



Review Paper

Conservation status of flying mammal : Bats

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Abstract: Bats are the only mammals that are capable of true flight. They belong to order Chiroptera, class of Mammalia. At present, there are approximately 1001 species of bats that are subcategorized as Megachiroptera (1 Family, 167 Frugivorous bat species) and Microchiroptera (16 Families, 834 Insectivorous species). They are found all over the world except the Arctic, the Antarctic and some islands. One of most unique features of bats is their modified forelimbs which support a wing membrane- Patagium (Flight adaptation). Bats play an important role in various ecosystems as they are important pollinators, seed dispersors and the most effective biological control agents of insect pests. Like many other species of wildlife, bats have also been subjected to the pressures of human population growth and development. The population decline for various species of bats have been attributed mainly to loss of habitats and persecution by humans. Approximately 25% of all species (nearly 238 species) are considered threatened by the International Union for Conservation Nature and Natural resource (IUCN), of which 29 bat species are categorized as critically endangered. Literature reveals that bats are no popular mammal and one of the least studied mammalian groups in Indian subcontinent. Besides other conservative measures, it is necessary to tackle the negative attitudes towards bats through a variety of educational activities, items and projects aimed at different strata of our society.

Key words: Chiroptera, Insectivorous, Frugivorous, Patagium, Pollinators, Critically endangered

Introduction

Bats are unique among mammals as they are the only group that has evolved true powered flight. Their fossil records extend back to atleast early Eocene (Simmons and Geisler, 1998). They belong to class Mammalia, subclass Theria, infraclass Eutheria and order Chiroptera. Among the world's mammals, bats make up 20% of the total number. The order Chiroptera contains about 1001 species of bats that are subcategorized as Megachiroptera and Microchiroptera, on the basis of their specialization in feeding habits and morphological adaptations. Microchiroptera, which form the majority of bat species globally, feed on insects. Megachiroptera are predominantly fruit eaters. They exhibit a great dietary diversity of insects, fish, blood, fruit, nectar and pollen (Kunz, 1982). There are about 834 species of insectivorous bats and about 167 species of fruit bats in the world. There are 119 species of bats belonging to 37 genera and 8 families in Indian subcontinent encompassing India, Pakistan, Nepal, Sri Lanka, Maldives, Afghanistan, Tibet and Northern Myanmar. In India, a total of 110 species of bats belonging to 33 genera and 8 families have been recorded (Bates and Harrison, 1997). Bats are found all over the world except the Arctic, the Antarctic and some islands (Mickleburgh *et al.*, 2002). They reach their greatest diversity in tropical forests (Vaughan *et al.*, 2000). They are contributing extensively to global biological diversity. Their diversity is reflected not only in the number of species but also through different aspects of morphology, roosting and feeding behaviour (Fenton, 1997).

Bats play several major ecological roles in many ecosystems. They are important mobile links as pollinators and also serve in seed dispersal. They also are important biological

control agents of insects pests and are the major predators of nocturnal flying insects (Kunz *et al.*, 1995; McCracken *et al.*, 1996; Whitaker *et al.*, 1996; Akbar *et al.*, 1996).

Like many other species of wildlife, bats have also been subjected to the pressures of human population growth and development. Documented and suspected population declines for numerous species of bats have been attributed to loss of habitat, and persecution by human and some species of bats have either became extinct or are considered threatened, endangered, or vulnerable (Mickleburgh *et al.*, 2002).

Classification:

Phylum-	Chordata
Group-	Craniata or Euchordata
Sub-phylum-	Vertebrata
Super-class-	Tetrapoda
Class-	Mammalia
Sub-class-	Theria
Infraclass-	Eutheria
Order-	Chiroptera

Two sub-orders:

a- Megachiroptera (1 Family)

- Family *Pteropodidae*: flying foxes (Africa, Eurasia & Australia)

b- Microchiroptera (16 Families)

- Family *Rhinolophidae*: Old World horseshoe and leaf-nosed bats (Old World)
- Family *Emballonuridae*: Sac-winged bats (southern continents)
- Family *Craseonycteridae*: Kitti's hog-nosed bat (Thailand)

- Family Rhinopomatidae: Mouse-tailed bats (Africa, Southeast Asia)
- Family Nycteridae: Slit-faced bats (Africa, Southeast Asia)
- Family Megadermatidae: False vampire bats (Africa, Southeast Asia, Australia)
- Family Phyllostomidae: Leaf-nosed bats (South America)
- Family Mormoopidae: Leaf-chinned bats (South America)
- Family Noctilionidae: Fishing bats (South America)
- Family Mystacinidae: Short-tailed bats (New Zealand)
- Family Molossidae: Free-tailed bats (cosmopolitan)
- Family Myzopodidae: Sucker-footed bats (Madagascar)
- Family Thyropteridae: Sucker-footed bats (South America)
- Family Furipteridae: Smoky bats (South America)
- Family Natalidae: Funnel: Eared bats (South America)
- Family Vespertilionidae: Vesper bats (cosmopolitan)

