Extinct and Endangered Owls of Old Forests

Extinct owls-Clark and others (1978) list nine owl species that became extinct during historic time. Among these, the Anjouan Island Scops Owl, Mauritius Scops Owl, Leguat's Owl, and Mauritius Owl likely inhabited native forests. Their populations probably declined from deforestation of their island environments.

Owls of Old Forests of the World
Recently extinct species

Andros Island Barn Owl	*Tyco pollens*
Anjouan Island Scops Owl	*Otus rutilus capnodes*
Mauritius Scops Owl	*Otus commersoni*
Leguat's Owl	*Bubo leguati*
Maruituis Owl	*Strix sauzieri*
Forest Spotted Owlet	*Athene blewitti*

At least two additional species can be added to this list. *Tyto pollens* was a flightless, 1-m-tall congener of barn owls that likely occurred in old-growth Caribbean pine *(Pinus caribaea)* barrens of Andros Island, Bahamas, in association with early human settlers (see figs. 6-9). It probably gave rise to local lore of chickcharnies, a mischievous leprechaunlike, nocturnal imp said to have three toes and the ability to turn its head all the way around. If disturbed, chickcharnies would impart terrible misfortune. It is possible that territorial defense behaviors of a meter-tall *Tyto* could give rise to such legends.

The Forest Spotted Owlet of central India is known from less than a dozen specimens and has not been reported since 1914 (Ali and Ripley 1983). It was associated with dense or mature deciduous forests, particularly moist-deciduous jungle and groves of wild mango near streams, in the Satpura Range of Maharashtra and Madhya Pradesh States (Ali and Ripley 1983; also see fig. 36). These forests have become heavily modified during the 20th century by clear-felling and conversion to coppice, by planting of even-aged stands of teak *(Tectona grandis)*, and from intensive human intrusions to extract other forest products (Marcot and others 1991; also see fig. 36). Although members of *Otus* and *Glaucidium* still inhabit these teak forests (personal observation), the Forest Spotted Owlet has not been reported recently.

Endangered owls-Clark and others (1978) also listed nine endangered owl species or subspecies, some of which may be associated with old native forest. Such species might include Lan Yu Scops Owl of Taiwan, and Nduk Eagle-Owl, a local endemic of Usambara Mountains, Tanzania (fig. 29). Little is known, however, of the ecology of either species. In addition, Hume and Boyer (1991) list the Sula Islands Barn Owl as known from only one specimen and possibly extinct. This species might have inhabited older native forests, but nothing is known of its habitat associations and status. They also list the Minahassa Barn Owl as a rare or endangered species in northern Sulawesi where rich tropical rain forests abound, but nothing is known of the ecology of the species.

Old-Forests Owls in Continential and Island Settings

Of all 83 extant owl species of old forests (table 1), almost a third-26 species (31 percent)-occur only on islands or peninsulas (for example, Malay Peninsula), and the remainder are found in continental settings (fig. C). This proportion of island forms is greater than that of all owls of the world regardless of habitat association: only about one-fourth (26 percent) of the 155 owl species worldwide in all habitats are found on islands or peninsulas. In general, species occurring only on islands typically are at much greater risk than are species found in continental settings, because small population dynamics increase the risk of local extinctions (Gilpin and Soule 1986). Add to this the loss of old-forest habitats and direct exploitation,

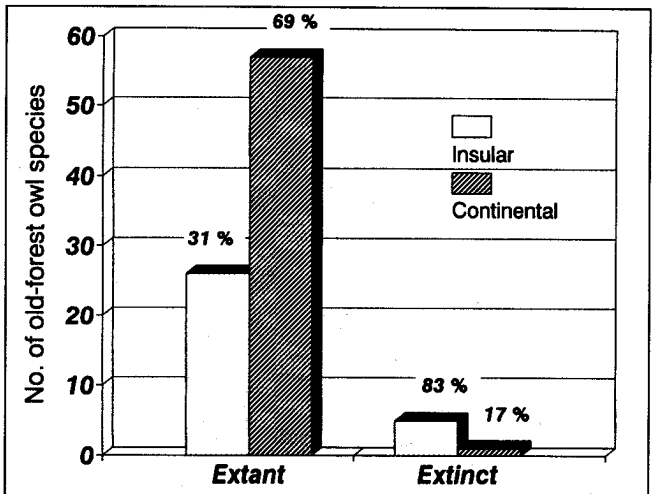


Figure C-Number of extant and recently extinct old-forest owl species in insular and continental settings.

and the threat of extinction to associated owl species greatly increases. Further, of the six extinct species of owls likely associated with old forests (discussed above), five (83 percent) were island forms (fig. C). Clearly, island living adds substantial risk to viability.

If habitats and populations are left undisturbed, many populations not already depressed to moribund levels may survive. For example, Walter (1990) cites the case of the Socorro Island Red-Tailed Hawk (*Buteo jamaicensis socorroensis*) persisting in isolation in small local numbers (20 5 pairs) because it has been undisturbed. Although this hawk is more of a generalist in habitat and diet than many old-forest owls, it nonetheless is illustrative of how small-island populations can persist with local protection of habitats and resources. Few, if any, such studies have been made, however, of population persistence of old-forest owls on islands.

Threats to Owls of Old Forests

> Most owls live outside reserves and their fortunes are largely dictated by the activities of landowners, foresters, farmers, and planners.
>
> Mikkola (1983:311)

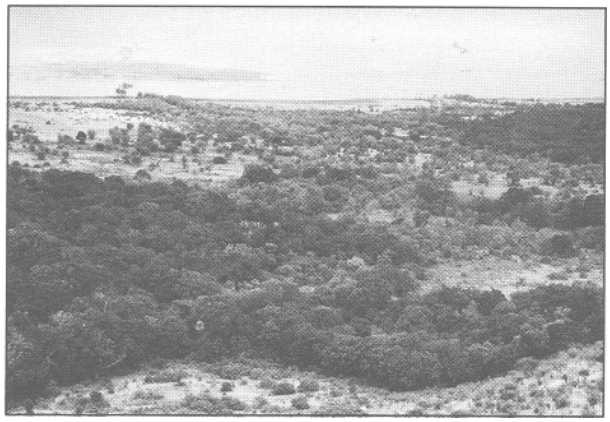
The greatest threat to owls of old forests is the direct loss of their habitats. Old forests are logged throughout the world for wood and other forest products, thereby resulting in their conversion to young forests or nonforest conditions. Many old forest have been converted to pasture and croplands, human habitations, and other uses (Wilson and Peter 1988).

There are few forest conservation reserves established for owls per se throughout the world. In Europe, as of 1981, only one reserve had been designed for birds of prey at Sabed, near the town of Tirgu Mures in Romania (Mikkola 1983). This reserve provides habitat for Long-Eared (*Asio otus*), Scops (*Otus scops*), Little (*Athene noctua*), and Tawny Owls.

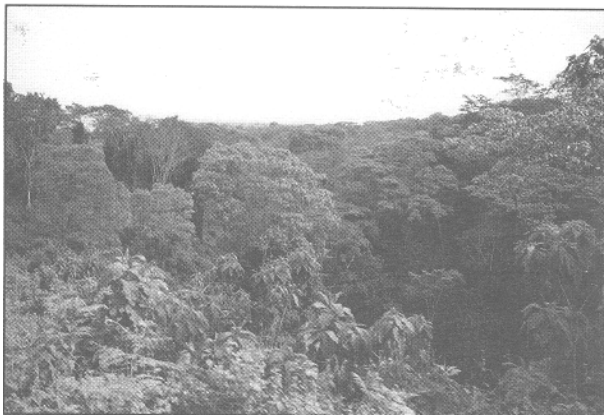
Threats to Owls of Old Forests

- Loss of habitat
- Isular settings
- Pesticides
- Disturbance
- Persecution
- Collection

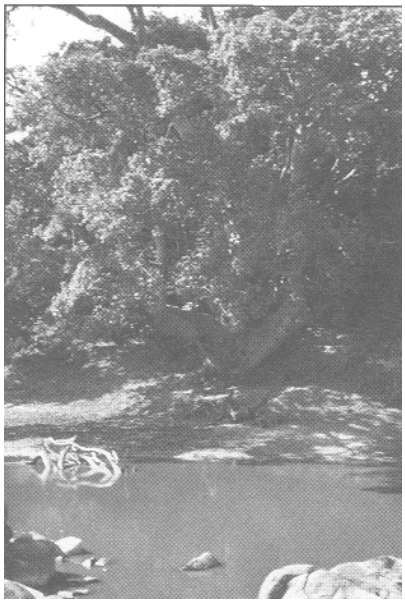
Old Forests of Africa



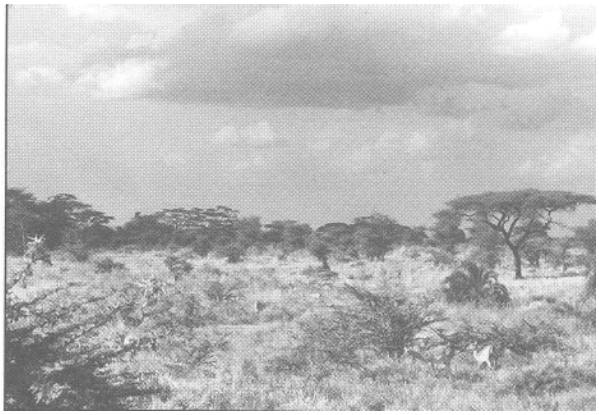
28. Tropical and subtropical forests of southern Africa contain Shelley's Eagle-Owl *(Bubo shelleyi*), Akun Eagle-Owl *(B. leucostictus*), and Fraser's Eagle-Owl *(B. poensis*). Shown here is Lake Manyara National Park, central Tanzania, in a rift valley at an elevation of 945 m. Old tropical forest in foreground, savannah with acacia trees behind; baobob tree legacies on hillsides. (Photo courtesy of David Hays)



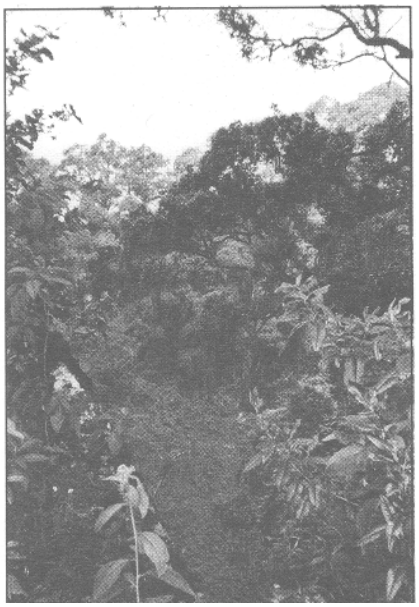
29. Mountain forests northwest of Lake Tanganyika and possibly within Zaire provide habitat for the rare Prigogine's *Owl (Phodilus prigoginei*). Such habitat appears as these semideciduous forests occuring near the rim of Ngorongoro Crater, Tanzania, at 2440 to 2740 m elevation. In the Usambara Mountains of Tanzania this type of forest provides habitat for the locally endemic Nduk Eagle-Owl *(Bubo vosseleri*). (Photo courtesy of David Hays)



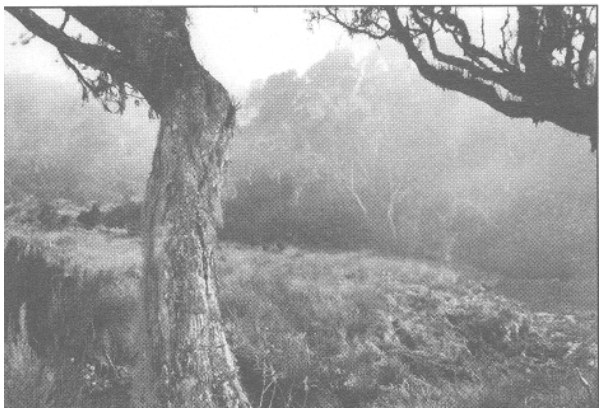
30. Dense riverine tropical forests of sub-Sahara Africa provide habitat for the scarce Milky or Verreaux's Eagle-Owl *(Bubo lacteus*) and the more widespread African Wood Owl (*Ciccaba woodfordii sokokensis).* Such tropical gallery forests also contain several species of fishing owls, including Pel's (*Scotopelia peli*), Rufous (*S. ussheri),* and Vermiculated (S. bouvieri) Fishing Owls. Riparian forest of Serengeti National Park, Tanzania along the Grumeti River. (Photo courtesy of David Hays)



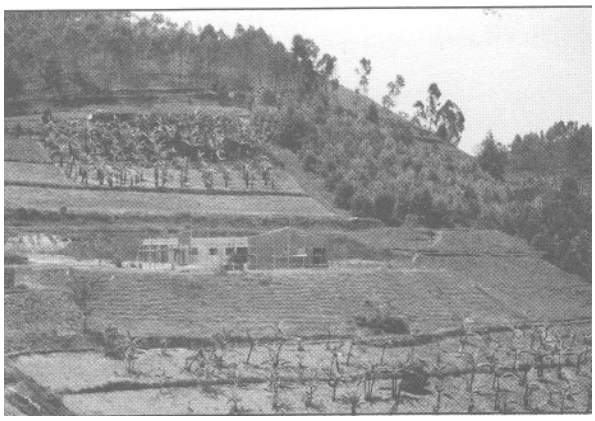
31. This mature riparian forest along the Seronera River in Serengeti National Park, Tanzania, at approximately 1525 m elevation, provides roosting habitat for the Milky or Verreaux's Eagle-Owl. (Photo courtesy of David Hays)



32. The hagenia forests of Virunga Mountains, Rwanda, 2440 to 3050 m elevation, are the home of the mountain gorilla and eagle-owls. (Photo courtesy of David Hays)



33. In Zaire, mountain heath and cedar forests are habitat for the Abyssinian Long-Eared Owl (*Asio abyssinicus).* Photo taken in Aberedere National Park, central Kenya, at approximately 3050 m elevation. (Photo courtesy of David Hays)



34. Deforestation in Rwanda includes terracing hillsides for row crops and eucalyptus plantations (upper right). (Photo courtesy of David Hays)

In the Pacific Northwest, some of the last remaining old-growth conifer forests ors federally administered public lands are being designated as ancient forest reserves, in part for protection of the Northern Spotted Owl. Current polemics over use and conservation of these ancient forests, however, are unique only in the degree of popularity of the issues and the specific kinds of forests involved. The general issues are timeworn when compared to the fate of many other owl species associated with old forests throughout the world. Examples of such issues, listed by genus, follow.

Tyto-Soumagne's Owl likely is endangered from destruction of its tropical evergreen forest habitat on Madagascar. This species is included in appendix I of the 1977 CITES Resolutions and in the IUCN Red Data Book of 1968 and updates thereto (Clark and others 1978). Conversion of humid rain forests on Madagascar likely is causing declines of this little-known species (Hume and Boyle 1991).

