CONSULTANCY REPORT

ELABORATION OF A CONSERVATION MANAGEMENT PLAN FOR THE MT MABU REGION: BIOPHYSICAL ATTRIBUTES

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1. INTRODUCTION

Much international attention was given to the discovery of the forest and associated biodiversity of Mt Mabu in Zambézia Province of north-central Mozambique in late 2008 and 2009 (Timberlake *et al.* 2012, Bayliss *et al.* 2014), although the actual "discovery" of the mountain by scientists was in 2005 (Spottiswoode *et al.* 2008, Timberlake *et al.* 2012). Following this international attention many calls have been made for its conservation (e.g. Bayliss *et al.* 2014), not least in that it was not, and is still not, under any form of formal protection.

Mabu supports what is possibly the largest remaining area of medium-altitude moist forest (800–1400 m altitude) remaining in south-central Africa, presumably as the massif comprises mostly steep and rugged terrain and was not suitable for either commercial or subsistence agriculture. Tea plantations were active in the Portuguese colonial period (Timberlake *et al.* 2012 and see Wilson, Smithett & Co. 1962), later abandoned, but these were confined to the more gentle lower altitude (300–500 m) slopes in the south and east.

It was surprising to realise that Mt Mabu had not previously been known to biologists, or at least not formally recorded as such prior to 2005 (Timberlake *et al.* 2012), and the full extent of its biological riches was only realised in 2008 and 2009. It is also surprising to realise that, in terms of fieldwork and despite the publicity, not much has been added to that biological knowledge over the last few years, with the exceptions of studies on chameleons (Tolley 2015) and bryophytes (mosses; Hedderson *et al.* 2015). However, a number of scientific papers have appeared based on knowledge obtained during the 2005–2009 period, e.g. Congdon, Collins & Bayliss (2010) on butterflies, Branch & Bayliss (2009), Branch & Tolley (2010) and Branch, Bayliss & Tolley (2014) on reptiles, Curran & Kopp (2009), Monadjem *et al.* (2010), Taylor *et al.* (2012) on bats, Daniels & Bayliss (2012) on freshwater crabs, Spottiswoode *et al.* (2008) and Dowsett-Lemaire (2010) on birds, and Harris, Darbyshire & Polhill (2011) on plants.

The international NGO, Fauna and Flora International (FFI), in conjunction with the Mozambican NGO Justiça Ambiental (JA!), obtained a grant from the Critical Ecosystems Partnership Fund (CEPF) in 2013 to develop a conservation strategy and the beginnings of a conservation management plan. This consultancy report forms part of that and is intended to bring together what is known on the biodiversity of Mt Mabu and the immediately surrounding area (the ill-defined Mt Mabu Greater Region), to add to that outlined in Bayliss *et al*. (2014).

The main objective is to produce initial botanical and zoological (biophysical) components for the Mt Mabu Conservation Management Plan in order to help maintain or improve biodiversity values in the face of current development plans. Specifically, the two Consultants are required to:

- Define and describe the Mt Mabu Greater Region based on ecological factors, if possible considering socio-economic and administrative aspects;
- Map the regional biodiversity patterns and processes based on species distribution and habitat classification;
- Establish and characterize landscape units, outlining multiple zones which would have different levels of protection (e.g. no-go areas, partially protected areas, open access).

2. DESCRIPTION OF MT MABU

2.1 Geography and Geology

The highest of a series of blocks, Mt Mabu rises above the surrounding lowland plains at around 350–450 m altitude, just north of the Rio Lugela in Zambézia Province, north-central Mozambique (Fig. 1). It is centred on 16º17'S, 36º24'E, with the 1710 m summit at 16º17'56.5"S, 36º23'44.3"E. Situated within the District of Lugela, it lies some 95 km south-east of Mt Mulanje in southern Malawi, 120 km south-west of Mt Namuli and 200 km from the Provincial Capital of Quelimane on the Indian Ocean coast. The district centre of Lugela is 40 km away, while the larger town of Mocuba, at the confluence of the Lugela and Licungo rivers, is 85 km to the south-east.

The Mabu massif is essentially a complex of granitic inselbergs ('whalebacks') or ancient igneous intrusions, exposed by millions of years of subsequent erosion. It is significantly smaller than the better-known Namuli complex and, unlike Namuli, does not include any substantive area of upland plateau. The rock forming the Mabu massif is syenite, similar to granite, an igneous intrusion of the younger Precambrian Namarroi series dating from 850–1100 Mya (Instituto Nacional de Geologia 1987).

Lugela District contains four Posto Administrativos and 16 Localidades. Mabu lies in the Posto Administrativo (P.A.) of Tacuane, Mabu Localidade. The nearest main administrative centre is Tacuane, 15 km away, with the smaller administrative post of Limbuè on the southern footslopes of Mabu. Population pressure is not high in this area, although the area may well have been more populous during the colonial period when the tea estates were providing employment.

A GIS-based altitudinal analysis of the Mt Mabu area by Julian Bayliss (Timberlake *et al.* 2012: 10) showed that of the c.300 km^2 area surrounding the Mabu massif (although maps showing this have not been located), 8308 ha lies above 1000 m (Table 1, and see Fig. 2). This is around the lower limit of true moist forest (at least on the eastern slopes), although lowland gully forest can be found below this.

2.2 Climate

Climate data from the Mabu massif itself above 1000 m altitude are not available, but data for the Madal tea estates near Tacuane (16º21'S, 36º22'E, 400 m altitude), possibly at Limbuè just

7 km away, are summarised in Kassam *et al.* (1981). These data probably date from the mid-1960s.

Table 1. Extent of area above 1000 m by altitudinal class for the Mt Mabu massif.

Altitude (m)	extent (ha)	%
1000–1200	3527	42.5
1200–1400	3723	44.8
1400–1600	1031	12.4
1600+	27	0.3
Total	**8308**	100.0

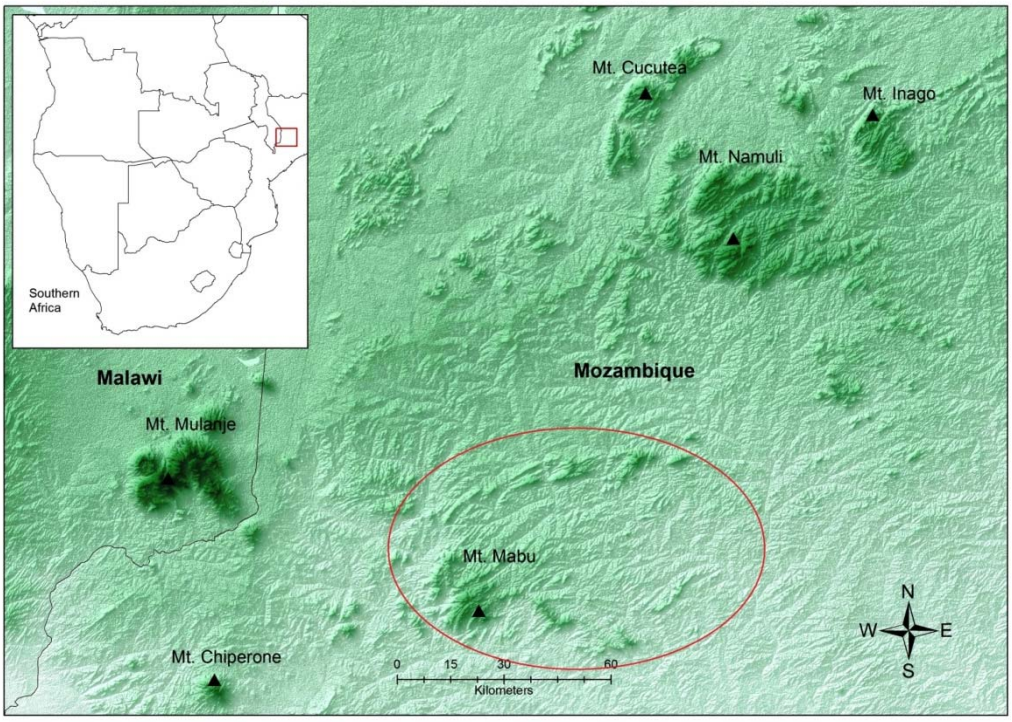

Fig. 1. The Mabu Conservation Area in a regional context showing its location in relation to the surrounding high altitude mountain massifs above 1500 m (deeper green). [JB]

Mean annual rainfall is given as 2119.1 mm, ranging from a monthly mean of 34.2 mm in September to 362.3 mm in January. The main rainfall months are November to April (1793.1 mm over 6 months or 84.6% of annual total), while the four months from December to March have a mean of 1410.9 mm (66.6% of total). Over the 16 years recorded the wettest months were March (mean 381.1 mm) and January (mean 362.3 mm).

Mean annual temperature was 23.7ºC, ranging from 21.0 in July to 25.5ºC in October. The mean maximum of 32.9ºC was in October with a mean minimum of 14.9ºC in July. Unlike on Mt Namuli, frost is likely to be rare. Evapotranspiration (Penman) was 1252.6 mm/year, ranging from 63.7 mm in June to 142.5 in October. During the cooler winter months potential evapotranspiration is roughly equivalent to rainfall, but in October it is more than three times monthly rainfall.

According to Reddy (1984) in his overview of Mozambique's climate, rainfall in the area should be around 1500 mm/year (surprisingly less than shown by actual rainfall records) with a low variation of only 20%. In a national context the Cha Madal area is a relatively high rainfall area similar to Mt Namuli (zone 1–2a, moderately cool; national climatic resources inventory, Voortman & Spiers 1982), with the possibility of two rain-fed growing periods in 10% of years, perhaps with a 300 day growing period each year.

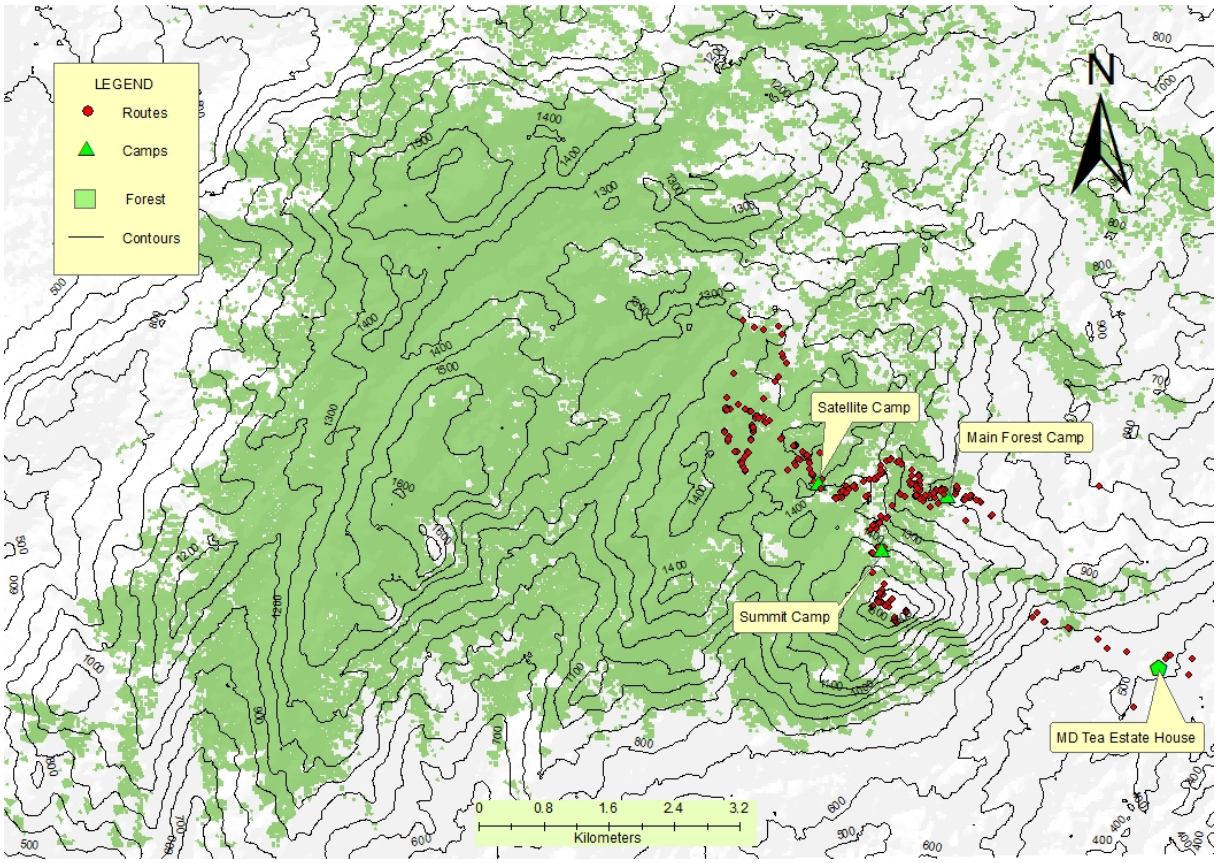

Fig. 2. Map of Mt Mabu area showing forest extent and main localities visited in Oct 2008.

