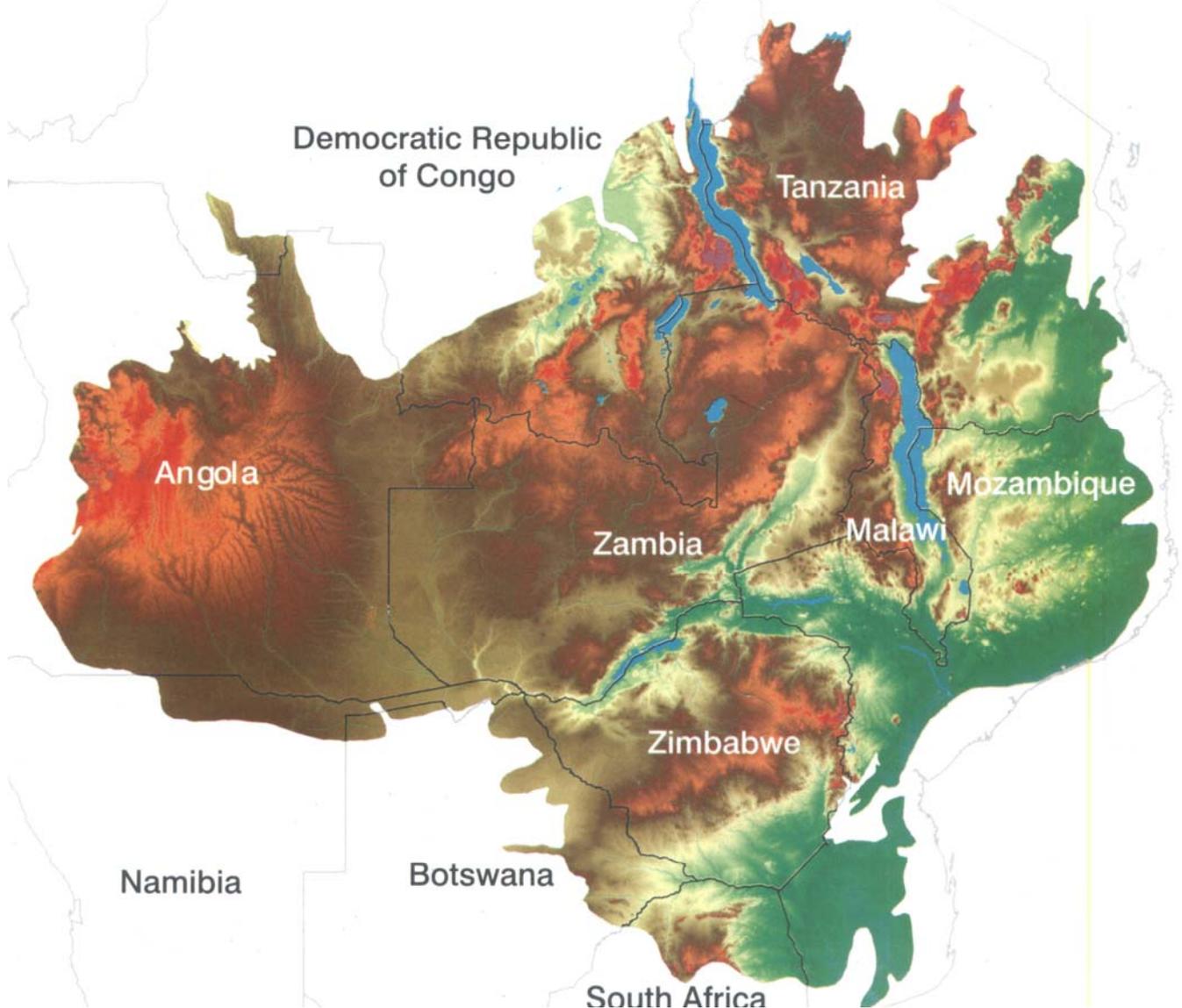




# THE MIOMBO ECOREGION

## AREAS OF BIOLOGICAL IMPORTANCE



J.R. Timberlake, F.P.D. Cotterill, P.J. Mundy,  
D.G. Broadley, B. Marshall, A.J. Gardiner & M. Fitzpatrick

September 2001 (published 2018)

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## INTRODUCTION

In 1998 the Conservation Science Program of the WorldWide Fund for Nature (WWF), part of WWF US, undertook to divide up Africa into what they termed ecoregions (Olson & Dinerstein 1998, Dinerstein *et al.* 2000, Burgess *et al.* 2004). An ecoregion is an area that is a relatively large unit of land or water, biologically distinct from its neighbours, which harbours a characteristic set of species, communities, dynamics and environmental conditions. As an initial part of this process, WWF's Southern African Programme Office (WWF SARPO) in Harare undertook a visioning and descriptive process for a set of ecoregions found across south-central Africa (Byers 2001a, 2001b, Timberlake & Chidumayo 2001, WWF 2001, 2003), an area later called the "Miombo Ecoregion" and designated as one of WWF's Global 200 Ecoregions (Olson & Dinerstein 1998). In reality, this is an agglomeration of a number of ecoregions, each characterised by deciduous woodlands with a dominance of various trees belonging to the legume subfamily Caesalpinioideae. Its mapped limits drew heavily on vegetation boundaries originally described by Frank White in his vegetation map of Africa (White 1983). However, this 'super ecoregion' also covered some associated vegetation types such as grasslands, wetlands and dry forests. The boundaries and the vegetation types comprising it are shown in Map 1.

The area covers 3.65 million km<sup>2</sup> across eleven countries – Angola, Namibia, Botswana, Zambia, Democratic Republic of Congo, Zimbabwe, Burundi, Tanzania, Malawi, Mozambique and South Africa (Byers 2001b, Figure 1) – and comprises most of the old African Plateau across southern and south-eastern Africa. There were a number of emergent properties that helped identify biological and ecological commonality across what is a very large region. The area and its attributes, and the vegetation comprising it, are described in the Miombo Ecoregion Vision report (Timberlake & Chidumayo 2001, now also available as a BFA Occasional Publication) and in two booklets (WWF 2001, 2003).

An important component of the Miombo Ecoregion vision process was the identification of areas of particular biodiversity interest, whether for high species diversity, the presence of endemic (range-restricted) or threatened species, significant populations, areas of migration, or areas of particular importance. These were to be mapped, group by group, and overlain in a geographic information system (GIS) in order to pick out areas of congruence that could form focal areas for subsequent conservation planning and action.

The Biodiversity Foundation for Africa was asked to produce a series of taxon-based maps for the Miombo Ecoregion using a common base map, with a brief justification for each. This was done rapidly in August/September 2001 in preparation for a large workshop held in Harare in September 2001, where a series of 20 areas of high biological and conservation interest were identified (see Timberlake & Chidumayo 2001, WWF 2003). These original maps with their supporting text were unfortunately never published or made widely available. With renewed interest in the (newly-named) Miombo–Mopane Ecoregion as a sub-continental planning framework, it was decided to tidy up the original hand-drawn maps and publish them in a more widely-available form.

The 36 maps are presented here by taxonomic group – plants, large mammals, small mammals, birds, herps (amphibians and reptiles), freshwater fish, butterflies and Odonata (dragonflies and damselflies). In most cases separate maps are given showing areas of high species diversity, areas with range-restricted species, and areas with threatened or rare species. After a vegetation

map, the areas with special or rare vegetation types are shown. For mammals and birds, additional maps are presented with areas of high population numbers or with important populations, and areas important for movement or migration. Important areas for fisheries, Important Bird Areas (the map presented here was drawn before the IBA book – Fishpool *et al.* 2001 – was published), and areas important for ecological goods and services are also presented. Finally, a series of maps giving a synthesis of areas of high species diversity, high endemism and of endangered species are given. Other maps show areas of evolutionary significance for aquatic and terrestrial species and biogeographical barriers.

