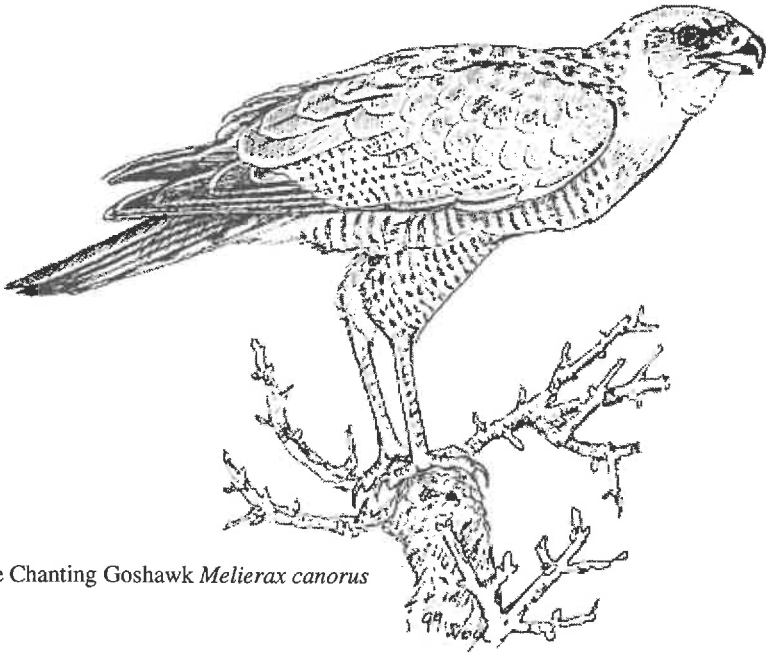


## Part 5

# Raptors in Urban Environments



Pale Chanting Goshawk *Melierax canorus*

Conveners:

David M. Bird & Greg Septon



# Raptors in Urban Landscapes: A Review and Future Concerns

Oliver P. Love and David M. Bird

## ABSTRACT

Over 25 of the world's raptor species can now be found living in or near modern urban settings. They are adapting by taking advantage of new food sources including refuse dumps and commercial slaughterhouses, accepting artificial and unusual nest structures and locations and by over-wintering in urban areas. However, competition for limited resources combined with a drastic reduction of suitable traditional habitat may be potential problems as raptors inhabit urban areas. In addition, it is not known with certainty whether species are thriving, or merely surviving, since the reproductive success of urban raptor populations has rarely been compared with those of former habitats. Furthermore, modern cities bring new sources of danger to raptors, as buildings, vehicles, refuse, chemicals, and people themselves pose a myriad of potential problems. Finally, urban areas may in fact foster the proliferation of single species rather than encourage raptor community diversity. This paper reports on current urban raptor research, emphasizing the vital need to encourage diversity in our cities as well as determine whether these new landscapes are important sources, or destructive sinks, for future raptor populations.

## INTRODUCTION

Many reports as well as documented research describe raptors frequenting and nesting within urban centres the world over (Oliphant & McTaggart 1977, Stahlecker & Beach 1979, Shaw 1985, James & Smith 1987, Gennaro 1988, Cade & Bird 1990, Sodhi *et al.* 1991, James 1992, England *et al.* 1995, Bell *et al.* 1996, Bird *et al.* 1996, Bloom & McCrary 1996, Cade *et al.* 1996, Parker 1996, Rosenfield *et al.* 1996, Stout *et al.* 1996, Tella *et al.* 1996, Bosakowski & Smith 1997, Blanco 1997).

Some noted success stories include the Peregrine Falcon *Falco peregrinus* in North America, where almost one hundred pairs are nesting during 1997 (Tordoff & Redig 1997); increased reproductive success of the urban-nesting Red-shouldered Hawk *Buteo lineatus* compared well with that of rural areas in California (Bloom & McCrary 1996) and the Mississippi Kite *Ictinia mississippiensis* may be the most widespread urban raptor in North America (Parker 1996). Even accipiters, traditionally regarded as nervous, secretive birds, are adapting to urban habitats. Besides some of the highest breeding densities of Cooper's Hawks *Accipiter cooperii* in urban areas of the U.S state of Wisconsin (Rosenfield *et al.* 1996), Black Sparrowhawks *A. melanoleucos* are nesting within the city limits of Durban, South Africa (G. Malan, pers. comm.) and European Goshawks *A.*

*gentilis* have established urban populations in both Moscow, Russia (V. Galushin, pers. comm.) and in Cologne, Germany (E. Guthmann, pers. comm.). Table 1 summarizes the species known to be utilizing urban centres.