2.3 Aerial Photos and Satellite Imagery

The only aerial photos apparently available are from August 1965 and June 1969 at a given scale of around 1:43,000, although subsequent analysis and measurements from the 1:50,000 map sheet suggest the scale is actually around 1:35,000.

Google Earth imagery is available back to 1973, but this is at very low resolution. Landsat 7 imagery has been obtained from 2000 and from July 2005 (see Fig. 3). It was the latter imagery that was used to determine forest extent (see Timberlake *et al.* 2012).

3. VEGETATION TYPES

3.1 Previous Studies

There are apparently no previous studies on, or even recognition of, the vegetation of Mt Mabu or the immediate area. However, the presence of a number of tea estates on the lower slopes means that the surrounding vegetation must have been known to agriculturalists, even if not formally documented.

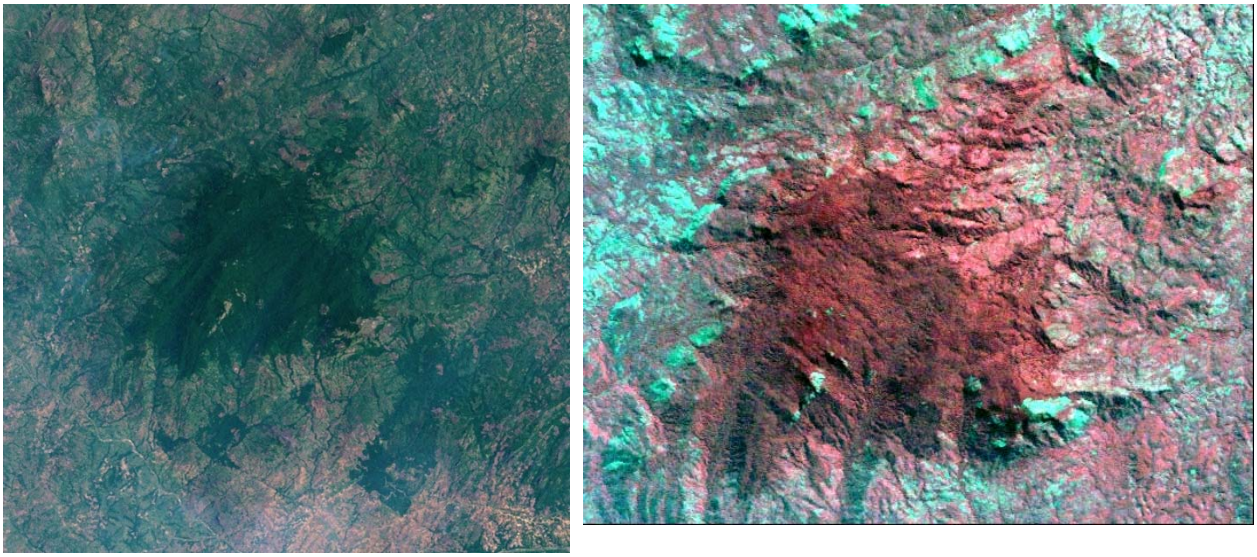

Fig. 3. Google Earth image of Mt Mabu massif from 2006 (left) showing forest + dense woodland cover in dense green and abandoned tea plantations in paler blue-green (lower right and lower centre, with straight lines) and false-colour Landsat image (right) from July 2005 with dense vegetation cover shown in red.

On a continental or regional scale, the Mabu area is shown by White (1983) as forest patches of the East African coastal mosaic (type 16b) surrounded by Wetter Zambezian miombo woodland (type 21). White is wrong in his assertion that these forests are linked to those on the East African coast as they are clearly montane and medium altitude forests, very similar to those found on mountains in southern Malawi and eastern Zimbabwe. The more detailed study by Wild & Barbosa (1968), on which White's study for this area was based, maps the Mabu area as Moist Evergreen Forest at low and medium altitudes (Type 1) surrounded by *Brachystegia spiciformis* (high rainfall) woodland (Type 21).

The more detailed (and earlier) map of Zambézia Province by Barbosa (1952) shows the Mabu massif as Unit 1 "Floresta higrófila tropical altimontana, de chuvas e nevoeiros" (moist high-altitude rain and cloud forest), the same as Mt Namuli, surrounded by Unit 2 "Floresta sub-higrófila, das altitudes medias, de *Brachystegia spiciformis* com elementos da floresta higrófila" (medium-altitude sub-moist forest [woodland] with *Brachystegia spiciformis* and moist forest patches). They describe the moist status due to incoming rain and clouds, with a transition to xerophytic cold-adapted vegetation higher up.

A subsequent, more detailed study by Pedro & Barbosa (1955) looked at vegetation across the whole country from an agro-ecological viewpoint. The accompanying map shows Mabu ("Alto Lugela") as unit 79 (Zonas altimontanas da Zambézia–Niassa) occurring between 1000–1800 m. However, they mention that these zones had not been visited by them so no species are listed.

3.2 Vegetation Mapping and Forest Extent

Vegetation description of Mt Mabu was carried out by Timberlake *et al.* (2012) in two ways – determination of the possible extent of forest using satellite imagery supported by the use of historical panchromatic aerial photos, and categorisation of vegetation types seen up the altitudinal gradient to the peak in the south-eastern part of the massif.

Two separate studies of forest extent on Mt Mabu have been carried out. An unsupervised classification was done in 2006 (Bayliss in Spottiswoode *et al.* 2008) using Landsat 7 ETM+ image from the year 2000, viewed through very near infra-red (VNIR) filters. A second area determination was done by Julian Bayliss in 2011 using a supervised classification based on locations noted in the field during October 2008.

Results from the Spottiswoode *et al.* study, although not rigorous, suggested an area of dense vegetation above 1000 m altitude, assumed to be moist forest, of between 5000 and 7000 ha. This excluded the fairly obvious old tea plantations (about 2000 ha).

The second determination of forest extent was done by making a draft vegetation map based on an unsupervised classification using Erdas Imagine of a Landsat ETM+ image with 30 m resolution from July 2005. Twelve classes in nine broad habitat types were recognised, including an 'unclassified' class.

Following fieldwork in 2008 a final vegetation map was developed using a supervised classification of the same Landsat image with radiometric and geometric correction, in which four broad habitat types were separated out – moist forest, woodland, agriculture, rock and bare ground (Fig. 4). Based on this latter interpretation, it was calculated that 6937.4 ha of moist forest were present on Mt Mabu (Table 2), the majority of it above 1000 m; a substantial buffer of woodland is also shown. Although the figure for forest extent may be an overestimate as the difference between moist forest and dense woodland is not clear-cut, it is believed to be the best estimate available at present without more field survey.

The forested area was divided into altitudinal classes (Table 2). Out of a total (planimetric) forest area of 6937.4 ha, 4563.6 ha lies between 1000 and 1400 m, which we consider to be primarily mid-altitude moist forest, and an additional 919.5 ha lies above 1400 m, which we consider to be high altitude or Afromontane moist forest. In addition, there is a significant amount of forest below 1000 m, but much of this is riverine or gully forest and perhaps some is overgrown plantation. The main forest block is that area above 1000 m altitude, which is 5483 ha.

Table 2. Extent of forest area by altitudinal class for the Mt Mabu massif (derived from J. Bayliss supervised classification, 2011).

Altitude (m)	measured planimetric extent (ha)	%	estimated extent using slope correction factors (ha)
below 1000	1454.3	21.0	1600
1000–1200	1719.9	24.8	5270
1200–1400	2843.7	41.0	
1400+	919.5	13.2	1010
Total	**6937.4**	100.0	**7880**

As these forests are mostly on steep slopes, hence the actual area covered is significantly larger than the planimetric figures given above, correction factors were applied. Given an approximation of a 30^{o} slope between 1000–1400 m and an estimated 15^{o} slope below 1000 m and above 1400 m, using tangent tables a rough rounded estimate of forest area in these various altitudinal bands was calculated (right-hand column of Table 2). The forest extent in the 1000–1400 m band is 5270 ha, higher than the cumulative planimetric figure of 4564 ha.

Coupled with forest extent above and below on less steep slopes, this gives a total forest cover on the mountain (excluding the tea plantations) of around 7880 ha.

In totally separate exercises, the National Land Cover map of Mozambique gave the total extent (planimetric) of forest cover in the Mabu area as around 5500 ha (J. Francisco, pers. comm. 2010), while Susana Baena (RBG Kew GIS Unit) did an initial partially supervised classification using 26 ground control points derived from a reconnaissance in June 2008 that arrived at a more conservative figure of 5998 ha.

All these studies show that the area of moist forest is very extensive for the region (between 5500 and 7900 ha), with the great majority of it being found between 1000 and 1400 m. Such mid-altitude forest is increasingly rare in the southern African region as these areas have often been cleared in the past 100 years for timber and agriculture. We believe that it represents perhaps the largest extent of moist forest at such altitudes in southern Africa.

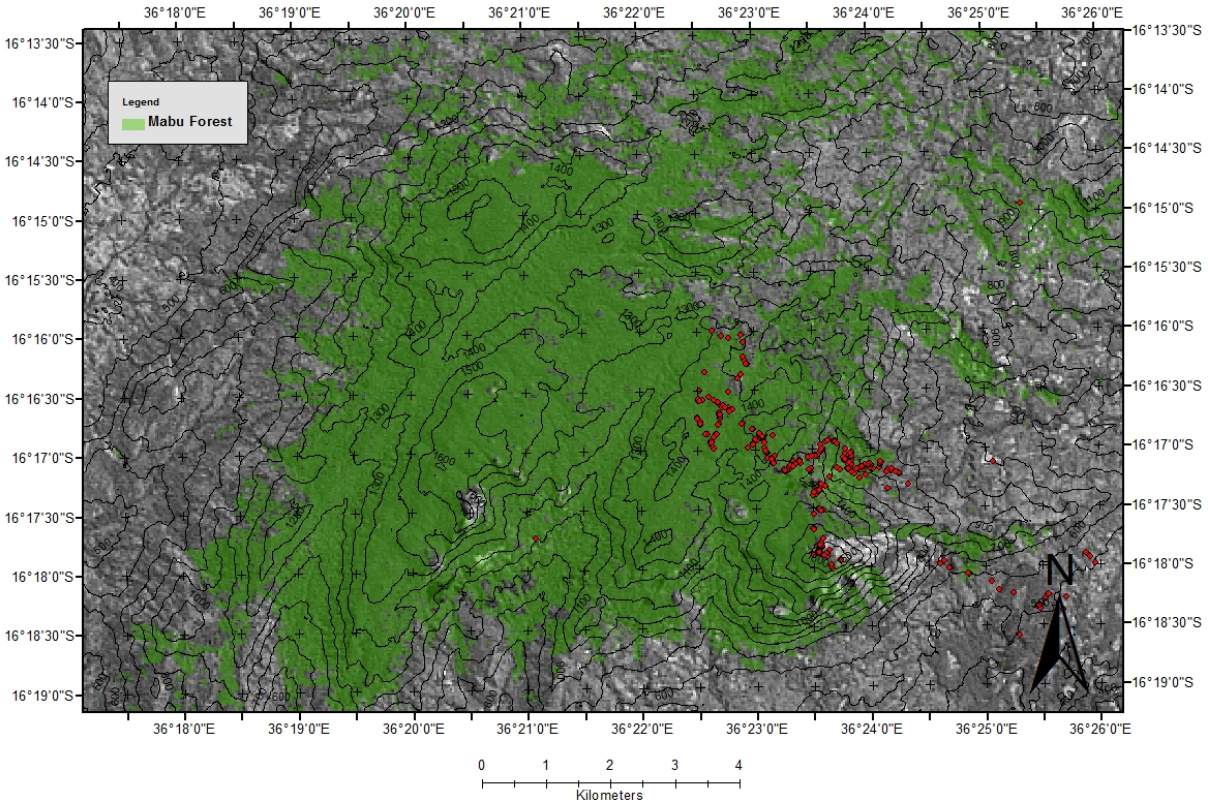

Fig. 4. Supervised classification of Mt Mabu forest vegetation, 2011 (JB). Red dots indicate routes travelled on the 2008 expedition.

