

Hawks Aloft Worldwide: a network to protect the world's migrating birds of prey and the habitats essential to their migrations

K. L. Bildstein,¹ J. J. Brett,¹ L. J. Goodrich¹ and C. Viverette¹

Long-distance hawk and eagle migration represents the most spectacular movement of land-based predators on Earth. The concentration of large numbers of migrating raptors at traditional gathering points and bottlenecks along migratory corridors provides a unique opportunity for local peoples to observe large numbers of these normally secretive and dispersed predators. Hawk Mountain Sanctuary, Pennsylvania, USA, has used the spectacle of raptor migration to help protect populations of hawks and eagles in northeastern North America for more than 50 years. Historically, efforts like Hawk Mountain's have focused on single sites. Today, however, many threats facing migrating hawks and eagles are international, rather than local in nature, demanding broader landscape strategies for protecting these species. At the same time, recent trends of increased international co-operation, coupled with tremendous societal changes and a growing realization of the need to examine the effects of development and population growth on our natural resources, provide a timely opportunity to unite local conservationists globally.

Hawk Mountain Sanctuary is responding to this opportunity with *Hawks Aloft Worldwide*: a co-operative network strategy that uses migrating raptors as flagships to strengthen local conservation activities along migratory corridors. Specifically, the initiative is identifying raptor-migration watch sites globally and training local conservationists to oversee conservation activities at such sites. *Hawks Aloft Worldwide* has identified supporters in more than 100 countries on six continents, and is currently drafting site descriptions for over 300 raptor migration watch sites, worldwide. At present, the initiative's training efforts are focusing on migration watch sites in Latin America, especially in Central and northern South America, where significant raptor migrations and enthusiastic supporters have been identified.

INTRODUCTION

HAWKS, eagles, and falcons (Order Falconiformes), or raptors as they are often called, are high profile, charismatic, evocative predatory megafauna (Brown and Amadon 1968; Brown 1976). As relatively long-lived, wide-ranging top predators in many food chains, raptors serve as sensitive environmental indicators of local ecosystem health (Thiollay 1989; Stilling 1992). Most hawks and eagles are territorial; as such, they are usually widely spaced and somewhat secretive, both in and outside of the breeding season (Newton 1979). A striking exception to this pattern is long-distance migration, at a time when many raptors congregate at migratory bottlenecks and traditional roost sites, creating an extraordinary watchable wildlife experience

(Bildstein *et al.* 1993). At such times raptors offer considerable potential as powerful and effective flagships for broader conservation issues (Salathé 1991).

Hawks Aloft Worldwide, Hawk Mountain Sanctuary's global conservation initiative, uses the plight of migrating raptors to capture support for local conservation action along international migratory corridors. The co-operative initiative formalizes the Sanctuary's long-standing role as mentor and role model to raptor conservation organizations and activists throughout the world. The initiative, which was conceived in 1987 by the sanctuary's then Executive Director, Stan Senner, and its current Curator, Jim Brett (Senner and Brett 1989), is scheduled to produce the first world atlas of raptor migration in 1995.

Here, we describe the *Hawks Aloft Worldwide* network in detail, focusing on: the need to protect migrating raptors; the rationale for using migrating raptors as flagships for broader conservation issues; the history and development of Hawk Mountain Sanctuary's successful conservation efforts in this area; the growth of the *Hawks Aloft Worldwide* conservation network; and the initiative's progress through early 1994. Finally, we use our experiences with *Hawks Aloft Worldwide* to discuss essential features of successful conservation networks.

THE RESOURCE

The hawks, eagles, and falcons of the world represent a distinct ecological assemblage of approximately 285 species of diurnally active predatory birds with hooked beaks and talons (Brown and Amadon 1968; Newton 1979). Although somewhat similar in physical appearance and general ecology to owls (Strigiformes), falconiforms are not allied, phylogenetically, to their nocturnal counterparts (Sibley and Ahlquist 1990).

Diurnal raptors are some of the most cosmopolitan of all land birds. At least nine species regularly occur in both the Old and New World, and many others are widely distributed across several continents (Brown and Amadon 1968). One hundred and thirteen species, 38% of all diurnal raptors, including about half of those existing outside the tropics, are either complete or partial migrants (Table 1). An additional 24 species are considered irruptive migrants (Kerlinger 1989). Migration appears to be more typical in the Northern than in the Southern Hemisphere, although the difference, may simply result from under-reporting in the latter region (Kerlinger 1989). A continental distribution of the world's species of migrating raptors is presented in Figure 1.

As a group, raptors tend to be relatively large, lightly wing-loaded birds, capable of extended soaring flight (Kerlinger 1989). Consequently, many engage in considerable slope and thermal soaring while on migration (Amadon and Brown 1968). Most, if not all raptor migration occurs during the day, especially during periods of favourable weather, and most species avoid lengthy water crossings (Brown and Amadon 1968; Kerlinger 1989). Although a few raptors undertake considerable east-west movements, for example, the eastern red-footed falcon regularly migrates between northeastern China and east-central Africa, most raptor migration is largely north-south (Kerlinger 1989), with birds moving between high latitude breeding areas and low latitude wintering grounds.

Raptors frequently aggregate along established corridors while migrating, and enormous concentrations of tens of thousands of birds, regularly and predictably occur at certain geographic features, especially mountain ridges and passes, narrow coastal plains, isthmuses, and peninsulas (Haugh 1972). Raptors concentrate along such leading lines (*sensu* Geyr von Schweppenburg 1963: 192), either because of favourable conditions there, because of inappropriate habitats in adjacent areas, because the landscape features serve as orientation aids, or because of combinations of the above (Broun 1949; Williamson 1962; Mueller and Berger 1967; Brett 1991).

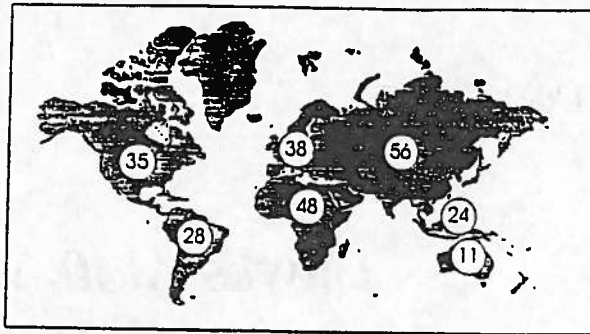


Fig. 1. World distribution of species of migrating raptors on a continental basis. The Pacific Islands, including New Guinea and New Zealand, were considered separately from Asia and Australia.

Because raptor migration occurs at predictable locations during daylight hours, and because birds of prey are large and evocative species, the phenomenon of raptor migration has attracted human attention for thousands of years (Brown and Amadon 1968). Yet in spite of the well-publicized migratory movements of raptors at a number of sites in North America (e.g., Hawk Mountain, Pennsylvania; Cape May Point, New Jersey), Europe (e.g., Gibraltar), and the Middle East (e.g., Eilat, Israel) (Haugh 1972; Evans and Lathbury 1973; Lesham 1985), movements at many other concentration points, are decidedly less well understood (Senner and Brett 1989; Bildstein *et al.* 1993).

THE CONSERVATION PROBLEM

Either because they are viewed as being rapacious and cruel, or because they are thought to threaten human interests, raptors have long evoked human hostility (Amadon and Brown 1968). Their systematic extermination as vermin can be traced at least as far back as 17th century England, when concern over birds competing with human hunters for prey resulted in extensive crusades against several species (Gensbol 1984). More recently, raptors have suffered indirectly from human activity, principally from habitat destruction (Thiollay 1989; Newton 1991) and the widespread use of organochlorine pesticides (Cade *et al.* 1988; Ratcliffe 1993); with the latter affecting both reproductive success through egg-shell thinning and embryo mortality, and adult mortality through direct toxicity.

Despite the fact that organochlorine use has been reduced in many parts of world, and that populations of several species have recently rebounded accordingly (e.g., North American and European populations of ospreys [Poole 1989] and peregrine falcons [Cade *et al.* 1988; Ratcliffe 1993], North American populations of bald eagles [Stalmaster 1989]), populations of many species of raptors remain substantially depressed as a result of this and other threats (Newton 1991). Overall, the world's predatory birds remain vulnerable.