**Table 1: Raptors Typically Associated with Urban Centres**

| <i>Common Name</i>   | <i>Scientific Name</i>          | <i>Source</i>                                                                                                                                        |
|----------------------|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| Peregrine Falcon     | <i>Falco peregrinus</i>         | Bell <i>et al.</i> 1996; Cade <i>et al.</i> 1988; Cade <i>et al.</i> 1996; Cade & Bird 1990; Wootton & Bell 1992; Sweeney 1997; Tordoff & Redig 1997 |
| Bat Falcon           | <i>Falco rufigularis</i>        | Seijas 1996                                                                                                                                          |
| Merlin               | <i>Falco columbarius</i>        | Oliphant & McTaggart 1977; Oliphant & Haug 1985; Oliphant & Haug 1985; Sodhi <i>et al.</i> 1991; James <i>et al.</i> 1994                            |
| American Kestrel     | <i>Falco sparverius</i>         | Palmer 1988                                                                                                                                          |
| Eurasian Kestrel     | <i>Falco tinnunculus</i>        | Village 1989                                                                                                                                         |
| Lesser Kestrel       | <i>Falco naumanni</i>           | Tella <i>et al.</i> 1996                                                                                                                             |
| Mississippi Kite     | <i>Ictinia mississippiensis</i> | Gennaro 1988; Parker 1996                                                                                                                            |
| Black Kite           | <i>Milvus migrans migrans</i>   | Blanco 1994, 97                                                                                                                                      |
| Goshawk              | <i>Accipiter gentilis</i>       | Bosakowski & Smith 1997; Galushin, pers. comm.; Guthmann, pers. comm.                                                                                |
| Cooper's Hawk        | <i>Accipiter cooperii</i>       | Stahlecker & Beach 1979; Rosenfield <i>et al.</i> 1996                                                                                               |
| Black Sparrowhawk    | <i>Accipiter melanoleucus</i>   | Malan, pers. comm.                                                                                                                                   |
| Eurasian Sparrowhawk | <i>Accipiter nisus</i>          | Frimer 1989a, 1989b                                                                                                                                  |
| Broad-winged Hawk    | <i>Buteo platypterus</i>        | Bosakowski & Smith 1997                                                                                                                              |
| Red-tailed Hawk      | <i>Buteo jamaicensis</i>        | Stout <i>et al.</i> 1996, 98; Bosakowski & Smith 1997                                                                                                |
| Red-shouldered Hawk  | <i>Buteo lineatus</i>           | Bloom & McCrary 1996; Bosakowski & Smith 1997                                                                                                        |
| Swainson's Hawk      | <i>Buteo swainsonii</i>         | James 1992; England <i>et al.</i> 1995                                                                                                               |
| Harris Hawk          | <i>Parabuteo unicinctus</i>     | Dawson & Mannan 1995                                                                                                                                 |
| Osprey               | <i>Pandion haliaetus</i>        | Poole 1989                                                                                                                                           |
| Crested Caracara     | <i>Polyborus plancus</i>        | Rodríguez-Estrella & Rodríguez 1997                                                                                                                  |
| Black Vulture        | <i>Coragyps atratus</i>         | Iñigo 1987                                                                                                                                           |
| Great-horned Owl     | <i>Bubo virginianus</i>         | Laidig & Dobkin 1995                                                                                                                                 |
| Barred Owl           | <i>Strix varia</i>              | Laidig & Dobkin 1995; Bosakowski & Smith 1997                                                                                                        |
| Burrowing Owl        | <i>Athene cunicularia</i>       | Botelho & Arrowood 1996                                                                                                                              |
| Screech Owl          | <i>Otus asio</i>                | Loos & Kerlinger 1993; Gehlbach 1996                                                                                                                 |
| Tawny Owl            | <i>Strix aluco</i>              | Zalewski 1994                                                                                                                                        |

## URBAN SUCCESS STORIES

As noted by Bird *et al.* (1996), in these times of massive changes to natural environments leading to dwindling wildlife populations, it is a relief to hear that some organisms can adapt to and even benefit from human-altered areas. Survival of raptors from fledging to first year of age is one of the greatest factors involved in the success of any raptor population (Newton 1979), and cities may be fostering increased survivorship in some raptor species. Tordoff and Redig (1997), in their study of mid-west Peregrine Falcon demography between 1982 and 1995, found that a greater number of city-hatched birds (19%) survived than did wild fledged birds (12%). The authors stressed that actual first-year survival is higher than minimum first-year survival and probably exceeds 30%. With 80% of the Peregrines in their study area nesting on man-made structures, with human help, this population should continue to show steady growth to its current carrying capacity, with city pairs being largely responsible.

Reproductive output in some urban-nesting raptor species has been found to be greater than in traditional rural habitats due largely to the factors discussed earlier. In a study of western Red-shouldered Hawks, Bloom and McCrary (1996) found that reproductive success of pairs nesting in urban locations was greater than that previously reported in natural areas in the same region of California. Rosenfield *et al.* (1996) investigated various aspects of the nesting biology of Cooper's Hawks in central Wisconsin and found the highest nesting density known for the species, as well as clutch size and number of bandable young per nest being comparable to the highest known for these accipiters.