3.3 Vegetation Types

To date, only the vegetation of the lower slopes in the south-eastern corner above the abandoned tea estate has been studied. The majority of the forested area of Mt Mabu has not yet been visited by biologists, hence any account of the vegetation is limited. The account below covers primarily the south-eastern side of the mountain; vegetation on the drier western and northern slopes appears to be somewhat different from that described here.

Above 600 m altitude vegetation on the Mabu massif can be classified into three main groups – woodland, forest, and scrub/sedge patches on bare rock. Below this altitude abandoned plantations and secondary vegetation are found, along with patches of lowland riparian forest.

Above 800 m the forest group can be further subdivided into tall riparian forest, tall medium altitude forest and shorter high altitude ("montane") forest (sub-montane in the classification of Müller 1999), but within which there was significant variation.

In the initial study, less emphasis was placed on woodland and vegetation on rocky outcrops around the summit. Boundaries between the different vegetation types were sometimes surprisingly clear-cut, e.g. between montane forest and low scrub on the summit, and in places between woodland and medium altitude forest. These 'hard' boundaries may in part be due to fire.

The main vegetation types are characterised and described below in terms of their structure (height, cover, etc.), species composition and ecology. Additional information was obtained from viewing old aerial photographs. Descriptions follow an altitudinal sequence. Additional details on vegetation are given in Dowsett-Lemaire and Dowsett (2009).

3.3.1 Plantations (400–600 m)
Around the ruined tea estate manager's house (16°18'20.5"S, 36°25'28.8"E, 550 m) there are a number of overgrown plantations of tea (*Camellia sinensis*) and *Eucalyptus* cf. *grandis*. Tea bushes, originally kept to around 1.5 m in height, have now grown up to 12–14 m high, many 2–3 stemmed with stems 10–15 cm in diameter. These are overtopped by *Albizia adianthifolia*, locally forming a closed canopy. Other native trees found here include *Macaranga capensis*.

Much of the planted and secondary growth around this area contains exotics (*Grevillea robusta*, *Delonix regia*, *Eucalyptus* cf. *grandis* and *Vernicia montana*) mixed with pioneer forest trees such as *Macaranga capensis*. Other exotics planted near the estate manager's house include *Ceiba pentandra*, *Artocarpus heterophyllus* (jackfruit) and *Ficus lutea*.

3.3.2 Woodland (600–1000 m)
Woodland was not examined in detail in the 2008 study, but on the lower sections of the main path up to Mt Mabu the woodland is clearly dominated by *Pterocarpus angolensis*. Other common trees include *Pteleopsis myrtifolia* and *Vitex doniana*, while *Pericopsis angolensis* and *Stereospermum kunthianum* were noted occasionally. The woodland is underlain by a carpet of *Aframomum albiflorum*; clumps of *Oxytenanthera abyssinica* bamboo often grow at the ecotone between woodland and dry forest or near dry streams. With increasing altitude, *Syzygium cordatum* becomes more common until it is locally dominant above 800 m, forming pure stands sometimes closed enough to be called forest. *Aframomum* remains common under *Syzygium* and the number of low-level epiphytes (ferns and orchids, also *Rhipsalis*) at 800–950 m suggests a high level of humidity for much of the year.

At 900 m the transitional woodland–forest on the ridge is drier, being dominated by *Syzygium cordatum* and *Xylopia aethiopica*. Other species noted were emergent *Newtonia buchananii*, *Albizia adianthifolia* and *Macaranga capensis*, with an understorey of *Craterispermum schweinfurthii*, *Cussonia arborea*, *Englerophytum magalismontanum*, *Erythroxylum emarginatum*, *Oxyanthus speciosus*, *Phoenix reclinata*, *Synsepalum cerasiferum* and *Tabernaemontana ventricosa*. Lianas present are mainly *Dalbergia lactea*, *Landolphia kirkii* and *Urera trinervis*.

3.3.3 Moist Forest (400–1650 m)
The following categories of forest can be recognized: lowland riparian forest (400–900 m),

mid-altitude moist forest (980 to 1350–1400 m) and Afromontane moist forest (from 1350–1400 m to 1650 m). Only the latter two have been extensively studied.

a) Lowland riparian forest (400–1000 m)
This forest type occurs over a significant altitudinal range and is fairly narrow in extent, so varies greatly in its composition and structure.

Lower down, in patches of lowland riparian forest at 400–500 m near the tea estate managers' house (16°18'26"S, 36°25'39"E), large (40–50 m high) trees of *Albizia adianthifolia* (dominant), *Erythrophleum suaveolens*, *Khaya anthotheca*, *Macaranga capensis*, *Newtonia buchananii*, *Parkia filicoidea*, *Pteleopsis myrtifolia* and *Synsepalum cerasiferum* were noted in the canopy. Edge or pioneer species included *Bridelia micrantha*, *Harungana madagascariensis*, *Trema orientalis* and *Vitex doniana*, while understorey species included *Dracaena mannii*, *Celtis gomphophylla*, *Clausena anisata*, *Ensete ventricosum* and various lianas.

Lowland riparian forest at 800–900 m near the path to the main forest camp was characterised by 45 m high emergent trees of *Newtonia buchananii* (*Khaya anthotheca* was rarely seen), with other canopy trees being *Albizia adianthifolia*, *Anthocleista grandiflora*, *Erythrophleum suaveolens*, *Macaranga capensis*, *Parinari excelsa*, *Synsepalum cerasiferum* and *Xylopia aethiopica*, with *Pteleopsis myrtifolia*, *Vitex doniana* and, locally, *Shirakiopsis* (*Sapium*) *elliptica* at the edges. The commonest understorey species were *Craterispermum schweinfurthii* and *Erythroxylum emarginatum*; others include *Dracaena mannii*, *Oxyanthus speciosus*, *Englerophytum magalismontanum*, *Tabernaemontana ventricosa*, small trees and saplings of *Cryptocarya liebertiana*, *Cussonia spicata* and *Polyscias fulva* (from 850 m). *Oreobambos buchwaldii* bamboo was fairly common, and locally the palm *Phoenix reclinata*. The tree fern *Cyathea dregei* occurs along the main streams, the large fern *Marattia fraxinea* is frequent, and the shrub *Carvalhoa campanulata* grows in light gaps. The commonest canopy liana by far is *Millettia lasiantha*, found with various Apocynaceae (*Dictyophleba*, *Landolphia kirkii*, *Saba comorensis*), *Combretum paniculatum*, *Dalbergia lactea* and *Urera trinervis*.

b) Mid-altitude moist forest (980–1400 m)
This is found between the altitudes of 980–1000 m and 1350–1400 m, after which a sudden change in the dominant canopy species occurs.

The main forest canopy trees in terms of basal area in the lower parts of medium-altitude forest are *Strombosia scheffleri*, *Newtonia buchananii*, *Chrysophyllum gorongosanum* and *Maranthes goetzeniana*. In addition, *Cryptocarya liebertiana*, *Ficus sansibarica* and *Trichila dregeana* are also seen, with occasional large trees of *Cassia angolensis*. Large strangling figs at 1000–1350 m are of two species, *Ficus sansibarica* and *Ficus thonningii*, being replaced at higher elevations by *Ficus scassellatii*. Away from the stream gullies the forest canopy is usually closed, except for small gaps caused by tree-falls.

The main sub-canopy trees (often with more stems but a lower basal area) are *Drypetes gerrardii*, *Drypetes natalensis*, *Funtumia africana*, *Garcinia kingaensis*, *Rawsonia lucida*, *Tabernaemontana ventricosa* and a number of Rubiaceae including *Heinsenia diervilleoides*, *Aidia micrantha*, *Tricalysia acocantheroides* (all the way to the top) and *Tricalysia pallens*. Other sub-canopy trees and shrubs seen included *Allophylus chaunostachys*, *Blighia unijugata*, *Cola greenwayi*, *Diospyros abyssinica* (starts just above 1100 m), *Myrianthus*

holstii, *Oxyanthus speciosus*, *Vepris nobilis* and *Zanthoxylum gilletii*. *Haplocoelum foliolosum* is common from 1150–1300 m and the first big *Tabernaemontana stapfiana* appear on the ridge at 1200–1250 m. Canopy lianas are dominated by *Millettia lasiantha*, with *Acacia pentagona*, *Agelaea heterophylla*, *Combretum paniculatum*, *Dictyophleba lucida*, *Landolphia kirkii*, *Oncinotis tenuiloba* and *Urera trinervis* commonly noted.

Enormous clumps of *Oreobambos buchwaldii* bamboo (confirmation of its identity is still required) to 18–20 m tall are frequent all the way up to 1400 m, particularly on dry slopes and in gullies.

At around 1000 m near the main forest camp (16°17'10"S, 36°24'01"E), tall trees reach an impressive height of 40–45 m, with *Strombosia scheffleri* being the commonest (largest between 45–50 m tall, 90 cm dbh). Other common canopy large trees here are *Newtonia buchananii* (largest to 50 m tall, 140 cm dbh), *Chrysophyllum gorungosanum* (over 45 m) and *Maranthes goetzeniana* (40 m, 35 cm dbh).

At about 1100 m altitude on more gentle slopes, the forest is very impressive with the tallest trees (at least 40 m) including many *Strombosia*. Several *Chrysophyllum gorungosanum*, *Maranthes goetzeniana* and *Newtonia buchananii* are seen, with a few tall *Cryptocarya liebertiana*, *Trichilia dregeana* and strangling figs (*Ficus sansibarica*). *Drypetes gerrardii*, *Garcinia kingaensis* and *Myrianthus holstii* are seen in the subcanopy. Smaller trees include *Drypetes natalensis*, *Pavetta gurueënsis*, *Rawsonia lucida*, *Rinorea ferruginea*, *Vepris* sp. nov. and *Synsepalum muelleri.*

Steep, wide gullies with permanent streams contain more light-demanding tree species such as *Albizia adianthifolia*, *Macaranga capensis*, *Newtonia* and *Polyscias fulva* (the latter becoming bigger and more frequent with increasing altitude). Also found here are *Anthocleista grandiflora*, *Funtumia africana* and medium-sized *Bridelia micrantha*, *Englerophytum magalismontanum*, *Xylopia aethopica* and small *Bersama abyssinica*. Tree ferns (*Cyathea dregei*) occur along streams to at least 1400 m while *Dracaena fragrans* is common in humid hollows and on some slopes.

c) Afromontane forest (1350–1650 m)
This forest type with its lower canopy height and much moister aspect is found up to 1650 m. The change from medium-altitude to high altitude forest is fairly abrupt at about 1350–1400 m, at least on the south-eastern slopes, and is seen from the dropping out of *Newtonia buchananii*, the replacement of *Albizia adianthifolia* by *A. gummifera*, and in *Olea capensis* becoming a conspicuous tall tree.

Canopy trees in the lower parts of Afromontane forest include *Strombosia scheffleri*, *Chrysophyllum gorungosanum*, *Maranthes goetzeniana* and *Newtonia buchananii*, with *Cola greenwayi*, *Garcinia kingaensis*, *Heinsenia diervilleoides*, *Myrianthus holstii*, *Tabernaemontana stapfiana* and *Vepris nobilis* in the sub-canopy. Small *Cassipourea malosana* and the understorey tree *Lasiodiscus usambarensis* appear around 1300 m, while *Maytenus acuminata* and *Eugenia capensis* subsp. *nyassensis* are common between 1300–1400 m. Higher up *Podocarpus latifolius* becomes increasingly common. *Anthocleista grandiflora* and *Polyscias fulva* are found in openings or gaps.