Phodilus-The Bay Owl is vulnerable to loss of its evergreen conifer and hardwood forests in the Himalayan foothills, where lopping and cutting of trees has accelerated in recent decades from increases in human populations. Over the past century, much of its habitat in wet evergreen tropical forests of south India and Sri Lanka has been converted to cropland or even-aged forest or coconut plantations, which has heavily fragmented remaining habitat into small isolated parcels (personal observation; figs. 38, 39). Bay Owls (and a host of other associated primary and secondary cavity-using species) might be particularly vulnerable to loss of large cavity-bearing trees in these areas. The related African Bay Owl might still occur in threatened forests of Zaire (fig. 33), but its response to commercial use of these forests is unknown.

Otus-Forest habitat of the Mountain Scops Owl is "constantly under threat of destruction" (Voous 1988:32). The Puerto Rican Screech Owl is one of the most endangered species of *Otus* because of the progressive felling of its forest habitat (Everett 1977; and see fig. 10).

On the other hand, Voous (1988) speculates that Flammulated Owls have benefited from the spread of open, arid ponderosa pine *(Pinus ponderosa)* forests in the Western United States from human-caused forest fires. Potential threats to the Flammulated Owl, an insectivore, also might include reduction of large flying insect populations from pesticide use (Voous 1988) and loss of dead trees with woodpecker cavities for nest sites (Goggans 1986, Marcot and Hill 1980). Similar loss of cavity trees in the Himalayas (personal observation) might adversely affect populations of the related Spotted Scops Owl, one subspecies of the Mountain Scops Owl.

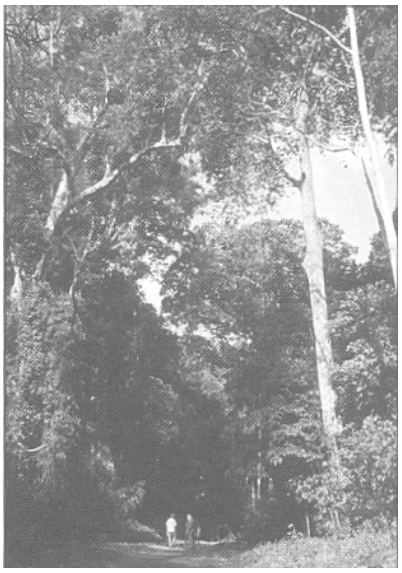
Pesticides also might have had adverse effects on populations of the European Scops Owl (*Otus scops*) (Voous 1988). Although this species likely has benefitted from its association with human-altered landscapes of Europe (figs. 26, 27) and is not an old-forest obligate, environmental pollution has caused population declines in the Middle East (Voous 1988). Understanding reasons for population declines of the European Scops Owl might aid in understanding other, less well-known congeners associated with old native forests. It is unclear how its populations might be affected by the current environmental crisis induced by the 1991 Iraqi war, especially pollution of the atmosphere from hundreds of burning oil wells and other battle-related fires. Other populations of the European Scops Owl have decreased because of conversion of woodlands to vineyards in the Rhone valley of Switzerland and the loss of trees with hollows (Arlettaz 1987, Voous 1988)

Old Forests of the Indian Subcontinent

35. The old forests of deodar (*Cedrus deogara*), blue pine or kail (*Pinus wallichiana),* and chir pine (*P. roxburghii*) of the Himalayas of India, Nepal, Tibet, and Bhutan, have provided habitat for the Bay Owl *(Phodilus badius), Forest* Eagle-Owl *(Bubo nipalensis), Himalayan* Wood Owl (*Strix aluco nivicola*), and Scully's Wood Owl (*S. aluco biddulphi).* However, severe overuse, including terracing, lopping of trees, fires, and deforestation, has eliminated forest habitats and resulted in great erosion and slope failures in many areas.

37. A remnant "preservation plot" of tropical moist deciduous forest in Kerela, southwest India, containing teak (*Tectona grandis)* and *Lagerstroemia lanceolata* in the overstory and *Randia dumetorum* and *Wrightia tinctoria* in the understory. Such forests provide habitat for Brown Wood Owls (*Strix leptogrammica*), one of the Asian cousins of North America's Spotted Owl

36. Much of the older, dry deciduous forests of India has been removed for agricultural production. Some have been replaced by plantations of sal (*Shoria robusta*) in the north and teak (*Tectona grandis) or* exotic species such as eucalyptus (*Eucalyptus globulus*) in the center and south. Forest reserves and wildlife sanctuaries protect remnants of the original dry deciduous forests. This forest reserve occurs in Melghat Tiger Reserve, Satpura Hills, Madhya Pradesh and Maharashtra of the High Deccan Plateau of central India. It is the last known forest habitat of the Forest Spotted Owlet (Athene blewetii), not seen since 1914.



38. A tropical wet evergreen rain forest in Tamil Nadu, south India (left). These amazingly diverse forests are characterized by Dipterocarp trees (for example, *Dipterocarpus grandiflorus, D. pilosus, D. kerrii, D. gracilis,* and others). Shown here is the scarce giant evergreen forest of the Western Ghats, containing trees of the families Clusiaceae, Anacardiaceae, Sapotaceae, Meliaceae, and Lauraceae. These forests host Brown Wood awls, Brown Fish Owls *(Bubo 7eylonensis),* and, in Southeast Asia, Spotted Scops Owls (*Otus spilocephalus spilocephalus*).

39. The lowland moist evergreen and wet evergreen tropical forests of south central and Southeast Asia have largely been converted to agriculture and other land uses. Some of these forests in upper elevations have been preserved in recently formed forest and wildlife reserves. Their small size and scattered distribution, however, do not guarantee the long-term viability of associated old-forest owls, including Forest Eagle-Owls, Brown Wood Owls, and Brown Fish Owls.

Loss and conversion of old forests also might adversely affect many other subtropical and tropical species of *Ofus*, including the Oriental Scops Owl, which is dependent on such habitats. Clearing of primary lowland rain forests in Malaysia, Sumatra, Java, Borneo, and the Philippines likely is threatening the Rufous Scops Owl, but nothing is known of how it might respond to increasing fragmentation of its primary forest habitat and to growth of secondary forest (flume and Boyer 1991). Although the species is not currently endangered, loss of its habitat should be of concern. Collared Scops Owls and Pacific Screech Owls, on the other hand, might be more able to persist in human-altered landscapes and various forested landscapes in the absence of old forests per se.

Actions Needed

- Inventories
- Studies of habitat associations
  -Tropical and insular settings
- Protect existing key old forests tracts
  -Temperate and tropical
- Study reforestation and vegetation manipulation

Ancient Mayan corn crop rotations and agricultural practices likely led to declines in amount of undisturbed forest vegetation in Mexico and Central America (Terborgh 1989). This may have had adverse effects on the Whiskered Screech Owl in the Neotropics (Voous 1988). More recent and widespread conversions of forest cover to human habitations and croplands in Mexico likely have caused greater population declines. The species still remains locally abundant, however, in areas of denser forest cover.

Populations of the Vermiculated Screech Owl also have declined because of destruction of its New World tropical forests in Mexico, which have all but been cleared and converted to cropland and secondary scrub forest (Voous 1988; see figs. 12 and 13). Voous (1988:78) notes that "local, geographically marginal populations in Mexico and South America have already disappeared as a result of habitat destruction, and some of these probably extinct populations have recently been described as new subspecies in an attempt to call attention to their former existence (Hekstra 1982)."

The Sokoke Scops Owl, discovered in 1965 by S. Dillon Ripley in the remnants of the Sokoke Forest on the Kenyan coast, is threatened by loss of its forest habitat and by specimen collectors (Everett 1977). Between 1956 and 1966, its forest habitat was halved to 350 km 2. Further deforestation poses a threat to the remaining population, as only one reserve of 40 km 2 has been established (flume and Boyer 1991). Its population has been estimated at 1,300-1,500 pairs and is considered endangered (Clark and others 1978). Its plight was highlighted in 1966 in the IUCN Red Data Book.

Continued clearing of tropical mountain forests in Sumatra, Java, and Borneo may be an increasing threat to the Rajah's Scops Owl (flume and Boyle 1991). In Mahe, Seychelles, new forest harvest methods have led to reduction of upper valley forests, habitat of the Seychelles Scops Owl. Apparently, the only habitat preserved for this species occurs in Morne Seychellois National Park. Eventual clearing of highland forests likely will separate the remaining individuals into one small, isolated population in the park.

In Brazil, loss of lowland dry deciduous tropical forest likely is reducing habitat available to Black-Capped Screech Owls.

The Giant Scops Owl also is threatened by loss of its forest habitat in the Philippines (Clark and others 1978, Everett 1977). Although not a forest bird, the Palau Scops *Owl (O. podarginus)* likewise is vanishing because its primary, lowland mangrove swamp habitat is "fast disappearing" from the Palau islands of Micronesia (Everett 1977:147).

Bubo-The Forest Eagle-Owl depends for its survival on the continued existence of the "much endangered" tropical south Asian lowland and hill forests (Voous 1988:108). Other, less well-known Asian and African congeners, including the Akun Eagle-Owl and Philippine Eagle-Owl, also might be adversely affected by removal, modification, and fragmentation of their tropical forest habitats (Hume and Boyle1991). Mikkola (1983:311) reports that the Eagle-Owl has been persecuted heavily by humans and "may well fade from the European avifauna if they are not strictly protected." In fact, Eagle-Owls were on a list of "vermin" in France until the early 1960s, and as a result, their range and numbers declined markedly (Mikkola 1983). Captive breeding programs are underway in Sweden, Germany, and England and are needed in Norway (Mikkola 1983).

Ecological Studies Needed

- In insular or fragmented environments (Celebes Barn Owl, Gian Scops Owl, etc.)
- In habitats threatened or in decline
  -Many tropical species (Scully's Wood Owl, Fulvous Owl, Malay Wood Owl, Spotted Wood Owl, Rusty-barred Owl, others)

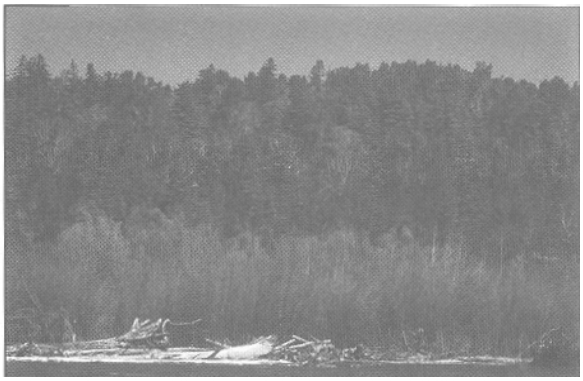
Strix-The Northern Spotted Owl has become the cause celebre for conservation of old-growth forests of the Western United States. Its numbers and distribution have doubtless declined from extensive clearcutting of ancient forests, thereby prompting a new wave of alternative forestry practices to be considered for use on commercial forest lands. Barred and Great Gray Owls have evolved greater tolerance for broken and open forest conditions and do not seem to be in similar peril. In particular, the Great Gray Owl might never have been very abundant in extensive dense forests as they usually forage in more open habitats (see footnote 5).

In Eurasia, the Ural Owl likely has suffered declines from widespread conversion of its northern forests to agriculture or human habitations. The species apparently is taking to other substrates for nesting, however. Mikkola (1983) notes that in former times, breeding habitat was old-conifer or mixed forest far from human habitation, but in the last 25 years this has become more varied. Ural Owls still favor damp heath forest but now also regularly nest in dry heath forests and spruce bogs, with additional breeding records in pine bogs and herb-rich forests. Mikkola (1983:171) concludes that "such adaptability will favor it in the future."

Because of its tolerance to young forest conditions and its small territory size among *Strix* species, the Tawny Owl has persisted in woodlands of Europe. Little is known, however, of the status of two Asian subspecies, the Himalayan Wood Owl and Scully's Wood Owl. As with the northern subspecies of the Spotted Owl, these subspecies of the Tawny Owl seem more dependent on dense or older forests of the mountains. Loss of ancient trees as nest and roost substrates in the Himalayas from burgeoning human populations very likely are adversely affecting the populations of the owls.

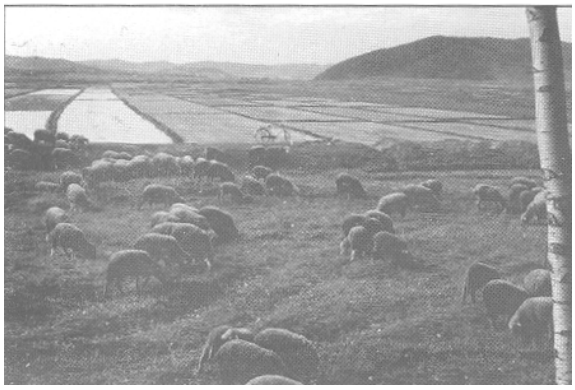
40. Broadleaf hardwood and conifer forests of Far East Russia supply habitat for Ural Owls, Eurasian (or Northern) Eagle-Owl, and Brown Hawk-Owl *(Ninox scutulata*). This forest is found in central Ussuriland south of Khabarovsk. The higher elevation larch and pine forests of Ussuriland support the more northern Holarctic species including Great Gray Owl, Eurasian Pygmy-Owl, and Boreal (Tengmalm's) Owl.

41. Forest reserves or *zapovedniki* help conserve old-forest habitats in the Ussuriland region of Far East Russia. Bolshe-Khekhtsivsky Zapovednik just south of Kabarovsk. Forests here consist of many locally endemic plants including large cork trees *(Phellodendron amurense),* two species of linden *(Tilia mandshurica* and *T. amurensis*), Korean pine (*Pinus koraiensis),* Manchurian walnut (*Juglans mandshurica),* Manchurian ash *(Fraxinus mandshurica),* and the ancient, relict Mongolian oak (*Quercus mongolica*).



42. Undeveloped broad flood-plain forests of Far East Russia, eastern China, and Korea contain the rare Blakiston's Fish Owl (*Ketupa blakistorni).* Upper Bikin River Basin, Ussuriland, Far East Russia.

Little is known also of the population status of the Brown Wood Owl. This species is a close associate of interiors of dense old forests in the Indo-Malaysian area. Like its Tawny Owl relatives, likely it has suffered declines in recent decades. Its evergreen, moist deciduous, subtropical submontane, and lowland rain forest habitats have been reduced greatly. Altering and fragmenting its selected habitats, as with the conversion of wet evergreen forests to teak plantations in south India (fig. 39) and Sri Lanka, may pose an even greater threat to the Brown Wood Owl than to the Tawny Owl, which may be more tolerant of forest edges and openings.