Habitat degradation and loss, environmental contaminants (including organochlorine and other classes of pesticides), trapping, and shooting continue to plague many species of raptors (Newton and Chancellor 1985; Meyberg and Chancellor 1989).

Table 1. Continental occurrence of the world's complete and partial migrant raptors (after Kerlinger 1989). Complete migrants are species in which more than 90% of all individuals leave the breeding range during the non-breeding season. Partial migrants are those in which 90% or fewer of all individuals leave the breeding range. (Migratory status is based primarily on Kerlinger 1989, taxonomic status and distribution is based, primarily, on Amadon and Bull 1988. Listed species are not necessarily migratory in all continents in which they occur.) AUS = Australia; AFR = Africa; NAM = North America; SAM = South America; ASI = Asia; PIS = Pacific Islands; EUR = Europe.

| Species | Continental occurrence | | | | | | |
|--|------------------------|-----|-----|-----|-----|-----|-----|
| | AUS | AFR | NAM | SAM | ASI | PIS | EUR |
| Complete migrants | | | | | | | |
| Osprey <i>Pandion haliaetus</i> | X | X | X | X | X | X | X |
| Western honey buzzard <i>Pernis apivorus</i> | | X | | X | X | X | X |
| Eastern honey buzzard <i>P. ptilorhynchus</i> | | | | | X | | |
| Mississippi kite <i>Ictinia mississippiensis</i> | | | | X | X | X | |
| Short-toed eagle <i>Circus gallicus</i> | | X | | | X | X | X |
| Grey-faced buzzard <i>Butastur indicus</i> | | | | | X | X | |
| Montagu's harrier <i>Circus pygargus</i> | | X | | | X | X | |
| Grey frog hawk <i>Accipiter soloensis</i> | | | | | X | | X |
| Broad-winged hawk <i>Buteo planipterus</i> | | | | | X | X | |
| Swainson's hawk <i>B. swainsoni</i> | | | X | X | | | |
| Rough-legged hawk <i>B. lagopus</i> | | | X | X | | | |
| Lesser spotted eagle <i>Aquila pomarina</i> | | X | | | X | | X |
| Greater spotted eagle <i>A. clanga</i> | | X | | | X | | X |
| Lesser kestrel <i>Falco naumanni</i> * | | X | | | X | | X |
| Western red-footed falcon <i>F. vespertinus</i> | | X | | | X | | X |
| Eastern red-footed falcon <i>F. amurensis</i> | | X | | | X | | X |
| Northern hobby <i>F. subbuteo</i> | | X | | | X | | |
| Eleonora's falcon <i>F. eleonora</i> | | X | | | X | | X |
| Sooty falcon <i>F. concolor</i> | | X | | | X | | X |
| Partial migrants | | | | | | | |
| Turkey vulture <i>Cathartes aura</i> | | | X | X | | | |
| Black vulture <i>Coragyps atratus</i> | | | X | X | | | |
| African cuckoo hawk <i>Aviceda cuculoides</i> | | X | | | | | |
| Black baza <i>A. leuphotes</i> | | | | | X | X | |
| Asian baza <i>A. jerdoni</i> | | | | | X | X | |
| Swallow-tailed kite <i>Elanoides forficatus</i> | | | X | X | | | |
| Black-shouldered kite <i>Elanus caeruleus</i> | | X | | | X | X | X |
| White-tailed kite <i>E. leucurus</i> | | | X | X | | | |
| African swallow-tailed kite <i>Chelictinia ricouri</i> | | X | | | | | |
| Snail kite <i>Rostrhamus sociabilis</i> | | | X | X | | | |
| Plumbeous kite <i>Ictinia plumbea</i> | | | X | X | | | |
| Black kite <i>Milvus migrans</i> | X | X | | | X | X | X |
| Red kite <i>M. milvus</i> * | | X | | | X | X | X |
| Whistling kite <i>Haliastur spheurnus</i> | X | | | | X | | |
| Brahminy kite <i>H. indicus</i> | X | | | | X | X | |
| Pallas' fish eagle <i>Haliaeetus leucorhynchus</i> * | | | | | X | X | |
| Bald eagle <i>H. leucocephalus</i> | | | X | | | X | |
| White-tailed eagle <i>H. albicilla</i> | | | X | | | | |
| Steller's sea-eagle <i>H. pelagicus</i> * | | | X | | X | | X |
| Lesser fishing eagle <i>Ichthyophaga humilis</i> | | | | | X | | |
| Cinereous vulture <i>Aegypius monachus</i> * | | | | | X | X | |
| Lappet-faced vulture <i>A. tracheliotus</i> | | X | | | X | | X |
| Eurasian griffon <i>G. fulvus</i> | | X | | | X | | |
| Ruppell's griffon <i>G. rueppellii</i> | | X | | | X | | X |
| Asian white-backed vulture <i>Gyps bengalensis</i> | | | | | X | | |
| African white-backed vulture <i>G. africanus</i> | | X | | | | | |
| Palm-nut vulture <i>Gypohierax angolensis</i> | | X | | | | | |
| Egyptian vulture <i>Neophron percnopterus</i> | | X | | | X | | |
| Bearded vulture <i>Gypaetus barbatus</i> | | X | | | X | | X |
| African harrier hawk <i>Polyboroides typus</i> | | X | | | X | | X |
| Madagascar harrier hawk <i>P. radiatus</i> | | X | | | | | |
| Dark chanting goshawk <i>Melierax metabates</i> | | X | | | X | | |
| Gabbar goshawk <i>M. gabar</i> | | X | | | X | | |
| Grasshopper buzzard <i>Butastur rufipennis</i> | | X | | | X | | |
| White-eyed buzzard <i>B. teesa</i> | | | | | X | | |
| Spotted harrier <i>Circus assimilis</i> | X | | | | | X | |
| Northern harrier <i>C. cyaneus</i> | | X | X | X | X | X | X |
| Cinereous harrier <i>C. cinereus</i> | | | | X | | | |
| Pallid harrier <i>C. macrourus</i> | | X | | | X | | X |
| Pied harrier <i>C. melanoleucus</i> | | | | | X | | |
| Western marsh harrier <i>C. aeruginosus</i> | | X | | | X | X | |
| Eastern marsh harrier <i>C. spilonotus</i> | | | | | X | | X |
| Swamp harrier <i>C. approximans</i> | X | | | | X | X | |