On a ridge in the transition zone several large *Newtonia*, *Olea capensis*, *Parinari excelsa* and *Polyscias fulva* (30–35 m tall) are seen, with *Aphloia theiformis* in the gaps. Other trees

present include *Chrysophyllum gorungosanum*, *Maranthes goetzeniana*, *Strombosia scheffleri* and *Zanthoxylum gilletii* in the canopy, with *Cola greenwayi*, *Craibia brevicaudata*, *Garcinia kingaensis*, *Myrianthus holstii*, *Tabernaemontana stapfiana* and *Vepris nobilis* in the subcanopy. Common small trees and shrubs include *Alchornea hirtella*, *Heinsenia diervilleoides*, *Carissa bispinosa*, *Chassalia parvifolia*, *Clausena anisata*, *Diospyros abyssinica*, *Dovyalis macrocalyx*, *Dracaena laxissima*, *Drypetes natalensis*, *Erythrococca polyandra*, *Eugenia capensis* subsp. *nyassensis*, *Lasianthus kilimandscharicus*, *Maytenus acuminata*, *Mostuea brunonis*, *Pauridiantha paucinervis*, *Pavetta gurueënsis*, *Peddiea fischeri*, *Psychotria zombamontana*, *Rinorea angustifolia*, *Rytigynia uhligii*, *Synsepalum muelleri*, *Tricalysia acocantheroides*, *Vepris* sp. nov., *Vepris nobilis* and *Memecylon* sp.

At the upper end of the forest at 1600 m, the taller trees (to 25 m high) are *Olea capensis* and *Rapanea melanophloeos*, with lower trees of *Aphloia theiformis*, *Bersama abyssinica*, *Cassine aethiopica*, *Cassipourea malosana*, *Cryptocarya liebertiana*, *Faurea racemosa*, *Macaranga capensis*, *Nuxia congesta*, *Ochna holstii*, *Pittosporum viridiflorum*, *Podocarpus latifolius*, *Polyscias fulva*, *Prunus africana* and *Syzygium guineense* subsp. *afromontanum*. Conspicuous lianas at the forest edge include *Rutidea orientalis* and *Schefflera goetzenii*, already common around 1400 m, and *Canthium gueinzii*.

Lower down at 1550–1600 m small understorey trees and shrubs of *Carissa bispinosa*, *Chassalia parvifolia*, *Diospyros abyssinica*, *Diospyros whyteana* (at edges), *Dovyalis macrocalyx*, *Dracaena laxissima*, *Erythroxylum emarginatum*, *Eugenia capensis*, *Lasianthus kilimandscharicus*, *Maytenus acuminata*, *Mostuea brunonis*, *Pavetta gurueënsis*, *Rinorea angustifolia*, *Rytigynia uhligii*, *Tricalysia acokantheroides*, *Memecylon* sp. and *Vepris nobilis* were noted.

3.3.4 Montane Shrubland (1600–1700 m)
At 1600–1700 m just below the peak there is a limited area of montane shrubland where large boulders and rocky slopes are covered by scattered tufts of grass and sedge. Above this the summit is exposed and vegetation comprises mostly sedges and shrubby herbs. Such vegetation appears to be very typical of exposed granitic peaks across the region. This habitat covers just a few hectares on the rounded peaks.

Much of the area is bare rock with patches of small trees and shrubs in sheltered or more moisture-rich sites. In these patches *Rapanea melanophloeos* is the most frequent small tree, next to a few stunted *Syzygium cordatum*, *Aphloia theiformis*, *Maytenus acuminata*, *Aeollanthus buchnerianus*, *Tetradenia riparia* and *Dissotis* sp. Scattered *Aloe arborescens* are present.

In somewhat more exposed sites, the dominant low shrub, 0.5–2.5 m high is *Aeschynomene nodulosa*, along with *Kotschya recurvifolia*. Common prostrate or semi-prostrate herbs include *Ipomoea involucrata*, *Corrigola drymerioides*, *Indigofera* sp. and *Lobelia trullifolia*. The dominant feature, however, is large clumps of the sedge *Coleochloa setifera*, with smaller clumps of the grasses (?)*Danthoniopsis* sp. and *Helictotrichon elongatum* and the sedge *Cyperus fischerianus*. Many of the large clumps had an abundance of the small pink-flowered orchid, *Polystachya songaniensis*.

3.3.5 Vegetation of the Drier Western and Northern Slopes
In the western parts of the massif, which lie in the rain shadow and away from the prevailing oceanic moisture-bearing air currents, aerial photographs and study of Google Earth imagery

suggest that the lower limit of moist forest is around 1200–1250 m, although extending lower to 1050 m on sheltered slopes and along drainage lines and gullies. On the northern boundary the lower limit is around 1400 m. Below the forest on this drier side is what appears to be woodland and bushland. However, as these areas have not yet been visited it is not possible to confirm this. This compares to a lower forest limit of 950 m in gullies and valleys on the southern and eastern slopes.

There appears to be a marked break on the western side of Mabu between higher altitude forest (smooth texture, low canopy height) and medium altitude forest (rough texture, varying canopy height and colour) at around 1350–1400 m. This disjunction is not so apparent on the moister eastern slopes.

4. BOTANY

4.1 Previous Studies

No previous biological collecting or survey work (botanical or zoological) seems to have been carried out on the Mabu massif prior to the first reconnaissance visit of the Darwin project in December 2005, nor are any descriptions of the area available. However, specimens cited in Flora Zambesiaca indicate that the botanists Barbosa and Carvalho collected in the Tacuane area in May 1949, including along the road from Tacuane to Limbuè, and there are also numerous collections made from 1943 to 1949 by Helen Faulkner from Namagoa Estates (16º47' S, 36º58' E, alt. 150 m) in Lugela District, 70 km to the south-east.

4.2 Plant Collections

During the Darwin expedition plant specimens were collected from forest, woodland, shrubland, rocky outcrops and from the overgrown tea estates across the south-eastern part of the mountain. Particular attention was paid to the main forest species. Complete sets have been deposited at the National Herbarium in Maputo (LMA) and at Kew. A full checklist of species identified is given as Annex 3 in Timberlake *et al.* (2012) and as Supplementary Table S1 in Bayliss *et al.* (2014), available at: http://journals.cambridge.org/action/displaySuppMaterial?cupCode=1&type=4&jid=ORX&volumeId=48&issueId=02&aid=9202615

The total number of plant taxa recorded from above 800 m was 249, comprising 9 Pteridophytes, 1 Gymnosperm, 35 monocotyledons and 204 dicotyledons, covering 90 families. The largest families in terms of taxa were Rubiaceae (24), Euphorbiaceae (13), Leguminosae: Papilionoideae (12), Acanthaceae (12) and Apocynaceae (10). Not unexpectedly, the forest understorey families Rubiaceae (mostly in montane forest), Acanthaceae and Euphorbiaceae were particularly common. It is probable that, after more detailed survey work, the full species list from the Mt Mabu area above 800 m altitude will exceed 350 taxa.

There is much similarity with the flora on Mt Namuli (Timberlake *et al.* 2009), with 118 (48%) of the species found on Mt Mabu also being found there. However, the checklist for Namuli only covers those species above 1300 m (most of the moist forest on Mt Namuli is montane and above 1600 m), whereas most of the forest on Mabu is at medium altitude (1000–1400 m). Medium altitude forest is known to be more species-rich than montane forest (T. Müller, pers. comm.).

4.3 Bryophytes

The only significant botanical study that has appeared since the Darwin project report on Mabu (Timberlake *et al.* 2012) is that by Hedderson, Gwynne-Evans, Ah-Peng & Ribeiro (2015) on bryophytes (mosses and liverworts). This paper was based on a series of collections made in the forest and peak areas there by David Gwynne-Evans in May 2010.

Subsequent identifications have yielded a total of 56 species, of which 16 were liverworts and 40 were mosses. Mozambique has been poorly-collected for this plant group, so it is not surprising that of the total 43 (77%) were new Mozambique records, of which 30 were mosses. Several species are thought to be predominantly West African in distribution, and rare on the east of the continent.

4.4 Species of Particular Interest

Species of particular interest comprise those that are new, endemic, threatened or of particular conservation concern, and those that are new records or significant range extensions. To date, 18 species of particular interest have been recorded from Mt Mabu, shown in Table 3. This is the same list as presented in Timberlake *et al.* (2012) as no significant additions have been found since.

Table 3. Plant species of interest recorded from Mt Mabu.

Family	**Species**	**notes**
Amaryllidaceae	Cryptostephanus vansonii	previously a E Highlands/Moz border endemic
Orchidaceae	Bulbophyllum ballii	1st record for Moz; previously a Zimbabwe endemic
Orchidaceae	Bulbophyllum sandersonii	1st record for Moz
Orchidaceae	Polystachya malilaensis	1st record for Moz
Orchidaceae	Polystachya songaniensis	previously thought endemic to Mts Mulanje & Zomba; 1st record Moz
Poaceae	Oreobambos buchwaldii	1st record for Moz
Xanthorrhoeaceae	Dianella ensifolia	in FZ area previously only known from Chimanimani Mts
Acanthaceae	Mimulopsis arborescens	1st record for FZ area; significant range extension from S Tanzania
Acanthaceae	Justicia asystasioides	significant range extension from N Malawi
Acanthaceae	Sclerochiton hirstus	only 2nd collection, previously thought to be a Namuli endemic
Asteraceae	Bothriocline glomerata	2nd FZ record (+ Namuli)
Euphorbiaceae	Crotonogynopsis usambarica	new genus for FZ area (previously Tanzania)
Loranthaceae	Helixanthera schizocalyx	new species; Mabu endemic
Molluginaceae	Corrigiola drymerioides	2nd record for Moz (Namuli)
Rubiaceae	Didymosalpinx norae	2nd record for Moz (Garuso)
Rubiaceae	Rytigynia sp.	not matched at K
Rutaceae	Vepris sp.nov. near V. bachmannii	possible new sp.
Viscaceae	Viscum cylindricum	1st record for Moz (previously Mal + Tanz)

New Species and Records

Of the 18 species listed as being of interest in Table 3, only one (*Helixanthera schizocalyx*, Harris *et al.* 2011) has been described as new to science, while another is thought to be new

(*Vepris* sp. nov. near *V. bachmanii*) but requires further study. Six represent significant range extensions (*Cryptostephanus vansonii* and *Dianella ensifolia* from the Chimanimani Mountains 600 km to the south; *Mimulopsis arborescens*, *Justicia asystasioides*, *Crotonogynopsis usambarica* and *Viscum cylindricum* from N Malawi or S Tanzania 700 km to the north). There are 12 species that are new records for Mozambique, of which four are known from Mt Mulanje in Malawi (Strugnell 2006); their occurrence in a similar habitat a relatively short distance away is not surprising.

Helixanthera schizocalyx is a tropical mistletoe and was first noted by Colin Congdon on stunted trees of *Psychotria zombamontana* on the edge of the moist montane forest near the open peak area of Mabu (Timberlake 2010). So far it is only known from five specimens, all from more-or-less the same locality near the summit. Its nearest relation is *Helixanthera verruculosa* (Harris *et al.* 2011) from the southern highlands of Tanzania and, in 2009, it was also found on Mt Namuli.

Didymosalpinx norae was previously only known from Chirinda Forest in SE Zimbabwe (Timberlake & Shaw 1994) and from Garuso Forest near Chimoio in central Mozambique, as well as in a few lowland forests in Kenya and Tanzania. It discovery almost 400 km north-east from its previous known southern African populations is quite unusual for a fairly showy flowering shrub.

There was no sign of the fairly widespread *Widdringtonia nodiflora* on Mabu, nor on any adjacent mountains. Perhaps the massif may be too low and warm for it. However, *W. whytei* has been recorded from Mt Gorongosa in the centre of the country at around 1500 m (Müller *et al.* 2008).

Although its presence is not unexpected, and probably more a reflection of under-recording in Mozambique rather than a particularly significant range extension, it is interesting to note that the forest on Mt Mabu is the first record of the large common forest bamboo, *Oreobambos buchwaldii*, for Mozambique. However, its identification still needs to be confirmed.

It was interesting to note the abundance of *Maranthes goetzeniana*, a large forest tree that to date does not appear to have been recorded from any forest in Malawi (White *et al.* 2001). However, it is common in mid-altitude forests on the eastern and southern footslopes of the Chimanimani Mountains at under 500 m altitude and in adjacent parts of Zimbabwe.

Threatened and Endemic Species

Apart from the newly-described mistletoe (*Helixanthera*) and the possibly new *Vepris*, no other endemic plant species have yet been found on Mt Mabu, nor are any taxa there known to be particularly threatened across their range. This is in marked contrast to the situation on Mt Namuli where 16 endemic plant taxa, including five new species, were recorded (Timberlake *et al.* 2009).

