ORDER CHIROPTERA: BATS

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INTRODUCTION

Recent surveys in Lao PDR have recorded nearly 90 species of bats, and new species for the country continue to be recorded on most surveys. Because many areas of Lao PDR have not yet been surveyed, it seems likely that additional species remain to be found. For this reason, following the practice of the first edition (Salter 1993b), the list below includes species potentially occurring in Lao PDR based on known occurrence in adjacent countries, even if they have not yet been reported from Lao PDR. These species are indicated in square brackets. If the identity of a species has not yet been confirmed in Lao PDR, the account is again set in square brackets. Bats caught which clearly did not belong to any named species known from Lao PDR, and where the correct name remains uncertain are not in square brackets, and are listed as 'sp.' or using 'cf.' in the provisionally-assigned scientific name. Some of these are doubtless undescribed to science. Including species thought likely to occur, but not yet confirmed, as well as several species whose identity has not yet been worked out, the number of species in Lao PDR is probably over 100. In each species account, 1-3 references are cited for specific reports of specimens in each of north, central and south Lao PDR. No attempt has been made to list all records for each species in a region, and some species have been identified from many localities. Because we are most concerned with the current status of each species, preference has been given for recent reports. Older references are only cited if there is little doubt about the identification, based on the fact that the record has been repeated or confirmed in more recent compilations (e.g. Corbet and Hill 1992). References frequently cited for distribution are abbreviated thus: [C1]Francis and Khounboline (1996), [C2]Francis *et al*. (1996), [C3]Francis *et al*. (1997a), [C4]Francis *et al*. (1997b), [C5]Francis *et al*. (1997c), [C6]Francis and Khoonmy (1998a), [C7]Francis and Khoonmy (1998b), [C8]Francis and Khoonmy (1998c), [C9]Francis and Khoonmy (1998d), [C10]Francis and Vongkhamheng (1998), [C11]Guillén *et al*. (1997), [C12]Guillén and Francis (1998a), [C13]Guillén and Francis (1998b), [C14]Guillén and Francis (1998c), [C15]Robinson (1998), [C16]Robinson and Webber (1998a), [C17]Bergmans (1995) and [C18] WCS (1995b).

Most of the citations for surveys by WCS refer to unpublished reports. Those reports were generally prepared shortly after completion of field work, at which point many identifications were still tentative. Subsequent study of voucher specimens in museum collections has resulted in re-identification of some specimens. Citations in this report refer to the currently accepted identification, and discrepancies from the original identification are only discussed with respect to published references. CMF and AG are preparing a separate report on the WCS bat surveys for formal publication that will provide more complete details on individual surveys. Taxonomy and nomenclature follow Corbet and Hill (1992), except as mentioned in the text.

Conservation significance is indicated for individual species if they have been listed under one of the IUCN red list categories (IUCN 1996; see Conventions), or are listed in CITES Appendix I or II (WCMC 1998). Also mentioned are species with changes in conservation status proposed in the draft global action plan for microchiropteran bats (Hutson *et al*. in prep.). Most status listings for South-east Asian bats are based on very limited information, because the region has not yet been well surveyed for bats. Some species listed in IUCN (1996) as threatened, on the basis of the few known records, were found at several additional localities during our surveys, and probably should be reclassified. Conversely, some other species, that were not listed, appear to be fairly rare (at least based on our surveys in Lao PDR) and probably should be listed. Where appropriate, we have indicated this additional information on status in the species accounts. In addition, our surveys suggest that bats roosting in large colonies, primarily in caves, are at risk of extirpation in many parts of Lao PDR because of exploitation for food. Cave-dwelling species that roost in small scattered groups may be less at risk, but they are also often rare species, so they could be vulnerable to incidental harvest along with more common species. Species that use caves, but also roost elsewhere are probably less at risk, but in many cases it is not known which species those are. Because of this uncertainty, we have listed most cave-roosting species as Potentially At Risk in Lao PDR. A few species are listed as At Risk in Lao PDR, because they are only known to roost in large colonies that are clearly being exploited. The list of key species for Lao PDR is given in Annex 6; species listed in CITES Appendix I or Appendix II are detailed in Annex 3.

ANNOTATED LIST OF SPECIES

Pteropodidae: Old-world fruit bats (8-11 species)

[• ***Pteropus vampyrus*** Large Flying-fox]. *Conservation Significance:* Potentially At Risk in Lao PDR; CITES Appendix II. *Documented Range and Habitat:* North? A captive bat apparently of this species was photographed in western Bolikhamxai Province in 1998, well north of its range as mapped in Corbet and Hill (1992) but its origin is not known (WGR; Plate 18). May occur as a vagrant, but unlikely to be regular or resident in Lao PDR because not reported by villagers who have been asked in central or southern Lao PDR where it would be most expected based on range. Species usually roosts in large flocks in tree tops, but is semi-nomadic, probably in response to regional variation in fruit availability. Likely to be hunted for food if encountered; large camps would be vulnerable to disturbance from hunting.

Plate 18:

Scotomanes ornatus, Hin Namno NBCA, February 1998. A medium-sized and very colourful species of forest glades and streams. *C. M. Francis / WCS.*

Myotis ricketti, Khammouan Limestone NBCA, January 1998. The large feet of this species are used to scoop large insects and small fish from water. *C. M. Francis / WCS.*

Harpiocephalus sp., Khammouan Limestone NBCA, January 1998. A poorly known insectivorous bat unusual in the thick hairs all over the tail membrane and tubular nostrils. Two species of the genus occur in Lao PDR; they are difficult to distinguish.
C. M. Francis / WCS.