Distribution

Bats are found throughout the world in tropical and temperate habitats. They are absent only from polar regions (Arctic and Antarctic) and some isolated islands (Fig. 1). Although bats are relatively common in temperate regions, they reach their greatest diversity in tropical forests (Hill and Smith, 1984; Vaughan *et al.*, 2000). Microchiropteran bats are found in all areas of the world apart from the Arctic and Antarctica and some isolated oceanic islands (Nowak and Walker, 1994). The Megachiroptera (Old world fruit bats or flying foxes) are found throughout the old world tropics and range from Africa, the eastern Mediterranean, Madagascar and the Indian ocean island in west, across mainland southern Asia, throughout the islands of the western pacific from the Ryukyu Archipelago and Ogasawara-Shoto in the north, to coastal eastern Australia, New Caledonia and the Loyalty Islands in the south and east to Fiji, Samoa and the Cook Islands (Mickleburgh *et al.*, 1992). They are especially diverse in south-eastern Asia and Indo-Australia (Hall and Richards, 2000; Mickleburgh *et al.*, 1992).

Habit

Bats are mostly nocturnal animals. All megachiropterans are nocturnal with the notable example of *Pteropus samensis* (Brooke, 2001). Microchiropterans are skilful nocturnal hunters and majority are insect feeders, although other food sources include fish, amphibians, small mammals (including bats), blood, fruits and flowers (Altringham, 1996). All pteropodids are frugivorous or nectarivorous (Mickleburgh *et al.*, 1992). Microchiropteran bats are, with rare exceptions among the Megachiroptera (some *Rousettus* and *Epomophorus* species), the only land mammals that emit sounds and then detect and characterize the time delay and signal properties of returning echoes for the purpose of navigation (echolocation). Echolocation signals are produced by the larynx, are powered by the muscles of the abdominal wall of bats and are emitted through the mouth or nostrils, ranging between 80 to 120 dB at a distance of 1 m from emitting bat (Neuweiler, 2000).

Habitat

Bats can be found in many terrestrial habitats below the polar regions. Typical habitats include temperate and tropical forests,

desert, open fields, agricultural areas, and in suburban and urban environment. Many bats forage near freshwater streams, lakes and ponds, preying on insects as they emerge from the water. Bats generally have very specific roosting requirements, which differ among species. They may roost in caves (Fig. 2), crevices, trees, under logs, and even in human dwellings. Bats may also use different types of roosts at different time. For example, a species that hibernates in a cave during the winter, may use crevices in tree holes as roosts during warmer months.

Morphology and unique characteristics

The body of bat is ventrally compressed with a short neck region. The bones tend to be slender and light in weight. The majority of the body weight is concentrated in the chest region due to the large flight muscles (Fig. 3). An important cranial characteristic for recognizing bat families is the nature of the premaxilla. There is a correlation between the shape of the head and the type of food eaten. Most nectar feeders have long, narrow muzzles that are good for reaching into flowers, while many fruit eaters have short broad faces good for biting rounded fruits (Hill and Smith, 1984). Megachiroptera are larger in size measuring head and body length from 52 to 400 mm. Adults range in weight from 10 to 1500 g and have a forearm length of 36 to 228 mm. The largest is the Indonesian flying fox with a wingspan of 6 ft. *Microchiroptera* are smaller in size weighing from 2 to 200 gm and have a forearm length of 22 to 115 mm. The smallest bat is a microchiropteran (*Craseonycteris thonglongyai*) and weighs only 2 to 3 g (Vaughan *et al.*, 2000). There are several obvious morphological features that distinguish the two suborders. *Megachiroptera* rely on vision to orient in the dark of night, thus have large, prominent eyes, whereas all microchiropterans rely heavily on echolocation and generally have small eyes. Most microchiropterans have large, complex pinnae including an elongated tragus or antitragus. Megachiropterans have claws on the second digits supporting wings, this is never in the case of microbats. Microbats have dihyoid cheek teeth whereas megabats have simplified cheek teeth (Hill and Smith, 1984; Vaughan *et al.*, 2000).