From the Sabonet Red Data List (Golding 2002, Izidine & Bandeira 2002, Timberlake *et al.* 2006) 14 species on Mabu are said to be endemic to the Flora Zambesiaca area, Mozambique or adjacent countries, or were on one or more country's Red Lists (see Table 7 in Timberlake *et al.* 2012)). However, some of these have since been shown not to be as restricted in distribution as was originally believed or were cited in error. None of them are yet formally listed on the IUCN Red Data List (accessed January 2016).

Compared to the zoological findings, it is clear that Mabu's flora contains few species of particular interest; most plant species are moderately widespread across the scattered patches of moist forest in Eastern and Southern Africa. Of much greater botanical significance is the extent and good condition of the moist forest at an altitude where, elsewhere, so much has been cleared. For example, the total extent of moist forest on Mt Mabu is around 7880 ha, of which 5270 ha lies between 1000 and 1400 m, compared to 1300 ha of similar forest on Mt Chiperone (Timberlake *et al.* 2007), 135 ha on Mt Namuli (Timberlake *et al.* 2009) and an unknown extent (perhaps 1000–2000 ha, figure not given in Müller *et al.* 2008) on Mt Gorongosa.

Further survey work needs to focus on medium altitude forest areas, particularly gullies and streams within the forest and on the gully or riverine forests at lower altitudes. The drier side of the mountain has not yet been investigated biologically, and should contain some different habitats and species from the moister eastern side.

5. ZOOLOGY

5.1 Background

The zoology of Mt Mabu and the surrounding area has proved to be interesting and unique with numerous endemic species recorded. Most biodiversity surveys and discoveries occurred over the five-year period between 2005 and 2010, with eight separate visits to Mt Mabu and the surrounding area (Bayliss *et al.* 2014). Since this time there has been only one other scientific expedition – in 2014 looking at reptiles and amphibians. To date, 13 new species have been recorded for Mabu, with another five probable new species. All biological studies to date have concentrated on the eastern forest edge, the main summit, and the woodlands and the tea estate just outside the forest. The central forest areas as well as the western, northern and southern boundaries have yet to be looked at.

The zoology was first documented in December 2005 when Julian Bayliss, Claire Spottiswoode, Eric Hermann and Hassam Patel explored Mt Mabu and the surrounding area (Spottiswoode *et al.* 2008). As well as sampling the avifauna, this first visit was a reconnaissance one intended as a scoping mission in preparation for the Royal Botanic Gardens Kew Darwin Initiative project, which started later in 2006 (Timberlake *et al.* 2012). It was on this first visit that the vast expanse of moist forest was first observed. The Mabu area was initially identified, along with several other mountains, using Google Earth imagery, which later earned it the title of "the Google Forest" (see https://www.youtube.com/watch?v=mni8mSS4KDU).

On this first visit several rare and threatened birds were recorded, such as the Cholo Alethe and Gunning's Akalat (Spottiswoode *et al.* 2008). In January 2006, Bayliss returned to Mabu forest and found two species of reptile which have since been described as new – the Mabu Forest Viper *Atheris mabuensis* (Branch & Bayliss 2009) and the Mabu Pygmy Chameleon *Rhampholeon maspictus* (Branch, Bayliss & Tolley 2014).

In September 2008 a reconnaissance visit was undertaken in preparation for the main Kew expedition later that year. On this visit a new species of butterfly *Cymothoe* sp. nov. was collected (Congdon, Bayliss & Collins 2010). During the main Kew expedition of October 2008 more new species were discovered, notably a species of bat *Rhinolophus mabuensis* (Taylor *et al.* 2012) collected by Michael Curran and Miriam Kopp, several new species of

butterfly – *Epamera* and *Leptomyrina* (*Gonatomyrina*) – and new sub-species *Papilio pelodurus* subsp. nov., *Baliochila woodi* subsp. nov. and *Neocoenyra bioculata* subsp. nov. Some snakes also collected at this time have recently been confirmed as probable new species, including an unusual large-scaled bush snake (*Philothamnus* cf. *macrops*) and a tree snake (*Dipsadoboa* sp.). The taxonomic status of other species is also currently under investigation, including a rare burrowing skink (*Melanoseps* sp.) and two cryptic leaf-litter frogs (*Arthroleptis* sp). In May 2009, a new species of chameleon *Nadzikambia baylissi* was discovered (Branch & Tolley 2010). Since this time there has been only one zoological survey of Mabu's forest, undertaken in 2014, which focused again on reptiles and amphibians (Tolley 2015). This visit also resulted in several new additions to the list for Mabu forest, which is emerging as a possible centre of endemism for reptiles and a refuge for other rare and threatened species.

The list of species of all animal groups surveyed up until 2013 is given as supplementary material to the paper on Mabu's discovery, biodiversity and conservation (Bayliss *et al.* 2014), http://journals.cambridge.org/action/displaySuppMaterial?cupCode=1&type=4&jid=ORX&volumeId=48&issueId=02&aid=9202615, but this list does not contain the additional 15 reptile species found in 2014 (Tolley 2015).

5.2 Mammals

The small mammals (excluding bats) found on Mt Mabu have been sampled opportunistically on several visits by Julian Bayliss, but only from within Mabu forest itself. Seven species were collected over the altitudinal range 1000–1300 m comprising four species of rodents and three shrews. The four rodent species are tropical forest specialists and, except for *Grammomys dolichurus*, represent their southernmost populations. The main rodent species collected was the Soft-furred Mouse *Praomys delectorum*. Although the Lesser Pouched Rat *Beamys major* has been included taxonomically in the widespread *Beamys hindei*, and *Lophuromys aquilus* in the widespread *Lophuromys flavopunctatus*, which has led to IUCN Red List categories of Least Concern, it is likely that these southern populations will prove to be distinct (Musser & Carleton 2005). The two shrews found, *Crocidura luna* and *Crocidura olivieri*, are also associated with tropical forest and woodlands.

Bat assemblages were sampled opportunistically on a number of occasions by Bayliss, and more systematically on the Kew expedition of 2008 by Curran and Kopp. In total 12 species were recorded and the assemblage, dominated by species of Rhinolophidae and Hipposideridae, was similar to that of nearby mountains such as Mt Mulanje. A single specimen of an unidentified *Kerivoula* was collected; it seems to be distinct from the two recognized southern African species, *K. argentata* and *K. lanosa*. One new species of horseshoe bat (Fig. 5), *Rhinolophus mabuensis* (Taylor *et al.* 2012), was collected and has also been found on neighbouring Mt Inago (Bayliss *et al.* 2010, Monadjem *et al.* 2010, Taylor *et al.* 2012).

During the 2008 Kew expedition, information on larger mammals was recorded opportunistically and with the knowledge of a local hunter (Dowsett-Lemaire & Dowsett 2009). The Blue Monkey *Cercopithecus albogularis* is common within the forest and is hunted by the local community using bow and arrows, and Grant's Bushbaby *Galagoides (zanzibaricus) granti* was heard calling at night. Forest antelopes such as Blue Duiker *Cephalophus monticola*, Bushbuck *Tragelaphus scriptus* and Klipspringer *Oreotragus oreotragus* are hunted for bushmeat, primarily using gin-traps, along with the two hyrax species *Procavia capensis* and *Heterohyrax brucei*, and the Red-bellied Squirrel *Paraxerus*

palliatus. According to local hunters, Leopard *Panthera pardus* are occasionally encountered. Buffalo *Syncerus caffer* and Elephant *Loxodonta africana* were historically common in the forest, although they have not been seen in recent years.

Main conservation issues and recommendations

There is a need for much more biological survey of all of the mammal groups at Mabu, especially within the small mammals and the primates. It is quite likely that new species of rodents, shrews, and bats are yet to be discovered within the forest, and so far only the forest edge has been sampled. Several of the species already caught are rare and endangered, such as the new species of bat and the some of the rodents. The bushbaby *Galagoides granti* may also prove to be an interesting sub-species and requires further investigation. The DNA of the Red-bellied Coastal Squirrel *Paraxerus palliatus* should be looked at to see if it is an endemic new sub-species to Mabu, as has been recorded for Mt Namuli. Based on the high levels of endemism found at Mabu this is quite possible. However, if it proves to be the Namuli race, *P. palliates vincenti*, it would demonstrate the linkage between these forests and mountains at some point in the past, as is the case for the snake *Atheris mabuensis* which was later discovered on Mt Namuli.

Despite the fact that the forest itself is in good condition with little evidence of timber extraction, there is a heavy hunting pressure especially in the use of gin trapping. This is particularly evident around the forest edges and up on the main summit. Alternative sources of meat should be encouraged within the local communities through a sustainable livelihood programmes to relieve hunting pressure.

Fig. 5. A new species of horseshoe bat *Rhinolophous mabuensis* [JB].

Fig. 6. The endangered Cholo Alethe (*Alethe choloensis*), locally common in forest [JB].

5.3 Birds

The avifauna of Mt Mabu has been looked at in detail on two separate occasions. The first visit was in late 2005 (Spottiswoode *et al.* 2008), while the second was the Kew expedition of 2008 (Dowsett-Lemaire 2010). Both trips resulted in interesting records of rare bird species, and together they form a fairly comprehensive avifauna description for the general area (i.e. tea estates, miombo woodlands and forest). Since that time there have been no additional avifauna records that we are aware of.

A total of 126 bird species, including 18 Afromontane endemic or near-endemic species, have been recorded (Spottiswoode *et al.* 2008, Dowsett-Lemaire 2010). Some of these were only found above 1350 m, e.g. Rameron Pigeon *Columba arquatrix*, Bar-tailed Trogon *Apaloderma vittatum*, Starred Robin *Pogonocichla stellata*, Swynnerton's Robin *Swynnertonia swynnertoni*, Namuli Apalis *Apalis (thoracica) lynesi*, Dapple-throat *Modulatrix orostruthus* and Cape Batis *Batis Capensis dimorpha*.

Main conservation issues and recommendations

The bird list includes seven species on the IUCN Red List (IUCN 2015) – Southern Banded Snake Eagle *Circaetus fasciolatus* (Near Threatened) which occurs in small numbers and mainly below 1000 m; Spotted Ground Thrush *Zoothera guttata* (Endangered, Mabu and Namuli being the only known breeding locations in Mozambique) is apparently rare; Cholo Alethe *Alethe choloensis* (Endangered) is common (Fig. 6), especially above 1200 m with Mabu being one of the two most important areas for its conservation; Gunning's Akalat *Sheppardia gunningi* (Near Threatened) with an important population at 400–1350 m, although it also occurs in the tea forest; Swynnerton's Robin (Vulnerable) occurs commonly above 1350 m and this population bridges the gap between known populations in eastern Zimbabwe/southern Mozambique and those in central Tanzania; Namuli Apalis (Near Threatened), hitherto thought to be endemic to Namuli where it is common, is rare and only found above 1400 m, its discovery suggests it may also be present on adjacent mountains; Dapple-throat (Vulnerable) for which Mabu represents a small range extension from Namuli to the south-west, is rare and found only above 1400 m. Hence Mabu's extensive forest cover is an important refuge for several rare and threatened bird species in this part of Africa.

5.4 Reptiles and Amphibians

Herpetological collections from Mabu forest started in 2006 when the first specimens of the new forest viper *Atheris mabuensis* (Fig. 7) and the pygmy chameleon *Rhampholeon maspitcus* (Fig. 8) were recorded (Bayliss *et al.* 2014). Since this time there have been other surveys leading to a more comprehensive picture of the herpetofauna. To date, five new species have been confirmed and another five are predicted making Mabu a probable centre of endemism for reptiles.

Fig. 7. New species of forest viper *Atheris mabuensis* [JB].

Fig. 8. New species of pygmy chameleon *Rhampholeon maspictus* [JB].

Fig. 9. New species of chameleon from Mabu forest *Nadzikambia baylissi* [JB].

Between 2005 and 2010, 7 amphibian and 15 reptile species (9 lizards and 6 snakes) were recorded from the area of moist forest and the surrounding lands, although most collecting has not been at optimum times. In addition to the discovery of *Atheris mabuensis*, the southernmost record of the genus, and the new species of pygmy chameleon *Rhampholeon maspictus* (Branch, Bayliss & Tolley 2014), another chameleon *Nadzikambia baylissi* (Fig. 9) was discovered in 2010 belonging to a genus previously thought to be endemic to Mt Mulanje (Branch & Tolley 2010, Branch 2011).