Table 1 — continued

| Species | Continental occurrence | | | | | | |
|--|------------------------|-----|-----|-----|-----|-----|-----|
| | AUS | AFR | NAM | SAM | ASI | PIS | EUR |
| Partial migrants — continued | | | | | | | |
| African marsh harrier <i>C. ranitorus</i> | | X | | | | | |
| Long-winged harrier <i>C. buffoni</i> | | | | X | | | |
| Northern goshawk <i>Accipiter gentilis</i> | | X | X | | X | | X |
| Ovambo sparrowhawk <i>A. ovampensis</i> | | X | | | | | |
| Japanese sparrowhawk <i>A. gularis</i> | | | | | X | X | |
| Besra <i>A. virgatus</i> | | | | | X | X | |
| Eurasian sparrowhawk <i>A. nisus</i> | | X | | | X | | X |
| Sharp-shinned hawk <i>A. striatus</i> | | | X | X | | | |
| Levant sparrowhawk <i>A. brevipes</i> | | X | | | X | | X |
| Shikra <i>A. badius</i> | | X | | | X | | |
| Cooper's hawk <i>A. cooperii</i> | | | X | | | | |
| Grey hawk <i>Asturina nitida</i> | | | X | X | | | |
| Common black hawk <i>Buteogallus anthracinus</i> | | | X | X | | | |
| Harris' hawk <i>Parabuteo unicinctus</i> | | | X | X | | | |
| Red-shouldered hawk <i>B. lineatus</i> | | | X | | | | |
| White-tailed hawk <i>B. albicaudatus</i> | | | X | X | | | |
| Red-backed hawk <i>B. polysoma</i> | | | | X | | | |
| Zone-tailed hawk <i>N. albonotatus</i> | | | X | X | | | |
| Red-tailed hawk <i>B. jamaicensis</i> | | | X | | | | |
| Eurasian buzzard <i>B. buteo</i> | | | | | X | | X |
| Long-legged buzzard <i>B. rufinus</i> | | X | | | X | | X |
| Upland buzzard <i>B. hemilasius</i> | | | | | X | | |
| Ferruginous hawk <i>B. regalis</i> | | | X | | | | |
| Red-necked buzzard <i>B. auguralis</i> | | X | | | | | |
| Steppe or tawny eagle <i>Aquila rapax</i> | | X | | | X | | X |
| Imperial eagle <i>A. beliiaca</i> * | | X | | | X | | X |
| Golden eagle <i>A. chrysaetos</i> | | X | X | | X | | X |
| Black eagle <i>A. verreauxi</i> | | X | | | X | | |
| Wahlberg's eagle <i>Hieraetus wahlbergi</i> | | X | | | | | |
| Bonelli's eagle <i>H. fasciatus</i> | | X | | | X | X | X |
| Booted eagle <i>H. pennatus</i> | | X | | | X | | X |
| Martial eagle <i>H. bellicosus</i> | | X | | | | | |
| Chimango caracara <i>Milvago chimango</i> | | | | X | | | |
| Fox kestrel <i>Falco alopex</i> | | X | | | | | |
| American kestrel <i>F. sparverius</i> | | | X | X | | | |
| Old world kestrel <i>F. tinnunculus</i> | | X | | | X | | X |
| Australian kestrel <i>F. cenchroides</i> | X | | | | | X | |
| Grey kestrel <i>F. ardosiaceus</i> | | X | | | | | |
| Red-headed falcon <i>F. chicquera</i> | | X | | | X | | |
| Merlin <i>F. columbarius</i> | | | X | X | X | X | X |
| Brown falcon <i>F. berigora</i> | X | | | | | X | |
| New Zealand hobby <i>F. novaeseelandiae</i> | X | | | | | | |
| Oriental hobby <i>F. severus</i> | | | | | X | X | |
| Australian hobby <i>F. longipennis</i> | X | | | | | | |
| Aplomado falcon <i>F. femoralis</i> | | | X | X | | | |
| Lanner falcon <i>F. biarmicus</i> | | X | | | | | X |
| Prairie falcon <i>F. mexicanus</i> | | | X | | | | |
| Saker falcon <i>F. cherrug</i> | | | | | X | | X |
| Gyr falcon <i>F. rusticolus</i> | | | X | | X | | X |
| Peregrine falcon <i>F. peregrinus</i> | X | X | X | X | X | X | X |
| Barbary falcon <i>F. pelegrinoides</i> | | X | | | X | | |
| Continental total | 11 | 48 | 35 | 28 | 56 | 24 | 38 |

*Species listed in the 1994 International Union for Conservation of Nature's Red List of Threatened Animals (Groombridge 1994).

World populations of one New World vulture (Family Cathartidae), 37 hawks and eagles (Accipitridae), and six falcons and caracaras (Falconidae), 14% of all diurnal raptors, currently are listed as threatened or endangered by the international conservation community (Collar and Andrew 1988; Rands 1991).

Though it is exceedingly difficult to collect survivorship data on migrating birds, the data that do exist suggest that migration, especially long-distance migration, is probably one of the most difficult and dangerous activities in a bird's life (Owen and Black

1991). Thus, while raptors may be at risk for many reasons, those that migrate long distances are especially vulnerable (Biber and Salathé 1991).

Even before their journeys begin, long-distance migrants need to acquire sufficient water and energy reserves from breeding or wintering grounds to help sustain them on their travels. Although many individuals effectively reduce these bioenergetic requirements by choosing routes favourable for soaring and gliding, the resulting concentrations of birds along such corridors create their own suite of problems (Hunter *et al.* 1991).

Migration choreography positions enormous numbers of raptors, in some instances entire species, at the same place at the same time, thereby increasing intra- and inter-species competition, both for food and roosting sites, as well as the risk of inter-species predation. The concentration of birds also increases the potential impact of any natural or human-made environmental hazards the birds might encounter at such times (Senner and Fuller 1989). For example, many species of raptors congregate overnight at communal traditional roost sites while on migration (Severinghaus 1991). Habitat destruction or environmental contamination of these essential stopover sites has the potential for significant impact on entire flyway populations. This concentration of birds also makes them vulnerable to additional human threats: systematic shooting and trapping (Broun 1948; Bildstein *et al.* 1993). The daily passage of hundreds, even thousands of birds at single sites at predictable times (Lesham 1985; Smith 1985) provides shooters with an abundant and seemingly endless source of targets. Once a ubiquitous problem, shooting and trapping are now considerably less widespread. However, the problem remains in parts of Central and South America, eastern Asia, and much of the Mediterranean. The examples below help illustrate the extent of the situation.

Each year hundreds of thousands of raptors fly between breeding sites in Europe and wintering grounds in Africa. Some avoid extended passage over the Mediterranean Sea by flying south-west through the Iberian Peninsula and crossing the narrow Straits of Gibraltar (Moreau 1972); others fly south-east through the Balkans and Middle East, entering Africa through Egypt or Djibouti (Lesham 1985). Still others island-hop across the Mediterranean by flying down the Italian Peninsula, crossing the Straits of Messina on to Sicily and then south-west across the Sicilian Channel to Cape Bon, Tunisia, or south to Malta and, eventually, Libya and Tunisia (Beaman and Galea 1974; Galea and Massa 1985). Many choosing this last flight path are shot enroute.

In Sicily, and in Malta, thousands of harriers, buzzards, and falcons, representing more than a dozen species of raptors, including the endangered lesser kestrel, are routinely shot by local inhabitants (Iapichino and Massa 1989; Portelli 1992). Recent estimates suggest that at least 64 000 raptors are killed annually in Malta alone (Table 2; Fenech 1992); with a conservative regional total in excess of 100 000 (Magnin 1991). Many of the birds end up as taxidermy specimens in private "museum" collections and atop televisions in living rooms (Fenech 1992).

In eastern Asia, hundreds of grey-faced buzzards are trapped for sale as live birds or killed outright as they roost at the species' largest known migratory stopover site in Taiwan's Kenting National Park (Severinghaus 1991). In South America, thousands of Swainson's and broad-winged hawks are shot at traditional roost sites in Colombia's Combeima Canyon on the western slopes of the Andes, where local campesinos believe that killing the birds will hasten the passage of Lent, and that fat rendered from the carcasses has medicinal applications (Bildstein *et al.* 1993). Elsewhere in Latin

Table 2. Conservative estimates of the numbers of raptors shot each year in Malta, extrapolated from bag records of 10 hunters (after Fenech 1992).

| Species | Estimated number shot |
|---------------------------|-----------------------|
| Western honey buzzard | 3 500 |
| Western marsh harrier | 9 700 |
| Montagu's harrier | 4 000 |
| Pallid and hen harriers | 2 100 |
| Old world kestrel | 16 000 |
| Western red-footed falcon | 6 000 |
| Northern hobby | 6 500 |
| Other raptors | 3 000 |
| All raptors | 64 000* |

*Includes raptors that were not identified to species.

America, Argentine ranchers routinely kill and display peregrine falcons (Ellis and Smith 1986), while in Mexico, 15 species of raptors, 27% of the country's falconiform diversity, were being offered for sale in Mexico City markets in the mid-1980s (Inigo-Elias 1986).

Although shooting tends to be most problematic in developing nations, difficulties exist in developed countries as well (Bildstein *et al.* 1993).

Although raptors are protected by legislation in most of the countries mentioned above, enforcement is often lacking. In many locations tradition and ignorance ensure that the shooting continues.

A CONSERVATION OPPORTUNITY

Ironically, the same attributes that make migratory raptors easy targets for hunters, also make them eminently attractive as watchable wildlife (Broun 1948). Long-distance raptor migration represents the most spectacular movement of land-based predators on Earth. Immense flocks of hawks, eagles, and falcons flying past traditional concentration points along major international corridors provide an unparalleled opportunity to introduce the public to these secretive and normally widely-dispersed birds of prey. The charismatic and evocative nature of the birds, together with their extensive habitat needs, makes them useful flagships for broader conservation issues.