In addition to the fulfilment of basic needs such as adequate prey and nesting locations, city areas can offer some degree of relief from traditional habitat loss at a number of other levels. Urbanized green spaces can become sanctuaries for raptors, offering refuges for nesting, as well as for inexperienced juvenile birds. Cities not only offer vital stopovers during migration, but can even be so attractive as to allow for over-wintering to such raptors as Peregrines (Septon, this volume) and Merlins (Oliphant & Haug 1985). In addition, cities may act as potential genetic reservoirs allowing some species to survive genetically, as well as offering a potential source for reintroduction to new and reclaimed habitats. Sometimes even more important is the public relation and educational value of city raptors, as their high visibility and general allure make them ideal candidates for public education and general awareness of wildlife issues within our downtown cores. The Peregrine Information Centre in Montreal, Canada attracts thousands of visitors annually not only to the building where the birds nest and where information about saving endangered wildlife is located, but also to a world-wide-web site which links similar projects from all over the world.

## WHAT ATTRACTS RAPTORS TO URBAN HABITATS?

Resources, including food, nesting sites and shelter from predators, are known to be important factors which limit or encourage raptor expansion and proliferation in any new environment, including the urban world. Raptors are attracted to cities because of abundant food sources such as urban passerines and pigeons, prey attracted to night lights, refuse dumps and commercial slaughterhouses. Modern refuse dumps and slaughterhouses, a by-product of the urban landscape, offer important sources of food for both breeding and migrating raptors in urbanized areas. In their study area in the Cape Region of Baja California, Mexico, Rodríguez-Estrella *et al.* (1997) found that most immature Crested Caracaras *Polyborus plancus* foraged near slaughterhouses and garbage sites rather than in natural areas. These predictable sources of food not only brought in adult and young birds, but also attracted invertebrates as yet another food source for the Caracaras. Blanco (1994) noted that Black Kites *Milvus migrans* in Spain also utilize urban refuse dumps as an abundant and predictable food supply during both pre- and post-breeding migratory passages.

Predatory birds that increasingly colonize urban areas must either find a habitat containing natural food resources close by or change their feeding ecology. The Tawny Owl *Strix aluco* is an example of the latter, a polyphagous species (Mikkola 1983) that can inhabit many environments and adapt to preying upon the most abundant species (Zalewski 1994). In his study comparing the diet of urban

and suburban Tawny Owls in Poland, Zalewski found that urban owls preyed upon significantly more diurnal passerines, especially the abundant House Sparrow *Passer domesticus*, than suburban owls which preyed mainly upon nocturnal mammals.

Urban environments can also provide prey for other adaptable raptor species such as the Bat Falcon *Falco rufigularis* in Venezuela. This species augmented its diet of bats from approximately 16% in rural areas to almost 64% of its diet in an urban area of Venezuela (Seijas 1996). As the author suggested, these findings emphasize the ecological plasticity of the Bat Falcon and may make it an excellent candidate for an urban lifestyle.

Urban raptors also make successful use of the many city structures for nesting, as traditional haunts such as cliffs and trees are replaced by ever-advancing urban centres. Peregrine Falcons and Merlins *Falco columbarius* utilize high-rise buildings, smokestacks, and bridges (Oliphant & Haug 1985, Cade *et al.* 1996); Ospreys *Pandion haliaetus* use transmission towers (Poole 1989) and Red-tailed Hawks *Buteo jamaicensis* accept power poles and billboards as suitable nesting sites (Stout *et al.* 1996). Another raptor which appears to show nesting plasticity is the Saker Falcon *Falco cherrug* in Mongolia. Ellis *et al.* (1997) noted the Saker's remarkable adaptability in using a wide range of breeding situations, including a number of man-made structures, making it a possible breeding contender for urban environments.

Lowered predation in cities as compared to rural habitats may be another important factor which attracts raptors to urban centres. In a comparison of Lesser Kestrels *Falco naumanni* in Spain, Tella *et al.* (1996) found that rural nesting kestrels were faced with nine possible predators, whereas urban-nesting birds were faced with only three.

## DRAWBACKS TO URBAN LIVING

### Alterations of Foraging Behaviour

Although the number of raptor species inhabiting and breeding in urban locations is increasing, there are many drawbacks and shortcomings of city life, the first being alterations in foraging and nesting behaviour. From their study of reproductive performance of urban-nesting Swainson's Hawks *Buteo swainsonii* in California's Central Valley, England *et al.* (1995) found that fewer young fledged from nests in urban than in rural settings. Also, the numbers of young fledged per nesting attempt and per successful nest for urban nests were among the lowest reported for this species. The cost for these urban-nesting buteos appears to be the long-distance transport of prey throughout the entire nesting cycle due to the lack of suitable foraging areas located near nesting locations. The authors suggested that rapid urbanization could cause the long-term decline of Swainson's Hawks in existing urban neighbourhoods. Lower reproductive success in urban areas as compared to rural ones means that urban populations may be acting like sinks, pulling breeding adults from potentially productive habitats.