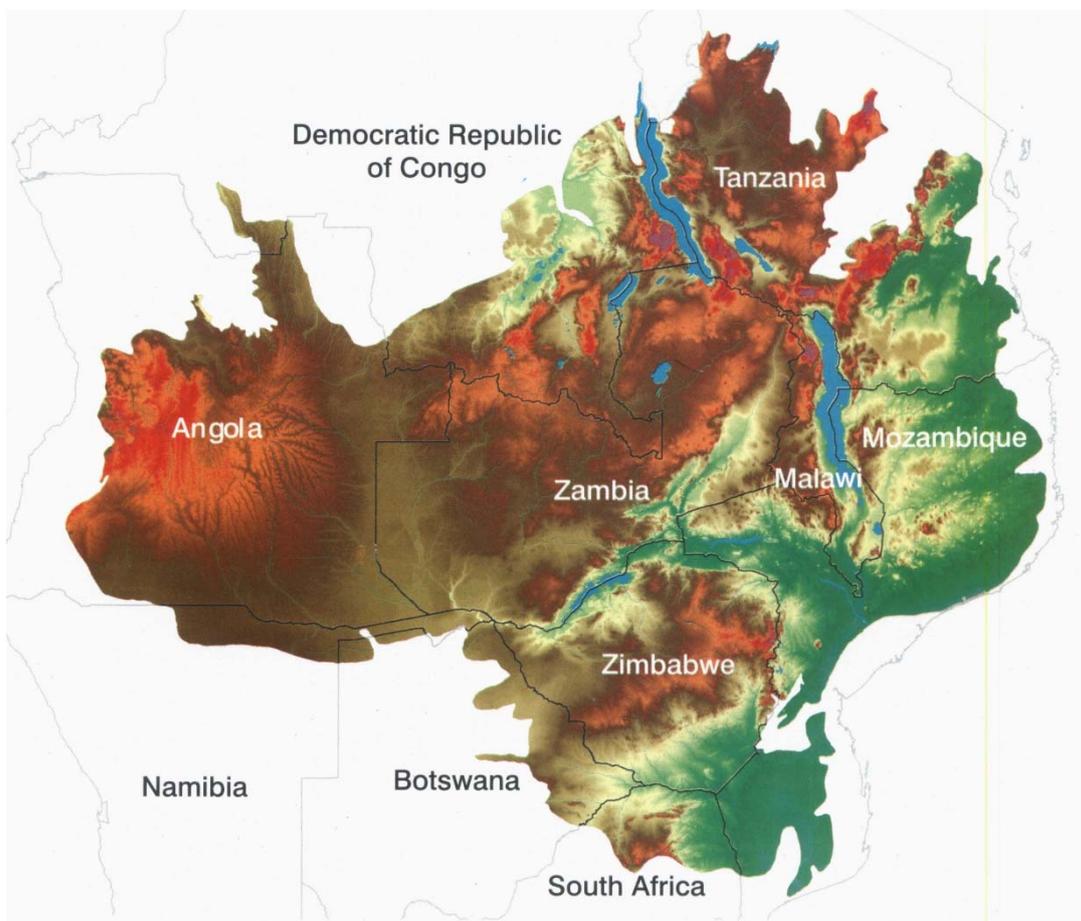


Figure 1. The Miombo Ecoregion, showing relief and political boundaries.

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## Map 1. Main Vegetation Types

1. **Wet Miombo Woodland** (1,358,175 km<sup>2</sup>). A floristically-rich woodland, often dense, with a canopy usually greater than 15 m high. Dominant species include *Brachystegia floribunda*, *B. glaberrima*, *B. taxifolia*, *B. wangermeeana* and *Marquesia macroua*. Annual rainfall is reliable and usually more than 1000 mm, but less in areas on Kalahari sands. The herbaceous layer comprises tall grasses such as *Hyparrhenia*. In the wettest areas the dominant trees are only briefly deciduous, the canopy is almost closed, and shade-tolerant species (such as Rubiaceae) are found in the understorey. (White 1983)

2. **Dry Miombo Woodland** (1,214,533 km<sup>2</sup>). This type is floristically poorer than wet miombo with *Brachystegia spiciformis*, *B. boehmii* and *Julbernardia globiflora* dominating. *B. floribunda* is generally absent. The canopy is generally less than 15 m in height and trees are deciduous for a month or more during the dry season. Species of *Acacia* are found on clay soils in drainage lines. Annual rainfall is less than 1000 mm and less reliable than further north. The herbaceous layer consists of medium to tall C4 grasses. In drier areas, *Julbernardia* and *Combretum* become dominant. There is an extensive area on Kalahari sands in central Angola dominated by thicket-forming *Brachystegia bakeriana*, which appears transitional to *Baikiaea* woodland. (White 1983)

3. **Evergreen Dry Forests (*Cryptosepalum*)** (37,908 km<sup>2</sup>). Dry evergreen forest dominated by *Cryptosepalum exfoliatum* subsp. *pseudotaxus* (mavunda) is found on Kalahari sands in western Zambia, to the east of the Zambezi floodplain. Most species found here are evergreen but are distinct from the moist forest species of the Congo Basin. The vegetation type is unique to this ecoregion. (White 1983)

4. ***Baikiaea* Woodland** (260,171 km<sup>2</sup>). This woodland type varies in structure from almost dry forest or thicket to a moderately dense woodland. It is characterised by a dominance of the deep-rooted tree *Baikiaea plurijuga* and is confined to deeper Kalahari sands. Canopy height varies from 8 to 20 m, depending on rainfall. Other typical species include *Burkea africana*, *Combretum collinum* and *Guibourtia coleosperma*. Dry miombo species such as *Brachystegia spiciformis* and *Erythrophleum africanum* become co-dominant in western Zimbabwe. Areas of thicket contain *Combretum celastroides*, *Pterocarpus lucens* and, occasionally, *Entandrophragma caudatum*. Both woodlands and thickets are deciduous, often for some months. Annual rainfall varies from 500 to 800 mm, but the deep sands absorb and retain moisture well.

5. **Mopane Woodland** (384,037 km<sup>2</sup>). This woodland type is characterised by a dominance, sometimes almost exclusive, of *Colophospermum mopane*. The canopy is from 6 to 18 m high, depending on climate and soil depth. Mopane is deciduous for some months of the year. Generally the grass layer is poorly developed. Associated species include *Acacia* and those from the Capparidaceae family. The woodland is species-poor. Shrub mopane is dominant in parts in the south.

6. ***Burkea* / *Terminalia* / *Combretum* Woodland** (96,162 km<sup>2</sup>). This rather impoverished type is found at the southern margins of the ecoregion. Although similar in structure and broad ecology to dry miombo woodland, it does not contain any of its defining species. Instead there is a high frequency of *Burkea africana*, *Terminalia sericea*, *Combretum* spp., *Pterocarpus* spp.,

*Pseudolachnostylis maprouneifolia* and other broad-leaved trees typical of dystrophic (nutrient-poor) woodland, along with species of *Acacia*, *Albizia* and *Peltophorum africanum*. It is, in some respects, a transition unit to microphyllous (*Acacia*) savanna. There are many rocky outcrops which support more moisture-demanding plant species.

7. **Itigi Thicket** (15,405 km<sup>2</sup>). Dry deciduous forests are found in the north east (the Itigi thickets of Tanzania and Zambia, dominated by *Baphia* and *Combretum* species and *Bussea massaiensis*). Further south, in the Zambezi and Shire valleys, are similar thickets characterised by early-deciduous *Combretum* shrubs and scattered emergent deciduous or evergreen trees. In places *Xylia torreana* forms a canopy. Many of these thicket patches are too small to map at the present scale. This vegetation type appears to be unique to the ecoregion.