Megaderma spasma, Dong Ampham NBCA, May 1997. This species takes prey (large invertebrates and sometimes small vertebrates) from surfaces. *C. M. Francis / WCS.*

Rhinolophus acuminatus, Dong Khanthung PNBCA, February 1998. Individuals of this species may be bright orange or dark grey-brown. *C. M. Francis / WCS.*

Myotis formosus, Dong Ampham NBCA, May 1997. A poorly-known bat of which this individual is the only Lao record. *C. M. Francis / WCS.*

Cynopterus sphinx, Dong Ampham NBCA, April 1997. One of the most widespread fruit bats in Lao PDR. An important seed-disperser and pollinator of fruit trees. *C. M. Francis / WCS.*

A bat believed to be *Pteropus vampyrus*, the largest bat from Lao PDR. This individual, caged in a village in Bolikhamxai Province in 1998, is the only Lao record and its origin is unclear. *Po Souvannalath / WCS and IUCN.*

• ***Rousettus leschenaulti*** Leschenault's Rousette. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C17], centre[C10] (Phillips 1967), south[C17, C8]. Roosts in caves (Lekagul and McNeely 1977).

• ***Rousettus amplexicaudatus*** Geoffroy's Rousette. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* Centre[C16], south[C3, C15]. Roosts in caves (Lekagul and McNeely 1977). Appears to be less widespread than *R. leschenaulti*, but there are relatively few records on which to base this judgement; externally, both species are similar in appearance.

Cynopterus brachyotis Lesser Short-nosed Fruit Bat. South[C9]; range maps in Corbet and Hill (1992) suggest it may extend to centre and north, but the nearest location cited in the text is Vietnam. Forests, orchards and open country (Lekagul and McNeely 1977).

Cynopterus sphinx Short-nosed Fruit Bat. North[C1], centre[C7, C10, C16], south[C8, C9] (Plate 18). Probably widespread throughout the country, especially in open forest areas (Corbet and Hill 1992). Often feeds on flowers of cultivated plants such as kapok and bananas, presumably pollinating them (Robinson and Webber 1998a).

[***Cynopterus horsfieldi*** Horsfield's Fruit Bat]. Centre (provisionally[C7]). One specimen captured at Hin Namno NBCA, together with *C. sphinx*, appeared to be this species, but further study of the specimen is required to confirm the identity.

Megaerops niphanae Northern Tail-less Fruit Bat. North[C17, C11], centre[C2, C10], south[C3, C9]. Probably the most widespread fruit bat in forested areas of Lao PDR, but also found in more open areas. This species was described in 1983, prior to which it was confused with *M. ecaudatus*.

Megaerops ecaudatus Tail-less Fruit Bat. South[C3, C9], sympatric with *M. niphanae*. Probably has similar habitat requirements to *M. niphanae*, but may not extend as far north. Externally, this species is similar to *M. niphanae*, and further research is required to determine which field marks are most reliable for identifying live animals.

[***Sphaerias blanfordi*** Mountain Fruit Bat]. Not recorded from Lao PDR, but occurs in northern Thailand and Myanmar (Corbet and Hill 1992) and might be expected in northern Lao PDR.

• ***Eonycteris spelaea*** Cave Nectar Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C17, C12], centre[C16], south[C3, C15] (Osgood 1932). Probably widespread throughout the country. Roosts in caves (Lekagul and McNeely 1977). Feeds on nectar and pollen from flowers, and pollinates many trees including some economically important species such as durian, jackfruit and jambu (Start and Marshall 1976), as well as kapok and bananas (Robinson and Webber 1998a).

Macroglossus sobrinus Hill Long-tongued Fruit Bat. North[C12, C13], centre[C2] (Phillips 1967). Mapped from south by Corbet and Hill (1992). Evergreen forests (Lekagul and McNeely 1977). In older literature was known as *M. minimus*, but that name is now known to belong to a different species found only in Malaysia (Hill 1983). Feeds primarily on nectar and pollen of bananas and hence is an important pollinator (Start and Marshall 1976).

Emballonuridae: Sheath-tailed bats (3-4 species)

Note: Most species in Lao PDR are known from few records, because they forage relatively high off the ground and hence are difficult to catch away from roosts. Unidentified *Taphozous* bats have been recorded in many areas based on echolocation calls (CMF and AG), indicating that at least some species are fairly widespread.

Taphozous melanopogon Black-bearded Tomb Bat. North, at Pakou (Osgood 1932). Mapped as throughout Lao PDR (Corbet and Hill 1992), but basis for records not listed. Forested hills, roosting in caves and faults in cliffs (Lekagul and McNeely 1977).

[***Taphozous longimanus*** Long-winged Tomb Bat]. Not recorded from Lao PDR, but occurs in adjacent Thailand (Lekagul and McNeely 1977, Corbet and Hill 1992), and probably therefore also in Lao PDR. Roosts in houses, hollow trees and caves (Lekagul and McNeely 1977).

• ***Taphozous theobaldi*** Theobald's Tomb Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* Centre[C16], south[C15]. Roosts in caves (Lekagul and McNeely 1977, Robinson 1998) and possibly also hollow trees.

• ***Taphozous saccolaimus*** Pouched Tomb Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* South[C17]. In Thailand, the species roosts in houses, rock crevices or hollow trees (Lekagul and McNeely 1977).