Similarly, Seijas (1996) noted that although aquatic birds made up over 35% of the diet of Bat Falcons in Venezuela, the urban falcons were capturing prey from a river some 6km outside the city. With this long-distance travel, prey may be available, but not in quantities sufficient to produce successful reproductive outputs.

Ecological shifts, such as changes in prey as raptors move into cities from non-urban areas, can also lead to problems. In his study comparing the diets of urban and suburban Tawny Owls in Poland, Zalewski (1994) found that diurnal passerines, the most numerous prey in cities, are probably more difficult to catch than the majority of nocturnal, terrestrial and vocally 'noisy' small mammals. However, because this owl relies upon hearing to locate prey, higher noise levels in cities may be interfering with prey location and capture. This may be a drastic problem for those nocturnal owls which cannot switch to day hunting of passerines, and furthermore cannot capture mammals at night due to increased noise levels.

### Inherent Dangers of Cities

As noted by Cade and Bird (1990), Bird *et al.* (1996) and Cade *et al.* (1996), urban sites present

unique hazards to raptors that can lead to juvenile and adult mortality. Hazards such as collisions with airplanes, vehicles and windows, secondary poisoning from pigeon control efforts, illegal shooting, as well as disturbance associated with building and city maintenance, are all factors with which city raptors must deal with.

A large potential problem for raptors in urban locations is collisions with the vast numbers of motor vehicles present throughout the day and night in our cities. Certain species, age-classes and even sexes may be affected to greater degrees than others. In their examination of morbidity, survival and breeding success of free-ranging Peregrine Falcons submitted to The Raptor Centre of the University of Minnesota for veterinary care during 1984-94, Sweeney *et al.* (1997) found that 81% of these raptors suffered traumatic injuries resulting from collisions with buildings, motor vehicles and utility lines. Almost 75% of these were first-year birds, indicating an increased risk for young, inexperienced raptors in cities. These findings support previous work showing that collisions with man-made objects are the leading cause of injury and death among midwestern Peregrines.

In a 1993 study of road mortality of raptors in New Jersey, Loos and Kerlinger found that Northern Saw-whet Owls *Aegolius acadicus* and eastern Screech Owls *Otus asio* accounted for 45% and 36% of all raptor road kills, respectively. A large percentage of the Saw-whet (79%) and Screech Owls (88%) found were less than one year old. In addition, more than 87% of the Saw-whets and 71% of the Screech Owls were found between November and January, thought to be the key times of wintering and migration. Thus, certain species may be more vulnerable than others to road mortality due to factors such as age, geographic distribution, specific hunting or nesting requirements (including sexually biased hunting), as well as the seasonal tendency of various species to be in or near cities.

Electrocution is also responsible for many raptor deaths, and as urban areas are cores of power usage, they may be significant sources of mortality, especially for younger birds and larger species. In a report on electrocution as a mortality factor in an urban population of Harris' Hawks *Parabuteo unicinctus*, Dawson and Mannan (1995) found that although nesting success by urban breeding groups was high, survival of fledglings was low due to electrocution. In fact, electrocution was the most common mortality factor encountered during the study, accounting for 112 of 177 deaths. Furthermore, they found that nests located near or on power poles were particularly susceptible to electrocution during the first two weeks after fledging, the time period when young are practicing and preparing for flight. Urban raptors are attracted to utility poles as nesting sites, and further measures must be taken to reduce mortality, especially for vulnerable fledglings.

A number of factors which may play a role in attracting and sustaining raptors in urban areas can also have dangerous tradeoffs, such as the ingestion of synthetic products from refuse dumps (Inigo 1987, Donazar 1992). As mentioned earlier, although Blanco (1994) found that Black Kites in Spain utilize urban refuse dumps as an abundant and predictable food supply, he also noted that kites may face some dangers from entanglement in plastic materials and other rubbish. In his study, five kites were observed with pieces of rope, plastic bags, and pieces of plastic (up to 40cm long) entangled in their legs, and one immature was seen with an empty can caught on a leg. The effects of these and other potential dangers of modern refuse dumps remain unknown.

## RAPTOR DIVERSITY IN CITY LANDSCAPES

Although a number of noteworthy species such as the Peregrine Falcon, Merlin and Mississippi Kite are definite success stories in urban environments, other genera such as *Elanus*, *Circus*, *Aquila* and many of the nocturnal owls and raptors with specific habitat requirements, may never nest in urban areas (Bloom & McCrary 1996). The importance and dynamics of raptor community diversity within urban centres remains to be studied and fully understood. However, factors that have been found to promote raptor diversity, such as high habitat heterogeneity (White 1974), are often limited in urban situations. Conversely, forest fragmentation and reduced forest interior are also known to reduce raptor community diversity (Thiollay & Meyburg 1988).