8. **Acacia / Combretum Woodland** (103,887 km<sup>2</sup>). This type differs from the preceding broad-leaved, mostly dystrophic, woodland types. It comprises open woodland to wooded grassland dominated by species of *Acacia* and *Combretum*, often with trees from the legume subfamily Papilionoideae. There are two variants. One is found up on the central plateau in dry miombo in areas of nutrient-rich soil, sometimes locally called "munga". It consists of open woodland to wooded grassland with a well-developed grass layer, and is frequently burnt. Significant areas are found around the Kafue Flats in southern Zambia and around Lilongwe in central Malawi. Along with *Combretum* and *Terminalia*, a number of mesic *Acacia* and *Albizia* species occur, and species from the families Papilionoideae and Bignoniaceae. The other variant is found where the central plateau falls away to the Mozambique coastal plain and Zambezi valley in north-east Zimbabwe. The climate is generally warmer and fire less frequent. *Acacia* and *Combretum* species are very common, associated with *Lonchocarpus capassa*, *Xeroderris stuhlmannii*, *Sterculia africana*, *Adansonia digitata* (baobab) and *Cordyla africana*. Trees bearing large fruits and Papilionoideae are typical. Mopane is often present, but is not dominant or abundant, except in small patches. The grass layer is variously well or poorly-developed, depending on soil depth and rainfall. (Wild & Barbosa 1967, White 1983)

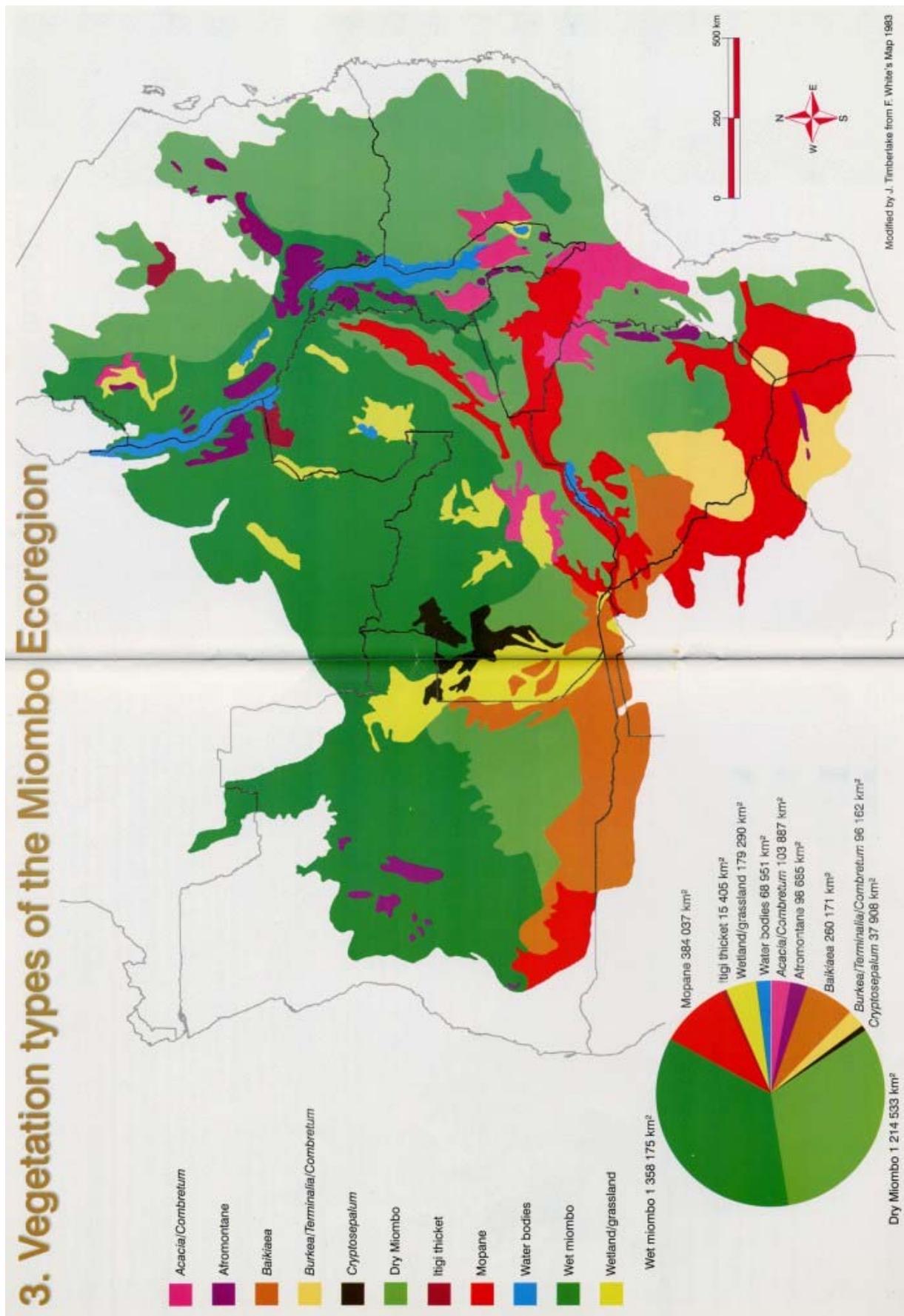
9. **Afromontane Vegetation** (98,685 km<sup>2</sup>). This type does not form part of the Miombo Ecoregion, but significant areas of it are found within the ecoregion's boundaries. It consists of a mosaic of moist evergreen forest and grasslands found on higher mountains across eastern Africa. Afromontane ecology is very different from that of the Caesalpinoid woodlands, but at the present mapping scale it is only possible to separate out larger patches, including Chimanimani and Nyanga in Zimbabwe, the Soutspansberg in South Africa, Mount Mulanje, Zomba Highlands, Kirk range, the Viphya and Nyika plateaux in Malawi, the Misuku Hills in Tanzania, and the forests associated with Lake Tanganyika in Congo and Tanzania.

10. **Wetland / Grassland** (179,290 km<sup>2</sup>). These are edaphic (soil-determined) grasslands, floodplains, dambos (seasonally waterlogged drainage grasslands) and wetlands are of sizeable extent in Zambia (Barotse floodplains, Kafue Flats, Busango, Lukango and Bangweulu swamps), Tanzania (Lake Rukwa, Mavowsi/Igombe) and in Malawi (Lake Chilwa). Wetland vegetation is often dominated by stands of papyrus (*Cyperus papyrus*) with floating-leaved aquatics. Floodplains are extensive areas flanking rivers that are occasionally flooded. They are usually more species-rich than wetlands, but are dominated by grasses and sedges. In seasonally-inundated areas, similar edaphic grasslands can be found with a rich geophyte flora. Dambo vegetation consists of open grasslands with scattered trees, often rich in forbs and suffrutex woody plants.

**11. Water Bodies** (68,951 km<sup>2</sup>). Areas of open water with little vegetation. The main water bodies are the artificial Lakes Kariba and Cabora Bassa, and the deep rift valley lakes of Lakes Malawi and Tanganyika.