Indeed, several species of raptors, most notably the osprey, American bald eagle, Eurasian sparrowhawk, old world kestrel and peregrine falcon, have played significant roles in exposing the hazards associated with the widespread use of organochlorine and mercurial pesticides (Carson 1962; Hickey 1969; Newton 1979; Cooke *et al.* 1982; Cade *et al.* 1988). Other species, including several large tropical eagles and the North American spotted owl *Strix occidentalis*, have been used by conservationists to protect contiguous stands of ancient forest (Kennedy 1986; Simberloff 1987; Thiollay 1989).

In addition to their value as conservation flagships, there are powerful indications that migrating raptors offer a largely untapped, but potentially substantial source of ecotourism revenue (Robinson and Redford 1991; Kerlinger 1993). Hawk Mountain Sanctuary currently attracts more than 70 000 visitors annually; with most traveling to the site between September and late November at the peak of

raptor migration in the region. By comparison, the entire Galapagos Archipelago, was attracting about 40 000 visitors annually in the late 1980s (President's High Level Commission 1991).

A recent analysis of Hawk Mountain's role in the local economy (i.e., the area within a 50 km radius of the site) suggests an annual input of \$US1.5 million, mainly in the form of accommodation and food expenses (Kerlinger and Brett 1995). Tourists visiting the sanctuary annually support numerous restaurants, hotels, motels, guest houses, and campsites, many of which distribute sanctuary brochures, and several of which have even incorporated the "Hawk Mountain" place name into their own. Local economic value can provide significant incentive for protecting and sustaining what eventually comes to be viewed as a valuable natural and economic resource.

The easiest way to describe the potential for *Hawks Aloft Worldwide* as a conservation tool is to detail the history of Hawk Mountain Sanctuary and its successful conservation programmes.

HAWK MOUNTAIN SANCTUARY

Hawk Mountain Sanctuary was established in 1934 by New York conservationist Rosalie Edge to prevent the slaughter of hawks and eagles migrating past a rocky promontory in eastern Pennsylvania, USA, and to foster an understanding of Appalachian Mountain environments (Broun 1948). The sanctuary is the world's first refuge created to study and protect birds of prey. Hawk Mountain's 890 ha straddles the eastern-most ridge of the Appalachian Mountains 175 km west of New York City. A combination of prevailing north-westerly winds and mountain topography places the sanctuary along a major Western Hemisphere avian migration corridor (Broun 1948; Kerlinger 1989). Each autumn, tens of thousands of raptors from north-eastern North America migrate along the mountain ridge. Occasionally, spectacular migrations of thousands of birds are recorded on single days. During the 58-year period between 1934 and 1991, an annual average of more than 17 000 diurnal raptors, representing 16 of North America's 34 raptor species, have been counted at the site (Table 3).

Prior to the establishment of Hawk Mountain Sanctuary, hunters traditionally gathered on the ridge tops of eastern Pennsylvania each autumn to shoot migrating hawks and eagles. Raptors were considered vermin at the time, and the Pennsylvania Game Commission had established bounties on several species (Senner 1984). Over the years, thousands of birds were killed as they travelled south along the Appalachian Mountains. Hawk Mountain, in particular, became a favoured shooting site (Sutton 1928; Pough 1932; Collins 1933). By the early 1930s, shooting at the site was so intense that individuals collected brass from discharged cartridges and sold it for scrap.

All of this changed in August of 1934, when Rosalie Edge hired naturalist, Maurice Broun, to become the first warden at the newly acquired sanctuary. Broun spent his first year posting the property and confronting local shooters. Publicity surrounding the sanctuary's birth was considerable, and the following autumn,

Table 3. Total numbers of raptors seen at Hawk Mountain Sanctuary, 1934–1991 (except 1943–1945).

| Species | Numbers of individuals |
|------------------------|------------------------|
| Turkey vulture | 3 957 |
| Black vulture | 203 |
| Northern goshawk | 3 853 |
| Sharp-shinned hawk | 234 733 |
| Cooper's hawk | 14 541 |
| Unidentified accipiter | 453 |
| Red-tailed hawk | 177 688 |
| Red-shouldered hawk | 14 908 |
| Swainson's hawk | 12 |
| Rough-legged hawk | 523 |
| Broad-winged hawk | 467 128 |
| Unidentified buteo | 923 |
| Golden eagle | 2 448 |
| Bald eagle | 2 467 |
| Unidentified eagle | 10 |
| Northern harrier | 12 382 |
| Osprey | 18 603 |
| Peregrine falcon | 1 203 |
| Gyr Falcon | 6 |
| Merlin | 1 616 |
| American kestrel | 19 445 |
| Unidentified falcon | 104 |
| Unidentified raptor | 4 767 |

bird-watchers and naturalists began to flock to the new wildlife refuge in large numbers. As they did, the mountain shooting gallery faded into history (Broun 1949).

Today, Hawk Mountain is a leading example of what conservation, environmental education, and ecological monitoring and research together can accomplish (Council on Environmental Quality 1984). Throughout its history, the sanctuary's, community-based conservation programmes have focused on long-term environmental monitoring, applied research, local land-use planning, and public education.

Hawk Mountain Sanctuary maintains the longest and most complete record of raptor migration in the world. Its annual counts of migrating hawks and eagles have proved to be an essential tool in assessing long-term trends in raptor populations throughout eastern North America (Bednarz *et al.* 1990). The extensive data base played a key role in exposing first-generation organochlorine pesticides, including DDT, as causative agents for precipitous declines in the populations of several species of birds of prey that occurred earlier this century (Hickey 1969), as well as in measuring subsequent rebounds in raptor populations following decreases in the use of these environmental contaminants (Cade *et al.* 1988).

Since 1935, Hawk Mountain's staff and collaborators have contributed more than 100 technical publications, reviews, theses, and dissertations to the scientific literature, mostly on aspects of avian and Appalachian ecology. Sanctuary programmes have spawned research on predatory birds throughout the world (Harwood 1975, 1985; Newton and Chancellor 1985; Meyburg and Chancellor 1989). The Hawk Migration Association of North America, an association of North American hawkwatchers that monitors raptor migration throughout most of North America, owes much of its existence to the leadership of Hawk Mountain

Sanctuary. Currently, members of the sanctuary's research staff play leading roles in a host of international ornithological, ecological, and conservation organizations.

The sanctuary offers an extensive on-site education programme that includes weekend interpretive programmes for the general public, weekday guided programmes for primary and secondary school children, and fully accredited college-level courses offered in co-operation with local colleges and universities. Off-site programmes include slide-illustrated talks for school groups and civic organizations, a recently initiated bilingual-bicultural programme for urban Hispanic students in eastern Pennsylvania, and workshops for local educators. Sanctuary education programmes have stimulated considerable local and regional interest in raptors and other birds, Appalachian Mountain ecology, and conservation in general.

The sanctuary's International Internship Program, begun in 1976, has trained more than 150 young ecologists and environmental educators from 15 countries on six continents. Many interns publish their studies in scientific journals, and most have gone on to pursue active careers in science and conservation. Sanctuary research personnel also work closely with dozens of volunteers who assist in migration counts and research.

The sanctuary is maintained and managed by the Hawk Mountain Sanctuary Association, a private, non-profit organization supported by more than 8 200 individual and corporate members, 60% of whom reside in Pennsylvania. Hawk Mountain has been a nationally Registered Natural Landmark since 1965. In 1984, the President's Council on Environmental Quality reported that "the history of Hawk Mountain Sanctuary offers a striking example of the role of private initiative in achieving major accomplishments in wildlife conservation" (Council on Environmental Quality 1984). The sanctuary was honoured with the prestigious Chevron Conservation Award in 1987.

SEIZING THE OPPORTUNITY

Unlike global climate change and many other international environmental concerns, the information needed to protect migratory raptors lies principally in the hands of local conservationists (Mittermeier and Bowles 1994). Unfortunately, much of this expertise remains largely unorganized and inaccessible to other conservationists.