Since then DNA analysis has also identified two other distinct new species of snake from Mabu collected in 2009 and 2010 – an unusual large-scaled bush snake *Philothamnus cf. macrops* and a tree snake *Dipsadoboa* sp. The taxonomic status of other species is also currently under investigation, including the status of a rare burrowing skink *Melanoseps* sp. and two cryptic leaf-litter frogs *Arthroleptis* sp. Many of the species recorded are at the southernmost limits of their ranges and have affinities to groups from the north and west (Bayliss *et al.* 2014).

In 2014 a further herpetological survey took place which added an additional 17 species to the list for Mabu (Tolley 2015). These additional records are likely to yield new species within the genera *Lygodactylus*, *Holaspis*, *Melanoseps*, *Amietia*, *Strongylopus* and *Arthroleptis*; DNA barcoding is currently being used to evaluate them.

Main conservation issues

The total list of herpetofauna for Mt Mabu now stands at 37 species, out of which there are five confirmed new species and an additional six suspected. If confirmed, this equates to approximately 30% of the herpetofauna recorded on Mt Mabu being new or endemic species. There are likely to be more discoveries. Further scientific expeditions to survey this group are encouraged, especially from within the moist forest.

5.5 Butterflies

The butterfly fauna of Mabu and the surrounding area received significant attention between 2005 and 2010 and a comprehensive species list was created from Mabu forest and the surrounding lands (Timberlake *et al.* 2012).

The group has been studied on eight visits and in various seasons (Bayliss 2008, Congdon & Bampton 2009, Congdon *et al.* 2010, Timberlake *et al.* 2012, Bayliss *et al.* 2014), with a total of 203 taxa recorded. The expected total is likely to be around 250 species, similar to the

butterfly fauna of neighbouring mountains such as Mt Mulanje. Four of these are new species (*Baliochila* sp. nov., *Cymothoe* sp. nov., *Epamera* sp. nov. and *Leptomyrina (Gonatomyrina)* sp. nov.) and three are new subspecies (*Papilio pelodurus* subsp. nov., *Baliochila woodi* subsp. nov. and *Neocoenyra bioculata* subsp. nov.). Of the overall species list, 35 taxa are new records for Mozambique (Congdon *et al.* 2010). Several of the new species have since been caught on neighbouring mountains, such as the new *Cymothoe* (Mt Namuli, Mt Inago), *Epamera* (first caught on Mt Namuli) and *Leptomyrina* (Mt Namuli, Mt Inago).

The phenomenon known as hill-topping (Shields 1967), where hundreds of butterflies from many families gather *en masse* and perform territorial and mating displays, has been observed on the summit of Mt Mabu throughout October and November between 10:30–11:30 am. It was the main theme in the coverage of Mt Mabu in the BBC Natural History Unit series *Africa* (Bright 2012). Indeed, Mabu was called the 'Butterfly Forest' by David Attenborough while narrating the BBC series. Whilst such an event is not particularly rare, this natural phenomenon is attractive to visitors and can be used to promote ecotourism.

Main conservation issues
A number of new butterfly species and subspecies have been discovered in the moist forests on Mt Mabu. As with other groups, there appears to be high levels of endemism amongst forest-dependant species. All new species found so far are from the moist forest or upland grasslands close to the summit. Conservation of the forest and measures taken to prevent deforestation and fire damage are therefore important.

6. REGIONAL BIOGEOGRAPHICAL CONTEXT

6.1 Regional Forests

Moist forests in Zimbabwe and Malawi have been much better studied than those in Mozambique (e.g. Dowsett-Lemaire 1989a, Müller 1999, 2006, White *et al.* 2001), and comparisons can be made to these, particularly as regard to the composition of forests occurring at medium altitude (medium altitude and sub-montane according to Müller 1999). However, a full comparison across these countries has not yet been done.

The Afromontane forests on Mt Mabu have many similarities in terms of species composition and structure to what was termed High-altitude forest on Mt Chiperone (above 1600 m altitude, Timberlake *et al.* 2007), while the Medium-altitude forest on Chiperone (800–1600 m altitude), as would be expected, has many similarities to the lower end of Afromontane forest and Mid-altitude moist forest on Mt Mabu. As on Chiperone, moist forest on Mt Mabu gives way to miombo woodland at an altitude of around 1000 m. A similar situation is seen on both Mt Namuli (Timberlake *et al.* 2009) and on Mt Gorongosa (Muller *et al.* 2008).

Montane forest (1600–1900 m) on Namuli is not really represented on Mabu, although some forest species common on Namuli at these altitudes (Timberlake *et al.* 2009) are found in Afromontane forest on Mabu. There was very little forest found on Namuli below 1600 m. On Mt Gorongosa *Syzygium guineense* subsp. *afromontanum* forest is found above 1600 m and, along with Mixed sub-montane forest (1300–1600 m), has many similarities to Afromontane forest on Mabu. While the small extent of Medium-altitude forest on Namuli has many similarities to than on Mabu. As on Mabu, *Newtonia buchananii* is only found below 1300 m altitude.

In the Eastern Highlands of Zimbabwe, Müller describes a range of moist forest types. His *Syzygium guineense* subsp. *afromontanum* (Type 5) is quite similar to Afromontane forest on Mabu, while his Mixed sub-montane (Type 7) forms a transition to Medium altitude forest (Type 11), and equates to Medium altitude forest on Mabu. Müller's Medium altitude forest type in Zimbabwe is best developed at Chirinda Forest near Espungabera, and the lower forests on Mabu are very reminiscent of Chirinda, although *Craibia brevicaudata*, very common there, appears to be absent and *Trichilia dregeana* is less common.

In summary, the forests on Mt Mabu have many similarities, both in species composition and structure, to moist forests found on a number of nearby mountains or massifs. The altitudinal extents can vary slightly, but this is only to be expected as these depend on the latitude, geomorphology, relative elevations and exposure to the moisture-bearing airflows coming from the Indian Ocean. Although the forest on Mt Mabu are not significantly differ from those found elsewhere, two of their major attributes are (1) that they are mostly in very good condition with little evidence of previous disturbance or logging, and (2) their great extent, greater than in other regional forests at these altitudes (1000–1400 m).

6.2 Regional Zoology

Mt Mabu and the immediate surrounding area is emerging as an important centre of endemism for many animal groups. The high number of endemic species discovered on Mabu and surrounding mountains suggests a long period of isolation and ancient linkages with the north (Bayliss *et al.* 2014). There is evidence of a significant influence from the mountains in Tanzania and to the west in Malawi, such as the Eastern Arc Mountains and Moreau's Tanganyika–Nyasa Montane Chain, with greater influence from the latter. This is particularly evident in the butterfly fauna (Congdon *et al.* 2010, Van Velsen *et al.*, in review). Many species and genera collected are at the southernmost limits of their range, such as the Lesser Pouched Rat *Beamys major*, the new forest viper *Atheris mabuensis*, the new pygmy chameleon *Rhampholeon maspictus*, burrowing skink *Melanoseps* sp., and montane *Cymothoe* butterfly.

The terrestrial small mammal fauna of the isolated montane forests of northern Mozambique forms an important southern refuge biogeographically, linked with the montane forests of central Malawi and eastern Africa (Kenya, Uganda, Tanzania, Democratic Republic of Congo). Some found here are not listed as being in the southern African subregion (i.e. south of the Zambezi River) as defined by Skinner & Chimimba (2005).

Only 18 species of Afromontane birds are found on Mabu, which is relatively low in comparison with neighbouring mountains (Mt Mulanje has 31). This is probably because of the limited extent of montane grassland and shrubland on Mabu, hence species such as the Blue Swallow *Hirundo atrocaerulea* cannot occur and the areas covered by Afromontane forest are relatively small compared to mid-altitude forest.

Within the herpetofauna a number of species are shared with adjacent Mt Mulanje. Closely-related chameleons occur on both mountains, with *Nadzikambia mlanjensis* and *Rhampholeon platyceps* on Mt Mulanje and the sister taxa *Nadzikambia baylissi* (Branch & Tolley 2010) and *Rhampholeon maspictus* on Mt Mabu (Branch, Bayliss & Tolley 2014). No forest viper (*Atheris*) has been recorded from Mt Mulanje, but *A. mabuensis* is now known from both Mt Mabu and Mt Namuli (Branch & Bayliss 2009), proving a link between the forests at these sites at some point in the past.

6.3 Montane Inselbergs across South-Central Africa

In WWF's Terrestrial Ecoregions of Africa (Burgess *et al.* 2004) the forests of Mt Mabu and similar mountains are included under South Malawi Montane Forest–Grassland Mosaic (type 75) and Eastern Zimbabwe Montane Forest–Grassland Mosaic (type 76). However, this arrangement lumps montane grasslands at over 2000 m with medium altitude forest at 1200 m, with greatly different biodiversity and ecological drivers. Although at the scale used, a different arrangement would be difficult.

What has been proposed (Bayliss *et al.* 2014) is that there should be an additional ecoregion created to encompass the isolated archipelago-like chain of montane inselbergs scattered across northern Mozambique and Malawi, which would include Mts Mabu, Namuli, Chiperone, Mecula, Serra Jao, and possibly also Mt Gorongosa. These syenite or granite massifs support forest on their slopes, but a distinct heath-like and bare-rock vegetation on the peaks. There are also zoological similarities as well as botanical. Mabu forms an important link between them – if all have some sort of protection the ability of organisms (plants and animals) to move between massifs would be guaranteed. Given its fairly central position filling a gap between the Nyanga–Gorongosa area and those further north on southern Malawi and northern Mozambique, the conservation of the forests on Mt Mabu and rocky areas above are of particular significance.

7. CONSERVATION AND MANAGEMENT

7.1 Proposed Management Zones

Any management plan for the Mabu area needs to focus clearly on the main habitats and species of ecological importance and/or conservation interest. These have been outlined in the botany and zoology sections above and are further discussed here.

There has been some suggestion of a Mt Mabu Greater Region (see Consultancy ToR), although it is not clear what is meant by this and no boundaries have been specified. As management normally takes place within administrative or ecological boundaries, and any management plan needs to take these into account, we restrict ourselves here to describing the main conservation management attributes of a Core Area – principally the moist forests – and also refer to a Buffer Zone or slightly broader District-level context.

Greater Mabu Region

The Greater Mabu Region could be considered as consisting of two main management zones. The area of moist forest on the slopes of the mountain is the priority core area, and should be protected at all costs. This is where the endemic, rare and restricted range species are to be found. It is clearly seen in darker green inside the box in Fig. 3. The area outside the main forest block includes the tea estates, miombo woodlands, villages and surrounding hills. It should be viewed as a possible buffer zone to the main forest block. Land use and land management within this area will have an affect the condition of the main forest area, but primarily indirectly in the form of increasing exploitation pressures and as a source of wildfires.

Core Zone

The main block of forest on Mt Mabu starts between 900–1000 m and covers an area of over 7800 ha. This area should be considered as a no-use zone and left for conservation and ecotourism purposes. It is suggested here that the Core Zone should start at 900 m (not 1000

m as suggested previously) as there is substantial moist forest below 1000 m. Figs. 10a and 10b clearly show that there is a significant extent of dense vegetation (much of which is probably moist forest) below the 1000 m contour line, especially along the southern boundary. A 900 m contour line is therefore proposed as the approximate boundary for a protected area. The suggested Core Area is very similar to that area originally submitted by JA! to the Provincial Governor of Zambézia in 2012 for an ecotourism concession. The latter is shown in Fig. 11. As can be seen from that map, there are some significant areas of dense vegetation (probably forest) in the north-east corner that lie outside the proposed concession area. If more detailed and inclusive markers are required, suggestions are given in Fig. 12.

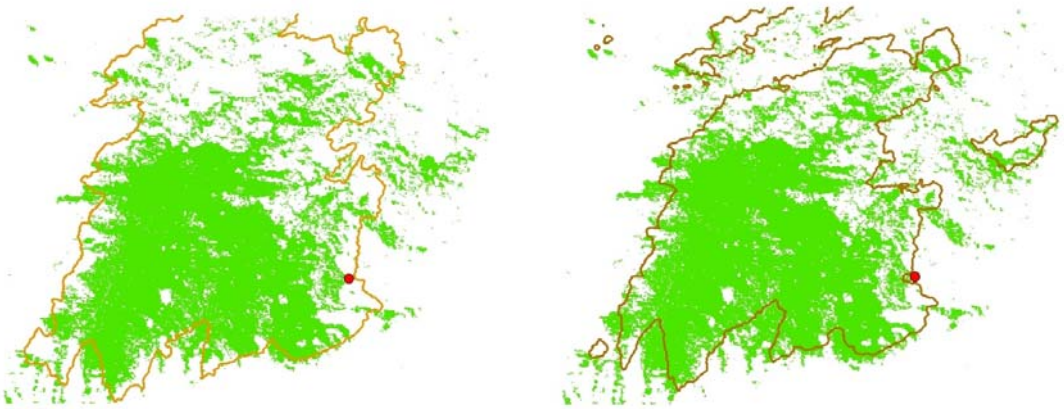

Fig. 10. Images showing (a) the 900 m and (b) the 1000 m contour line, respectively, encompassing most of the forest; the dot represents the main forest base camp [JB].