**Note**

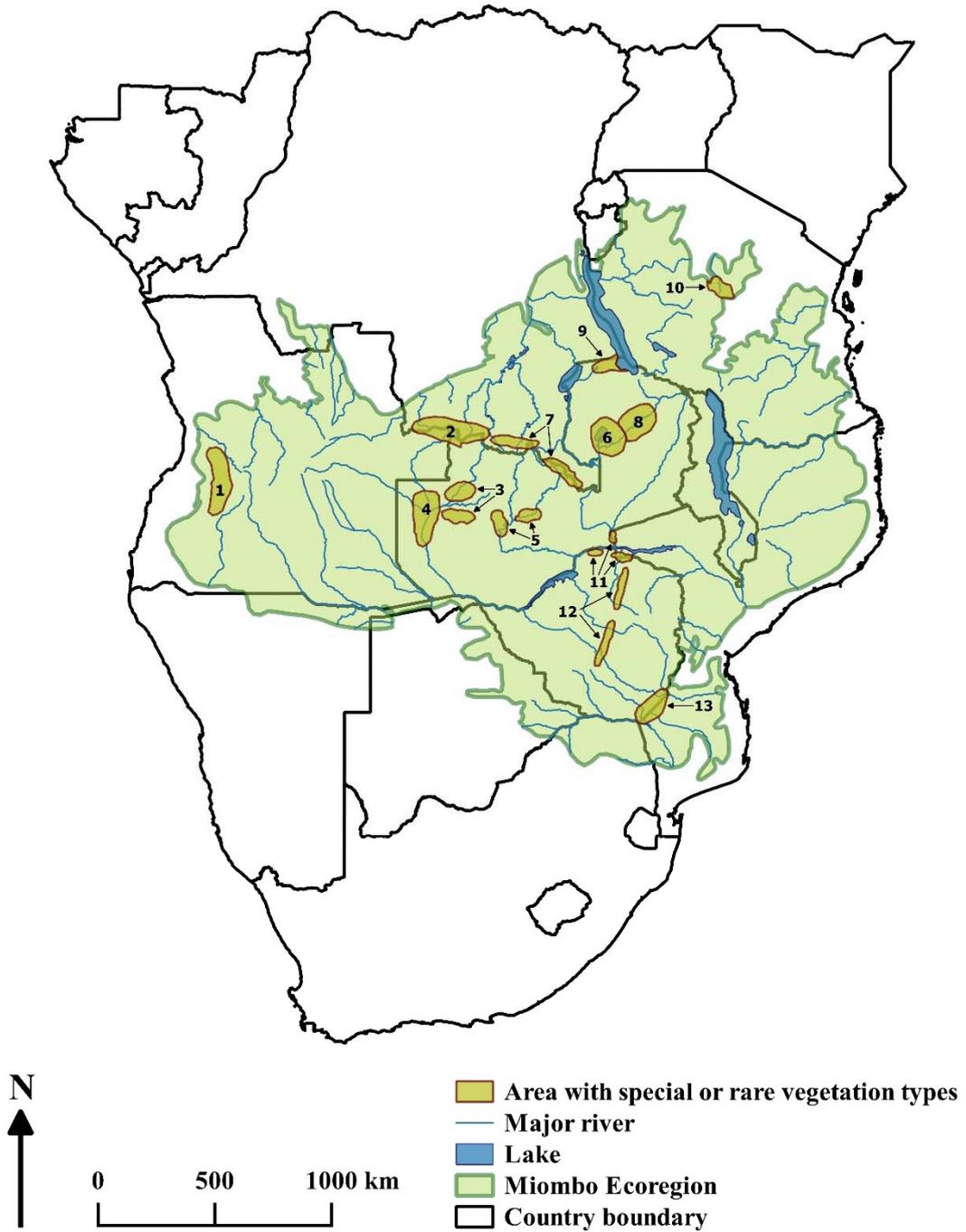
Strictly-speaking, Afromontane vegetation and water bodies (map units 9 and 11) do not form part of the Miombo Ecoregion. They are included here for convenience as they are found within the ecoregion's external boundaries. The total extent given excludes both.



## Map 2. Areas with Special or Rare Vegetation Types

1. **Angolan montane forest.** Westernmost extension of Afromontane forest. Could be considered part of the Afromontane Ecoregion. Species-rich and with a number of endemics. (White 1983).
2. **Mushitu forests.** A mosaic of rich forest types with both Zambezan and Congolian elements. Typical species include *Entandrophragma devevayi*, *Berlinia giorgii* and *Syzygium guineense*, with *Marquesia acuminata* in drier areas. The forests are interspersed with rich edaphic grasslands. Similar forests are scattered across N Zambia and southern D.R. Congo, but are particularly well developed and rich in the Ikelege pedicle in NW Zambia. (Werger & Coetzee 1978, White 1983)
3. **Cryptosepalum forest.** Dry evergreen forest dominated by *Cryptosepalum exfoliatum* (mavunda) occurring on Kalahari sand in Barotseland (W Zambia). This vegetation type is found across much of N Zambia, but is best developed and most extensive here. (White 1983)
4. **Barotseland floodplains, grasslands and pan mosaic.** Found in the middle reaches of the Upper Zambezi in W Zambia. Grasslands and dambos include many suffrutices. (Wild & Barbosa 1967, White 1983)
5. **Lukanga and Busango swamps.** Situated on the Kafue River in C Zambia. Extensive area of swamp vegetation. (Wild & Barbosa 1967, White 1983)
6. **Bangweulu Swamps.** Situated in NE Zambia at the headwaters of the Luapula River. Mostly floodplain grassland and swamp vegetation, but mushitu and mavunda (*Cryptosepalum*) forest patches are found close by. (Wild & Barbosa 1967, Werger & Coetzee 1978, White 1983)
7. **Kolwezi – Lubumbashi.** Two areas of cobalt and copper-rich soils in the Kolwezi-Lubumbashi area of southern D.R. Congo and the Kitwe area of the north-central Zambian Copperbelt. These differ from the ultrabasic serpentine soils of the Great Dyke in Zimbabwe. Comprise open woodland and bushed grasslands. There are 53 endemic (or near-endemic) taxa on these soils. (Brooks & Malaisse 1985).
8. **Marquesia woodland.** Dense evergreen woodland with patches of dry evergreen forest, locally termed mateshi. The most typical species is *Marquesia macroura*, with shrubs of *Bridelia divigneaudii* and the lianas *Strophanthus welwitschii* and *Landolphia* sp. The best area is between the Bangweulu swamps and Kasama in NE Zambia, but small patches can also be found along the Zambia/D.R. Congo border north of Ndola. Chipya is sometimes regarded as a degradation product of this type (but see Smith & Trapnell 2001). (Wild & Barbosa 1967)
9. **Mweru Wantipa thickets.** Dense thickets between Lake Mweru-Wantipa on the southern end of Lake Tanganyika. Similar to the Itigi thickets. Unique in Africa. (Wild & Barbosa 1967, White 1983)
10. **Itigi thicket.** Dry deciduous forest and dense thicket with emergent trees in C Tanzania. Unique in Africa. (White 1983)

**Map 2. Areas with Special or Rare Vegetation Types**



11. **Mid-Zambezi thickets.** Dry deciduous forest and dense thickets on sandy soils scattered through the middle Zambezi and lower Luangwa valleys. Most are dominated by *Xylia torreana*. (Wild & Barbosa 1967)

12. **Great Dyke.** Grasslands (owing to mineral toxic soils) in a narrow band running NE–SW through C Zimbabwe. Many endemics. Similar mineral-toxic or serpentine grasslands are rare, being otherwise principally confined to Katanga in southern D.R. Congo. (Wild 1965, White 1983)

13. **Limpopo thickets.** Dry deciduous thickets on Cretaceous sands in the Gonarezhou National Park / N Kruger National Park / Chicualacuala District of SE Zimbabwe, NE South Africa and SW Mozambique. Typical species include *Guibourtia conjugata* and *Androstachys johnstonii*.

#### **Note**

There are a number of additional areas of special vegetation types – principally moist forest and high-altitude grasslands – but these are best regarded as part of the Afromontane Ecoregion. Examples include:

- Misuku Hills (northern end of Lake Malawi);
- Nyika Plateau (N Malawi)
- Mount Mulanje (S Malawi);
- Eastern Highlands forest and grassland – Nyanga, Vumba, Chimanimani, Chirinda (E Zimbabwe).