One unique feature of bats is their modified forelimbs which support a wing membrane (Patagium). The basic elements of the mammalian limbs are present in bats, although the relative size of most bones and muscles differ from those of nonflying mammals. The most elongated parts of the limbs are those of the hand (metacarpal bones) and fingers (phalanges) (Fig. 4 A and B). The patagium stretches between the fingers and attaches to the side or back of the bat and the hindlimbs. Bats also have a tail membrane called uropatagium. Numerous blood vessels and nerves are present throughout the wing membrane. Bats also have five unique muscles present in the patagium, and use additional muscles in the chest and back to move the wings up and down. A massive chest and shoulders maintain the center of gravity between the wings, making flight more efficient. The most obvious difference between bird wings and those of bats is that bird wings are made of feathers, not a skin membrane. Birds have elongated arms and wings are

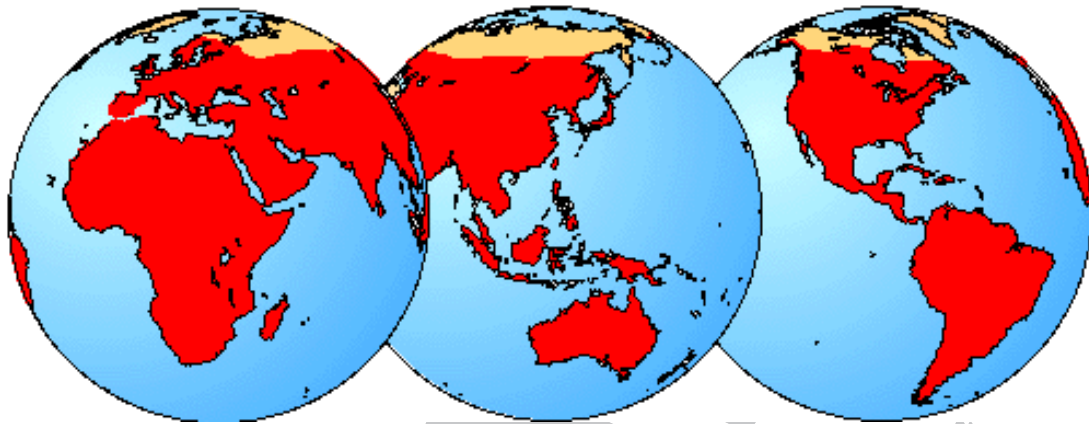


Fig. 1: The geographical distribution of bats is shown in red (Hill and Smith, 1984)



Fig. 2: A colony of bats in a cave



Fig. 3: External features of the bat

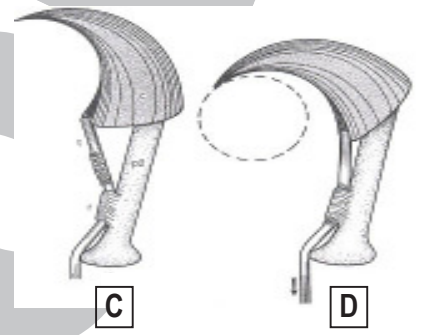


Fig. 4: Flight Adaptations – Bats; (A) Megachiroptera-bat wing, (B) Close-up of the wing to show reduced ulna at the elbow, (C) A typical bat hindlimb, digit, (D) When the tendon is pulled, the digit locks into a 'hook'

supported by the wrist and two digits whereas in bats, no elongated arms and wings are supported by four elongated fingers. Additionally, the muscles used in both the upstroke and downstroke are found in the chest of birds whereas the upstroke muscles are on the back in bats (Fenton, 1983, 2003). The hindlimbs are generally short and small with sharp, curved claws that help bats cling to surfaces in their roost. Most bats have tendon system in the toes that locks the claws in place so the bat can hang upside down even when asleep (Fig. 4 C and D).

Consevation status

Approximately 25% of all species (nearly 238 species) are considered threatened by the International Union for Conservation of Nature and Natural resource (IUCN). At least 12 species have gone extinct in recent time. Megachiropterans tend to be more at risk than microchiropterans (34% and 22% of species, respectively) (Jones *et al.*, 2003). Of the 238 species considered to be threatened, 29 species are categorized as critically endangered (Mickleburgh *et al.*, 2002).

Table - 1: Critically endangered bats, with the criteria used for their categorization and their distribution (Mickleburgh *et al.*, 2002)

