

Bonelli's Eagle *Aquila fasciata renschi* in the Lesser Sundas, Wallacea: distribution, taxonomic status, likely origins and conservation status

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Records of Bonelli's Eagle *Aquila fasciata renschi* on 18 islands in the Lesser Sundas, from Lombok to the Tanimbar islands, in Indonesia and Timor-Leste are reviewed, and its taxonomic status examined. The species is resident on many islands, known to breed on several of the larger islands and is most abundant on Flores and Timor. It appears to be rare on Lombok and Sumba. There is minimal genetic differentiation between local subspecies *A. f. renschi* and nominate *A. f. fasciata*, suggesting only recent geographic isolation and that it should not be afforded species status. The species may have been introduced to the Lesser Sundas by traders or colonists in the past. The species's biology and ecology are poorly known in Wallacea. It occurs in a wide range of sites from sea level to about 2,000 m, in wooded habitats with a preference for tropical forest. The sparse data on diet show that it feeds on introduced wild junglefowl *Gallus* sp., but presumably it also feeds on large-bodied frugivorous pigeons, other birds and small mammals. The two reports of nesting were in May and June–July. The frequency of records on Flores and Timor suggests that these populations are currently secure, but may be threatened by hunting, capture and deforestation. A predator of village chickens, it is likely to be targeted by local communities. Conservation priorities include distribution and population density surveys and awareness projects throughout its range.

INTRODUCTION

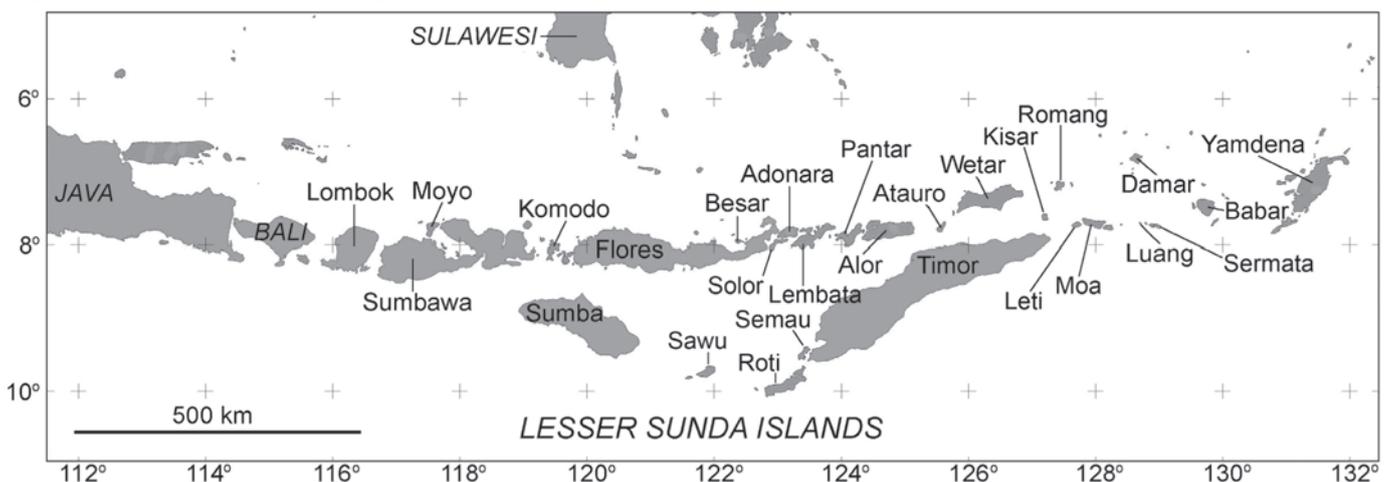
It has been proposed that the isolated Lesser Sundas population of Bonelli's Eagle *Aquila fasciata renschi* should be regarded as a distinct species (Thiollay 1994, Ferguson-Lees & Christie 2001), partly based on biogeography. However, this has not prompted specific field or taxonomic studies of this taxon. According to recent evaluations the Wallacean subspecies is found on the Lesser Sunda islands of Sumbawa, Komodo, Flores, Besar, Timor, Wetar and Luang, and Yamdena in the Tanimbar islands (White & Bruce 1986, Coates & Bishop 1997, Ferguson-Lees & Christie 2001). The nominate form *fasciata* has a wide but fragmented distribution; it is resident, with little or no evidence of migration, in North Africa, the Iberian peninsula, the Mediterranean, parts of the Arabian Peninsula, the Middle East, Afghanistan, Pakistan, India and disjunctly to north Indochina and southern China (Thiollay 1994, Hernández-Matías *et al.* 2011). The Lesser Sundas are about 3,000 km from the nearest Asian population in Vietnam (Ferguson-Lees & Christie 2001). In Vietnam, Laos, Thailand and Myanmar there are very few records and it appears to be sedentary (Duckworth *et al.* in press).