### Map 3. Areas of High Plant Species Diversity

1. **Highlands and escarpments of Huila, Huambo and Bié Provinces.** Area of wooded highlands with grasslands and escarpments in W Angola. High altitude wooded grassland mixed with miombo woodland and gallery forest; scrub and thicket lower down. Many of Angola's 1260 endemic plant species are found in these highlands and escarpments. Total species number not available. (Monteiro 1970, Werger & Coetzee 1978, Davis *et al.* 1994)

2. **Cuango.** Area in N Angola and southwestern D.R. Congo associated with the Cuango and Kwenge rivers in Malange and Uige provinces. Low-lying mosaic of humid riverine and escarpment forests and dry *Marquesia* forests, alternating with undulating plains of tall savanna vegetation. A transitional zone between Guineo-Congolian and Zambesian vegetation, similar to that around the Zambezi headwaters. Total species number not available. (Monteiro 1970, Werger & Coetzee 1978)

3. **Zambezi Headwaters.** Area of around 4000 km<sup>2</sup> (1700 km<sup>2</sup> in NW Zambia) associated with the headwaters and watershed of the Zambezi River where NW Zambia, NE Angola and southern D.R. Congo join. It comprises riverine and swamp forest, dry evergreen forest, miombo woodland, scrub, suffrutex savanna and dambos. The high species richness results from a mosaic of Guineo-Congolian and Zambesian vegetation. There are at least 950–1000 species, but few endemic plants; most species are more widespread to the north or south. (Davis *et al.* 1994)

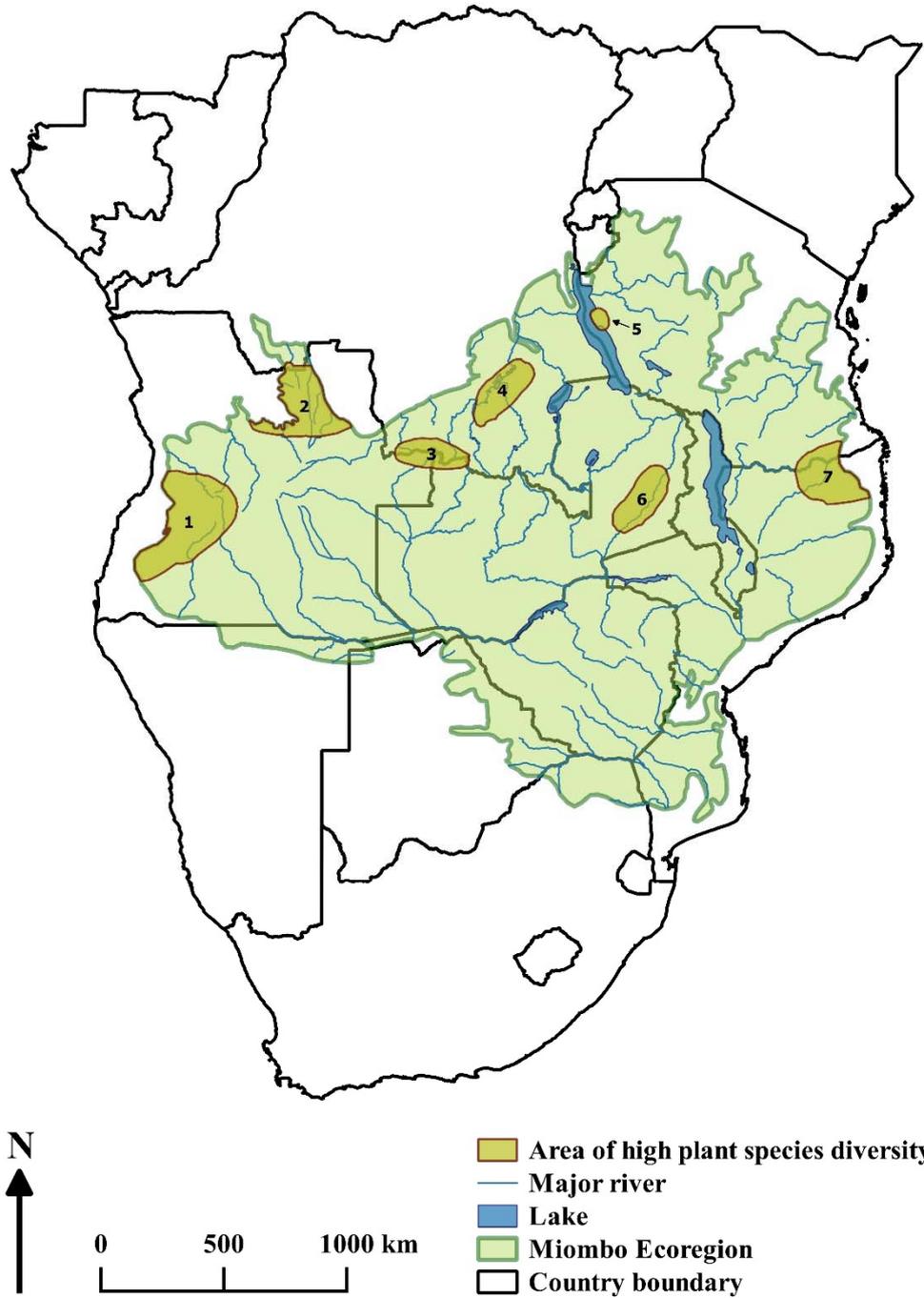
4. **Upemba National Park.** Area in Shaba Province, southern D.R. Congo of around 12,000 km<sup>2</sup>, comprising rich miombo woodland, dry evergreen forest, *Acacia* woodland (chipya), grassland, swamps and riparian forest. Also a transition zone between Guineo-Congolian and Zambesian vegetation. Around 2400 species, especially rich on poor soils. Some mineral-toxic endemics. (Davis *et al.* 1994)

5. **Mahale–Karobwa Hills.** Area on the eastern shore of Lake Tanganyika in Tanzania of around 4000 km<sup>2</sup>, rising to peaks of over 2000 m. Comprises Congolian rainforest, miombo woodland at lower levels (900–1800 m) and open grassland. There are over 2000 plant species, but some of these are montane and do not properly belong to the Miombo Ecoregion. (Davis *et al.* 1994)

6. **Luangwa Valley.** Area in a rift valley covering 40,000 km<sup>2</sup> in E Zambia. Comprises *Acacia*, *Combretum* and mopane woodlands, with miombo woodland on the Muchinga escarpment. Thickets, grasslands and riparian forests are also present. 1350 species recorded. (Davis *et al.* 1994, Astle *et al.* 1997, Smith 1997)

7. **Lower Rovuma.** Area in NE Mozambique incorporating plateau, lowland and inselbergs. Vegetation comprises miombo and *Acacia* woodland, dry deciduous forest and thicket, and dwarf shrubland on the inselbergs. The area is transitional between Zambesian and East African coastal vegetation. It has not been well studied, but is known to be rich. Species number is not known. (Werger & Coetzee 1978, White & Moll 1978)

**Map 3. Areas of High Plant Species Diversity**



### Other possible areas of high species richness

- Middle Zambezi Valley (N Zimbabwe/SE Zambia/NW Mozambique). Very similar to the Luangwa Valley.
- Eastern Highlands (E Zimbabwe). Transitional zone between Zambezian and Afromontane vegetation, with East African coastal elements at lower altitudes.
- Nyika Plateau slopes (N Malawi). Transitional zone between Zambezian and Afromontane (forest and grassland) vegetation.
- Shire Valley (S Malawi). Rift valley lowland flora with elements of both Zambezian and East African coastal vegetation on the valley bottom, and transitional to Afromontane (e.g. Shire Highlands, Zomba, Mt Mulanje) on slopes.
- Gorongosa National Park / Cheringoma Plateau (C Mozambique). Although the rift valley vegetation is Zambezian, the Cheringoma Plateau is best regarded as East African coastal, so it falls outside the Miombo Ecoregion. The slopes of Gorongosa mountain are transitional to Afromontane.
- Plateau areas in NW Mozambique and SW Tanzania. These are best regarded as East African coastal vegetation types, but there is a large element of Zambezian species.

### **Notes**

Most areas of high species richness are transition zones between Zambezian vegetation types (those predominantly composed of plant species typical of the broadly-defined Miombo Ecoregion) and other, richer phytochoria such as Guineo-Congolian (mostly moist rainforest), East African coastal (lowland evergreen forest) and Afromontane (highland evergreen rainforest). The Miombo Ecoregion otherwise does not appear to have significant "hot spots" of general plant species richness. Moister areas to the north have significantly more species than drier areas to the south and south west.