Family / species	Criteria for CR categorisation	Distribution
Megachiroptera :		
Pteropodidae		
<i>Aproteles bulmerae</i>	B1+2c	Popua New Guinea
<i>Latidens salimalii</i>	B1+2c,D	India
<i>Pteralopex acrodonta</i>	A1c,B1+2c	Fiji
<i>Nyctimene rabori</i>	A2c	Philippines
<i>Pteralopex anceps</i>	A1c	Popua New Guinea, Solomons
<i>Pteralopex pulchra</i>	A1c	Solomons
<i>Pteralopex atrata</i>	A1c	Solomons
<i>Pteropus insularis</i>	A1cd	Federated states of Micronesia
<i>Pteropus livingstonei</i>	A1c+2cd, B1+2c,C2a	Comoros
<i>Pteropus molossinus</i>	B1+2ce	Federated states of Micronesia
<i>Pteropus phaeocephalus</i>	B1+2e	Federated states of Micronesia
<i>Pteropus pselaphon</i>	B1+2ce	Japan
<i>Pteropus rodricensis</i>	B1+3d	Mauritius
<i>Pteropus voeltzkowi</i>	C2a	Tanzania
Microchiroptera :		
Emballonuridae		
<i>Coleura seychellensis</i>	B1+2cde, C2b, D	Seychelles
<i>Taphozous troughtoni</i>	A1ac, B1+2abcde, D	Australia
Hipposideridae		
<i>Hipposideros nequam</i>	B1+2c	Malaysia
<i>Paracoelops megalotis</i>	B1+2c	Vietnam
Rhinolophidae		
<i>Rhinolophus convexus</i>	D	Malaysia
Vespertilionidae		
<i>Myotis cobanensis</i>	B1+2c	Guatemala
<i>Myotis plamiceps</i>	B1+2c	Mexico
<i>Pharotis Imogene</i>	B1+2c, C2b	Popua New Guinea
<i>Pipistrellus anthonyi</i>	B1+2c	Myanmar
<i>Pipistrellus joffrei</i>	B1+2c	Myanmar
<i>Scotophilus borbonicus</i>	A1c	Madagascar, Reunion
<i>Murina tenebrosa</i>	B1+2c, D	Japan
Molossidae		
<i>Chaerephon gallagheri</i>	B1+2c	Democratic Republic of Congo
<i>Mops niangarae</i>	B1+2c	Democratic Republic of Congo
<i>Otomops wroughtoni</i>	B1+2c	India

Signigicance

Because of their high metabolic needs and diverse diets, bats impact the communities, in which they live, in a variety of important ways. They are important pollinators and seed dispersors. Through seed dispersal, bats have established a mutualistic interaction with many hundreds of plants species. Seed-dispersal rate by bats is greater than that by birds (Medellin and Gaona, 1999; Korine *et al.*, 2000).

Although fruit bats damage a small percentage of agricultural crops, but their role in forest regeneration more than compensates this loss. Bats may be keystone species in many communities, particularly in the tropics where they are most abundant and diverse (Hill and Smith, 1984; Jones *et al.*, 2003; Vaughan *et al.*, 2000).

Bats also are important biological control agents of insect pests and are the major predators of nocturnal flying insects, ingesting immense amount of insects every night (Akbar *et al.*,

1999). Research on insect consumption by bats has shown that *Tadarida brasiliensis* of Mexico can consume more than half its weight. Similar estimates for other insectivorous species are known from Borneo where one cave population consumes 7500 kg per night. *Myotis lusifugus*, the little brown bat, which can eat up to its own body weight in insects per night (Mistry, 1995). Sinha (1986) has described the Indian false vampire (*Megaderma lyra*) as a 'good friend of farmers' in the state of Bihar. Colonies of this species, ranging from 25 to 240 individuals, consume rats and mice which destroy different grains stored in bags and rewarded with protection by farmers, who call it the 'Goddess Laxmi'. Human in some regions benefit from Indian flying fox (*Pteropus giganteus*) by hunting them for food and medicinal purposes (Marimuthu, 1998).

Bats could be good indicators of the integrity of biological systems because of their combination of size, mobility, and longevity as well as the variety of trophic roles (Kunz and Fenton, 2003;

Table - 2: Bats of south Asia with status in individual countries [Source: Status of South Asian Chiroptera; Conservation Assessment and Management Plan (C.A.M.P.) Workshop Report, 2002]