Although the species has a relatively distinctive appearance there have been identification problems in the Lesser Sundas. The

type specimen was originally identified by Rensch (1931) as a Changeable Hawk Eagle *Nisaeetus cirrhatus*— the Lesser Sunda population of this species is now known as the Flores Hawk Eagle *N. floris* (Gjershaug *et al.* 2004), and a Wetar island record of 'Changeable Hawk Eagle' (Hartert 1904) was later identified as Bonelli's Eagle (Mees 2006). Bonelli's Eagle is now in the genus *Aquila* rather than *Hieraaetus*, based on DNA data (Wink & Sauer-Gürth 2004, Helbig *et al.* 2005, Lerner & Mindell 2005) demonstrating that *Aquila* and *Hieraaetus* as conventionally circumscribed were paraphyletic.

Recent observations confirming the species's presence on Lombok and Sumba, and on several other islands and islets in the Lesser Sundas, are reviewed, and substantial populations on at least Flores and Timor are documented. Records were collected from published and unpublished trip reports, bird tour reports and grey literature, and by canvassing individuals and the Orientalbirding e-group. The taxonomic status of *renschii* is assessed using DNA evidence. Some of the text of this paper was originally submitted as a book chapter in 2007 (still unpublished), which was split into two chapters by the editor (Christidis *et al.* in press, Debus *et al.* in press) and is expected to be published in late 2013. This opportunity is taken to substantially update those manuscripts, particularly in relation to distribution, ecology and taxonomy.

Figure 1. Map of the Lesser Sundas region, showing the islands mentioned in the text.



Study region

The Lesser Sundas are located in the extreme south-east of Asia, between continental Java and Bali and the Australo-Papuan region (Figure 1). Lying west to east in a 1,700 km arc, they comprise about 20 large oceanic islands and several hundred small islands and islets. The inner Banda arc includes young volcanic islands (Monk *et al.* 1997) from Lombok to Damar in Maluku province and the outer Banda arc, dominated by sedimentary rocks such as limestone, extends from Sawu (Sabu), Roti, Timor, Moa and Babar to the Tanimbar islands. Sumba is considered to be a continental fragment. Most islands are only a few kilometres apart and would have been contiguous during the last glacial period 9,000 to 18,000 years ago, thus aiding avian dispersal (Voris 2000), but Sumba, Wetar, the Tanimbar islands and Damar are separated from their nearest neighbours by tens of kilometres. The natural vegetation of the islands is closed-canopy tropical forest (tropical dry to evergreen) and various savannahs, including *Eucalyptus*, but on many islands, agriculture has repeatedly changed this to regrowth forest and savannah woodland (Monk *et al.* 1997). The main islands have been cleared to varying extents, many now being essentially deforested (Table 1). On large islands, forest fragments are often restricted to steep mountain slopes and peaks, but on some isolated islands in the Banda Sea (e.g. Wetar, Romang, Babar and Damar) forest cover is extensive.

Table 1. Area, climate (in relative terms), estimated remaining forest cover and relative biological survey effort, on Indonesian islands inhabited by Bonelli's Eagle (source: CRT unpubl. data, who has visited all islands mentioned, but has only sailed past Luang Island).