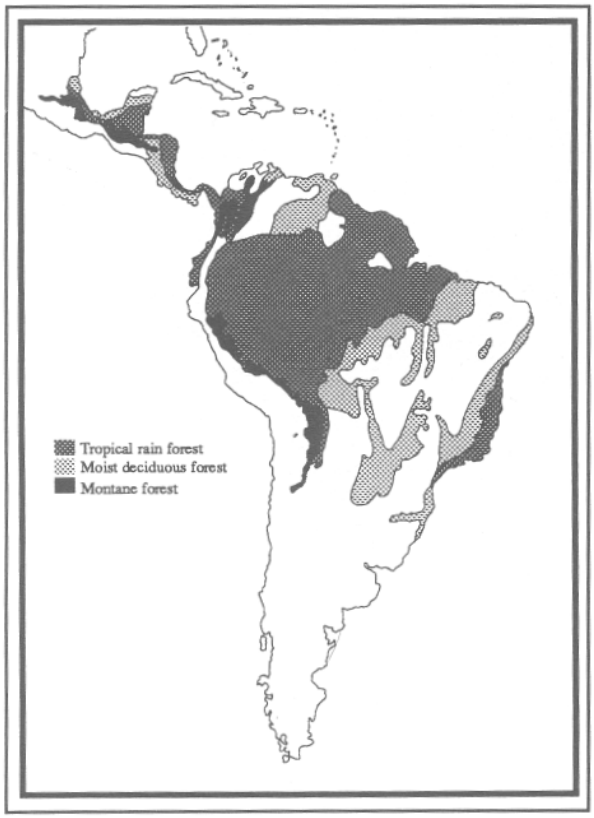


43. Across the border from the Russian Far East is Heilongjiang Province, northeast China, where lowland forests have long since given way to rice paddies, agricultural fields, and pasturelands. Old-forest owls of the Far East are essentially extirpated throughout most of eastern China under the enormous and growing human population pressures for land use.

45. Eastern China has seen great episodes of deforestation. Its rich, loess-covered agricultural fields are subject to tremendous wind erosion and gullying, further reducing suitability for growth of forests. Restoration of native forests is virtually unheard of and most forest cover consists of plantations of three or fewer tree species where dozens once stood. Few if any old-forest owls have survived these changes.

Partly sympatric with the Brown Wood Owl is the Mottled Wood Owl, which is more tolerant of human-altered landscapes and may not be as affected by loss and conversion of old-forest habitats. Recently, measures have been taken to protect wet evergreen forest stands in Kerela and Tamil Nadu states in south India, such as with the creation of Indira Ghandi Wildlife Preserve. These are major positive steps that will aid in conserving habitat for Brown Wood Owls, Mottled Wood Owls, and their old-forest associates (for example, Uniyal and Surendrnathan Asari 1988).

Examples of Forest Distributions and Owl Ranges
Central and South America



46. Distribution of South American tropical rain forest, moist deciduous forest, and montane forest.

48. Range (above) of Band-Bellied Owl *(Pulsatrix melanota)* coincides with lowland tropical forests east of the Andes.

49. Band-Bellied Owl (left).

47. Range of Mottled Owl *(Ciccaba virgata)*. Note coincidence with distribution of tropical forests.

50. Range of Cloud-Forest Screech Owl *(Otus marshalli)* in Andean cloud forests of Peru. An example of a locally endemic species with narrow distribution.

51. Cloud-Forest Screech Owl.

A more subtle potential threat to the Brown Wood Owl and associates may be the intensive use of forests by humans for forest products other than commercial timber. In Southeast Asia, such forest products and uses include gathering of bamboo, canes, resins, and bidi leaves; collection of deer antlers; falling of hazard trees; selection cutting of trees for poles and construction; lopping of tree limbs for livestock fodder; and grazing livestock. Such use, if conducted in moderation, should pose no threat to the owls or their habitats. Unconstrained use, however, results in forests of substantially sparser canopy and ground cover and lower overall plant and animal diversity (personal observation). This use is apt to adversely affect resident owl populations by reducing forest cover and availability of trees with nest cavities. Such potential effects on owl populations need further study.

Little is known of the population status of Fulvous Owls in the Neotropics. It can be surmised that cutting of their associated pine-oak and cloud-forest habitats has detrimental effects on population sizes of this and other related owl species of the New and Old World tropics, including the Malay Wood Owl, Spotted Wood Owl, and Rufous-Legged Owl.

***Ciccaba*-**The Mottled Owl does not seem threatened as long as tropical forests remain protected in sundry parks and reserves, such as the cloud forests of Monteverde Biological Preserve in Costa Rica (fig. 15). Little is known of the population status of other tropical members of *Ciccaba,* although it can be surmised that reduction of tropical gallery and evergreen forests has adversely affected Black-and-White and Black-Banded Owls in the lowlands and perhaps also Rufous-Banded Owls in the Andean highlands.

Other genera-The Blakiston's Fish Owl is threatened with the removal of the taiga forests on which it depends in Japan and the Russian Far East (Voous 1988; personal observation). The Japanese race *Ketupa b. blakistoni* of Hokkaido and Kunashire Island numbered 50 birds in 1984 (Hume and Boyle 1991) and is endangered from loss of its dense, primary forest habitat (Clark and others 1978). In the Russian Far East, its primary habitat is mixed old-growth forests of broadleaved and conifer trees; most of these forests have been logged and the species persists only in small, isolated populations in broad, mostly undisturbed valleys of the Amur, Bikin, Khor, and a few other major rivers of the region. Likely, it is mostly extirpated in northeast China because of conversion of vast native forests to agriculture, pasture, or forest plantations (personal observation; figs. 43-45). Other threats to its persistence include increasing human populations, selective harvesting of its nest trees, and disturbance from tourists, although it seems to be taking to use of nest boxes in Hokkaido (Hume and Boyle 1991).

The Eurasian Pygmy-Owl *(Glaucidium p. passerinum)* had disappeared from the Black Forest mountains of Germany because of intensive timber management activities, including parcelling of the spruce-fir forests and clearcutting of old-growth forest stands (Konig 1981; see figs. 26, 27). More recently, the species has been at least partially restored with the use of nest boxes (Voous 1988). The Albertine Owlet likely is endangered because of logging and clearing of the Nyungwe Forest in Rwanda and mining in the Itombwe Mountains of central Africa (flume and Boyle 1991). Zaire and Rwanda have planned, but not yet implemented, some conservation measures. Other species, including Papuan Hawk Owl, Ochre-Bellied Hawk Owl,

Indonesian Hawk Owl, Stygian Owl (*Asio stygius*; see fig. 11), and Madagascar Long-Eared Owl, also increasingly might be threatened from reductions in their tropical forest habitats.

Certainly, there are many other threats to forest owl species of the world, including disturbance by photographers, birders, and tourists, as with Eagle-Owls in Britain and Great Gray Owls in California; use of pesticides; poisoning, shooting, and electrocution; and collecting of eggs and specimens. Another major cause of habitat loss is reduction of riparian forests from drainage of wetlands, streams, and lakes. This probably has reduced numbers and distributions of Eagle-Owls and Brown Fish Owls throughout Europe and the Mediterranean region, particularly in Israel (Mikkola 1983) and India (personal observation).

Restoration of Old Forests

Cleared old native forests rarely are returned to original or near-original condition. I am aware of no scientific study that has demonstrated unequivocal success in intentionally restoring an owl species or other wildlife associated with ancient forest conditions through use of reforestation or other specific forest management practices. Several projects underway deserve special mention and support, however.

In temperate conifer forests, environmental concerns for loss of old-forest habitats are fostering a new era of forest management techniques. In part, such techniques are aimed at maintaining and restoring at least some older forest conditions on public commercial timber lands of the Pacific Northwest (for example, Franklin and others 1986, Klinka and others 1990). Silvicultural prescriptions are .being written to demonstrate and test how well old-forest components, such as large live trees, large snags and down dogs, and dense and diverse vegetation structures, can intentionally be maintained or induced by direct stand manipulation. One phase of these studies involves testing behavioral and population response by the Northern Spotted Owl on National Forests. Indeed, one conservation strategy for managing habitat for Northern Spotted Owls on Federal forest lands (Thomas and others 1990) calls for developing and testing such silvicultural techniques as an integral part of the long-term success of the strategy. Such new forestry tactics are best applied in a careful scientific program of hypothesis testing to evaluate effects on forest stand structure and composition, production of desired commodities, and particularly long-term response by owl populations. In using an approach of this type, existing scarce and declining old forests should be protected at least in the interim (Johnson and others 1991).

Restoration of wetlands and associated riparian gallery forests in Europe and Asia could aid in recovery of associated owl species. Brown Fish Owls, Eagle-Owls, and the host of other fishing owl species would benefit.

Several owl species primarily associated with old forests also show some use of mixed-age or older secondary forests. These species include the Tawny-Bellied Screech Owl, Fraser's Eagle-Owl, and perhaps the Spotted Owl in limited parts of its range. Manipulation experiments to test the response of these species to carefully applied silvicultural prescriptions might help identify new methods for conserving their habitats and allowing some degree of use of forest commodities. Such experiments should be conducted, however, as strict scientific and statistical studies, as aberrant case observations can easily lead to overestimating the degree of adaptability of these species.

In tropical forest systems, restoration projects are being proposed or implemented to help bring back old-forest conditions. Among these is the restoration of dry deciduous tropical forests in the Guanecaste region of northwestern Costa Rica (Jantzen 1988). Success of this project might benefit species of *Ciccaba, Otus,* and other tropical genera and concomitantly would provide for sustained use by humans for farming and livestock grazing. In the Western Ghats mountains of southern India, silvicultural monitoring projects are aimed at restoring some of the highly modified and fragmented wet evergreen forests from converted teak plantations (fig. 37). The restoration also might help recover Forest Eagle-Owls and Brown Wood Owls in these areas (personal observation). Many other tests of effects of forest openings, patch cuts, and canopy gaps in Brazilian Amazonia (Lovejoy and others 1986) and Caribbean slope rain forests of Costa Rica (for example, Denslow and others 1990) are being explored as well. Results of these and other studies can be used to identify forest management activities that can restore or maintain old-forest owl species even in the presence of human use of forests.

Nest Boxes Are Not a Lonmg-Term Solution

Many forest owl species benefit from nest boxes or artificial nest platforms, including Tawny (Southern 1970), Barred (Johnson 1987), Great Gray (Bull and others 1987), Flammulated (Hasenyager and others 1979), Striated Scops (O. *brucei;* Voous 1988), European Scops (Arlettaz 1987, Barthos 1957, Kadochnikov 1963, Randik 1959), and Collared Scops (Pukinsky 1977) Owls. Mikkola (1983) also lists the Hawk *(Surnia ulula),* Tengmalm's, and Little Owls as readily using nest boxes.

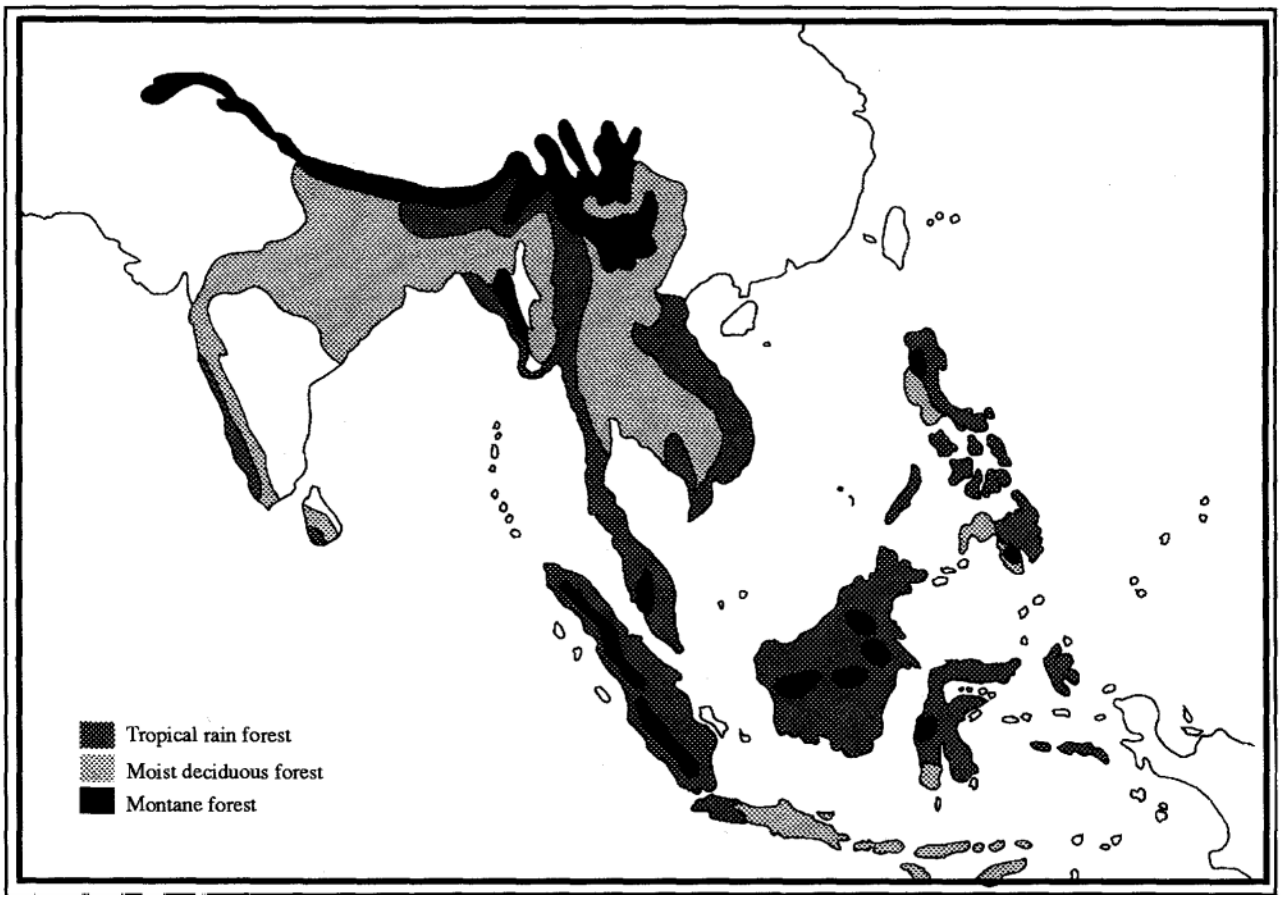
By far, however, most of these species are notably more generalist in the ages and kinds of forests they inhabit than are their old-forest congeners discussed in this report. Similar nest-box programs for owl species more closely associated with old forests, such as for Brown Wood Owls and Northern Spotted Owls, likely would not meet all their life needs found in old forests, including availability of prey and thermal and predation cover. Possibly for this reason, the Northern Pygmy-Owl has not taken to nest boxes as has its European congener the Eurasian Pygmy-Owl (Voous 1988), and the Northern Spotted Owl has been induced to use nest boxes or artificial nesting platforms only in isolated cases.[6] The removal and prevention of old rotting wood in European forests by modern forestry programs is detrimental to breeding successes of Hawk, Tawny, Ural, Tengmalm's, and Pygmy Owls, who use natural fissures and tree cavities as nest sites (Mikkola 1983). In Sweden and Finland, however, many nest boxes have aided in increasing local numbers of Ural Owls. If instituted for old-forest owls, nest-box programs should first be conducted to scientifically test hypotheses of behavioral and long-term population responses rather than as a full-fledged management program (Marcot and Gardetto 1980).