Scientific name	Family	South Asia	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka
Endemics of south Asia									
<i>Eptesicus tatei</i> (Elleman and Morrison-Scott, 1951)	Vespertilionidae	DD	-	-	DD	-	-	-	-
<i>Hipposideros durgadasi</i> (Khajuria, 1970)	Hipposideridae	EN	-	-	EN	-	-	-	-
<i>Hipposideros hypophyllus</i> (Kock and Bhat, 1994)	Hipposideridae	EN	-	-	EN	-	-	-	-
<i>Hipposideros lankadivi</i> (Kelaart, 1850)	Hipposideridae	LC	LC	-	LC	-	-	-	LC
<i>Hipposideros speoris</i> (Schneider, 1800)	Hipposideridae	LC	-	-	LC	-	-	-	LC
<i>Latidens salimalii</i> (Thonglongya, 1972)	Pteropodidae	EN	-	-	EN	-	-	-	-
<i>Murina grisea</i> (Peters, 1872)	Vespertilionidae	CR	-	-	CR	-	-	-	-
<i>Myotis csorbai</i> (Topal, 1997)	Vespertilionidae	DD	-	-	-	-	DD	-	-
<i>Myotis sicarius</i> (Thomas, 1915)	Vespertilionidae	VU	-	-	EN	-	VU	-	-
<i>Pipistrellus dormeri</i> (Dobson, 1875)	Vespertilionidae	LC	LC	DD	LC	-	-	NT	-
<i>Pteropus faunulus</i> (Miller, 1902)	Pteropodidae	EN	-	-	EN	-	-	-	-
<i>Rhinolophus beddomei</i> (Andersen, 1905)	Rhinolophidae	NT	-	-	NT	-	-	-	NT
<i>Rhinolophus cognatus</i> (Andersen, 1906)	Rhinolophidae	VU	-	-	VU	-	-	-	-
<i>Rhinolophus ferrumequinum</i> (Schreber, 1774)	Rhinolophidae	VU	-	-	VU	-	-	-	-
<i>Rhinolophus mitratus</i> (Blyth, 1844)	Rhinolophidae	VU	-	-	VU	-	-	-	-
<i>Scotoecus pallidus</i> (Dobson, 1876)	Vespertilionidae	NT	-	-	NT	-	-	NT	-
<i>Taphozous perforatus</i> (E. Geoffroy, 1818)	Emballonuridae	LC	-	-	LC	-	-	LC	-
Non-endemics of south Asia									
<i>Areilulus circumdatus</i> (Temminck, 1840)	Vespertilionidae	LC	-	-	LC	-	NT	-	-
<i>Asellia tridens</i> (Geoffroy, 1813)	Hipposideridae	NE	-	-	-	-	-	NE	-
<i>Barbastella leucomelas</i> (Cretzschmar, 1830/31)	Vespertilionidae	NT	-	-	NT	-	NT	DD	-
<i>Coelops frithii</i> (Blyth, 1848)	Hipposideridae	NT	NT	-	NT	-	-	-	-
<i>Cynopterus brachyotis</i> (Muller, 1838)	Pteropodidae	LC	-	-	LC	-	-	-	LC
<i>Cynopterus sphinx</i> (Vahl, 1797)	Pteropodidae	LC	LC	DD	LC	-	LC	DD	LC
<i>Eonycteris spelaea</i> (Dobson, 1871)	Pteropodidae	LC	-	-	LC	-	-	-	-

<i>Eptesicus bottae</i> (Peters, 1869)	Vespertilionidae	DD	-	-	-	-	-	DD	-
<i>Eptesicus gobiensis</i> (Bobrinskii, 1926)	Vespertilionidae	DD	-	-	-	-	-	DD	DD
<i>Eptesicus nasutus</i> (Dobson, 1877)	Vespertilionidae	DD	-	-	-	-	-	DD	-
<i>Eptesicus pachyotis</i> (Dobson, 1871)	Vespertilionidae	DD	LC	-	-	DD	-	NT	-
<i>Eptesicus serotinus</i> (Schreber, 1774)	Vespertilionidae	NT	-	-	-	NT	-	NT	DD
<i>Harpiocephalus harpia</i> (Temminck, 1840)	Vespertilionidae	NT	-	-	DD	NT	-	-	-
<i>Harpiocephalus mordax</i> (Temminck, 1840)	Vespertilionidae	DD	-	-	-	DD	-	-	-
<i>Hesperoptenus tickelli</i> (Blyth, 1851)	Vespertilionidae	LC	-	-	DD	LC	-	DD	-
<i>Hipposideros armiger</i> (Hodgson, 1835)	Hipposideridae	LC	-	-	-	LC	-	LC	-
<i>Hipposideros ater</i> (Templeton, 1848)	Hipposideridae	LC	-	-	-	LC	-	-	LC
<i>Hipposideros cineraceus</i> (Blyth, 1853)	Hipposideridae	NT	-	-	-	NT	-	NT	DD
<i>Hipposideros diadema</i> (E. Geoffroy, 1813)	Hipposideridae	VU	-	-	-	VU	-	-	-
<i>Hipposideros fulvus</i> (Gray, 1838)	Hipposideridae	LC	-	-	-	LC	-	LC	LC
<i>Hipposideros galeritus</i> (Cantor, 1846)	Hipposideridae	NT	NT	-	-	NT	-	-	VU
<i>Hipposideros larvatus</i> (Horsfield, 1823)	Hipposideridae	NT	NT	-	-	NT	-	-	-
<i>Hipposideros pomona</i> (Andersen, 1918)	Hipposideridae	LC	DD	-	-	LC	-	NT	-
<i>Ia io</i> (Thomas, 1902)	Vespertilionidae	EN	-	-	-	EN	-	CR	-
<i>Kerivoula hardwickii</i> (Horsfield, 1824)	Vespertilionidae	LC	-	-	-	LC	-	-	DD
<i>Kerivoula papillosa</i> (Temminck, 1840)	Vespertilionidae	NT	NT	-	-	NT	-	-	-
<i>Kerivoula picta</i> (Pallas, 1767)	Vespertilionidae	LC	LC	-	-	LC	LC	-	LC
<i>Macroglossus sobrinus</i> (Andersen, 1911)	Pteropodidae	NT	-	-	-	NT	-	-	-
<i>Megaderma lyra</i> (Geoffroy, 1810)	Megadermatidae	LC	LC	-	-	LC	-	LC	LC
<i>Megaderma spasma</i> (Linnaeus, 1758)	Megadermatidae	LC	LC	-	-	LC	-	-	LC
<i>Megaerops niphanae</i> (Yenbutra & Felten, 1983)	Pteropodidae	NT	-	-	-	NT	-	-	-
<i>Miniopterus pusillus</i> (Dobson, 1876)	Vespertilionidae	VU	-	-	-	VU	-	CR	-
<i>Miniopterus schreibersi</i> (Kuhl, 1819)	Vespertilionidae	LC	-	-	-	LC	-	LC	-
<i>Murina aurata</i> (Milne-Edwards, 1872)	Vespertilionidae	NT	-	-	-	NT	-	NT	-