Island	Area (km ²)	Climate	Forest cover (%)	Survey effort
Lombok	4,625	wet (dry on coast)	10	Moderate
Sumbawa	14,386	dry	15	Moderate
Komodo	330	dry	40	Moderate
Flores	14,154	wet (dry on coast)	15	High
Besar	64	dry	75	High
Adonara	509	dry	5	Moderate
Pantar	728	dry	15	Low
Alor	2,864	dry	3	Moderate
Sumba	10,711	dry	12	High
Timor	28,418	dry	10	High
Wetar	2,684	dry	97	Moderate
Atauro	147	dry	10	High
Romang	184	wet	75	Low
Luang	5	wet	25	Moderate
Sermata	103	wet	35	Low
Damar	198	wet	75	Moderate
Yamdena	3,333 (+ satellites c.1,500)	wet	75	High

RESULTS

Summary of Bonelli's Eagle records in the Lesser Sundas

Islands are listed west to east.

Lombok: adult pairs observed in Gn Rinjani National Park, and between Sembalum and Sapit, in June–July 2003 (J. M. Thiollay *in litt.* 2007); the first records for the island. None was reported in a review by Myers & Bishop (2005) or during surveys for the Critically

Endangered Flores Hawk Eagle (Raptor Conservation Society 2011).

Sumbawa: a single historical specimen is the *renschii* holotype (Stresemann 1932), a male (Mees 2006). Two birds were recorded by Johnstone *et al.* (1996), who considered it rare. J. M. Thiollay (*in litt.* 2007) observed it at four locations (Alas, Reloka, Ropang valley and Tambora peninsula), where it seemed common in June–July 2003. One bird was seen at Teluk Saleh in 2009 (V. Dinets *in litt.* 2013).

Moyo: a pair recorded in December 1999 (Trainor *et al.* 2006); first record for this almost land-locked island.

Sumba: observed at Lake Pambotanjara and Lewa on 14 July 1991 (Dreyer 1993), apparently the first records for the island. One bird was observed at Lewapaku in October 1998 (Trainor *et al.* 2006). It was not observed in four weeks by Olsen & Trost (2007), suggesting that it is uncommon or rare. None have been recorded by recent bird tour visits to the island. Sumba and Flores are visible from each other and separated by 45 km of sea, which should present little barrier to an eagle's flight. Sumba appears to hold suitable habitat: a dry limestone island cut by canyons, with abundant parrot, pigeon and junglefowl prey (JO, pers. obs.).

Komodo: recorded in semi-deciduous forest and savannah (Butchart *et al.* 1994). At least two observed in June–July 2003 (J. M. Thiollay *in litt.* 2007).

Flores: two fairly recent specimens, collected in 1971, identified as male and female (Mees 2006). Coates & Bishop (1997) considered it locally moderately common. Fourteen records mostly of pairs, mainly in hilly and mountainous terrain with cultivation, coconut plantations, scrub and secondary forest; also on a cultivated and scrubby plain (Verhoeve & King 1990). Recorded in moist and semi-deciduous forest, thorn scrub and montane forest, from sea level to 2,000 m (Butchart *et al.* 1994). Two observed in coastal scrub, gallery forest and grassland (Gibbs 1990). Verhoeve & Holmes (1999) reviewed about 20 records from cultivated and wooded hills; there are five additional records for forest and cultivated land (Pilgrim *et al.* 2000), and eight sightings (including a pair twice) from six localities in September–November 1998 (R. Drijvers unpubl. data). Recorded at 12 locations by Trainor & Lesmana (2000). Observed at eight locations in June–July 2003 and found to be widespread on the island; one nest found (J. M. Thiollay *in litt.* 2007). Observed throughout the island, from sea level to at least 1,600 m in forest, rice fields and valleys; common in central Flores; a captive juvenile (Plate 1) observed on 14 October 2004 originated from the slopes of Gn Iya, near Ende (M. Schellekens *in litt.* 2007). One bird was photographed at Riung in April 2012 (O. Hidayat *in litt.* 2013). The species is recorded regularly by tour groups and individual birdwatchers at several sites.

Besar: considered locally moderately common (Coates & Bishop 1997). Recorded in semi-deciduous, deciduous and coastal forest (Butchart *et al.* 1994).

Adonara: two over dry agricultural land and closed forest on mountain slopes, December 2000 (Trainor 2002); first record for the island.

Pantar: the only record was an adult observed by P. Verbelen at Gn Wasbila on 3 September 2009 (Trainor *et al.* 2012).