Interpreting Habitat Associations

Studies of the Northern Spotted Owl have described clearly its selected habitat as mature and old-growth conifer forests (Thomas and others 1990). Nevertheless, many people interested in the commercial values of its preferred habitat cite occurrence of the subspecies in second- and young-growth forests as evidence of its "adaptability" (for example, Craig 1986). Studies have revealed that such atypical associations occur for only a small portion of the subspecies, if at all (atypical associations with young forests also are reported with other old-forest owl species).

[6] Personal communication. Jeffery Mattison, Six Rivers National Forest, Fish and Wildlife Unit, 1330 Bayshore Way, Eureka, CA 95501.

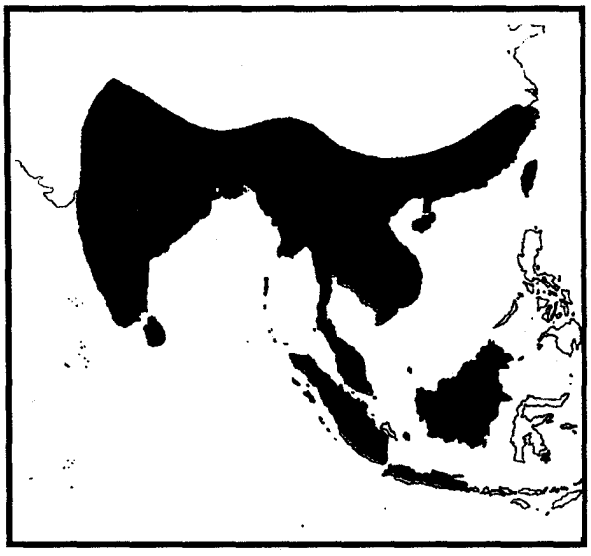
Examples of Forest Distributions and Owl Ranges
Southeast Asia

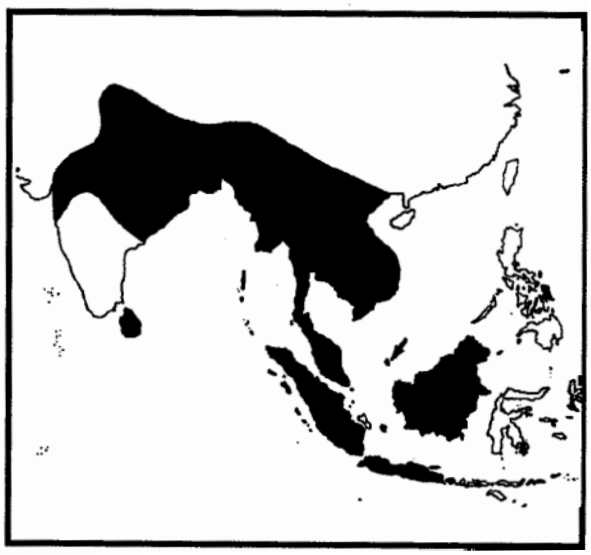


52. Distribution of rain forests of the Indo-Malaysian region.

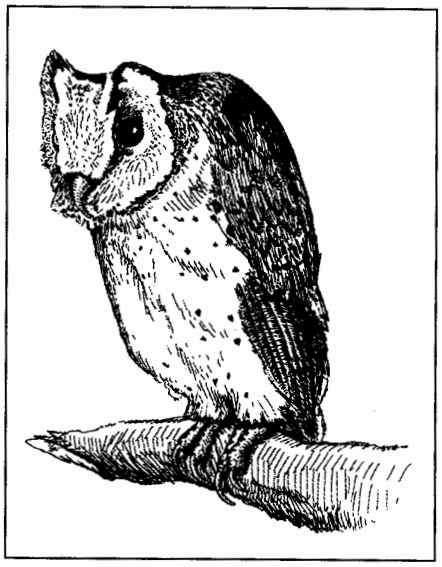
53. Range of Brown Wood Owl (*Strix leptogrammica*) in Southeast Asia. Note general coincidence with distribution of tropical rain forests.

54. Brown Wood Owl (far right).

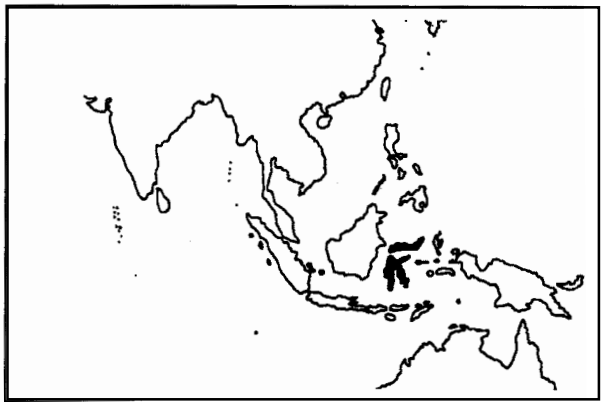




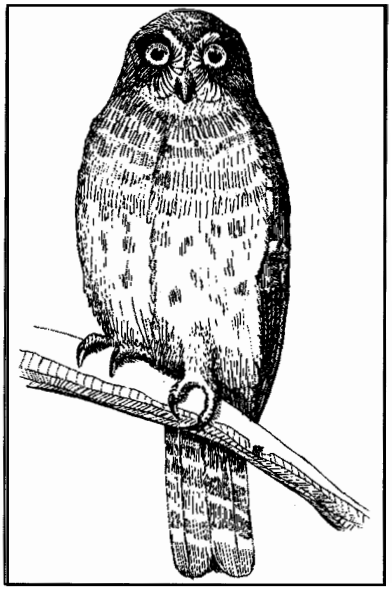
55. Range of Bay Owl *(Phodilus badius)* in Southeast Asia.



56. Bay Owl.



57. Range of Ochre-Bellied Hawk Owl *(Ninox penrersa)* in tropical rain forests of Celebes.



58. Ochre-Bellied Hawk Owl.

Also, within young forests, Northern Spotted Owls typically are found tightly associated with elements or small patches of old forests (Forsman and others 1977, Thomas and others 1990). The Northern Spotted Owl evolved in association with, and is adapted to, old forests. Populations likely would fare poorly in landscapes with highly fragmented old forests or with purely young-forest conditions (Thomas and others 1990).

Ongoing research is testing these concepts and assessing how well silvicultural manipulations can provide old-forest elements for Spotted Owls and other old-forest associates in commercially managed forest lands (Nyberg and others 1987). Also of particular relevance to management of Spotted Owls would be an understanding of its old-forest congeners, particularly the Himalayan Wood Owl and Scully's Wood Owl, in their increasingly fragmented and altered mountain forest habitats. Unfortunately, no ecological or demographic studies seem to have been conducted on these populations.

Conservation Activities Needed

- Create old-forest reserves
- Restore old-forest conditions
- Study behavioral and population response
- Restore wetlands, riparian habitats
- Nest boxes . . . ?

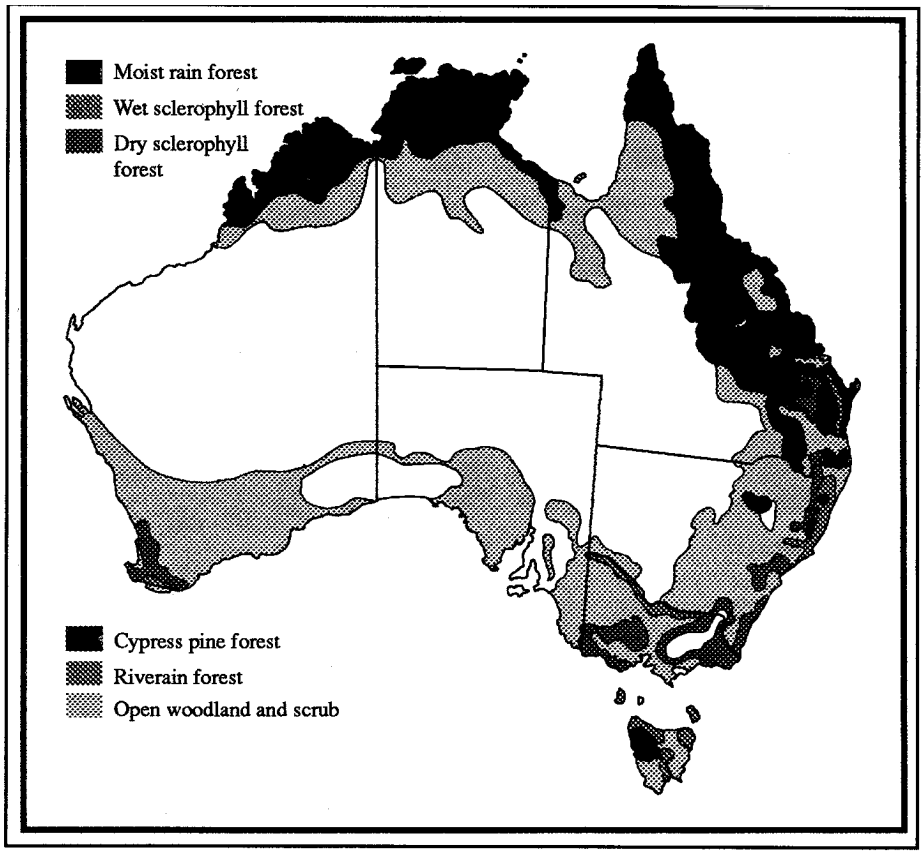
Some species of *Otus*, such as the European Scops Owl, the Striated Scops Owl, and the Collared Scops Owl, seem to do well in cultivated and human-altered habitats. Other congeners, however, such as the Mountain Scops Owl and the Oriental Scops Owl, are associated primarily with old, denser forests and do not tolerate human alteration of landscapes. Similarly, among species of *Strix*, the Barred Owl and Tawny Owl likely are more tolerant of human-altered habitats and concomitant invasions by potential predators and competitors than are other congeners such as the Brown Wood Owl and the Spotted Owl. In the same way, among species of *Bubo*, the Great Horned Owl is more catholic in ages and structures of forests it inhabits than is its Asian cousin, the Forest Eagle-Owl.

It should be no surprise that the various species of a genus complex, such as *Strix* and *Otus*, have evolved to specialize in use of different environments including undisturbed, old forests. Nor should it be a surprise, following this evolutionary. history, that no one species of a given genus exhibits the full range of ecological adaptations and habitat associations as seen among all its congeners, just as no one individual of a species exhibits the behavioral variation of all races of the species (Ruggiero and others 1988). Thus, the best way to ensure the continued existence of all species of each genus complex is to provide for the full range of habitat conditions, including old forests, needed by each species.

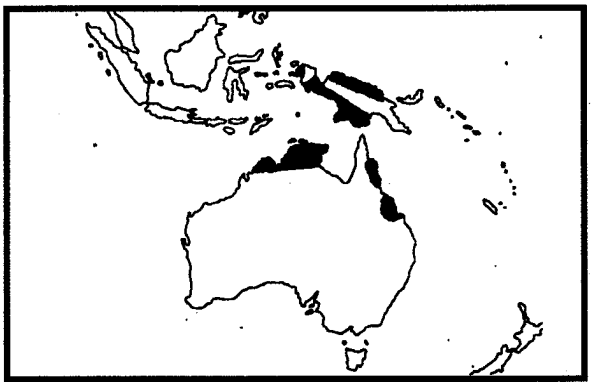
Forest Owls in Human Cultures

Many species of forest owls have played prominent roles in myths and religious beliefs (Holmgren 1988). The plaintive song of the Mountain Scops Owl is known in legends of the mountainous tribes of Myanmar (Smythies 1953, Voous 1988). The Oriental Scops Owl is the subject of folklore in Japan and Korea, its call associated with the mystical treasures of Buddhism (Austin and Kuroda 1953, Voous 1988).

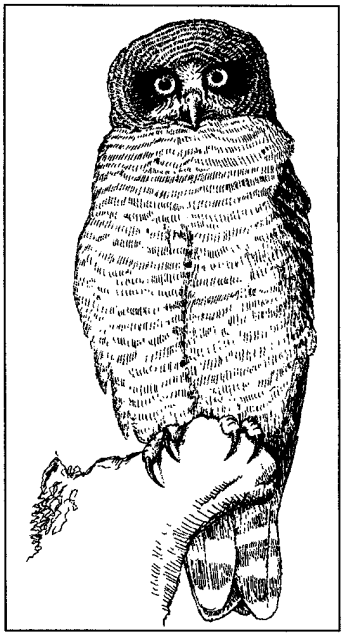
Examples of Forest Distributions and Owl Ranges Australia



59. Distribution of rain forests in Australia.



60. Range of Rufous Owl *(Ninox rufa)* in moist rain forests of northern Australia



61. Rufous Owl (right).

Old-forest owls often are associated with sacred, large trees in riparian gallery forests, near temples, and in cemeteries. In India, the Forest Eagle-Owl plays a major role in many legends and is said to be found calling from Hindu cemeteries that are often the only local bastion of old-growth forests with large hollow trees and snags.[7] The Brown Wood Owl, Forest Eagle-Owl, and Brown Fish Owl are found in sholas and gallery forests of Ficus near waterholes and streams in northern and southern India, sacred areas with mundirs and temples (personal observation; fig. 38). In a sense, then, many of these owl species serve as indicators of the religious value of a forest.

The Collared Scops Owl has survived on Java and Borneo possibly in part because of the ill omen or reverence it represents in legends there (Voous 1988). In China and Korea, these owls are used for medicinal purposes and many have been taken annually for this purpose (Austin 1948, Gore and Won 1971, Voous 1988). For the most part, however, the Collared Scops Owl has adapted well to areas of human habitation.

Ultimately, the Spotted Owl finds itself in similar circles of controversy over forest management as have many other species in other parts of the globe. The fate of Brown Wood Owls in southern India, Sikkim Bay Owls in the Himalayas, and Crested, Black-and-White, and other Neotropical owls in Central and South America similarly are caught in disputes over human use of their selected old-forest habitats. Such controversies include the closure of local forests to commercial timber harvest, national policies in India that have brought hardship to some local tribes and villagers. In response, the Government of India has instituted retraining programs to school the former loggers to become environmental educators and field tour leaders for the growing industry of environmental tourism (Panwar and Rao 1990). Perhaps by similarly incorporating the Spotted Owl once again into the culture of North America through recreational, aesthetic, artistic, scientific, and even ethical interests, it can play a legitimate role in the well being of human societies and thereby continue to persist in some of the least disturbed and oldest temperate forests the world now knows.

Acknowledgments

I thank Evelyn Bull, Carl Marti, David Wilcove, and Jon Winter for helpful technical reviews of the manuscript, and Steven McDonald for a policy review. This paper is dedicated to the many field biologists of Federal and state forest management agencies, universities, research stations, and other private and public organizations whose work is helping to protect owls of old forests throughout the world.

Measure Equivalencies

1 meter (m) = 39.37 inches or 3.28 feet
1 square kilometer (km^2) = 0.3861 square mile

[7] Personal communication. V.B. Sawarkar, Wildlife Institute of India, P.O. New Forest, Dehra Dun 248006, India.