<i>Murina cyclotis</i> (Dobson, 1872)	Vespertilionidae	LC	-	-	LC	-	-	-	LC
<i>Murina huttonii</i> (Peters, 1872)	Vespertilionidae	LC	-	-	LC	-	DD	DD	-
<i>Murina leucogaster</i> (Milne-Edwards, 1872)	Vespertilionidae	NT	-	-	NT	-	VU	-	-
<i>Murina tubinaris</i> (Scully, 1881)	Vespertilionidae	NT	-	-	NT	-	-	NT	-
<i>Myotis annectans</i> (Dobson, 1871)	Vespertilionidae	VU	-	-	VU	-	-	-	-
<i>Myotis blythii</i> (Tomes, 1857)	Vespertilionidae	VU	-	-	VU	-	VU	DD	-
<i>Myotis daubentonii</i> (Kuhl, 1819)	Vespertilionidae	EN	-	-	EN	-	-	-	-
<i>Myotis formosus</i> (Hodgson, 1835)	Vespertilionidae	LC	LC	-	LC	-	NT	-	-
<i>Myotis hasseltii</i> (Temminck, 1840)	Vespertilionidae	NT	-	-	NT	-	-	-	VU
<i>Myotis horsfeldii</i> (Temminck, 1840)	Vespertilionidae	LC	-	-	LC	-	-	-	-
<i>Myotis longipes</i> (Dobson, 1873)	Vespertilionidae	NT	-	-	NT	-	NT	-	-
<i>Myotis montivagus</i> (Dobson, 1874)	Vespertilionidae	VU	-	-	VU	-	-	-	-
<i>Myotis muricola</i> (Gray, 1846)	Vespertilionidae	LC	-	-	LC	-	LC	LC	DD
<i>Myotis mystacinus</i> (Kuhl, 1819)	Vespertilionidae	VU	-	-	VU	-	VU	VU	-
<i>Myotis siliigorensis</i> (Horsfield, 1855)	Vespertilionidae	NT	-	-	NT	-	NT	-	-
<i>Nyctalus leisleri</i> (Kuhl, 1819)	Vespertilionidae	EN	-	-	EN	-	-	EN	-
<i>Nyctalus montanus</i> (Barrett-Hamilton, 1906)	Vespertilionidae	NT	-	-	NT	-	NT	-	-
<i>Nyctalus noctula</i> (Schreber, 1774)	Vespertilionidae	LC	-	-	LC	-	LC	LC	-
<i>Otomops wroughtoni</i> (Thomas, 1913)	Molossidae	CR	-	-	CR	-	-	-	-
<i>Otonycteris hemprichi</i> (Peters, 1859)	Vespertilionidae	NT	-	-	NT	-	-	NT	-
<i>Philetor brachypterus</i> (Temminck, 1840)	Vespertilionidae	VU	-	-	EN	-	VU	-	-
<i>Pipistrellus abramus</i> (Temminck, 1840)	Vespertilionidae	DD	-	-	DD	-	-	-	-
<i>Pipistrellus affinis</i> (Dobson, 1871)	Vespertilionidae	NT	-	-	NT	-	-	-	-
<i>Pipistrellus cadomae</i> (Thomas, 1916)	Vespertilionidae	NT	-	-	NT	-	-	-	-
<i>Pipistrellus ceylonicus</i> (Kelaart, 1852)	Vespertilionidae	LC	LC	-	LC	-	-	LC	LC
<i>Pipistrellus coromandra</i> (Gray, 1838)	Vespertilionidae	LC	LC	-	LC	-	LC	-	LC
<i>Pipistrellus javanicus</i> (Gray, 1838)	Vespertilionidae	LC	LC	-	LC	-	LC	LC	-