Alor: observed in *Eucalyptus* savannah in May 2002 (Trainor 2005a); first record for the island. Some records in 2002, 2009 and

2010 by CRT and P. Verbelen may have been confused with Flores Hawk Eagle, but pairs and singles were seen and confirmed with photographs at several sites up to about 1,100 m (Trainor *et al.* 2012).

Timor: single historical specimen, a male (Mees 2006). One sighting, over mountain forest and peaks at 2,000 m, East Timor, in 1972 (White & Bruce 1986). Three records in East Timor in 1974 (H. Thompson, J. McKean & I. Mason unpubl. data). Since the 1990s it has been regularly observed in West Timor, particularly at Bipolo and Camplong (Verbelen 1996, Mauro 1999, Van Biers 2004, N. Kemp *in litt.* 2007). Noted at four forested localities in West Timor by Noske & Saleh (1996). CRT had 36 sightings, 25 of single birds, 7 of two birds and 4 of three birds, from eight districts in Timor-Leste over four years 2003–2006; from sea level to 1,200 m in habitats ranging from coastal flats to village cultivation, freshwater lakes/swamps, secondary forest and primary forest (dry deciduous, semi-evergreen, evergreen and montane).

Atauro: pair over montane forest in December 2003, and a captive juvenile was said to have originated from a nest on Atauro (Trainor & Soares 2004); first records for the island.

Wetar: single historical specimen, originally sexed as male but probably a female (Mees 2006). Considered locally moderately common (Coates & Bishop 1997), although this assessment was based on a half day observation in west Wetar. In 2008, a 44-day survey recorded it from 8 of 12 sites up to about 500 m: the island is one of the least disturbed in insular South-East Asia (Trainor *et al.* 2009); there is at least one additional record of a bird photographed at sea level in September 2010 (CRT unpubl. data).

Romang: during the first ornithological visit to the island since 1902, a single bird and a displaying pair were observed over tropical forest at two sites at about 300 m, during two weeks in October 2010 (Trainor & Verbelen *in press*).

Luang: two historical specimens, both males (Mees 2006).

Sermata: one adult bird photographed at forest edge in November 2010 during the first ornithological exploration of the island since 1906 (Trainor & Verbelen *in press*).

Damar: two sightings over forest and forest edge, August 2006 (Trainor 2007); first records for the island.

Tanimbar islands: first observed on Yamdena, Tanimbar, by F. Rozendaal between August and November 1985 (F. G. Rozendaal unpubl. data). Also observed on Yamdena in August 1994 by Verbelen (1996); and in October 1998 by Mauro (1999). A pair was observed over tall subcoastal primary and secondary semi-evergreen forest and woodland in January 1996 (Coates & Bishop 1997, Bishop & Brickle 1999). Most recent tour group records are from the Lorulun area, 20 km north of Saumlaki, but there are records closer to Saumlaki.

Taxonomic status

In using levels of DNA differentiation to assess taxonomic assignments of species and subspecies, Norman *et al.* (1998) and Christidis & Norman (2010) advocated the requirement to include a relative hierarchical perspective of DNA divergences in the genus of interest. The relevant DNA data dealing with the taxonomy of the *Aquila fasciata* species-complex are summarised below.

The taxonomy of Bonelli's Eagle and the African Hawk Eagle *Aquila spilogaster* has been a contentious issue. Long regarded as a single species (Brown & Amadon 1968), the recent tendency is to

treat the two as separate species (Thiollay 1994, Ferguson-Lees & Christie 2001). The consistent morphological, plumage and behavioural differences have been cited as evidence for species-level separation. Lerner & Mindell (2005) give a molecular perspective through their examination of mitochondrial DNA differentiation in a range of birds of prey, including Bonelli's Eagle and African Hawk Eagle. Between the two species there were 16 and 18 base-pair differences in cytochrome *b* and ND2, respectively. These figures were larger than those recorded between other species-pairs identified in the study: Wedge-tailed Eagle *Aquila audax* and Gurney's Eagle *A. gurneyi*; and Little Eagle *Hieraaetus morphnoides* and Booted Eagle *H. pennatus*. Although not conclusive, the DNA data support separate species treatment for *Aquila fasciata* and *A. spilogaster*.