Megadermatidae: False-vampires (2 species)

Megaderma spasma Lesser False-vampire. Centre[C10, C7], south[C3, C15] (Plate 18). Probably throughout (Corbet and Hill

1992). In Lao PDR has been found roosting in caves (Robinson and Webber 1998a) and hollow trees (Robinson 1998).

Megaderma lyra Greater False-vampire. North[C13], centre[C7, C10], south[C3, C15]. In Lao PDR has been found roosting in caves (Francis and Khoonmy 1998b, Robinson 1998), but also roosts in temples, wells and old buildings in Thailand (Lekagul and McNeely 1977). Often caught foraging in the same sites as the smaller *M. spasma* (Francis *et al*. 1997a, Francis and Vongkhamheng 1998).

Rhinolophidae: Horseshoe bats (15-19 species)

• ***Rhinolophus luctus*** Large Woolly Horseshoe Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C12], centre[C10], south[C3]. Apparently widespread, but appears to be relatively uncommon. Has been caught roosting in caves (Francis and Vongkhamheng 1998, Robinson and Webber 1998a) but also may use hollow trees (Lekagul and McNeely 1977). Probably not in large colonies.

• ***Rhinolophus paradoxolophus*** Bourret's Horseshoe Bat. *Conservation Significance:* Globally Threatened - Vulnerable; Potentially At Risk in Lao PDR. Now known from several more localities than were known at the time of the IUCN (1996) listing, and probably should be reclassified. *Documented Range and Habitat:* North[C12], centre[C2, C10]. A roost of about 50 individuals was found in a cave in Khammouan Limestone NBCA (Robinson and Webber 1998a). Has been caught foraging in relatively undisturbed evergreen forest.

• ***Rhinolophus marshalli*** Marshall's Horseshoe Bat. *Conservation Significance:* Proposed IUCN listing (Hutson *et al*. in prep.): Globally Near-Threatened; Potentially At Risk in Lao PDR. In Lao PDR appears to be less common than preceding species. *Documented Range and Habitat:* North[C11, C12]. Has been caught near limestone caves in Lao PDR (Guillén and Francis 1998a), and has been found roosting in caves in Thailand (Robinson and Smith 1997). May also roost in hollow trees.

• ***Rhinolophus macrotis*** Big-eared Horseshoe Bat. *Conservation Significance:* Potentially At Risk in Lao PDR; apparently rare in region but not listed by IUCN (1996). *Documented Range and Habitat:* North[C12], centre[C2]. Probably roosts in caves, and potentially hollow trees.

• ***Rhinolophus* cf. *siamensis***. *Conservation Significance:* Potentially At Risk in Lao PDR; formerly considered a subspecies of *R. macrotis* (Corbet and Hill 1992), so not evaluated by IUCN (1996). *Documented Range and Habitat:* North[C12, C13, C14], centre[C2]. Has been caught near limestone caves. This species resembles *R. macrotis*, and is very similar genetically (AG), but differs in smaller size, slightly different noseleaf and higher echolocation calls. It has been caught in the same sites as the larger form (*R. m. caldwelli*) in both Lao PDR (Francis *et al*. 1996, Guillén and Francis 1998a) and Vietnam (Osgood 1932). The appropriate name appears to be *R. siamensis*, which was originally described as a subspecies of *R. macrotis* (Gyldenstolpe 1916), but the type specimen has not yet been examined to confirm this.

• ***Rhinolophus coelophyllus*** Croslet Horseshoe Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C11]. So far recorded in Lao PDR only from Phou Khaokhoay NBCA, but widespread in Thailand, and probably occurs elsewhere in Lao PDR. Has been recorded roosting in caves in Thailand (Robinson *et al*. 1995, Robinson and Smith 1997).

• ***Rhinolophus shameli*** Shamel's Horseshoe Bat. *Conservation Significance:* Globally Near-Threatened; Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C1], centre[C7], south[C3, C8]. Probably roosts mainly in caves.

• ***Rhinolophus pearsonii*** Pearson's Horseshoe Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C11, C12, C13], centre[C7, C10], south[C8]. Roosts in caves (Francis *et al*. 1996, Robinson and Webber 1998a).

[• ***Rhinolophus yunanensis*** Dobson's Horseshoe Bat]. *Conservation Significance:* Globally Near-Threatened. *Documented Range and Habitat:* Not recorded from Lao PDR, but known from southern China, Myanmar and Thailand (Corbet and Hill 1992), and may extend into Lao PDR, most likely in the north-west.

Rhinolophus acuminatus Acuminate Horseshoe Bat. South[C3, C9, C15] (Plate 18). Has been caught in dry evergreen, mixed deciduous, and dry dipterocarp forests. In Xe Pian NBCA was caught roosting in a hollow log, hollow tree, and a cave (Robinson 1998).

• ***Rhinolophus pusillus*** Least Horseshoe Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C12, C13, C14, C6], centre[C2, C16], south[C3, C8]. Roosts in caves (Francis *et al*. 1996, Robinson and Webber 1998a). Specimens referred here to this species appear to represent at least two and probably three species, based on genetic, morphological and echolocation call differences (AG). Some of them may represent one or both of the following two species, but further study is required to determine their identities.

[***Rhinolophus lepidus*** Blyth's Horseshoe Bat]. Not recorded from Lao PDR, but occurs in north Myanmar and southern China, and may well be in northwestern Lao PDR (Corbet and Hill 1992). Roosts in caves (Lekagul and McNeely 1977).