Historically, community-based conservation efforts like Hawk Mountain's have focused on single sites and clusters of sites (Newton and Chancellor 1985; Meyburg and Chancellor 1989). Current regional and international threats to raptors require a broader approach to their conservation (Norton 1991). At present, little coordination exists among community-based raptor conservationists internationally. Although most are interested in protecting birds throughout their ranges, their efforts have been mainly local in scope.

At the same time, global trends of increased co-operation on both economic and political fronts, coupled with tremendous societal changes in many

parts of the world, provide an opening to tap existing human resources and empower local raptor conservationists.

Hawks Aloft Worldwide is Hawk Mountain Sanctuary's response to this unparalleled opportunity. The initiative offers a co-operative network strategy for strengthening local community-based conservation action. The project uses the impressive natural phenomenon of long-distance raptor migration together with small-scale, community-based conservation, to capture the attention of local populations, and to increase their environmental awareness, not only for the birds, but also for the sensitive habitats upon which they depend.

The initiative links the important and achievable goal of protecting migratory raptors and their essential habitats, with the establishment of locally supported conservation groups (Soulé and Kohm 1989). *Hawks Aloft Worldwide* also promotes the use of raptors as bioindicators for the ecosystems they inhabit, the need for greater international co-operation in conservation efforts, and, when appropriate, the use of ecotourism to support indigenous populations and to protect natural habitats (Senner and Brett 1989; Bildstein *et al.* 1993; Brett and Bildstein 1993).

Specifically, *Hawks Aloft Worldwide* is: identifying raptor migration watch sites similar to its own that can function as local conservation foci; publishing the first World Atlas of such sites for use by the conservation community; training local conservationists at newly identified raptor migration watch sites in ecological monitoring, education focused advocacy, and policy reform; and forging a sustainable global conservation network. The initiative has been endorsed by the World Working Group for Birds of Prey and Owls and by the Raptor Research Foundation, Inc.

Hawks Aloft Worldwide is organized in two phases. Phase I involves using existing literature and Hawk Mountain's extensive personal contacts to identify and describe sites of ecological significance to raptor populations. Phase II focuses on developing training materials, and offering internships and workshops for local conservationists overseeing these sites. We provide below details on both phases of the initiative.

Phase I

Before we can protect migrating hawks, eagles, and falcons, we need to know where, when, and how they migrate (Lubchenco *et al.* 1991). The "World atlas of hawk and eagle migration watch sites" will be modelled after the International Council for Bird Preservation and the International Waterfowl and Wetlands Research Bureau's "Important Bird Areas in Europe" (Grimmett and Jones 1989), and the International Union for Conservation of Nature and Natural Resources' "Directory of Neotropical Wetlands" (Scott and Carbonell 1986). Copies of the Atlas will be distributed to all network participants, as well as to appropriate government agencies and non-governmental organizations.

The Atlas will consist of a series of country reports grouped by continent. Each report will begin with an introduction summarizing the status of raptor conservation in that country, including information on the

legal status of raptors and their major threats. Introductions will be followed by an inventory of all known migration watch sites, together with a map depicting their locations. Site descriptions will include directions to the site, information on habitat associations, land tenure and use, degree of protection, threats to hawks and eagles, ongoing research and conservation efforts, relevant literature, and the name and address of the local contact organization or individual, along with a summary account of raptor migration at the site.

The Atlas will include chapters on the biology and geography of raptor migration, an overview of the initiative's network and registry concepts (see below), conservation strategies for migrating raptors, and an extensive bibliography of the English language raptor-migration literature. Publication and distribution of the Atlas will help conservationists focus monitoring, research, education, and protection efforts on important migration corridors.

Although Hawk Mountain Sanctuary personnel are organizing and editing site-description data for the Atlas, individual site descriptions are being sought from local *Hawks Aloft Worldwide* network supporters familiar with each site.

The Atlas also will include a "Registry of sites of international importance to raptor migration and conservation". The Registry will consist of expanded site descriptions of several dozen migration sites deemed to be of critical international significance to migratory hawks and eagles.

Publication of the registry will help conservationists attempting to protect raptors by placing the relative importance of each site in the light of international conservation efforts. Designation also should help local conservationists in their attempts to convince local communities, as well as local, regional, and national governments, of the relative significance of site.

Phase II

Once we know where and when the birds migrate, we will need to train and assist local conservationists in their efforts to protect them (Soulé and Kohm 1989).

To accomplish this goal, *Hawks Aloft Worldwide* is training conservationists and community activists to effect action at critical migration sites through environmental education and focused advocacy, as well as to strengthen their influence, both locally and regionally. Where appropriate, the initiative will cultivate sites as environmentally and culturally sustainable centres of ecotourism (*sensu* Allcock *et al.* 1994). With supporting training and materials, local network members will be better equipped to establish local sites as community-based conservation foci for protecting the local biological resources, and to protect the integrity of critical migration corridors.

Whenever possible, *Hawks Aloft Worldwide* is working with existing organizations, and attempting to unify local and regional groups. As participation in the network increases, and as new sites are found, the sanctuary's international internship programme will be used to train individuals from these locations on an ongoing basis.

Given the scope of the second phase of the initiative, initial efforts in this aspect of the work are focusing on Latin America, especially Central and Northern South America. Initially, our work is centring on migration watch sites in Veracruz, Mexico; Izabal, Guatemala; and Combeima Canyon, Colombia. Each of these three sites was chosen for different reasons.

Veracruz, Mexico, was selected as a focal site because of its potential as an important ecotourist destination, and because *Hawks Aloft Worldwide* supporters working with a local conservation organization at the site have already been trained at Hawk Mountain Sanctuary, and are ready to offer training workshops for watch-site staff at other Latin American sites. Izabal, Guatemala, was chosen because the development of a raptor migration watch site there will help FUNDAECO (Fundación para el ecodesarrollo y la conservación), a well-established Guatemalan conservation organization achieve increased protection status for remnant forest reserves in the region, and because this site, too, has the potential to become an important ecotourist destination. Combeima Canyon, Colombia, was chosen because local conservationists have identified a major conservation challenge at the site: the shooting of hundreds of roosting migrant hawks each spring.

Work at all three sites is well underway. In 1991, in co-operation with HawkWatch International of Albuquerque, New Mexico, Hawk Mountain launched a conservation effort focused on the migration of hawks and eagles along the coastal plain of Veracruz, Mexico. The coastal lowlands of Veracruz were chosen because preliminary reports suggested substantial fall and spring migrations of several North American *Buteos* (Thiollay 1980; Smith 1985; F. Tilly, pers. comm.), and because of the availability of qualified local personnel. Two young Mexican conservationists, both graduates of Hawk Mountain's internship programme, were already in Veracruz, both were active within the local conservation community, and both possessed the levels of expertise and enthusiasm needed to develop a raptor migration watch site in the area.

In 1991, the project recorded a spring migration of more than 400 000 raptors representing 17 species. In 1992, the project, funded in part by the National Fish and Wildlife Foundation, monitored the movements of more than 2.5 million fall migrants (Table 4), establishing Veracruz, as the Western Hemisphere's most important raptor migration monitoring site. In comparison, Hawk Mountain Sanctuary counted a total of just over 1 000 000 raptors during its entire first 57 years of operation. In addition to raptors, the southward movements of other soaring birds, including, tens of thousands of anhingas *Anhinga anhinga*, white pelicans *Pelecanus erythrorhynchos* and wood storks *Mycteria americana*, were also recorded at the site.

Given the spectacular nature of the flight, Veracruz has considerable potential as a centre for regional environmental education programmes, as well as a national and international ecotourism destination.

Table 4. Numbers of raptors seen migrating past *Hawks Aloft Worldwide* watch sites in Veracruz, Mexico, September–November, 1992. Data courtesy of E. Ruelas Inzunza.

| Species | Numbers seen |
|----------------------|--------------|
| Turkey vulture | 1 034 100 |
| Osprey | 1 100 |
| Mississippi kite | 12 000 |
| Sharp-shinned hawk | 2 700 |
| Cooper's hawk | 760 |
| Broad-winged hawk | 929 900 |
| Swainson's hawk | 446 300 |
| American kestrel | 3 750 |
| Peregrine falcon | 270 |
| Other species | 500 |
| Unidentified species | 76 600 |
| All raptors | 2 517 800 |

By fall of 1992, Veracruz participants had developed a series of educational brochures, posters, and workshop guides, and were offering programmes for primary school children in the vicinity of the watch site, as well as workshops for their teachers. Although Hawk Mountain Sanctuary and HawkWatch International initially assumed leadership roles for the Veracruz Project, Pronatura-Veracruz, a well-established and widely recognized Mexican conservation organization is currently overseeing the effort.