Apart from the three individuals of *A. fasciata* examined by Lerner & Mindell (2005), cytochrome *b* data are available for a further six individuals. Haring *et al.* (2007) lodged a 264-base-pair fragment on GenBank (accession numbers EF459628–EF459631) from two individuals of *A. f. fasciata* (one from Italy and one with no locality information), and two individuals of *A. f. renschi* from Flores. Helbig *et al.* (2005) examined a 1,143-base-pair fragment from an individual of *A. f. fasciata* from Israel, and Bunce *et al.* (2005) examined 1,017 base pairs in another *A. f. fasciata* individual (no locality data). In addition, JAN & LC sequenced 409 base pairs of an individual *A. f. renschi* from Timor, feathers of which were collected by JO. A 217-base-pair fragment was common to all five studies, and this was compared across the three individuals of *A. f. renschi* and seven individuals of *A. f. fasciata* examined. There were only three variable sites, and this variation was limited to a unique base change in each of three individuals of *A. f. fasciata*. By excluding the four samples from Haring *et al.* (2007), it was possible to compare a 267 base-pair fragment across the remaining six individuals, but this did not reveal any additional variation. There were no differences recorded between *A. f. renschi* and the common *A. f. fasciata* haplotype. The negligible cytochrome *b* variation recorded was, therefore, limited to comparisons within *A. f. fasciata*. This lack of any molecular differentiation between the subspecies *A. f. fasciata* and *A. f. renschi* is consistent with a very recent separation.

Variation in a 253-base-pair fragment of the mitochondrial control region was assessed in 72 individuals of *A. f. fasciata* from Spain, Portugal and Morocco by Cadahía *et al.* (2007). They found four mitochondrial types each differing from the other by a single base-pair change. Moreover, there did not appear to be any geographic structure to the genetic variation observed across the populations surveyed. One explanation offered for the low levels of genetic variation was a loss of genetic variation caused by population reduction during the Pleistocene glaciations, and more recently through human activities such as habitat clearance and hunting.

Control-region sequence data for *A. fasciata* have also been lodged on GenBank (Accession Numbers EF459585–459588) by Haring *et al.* (2007). Unfortunately, the 237-base-pair fragment does not correspond to the region examined by Cadahía *et al.* (2007). The control-region data of Haring *et al.* (2007) was obtained from the same specimens that cytochrome *b* data were obtained (see above): two individuals of *A. f. fasciata* (one from Italy and one with no locality information) and two individuals of *A. f. renschi* from Flores. The *A. f. fasciata* individual from Italy differed by 5–6 changes from the other three individuals. The remaining three individuals differed from each other by 1–2 changes. Although the level of variation is low, there is nevertheless more variation recorded within *A. f. fasciata* than between *A. f. fasciata* and *A. f. renschi*.

Both the cytochrome *b* and control-region DNA datasets showed similar patterns: low levels of DNA variation across the range of *A. fasciata*; no diagnostic DNA marker distinguishing *A. f. fasciata* from *A. f. renschi*; and more variation within *A. f. fasciata* than between the two subspecies. Although this pattern of variation



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Plate 1. Captive juvenile Bonelli's Eagle *A. f. renschi* on Flores, Indonesia, 14 October 2004. The captive bird was kept tethered to a wooden plank, by a short rope tied to one ankle; the bird had a small wound on the underside of its carpal joint, and an overgrown bill.



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Plate 2. Captive juvenile Bonelli's Eagle in Timor-Leste, 10 April 2003.

could be indicative of a slow rate of mitochondrial evolution in *Aquila*, the comprehensive cytochrome *b* and ND2 datasets of Lerner & Mindell (2005) do not provide any such indication. The widely disjunct distributions of *A. f. fasciata* and *A. f. renschi* also make it unlikely that a lack of differentiation is caused by past bottlenecks. It is difficult to envisage similar genetic bottlenecks occurring in such widely separated populations.

Juvenile morphology

Colour photographs (Plates 1 & 2) and other unpublished images of the same birds show that juveniles of *A. f. renschi* are similar in plumage to juveniles of the nominate subspecies, with few evident differences (V. Hernández *in litt.* 2007). The photographic evidence shows colour variation within the range of that of juvenile Eurasian Bonelli's Eagles. However, Wallacean birds are more lightly built than Eurasian birds. Juveniles of each subspecies would be indistinguishable, and only separable by measurement (V. Hernández *in litt.* 2007).