[***Rhinolophus subbadius***]. A skull and ramus possibly of this species was found in central Lao PDR (Robinson and Webber 1998a). Occurs in north Myanmar and northern Vietnam (Corbet and Hill 1992), and probably in intervening areas of Lao PDR.

Rhinolophus* cf. *chaseni. North[C1, C11], south[C3]. So far recorded from relatively few, scattered sites. It probably roosts mainly in hollow trees, rather than in caves. These bats match the description of bats from Cambodia reported by Hill and Thonglongya (1972) as *R. borneensis chaseni*. However, they are quite distinct in morphology and genetics from specimens of *R. borneensis* from Sabah and appear to represent a distinct species. Further study, including comparison with the type is required to determine whether *R. chaseni* is the correct name for this species.

• ***Rhinolophus malayanus*** Malayan Horseshoe Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C6], centre[C2, C10], south[C3, C8]. Relatively widespread. Roosts in caves in Thailand (Robinson *et al*. 1995, Robinson and Smith 1997), and probably also in Lao PDR.

• ***Rhinolophus thomasi*** Thomas's Horseshoe Bat. *Conservation Significance:* Globally Near-Threatened; Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C12, C13], centre[C2, C10, C7], south[C4]. Roosts in caves (Lekagul and McNeely 1977, Robinson and Webber 1998a).

• ***Rhinolophus stheno*** Lesser Brown Horseshoe Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C12, C13], centre[C2, C10], south[C3]. In Thailand has been found roosting in caves (Robinson *et al*. 1995). May also roost in hollow trees. Widespread but not common. Bats in Lao PDR represent the subspecies *R. s. microbullatus* which was recently described from Vietnam (Csorba and Jenkins 1998).

[***Rhinolophus rouxii***]. Mapped in northern Lao PDR by Corbet and Hill (1992), but the only records they cite are from adjacent southern China and northern Vietnam.

• ***Rhinolophus affinis*** Intermediate Horseshoe Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C12, C13, C6], centre[C2], south[C3, C4]. In Thailand has been found roosting in caves (Robinson *et al*. 1995). May also roost in hollow trees. Echolocation calls of specimens from Dong Hua Sao NBCA differed from those of specimens caught elsewhere in Lao PDR, suggesting the possibility of some genetic differentiation among regions (Francis *et al*. 1997b).

Hipposideridae: Roundleaf bats, trident bats (9-17 species)

• ***Hipposideros pomona***. *Conservation Significance:* Data Deficient (Global). *Documented Range and Habitat:* North[C11, C12, C13], centre[C2, C10], south[C3, C15]. Captured on most surveys in Lao PDR. Has been found roosting in caves (Robinson and Webber 1998a, Robinson 1998), but probably also uses hollow trees. Listed as a synonym of *H. bicolor* in Lekagul and McNeely (1977), but recent work has shown that *H. pomona* and *H. bicolor* are distinct species (Hill *et al*. 1986), and the species formerly known as *H. fulvus* in Thailand (Lekagul and McNeely 1977) is *H. pomona*.

• ***Hipposideros cineraceus*** Least Roundleaf Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C12, C13, C6], centre[C10], south[C3, C15]. Caught much less frequently than *H. pomona*. May roost mainly in caves, and a cave roost has been found in southern Lao PDR (Robinson 1998).

• ***Hipposideros* spp**. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* Two undescribed species in the *H. bicolor* group, both with some resemblance to *H. ridleyi* of peninsular Malaysia, have been captured in north Lao PDR (Guillén *et al*. 1997, Guillén and Francis 1998c), and one of them also in the centre (Francis *et al*. 1996). Both species potentially roost in caves and are so far known only from Lao PDR.

• ***Hipposideros galeritus*** Cantor's Roundleaf Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat*: South[C3, C9]. Known to roost in caves in Malaysia (Payne *et al*. 1985).

[• ***Hipposideros pratti*** Pratt's Roundleaf Bat]. *Conservation Significance:* Globally Near-Threatened. *Documented Range and Habitat:* Occurs in southern China and northern Vietnam (Corbet and Hill 1992), and may therefore occur in Lao PDR.

• ***Hipposideros lylei*** Shield-faced Roundleaf Bat. *Conservation Significance:* Globally Near-Threatened; Potentially At Risk in Lao PDR. *Documented Range and Habitat:* Centre[C2]. Roosts in caves (Medway 1983). In Lao PDR, so far recorded only from around Nakai-Nam Theun NBCA.

• ***Hipposideros armiger*** Great Roundleaf Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C11, C12, C13], centre[C2, C7], south[C3, C8]. Roosts in caves (Lekagul and McNeely 1977, Robinson and Webber 1998a). Has been caught foraging low among trees, but also seen foraging high in the sky (Francis *et al*. 1996).

[• ***Hipposideros turpis*** Lesser Great Roundleaf Bat]. *Conservation Significance:* Globally Threatened - Endangered. *Documented Range and Habitat:* Occurs in south Thailand, northern Vietnam, and the Ryukyu Islands in Japan (Corbet and Hill 1992), so may be found in Lao PDR.

• ***Hipposideros larvatus*** Intermediate Roundleaf Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C11, C12, C13], centre[C2], south[C3, C8]. Roosts in caves in Malaysia (Medway 1983), and large numbers have been caught around limestone areas in Lao PDR suggesting also roosts in caves there (Francis *et al*. 1996). Has also been found roosting in buildings near Wat Phu, Champasak (CMF, AG).

• ***Hipposideros*** **spp**. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* Centre[C2]. Two species closely resembling *H. larvatus* have been caught near Khammouan Limestone NBCA. Most likely these will prove to be forms originally described as subspecies of *H. larvatus*, which actually should be recognised as full species. Further research is required to determine which names are appropriate.