Literature Cited

Ali, Salim. 1949. Indian hill birds. [reprinted 1987]. Bombay, India: Oxford University Press. 188 p.

Ali, Salim. 1962. The birds of Sikkim. Delhi, India: Oxford University Press. 414 p.

All, Salim. 1977. Field guide to the birds of the eastern Himalayas. Delhi, India: Oxford University Press. 265 p.

Ali, Salim. 1979. The book of Indian birds. [reprinted 1988]. Bombay, India: Oxford University Press. 187 p.

Ali, Salim; Ripley, S. Dillon. 1983. Handbook of the birds of India and Pakistan. Compact edition. Delhi, India: Oxford University Press. 737 p. (plus 113 plates).

Amadon, D.; Bull, J. 1988. Hawks and owls of the world: a distributional and taxonomic list. Proceedings of the Western Foundation of Vertebrate Zoology. 3(4): 295-357.

Arlettaz, R. 1987. Statut de la population relictuelle du hibou scops en Valais central. Stat. Orn. Suisse, Sempach: 1-32.

Austin, O.L. 1948. The birds of Korea. Bulletin of the Museum of Comparative Zoology of Harvard College. 101: 1-301.

Austin, O.L.; Kuroda, N. 1953. The birds of Japan, their status and distribution. Bulletin of the Museum of Comparative Zoology of Harvard College. 109: 277-637.

Barthos, G. 1957. Breeding scops owl in southwestern Hungary. Aquila. 63-64: 344-345.

Bosakowski, Thomas; Speiser, Robert; Benzinger, John. 1987. Distribution, density, and habitat relationships of the barred owl in northern New Jersey. In: Nero, Robert W.; Clark, Richard J.; Knapton, Richard J.; Hamre, R.H., eds. Biology and conservation of northern forest owls, symposium proceedings; 1987 February 3-7; Edmonton, AB. Gen. Tech. Rep. RM-142. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 135-143.

Bull, Evelyn L.; Henjum, Mark G. 1990. Ecology of the great gray owl. Gen. Tech. Rep. PNW-GTR-265. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 39 p.

Bull, Evelyn L.; Henjum, Mark G.; Anderson, Ralph G. 1987. Nest platforms for great gray owls. In: Nero, Robert W.; Clark, Richard J.; Knapton, Richard J.; Hamre, R.H., eds. Biology and conservation of northern forest owls, symposium proceedings; 1987 February 3-7; Edmonton, AB. Gen. Tech. Rep. RM-142. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 87-90.

Bull, Evelyn L.; Henjum, Mark G.; Rohweder, R.S. 1988. Nesting and foraging habitat of great gray owls. Journal of Raptor Research. 22: 107-115.

Bull, Evelyn L.; Wright, A.L.; Henjum, Mark G. 1990. Nesting habitat of flammulated owls in Oregon. Journal of Raptor Research. 24: 52-55.

Burton, John A., ed. 1973. Owls of the world, their evolution, structure, and ecology. New York: E.P. Dutton. 216 p.

Cayley, N.W. 1975. A guide to the birds of Australia. Sydney, Australia: Angus and Robertson Publishers. 325 p.

Clark, Richard J. 1987. Symposium summary and concluding remarks. In: Nero, Robert W.; Clark, Richard J.; Knapton, Richard J.; Hamre, R.H., eds. Biology and conservation of northern forest owls, symposium proceedings; 1987 February 3-7; Edmonton, AB. Gen. Tech. Rep. RM-142. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 4-8.

Clark, Richard J.; Smith, Dwight G.; Kelso, Leon. 1978. Working bibliography of owls of the world. National Wildlife Federation Scientific/Technical Series 1. Washington, DC: Raptor Information Center, National Wildlife Federation. 319 p.

Clark, Richard J.; Smith, Dwight G.; Kelso, Leon. 1987. Distributional status and literature of northern forest owls. In: Nero, Robert W.; Clark, Richard J.; Knapton, Richard J.; Hamre, R.H., eds. Biology and conservation of northern forest owls, symposium proceedings; 1987 February 3-7; Edmonton, AB. Gen. Tech. Rep. RM-142. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 47-55.

Craig, G.A. 1986. The spotted owl and wise forest use. Sacramento, CA: Western Timber Association and Artprint Press.

Denslow, J.S.; Schultz, J.C.; Vitousek, P.M.; Strain, B.R. 1990. Growth responses of tropical shrubs to treefall gap environments. Ecology. 71: 165-179.

de Schauensee, Rodolphe Meyer. 1984. The birds of China. [reprinted 1989]. Oxford, UK: Oxford University Press. 602 p.

Ehrlich, Paul R.; Dobkin, David S.; Wheye, Darryl. 1988. The birder's handbook: a field guide to the natural history of North American birds. New York: Simon and Schuster. 785 p.

Everett, M. 1977. A natural history of owls. London: Hamlyn. 156 p.

Fogden, Michael. 1973. Fishing owls, eagle owls and the snowy owl. In: Burton, John A., ed. Owls of the world: their evolution, structure and ecology. New York: E.P. Dutton: 61-93.

Forsman, Eric D. 1980. Habitat utilization by spotted owls in the west-central Cascades of Oregon. Corvallis, OR: Oregon State University. Ph.D. dissertation.

Forsman, Eric D.; Meslow, E. Charles; Strub, Monica J. 1977. Spotted owl abundance in young versus old-growth forests, Oregon. Wildlife Society Bulletin. 5: 43-47.

Franklin, Jerry F.; Spies, Thomas; Perry, David [and others]. 1986. Modifying Douglas-fir management regimes for nontimber objectives. In: Oliver, C.D.; Hanley, D.P.; Johnson, J.A., eds. Douglas-fir: stand management for the future: Proceedings of a symposium; 1985 June 18-20; Seattle, WA. Seattle, WA: College of Forest Resources, University of Washington: 373-379.

Fremming, O.R. 1987. Population decline of eagle owls *(Bubo bubo)* in east Norway 1920-1980. Viltrapport. 40: 1-45.

Gilpin, Michael E.; Soule, Michael E. 1986. Minimum viable populations: processes of species extinction. In: Souls, Michael E., ed. Conservation biology: the science of scarcity and diversity. Sunderland, MA: Sinauer Associates: 19-34.

Goggans, Rebecca. 1986. Habitat use by flammulated owls in northeastern Oregon. Corvallis, OR: Oregon State University. 54 p. M.S. thesis.

Gore, M.E.J.; Won, P. 1971. The birds of Korea. Seoul, Korea: Royal Asiatic Society, Korea Branch.

Hamer, T. 1985. Continued range expansion of the barred owl (*Strix varia*) in western North America from 1976-1985. In: Proceedings of a symposium on the biology, status, and management of owls; 1985 November 9-10; Sacramento, CA. [Place of publication unknown]: Raptor Research Foundation Conference.

Harrison, Colin. 1973. Hawk owls. In: Burton, John A., ed. Owls of the world: their evolution, structure and ecology. New York: E.P. Dutton: 147-163.

Hasenyager, R.N.; Pederson, J.C.; Heggen, A.W. 1979. Flammulated owl nesting in a squirrel box. Western Birds. 10: 224.

Hekstra, G.P. 1973. Scops and screech owls. In: Burton, John A., ed. Owls of the world their evolution, structure and ecology. New York: E.P. Dutton: 94-115.

Hekstra, G.P. 1982. A revision of the American screech owls (*Otus*). Amsterdam: Free University. Ph.D. dissertation.

Hilden, Olavi; Solonen, Tapio. 1987. Status of the great gray owl in Finland. In: Nero, Robert W.; Clark, Richard J.; Knapton, Richard J.; Hamre, R.H., eds. Biology and conservation of northern forest owls, symposium proceedings; 1987 February 3-7; Edmonton, AB. Gen. Tech. Rep. RM-142. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 115-120.

Hilty, Steven L.; Brown, William L. 1986. A guide to the birds of Columbia. Princeton, NJ: Princeton University Press. 836 p.

Holmgren, Virginia C. 1988. Owls in folklore and natural history. Santa Barbara, CA: Capra Press. 175 p.

Howie, R. Richard; Ritcey, Ralph. 1987. Distribution, habitat selection, and densities of flammulated owls in British Columbia. In: Nero, Robert W.; Clark, Richard J.; Knapton, Richard J.; Hamre, R.H., eds. Biology and conservation of northern forest owls, symposium proceedings; 1987 February 3-7; Edmonton, AB. Gen. Tech. Rep. RM-142. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 249-254.

Hume, Rob; Boyer, Trevor. 1991. Owls of the world. Philadelphia, PA: Running Press Book Publishers. 192 p.

Jantzen, Daniel H. 1988. Tropical dry forests: the most endangered major tropical ecosystem. In: Wilson, E.O.; Peter, Frances M., eds. Biodiversity. Washington, DC: National Academy Press: 130-137.

Janulewicz, Michael A.; Roberts, Leonard; Mulvihill, Margaret [and others]. 1981. The international book of the forest. New York: Simon and Schuster. 224 p.

Johnson, D. 1992. Interspecific interactions involving northern spotted owls. In: Proceedings of a symposium on the biology, conservation, and management of the northern spotted owl; 1992 November 12; [meeting location unknown]. Bellevue, WA: Raptor Research Foundation Conference.

Johnson, David H. 1987. Barred owls and nest boxes-results of a five-year study in Minnesota. In: Nero, Robert W.; Clark, Richard J.; Knapton, Richard J.; Hamre, R.H., eds. Biology and conservation of northern forest owls, symposium proceedings; 1987 February 3-7; Edmonton, AB. Gen. Tech. Rep. RM-142. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 129-134.

Johnson, K. Norman; Franklin, Jerry F.; Thomas, Jack Ward; Gordon, John. 1991. Alternatives for management of late successional forests of the Pacific Northwest: a report to the Agriculture and Merchant and Marine Fisheries Committees of the U.S. House of Representatives. Washington, DC: Scientific Panel on Late Successional Forest Ecosystems.

Kadochnikov, N.P. 1963. On the breeding biology of the scops owl in the Voronesh Region. Ornithologiya. 6: 104-110.

King, Ben; Woodcock, Martin; Dickinson, E.C. 1975. The Collins field guide to the birds of south-east Asia. Lexington, MA: The Stephen Greene Press. 480 p.

Klinka, K.; Carter, R.E.; Feller, M.C. 1990. Cutting old-growth forests in British Columbia: ecological considerations for forest regeneration. Northwest Environmental Journal. 6: 221-242.

Knystautas, A.J.V.; Sibnev, J.B. 1987. Die Vogelwelt Ussuriens. Hamburg-Berlin: [Publisher unknown].

Konig, C. 1981. Die Wiedereinburgerung des Sperlingskauzes (*Glaucidium passerinum*) im Schwarzwald. Forschungsberichte der Nationalpark Berchtesgaden. 3: 17-20.

Lahti, E. 1972. Nest sites and nesting habitats of the ural owl (*Strix uralensis*) in Finland during the period 1890-1969. Ornis Fennica. 49: 91-97.

Lovejoy, T.E.; Bierregaard, R.O., Jr.; Rylands, A.B. [and others]. 1986. Edge and other effects of isolation on Amazon forest fragments. In: Soule, Michael E., ed. Conservation biology: the science of scarcity and diversity. Sunderland, MA: Sinauer Associates: 257-285.

Lundberg, A.; Westman, B. 1984. Reproductive success, mortality and nest site requirements of the ural owl *Strix uralensis* in central Sweden. Annales Zoologica Fennici. 21: 265-269.

Marcot, Bruce G.; Gardetto, Jeffrey. 1980. Status of the spotted owl in Six Rivers National Forest, California. Western Birds. 11: 79-87.

Marcot, Bruce G.; Hill, Randy. 1980. Flammulated owls in northwestern California. Western Birds. 11: 141-149.

Marcot, Bruce G.; Vora, Robin; Lehmkuhl, John. 1991. Threatened forests of India: our future dilemma? Natural Areas Report. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 3(2): 1, 3-4.

Marshall, J.T. 1966. Relationships of certain owls around the Pacific. Natural History Bulletin of the Siam Society. 21: 235-242.

Marshall, J.T. 1967. Parallel variation in North and Middle American screech owls. Monographs of the Western Foundation of Vertebrate Zoology. 1: 1-72.

Marshall, J.T. 1978. Systematics of smaller Asian night birds based on voice. Ornithological Monographs of the American Ornithologists' Union. 25: 1-58.

Marshall, J.T.; King, B.F. 1988. Subfamily Striginae typical owls genus *Otus*. In: Amadon, D.; Bull, J., eds. Hawks and owls of the world: a distributional and taxonomic list. Proceedings of the Western Foundation of Vertebrate Zoology. 3(4): 331-336.

Mikkola, H. 1983. Owls of Europe. Vermillion, SD: Buteo Books.

Mikkola, Heimo. 1987. Ecology of the three species of *Strix* owls in Finland. In: Nero, Robert W.; Clark, Richard J.; Knapton, Richard J.; Hamre, R.H., eds. Biology and conservation of northern forest owls, symposium proceedings; 1987 February 3-7; Edmonton, AB. Gen. Tech. Rep. RM-142. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 144.

Nechaev, V.A. 1971. On the distribution and biology of some birds in Southern Primorye Territory. In: Ivanov, A.L, ed. Ornithological researches in the south of the Far East. Vladivostok: Trudy Academic Society of USSR, Far-East Center, Institute of Pedology and Biology. 6: 193-200.

Newman, K. 1991. Newman's birds of southern Africa. South Africa: Southern Book Publishers. 480 p.

Nyberg, J. Brian; Harestad, Andrew S.; Bunnell, Fred L. 1987. "Old growth" by design: managing young forests for old-growth wildlife. Transactions of the North American Wildlife and Natural Resources Conference. 52: 70-81.

O'Connell, M.W. 1987. Occurrence of the boreal owl in northeastern Washington. In: Nero, Robert W.; Clark, Richard J.; Knapton, Richard J.; Hamre, R.H., eds. Biology and conservation of northern forest owls, symposium proceedings; 1987 February 3-7; Edmonton, AB. Gen. Tech. Rep. RM-142. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 185-188.

Panwar, Hemandra S.; Rao, Kishore. 1990. Planning criteria for wildlife tourism in protected areas. In: Syllabus for capsule course in wildlife management; 1990 January 8-19; Dehra Dun, India. Dehra Dun, India: Wildlife Institute of India: [not paged].

Perrins, Christopher. 1987. Collins new generation guide to the birds of Britain and Europe. London, England: William Collins Sons and Co. Ltd. 320 p.

Peterson, Roger Tory; Chalif, Edward L. 1973. A field guide to Mexican birds. Boston, MA: Houghton Mifflin Co. 298 p.

Petty, S.J. 1983. A study of tawny owls, *Strix aluco*, in an upland spruce forest. Ibis. 125: 592.

Pizzey, Graham. 1980. A field guide to the birds of Australia. Princeton, NJ: Princeton University Press. 460 p.