<i>Pipistrellus kuhlii</i> (Kuhl, 1819)	Vespertilionidae	LC	-	-	LC	-	-	LC	-
<i>Pipistrellus paterculus</i> (Thomas, 1915)	Vespertilionidae	LC	-	-	LC	-	-	-	-
<i>Pipistrellus pipistrellus</i> (Schreber, 1774)	Vespertilionidae	LC	-	-	LC	-	-	LC	-
<i>Pipistrellus savii</i> (Bonaparte, 1837)	Vespertilionidae	VU	EN	-	VU	-	-	-	-
<i>Pipistrellus tenuis</i> (Temminck, 1840)	Vespertilionidae	LC	LC	-	LC	-	LC	LC	LC
<i>Plecotus auritus</i> (Linnaeus, 1758)	Vespertilionidae	NT	-	-	NT	-	NT	NT	-
<i>Plecotus austriacus</i> (Fischer, 1829)	Vespertilionidae	NT	-	-	NT	-	NT	NT	-
<i>Pteropus giganteus</i> (Brunnich, 1782)	Pteropodidae	LC	EN	-	LC	LC	LC	LC	LC
<i>Pteropus hypomelanus</i> (Temminck, 1853)	Pteropodidae	EN	-	-	EN	CR	-	-	-
<i>Pteropus melanotus</i> (Blyth, 1863)	Pteropodidae	VU	-	-	VU	-	-	-	-
<i>Pteropus vampyrus</i> (Linnaeus, 1758)	Pteropodidae	EN	-	-	EN	-	-	-	-
<i>Rhinolophus affinis</i> (Horsfield, 1823)	Rhinolophidae	LC	-	LC	LC	-	LC	-	-
<i>Rhinolophus blasii</i> (Peters, 1866)	Rhinolophidae	NT	-	-	-	-	-	NT	-
<i>Rhinolophus hipposideros</i> (Bechstein, 1800)	Rhinolophidae	VU	-	-	VU	-	-	VU	-
<i>Rhinolophus lepidus</i> (Blyth, 1844)	Rhinolophidae	LC	LC	-	LC	-	NT	NT	-
<i>Rhinolophus luctus</i> (Temminck, 1835)	Rhinolophidae	NT	NT	-	NT	-	NT	-	-
<i>Rhinolophus macrotis</i> (Blyth, 1844)	Rhinolophidae	NT	-	-	NT	-	NT	NT	-
<i>Rhinolophus pearsonii</i> (Horsfield, 1851)	Rhinolophidae	LC	NT	NT	LC	-	LC	-	-
<i>Rhinolophus pusillus</i> (Temminck, 1834)	Rhinolophidae	LC	-	-	LC	-	LC	-	-
<i>Rhinolophus rouxii</i> (Temminck, 1835)	Rhinolophidae	NT	-	-	NT	-	NT	-	NT
<i>Rhinolophus sinicus</i> (Andersen, 1905)	Rhinolophidae	LC	-	-	LC	-	LC	-	-
<i>Rhinolophus subbadius</i> (Blyth, 1844)	Rhinolophidae	VU	VU	-	VU	-	EN	-	-
<i>Rhinolophus trifolius</i> (Temminck, 1834)	Rhinolophidae	VU	-	-	VU	-	-	-	-
<i>Rhinolophus yunanensis</i> (Dobson, 1872)	Rhinolophidae	VU	-	-	VU	-	-	-	-
<i>Rhinopoma hardwickii</i> (Gray, 1831)	Rhinolophidae	LC	LC	-	LC	-	-	LC	-
<i>Rhinopoma microphyllum</i> (Brunnich, 1782)	Rhinolophidae	LC	LC	-	LC	-	-	LC	-
<i>Rhinopoma muscatellum</i> (Thomas, 1903)	Rhinolophidae	NT	-	-	NT	-	-	NT	-