• ***Hipposideros diadema*** Diadem Roundleaf Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* Centre[C16], south[C3, C9]. Roosts in caves (Medway 1983, Robinson and Webber 1998a), although has also been caught far from known caves (Francis *et al*. 1997a, Francis and Khoonmy 1998d).

• ***Aselliscus stoliczkanus*** Stoliczka's Trident Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C11, C12, C13], centre[C2, C7]. Roosts in limestone caves (Lekagul and McNeely 1977).

• ***Coelops frithii*** Larger Tail-less Leaf-nosed Bat. *Conservation Significance*: Potentially At Risk in Lao PDR. *Documented Range and Habitat:* Hill (1972) cited a specimen from Lao PDR in the NHM, London, but no locality details were given. Roosts in hollow trees or caves (Lekagul and McNeely 1977).

[• ***Coelops*** **cf.** ***robinsoni*** Lesser Tail-less Leaf-nosed Bat]. *Conservation Significance:* Globally Near-Threatened; Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C18, C12, C14]. These specimens more closely resemble *C. robinsoni*, for which the next nearest known location is peninsular Malaysia (Corbet and Hill 1992), than *C. frithii*, but their identity has not yet been confirmed.

[***Paracoelops megalotis***]. Known only from one specimen in northern Vietnam (Corbet and Hill 1992), but potentially also occurs in Lao PDR.

Vespertilionidae: Evening bats (37-53 species)

Myotis **spp**. At least four, and possibly five species of *Myotis* additional to those listed below have been captured during surveys by WCS. D. Kock (*in litt*. 1997) tentatively referred one of these to *M. alticraniatus* as a species distinct from *M. siligorensis* and another as *M. deignani* as a species distinct from *M. horsfieldi*. In addition, two species resembling, but larger than, *M. muricola* have been captured. One of these might be *M. ater*. Further study of the specimens is required to determine which names are actually appropriate for each of these species.

[***Myotis chinensis*** Large Myotis]. Recorded from south China and north Thailand. May prove to occur in Lao PDR.

Myotis formosus Painted Myotis. South[C3] (Plate 18). Probably occurs sparsely in all regions, because known records are scattered from India to Taiwan and south to Indonesia and the Philippines, with very few in mainland South-east Asia (Corbet and Hill 1992).

• ***Myotis annectans*** Hairy-faced Myotis. *Conservation Significance:* Globally Near-Threatened; Little Known in Lao PDR. *Documented Range and Habitat:* North[C12], centre[C2], south[C3].

• ***Myotis rossetti*** Thick-thumbed Myotis. *Conservation Significance:* Globally Near-Threatened; Little Known in Lao PDR. *Documented Range and Habitat:* South[C3]. The only known Lao specimen was caught beside a small stream in open dipterocarp forest.

• ***Myotis siligorensis*** Small-toothed Myotis. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C12, C14], centre[C2, C7, C10]. Most records are in the vicinity of limestone, where it has been found roosting in caves (Francis *et al*. 1996). Bats currently keyed out to *M. siligorensis* include at least two and possibly three species in Lao PDR (see *Myotis* spp.).

Myotis **cf.** ***muricola*** Eastern Whiskered Myotis. North[C1, C12, C13], centre[C2], south[C3, C15]. Bats currently keyed out to *M. muricola* include at least three species, differing mainly in size, colour and insertion of the wing membrane. Further

research, including comparison with type specimens, is required to determine which species (if any) is actually *M. muricola*, and whether appropriate names exist for the other two species.

• ***Myotis montivagus*** Large Brown Myotis. *Conservation Significance:* Globally Near-Threatened; Little Known in Lao PDR. *Documented Range and Habitat:* Centre[C2]. Lao records come from hill forest at 1000 m altitude, and open forest on the Nakai Plateau at 500 m.

Myotis horsfieldii Horsfield's Myotis. North[C6], centre[C2], south[C3, C9].

[***Myotis hasseltii*** Large-footed Myotis]. Not yet reported from Lao PDR, but occurs in Vietnam, Thailand and Cambodia (Lekagul and McNeely 1977). However, in Malaysia it is most frequently encountered in coastal areas (Medway 1983), and if that is true elsewhere, it may not occur in Lao PDR.

• ***Myotis ricketti*** Rickett's Large-footed Myotis. *Conservation Significance:* Globally Near-Threatened; Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C2], centre[C2, C16] (Plate 18). Feeds low over streams and roosts in caves (Francis *et al*. 1996, Robinson and Webber 1998a). Known to feed on fish (Robinson and Webber 1998b), but probably also eats insects.

• ***Scotomanes ornatus*** Harlequin Bat. *Conservation Significance:* Globally Near-Threatened; Little Known in Lao PDR. *Documented Range and Habitat:* North[C12, C13], centre[C7] (Plate 18). Roosts in trees (Lekagul and McNeely 1977), but also caught near limestone caves (Francis and Khoonmy 1998b).

• ***Thainycteris aureocollaris*** Gold-collared Bat. *Conservation Significance:* Proposed listing as Data Deficient (Global) (Hutson *et al*. in prep.). Little Known in Lao PDR. *Documented Range and Habitat:* North[C12]. Only recently described from Thailand (Kock and Storch 1996), and hence not included in Corbet and Hill (1992).