Hawks Aloft Worldwide hosted a training workshop in Veracruz, in the spring of 1995, where migration watch site workers from the three focal sites in Mexico, Guatemala, and Colombia, and from other Latin American countries were trained in various aspects of watch-site development and management, including how to monitor raptor migration, conduct research on habitat associations during migration, establish on- and off-site education programmes for school children and local inhabitants, develop a migration site for ecotourism, and establish effective programmes for educating legislators and affecting changes in government conservation policy.

In early 1993, *Hawks Aloft Worldwide* and FUNDAECO, a community-based 14-person, conservation organization in Oakland, Guatemala, discussed the feasibility of instituting a raptor-migration watch site in the proposed remnant-forest reserves of Izabal, in the eastern portion of that country. FUNDAECO has already raised more than \$US35,000 to acquire land in the region, and has plans to secure an additional \$US150,000 for the project. The Foundation currently is conducting ecological and agro-forestry research at the site. Twenty-eight species of raptors, including both North American migrants and Central American residents, have been reported from the 39 000 ha tract (FUNDAECO, unpubl. data). The area's strategic location between the Caribbean coast and the cloud forests of Cerro San Gil, together with anecdotal reports of flights of thousands of broad-winged hawks, suggest the site is along a major corridor for North American migrants travelling to and from South America. FUNDAECO believes that locating a raptor migration watch site in Izabal would "greatly enhance the prestige of the conservation areas and emphasize the importance of protecting the remnant forest reserves of Izabal" (J. Bucklin, FUNDAECO, pers. comm.).

Newspaper accounts describing the large-scale slaughter of migrating raptors in the Combeima Canyon, Departamento del Tolima, Colombia, in spring of 1992 prompted *Hawks Aloft Worldwide* staff to initiate a lengthy correspondence with local conservationists monitoring the situation. Combeima Canyon, along the forested western slopes of the Colombian Cordillera, is used as an evening roost site by thousands of raptors, especially Swainson's and broad-winged hawks, which stop over during spring migration each year on their return flights to North America. Although raptor movements at the site have yet to be monitored in detail, anecdotal reports suggest that Combeima Canyon, too, is situated along a major migratory corridor for North American buteos, and possibly, kites.

Given the striking similarities between the current plight of raptors in the Combeima Canyon, and those at Hawk Mountain in the early 1930s, Combeima appears to be a especially appropriate site for *Hawks Aloft Worldwide* efforts. In addition to protecting raptors from shooting, establishment of a Combeima Canyon raptor migration watch site will help consolidate a buffer zone around Los Nevados National Natural Park, a high-altitude paramos landscape that provides much of the freshwater for the region's cities.

Local conservationists in Colombia are using Hawk Mountain Sanctuary brochures and posters as a model, in an education campaign designed to reverse the situation in Combeima. The group has already organized an annual "Aguilas Cuaremeras Festival" celebrating the birds' passage each spring (C. Márquez Reyes, pers. comm.).

Progress to date

Work on the Atlas and Registry phase of *Hawks Aloft Worldwide* is well underway. Published references on hawk migration are being accumulated, and a computerized, key-worded, bibliographic data base is being prepared. To date, more than 150 individuals in 70 countries have returned completed site descriptions (Fig. 2).

As of October 1994, preliminary site descriptions have been drafted for more than 250 sites, 110 of which are outside of the United States, and 17 of which are in Latin America (Fig. 3). Although several of the sites were previously documented, most, including several candidates for inclusion in the Registry, were undescribed.

Copies of the initiative's biannual newsletters are distributed to more than 1 000 individuals and groups. Preliminary results of the project have been presented at conservation and scientific meetings in Berlin, Germany; Seattle, Washington (USA); San Jose, Costa Rica; Eilat, Israel; Canterbury, England and Geraldton, Australia.

Training aspects of the initiative also are well underway. A bilingual watch-site training manual for use at initiative workshops has been drafted at the sanctuary. The Veracruz training workshop will achieve one of its most fundamental goals, that of training the network's trainers, thereby creating the positive feedback loop needed to sustain the project.

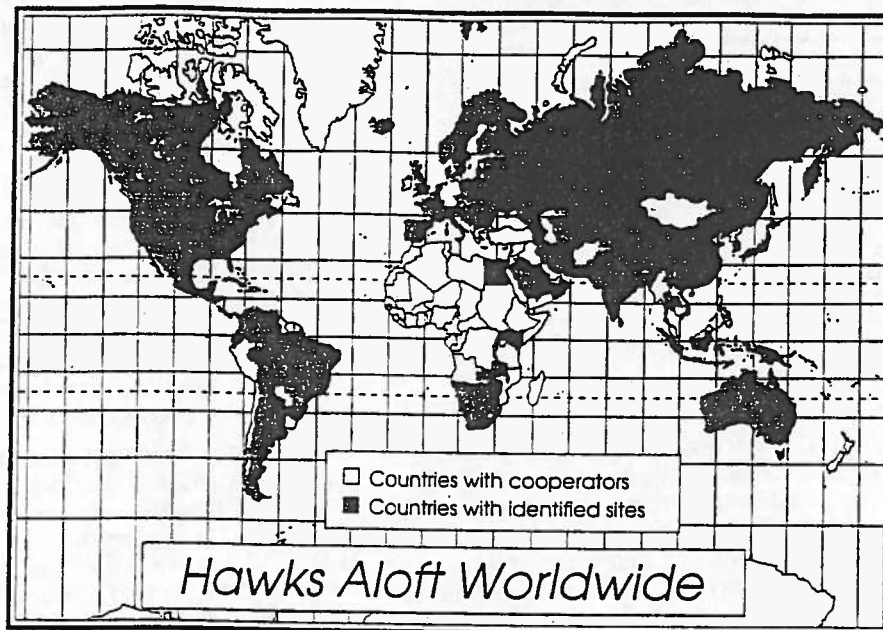


Fig. 2. World distribution of *Hawks Aloft Worldwide* co-operators by country, as of April 1994

SUCCESSFUL NETWORKING IN CONSERVATION

Although many of today's most pressing environmental problems are "global" in nature, in a very real sense all environmental conservation is "local". This, of course, is not new information. Conservationists are quite familiar with the well-worn aphorism "Think globally, but act locally". And indeed, truly effective conservation programmes (i.e., those that are both inclusive and sustainable) have almost always been built upon the early and continual input of local populations working within existing community structures. Without such input typically little is accomplished. Nevertheless, the conservation landscape is littered with examples of "top-down" global conservation efforts that have overlooked or ignored this central dictum, and have excluded local participants in decision-making processes regarding the protection of their natural resources. The current initiative does not take this approach.

The overarching philosophy of *Hawks Aloft Worldwide* is to strengthen small-scale community-based conservation organizations already in place and, where none exist, to assist local peoples in creating them. The initiative's role is to serve as an information conduit and to facilitate action, not to direct the activities of local network participants. One of the initiative's fundamental goals is to encourage and empower local conservationists to ensure community control of locally-tenured natural resources.

A first step in working with local peoples is to identify community leaders and facilitators (Brandon 1993). With over half a century of experience doing so in eastern Pennsylvania, Hawk Mountain Sanctuary personnel are well aware of the importance of this, and are taking care to ensure that their activities are fully integrated into *existing* power structures within local communities.