Prestt, Ian; Wagstaffe, Reginald. 1973. Barn and bay owls. In: Burton, John A., ed. Owls of the world: their evolution, structure and ecology. New York: E.P. Dutton: 42-60.

Pukinsky, Y.B. 1977. The life of owls. Leningrad: [Publisher unknown].

Randik, A. 1959. A distribution of the scops owl in the Carpathian Basin. Aquila. 66: 99-106.

Reynolds, Richard T.; Linkhart, Brian D. 1987. Fidelity to territory and mate in flammulated owls. In: Nero, Robert W.; Clark, Richard J.; Knapton, Richard J.; Hamre, R.H., eds. Biology and conservation of northern forest owls, symposium proceedings; 1987 February 3-7; Edmonton, AB. Gen. Tech. Rep. RM-142. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 234-238.

Roberts, T.J.; King, B. 1986. Vocalizations of the owls of the genus *Otus* in Pakistan. Ornis Scandinavia. 17: 299-305.

Ruggiero, Leonard F.; Holthausen, Richard S.; Marcot, Bruce G. [and others]. 1988. Ecological dependency: the concept and its implications for research and management. Transactions of the North American Wildlife and Natural Resources Conference. 53: 115-126.

Ryder, Ronald A.; Palmer, David A.; Rawinski, John J. 1987. Distribution and status of the boreal owl in Colorado. In: Nero, Robert W.; Clark, Richard J.; Knapton, Richard J.; Hamre, R.H., eds. Biology and conservation of northern forest owls, symposium proceedings; 1987 February 3-7; Edmonton, AB. Gen. Tech. Rep. RM-142. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 169-174.

Scherzinger, Wolfgang. 1983. Beobachtungen an Waldkauz-Habichtskauz-Hybriden (*Strix aluco x Strix uralensis).* Zoologische Garten. 53: 133-148.

Scherzinger, Wolfgang T. 1987. Reintroduction of the ural owl in the Bavarian National Park, Germany. In: Nero, Robert W.; Clark, Richard J.; Knapton, Richard J.; Hamre, R.H., eds. Biology and conservation of northern forest owls, symposium proceedings; 1987 February 3-7; Edmonton, AB. Gen. Tech. Rep. RM-142. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 75-80.

Smythies, B.E. 1953. The birds of Burma. 2d ed. Edinburgh-London: [Publisher unknown].

Smythies, B.E. 1984. Birds of Burma. [Reprinted; original published 1940, Rangoon, Burma: American Baptist Mission Press] Dehra Dun, India: International Book Distributors. **589 p.**

Southern, H.N. 1970. The natural control of a population of tawny owls (*Strix aluco*). Journal of Zoology. 162: 197-285.

Spreyer, Mark F. 1987. A floristic analysis of great gray owl habitat in Aitkin County, Minnesota. In: Nero, Robert W.; Clark, Richard J.; Knapton, Richard J.; Hamre, R.H., eds. Biology and conservation of northern forest owls, symposium proceedings; 1987 February 3-7; Edmonton, AB. Gen. Tech. Rep. RM-142. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 96-100.

Stiles, F. Gary; Skutch, Alexander F. 1989. A guide to the birds of Costa Rica. Ithaca, NY: Cornell University Press. 511 p.

Taylor, A.L., Jr.; Forsman, E.D. 1976. Recent range extensions of the barred owl in western North America, including the first records for Oregon. Condor. 78(4): 560-561.

Terborgh, John. 1989. Where have all the birds gone? Princeton, NJ: Princeton University Press. 207 p.

Thomas, Jack Ward; Forsman, Eric D.; Lint, Joe B. [and others]. 1990. A conservation strategy for the northern spotted owl: Interagency Scientific Committee to address the conservation of the northern spotted owl. Portland, OR: U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Management [and others]. 427 p.

Uniyal, Vinod K.; Surendrnathan Asari, P.K. 1988. The first management plan for Parambikulam Wild Life Sanctuary 1987-88 to 1996-97. Kerela, India: Indian Forest Service, Government of India. [Not paged].

Verner, Jared; McKelvey, Kevin S.; Noon, Barry R. [and others]. 1992. Assessment of the current status of the California spotted owl, with recommendations for management. In: Verner, Jared; McKelvey, Kevin S.; Noon, Barry R. [and others], eds. The California spotted owl: a technical assessment of its current status. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 3-26.

Voous, Karel H. 1988. Owls of the northern hemisphere. Cambridge, MA: The MIT Press. 320 p.

Walter, Hartmut S. 1990. Small viable population: the red-tailed hawk of Socorro Island. Conservation Biology. 4: 441-443.

Whelton, Bartlett D. 1989. Distribution of the boreal owl in eastern Washington and Oregon. Condor. 91: 712-716.

Wilson, E.O.; Peter, Frances M., eds. 1988. Biodiversity. Washington, DC: National Academy Press. 521 p.

Winter, J. 1986. Status, distribution and ecology of the great gray owl in California. San Francisco, CA: San Francisco State University. M.A. thesis.

Appendix A: The Songs of *Strix*

Introduction

The past decade has seen an exponential increase in studies, inventories, and monitoring of Spotted Owls (*Strix occidentalis)* on Federal, state, and even private lands throughout the Western United States and Canada (for example, Allen and others 1989, Fredrickson and others 1990, Simon-Jackson 1989). The USDA Forest Service (1988) has been using protocols for monitoring Northern Spotted Owls (*S. o. caurina).* Such protocols stipulate the use of nocturnal and diurnal calling surveys (Forsman 1983) to locate owls (see also Johnson 1986).

Spotted Owls have a wide variety of songs and calls (Fitton 1991, Forsman and others 1984). Some of these vocalizations have been recorded on audio tape for use in conducting calling response surveys in the field and for training of personnel to recognize owl species (see also Ganey 1990, Laymon 1985, and USDA Forest Service 1988 for studies of Spotted Owl vocalizations and their use in monitoring surveys). In recent years, a small army of field personnel have scoured many types of forests for presence of Spotted Owls by using taped or vocalized calls. What these biologists might not realize is that the Spotted Owl has many cousins throughout the world with rather similar vocalizations. The purpose of this paper is to review the various *Strix* species and their calls. Herein, I compare descriptions of vocalizations from field guides and other sources, many not commonly known by most field-going wildlife biologists. I hope this brief review of vocalizations of 13 species of *Strix*[1] and 5 species of *Ciccaba* (appendix B) will highlight similarities and help foster a greater understanding and appreciation for Spotted Owls and their relatives.

Origin and Purpose of Vocalizations

The evolution of vocalizations by birds, including owls, can be attributed to acoustic properties of their primary habitats, as well as to selective forces of sexual recognition and other intraspecific and interspecific interactions. Specific vocalizations given in particular instances are often the result of mood, pair and breeding status, time of day, age and sex class, and season. Vocalizations generally are given to announce and defend territories for mates or resources or to maintain contact with mates or young (Jellis 1977).

With few exceptions, most species of *Strix* occupy woodland and forested habitats mostly in the Holarctic zoogeographic region. A few species occur in the Neotropical and Oriental zoogeographic regions (Voous 1988). Most *Strix* species are typically monogamous and vocally defend territories for mates or resources. Many vocalizations for territorial defense are loud and forceful, and they consist of various series of several individually recognizable hooting notes. Other vocalizations, projecting a greater state of agitation as when confronting a conspecific at close range, typically include various shrieks, howls, and screams, such as with the Spotted Owl (Forsman and others 1984). Still other sounds include softer calls given by young as food-begging calls, or by females to locate and maintain contact with their young.

Vocalizations of *Strix*

The following accounts describe many of these calls listed by species. Vocalizations for many species are yet undescribed in published material.

I recognize the long-acknowledged difficulty in describing bird sounds with words or phrases (Jellis 1977). Sound spectrograms are vastly superior to words for denoting durations, frequencies, harmonics, and overtones. They are difficult to obtain, however, for as full a set of species as offered in this report and are less mnemonic than are the more subjective descriptions herein.

[1] Fourteen species, if *Strix davidi* is considered separately from *S. uralensis.*

Strix of the Nearctic Region

Spotted Owl (*S. occidentalis*)-Spotted Owls are found throughout western and southwestern North America from southern British Columbia into the mountains of northwestern Mexico. Spotted Owl vocalizations are quite varied, and have been well described by Forsman and others (1984). They include high-pitched hoots, like the barking of a small dog, usually in groups of four, as in **hoo,who-who,whooo** (Peterson 1961), the last note drawn out and descending in pitch. These are location calls given by both sexes, with the female's call being slightly higher in pitch.

When more greatly agitated, Spotted Owls also give a call consisting of a rising inflection of **whoo, whoo, hoo, hoo, hoo, hoo-hoot-hoot, hoo-hoot-hoot,** cut off at the end or occasionally terminated with a descending **hoooo**. This call may escalate to a shrill **kre-ick! kre-ick!,** which in turn might escalate to a rising whistle, which rises most abruptly at the end and is cut off sharply, as in **wheee-et!** or **cooo-weep**! This is often given repeatedly and is a contact call, more often given by the female. Other calls include a crowlike bark **khaw khaw khaw**, given by the female. Food-begging calls given by the young or female-young contact calls given by the female generally are heard only at close range and are not commonly encountered during field surveys.

Barred Owl (*S. varia*)-Barred Owls occur throughout southern Canada, the Eastern United States, and into northeastern and central Mexico. Udvardy (1977) described calls as a distinctive, rhythmic series of loud hoots, **who-cooks-for-you, who-cooks-for-you-all** (see also Forrand 1983). The call also has been described as **hoohoo-hoohoo-hoohoo-hoohoooaw**, the ending **aw** being characteristic; and other calls include sounds like the barking of a dog (Peterson 1961; personal observation of the author). Still other calls include a hoot that terminates with a diminishing **waahh-ah** that fades away, and a "pleasant duet of the pair with one on a higher tone and twice as fast, and a number of weird chuckles, screams, and assorted haunted-house noises" (Tyler and Phillips 1978:138-139).

Great Gray Owl (*S. nebulosa)*-Great Gray Owls are circumpolar and found in boreal regions of North America, Europe, and Russia (Holarctic distribution). Calls include a series of deep, resonant **whoo**s (Udvardy 1977), also described by Peterson (1961) as a deep booming **whoo-hoo-hoo** and deep single **whoos**. The male's territorial call is a regular, deep, booming series **hoo-hoo-hoo**, which can rise gradually in pitch (Hume and Boyer 1991). In Far East Russia, the calls are a loud and muffled **hoo-hoo-hoo** (Flint and others 1984). Perrins (1987:140) reported the voice of the male as "regular, deep growling or booming hoots and **ke-wich** calls" similar to those of the Tawny Owl but deeper.

Mikkola described the primary territorial song given by the male (and sometimes by the female) as a series of up to 8 to 12 regularly spaced ho notes given at a rate of 1.5 notes per second, the series lasting 6-8 seconds, with 33 seconds between series. The most common call of the female is a soft mellow hoot used to communicate with her mate at the nest. Various depictions are **vee-vee**, **nieh-nieh**, and **whoop**. In addition, both sexes give a series of rapid double notes as a defensive or warning cry. The female also gives a loud heronlike squawk or bark at the end of a series of notes ranging from vigorous hooting to high-pitched wails and squeals, as in alarm.

Strix of the Neotropical Region

Fulvous Owl or Guatemala Barred Owl (*S. fulvescens*)-This species occurs in tropical and temperate forests of southern Mexico and northern Central America. The call is described as a four-noted **huho, huhoo,** the combination sometimes repeated twice rapidly (Edwards 1972). Fulvous Owls previously were considered by some to be a race of the Barred Owl (Davis 1972, Eck 1971, Peters 1940). Their calls were described by Peterson and Chalif (1973) as hooting similar to that of the Barred Owl. Indeed, the repeated four-note series sounds similar to the location call of the Barred Owl (see above). Its hooting calls also have been described as similar to those of the Spotted Owl (Dickey and van Rossem 1938, Monroe 1968, Voous 1988).

Rusty-Barred Owl (*S. hylophila)-* *This species* and the Rufous-Legged Owl are the only *Strix* species in South America. The Rusty-Barred Owl inhabits woodlands of the central part of the continent, and its calls include a rolling **rrrrro;** a rhythmic, descending gutteral **gu gu gu gu gu, u, u, u, u;** and a long-drawn **i-u-a** (Hume and Boyer 1991) or ascending and then descending scratchy scream sounding like a frightened human.

Rufous-Legged Owl (*S. rufipes*)-This species is found in southern South America. I could find no reports of its vocalizations. However, the recordings by Hardy and others (1990) include 2-note and 4-note songs, sounding like a scratchy **prr-prrrrr** (sometimes doubled in the 4-note song), the second note accented and descending in pitch; and the same song with 2 or 3 brief introductory notes and 2 ending notes of the same **prr** quality added.

Strix of the Palearctic and OrientalRegions

Tawny Owl (*S. aluco*)-Tawny Owls are found throughout Europe and in disjunct populations in the Near East, Far East, and southeastern Asia. Their voice, as reported by Perrins (1987) in Britain and Europe, is quite variable with the male giving a **tu-whit-tu-whoo** and the female responding **ke-wick;** the young give a scratchy persistent **ti-sweep.** In Far East Russia, Flint and others (1984) wrote that the male gives a **hoo-hoo-hoooo,** and the female a **kyouyouyouveeh.** In Southeast Asia, King and others (1975) reported the voice as a high, screeching, sharply accented call of two syllables, **buku.**

Hume and Boyer (1991:139-140) described the call as “a long, pure, or faintly wheezy, hoot, followed by a short pause, then a brief, abrupt hu and a long, resonant, wavering **huhuhuhoooo.”** The contact call is **kewick,** and as followed by a hoot has given rise to the “somewhat inaccurate” depiction as **tu-whit-tuwhoo** (Hume and Boyer 1991). Fledged young have a similar call, but it is a more wheezing, strained, lower, and less explosive **tsi-weep.**

Mikkola (1983) denoted their calls as the most diverse of all European owls, with 10 different basic calls given by breeding adults and 5 calls given by young. The basic call of the male serves for marking territories, during courtship, and when bringing food to the female and young. This call is a long drawn out **hooo,** a pause of 2 to 6 seconds, an abrupt and subdued **hu**, followed at once by a long, resonant **huhuhuhooo.** The females’ calls are less clear-phrased, ending with a wailing **wow-wow-hooo.** Other calls include an **oo**-trill given by the male after delivery of prey and as a territorial conflict call; this call also has been described as a loud discordant “caterwauling.” Another call is a hissing trill **co-co-co-co-co-co** given during courtship and territorial fights.