## Map 4. Areas of High Plant Species Endemism

- 1. Highlands and escarpments of Huila, Huambo and Bié Provinces.** Area of highland woodland, grassland and escarpment woodland in W Angola. Many of Angola's 1260 endemic plant species are found in these highlands and escarpments. (Monteiro 1970, Werger & Coetzee 1978, Davis *et al.* 1994)
- 2. Barotse Centre.** A very extensive area of endemism on Kalahari sands in W Zambia/SE Angola/ NE Botswana/NW Zimbabwe, associated with the Upper Zambezi, Kwando and Kavango rivers. Mostly miombo and *Baikiaea* woodlands, edaphic grasslands and floodplains. *Baikiaea plurijuga*, *Cryptosepalum exfoliatum* and a large range of suffrutex plants are typical. (White 1965, Werger & Coetzee 1978)
- 3. Katangan Centre (Haut Shaba).** A large area on the watershed of the Kafue, Luapula and Congo rivers incorporating nutrient-poor plateau woodland (some rich in copper and cobalt), swamps, grasslands and forests. About 1450 species present, with over 300 endemics, many confined to high metal soils. (White 1965, Werger & Coetzee 1978, Davis *et al.* 1994)
- 4. Mweru Wantipa thickets.** A small area between Lake Mweru Wantipa and the southeast corner of Lake Tanganyika in NE Zambia. Thicket and dry deciduous forest vegetation very similar to that of the Itigi thickets, dominated by *Baphia*, *Bussea* and *Pseudoprosopis*. Contains species confined to these thicket types. (White 1983, Davis *et al.* 1994)
- 5. Itigi thicket.** Area of around 130 km<sup>2</sup> in C Tanzania between Tabora and Dodoma. Thicket and deciduous forest vegetation on specialised soils, very distinct in composition from surrounding miombo woodland. Dominated by *Baphia*, *Bussea massaiensis* and *Pseudoprosopis fischeri*. Contains a number of species confined to these thicket types, which are very localised. (White 1983, Davis *et al.* 1994)
- 6. Kariba – Luangwa Centre.** Area of rift valley lowland, valley bottoms and escarpments in the middle Zambezi valley (N Zimbabwe/S Zambia/NW Mozambique) and the Luangwa Valley (E Zambia). Mostly comprising dry woodlands, thickets and riparian forest, with miombo woodland on the escarpments. At least 8 woody species are confined to this area, but can be found outside it on termitaria. (White 1965, Werger & Coetzee 1978, Davis *et al.* 1994)
- 7. Kolwezi – Lubumbashi.** Two areas (mostly in Shaba Province) of cobalt and copper-rich soils totalling 35,000 km<sup>2</sup> in the Kolwezi-Lubumbashi area of southern D.R. Congo and the Kitwe area of the NC Zambian Copperbelt. These differ from the ultrabasic serpentine soils of the Great Dyke in Zimbabwe. There are 53 endemic (or near-endemic) taxa on these soils. (Brooks & Malaisse 1985)
- 8. Great Dyke.** A long linear geological formation running for over 500 km NE–SW across Zimbabwe, composed of ultrabasic rocks with significant areas of mineral-toxic soils. The area is divided into a northern and southern section. Although just over 300 species have been recorded from the serpentine soil areas, 25 of them are endemic. (Wild 1965, Davis *et al.* 1994)

**9. Limpopo Valley.** Low-lying and arid area along the Limpopo River from E Botswana, through S Zimbabwe and N South Africa to S Mozambique. A number of semi-arid species are confined to this broad area, including various *Acacia* species. (White 1983)

#### Other Possible Areas of High Species Endemism

- Rondo Plateau (S Tanzania). This is a very important area of endemism, but is best considered as part of the East African Coastal Ecoregion.
- Limpopo escarpment hills (S Zimbabwe). Scattered endemics are found on the slopes of hills associated with the poorly-defined Limpopo escarpment, such as the Matobo, Buchwa, Chibi.

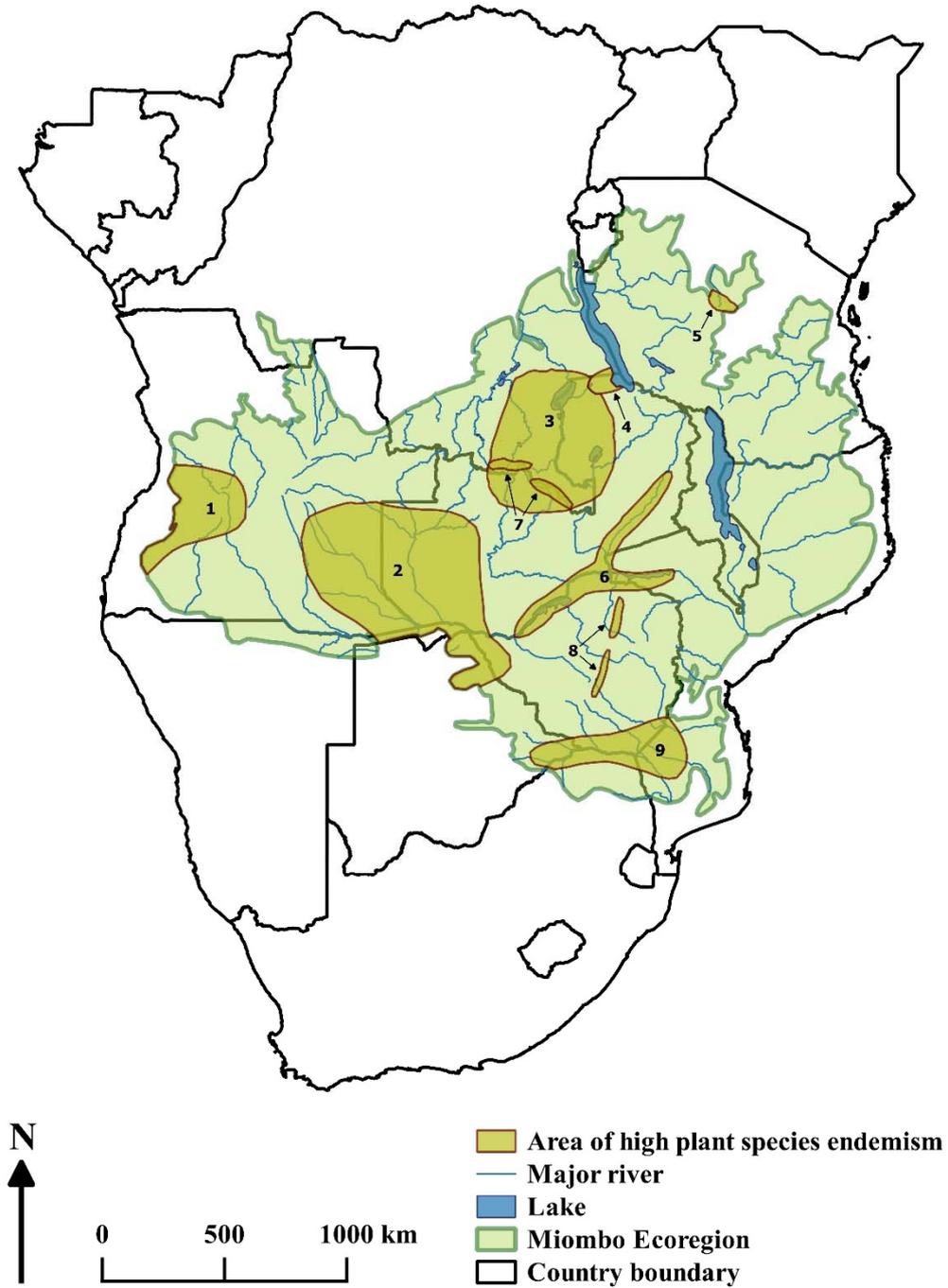
#### **Notes**

Most of the endemics in south central Africa are associated with montane grassland and with coastal or lowland forests, both of which lie outside the Miombo Ecoregion.

The Katangan and Huila–Bié areas are probably the richest for endemic species, followed by the very extensive Barotse Centre.

Data on any possible areas of local endemism in Malawi and Mozambique are lacking.

