus rural-nesting Peregrine Falcons in North America.

Because reproductive parameters can vary temporally in raptors (e.g., Newton 1979), comparisons of these characteristics for populations that are not coincident in time is difficult. Similarly, comparisons of populations separated geographically must account for underlying differences in

landscape characteristics that might influence reproduction and behaviour. Bearing these constraints in mind, it may still be informative to compare reproductive parameters and habitat use in urban raptor populations to the range of values observed in non-urban populations of the same species. Boal (1997) and Rosenfield *et al.* (1995, 1996) both reported high nesting densities of Cooper's Hawks in urban landscapes, compared with published nesting densities in non-urban landscapes. Similarly, estimated clutch sizes were high for both studies, and in central Wisconsin (Rosenfield *et al.* 1995, 1996), indices to productivity were also relatively high. In Arizona, however, Boal (1997) reported a high incidence of disease in nestling Cooper's Hawks, resulting in low productivity. He further suggested that exposure to disease in urban habitats resulted in survival rates so low that the population was unable to sustain itself in the absence of immigration.

In California, Bloom and McCrary (1996) reported higher nesting success and productivity for urban-nesting Red-shouldered Hawks, compared with non-urban hawks (Wiley 1975). Oliphant and Haug (1985) reported higher nesting densities for urban-nesting Merlins in Saskatchewan, compared with rural Saskatchewan (Schmutz 1982). Conversely, England *et al.* (1995) reported low nesting success and productivity of Swainson's Hawks breeding in central California cities, compared with estimates from other studies conducted in non-urban landscapes (e.g., Olendorff 1978, Schmutz *et al.* 1980). Parker (1996) reported higher nest densities, nesting success, and productivity for urban Mississippi Kite colonies compared with rural colonies.

Fewer data exist comparing habitat use and behaviour of urban versus non-urban raptors. In east-central Colorado (Plumpton 1996; Plumpton & Andersen 1997, 1998), Ferruginous Hawks wintering in urban landscapes foraged in isolated, remnant Black-tailed Prairie Dog (*Cynomys ludovicianus*) towns, and modified perch use, time budgets, and roosting habits compared with hawks occurring in non-urban habitats. In a study of winter behaviour and habitat use, Buehler *et al.* (1991) reported that Bald Eagles avoided urban habitats, using them less than expected based on their availability.

3. Use of urban landscapes by raptors

Based on our review of published literature regarding raptor population ecology in urban landscapes, we propose three categories of landscapes, based on their ability to support raptor populations. First, raptors may use urban landscapes because these exceed the ability of non-urban landscapes to support raptor populations. This may be the case for urban-nesting Peregrine Falcons in eastern North America (e.g., Cade & Bird 1990, Cade *et al.* 1996) and Cooper's Hawks in central Wisconsin (Rosenfield *et al.* 1995, 1996) and Arizona (Boal & Mannan 1998), where parameters related to breeding indicated that food was abundant, and where nest sites were not limiting. Second, raptors may use urban landscapes in spite of urbanization. Ferruginous Hawks in east-central Colorado (Plumpton 1996; Plumpton & Andersen 1997, 1998) continued to forage in remnant Prairie Dog colonies, even as those colonies become more and more isolated due to urbanization. These hawks appear to modify their behaviour to persist in urban landscapes. Similarly, wintering Bald Eagles in Chesapeake Bay (Buehler *et al.* 1991) appeared to avoid urban landscapes, although they continued to use urban sites to some extent. Finally, whether a landscape is urban or non-urban may be a neutral factor in terms of the ability of that landscape to support a raptor population. Several authors (e.g., Bloom & McCrary 1996, Boal 1997) have indicated that at the level of an individual territory or home range, habitat features (both structural and compositional) are similar to characteristics of non-urban, high quality habitat. In some instances, where mortality is not increased through direct or indirect impacts of human activity, urban landscapes may be capable of supporting self-sustaining, high-density raptor populations.

CONCLUSIONS

Relatively few quantitative data exist regarding population ecology of raptors in urban landscapes, far too few to make generalizations about characteristics of urban landscapes that enhance the potential for raptors to occur there in self-sustaining populations (other than what is known generally about raptor populations [e.g., Newton 1979]). Several difficulties confound any attempt to quantify the

effects of urbanization on raptors. One difficulty we encountered was in delimiting the topic of urbanization; it is neither as narrow and specific a causal agent as is direct human persecution or environmental contamination, nor is it as broad and all-encompassing as are human disturbance and habitat loss. The relative paucity of published information on population ecology of raptors in urban landscapes reflects this difficulty. Another problem we encountered was in separating the potential effects of multiple factors. For example, road construction, often a harbinger of urbanization, improved access into certain areas of Italy. This improved access led to widespread shooting of Red Kites *Milvus milvus* (Cortone *et al.* 1994), and caused significant population decline. Finally, there are a number of accounts of population declines or local extinctions of raptors following human population growth in previously undeveloped areas (e.g., Abuladze 1994), yet these accounts are not often supported by population counts or other data collected during the period of urbanization.

With a few notable exceptions, most studies of urban raptors have not estimated population attributes that allow thorough evaluation of population dynamics, nor have comparable data been collected on non-urban raptor populations coincident in time and in close geographic proximity. What is clear, is that a number of raptor species breed in urban landscapes, sometimes at relatively high densities and with high reproductive success and productivity. However, there is not a consistent pattern of breeding density and reproduction across species, or within the same species, and in most instances survival has not been measured, limiting the ability to project population trajectory. Although behaviour has been studied in only a few urban raptor populations, some species appear able to adapt their behaviour to forage and breed successfully in urban landscapes.

Although we believe that it is not currently possible to make broad generalizations about the effects of urbanization on raptor population ecology, we suggest that future studies could improve understanding about specific populations, and about urban raptor populations in general. Before-and-after studies (e.g., Bloom & McCrary 1996) and simultaneous comparison of areas with different levels of urbanization (e.g., Plumpton 1996; Plumpton & Andersen 1998; Boal & Mannan 1998) provide deeper insight than simple descriptions of urban-nesting raptors. Higher priority assigned to understanding their population ecology, combined with well-designed studies, would provide important information necessary to conserve raptors in urban landscapes.

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