## Habitat Fragmentation in Urban Landscapes

Raptors are sensitive to habitat fragmentation due to their large foraging ranges, low population densities, sensitivity to disturbance, and their reluctance to cross large open areas (Thiollay 1998, Watson 1998). Highly subdivided cities containing isolated patches of inadequately sized green space may reduce diversity and viability of raptors in urban spaces. In a study comparing nesting habitat and reproductive success of urban and rural Red-tailed Hawks, Stout *et al.* (1998) found that the density of the rural population was greater than in suburban areas and lowest in urban locations. The authors noted that cover was an important component of the nesting habitat for the species.

The biological consequences of habitat fragmentation for raptors are numerous and far-reaching. One of the first and obvious effects of fragmentation on raptor populations is the elimination of a species that occurred in portions of natural habitat not preserved when a city begins or expands. In effect, the species will be excluded from urban areas because suitable habitat has been replaced, and if habitat outside the urban area is also eliminated, those species will be lost by exclusion from the city area (Meeffe *et al.* 1997).

Isolation of habitats by barriers to movement such as buildings, roads and even city commotion, is a consequence of fragmentation as important as reduction in habitat size (Meeffe *et al.* 1997). Many animals including the majority of raptor species require a mixture of different habitats with distinct resources for nesting, hunting and roosting in order to meet their life history requirements. If barriers separate critical areas such as large parks and greenspaces in cities, raptor populations may decline, as human-created structures can greatly inhibit the movements of even highly mobile birds. Moreover, forest raptors may be especially sensitive due to their reluctance to cross large, open areas (Thiollay 1998). In a multi-species context, the overall landscape of a city in which habitat "islands" may be embedded is better seen as a filter, rather than a barrier, as it allows individuals of some species, but not others, to pass through (Meeffe *et al.* 1997). As discussed earlier, this may cause problems for raptor communities, as competition and even monopolization of limited resources can occur. As the landscape departs more and more from a raptor's natural habitat, isolation will increase as individuals may be less willing to travel from one patch of habitat to another.

## Core Habitat and Edge Effects

Even planned urban green spaces may not contain sufficient core habitat area, increasing edge effects and limiting community diversity. Temple (1986) looked at two wildlife areas each with a total area of 40 hectares. Habitat A had zero hectares of core area and contained no breeding bird species, whereas habitat B, of which half was core area, contained six breeding bird species.

Within a New Jersey watershed, Bosakowski and Smith (1997) found a strong correlation between species richness of forest raptors and the increasing size of wilderness core area. No area less than 1000 ha had more than four species present, while 4 to 8 species were found in areas from 1000 to 8000 ha in size. Furthermore, several species preferring extensive, remote areas of deep woods, the Red-shouldered Hawk, Northern Goshawk and the Barred Owl, had a greater vulnerability to urbanization, whereas Eastern Screech Owls and Broad-winged Hawks were less sensitive to urbanization. Furthermore, Great-horned Owls and Red-tailed Hawks clearly benefited from forest fragmentation and urbanization.

The structural contrast between a habitat island such as a forested park and surrounding urban landscape is not only an indicator of isolation, but also demonstrates the strength of edge effects. The outer boundary of any habitat, especially an urban one, is not a line, but rather a zone of influence that varies in width depending on what is measured (Murcia 1995). According to Wilcove (1985) nest predation rates in birds are higher in woodlots surrounded by suburbs than in those surrounded by agriculture, probably because refuse and other food subsidies in suburban areas encourage opportunistic predators.

Similarly, the diversity and abundance of birds in forest blocks surrounded by suburbs was much lower than in forests with few, or no nearby houses (Friesen *et al.* 1995). Habitat patches below a certain size will lack the true interior or "core" habitat that many raptorial species, especially forest-dwelling owls and hawks, require. In areas with limited core forest area, edge effects are

increased, which eliminates forest species and encourages opportunistic competitors and predators. The best urban areas for community diversity are those with large core areas of green space such as Tucson, Arizona (Mannan *et al.*, this volume) and those with limited distance from traditional habitats. Effective planning and management can allow for adequately sized and shaped habitats that can support raptor community diversity.

### **Competition limits Urban Diversity**

As more and more raptors are forced to inhabit smaller and more isolated habitats, competition may play a destructive role in maintaining raptor diversity. Laidig and Dobkin (1995) found that fragmentation of forests in southern New Jersey caused an extraordinary degree of habitat overlap between Barred Owls, closely associated with undisturbed mature forests, and Great-horned Owls, found in highly fragmented landscapes. This overlap resulted in substantial competition and predation on the former by the latter species and emphasizes that competition for limited space in urban areas can lead to permanent diversity loss.