**Map 4. Areas of High Plant Species Endemism**



## Map 5. Areas with Globally Endangered Plant Species

1. **Ikelenge Pedicle** (NW Zambia). Area of mushitu riparian forest and grasslands which is now being cleared and settled by refugees and others. (Zambian Plant Red Data List)
2. **Cryptosepalum forest** (W Zambia). Dry evergreen forest dominated by *Cryptosepalum exfoliatum*. Major threats are overexploitation and clearance for cultivation. (Zambian Red Data List)
3. **Mateshi evergreen thicket/forest** (NE Zambia). Dense evergreen woodland and dry forest on richer soils dominated by *Marquesia macroura*. Major threats are overexploitation and clearance for cultivation. (Zambian Red Data List)
4. **Itigi-type thicket** (N Zambia). Area of unique *Bussea* thicket/dry forest between Lake Mweru-Wantipa and Lake Tanganyika. Clearance for cultivation is the major threat. (Zambian Red Data List). It is probable that the Itigi thicket in SW Tanzania is also under severe threat; it contains many potentially threatened species.
5. **Limpopo escarpment hills** (S Zimbabwe). An area of scattered hills catching moist airflows during the long dry season. It contains a number of endemics or species of very limited distribution, which are under threat of overexploitation or habitat destruction.
6. **Limpopo lowveld** (S Zimbabwe, N South Africa, SW Mozambique). Extensive area of dry woodlands and shrublands, with scattered thickets. A number of species of restricted distribution are confined to this transfrontier area. Threats are habitat destruction and, to a lesser extent, damage by elephant and cattle.

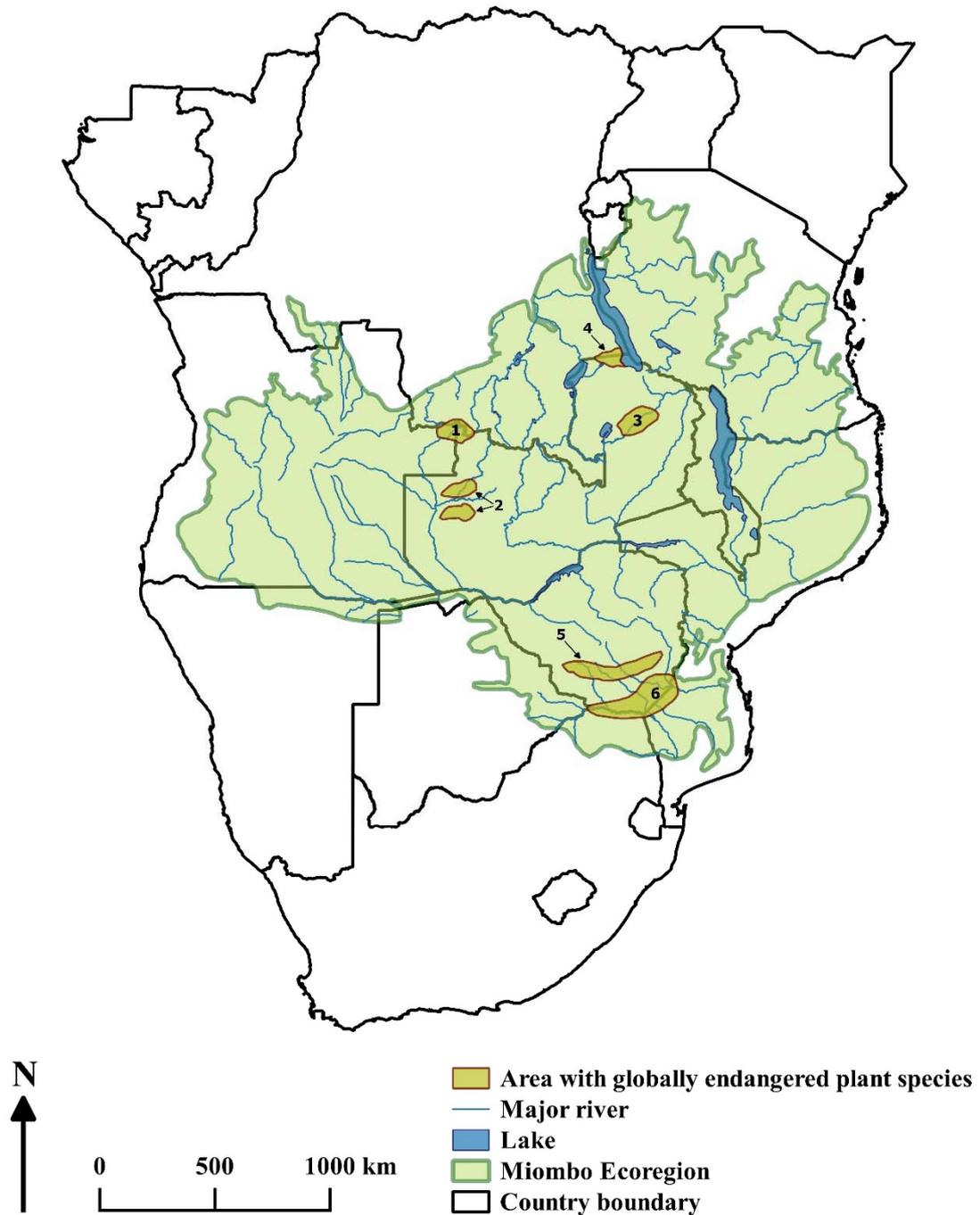
### Note

The map is limited as the only data available to date are from Namibia, South Africa, Zambia and Zimbabwe. Plant Red Data Lists should become available soon for Angola, Botswana, Malawi and Mozambique under the SABONET project.

Many threatened taxa in the region are found in Afromontane or coastal forests. These have not been included in the map presented here. For Zimbabwe, such areas would include Nyanga, Rusitu Valley and Chirinda; for Malawi, Nyika, Mount Mulanje and the Shire Highlands; and for Mozambique, Mount Gorongosa and the coastal forests in both the north and south of the country.

Most of the plant species on the WCMC List of Threatened Trees (Oldfield *et al.* 1998) are confined to montane or coastal forests, outside of the Miombo Ecoregion.

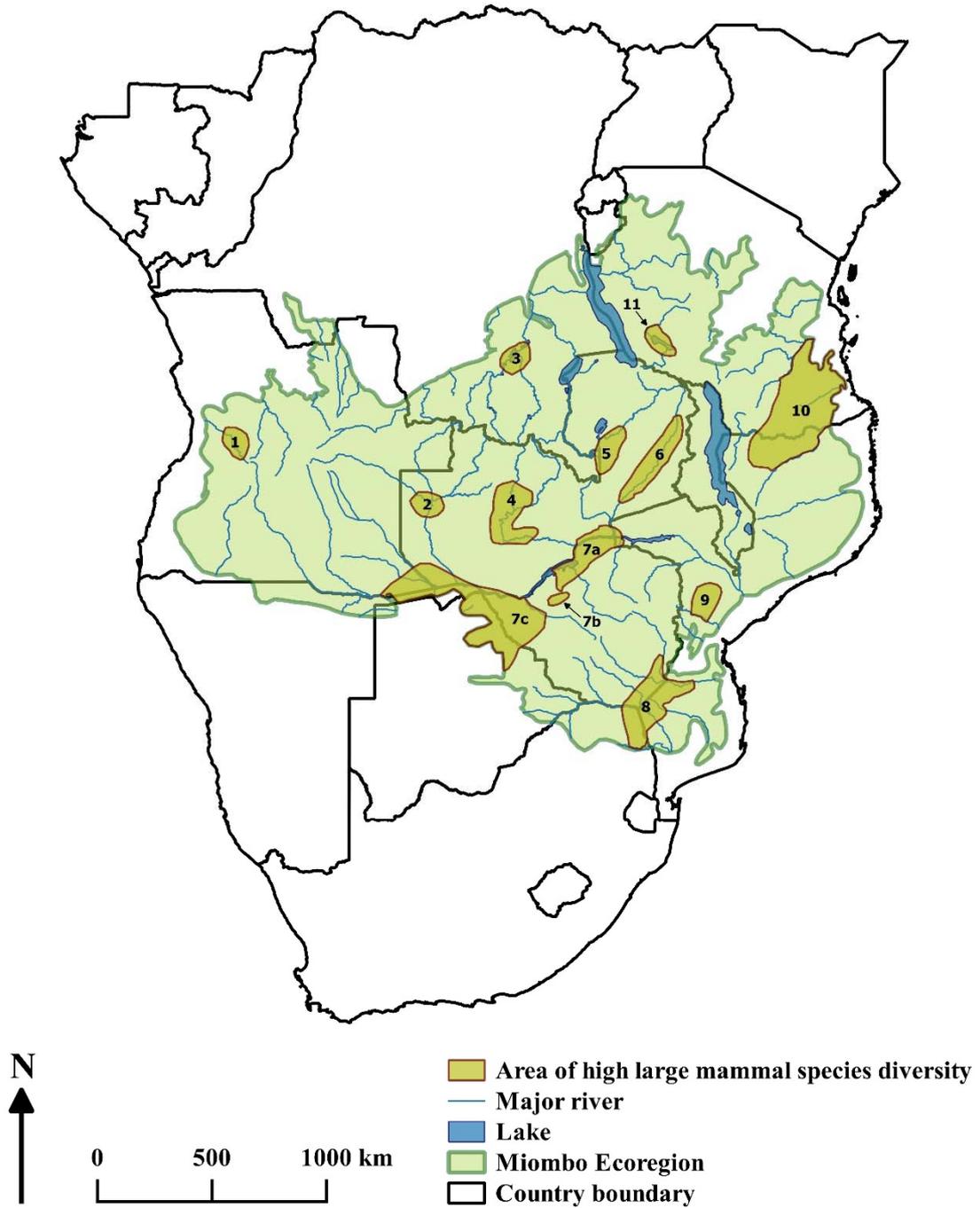
**Map 5. Areas with Globally Endangered Plant Species**