In India, calls of one subspecies, Scully's Wood Owl (*S. a, biddulphi)*, have been listed as "a loud **hoo ....hoo..hoo-ho-ho-hoop**, the final **hoo** being somewhat drawn out. There is a pause of about four seconds after the initial **hoo**, and half a second between the second and the rest of the concluding rolling note" (Ali and Ripley 1983: 257; similarly described in China by de Schauensee 1984). Other calls of this subspecies include a loud quack and a soft coo, the latter similar to those of a ring dove or turtle dove (Ali and Ripley 1983:257), and a **khawak** uttered when flying about at night, occasionally when perched (Ali and Ripley 1983:257). Ali and Ripley also noted that Scully's Wood Owls begin calling an hour or so after sunset from some exposed treetop and repeat the call for 10 minutes at a time, with a pair or several birds answering one another. The authors also described calls similar to the above for the Himalayan Wood Owl, *S. aluco nivicola*, including a "loud **hoo..hoo..hoo-ho-ho-hoo**, the final **hoo** drawn out;" and that the call sounds "sometimes merely as a hurried deep low **hu-hoo**" (Ali 1989:62).

The contact call of the Tawny Owl is **kewick** and is given mostly by the female (Mikkola 1983). This is quite similar to the contact calls given by female Spotted Owls. Mikkola (1983) described several other calls of Tawny Owl adults and young.

Ural Owl (*S. uralensis*)-The Ural Owl occurs in middle north temperate latitudes of Europe and Asia: Perrins (1987) reported the Ural Owl's calls as consisting of both hooting and **ke-wick** types, both deeper and more barking than those of the Tawny Owl. Flint and others (1984) noted that the Ural Owl's call in Far East Russia is a barking, high-pitched **hey-hey-hey** or **kaoo-vekk**. Calls in China were reported by de Schauensee (1984) as a long, quavering hoot, and also a barking **khau-khau** and a harsh **ke-wick**. Young Ural Owls give wheezy notes.

Hume and Boyer (1991:146) noted that its call is a double barking hoot, and that pairs might call together. The song is a "simple repetition of hoots, **huow-huow-huow**, the female's version being lower, weaker and harsher in quality." The male also gives a call consisting of **wohu**, a 4-second pause, and then a **wohu-huwohu**, for territorial defense or mate contact. Ural owls also give a loud, sharp **korrwick**, longer and harsher than the **kewick** note of Tawny Owls. Young give food-begging notes.

Hume and Boyer (1991:148) also separate the David's Wood Owl (*S. davidi*), which others consider as a strongly marked race of the Ural Owl. In their account, the David's Wood Owl gives a "long, quavering hoot and barking **khan khau**."

Mikkola (1983) described the courtship song of the male as a deep hooting **wohu...wohu-huwohu**, with a 4-second pause in the middle. Other calls include a barking **huow-huow-huow** given by the male; a single **huu** given by the male in excitement; various calls at the nest given by the female, including barking, gobbling, chuckling, and hissing; and a sharp cry **korrwick**, harsher and longer than similar notes of the Tawny or Great Gray Owls.

Brown Wood Owl (*S. Ieptogrammica*)-A resident of deep mountain forests in much of the Oriental zoogeographic region, the Brown Wood Owl is poorly studied. The 15 recognized races differ considerably in size and degree of isolation (flume and Boyer 1991). The outer ear structure is less complex than that of other *Strix* species, leading flume and Boyer (1991) to suggest its grouping with *Ciccaba.*

King and others (1975) listed calls as a 1-second series of four deep musical notes, **goke, goke-galoo,** with the first note emphasized and a wide variety of similar calls. In China, the voice was cited by de Schauensee (1984) as a mellow, musical, hollow sounding **tok...tu-hoo,** often repeated, with the **tok** note in undertone. In Sri Lanka, the voice is a sonorous **huhu-hooo (Henry** 1971). Other calls include a "barking **wow wow,** undoubtedly signifying alarm" (Voous 1988:208).

Ali (1962) described the call of the Himalayan Brown Wood Owl (*S. I. newarensis)* as "a deep four-noted hoot, **hoo...hoohoo...hoo."** Other calls include what is probably a conversational note between a pair at dusk-a low, sonorous **koo-krrri,** rather like a domestic pigeon-as well as querulous screams and loud snapping of the bill on detection of an intruder near the nest, and when apprehensive (Ali 1962), the calls sometimes being given diurnally (Ali and Ripley 1983). Calls of *S. I. newarensis also* have been described as "a low double hoot **tu-whoo** (Ali and Ripley 1983:256).

Smythies (1984: 310, 313) described calls of the Brown Wood Owl, *Strix indranee (= S. leptogrammica indranee)* of Burma, as a deep musical call of four syllables, **who-hoo-hoo-hoo,** with the emphasis on the first note, lasting about 1 second; and "diabolical screaming shrieks ...like that of a demented person casting himself over a precipice." Ali and Ripley (1983:256) described the calls of S. *leptrogrammica indranee* as a "mellow, musical, hollow-sounding **tok...tu-hoo** repeated every few seconds," the initial **tok** (sometimes twice) uttered as a low undertone and audible only at close range (also mentioned in Ali 1989 for *S. I. newarensis).* Birds were described by Ali and Ripley as being particularly vocal during moonlit nights and in the breeding season. Calls include various "weird, eerie shrieks and chuckles, in addition to the loud bill-snapping" (Ali and Ripley 1983:256) denoting aggression (Voous 1988).

Mottled Wood Owl (S, oscellatar-The Mottled Wood Owl occurs on the Indian subcontinent. Ali and Ripley (1983:256) described calls of *S. o. oscellata* as "a loud quavering eerie **chuhua-as** uttered regularly as the birds emerge from their daytime retreat, and again before retiring at dawn [and] also from time to time during the night, but not very frequently [see also Ali 1979]. At other [nonbreeding] seasons [calls are] mostly a single mellow, metallic hoot [and] an occasional harsh screech similar to the Barn Owl's." King and others (1975) listed the call as a loud, single hoot. In northern India, I have heard it give an eerie descending, quavering whistle, 4 to 5 per minute; a rising, then falling, plaintive vibrato hoot, 20 per minute; and a rather trilled, hooted series **pdd-pddd-ddddd-pdd.**

Hume's Owl (S. butlers)-Hume's Owls are found mostly in the Middle East. The Hume's Owl has been considered by some to be a desert offshoot of the temperate Tawny Owl (Voous 1988), but recent studies have not supported this hypothesis (Hume and Boyer 1991). In most accounts it is given separate specific status (Voous 1988). Calls include "an unmistakable clear long-drawn **huu** uttered at intervals, sometimes varied by a tremulous and more throaty hoot as in *Strix aluco,"* and variants (Ali and Ripley 1983:255).

Descriptions by Hume and Boyer (1991:135) include the following. The call has been reported to resemble that of the Tawny Owl and consists of a single long even note that lacks the quavering typical of Tawny Owls. The call also has been described as a "hoot followed by two shorter, double notes-**hoooo huhu huhu**." Another call, given in agitation, is **hu-hu-hu-hu-hu-hu-hu**, which lasts for 2 to 3 seconds. Two birds have been heard calling in duet. In southern Israel, calls include a series of 12, sometimes 13, notes,given at dusk, the notes increasing slightly in speed and noticeably in volume. The final note in the series was lower and cut short and call series "had a deep, slightly booming but rather muffled quality-**bu bu bu bu bu bu bu BU BU BU BU b**"-and was unlike calls of the Tawny Owl.

Mikkola (1983) described calls of the Hume's Owl as **hoooo-huhu-huhu** and **whoo-who-whoo**, a longish hoot followed by two short double hoots. The birds also give an excited and agitated **hu-hu-hu-hu-hu-hu-hu** lasting 2 to 3 seconds when another bird is nearby or in response to taped calls.

Malay Wood Owl (*S. orientalis*)--The Malay Wood Owl occurs in southeast Asia. Smythies (1984) described the calls of *S. orientalis orientalis* as commencing with a rolling **hoo-hoo-hoo** and ending with a prolonged and deep drawn **hoooo**.

Spotted Wood Owl (*S. seloputo*)-The Spotted Wood Owl is found in subtropical and tropical parts of Southeast Asia. In some accounts, it is listed as a subspecies of the Malay Wood Owl. King and others (1975) listed the Spotted Wood Owl in Southeast Asia as S. *seloputo (orientalis),* whose varied calls include a deep rolling **hoo-hoo-hoo** ending with a prolonged deep **hooo**'. Hume and Boyer (1991:137) noted that its calls include a "series of low, musical notes that end with a longer, deeper hoot."

Ciccaba: Tropical Cousins

Although some authors (Norberg 1977, Voous 1964, 1988) have assigned the mostly tropical wood owls of *Ciccaba* to the genus *Strix,* in this account I retain the separate genera designations, following American Ornithologists' Union (AOU) (1983).

Mottled Owl (*C. virgata*)-Mottled Owls occur in the New World tropics in Central and South America. Their most common call is "2-3 successively louder grunts, low and guttural, then 2 sharp downslurred hoots, the first louder: **huh-huh; WHOO', WHOO**;" and "sometimes a single hoot, or 1-3 grunts alone" (Stiles and Skutch 1989: 195). Hume and Boyer (1991) described other calls as a rising, whistling screech. Stiles and Skutch (1989:195) defined it as "a long-drawn-out catlike screech usually heard shortly after dusk or before dawn." Peterson and Chalif (1973) described the calls as "harsh and mournful **waaa-a'-oooo,** increasing then decreasing in pitch and volume; a **boo, boo-ab, boo-ab**, **boo-ab, boo-ab, boo-ab**; a descending modulated hoot; and a semi-whistled screech and a gruff growl" (Peterson and Chalif 1973). Hilty and Brown (1986:231) described the most common call in Colombia as "a very deep, resonant **whooou**, usually in pairs or triplets or sometimes 5-6 in a row," and that vocalizations also include, rarely, a catlike scream. Davis (1972) described the most frequently heard calls as a 2-second series of five hoots cut off, as in hut, the first two hoots spaced half a second apart and the others given at increasingly shorter intervals. In Mexico, I have beard a Mottled Owl give a 10-second series of short but notes, first increasing, then decreasing, in pitch. Edwards (1972:91) described the call as "a slow series of four or five, low-pitched, burred notes, descending in pitch, **hroot, hroot, hroot, hroot, hroot."**

Voous (1988) noted that Mottled Owls commonly interact vocally and territorially. Their territorial song is "invariably described as a series of deep, often guttural and slightly modulated hoots rendered as **bru bru** and **bu bu bu** (Panama; Wetmore 1968), **keeooweeyo** or **cowooawoo** (Panama, Ridgely 1981), or **whoo-oo** (Venezuela; de Schauensee and Phelps 1978), all of the same character and quality as the call of the Spotted Owl (Miller 1963)" (Voous 1988:203). Other calls of both juveniles and adults include a long, drawn out, whistled screech, and a call sounding like a child crying (Voous 1988). Immatures call with a catlike wail, louder and higher pitched than the previously mentioned call and lasting about 1 second (Davis 1972).

Gerhardt (1991) reported five different vocalizations, including a three- to six-note "hoot" given frequently by males and infrequently by females, the males in response to taped calls and across home range boundaries. Females called at a higher pitch than did the males. Another call given by adult females is used to solicit food from the male, particularly near the nest, and is a "cat-like yowl" (Gerhardt 1991:23). A third call is the food-begging call of juvenile mottled owls: a very soft "high-pitched rattling hiss." A fourth call is a growl given by adults during capture or when nest trees were climbed. Another call is a peeping of the very young nestlings.

Black-and-White Owl (*C. nigrolineata*)-Sometimes considered a subspecies of *C. huhula* of South America (see below), this species is found from lowland, mostly swampy forests in Central America and northwestern South America (Voous 1988). Its call differs across its range (flume and Boyer 1991). Its most common call is a "low grunt followed by a gruff, strident hoot: huh, **HOOoo**; these sometimes followed by 2 lower, softer, faster hoots, **huh, HOOoo hoo-hoo,** a 4-note call with pattern the reverse of that of Mottled Owls."

Young birds give an ascending, breathy shriek (Stiles and Skutch 1989:195). In La Selva, Costa Rica, they give a low-pitched hooted series **hu-hu-HU-HU-hu-hu**, the middle two notes higher in pitch and volume than the other notes (personal observation). Peterson and Chalif (1973) described calls as a loud, drawn out catlike **whee-u-u-u**, and a resonant, low-pitched **whoo, whoo, whoo**. Edwards (1972:91) described the voice as an "extended, slightly rasping, mewing sound." flume and Boyer (1991:131) described the calls as "loud and high-pitched, like a long **who-ah**"; in Panama, the call is a "long nasal **oo-weh** with a marked upward inflection, rather quieter than the similar call of the Mottled Owl."

Another more explosive, sharp sound is often repeated, sounding in Panama like a deep, resonant and deliberate **whoof, whoof, whoof**; in Colombia, gives a strained, rising and falling catlike scream, and a deeply resonant **hu, hu, hu hoo-ah**, and a series of 9 to 14 **hoo-ah** notes with an occasional single deep boo (flume and Boyer 1991). In Colombia, according to Hilty and Brown (1986:230-231), the species has two very different calls: "a high-pitched dry scream, rising, then falling, catlike, and strained as though only air is expelled (Hilty); and a deep, resonant, deliberate **hu, hu, hu, hoo-ah** (last phrase slurred) with variations." This last call also has been described as "a series of 9-14 slow **hu-wah's** and a single, loud, deep **boo** at intervals" (P. Schwartz in Hilty and Brown 1986:231).

Black-Banded Owl (*C. huhula*)-Black-Banded Owls generally are scarce inhabitants of rain forests and plantations in northern and central South America. Its voice is well described as a "rising cat-like scream followed by a loud hoot, **whoeeruh, hoo**", and also as a "deep, resonant **hu hu hu HOOOO"** (Hume and Boyer 1991:132). Hilty and Brown (1896:231, and P. Schwartz cited therein) described the voice as "an ascending catlike scream, whoeeeruh followed after a short pause by a loud **booo**; also a deliberate, deep, resonant **hu, hu, hu, HOOO,** with variations." The emphasized syllable is particularly forceful (personal observation in Upper Amazon Basin, Ecuador). Hume and Boyer (1991) and Hilty and Brown (1986) both noted that at times its voice is identical to that of the Black-and-White Owl, and that they commonly respond to one another's calls.

Rufous-Banded Owl (*C. albitarsis*)-This species occurs in Andean mountain forests of South America. The species is said to greatly resemble the Fulvous Owl (Kelso 1940) and is either an offshoot of the more northerly *Strix* or, less likely, is a relict of a tropical form from which *Strix* arose (Voous 1988). In Colombia, it is reported to give a deliberate pattern of deep, resonant notes, as in hu, **hu-hu-hu, HOOOa,** repeated every 8 to 11 seconds (Hume and Boyer 1991). Hilty and Brown (1986:231, and P. Schwartz cited therein) described it as "a deep, deliberate, resonant **hu, hu-hu-hu, HOOOa,** repeated at 8-11 second intervals." They also noted that in Colombia, the main song of the Rufous-Banded Owl is similar to those of the Black-Banded and Black-and-White Owls, but that it differs in cadence; the Rufous-Banded Owl's song includes a pause after the first note, the next three notes are quicker, and the final note is more prolonged and more strongly given. Local names of the Rufous-Banded Owl in Venezuela, including Borococo and Surrucuco, resemble the calls (Hume and Boyer 1991).