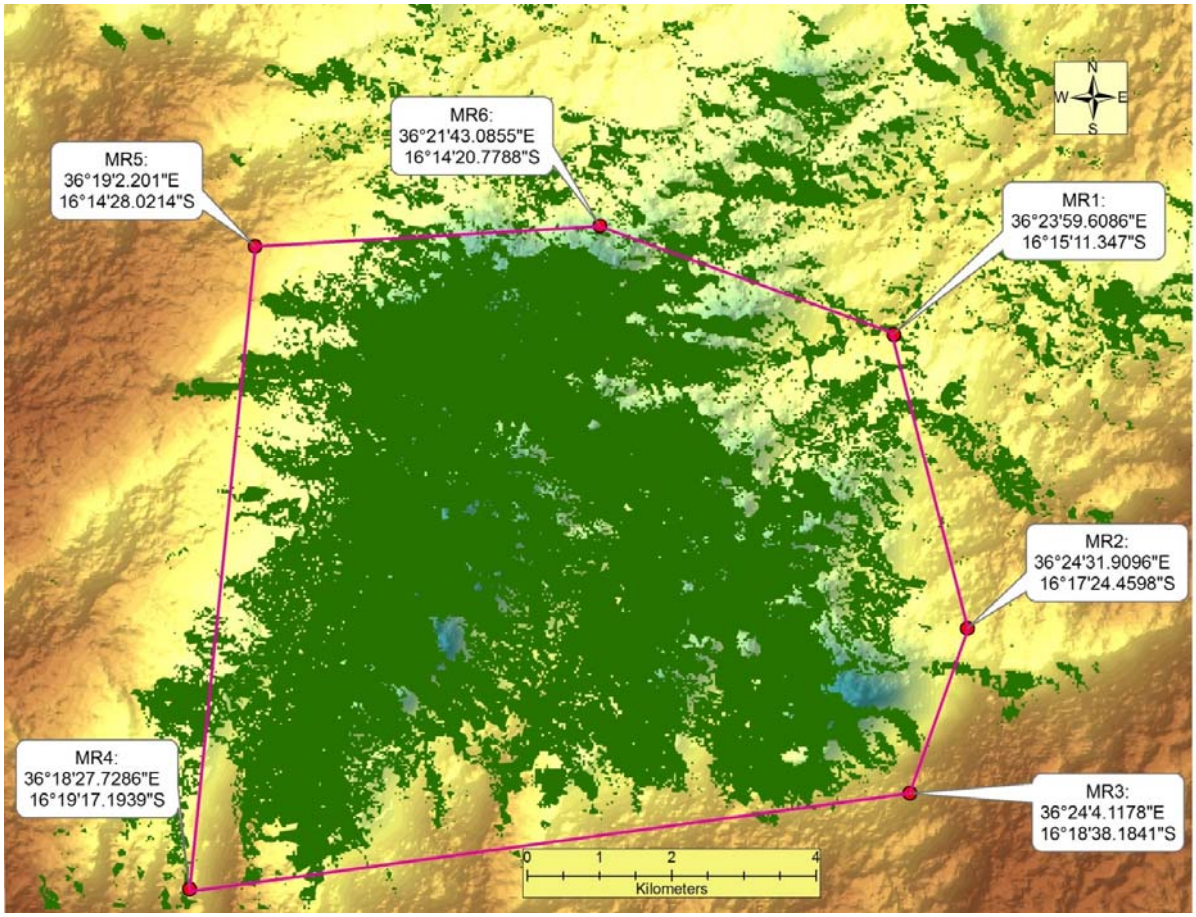

Fig. 11. Proposed Mabu Forest Protected Area following the JA! application to the Zambézia Provincial authorities in 2012. Areas of dense vegetation shown in dark green [map by JB].

Within this Core Zone it is envisaged there would be:

- No bushmeat hunting
- No planting of crops
- No villages or settlements
- Active ecotourism initiatives (e.g. scientific expeditions, birders)
- Employment of local hunters as forest guides
- Only limited collection of medicinal plants
- Controlled and limited collection of non-timber forest products (NTFPs).

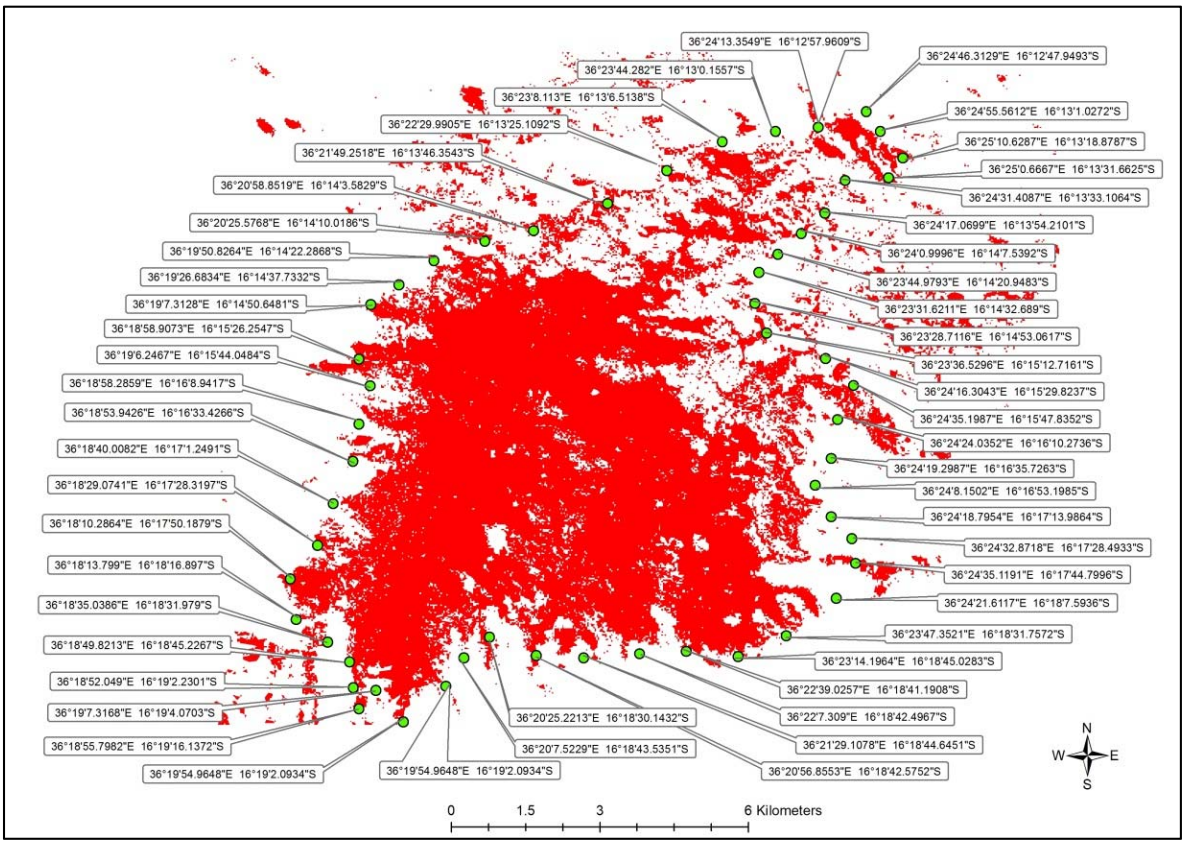

Fig. 12. Detailed outline of revised core forest area proposed (in red), with suggested markers [JB].

7.2 Main Habitats of Conservation Concern

The habitat of greatest significance on Mabu is undoubtedly moist forest, which covers 66% of the immediate Mabu massif area above 1000 m altitude (Timberlake *et al.* 2012). As mentioned earlier, given an area immediately around Mabu of around 300 km^2 (see Fig. 2), 83 km^2 lies above 1000 m altitude (Table 1) and of this moist forest comprises 54.8 km^2 (planimetric view only). Moist forest itself can be subdivided into four classes depending on altitude, which roughly correspond to differences in species composition and ecology – below 1000 m, 1000–1200 m, 1200–1400 m, and above 1400 m. Most (65.8%) of the forest on Mt Mabu lies between 1000 and 1400 m, but with a significant area (14.5 km^2 or 21%) of lowland riparian forest and overgrown tea plantations below 1000 m (Table 2). Given that much of the forest is on steep slopes, it is suggested that the true extent of moist forest on Mabu is actually around 78.8 km^2 (Timberlake *et al.* 2012). It is this extent of tropical moist

forest above 900 m altitude that is suggested should be the main focus of conservation attention on Mabu.

Other habitats of interest include the montane shrubland at 1600–1700 m just around the peak, and the moist woodland lying below the forest at 1000 m altitude and below. This woodland is surprisingly not really miombo, i.e. dominated by *Brachystegia* or *Julbernardia*, but is composed of species that are often found in miombo or similar woodlands such as *Pterocarpus angolensis*, *Pteleopsis myrtifolia* and *Vitex doniana*. But none of these contain the diversity of species found in moist forest, or any of particularly restricted distribution, perhaps with the exception of the ecotone between Afromontane forest and montane shrubland that supports interesting species such as the new *Helixanthera schizocalyx*.

Other habitats such as wetlands, upland grassland and thickets have not yet been found. However, it is possible some areas of wetland or different woodland types could be found on the western and northern sides of the massif, not yet visited. Montane grassland has not been seen on any imagery.

It is suggested that for management zonation, the following seven habitat/management units be used, described in order of declining elevation:

1. **Bare rock and montane shrubland**. Situated around the rocky peaks of Mabu, mostly above 1600 m altitude and probably not more than 30 ha in total extent.

2. **Afromontane forest**. A forest type with a lower canopy and species that are adapted to cold and high moisture levels; epiphytic lichens such as *Usnea* are common. Mostly found from 1300 or 1400 m up to 1600 m altitude, and including the shrubby ecotone with montane shrubland. The boundary between Afromontane and mid-altitude moist forest types is gradual, and may occur at a different altitude on the unsurveyed northern and western slopes. Total extent is around 1000 ha, but might be significantly greater if further surveys suggest that the altitudinal limit for Afromontane should be lower than 1400 m.

3. **Mid-altitude moist forest** (elsewhere called medium-altitude). A forest type including large towering trees of cold-sensitive, more tropical species. Found from around 900 m (but principally 1000 m) up to 1300 or 1400 m altitude, depending on position and level of shelter. This is the main forest type on Mabu and has an estimated extent of 5270 ha above 1000 m (perhaps less if transition types are managed with Afromontane forests).

4. **Moist woodland**. A miombo-type woodland of large trees and a well-developed grass layer. Extends from around 600 m altitude up to the forest margin at 1000 m. Total extent not known, but probably as extensive as the forest areas. It is within the area occupied by woodland that many of the plantations and settlements are situated. Species composition is not particularly species, and damage to the woodland generally does not affect the areas above. Burns regularly, which also helps maintain a "hard" boundary with the forest.

5. **Lowland riparian forest**. A limited habitat found in gullies or along watercourses, generally at 400 to 1000 m altitude, comprising large trees, often of fairly restricted distribution. The total extent is not known owing to confusion with dense woodland and plantations, but is probably in excess of 500 ha. It can have high biodiversity if mature and not badly damaged.

6. **Plantations**. Mostly of overgrown tea bushes and around 400–600 m altitude, although much of their original extent has recently been cleared. Extent not known.

7. **Cultivated fields and settlements**. These are found around the base of the mountain, but rarely up to 1000 m altitude. This habitat has expanded in recent years as old plantations have been cleared.

Of these seven habitat types, suggested as being appropriate management units, the most important are mid-altitude forest (3) and Afromontane forest (2), followed by bare rock/montane shrubland (1) and lowland forest (5). The other habitats are not of particular conservation concern. It is in the forest habitats that all the species of particular conservation interest or concern – plant, animal and insect – have been found.