## **URBAN LANDSCAPES: SINKS OR SOURCES?**

The fate of an entire raptor population may depend on whether the reproductive success of individuals in the productive habitats outweighs the lack of success by individuals in the poorer habitats, that is, source and sink dynamics (Meefe *et al.* 1997). Good habitats are sources, areas where local reproductive success is greater than local mortality. Poor habitats are termed sinks, that is areas where local productivity is less than local mortality. Without immigration from source areas, populations in sink areas inevitably spiral "down the drain" into extinction.

Wootton and Bell (1992) modelled the Californian Peregrine Falcon population as two sub-populations (northern and southern) linked by dispersal. Their analysis suggested that the northern population acts as a source for the southern population. The regional management strategy for this species includes the release of captive-reared young aimed primarily at the southern population, which the authors showed to be a sink. As Meefe *et al.* (1997) stated, management efforts would be more productive if efforts were directed at stabilizing the northern source population rather than the southern sink population.

Traditional landscapes, being suited for their resident organisms, may be important sources for raptor populations, whereas cities, which may lack many key elements, may be destructive sinks, pulling birds from the population without adding to them. If, in the worst possible case scenario, non-urban habitat for a given species becomes entirely replaced by an urban one, city populations will not be able to support themselves and will eventually become extinct.

Determining whether a habitat is a source or a sink requires a great deal of knowledge about the natural history of organisms. Researchers must know the birth and death rates of individuals in each habitat type, details of dispersal behaviour, and many other aspects of a species' life history. The gathering and interpretation of this basic information is absolutely fundamental in the planning of management and conservation strategies for our newest and one of the least understood environments, the city. Without this knowledge, it will be impossible to design a conservation plan that considers realistic population dynamics, and the idea of raptor diversity in cities will be a mute concern next to that of maintaining a single species, or even a single bird of prey, in an urban landscape.

## **FUTURE RESEARCH AND DISCUSSION**

Analyses of the requirements of each potential urban species, as well as comparisons between urban and non-urban populations, are necessary in order to determine the viability of cities as raptor refuges. Population Viability Analyses (PVA's) can determine how habitat loss/alteration, environmental uncertainty, population structure and gene flow are affecting the survival and viability of urban raptor populations (James *et al.* 1994). However, little research has thus far centred upon comparisons between urban and traditional habitats in an attempt to assess the costs and benefits of

urban-related resources, or reasons for raptors to leave or move from traditional habitats into urban ones (Blanco 1994, Tella *et al.* 1996). Raptor community diversity in urban areas has yet to be studied, and must be encouraged, as it is the best indicator that the green spaces are truly integrated, working ecosystems, rather than merely a visually pleasing yet empty framework. As stated earlier, the question of source and sink dynamics must be addressed for each raptor species inhabiting urban areas.

The key to the survival and productivity of urban raptors is to change the perception that cities are "areas of last resort". Instead, they must be looked at as potential refuges for raptors seeking shelter and success from an ever-shrinking natural world. They are areas that must be planned, maintained, studied and even altered as more information is gathered. It is simply not enough to build up an urban area with a few green spaces, and expect raptors to move in without worry or consequences. The ultimate value of raptors in urban areas may be their umbrella effect, as their high visibility and allure make them ideal species for conserving critically endangered habitats.