Biology

There is little information on the feeding ecology or breeding biology of Bonelli's Eagle in Wallacea. A bird was observed feeding on a Green Junglefowl *Gallus varius* carcass at Gn Ranaka, Flores, in August 2007 (Myers 2007), an adult bird was photographed holding a village chicken *Gallus* sp. near Gn Ranaka in 2011 (Plate 3), and in September 2011 an adult Bonelli's Eagle at Pagal, Flores, delivered a chicken *Gallus* sp. or a rallid to a juvenile (Robson 2011). In Ruteng, west Flores, Bonelli's Eagle were twice (in separate years) observed flying low over the town, and were suspected to be searching for village chickens (J. Eaton *in litt.* 2013). Other likely prey within their range includes Pink-headed Imperial Pigeon

Plate 3. Adult Bonelli's Eagle in flight near Mt Ranaka, Flores, holding a village chicken, 30 August 2011.



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Ducula rosacea, Green Imperial Pigeon *D. aenea*, Timor Black Pigeon *Turacoena modesta* and other forest pigeons, cuscus *Phalanger* sp., rats (Muridae) and medium-sized fruit-bats (Pteropodidae) that roost in caves, forests and savannah palms. A nest was found on 12 July 2003 on Gn Ranaka, Flores, at 1,420 m: an adult was sitting on the nest in a tree and the mate flew in with prey (J. M. Thiollay *in litt.* 2013). A second nest was found at Lematang on Yamdena, Tanimbar islands, on 22 May 2008 (Yong & Lee 2008): it was about 20–25 m up in a forest tree, approximately 1.5 m in diameter and consisted of sticks and vines. It was unclear whether the pair were sitting on eggs or had young, but they were actively managing the nest.

DISCUSSION

This review confirms that Bonelli's Eagle is more widespread in the Lesser Sundas than previously believed; recent new records from nine islands in addition to the nine where it was previously recorded have extended its range to a land area of about 87,400 km². The distinctiveness of the isolated Lesser Sunda population has been subject to ongoing speculation, due to its smaller size and plumage differences compared with *fasciata*; the tail being more strikingly barred and belly, thighs and crissum more boldly marked (Ferguson-Lees & Christie 2001). However, the negligible levels of genetic differentiation between *A. f. renschi* and *A. f. fasciata* do not support the contention of Thiollay (1994) and Ferguson-Lees & Christie (2001) that *renschii* should be accorded full species status, although it is harder to argue against subspecific recognition for both forms. The patterns of DNA variation are more consistent with the relatively recent arrival of *renschii* in the Lesser Sundas and it may have been introduced from Eurasia (see below). Accordingly, the smaller size of *renschii* and the plumage differences between it and *fasciata* would also have evolved relatively rapidly.

Within the archipelago Flores and Timor appear to be strongholds, with many records from human-modified landscapes, but this may be partly a result of greater observer effort on these islands compared with elsewhere. The lack of earlier records from Sumba and Sumbawa, and recent records from other islands, may partly reflect bias of historical collectors and recent increase in survey effort (M. Bruce *in litt.* 2007). For example, there was a reluctance to collect cumbersome large specimens including raptors because of the relatively high shipping costs (Hartert 1904). Sumba is relatively well surveyed, and tour parties now visit annually, so the paucity of records suggests that it is either a rare resident, or that birds are occasional visitors from nearby islands. Knowledge of the avifauna of Roti is improving (Verheijen 1975, Trainor 2005b, Collaerts *et al.* 2011, P. Verbelen *in litt.* 2010), but there are no records of Bonelli's Eagle from this largely deforested island. Lack of records from other largely deforested islands (Sawu [Sabu], Semau and Kisar) suggests that a minimum level of forest cover is necessary to sustain populations of the species. This could be associated with the scarcity of large prey species, such as frugivorous pigeons (Newbold *et al.* 2013), in agricultural land or savannah woodland.