<i>Rousettus aegyptiacus</i> (E. Geoffroy, 1810)	Pteropodidae	VU	-	-	-	-	-	VU	-
<i>Rousettus leschenaulti</i> (Desmarest, 1820)	Pteropodidae	LC	LC	NT	LC	-	NT	LC	LC
<i>Scotomanes ornatus</i> (Blyth, 1851)	Vespertilionidae	LC	NT	-	LC	-	NT	-	-
<i>Scotophilus heathii</i> (Horsfield, 1831)	Vespertilionidae	LC	NT	-	LC	-	LC	LC	LC
<i>Scotophilus kuhlii</i> (Leach, 1821)	Vespertilionidae	LC	LC	-	LC	-	NT	LC	LC
<i>Sphaerias blanfordi</i> (Thomas, 1891)	Pteropodidae	NT	-	NT	NT	-	NT	-	-
<i>Tadarida aegyptiaca</i> (E. Geoffroy, 1818)	Molossidae	LC	NT	-	LC	-	-	LC	LC
<i>Tadarida plicata</i> (Buchanan, 1800)	Molossidae	LC	-	-	LC	-	-	-	-
<i>Tadarida teniotis</i> (Rafinesque, 1814)	Molossidae	NE	-	-	NE	-	-	-	-
<i>Taphozous longimanus</i> (Hardwicke, 1825)	Emballonuridae	LC	LC	-	LC	-	DD	-	LC
<i>Taphozous melanopogon</i> (Temminck, 1841)	Emballonuridae	LC	LC	-	LC	-	-	-	LC
<i>Taphozous nudiventris</i> (Cretzschmer, 1830)	Emballonuridae	LC	-	-	LC	-	-	LC	-
<i>Taphozous saccolaimus</i> (Temminck, 1838)	Emballonuridae	LC	LC	-	LC	-	-	-	-
<i>Taphozous theobaldi</i> (Dobson, 1872)	Emballonuridae	VU	-	-	VU	-	-	-	-
<i>Triaenops persicus</i> (Dobson, 1871)	Hipposideridae	VU	-	-	-	-	-	VU	-
<i>Tylonycteris pachypus</i> (Temminck, 1840)	Vespertilionidae	NT	NT	-	NT	-	-	-	-
<i>Tylonycteris robustula</i> (Thomas, 1915)	Vespertilionidae	NE	NE	-	NE	-	-	-	-
<i>Vespertilio murinus</i> (Linnaeus, 1758)	Vespertilionidae	NT	NT	-	-	-	-	NT	-
Total		123	34	9	114	2	50	45	32

DD = Data deficient, EN = Endangered, LC = Least concern, CR = Critically endangered, VU = Vulnerable, NT = Near threatened, NE = Not evaluated

Altringham, 1996). One example of the potential utility of bats as environmental indicators is the accumulation of mercury and other metals in their furs (Hickey *et al.*, 2001).

Indian flying foxes cause extensive damage to fruit orchards, and are therefore considered pests in many regions. The Indian government also listed fruit bats as 'Vermin' in 1972 in the Indian Wildlife (Protection) Act. Bats may also be responsible for spreading diseases, particularly the Nipah virus which causes illness and death in humans (Kunz and Racey, 1998; Marimuthu, 1998). Bats are instrumental in the aerosol transmission of rabies virus (Gibbons, 2002). Bat biologists have coped with the reality that bat guano can be a source of infection of humans by histoplasmosis (Fenton, 2001) and even the alleged involvement of bats with emerging viruses such as Ebola (Preston, 1994). In Canada and USA between 1980 and 31 December 2000, 43 people died of rabies, 28 of them from

strains of rabies virus associated with bats. Vampire bats (*Desmodus rotundus*) feed on the blood of livestock or even of people.

Recommendations

Literature revealed that bats are one of the least studied mammalian group in the world especially in Indian subcontinent. Information for many species is based only on literature references without no recent population or distributional information. Following recommendations can be considered regarding the present status of bats-

- 1- Chiroptera surveys make up the primary research recommendation for nearly all bats.
- 2- Ecological studies should be strongly recommended for better understanding of the status and economic value of species as

- well as to provide justification for upgrading bats in national legislation.
- 3- Some research recommendations include life history studies, taxonomic studies, genetic studies and population and habitat viability analysis.
 - 4- Management recommendations should be focussed on the need for periodic monitoring, habitat management and public awareness.
 - 5- Habitat management includes not only conserving roosting areas such as caves, trees, old buildings, temples but also in conserving its sources of food (fruits or insects).
 - 6- Study and documentation of pollination and seed dispersal by bats in different ecosystems, would help improve the image of bats.
 - 7- Threatened bat species should be recommended for captive breeding programmes.
 - 8- Removal of Megachiroptera or fruit bats from shedule V of the Indian Wildlife (Protection) Act, 1972 with legislation to extend to other species of chiroptera also.
 - 9- Legislation and forest management plans and guidelines should include control measures for disturbance, selling, bartering whole or parts of bats, protection of key roosting sites and important habitats of bats.
 - 10- Measures for preventing deforestation which are the major source of their food.
 - 11- Migratory bat species should be identified and appropriate international agreement drafted.
 12. To tackle the negative attitudes towards bats through a variety of educational activities, items and projects aimed at audiences of different ages and in different strata of society.

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