African Wood Owl (*C. woodfordi*I)-African Wood Owls (sometimes *Strix woodfordii*, Newman 1991) are widespread and common in forests and open woodlands of sub-Sahara Africa and the only *Ciccaba* found outside the Neotropics. Descriptions of calls were given by Hume and Boyer (1991:133) as follows. Calls are sometimes given in late afternoon from the top of the forest canopy. Both sexes give a series of rapid hoots; the female's are higher pitched. Calls begin "loudly and evenly but fade away into an uneven rhythm-**whu-whu-whu whu-uh uh-uh-uh**." The female also gives a high wheeow which is answered by a low hoot from a nearby male. The pair also will call together in a coordinated duet or in a series of overlapping hoots. Newman (1991:216) described calls of males as "a rapid **HU-hu, hu-HU-hu-hu, hu-hu**," with females responding with a higher-pitched "hoo."

Discussion

Although vocalizations of every species of *Strix* and *Ciccaba* have not been studied, several similarities are evident from reports cited herein. Vocalizations of most *Strix* species include location calls. These calls typically consist of a series of four or more hooted notes such as given by Spotted, Barred, Great Gray, Brown Wood, Himalayan Brown Wood, and Fulvous Owls. Other similarities among *Strix* species include various screeched, wailed, or barking calls such as given by Spotted, Barred, Tawny, Ural, and Brown Wood Owls. Still other species give extended wavering notes or single loud hoots, as with Hume's and Mottled Wood Owls. Malay Wood and Spotted Wood Owls give a long rolling series of hoots. *Ciccaba* vocalizations include four- or five-note location type calls and variations on rolling and downward-slurred notes, similar in description to those of their *Strix* relatives.

Literature Cited

Degree of similarity in vocalizations can be one piece of evidence for degree of evolutionary relatedness. For example, in forests of the Pacific Northwest United States, hybrids of Spotted and Barred Owls (nicknamed "sparred owls") have been observed giving vocalizations intermediate between the two species.[1] It has been only in recent years that the two species have become sympatric with the Barred Owl invading the range of the Spotted Owl's (Boxall and Stepney 1982, Hamer 1985, Taylor and Forsman 1976). In Europe, Tawny and Ural Owls, a similar pair of closely related species, have hybridized in captivity (Scherzinger 1983, Voous 1988), with the fertile hybrids having a similar but "more varied vocabulary" than either parent. Also, van der Weyden (1972) demonstrated the close relatedness between the Tawny Owl and the Afrotropical Wood Owl (*Ciccaba woodfordii*, sometimes placed in *Strix*, as with Voous 1988) based on similarity of vocalizations of owls in Morocco and Senegal, West Africa. Understanding degree of relatedness among owl species might help in developing management guidelines by interpreting habitat requirements and evolutionary history of closely related species.

Allen, Harriet L.; Dixon, Kenneth R.; Knutson, K.L. 1989. Cooperative administrative study to monitor spotted owl management areas in National Forests in Washington. Final report to USDA Forest Service, Pacific Northwest Region, Portland, Oregon. Olympia, WA: Washington Department of Wildlife. 165 p.

All, Salim. 1962. The birds of Sikkim. Delhi, India: Oxford University Press. 414 p.

All, Salim. 1979. The book of Indian birds. [Reprinted 1988]. Bombay, India: Oxford University Press. 187 p.

All, Salim. 1989. Field guide to the birds of the eastern Himalayas. Bombay, India: Oxford University Press. 265 p.

Ali, Salim; Ripley, S. Dillon. 1983. Handbook of the birds of India and Pakistan. Compact Edition. Delhi, India: Oxford University Press. 737 p. (plus 113 plates).

American Ornithologists' Union (AOU). 1983. Check-list of **North American** birds. 6th ed. Lawrence, KA: Allen Press.

Boxall, P.C.; Stepney, P.H.R. 1982. The distribution and status of the barred owl in Alberta. Canadian Field-Naturalist. 96: 46-50.

Davis, L. Irby. 1972. A field guide to the birds of Mexico and Central America. Auston, TX: University of **Texas Press. 282 p.**

de Schauensee, Rodolphe Meyer. 1984. The birds of China. [Reprinted 1989]. Oxford, YT: Oxford University Press. 602 p.

de Schauensee, Rodolphe Meyer; Phelps, W.H. 1978. A guide to the birds of Venezuela. Princeton, NJ: Princeton University Press.

Dickey, D.R.; van Rossem, A.J. 1938. The birds of El Salvador. Zoological Series Field Museum of Natural History. 23: 1-609.

Eck, S. 1971. Katalog der Eulen des Staatlichen Museums fur Tierkunde Dresden. Zoologische Abhandlungen Staatlichen Museums Tierkunde Dresden. 30: 173-218.

[1] Personal communication. Eric Forsman, Pacific Northwest Research Station, forestry Sciences Laboratory, 3200 SW Jefferson Way, Corvallis, OR

Edwards, Ernest Preston. 1972. A field guide to the birds of Mexico. Sweet Briar, VA: Ernest P. Edwards, Publisher. 300 p. (plus 79 p. appendix).

Fitton, S. 1991. Vocal learning and call structure of male northern spotted owls in northwestern California. Arcata, CA: Humboldt State University. M.S. thesis.

Flint, V.E.; Boehme, R.L.; Kostin, Y.V.; Kuznetsov, A.A. 1984. A field guide to birds of the USSR. Princeton, NJ: Princeton University Press. 353 p.

Forrand, J., Jr. 1983. The Audubon Society master guide to birding. New York: Alfred A. Knopf. 3 vol.

Forsman, Eric. D. 1983. Methods and materials for locating and studying spotted owls. Gen. Tech. Rep. PNW-162. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 8 p.

Forsman, Eric D.; Meslow, E. Charles; Wight, Howard M. 1984. Distribution and biology of the spotted owl in Oregon. Wildlife Monographs. 87: 1-64.

Fredrickson, R.J.; English, A.K.; Moorhead, B.B. 1990. Spotted owl inventory and monitoring Olympic National Park 1990. Port Angeles, WA: Olympic National Park, National Park Service. 40 p.

Ganey, Joseph L. 1990. Calling behavior of spotted owls in northern Arizona. Condor. 92: 485-490.

Gerhardt, Richard Paul. 1991. Mottled owls (*Ciccaba virgata*): response to calls, breeding biology, home range, and food habits. Boise, ID: Boise State University. 44 p. M.S. thesis.

Hamer, Thomas. 1985. Continued range expansion of the barred owl (*Strix varia*) in western North America from 1976-1985. In: Proceedings of a symposium on the biology, status, and management of owls; 1985 November 9-10; Sacramento, CA. [Place of publication unknown]: Raptor Research Foundation.

Hardy, J.W. 1990. Voices of the New World owls. Cassette tape. Gainesville FL: Florida Museum of Natural History, University of Florida. ARA Records.

Henry, G.M. 1971. A guide to the birds of Ceylon. 2d ed. London: Oxford University Press.

Hilty, Steven L.; Brown, William L. 1986. A guide to the birds of Columbia. Princeton, NJ: Princeton University Press. 836 p.

Hume, Rob; Boyer, Trevor. 1991. Owls of the world. Philadelphia, PA: Running Press. 192 p.

Jellis, Rosemary. 1977. Bird sounds and their meaning. Ithaca, NY: Cornell University Press. 256 p.

Johnson, J.A. 1986. Spotted owl calling surveys in northern New Mexico. New Mexico: Department of Game and Fish; contract 516.6-73-15.

Kelso, L. 1940. Variation of the external ear-opening in the Strigidae. Wilson Bulletin. 52: 24-29.

King, Ben; Woodcock, Martin; Dickinson, E.C. 1975. The Collins field guide to the birds of Southeast Asia. Lexington, MA: The Stephen Greene Press. 480 p.

Laymon, Steven A. 1985. The use of playback response to census spotted owls *(Strix occidentalis):* a test of validity. In: Proceedings of a symposium on the biology, status, and management of owls; 1985 November 9-10; Sacramento, CA. [Place of publication unknown]: Raptor Research Foundation.

Mikkola, H. 1983. Owls of Europe. Vermillion, SD: Buteo Books.

Miller, A.H. 1963. The vocal apparatus of two South American owls. Condor. 65: 440-441.

Monroe, B.L. 1968, A distributional survey of the birds of Honduras. AOU Ornithological Monograph. 7: 1-458.

Newman, K. 1991. Newman's birds of southern Africa. 1991 update. South Africa: Southern Book Publishers. **480 p.**

Norberg, R.A. 1977. Occurrence and independent evolution of bilateral ear asymmetry in owls and implications on owl taxonomy. Philosophical Transactions of the Royal Society of London, Biological Sciences. 280(973): 375-408.

Perrins, Christopher. 1987. Collins new generation guide to the birds of Britain and Europe. London, England: William Collins Sons and Co. Ltd. 320 p.

Peters, J.L. 1940. Check-list of the birds of the world. Cambridge, MA: Harvard University Press. Vol. 4.

Peterson, Roger Tory. 1961. A field guide to western birds. Boston, MA: Houghton-Mifflin. 309 p.

Peterson, Roger Tory; Chalif, Edward L. 1973. A field guide to Mexican birds. Boston, MA: Houghton Mifflin Co. **298 p.**

Ridgely, R.S. 1981. A guide to the birds of Panama. 2d ed. Princeton, NJ: Princeton University Press.

Scherzinger, W. 1983. Beobachtungen an Waldkauz-Habichtskauz-Hybriden *(Strix aluco x Strix uralensis).* Zoologische Garten. 53: 133-148.

Simon-Jackson, Terry. 1989. 1989 annual report spotted owl inventory and monitoring program Pacific Southwest Region (R5) USDA Forest Service. San Francisco, CA: U.S. Department of Agriculture, Forest Service. 31 p.

Smythies, B.E. 1984. Birds of Burma (reprinted; orig. 1940, Rangoon, Burma: American Baptist Mission Press). Dehra Dun, India: International Book Distributors. 589 p.

Stiles, F. Gary; Skutch, Alexander F. 1989. A guide to the birds of Costa Rica. Ithaca, NY: Cornell University Press. 511 p.

Taylor, A.L., Jr.; Forsman, Eric D. 1976. Recent range extensions of the barred owl in western North America, including the first records for Oregon. Condor. 78 (4): 560-561.

Tyler, Hamilton A.; Phillips, Don. 1978. Owls by day and night. Happy Camp, CA: Naturegraph Publishers, Inc. 208 p.

Udvardy, M.D.F. 1977. The Audubon Society field guide to North American birds: western region. NY: Knopf Publishers. 854 p.

U.S. Department of Agriculture, Forest Service. 1988. Spotted owl inventory and monitoring handbook. Portland, OR: Pacific Northwest Region. 13 p.

van der Weyden, W.J. 1972. La huiotte africaine *Strix woodfordii* au Senegal. Os. Revue Francaise Orn. 42: 193-194.

Voous, Karel H. 1964. Wood owls of the genera Strix and Ciccaba. Zoologusche Mededlingen Rijks Museum van Natuurlijke Historie to Leiden. 39: 471-478.

Voous, Karel H. 1988. Owls of the northern hemisphere. Cambridge, MA: The MIT Press. 320 p.

Wetmore, A. 1968. The birds of the Republic of Panama. Zoological Smithsonian Miscellaneous Collection. 150(2): 1-603.

Appendix B: Species and Selected Subspecies

Species and selected subspecies mentioned in the appendix text

Genus *Strix*.
- *Strix* of the Nearctic Region
  - Spotted Owl (*S. occidentalis)*
  - Northern Spotted Owl (*S. o. caurina*) Barred Owl (*S. varia*)
  - Great Gray Owl (*S. nebulosa)*
- *Strix* of the Neotropical Region
  - Fulvous or Guatemala Barred Owl (*S. fulvescens)*
  - Rusty-Barred Owl (*S. hylophila)*
  - Rufous-Legged Owl (*S. rufipes)*
- *Strix* of the Palearctic and Oriental Regions
  - Tawny Owl (*S. aluco)*
  - Scully's Wood Owl (*S. a. biddulphi)*
  - Himalayan Wood Owl (*S. a. nivicola)*
  - Ural Owl (*S. uralensis)*
  - David's Wood Owl (*S. u. davidi)* (sometimes considered as the separate species *S. davidi)*
  - Brown Wood Owl (*S. leptogrammica)*
  - Himalayan Brown Wood Owl (*S. I. newarensis)*
  - Brown Wood Owl (Burma) (*S. I. indranee)*
  - Mottled Wood Owl (*S. oscellata*)
  - Mottled Wood Owl (India) (*S. o. oscellata*)
  - Hume's Owl (S, butlers)
  - Malay Wood Owl (*S. orientalis)*
  - Malay Wood Owl (*S. o. orientalis)*
  - Spotted Wood Owl (*S. seloputo (orientalis)) (often* combined with Malay Wood Owl)

Genus *Ciccaba*:
- *Ciccaba* of the Neotropical Region
  - Mottled Wood Owl (*C. virgata*)
  - Black-and-White Owl (*C. nigrolineata)* (sometimes considered a subspecies of *C. huhula)*
  - Black-Banded Owl (*C. huhula)*
  - Rufous-Banded Owl (*C. albitarsis*)
- *Ciccaba* of the Palearctic Region
  - African Wood Owl (*C. woodfordii)*

Marcot, Bruce G. 1995. Owls of old forests of the world. Gen. Tech. Rep. PNWGTR-343. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 64 p.

A review of literature on habitat associations of owls of the world revealed that about 83 species of owls among 18 genera are known or suspected to be closely associated with old forests. Old forest is defined as old-growth or undisturbed forests, typically with dense canopies. The 83 owl species include 70 tropical and 13 temperate forms. Specific habitat associations have been studied for only 12 species (7 tropical and 5 temperate), whereas about 71 species (63 tropical and 8 temperate) remain mostly unstudied. Some 26 species (31 percent of all owls known or suspected to be associated with old forests in the tropics) are entirely or mostly restricted to tropical islands. Threats to old-forest owls, particularly the island forms, include conversion of old upland forests, use of pesticides, loss of riparian gallery forests, and loss of trees with cavities for nests or roosts. Conservation of old-forest owls should include (1) studies and inventories of habitat associations, particularly for little-studied tropical and insular species; (2) protection of specific, existing temperate and tropical old-forest tracts; and (3) studies to determine if reforestation and vegetation manipulation can restore or maintain habitat conditions. An appendix describes vocalizations of ail species of *Strix* and the related genus *Ciccaba*.

Keywords: Owls, old growth, old-growth forest, late-successional forests, spotted owl, owl calls, owl conservation, tropical forests, literature review.

Pacific Northwest research Station
333 S.W. First Avenue
P.O. Box 3390
Portland, Oregon 97208-3390

U.S. Department of Agriculture
Pacific Northwest Research Station
333 S.W. First Avenue
P.O. Box 3890
Portland, Oregon 97208-3890