There are insufficient data to comment on population trends, but Bonelli's Eagle appears to be holding its own at present, although the extensive and rapid deforestation in Indonesia (Brooks *et al.* 1999) may adversely affect it. The species's Indonesian (at the time including East Timor) conservation status was assessed as 'no immediate danger' (van Balen 1994), and there seems no reason to amend this at present. The species currently occurs in cultivated lands and secondary forest as well as natural habitats.

Hunting either for food, or to reduce the perceived impact on village livestock, might also affect populations of Bonelli's Eagle.

Hunting is part of life for many villagers in the Lesser Sundas. On some islands, hunters are often armed with powerful air-rifles (comparable with a .22 rifle) and children have powerful slingshots. They shoot a wide range of wildlife, including raptors, and climb trees to collect nestlings for food. As a predator of village chickens, Bonelli's Eagle is likely to be targeted to reduce the perceived impact on economically important village livestock. Raptor nestlings are commonly taken captive, and suffer casual, habitual cruelty in captivity. A captive juvenile Bonelli's Eagle was photographed tethered by a metal ring on one ankle attached to a short rope and, not surprisingly, the bird had bumblefoot (a bacterial infection and inflammatory reaction) in the shackled foot as well as cere damage and abraded carpals (Plate 1). Another captive juvenile/subadult bird owned by a foreign defence worker in Timor-Leste was housed in a chicken wire cage at a United Nations military compound for months. It had serious cere damage (CRT unpubl. data). CRT has also been seen at least two other captive Bonelli's Eagles in Timor-Leste, although there may be many more out of sight.

Conservation priorities include further field surveys on the large islands of Sumba, Sumbawa, Wetar and Yamdena and on islands where there are no records (e.g. Babar, Moa, Roti, Solor and Lembata). The single largest tropical forest in the Lesser Sundas is in west Sumbawa (about 2,000 km²) (Jepson *et al.* 2001), whilst Wetar retains more than 97% forest cover; both deserve specific surveys for Bonelli's Eagle. The breeding biology of this subspecies is essentially unknown, so it would be useful to monitor population levels and breeding success at selected sites on various islands. There is also a need for an environmental education campaign to discourage persecution of eagles in general, improve the lot of captive birds, and encourage local people to 'own' and value such iconic species (Burnham *et al.* 1994, Salvador 1994). In Timor-Leste, for example, the campaigns should also target foreign nationals (military and embassy staff). Effective conservation of Bonelli's Eagle and other raptors in Wallacea is likely to deliver broader biodiversity benefits (Sergio *et al.* 2006).

Origins of the Wallacean population

The isolated populations of Bonelli's Eagle, and Short-toed Snake-Eagle *Circaetus gallicus*, in Wallacea stand out as zoogeographically anomalous—usually explained as relicts from past climatic and sea-level changes (Voris 2000). But it may be important to consider the human history of these islands; the first Dutch ships arrived in Indonesia (East Indies) in 1596 and determined exploitation started around 1830. The first Europeans to visit Timor were Portuguese, perhaps as early as 1512, and the Dutch occupied Kupang in present-day West Timor in the mid-seventeenth century, beginning a long conflict for control of the sandalwood trade. The Dutch controlled most of the Lesser Sundas from the 1600s, but the Portuguese held Flores (especially east Flores with forts on nearby Adonara and Solor) and East Timor, including the Ambeno (Oecusse) enclave, for long periods (Fox 2003).

Before assuming that the eagle occurs naturally on these islands, it is important (but difficult) to rule out the possibility that Bonelli's Eagles were transported from Europe or South Asia (notably India where the Portuguese also had colonies) by Dutch or Portuguese traders or settlers. Europeans may have introduced eagles to their Indonesian colonies as mascots, pets or falconry birds, perhaps from Iberia, North Africa or South Asia. Other birds, junglefowl *Gallus* spp., and Red Avadavat *Amandava amandava* are thought to have been introduced to the Lesser Sundas several centuries ago. The Red Avadavat is represented in the Lesser Sundas by the subspecies *flavidiventris*, which occurs naturally in South Yunnan (China), Thailand and Myanmar (White & Bruce 1986). There was also much movement of various animals, by Asian and Melanesian peoples, between Asia, Wallacea and New Guinea (Heinsohn 2003). Alternative hypotheses that need to be

investigated include vagrant Bonelli's Eagles from Asia settling in the Lesser Sundas.

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