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## REFERENCES

- BELL, D.A., D.P. GREGOIRE & B.J. WALTON 1996. Bridge use by Peregrine Falcons in the San Francisco Bay area. In D.M. Bird, D. Varland & J. Negro (Eds.) *Raptors in human landscapes*. Academic Press and The Raptor Research Foundation, London, U.K.
- BIRD, D.M., D.E. VARLAND & J.J. NEGRO (eds.) 1996. *Raptors in human landscapes: Adaptations to built and cultivated environments*. Academic Press and The Raptor Research Foundation, London, U.K. 396pp
- BLANCO, G. 1994. Seasonal abundance of Black Kites associated with the rubbish dump of Madrid, Spain. *J.Raptor Res.* 28(4):242-245.
- BLANCO, G. 1997. Role of refuse as food for migrant, floater and breeding Black Kites. *J.Raptor Res.* 31(1):71-76.
- BLOOM, P.H. & M.D. MCCRARY 1996. The urban buteo: Red-shouldered Hawks in southern California. In D.M. Bird, D. Varland & J. Negro (Eds.) *Raptors in human landscapes*. Academic Press and The Raptor Research Foundation, London, U.K.
- BOSAKOWSKI, T. & D.G. SMITH 1997. Distribution and species richness of a forest raptor community in relation to urbanization. *J.Raptor Res.* 31(1):26-33.
- BOTELHO, S & P.C. ARROWOOD 1996. Nesting success of western Burrowing Owls in natural and human-altered environments. In D.M. Bird, D. Varland & J. Negro (Eds.) *Raptors in human landscapes*. Academic Press and The Raptor Research Foundation, London, U.K.
- CADE, T.J., J.H. ENDERSON, C.G. THELANDER & C.M. WHITE (eds.) 1988. *Peregrine Falcon populations: their management and recovery*. The Peregrine Fund, Inc., Boise, Idaho.
- CADE, T.J., M. MARTELL, P. REDIG, G.A. SEPTON & H.B. TORDOFF 1996. Peregrine Falcons in urban North America. In D.M. Bird, D. Varland & J. Negro (Eds.) *Raptors in human landscapes*. Academic Press and The Raptor Research Foundation, London, U.K.
- CADE, T.J. & D.M. BIRD 1990. Peregrine Falcons nesting in an urban environment: a review. *Can. Field-Nat.* 104:209-218.
- DONÁZAR, J.A. 1992. Muladares y basureros en la biología y conservación de las aves en España. *Ardeola* 39:29-40.
- DAWSON, J.W. & R.W. MANNAN 1995. Electrocution as a mortality factor in an urban population of Harris Hawks. *J.Raptor Res.* March 1995 No. 1
- ELLIS, D.H., M.H. ELLIS & P. TSENTEG 1997. Remarkable Saker Falcon breeding records from Mongolia. *J.Raptor Res.* 31(3):234-240.
- ENGLAND, A.S., J.A. ESTEP & W.R. HOLT 1995. Nest-site selection and reproductive performance of urban-nesting Swainson's Hawks in the central valley of California. *J.Raptor Res.* 29 (3):179-186.