Scotophilus kuhlii Asiatic Lesser Yellow House Bat. Centre[C3]. Probably throughout Lao PDR (Corbet and Hill 1992). Roosts in buildings and hollow trees (Lekagul and McNeely 1977). A colony was found roosting in the top of a fan palm in Savannakhet town (Francis *et al*. 1997a).

Scotophilus heathii Asiatic Greater Yellow House Bat. North[C12], south[C3, C8]. Probably throughout Lao PDR. In Thailand, common around towns and villages (Lekagul and McNeely 1977), but specimens in Lao PDR have been caught in open forests or over rivers.

Eptesicus serotinus Serotine. North[C12], centre[C2]. Probably roosts mainly in hollow trees. Both Lao records are from hill forest at over 1000 m.

[• ***Eptesicus pachyotis*** Thick-eared Serotine]. *Conservation Significance:* Globally Near-Threatened. *Documented Range and Habitat:* Not recorded from Lao PDR, but occurs in northern Thailand (Lekagul and McNeely 1977) and may well occur in Lao PDR.

• ***Ia io*** Great Evening Bat. *Conservation Significance:* Globally Near-Threatened; Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North (Bourret 1942), centre[C7, C16]. Central records are from areas with limestone caves. Roost sites have been found both near the cave entrance and up to 1.5 km within cave systems (Robinson and Webber 1998a).

Tylonycteris pachypus Lesser Flat-headed Bat. North[C12] (Osgood 1932), centre[C10], south[C3]. Roosts in bamboo (Lekagul and McNeely 1977).

Tylonycteris robustula Greater Flat-headed Bat. North[C12, C13, C14] (Osgood 1932), centre[C10], south[C3]. Roosts in bamboo and also rock crevices (Lekagul and McNeely 1977).

• ***Eudiscopus denticulus*** Disc-footed Bat. *Conservation Significance:* Globally Near-Threatened; Little Known in Lao PDR. *Documented Range and Habitat:* North (Osgood 1932). Monospecific genus known only from Lao PDR (around Phongsali) and central Myanmar (Corbet and Hill 1992).

***Pipistrellus* spp**. At least seven species of pipistrelles have been captured during WCS surveys in Lao PDR, but reliable keys for field identification of these bats are not yet available. The list below gives tentative identifications for some of these specimens, and lists previously published records, but all of them are subject to review. Further study of museum specimens, including the use of molecular analyses, is required to sort out species within this genus.

[***Pipistrellus ceylonicus*** Kelaart's Pipistrelle]. Tentatively identified from centre (Eger and Francis 1999). Also known from south China and Vietnam (Corbet and Hill 1992).

[***Pipistrellus abramus*** Japanese Pipistrelle]. Occurs in south China and Vietnam, and mapped as occurring in Lao PDR (Corbet and Hill 1992).

Pipistrellus javanicus Javan Pipistrelle. Centre (Eger and Francis 1999). Possibly widespread, as also occurs in the adjacent countries including Thailand and Cambodia (Corbet and Hill 1992).

[***Pipistrellus coromandra*** Indian Pipistrelle]. Reported from northern Thailand, and hence might also occur in Lao PDR.

Pipistrellus tenuis Least Pipistrelle. North (Osgood 1932, Corbet and Hill 1992), centre[C16], south[C15] (Eger and Francis 1999). Probably widespread throughout Lao PDR. Forested areas and villages, roosting in buildings and hollow trees (Lekagul and McNeely 1977).

• ***Pipistrellus cadornae*** Cadorna's Pipistrelle. *Conservation Significance:* Globally Near-Threatened; Little Known in Lao PDR. *Documented Range and Habitat:* Centre (Eger and Francis 1999). Similar specimens have also been reported from north (Guillén and Francis 1998a) and south (Francis *et al*. 1997a).

• ***Pipistrellus pulveratus***. *Conservation Significance:* Globally Near-Threatened; Little Known in Lao PDR. *Documented Range and Habitat:* Centre[C16].

Glischropus tylopus Thick-thumbed Pipistrelle. North[C11, C18]. Forests, roosting in bamboo and rock crevices (Lekagul and McNeely 1977). D. Kock (pers. comm. 1996) considered a specimen from Nam Kading NBCA (WCS 1995b) to resemble *G. javanus* (which is otherwise known only from Java) more closely than *G. tylopus*. The taxonomy of this genus needs to be reviewed.

[***Nyctalus noctula*** Noctule]. Reported from northern Vietnam and tentatively from northern Thailand (Corbet and Hill 1992), so may occur in Lao PDR.

Hesperoptenus tickelli. North[C18], south[C9, C15]. Captured flying over streams or ponds.

Hesperoptenus blanfordi. Centre[C10, C16], south[C3, C15]. Captured flying near water.

***Miniopterus* spp**. Bent-winged bats. There are several species of this genus in South-east Asia, differing mainly in size. There is disagreement about the taxonomy of these groups, because of uncertainty as to which populations are distinct species. The notes below refer to species based on the taxonomy in Corbet and Hill (1992). In several areas of Lao PDR, at least two species (one large and one small) are found together, but it is not yet certain whether these always involve the same two species. Some species overlap in external measurements, so confirmed identifications require extracting and measuring the skull of a museum specimen.

• ***Miniopterus schreibersii*** Common Bent-winged Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* Centre[C16]. Mapped as throughout Lao PDR by Corbet and Hill (1992). Forested areas, roosting in large caves (Lekagul and McNeely 1977).