Hawks Aloft Worldwide is designed to create multi-directional flows of information and expertise. Phase I

of the initiative, perhaps offers the most obvious example of this feature of the network. Most of the information being used to construct the watch site descriptions that will form the core of World Atlas comes from the unpublished accounts of local



Fig. 3. Locations of *Hawks Aloft Worldwide* watch sites in Latin America, as of April 1994. (1) Veracruz, Mexico; (2) Izabal, Guatemala; (3) Panama City, Panama; (4) Paso de Portachuelo, Rancho Grande, Venezuela; (5) Parque Nacional Archipelago de los Roques, Venezuela; (6) Combeima Canyon, Colombia; (7) Estacion Biologica Cuybeno, Ecuador; (8) Olon, Ecuador; (9) Salinas, Ecuador; (10) Concepcion, Bolivia; (11) Laguna Alalay, Bolivia; (12) Joaquin V. Gonzalez, Argentina; and (13) Estancia Santa Teresa, Argentina; (14) Punta Rasa, Argentina; (15) San Carlos de Apoquindo, Chile; (16) Valdivia Wetland, Chile; and (17) Ilha do Cardoso, Brazil.

conservationists working at the sites. In turn, this information is being used by the initiative's Technical Advisory Committee (i.e., local, regional, and international raptor biologists and conservationists) in its deliberations regarding Registry criteria. The Atlas is a communal effort to consolidate and standardize existing information into a unified and more useful format. As a result, the world's raptor conservationists will be able to share each other's information and make essential comparisons regarding the significance of their conservation resources, as well as their efforts to protect those resources.

Phase II of the initiative is designed similarly. Young conservationists trained as part of Hawk Mountain's International Internship Program are returning home where they will serve as regional sources of information for network participants, as well as offer feedback to sanctuary staff. Although the sanctuary will serve as an initial focal point for training efforts, eventually, most network training will occur off-site as a result of our efforts to train the trainers.

In sum, *Hawks Aloft Worldwide* is a multi-directional information and expertise network designed to encourage and facilitate community-based conservation by providing information resources that, otherwise, would be unavailable to most local efforts. The initiative offers the advantages of international co-operation without impinging on the rights and responsibilities of local organizations to participate fully in decisions regarding the protection of their natural resources. By operating at this level, and by using the birds, themselves, to capture the attention of local peoples, *Hawks Aloft Worldwide* offers the promise of truly practical and effective conservation, both for migrating raptors, and for the sensitive migratory habitats upon which they depend.

ACKNOWLEDGEMENTS

The McLean Family Contributionship, the Prospect Hill Foundation, the General Service Foundation, the National Fish and Wildlife Foundation, the Laurel Foundation, the World Wildlife Fund, Julius Rosenwald, Nancy Frederick, the Center for the Study of Tropical Birds, Inc., and the members of Hawk Mountain Sanctuary have generously supported either *Hawks Aloft Worldwide*, our specific efforts in Veracruz, or both. The Australian Nature Conservation Agency helped support the presentation of this chapter at the Role of Networks Conference in Western Australia. Dan Brauning directed the initiative in the late 1980s and early 1990s. Ernesto Ruelas Inzunza was pivotal in establishing Veracruz, Mexico, migration watch site. Jack Bucklin in Guatemala, and Cesar Marquez in Colombia, provided information on their respective watch sites. We thank Nancy Keeler, Mike Collopy, John Craig, and Denis Saunders for improving earlier versions of the manuscript. This is Hawk Mountain Sanctuary contribution number 22.

REFERENCES

- Alcock, A., Jones, B., Lane, S. and Grant, J., 1994. National Ecotourism Strategy. Australian Government Printing Service: Canberra, Australian Capital Territory.
- Amadon, D. and Bull, J., 1988. Hawks and owls of the world: a distributional and taxonomic list. *Proc. Western Foundation Vertebr. Zool.* 3: 295-357.
- Beaman, M. and Galea, C., 1974. The visible migration of raptors over the Maltese Islands. *Ibis* 116: 419-31.
- Bednarz, J., Klem, D., Goodrich, L. J. and Senner, S. E., 1990. Migration counts at Hawk Mountain, Pennsylvania, as indicators of population trends. *Auk* 107: 96-109.
- Biber, J.-P. and Salathé, T., 1991. Threats to migratory birds. Pp. 17-36 in *Conserving Migratory Birds* ed by T. Salathé. ICBP Technical Publ. No. 12. International Conservation for Bird Preservation: Cambridge.
- Bildstein, K. L., Brett, J., Goodrich, L. and Viverette, C., 1993. Shooting galleries: migrating raptors in jeopardy. *American Birds* 47: 38-43.
- Brandon, K., 1993. Basic steps toward encouraging local participation in nature tourism projects. Pp. 13-31 in *Ecotourism: A Guide for Planners and Managers* ed by K. Lindberg and D. E. Hawkins. Ecotourism Society: North Bennington, Vermont.
- Brett, J. J., 1991. *The Mountain and the Migration*. Cornell University Press: Ithaca, New York.
- Brett, J. J. and Bildstein, K., 1993. An international scheme for monitoring raptor populations at migration sites. Pp. 367-70 in *Proceedings of the Eighth Pan-African Ornithological Congress*. Musée Royal de Afrique Centrale: Tervuren, Belgium.
- Brown, M., 1948. *Hawks Aloft: The Story of Hawk Mountain*. Cornwall Press: Cornwall, New York.
- Brown, L., 1976. *Birds of Prey: Their Biology and Ecology*. A & W Publishers: New York.
- Brown, L. and Amadon, D., 1968. *Eagles, Hawks and Falcons of the World*. McGraw-Hill: New York.
- Cade, T. J., Enderson, J. H., Thelander, C. G. and White, C. M., 1988. *Peregrine Falcon Populations*. The Peregrine Fund: Boise, Idaho.
- Carson, R., 1962. *Silent Spring*. Houghton Mifflin: Boston, USA.
- Collar, N. J. and Andrew, P., 1988. *Birds to watch*. International Council for Bird Preservation Technical Publication No. 8. Smithsonian Institution Press: Washington, D.C.
- Collins, H. H. Jr., 1933. Hawk slaughter at Dreher'sville. *Ann. Rept. Hawk and Owl Soc.* 3: 10-18.
- Cooke, A. S., Bell, A. A. and Haas, M. B., 1982. *Predatory Birds, Pesticides and Pollution*. Monks Wood Experimental Station, Institute of Ecology: Huntingdon.
- Council on Environmental Quality, 1984. *Environmental Quality 1984*. Government Printing Office: Washington, D.C.
- Ellis, D. H. and Smith, D. G., 1986. An overview of raptor conservation in Latin America. Pp. 21-25 in *Birds of Prey Bulletin* No. 3 ed by R. D. Chancellor and B.-U. Meyberg. World Working Group on Birds of Prey and Owls: Berlin.
- Evans, P. R. and Luthbury, G. W., 1973. Raptor migration across the Straits of Gibraltar. *Ibis* 115: 572-85.
- Fenech, N., 1992. *Fatal Flight: The Maltese Obsession with Killing Birds*. Quiller Press: London.
- Galea, C. and Massa, B., 1985. Notes on the raptor migration across the central Mediterranean. Pp. 257-61 in *Conservation Studies on Raptors* ed by I. Newton and R. D. Chancellor. International Union for Bird Preservation Technical Publication 5: Cambridge.
- Gensbol, B., 1984. *Birds of Prey of Britain and Europe*. North America and the Middle East. Collins: London, England.
- Geyr von Schweppenburg, H. F., 1963. Zur terminologie und theorie der leitlinie. *J. für Ornithol.* 104: 191-204.
- Grimmett, R. F. A. and Jones, T. A. (eds), 1989. *Important Bird Areas in Europe*. International Council for Bird Preservation Technical Publication 9: Cambridge.