- FRIESEN, L.E., P.F.J. EAGLES & R.J. MACKAY 1995. Effects of residential development on forest-dwelling neotropical migrant songbirds. *Conserv. Biol.* 9:1408-1414.
- FRIMER, O. 1989a. Food and predation in suburban Sparrowhawks *Accipiter nisus* during the breeding season. *Dansk ornitologisk Forenings Tidsskrift* 83: 35-44.
- FRIMER, O. 1989b. Breeding performance in a Danish suburban population of Sparrowhawks *Accipiter nisus*. *Dansk ornitologisk Forenings Tidsskrift* 83: 151-156.
- GEHLBACH, F.R. 1996. Eastern Screech Owls in suburbia: A model of raptor urbanization. In D.M. Bird, D. Varland And J. Negro (Eds.) *Raptors in human landscapes*. Academic Press and The Raptor Research Foundation, London, U.K.
- GENNARO, A.L. 1988. Breeding biology of an urban population of Mississippi Kites in New Mexico. In R.L. Glinski, B. Pendleton, M.B. Moss, M.N. LeFranc, Jr., B.A. Millsap S.W. Hoffman (Eds.) *Proc. SW Raptor Manage. Symp. and Workshop*. Natl. Wildl. Fed. Wash; D.C
- INIGO, E.M. 1987. Feeding habits and ingestion of synthetic products in a Black Vulture population from Chiapas, Mexico. *Acta Zool. Mex Nueva Ser.* 22:1-15.
- JAMES, P.C. 1992. Urban-nesting of Swainson's Hawks in Saskatchewan. *Condor* 94:773-774, 101:592-594.
- JAMES, P.C., I.G. WARKENTIN & L.W. OLIPHANT 1994. Populations viability analysis of urban Merlins. *J.Raptor Res.* 28(1):47.
- LADIG, K.J. & D.S. DOBKIN 1995. Spatial overlap and habitat associations of Barred Owls and Great-horned Owls in southern New Jersey. *J.Raptor Res.* 29(3):151-157.
- LOOS, G. & P. KERLINGER 1993. Road mortality of Saw-Whet and Screech Owls on the Cape May peninsula. *J.Raptor Res.* 27(4):210-213.
- MEEFE, G.K. & R.C. CARROLL 1997. *Principles of Conservation Biology*. 2nd ed. Sinauer Assoc., Inc. Massachusetts.
- MIKKOLA, H. 1983. *Owls of Europe*. T. & A.D. Poyser, London, UK.
- MURCIA, C. 1995. Edge effects in fragmented forests: Implications for conservation. *Trends Ecol.Evol.* 10:58-62.
- NEWTON, I. 1979. *Population ecology of raptors*. T. & A.D. Poyser, Calton, UK.
- OLIPHANT, L.W. & E. HAUG 1985. Productivity, population density and rate of increase of an expanding Merlin population. *J. Raptor Res.* 19:56-59.
- OLIPHANT, L.W. & S. MCTAGGART 1977. Prey utilized by urban Merlins. *Can Field-Nat* 91:190-192.
- PARKER, J.W. 1996. Urban ecology of the Mississippi Kite. In D.M. Bird, D. Varland And J. Negro (Eds.) *Raptors in human landscapes*. Academic Press and The Raptor Research Foundation, London, U.K.
- POOLE, A. F. 1989. *Ospreys: A natural and natural history*. Cambridge Univ. Press, Cambridge, England.
- RODRÍGUEZ-ESTRELLA, R. & L.B.RIVERA RODRÍGUEZ 1997. Crested Caracara food habits in the Cape Region of Baja California, Mexico. *J.Raptor Res.* 31(3):228-233.
- ROSENFELD, R.N., J. BIELEFELDT, J.L. AFFELDT, & D.J. BECKMANN 1996. Urban nesting biology of Cooper's hawks in Wisconsin. In D.M. Bird, D. Varland & J. Negro (Eds.) *Raptors in human landscapes*. Academic Press and The Raptor Research Foundation, London, U.K.
- SEIJAS, A.E. 1996. Feeding of the Bat falcon in an urban environment. *J.Raptor Res.* 30(1):33-35.
- SHAW, D. M. 1985. The breeding biology of urban-nesting Mississippi Kites (*Ictinia mississippiensis*) in west central Texas. MS thesis, Angelo State Univ; San Angelo, Texas.
- SODHI, N.S., I.G. WARKENTIN & L.W. OLIPHANT 1991. Hunting techniques and hunting rates of urban Merlins. *J.Raptor Res.* 25:127-131.
- STAHLCKER, D. W. & A. BEACH 1979. Successful nesting by Cooper's Hawks in an urban environment. *Inland Bird Banding News* 51: 56-57.
- STOUT, W.E., R.K. ANDERSON & J.M. PAPP 1996. Red-tailed Hawks nesting on human-made and natural structures in southeast Wisconsin. In D.M. Bird, D. Varland & J. Negro (Eds.) *Raptors in human landscapes*. Academic Press and The Raptor Research Foundation, London, U.K.
- STOUT, W.E., R.K. ANDERSON & J.M. PAPP 1998. Urban, suburban and rural Red-tailed Hawk nesting habitat and populations in southeast Wisconsin. *J.Raptor Res.* 32(3):221-228.
- SWEENEY S.J., P.T. REDIG & H.B. TORDOFF 1997. Morbidity, survival and productivity of rehabilitated Peregrine Falcons in the upper midwestern U.S. *J.Raptor Res.* 31(4):347-352.
- TELLA, J.L., HIRALDO, F., DONÁZAR-SANCHO, J.A. & J.J. NEGRO 1996. Costs and benefits of urban nesting in the Lesser Kestrel. In D.M.Bird, D. Varland & J. Negro (Eds.) *Raptors in human landscapes*. Academic Press and The Raptor Research Foundation, London, U.K.
- TEMPLE, S.A. 1986. Predicting impacts of habitat fragmentation on birds: A comparison of two models. In J. Verver, M.L. Morrison & C.J. Ralph (Eds.) *Wildlife 2000: Modelling Habitat Relationships of Terrestrial Vertebrates*. University of Wisconsin Press, Madison.

- THIOLLAY, J.M. 1998.** Current status and conservation of Falconiformes in tropical Asia. *J.Raptor Res.* 32(1):40-55
- THIOLLAY, J.M. & B.U. MEYBURG 1988.** Forest fragmentation and the conservation of raptors: a survey of the island of Java. *Biol. Conserv.* 44:229-250.
- TORDOFF, H.B. & P.T. REDIG 1997.** Midwest Peregrine Falcon demography, 1982-1995. *J.Raptor Res.* 31(4):339-346.
- VILLAGE, A. 1989.** Factors limiting European Kestrel *Falco tinnunculus* numbers in different habitats. In B.U. Meyburg & R.D. Chancellor (Eds.) *Raptors in the Modern World*. WWGBP, London.
- WATSON, R.T. 1998.** Conservation and ecology of raptors in the tropics. *J.Raptor Res.* 32(1):1-2.
- WHITE, C.W. 1974.** Current problems and techniques in raptor management and conservation. *Transac. Thirty-ninth North American Wildlife Conference*.
- WILCOVE, D.S., C.H. MCLELLAN & A.P. DOBSON 1986.** Habitat fragmentation in the temperate zone. In M.E. Soulé (ed.) *Conservation Biology: The Science of Scarcity and Diversity*. Sinauer Assoc., Inc. Sunderland, MA.
- WOOTON, T.J. & D.A. BELL 1992.** A meta-population model of the Peregrine Falcon in California: Viability and management strategies. *Ecol. Applic.* 2:307-321.
- ZALEWSKI, A. 1994.** Diet of urban and suburban Tawny Owls in the breeding season. *J.Raptor Res.* 28(4):246-252.

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