• ***Miniopterus magnater*** Large Bent-winged Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C11, C12], centre[C10], south[C8]. Habitat probably similar to other *Miniopterus* spp. Although confirmed from each region, its abundance relative to other species is uncertain because of difficulties in identifying specimens in the field.

• ***Miniopterus pusillus*** Small Bent-winged Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C13], centre[C10], south[C9]. Habitat similar to other *Miniopterus*. Specimen from centre confirmed based on skull measurements, but others were identified solely based on external measurements and still need to be confirmed.

***Murina* spp.** Tube-nosed bats. In addition to the four species listed below, three additional, apparently undescribed, species have been found in Lao PDR (Francis *et al*. 1996, Francis and Khounboline 1996, Francis *et al*. 1997a, Francis and Khoonmy 1998d). One of these has been found in dry areas both near Vientiane and in the south, while the other two have been found in Lao PDR only in the Annamites around the Nakai Plateau.

Murina tubinaris. North[C11], centre[C2], south[C3]. One of the more widespread species of *Murina* in Lao PDR, occurring in both primary and disturbed forest.

• ***Murina aurata*** Golden Tube-nosed Bat. *Conservation Significance:* Globally Near-Threatened; Little Known in Lao PDR. *Documented Range and Habitat:* Centre[C2], in hill forest of Annamites.

• ***Murina huttonii*** Hutton's Tube-nosed Bat. *Conservation Significance:* Globally Near-Threatened; Little Known in Lao PDR. *Documented Range and Habitat:* Centre[C2]. Habitat reported as grasslands and crops in Lekagul and McNeely (1977), but was caught in relatively undisturbed hill forest at 1100 m in Lao PDR. Known from very few specimens anywhere across its world range.

Murina cyclotis Round-eared Tube-nosed Bat. North[C6, C7], centre[C2], south[C3, C9]. The most widespread *Murina* in Lao PDR, found in primary and disturbed forests.

• ***Harpiocephalus mordax***. *Conservation Significance:* Globally Near-Threatened; Little Known in Lao PDR. *Documented Range and Habitat:* North[C12], centre[C7]. Overlaps in external characters with *H. harpia*, so abundance relative to next species is uncertain, although specimens are confirmed from each region.

Harpiocephalus harpia Hairy-winged Bat. North[C13, C18], centre[C16]. Owing to similarity with *H. mordax*, identity of

some specimens has not yet been confirmed, but there are confirmed records from Nam Kading and Khammouan Limestone NBCAs.

Kerivoula picta Painted Bat. North[C1] (Duckworth *et al*. 1994). Probably in most parts of Lao PDR, but possibly rather scarce (or using habitats where it is hard to catch). Has been caught in dry dipterocarp forest just outside Vientiane. Roosts in vines, flowers, tall grass (Lekagul and McNeely 1977).

Kerivoula papillosa Papillose Woolly Bat. North[C11], centre[C2], south[C3]. In forest or scrub. Probably roosts in hollows in trees or among leaves.

Kerivoula hardwickii Hardwicke's Woolly Bat. North[C11, C12, C13], centre[C2, C10], south[C3, C9]. Most abundant and widespread *Kerivoula* in Lao PDR.

***Kerivoula* sp.** At least one additional species of *Kerivoula* has been caught in Lao PDR, intermediate in size between *K. hardwickii* and *K. papillosa*. It was sympatric with both of those species at Dong Ampham (Francis *et al*. 1997a) and Phou Khaokhoay NBCAs (Guillén *et al*. 1997). Its identity has not yet been determined.

Phoniscus jagorii Greater Groove-toothed Bat. North[C12, C14], centre[C2, C10], south[C9]. Found in forest understorey. Some of the specimens, including those from the north, appear to be slightly smaller, and may represent a different species, possibly *P. atrox* which occurs in peninsular Thailand.

Molossidae: Free-tailed bats (2 species)

• ***Tadarida teniotis*** Eurasian Free-tailed Bat. *Conservation Significance:* Potentially At Risk in Lao PDR. *Documented Range and Habitat:* North[C12], centre (Evans *et al*. in prep. b). Record from the centre relates to market specimens from Ban Lak (20), of unknown but presumably local origin. Probably roosts in caves or rock crevices.

• ***Tadarida plicata*** Wrinkle-lipped Bat. *Conservation Significance:* At Risk in Lao PDR. *Documented Range and Habitat:* North[C13], centre (Robinson and Webber 1999, Evans *et al*. in prep. b); mapped range includes all of Lao PDR (Corbet and Hill 1992). Roosts in caves (Lekagul and McNeely 1977). The only confirmed large colony in Lao PDR, in the vicinity of Louang-Namtha, was being very heavily exploited, with several thousand bats per day being sold in the market. No data are available on how long this exploitation has been taking place, but it seems very unlikely that this level of exploitation could be sustainable, and the species is apparently at risk in Lao PDR. The records from centre refer to a dead specimen found in a cave that appeared to be this species (Robinson and Webber 1999), as well as specimens purchased from the market in Ban Lak (20).

THREATS TO BATS

Most bat species in Lao PDR are threatened by loss of habitat, by hunting for food or by both. Loss of habitat is a problem that affects most mammals in Lao PDR. All bats are dependent upon suitable habitat for foraging. Many species are able to forage in secondary forest or disturbed areas, but only a limited suite of species (those that feed outside of forest cover) can survive in areas cleared for agriculture. The majority of Lao bats are dependent upon some degree of forest cover. Many species of bats also require forest for roosting sites. Some species roost in bamboos. Although bamboos are abundant in disturbed areas, many bats are probably killed if the areas are burned for shifting cultivation. Other bats roost in hollow trees. Such trees are generally only found in relatively mature forests, and hence the species dependent upon them are not likely to be found in young regenerating habitats except if they are adjacent to tall forest. Many bats roost in caves, of which the largest occur in limestone karst areas. Most caves in Lao PDR are probably not (so far) seriously threatened with destruction, although some, along the Vietnamese border, were damaged by bombing during the war, and others (e.g. Louangphabang) are used for temples which may reduce their value for bats. However, cave dwelling bats are particularly vulnerable to disturbance, because so many are concentrated in a limited area.