7.3 Major Threats and Concerns

Mt Mabu has been surprisingly little disturbed over the last 100 years, possibly because it was not on any major trading routes and also owing to its steep terrain above the more gentle foot slopes. After its 'discovery' in 2008, a number of people were worried that it would become a prime target for logging. But this is not thought that likely owing, again, to the steep terrain and to the fact that most of the trees are not commercially-desirable species.

Fire is an issue, spreading up from the fields and cleared areas in the woodland to the forest margin. But the forest, if healthy, should be able to withstand this unless the fires become very fierce and frequent. If, however, canopy trees were removed and grass started to come into the forest areas, fire could become a more significant threat to forest regeneration.

From what was seen during the visits made, the use of forest products by the local population is low. The biggest threat is probably hunting for bushmeat. Hunting with gin traps (Fig. 13) and snares is common, and is probably having a deleterious effect on small mammal populations. It is also likely some use is made of plants for traditional medicines. In times of insecurity, such as during the civil war, it was said that many families moved into the forest and lived there in small shelters. They also cleared some small fields (of a few square metres), evidence of which can still be seen. But, apart from bushmeat hunting, no clear evidence was seen of any damage to forest biodiversity.

It is unclear what plans the company (Mozambique Holdings?) that now owns the old tea estates has for their area, which lies immediately adjacent to the forest at its main access point to date. It seems they do not plan to restore or replant tea. If industrial-scale development does take place, with an influx of workers and families from elsewhere, this will pose a threat to the forest. This will be particularly on its lower margins as people start to use forest products unsustainably, and perhaps also start clearing small patches of forest for crops.

7.4 Ecological Requirements and Issues

The main ecological requirement from both a conservation perspective and from the viewpoint of provision of ecosystem services is to retain the ecological integrity of the forested areas over the Mabu massif. At present they are in a good state, and should retain this if the forest is not damaged by cutting, excessive fire or settlement. The forest is healthy, reproducing well, and can survive perturbations owing to drought and minor use; it does not need any particular management intervention other than protection from significant disturbance. It should be, in effect, left to its own devices. In addition, as the forests are

mostly on a massif, vegetation destruction below has far less effect than it would if destruction was "upstream".

Fig. 13. Local hunter with large gin trap, Mabu forest [JB].

Many forest birds are fruit-eaters and will disperse seeds between forests and montane massifs in their travels. For many smaller forest animals, such as the reptiles and amphibians, movement between mountains or forests is now probably not possible, so each mountain becomes effectively an "island". Over the millennia this will allow for evolution to occur, and subsequently possibly speciation. This is particularly important attribute if Mabu is looked at in a broader regional context as an important "stepping stone" allowing organisms to move between montane massifs. It is interesting to note that species previously thought to be endemic to a particular mountain, such as the bird Namuli Apalis on Namuli and the Mabu forest viper (*Atheris mabuensis*) on Mabu, have since been found on another massif nearby, showing that such movements were, at least in the past, possible.

The streams and rivers flowing down the slopes of Mabu are also significant, and their interconnections. Freshwater crabs will need good forest cover between separated rivers to recolonise. Bats are also known to use the slightly more open-canopy "passageways" along streams for hunting insects at night. Damage to the hydrology and the vegetation along rivers would have a wider effect than just to that locality.

7.5 Carbon Storage

Carbon storage is worthy of mention as there are possibilities for carbon accreditation schemes for Mabu's forest and the surrounding lands which could support conservation of the area. On this basis a carbon analysis was undertaken (Bayliss *et al.* 2014). The total carbon storage value including above-ground live vegetation, litter layer, coarse woody debris, below-ground live matter, and soil carbon is estimated to be around 3,634,539 Mg (3.6 Tg) for the forest area only. Following the carbon storage values presented in Willcock *et al.* (2012), if the total forest area was converted to bushland with scattered crops (117.8 Mg ha^{-1}) a value of 0.9 Tg of carbon would be lost, a loss of 2.7 Tg of carbon into the atmosphere. Likewise if the area was converted to woodland with scattered crops (183.3 Mg ha^{-1}) the value would be 1.4 Tg, a loss of 2.2 Tg of carbon.

8. MAIN BIOPHYSICAL FINDINGS

1. The most significant and important biodiversity on Mt Mabu, and the most important species for conservation, are found in the moist forest that covers over 60 km^2 above the

900 m contour line. This consists of mid-altitude forest from 900(1000) m up to around 1400 m, with montane forest above.

The other habitats of conservation interest are the bare rock on the peaks and montane shrubland. Montane grassland, so important for plant endemics on Mt Namuli and Mt Mulanje, is not present on Mabu.

2. Most of the new and endemic species and subspecies are reptiles and butterflies. There is only one (possibly two) endemic plant species. Small mammals (rodents, shrews, squirrels, primates) require more detailed study.

3. At present there are no immediate or major threats to the forests of Mabu, although encroachment of agricultural fields or commercial plantations could rapidly develop into a real threat. The increased frequency of wildfires does damage the forest margins and inhibits forest regeneration.

4. A Mabu conservation area should consist of a Core Area, with strong controls on any extractive human activity, above roughly the 900 m contour line, the great majority of which consists of moist forest, and a Buffer Zone consisting primarily of moist woodland, old tea estates, agricultural fields and settlements. There are at present no fields and no habitation above the 1000 m contour.

9. MAIN RECOMMENDATIONS

1. The principal recommendation is that the main Mt Mabu massif area should fall under some form of strong conservation protection. Its forests and biodiversity are unique, and there are a number of species found here and nowhere else.

2. The suggested conservation area is very similar to that proposed by JA! to the Provincial Governor of Zambézia in 2012. However, some significant areas of dense vegetation to the north-east lie outside the original proposed boundary. They should be incorporated so as to lie within a revised boundary.

3. The concept of a Core Zone is supported, a zone that is fully protected and with minimal extractive use, but within which tourism is encouraged. This Core Zone will include the great majority of the forest area above 900 m altitude. It would be surrounded by a Buffer Zone incorporating the commercial plantations, small-scale farmer's fields and settlements. This area, consisting primarily of woodland and secondary vegetation, would be the focus of any sustainable livelihoods and support programmes.

Specific Recommendations

4. There should be a sustainable livelihoods programme for local communities, which, amongst other activities, would focus on alternatives to meat for hunting, such as livestock-rearing.

5. Within the surrounding area and local communities there needs to be training in best agriculture practices to maximise yields from the land area under agriculture. This is especially important for the woodland areas on the lower slopes of the mountain which act as a buffer to the main forest area.

6. Examples of alternative technology should be investigated and installed where possible, such as small-scale hydro power (used in the colonial period on the eastern and southern slopes) and solar power to reduce pressures for fuelwood, although it is recognised that pressures on the forest for fuelwood or construction wood are low at present.

7. Payment for Ecosystem Services (PES) should be explored, highlighting the environmental services used by the surrounding communities and the tea estates provided by the forest and forest cover, especially the plentiful and clean water supply. Payment does not have to come in the form of direct financial contribution, but can also take the form of conservation actions that protect the forest area. The possibilities of getting involved in carbon accreditation schemes for the forest and surrounding woodlands should be investigated.

8. There is a need to develop Mabu as an ecotourism destination that will ensure a steady supply of visitors. Local communities can earn extra income in hosting such visitors, acting as porters and guides, and possibly also helping to run a visitor / research centre.

9. A visitor and research centre needs to be constructed, or created through renovating one of the derelict tea estate buildings. Funds have already been secured (USD 100,000) which were given in trust to JA! in 2014 to provide such a property. This needs to be achieved before the international focus on Mabu diminishes, which is already happening.

10. A Monitoring & Evaluation system needs to be put in place to measure the impact of conservation activities. This could be something as simple as recording number of visitors, an assessment of animals hunted, or monitoring of forest cover extent and change.

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ANNEX 1

TERMS OF REFERENCE

Name of Consultants: **Jonathan Timberlake & Julian Bayliss**

Reporting to: **Bruno Nhancale**

1. Background Information & Context

An assessment to the Mountain Mabu Greater Region, an area of approximately 300 km^2 in Central Mozambique, Zambézia Province, as showed that almost 28% of it is comprised by contiguous moist forest vegetation, that lies above 1000 m of altitude forming thus the Mt Mabu Massif (Timberlake *et al.,* 2012). From a series of inselbergs, Mt Mabu rises to become the highest, at 1700 m, above the surrounding lowland plains of the Greater Region, at around 350–450 m altitude. Mt Mabu is located just north of the Rio Lugela and west of Tacuane Administrative Post village in Lugela District. The mount is a granitic massif and is mostly covered in exceptionally well developed and little-disturbed moist forest, covering an estimated area of 7880 ha, with around 70% of the area being of rain forest found at medium altitude (1000–1400 m).

Mt Mabu is a well-recognized site of global importance for biodiversity conservation due to its outstanding high species richness and rates of endemicity. An illustrative example is a recently study on amphibians and reptiles, through both field identification and DNA barcoding, which have found additional 60% of new species to the existing list of species: thirteen species previously reported from Mount Mabu and nine species reported from the surrounding modified habitats near the tea estate and villages (Bayliss *et al.,* 2014).

This is because Mt Mabu is sufficiently rugged that it has attracted little agriculture except on the more gentle footslopes where itinerant familiar cultivation occurs and tea and other plantations are also established, conferring thus a degree of protection. Although the Mountain is 40 km away from the district centre, 85 km from the larger town of Mocuba and 200 km from the south-east of the provincial capital of Quelimane on the Indian Ocean coast. However, recent development policy and plans may increase the accessibility and demand of natural resources from the Mt Mabu Greater Region becoming thus a primary source for many ecosystems services and goods.

For instance, the road Mocuba to Milange (border with Malawi) is being tarred, the Mozambique Holding Lda (ex-Tea Madal State) has resumed tea plantation activities, the creation of Mocuba Special Economic Zone (ZEE) which adjoins with the Post Administrative of Tacuane can trigger over-exploitation of resources if these enabled development environment is not followed by a sound and scientific conservation management plan can peril the biodiversity of the Mt Mabu Greater Region.

From the above, Fauna and Fauna International (FFI) an organization which mission is to conserve threatened species and ecosystems, choosing solutions that are sustainable, scientifically sound and taking into account human needs, started the Mt Mabu Conservation Project in 2013. As such, FFI would like to hire a consultant to produce a Conservation Management Plan so that Governmental Institutions, NGO's, Universities, Developing Agencies and a wider community could use to guide decision-making and also serve as the first comprehensive wider conservation assessment that will be the baseline information to produce a legal binding Land Use Management Plan by the government in future.

1.1 General objective

The objective of the consultancy is to produce botanical and zoological components for the Conservation Management Plan for Mt Mabu Greater Region in order to advise on how to maintain or improve biodiversity values in the face of current development plans and a time horizon of 10 years.

1.2 Specific objectives

The specific objectives of the consultancy are to:

- Define and describe the Mt Mabu Greater Region based of ecological limits and if possible considering socio-economic and administrative aspects;
- Map the regional biodiversity pattern and process based on species distribution and ecosystems classification: fauna and flora species and vegetation envelopes;
- Establish and characterize landscape units, creating thus multiple zones which have different levels of protection purposes (e.g. no-go areas, partially protected, open access).

2. Specific tasks and responsibilities

2.1 Define and describe the Mt Mabu Greater Region

- Establishment of the natural limits of Mt Mabu Greater Region based on existing biodiversity and geological data and the extension of area needed to maintain important ecological processes.

2.2 Map the regional biodiversity pattern and process

- Classify and map ecosystems based types of vegetation, species predominance, altitude and soil.
- Produce a list of important zoological and botanical species (e.g. endemic, restricted range, endangered, keystones, umbrella) and map its distribution "ecological envelopes" based on existing data, expert opinion and distribution rules from similar habitats elsewhere (e.g. proximity to water, altitude, associated vegetation).
- Identify important ecological process and where possibly map spatially its occurrence pattern e.g. fire regimes necessary for vegetation succession and seeds dispersal, fish migration and water channels connectivity.

2.3 Establish Multiple Management Zones

- Establish the landscape units and assessment sub-units to assess the level of biodiversity richness, threat to loss and abundance representation.
- Produce recommendation how to manage the different landscape units and management zones based on conservation and socio-economic interests.