- Groombridge, B. (ed), 1994. 1994 International Union for Conservation of Nature Red List of Threatened Animals. International Union for Conservation of Nature: Gland.
- Harwood, M., 1975. Proceedings of the North American Hawk Migration Conference 1974. Shiver Mountain Press: Washington Depot, Connecticut.
- Harwood, M., 1985. Proceedings of Hawk Migration Conference IV. Hawk Migration Association of North America: Lynchburg, Virginia.
- Haugn, J. R., 1972. A study of hawk migration in eastern North America. *Search* 2: 1-60.
- Hickey, J. J., 1969. Peregrine Falcon Populations: Their Biology and Decline. University of Wisconsin Press: Madison, Wisconsin.
- Hunter, L., Caenevari, P., Myers, J. P. and Payne, L. K., 1991. Shorebird and wetland conservation in the Western Hemisphere. Pp. 279-90 in *Conserving Migratory Birds* ed by T. Salathé. International Council for Bird Preservation Technical Publ. No. 12. International Conservation for Bird Preservation: Cambridge.
- Iapichino, C. and Massa, B., 1989. The birds of Sicily. British Ornithologists' Union Check-list No. 11. British Ornithologists' Union: Tring.
- Inigo Elias, E., 1986. Active trade threatens Mexican avifauna. *Traffic (USA)* 6(4): 6-7.
- Kennedy, R., 1986. Raptors in the tropics — the next 50 years. Pp. 17-25 in *Raptor Conservation in the Next 50 Years* ed by S. E. Senner, C. M. White, and J. R. Parrish. Raptor Research Foundation: Hastings, Minnesota.
- Kerlinger, P., 1989. Flight Strategies of Migrating Hawks. University of Chicago Press: Chicago, Illinois.
- Kerlinger, P., 1993. Birding economics as a tool for conserving neotropical migrants. *Trans. 58th Nth Amer. Wildl. Nat. Resour. Conf.*: 438-43.
- Kerlinger, P. and Brett, J., 1995. Hawk Mountain Sanctuary: a case study of birder visitation and birding economics at a private refuge. Pp. 271-80 in *Wildlife and Recreationists: Coexistence Through Management and Research* ed by R. Knight and K. J. Gutzwiller. Island Press: Washington, D.C.
- Lesham, Y., 1985. Israel: an international axis of raptor migration. Pp. 243-50 in *Conservation Studies on Raptors* ed by I. Newton and R. D. Chancellor. International Council for Bird Preservation Technical Publication 5: Cambridge.
- Lubchenco, J., Olson, A. M., Brubaker, L. B., Carpenter, S. R., Holland, M. M., Hubbell, S. P., Levin, S. A., MacMahon, J. A., Matson, P. A., Melillo, J. M., Mooney, H. A., Peterson, C. H., Pulliam, H. R., Real, L. A., Regal, P. J. and Risser, P. G., 1991. The sustainable biosphere initiative: an ecological research agenda. *Ecology* 72: 371-412.
- Magnin, G., 1991. Hunting and persecution of migrating birds in the Mediterranean region. Pp. 63-76 in *Conserving Migratory Birds* ed by T. Salathé. International Council for Bird Preservation Technical Publ. No. 12. International Conservation for Bird Preservation: Cambridge.
- Meyburg, B.-U. and Chancellor, R. D. (eds), 1989. *Raptors in the Modern World*. World Working Group on Birds of Prey and Owls: Berlin.
- Mittermeier, R. A. and Bowles, I. A., 1994. Reforming the approach of the global environmental facility to biodiversity conservation. *Oryx* 28: 101-06.
- Moreau, R., 1972. *The Palaearctic-African Bird Migration Systems*. Academic Press: London.
- Mueller, H. C. and Berger, D. D., 1967. Wind drift, leading lines, and diurnal migration. *Wilson Bull.* 79: 50-63.
- Newton, I., 1979. *Population Ecology of Raptors*. Buteo Books: Vermillion, South Dakota.
- Newton, I., 1991. Population limitation in birds of prey: a comparative approach. Pp. 3-21 in *Bird Population Studies* ed by C. M. Perrins, J.-D. Lebreton, and G. J. M. Hiron. Oxford University Press: Oxford.
- Newton, I. and Chancellor, R. D. (eds), 1985. *Conservation: Studies on Raptors*. International Council for Bird Preservation Technical Publ. No. 5. International Council for Bird Preservation: Cambridge.
- Norton, B. G., 1991. *Toward Unity Among Environmentalists*. Oxford University Press: Oxford.
- Owen, M. and Black, J. M., 1991. The importance of migration mortality in non-passerine birds. Pp. 360-71 in *Bird Population Studies* ed by C. M. Perrins, J.-D. Lebreton and G. J. M. Hiron. Oxford University Press: Oxford.
- Poole, A., 1989. *Ospreys: A Natural and Unnatural History*. Cambridge University Press: Cambridge.
- Portelli, P., 1992. Large-scale killing of migrating raptors on the Maltese Islands. Pp. 36-42 in *Birds of Prey Bulletin No. 3* ed by R. D. Chancellor and B.-U. Meyburg. World Working Group for Birds of Prey and Owls: Berlin.
- Pough, R. H., 1932. Wholesale killing of hawks in Pennsylvania. *Birdlore* 34: 429-30.
- President's High Level Commission (Comision de Alto Nivel), 1991. Elementos para diseño del plan global de turismo y conservación ecología de Galápagos. Presidencia de la Republica: Quito, Ecuador.
- Rands, M. R. W., 1991. Conserving threatened birds: an overview of the species and threats. Pp. 581-93 in *Bird Population Studies* ed by C. M. Perrins, J.-D. Lebreton and G. J. M. Hiron. Oxford University Press: Oxford.
- Ratcliffe, D. A., 1993. *The Peregrine Falcon*, second edn. Academic Press: New York.
- Robinson, J. G. and Redford, K. H., 1991. *Neotropical Wildlife Use and Conservation*. University of Chicago Press: Chicago.
- Salathé, T., 1991. The International Council for Bird Preservation Migratory Bird Conservation Program. Pp. 3-14 in *Conserving Migratory Birds* ed by T. Salathé. International Council for Bird Preservation Technical Publ. No. 12. International Council for Bird Preservation: Cambridge.
- Scott, D. A. and Carbonell, M., 1986. A directory of neotropical wetlands. International Union for Conservation of Nature: Cambridge and International Waterfowl Research Bureau: Slimbridge.
- Senner, S. E., 1984. The model hawk law — 1934 to 1972. *Hawk Mountain News* 62: 29-36.
- Senner, S. E. and Brett, J. J., 1989. A proposal to create a registry of sites of international importance to raptors, especially on migration. Pp. 33-37 in *Raptors in the Modern World* ed by B.-U. Meyburg and R. D. Chancellor. World Working Group on Birds of Prey and Owls: Berlin.
- Senner, S. E. and Fuller, M. R., 1989. Status and conservation of North American raptors migrating to the neotropics. Pp. 53-58 in *Raptors in the Modern World* ed by B.-U. Meyburg and R. D. Chancellor. World Working Group on Birds of Prey and Owls: Berlin.
- Severinghaus, L. L., 1991. The status and conservation of Grey-faced Buzzard-eagles and Brown Shrikes migrating through Taiwan. Pp. 203-24 in *Conserving Migratory Birds* ed by T. Salathé. International Council for Bird Preservation Technical Publ. No. 12. International Council for Bird Preservation: Cambridge.
- Sibley, C. G. and Ahlquist, J. E., 1990. *Phylogeny and Classification of Birds*. Yale University Press: New Haven, Connecticut.

- Simberloff, D., 1987. The Spotted Owl fracas: mixing academic, applied and political ecology. *Ecology* 68: 766-71.
- Smith, N. G., 1985. Dynamics of the transisthmian migration of raptors between Central and South America. Pp. 271-90 in *Conservation Studies on Raptors* ed by I. Newton and R. D. Chancellor. International Council for Bird Preservation Technical Publ. No. 5. International Council for Bird Preservation: Cambridge.
- Soulé, M. E. and Kohm, K. A., 1989. *Research Priorities for Conservation Biology*. Island Press: Washington, D.C.
- Stalmaster, M., 1989. *The Bald Eagle*. Universe Books: New York.
- Stillings, P. D., 1992. *Introductory Ecology*. Prentice Hall: Englewood Cliffs, New Jersey.
- Sutton, G. M., 1928. Notes on a collection of hawks from Schuylkill County Pennsylvania. *Wilson Bull.* 40: 84-95, 193-94.
- Thiollay, J. M., 1980. Spring hawk migration in eastern Mexico. *Raptor Res.* 14: 13-20.
- Thiollay, J. M., 1989. Area requirements for the conservation of rain forest raptors and game birds in French Guiana. *Conserv. Biol.* 3: 128-37.
- Williamson, K., 1962. The nature of "leading line" behaviour. *Bird Migration* 2: 176-82.