Bats are sometimes reported as crop pests (Table 2). However, such reports are not widespread and no specific information has been gathered recently on the subject.

The greatest threat to bats in Lao PDR appears to be exploitation for food. In all areas surveyed by WCS, bats were reported as being eaten by local villagers. On many occasions, local villagers reported that many bats were found in a particular cave, but subsequent surveys found few if any bats present. The explanation was that the villagers (often the guides) had trapped the bats until there were too few left to be worth trapping. The only large colony of bats seen by CMF or AG in a town was a maternity colony of *Scotophilus kuhlii* roosting in palm trees in Savannakhet town. This colony was being harvested by young boys who were killing bats by shooting into the trees with sling shots at dusk. Over 40 bats were seen to be killed within a 20 minute period at dusk. These youths indicated that up to 100 had been killed on each of the previous several nights, and the colony had only formed relatively recently. It appeared to contain no more than a few thousand individuals (including juveniles) and probably did not last long after that time. Bats have been observed for sale in the market at Ban Lak (20), including *Hipposideros armiger* and *H. lylei* (Francis *et al*. 1996) and *Tadarida* spp. (Evans *et al*. in prep. b). Robinson (1994) reported bats for sale in the markets of Chiang Khan in north-

east Thailand, that had apparently all come from Lao PDR. Trading is widespread (Annex 1). Very large numbers of bats have been observed for sale in northern Lao PDR. R. Tizard (pers. comm.) saw large vats containing several hundred or more small bats (at least some were *Myotis* spp.) being cooked for sale in markets north of Vientiane. Thousands of *Tadarida plicata* were being smoked in April/May 1999 at Ban Phoulan, a village in the vicinity of Louang-Namtha near the Nam Ha NBCA (Guillén and Francis 1998a). Over 3000 were sold to a single passing truck. The bats were apparently harvested using some sort of funnel trap as they flew out of a cave, and carried back to the village in large sacks. Even a colony of several hundred thousand bats will not be able to withstand this type of harvest pressure for long. Unlike rodents, bats are slow breeders, usually producing only one or two young per year, so they cannot recover quickly from heavy harvest. The bats most vulnerable to harvest are those that appear to be most abundant, because they roost in large colonies where they are concentrated and easy to harvest. Species that roost in small numbers in hollow trees or among branches or leaves are likely to be much less at risk. Although quantitative data are not available for confirmation, it seems likely that most species of cave-dwelling bats in Lao PDR have suffered very serious population declines over the past few decades.

CONSERVATION MANAGEMENT AND RESEARCH PROPOSED FOR BATS

The greatest conservation need is to encourage villagers to reduce or stop harvesting and eating bats. An educational campaign would be helpful that highlights the value of bats, especially their benefits to humans (pollination of various tree flowers including commercially important fruits, seed dispersal of forest fruits, consumption of harmful insects). Legal protection of all bats might be desirable, but is probably impractical and excessive as occasional disturbance to small numbers of bats is not a serious threat. The greatest need is to protect large colonies of bats, especially cave-dwelling species. A practical short-term solution might be to ban the harvest of bats in the vicinity of caves, and to ban the sale of bats for food. Also, elsewhere in South-east Asia (e.g. Malaysia), many bats roost safely in towns, using buildings and ornamental trees. This enhances the wildlife value of urban areas, and may help with control of various insect pests. In Lao PDR, few bats appear to live in towns. The reason is not known for certain, but it may again relate to exploitation of bats for food. Encouraging people not to disturb and consume bats they find in towns might help to restore bat populations.

It is also necessary to ensure continued protection of caves in limestone karst areas, as well as adequate areas of intact habitat around the caves for the bats to use. For forest-dwelling bats, protection of adequate forested areas is necessary, including retention of larger trees with hollow cavities suitable for roosting sites. Such areas are also needed for many other species of wildlife and this activity falls within the general management objectives of the protected area system. Because few surveys for bats have been done outside the current network of NBCAs, it is not known whether these protected areas are adequate to protect all Lao species of bat. Several species found in south-west Lao PDR around Dong Khanthung, which is not currently an NBCA, have not been reported elsewhere in Lao PDR. It is not yet known whether this is due to geographic limitations on range, differences in available habitat, or inadequate surveys in other areas. In addition, several important limestone areas are not currently within NBCAs, including at Vangviang, Louangphabang, and elsewhere in Lao PDR. Preliminary surveys of Vangviang (Guillén and Francis 1998c) suggest that significant populations of bats occur there. Land management in that area should be compatible with protecting the bat colonies. There is a need to survey potential bat habitat outside NBCAs, both limestone areas and other areas, to determine whether they also support significant populations of bats, and if so to identify appropriate conservation measures. Such measures need not be incompatible with other land uses. For example, around limestone outcrops, the most critical measures would probably involve protection of the major roosting caves from disturbance, and ensuring that adequate natural habitat (e.g. forest cover) is retained within the general vicinity of the caves.