## Map 6. Areas of High Large Mammal Species Diversity

1. **Luando.** Bovids; *Hippotragus variani* and *Kobus 'leche'* complement a wide diversity of savanna bovids.
2. **Liuwa Plains.** Bovids.
3. **Upemba – Kundelungu.** Bovids and primates. Representative fauna of large mammals.
4. **Kafue.** Bovids and carnivores.
5. **Bangweulu – Kasanka – Katanga pedicle.** Bovids, notably puku, *Kobus vardoni*, yellow-backed duiker *Cephalophus sylvicultor* and Crawshay's waterbuck *Kobus crawshawi*.
6. **Luangwa.** Primates, bovids, carnivores. Representative fauna of large mammals.
7. **Sioma – Luiana – Caprivi – Chobe – Hwange – Sebungwe – Middle Zambezi.** Representative fauna of all mammals, but especially bovids and carnivores.
8. **Kruger – Gonarezhou – Banhine – Zinave** (including SE lowveld conservancies). Representative fauna of all mammals, notably bovids, primates and carnivores.
9. **Gorongosa – Cheringoma.** Bovids, carnivores, primates. Representative fauna of all mammals, but especially bovids and carnivores. Includes indeterminate horseshoe bat.
10. **Niassa Reserve – Selous – Kilombero.** Representative fauna of large mammals.
11. **Rukwa.** Unusual bovid assemblage. Southern African fauna (including *Kobus vardoni*), and complementing *Giraffa camelopardalis tippelskirchi*, and *Damaliscus jimela*.

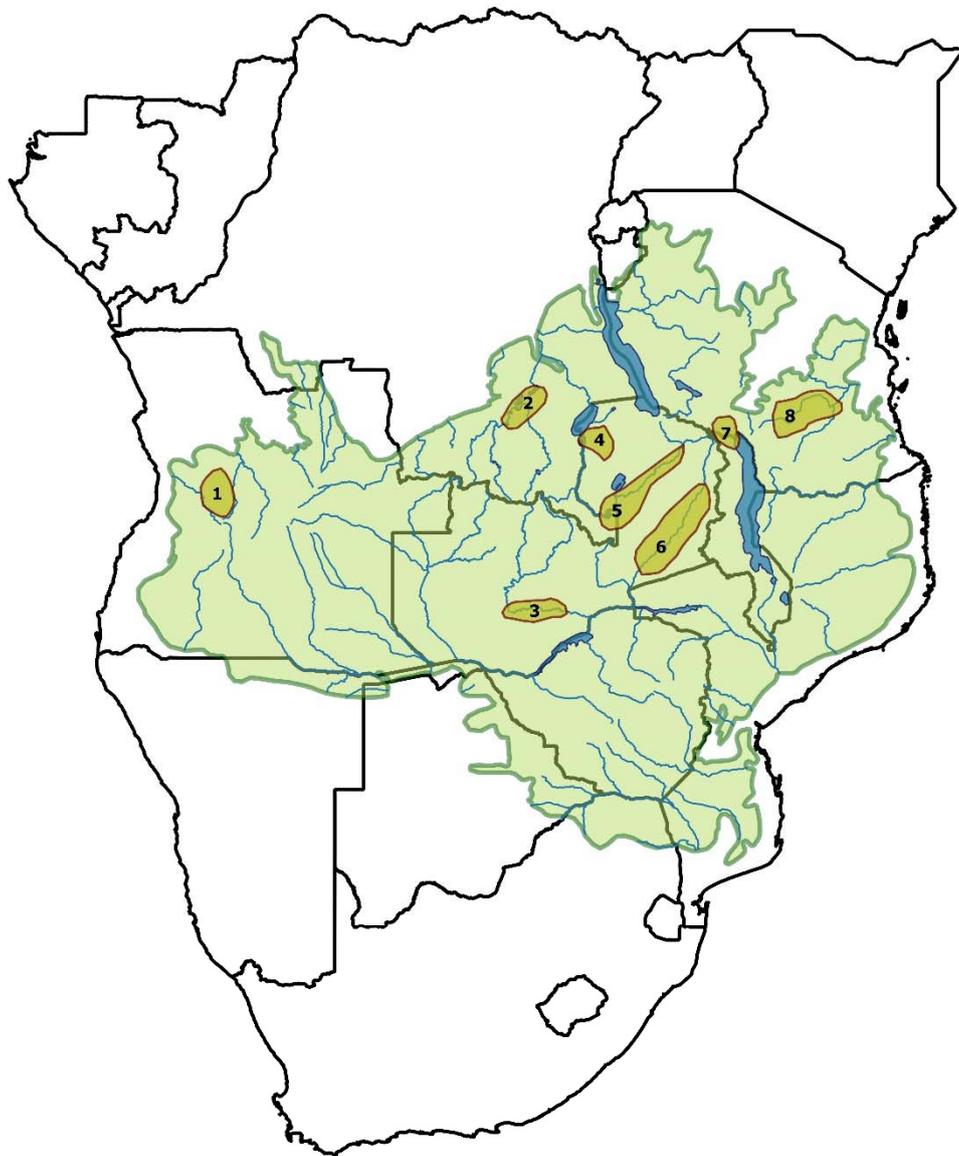
**Map 6. Areas of High Large Mammal Species Diversity**



## Map 7. Areas of Large Mammal Endemism

1. **Luando.** *Hippotragus variani*, *Kobus "leche"*.
2. **Upemba.** *Kobus* sp.
3. **Kafue Flats.** *Kobus kafuensis*.
4. **Kalungwishi – Lavushi Munda.** *Kobus robertsi*. Apparently extinct c.1950s. This region is poorly known with few collections of mammals.
5. **Bangweulu – Kasanka – Katanga pedicle.** *Kobus smithemani*, *Damaliscus* sp., Bangweulu Tsessebe.
6. **Luangwa.** *Giraffae thornicrofti*, *Connachaetes cooksoni*, *Kobus senganus*, *Cercopithecus moloneyi*.
7. **Northern Malawi Rift – Vipyra Plateau.** *Cercopithecus francescae*, *Paraxerus lucifer* in part.
8. **Kilombero – Ruaha.** *Kobus "senganus"*, *Piliocolobus gordonorum*.

**Map 7. Areas of Large Mammal Endemism**



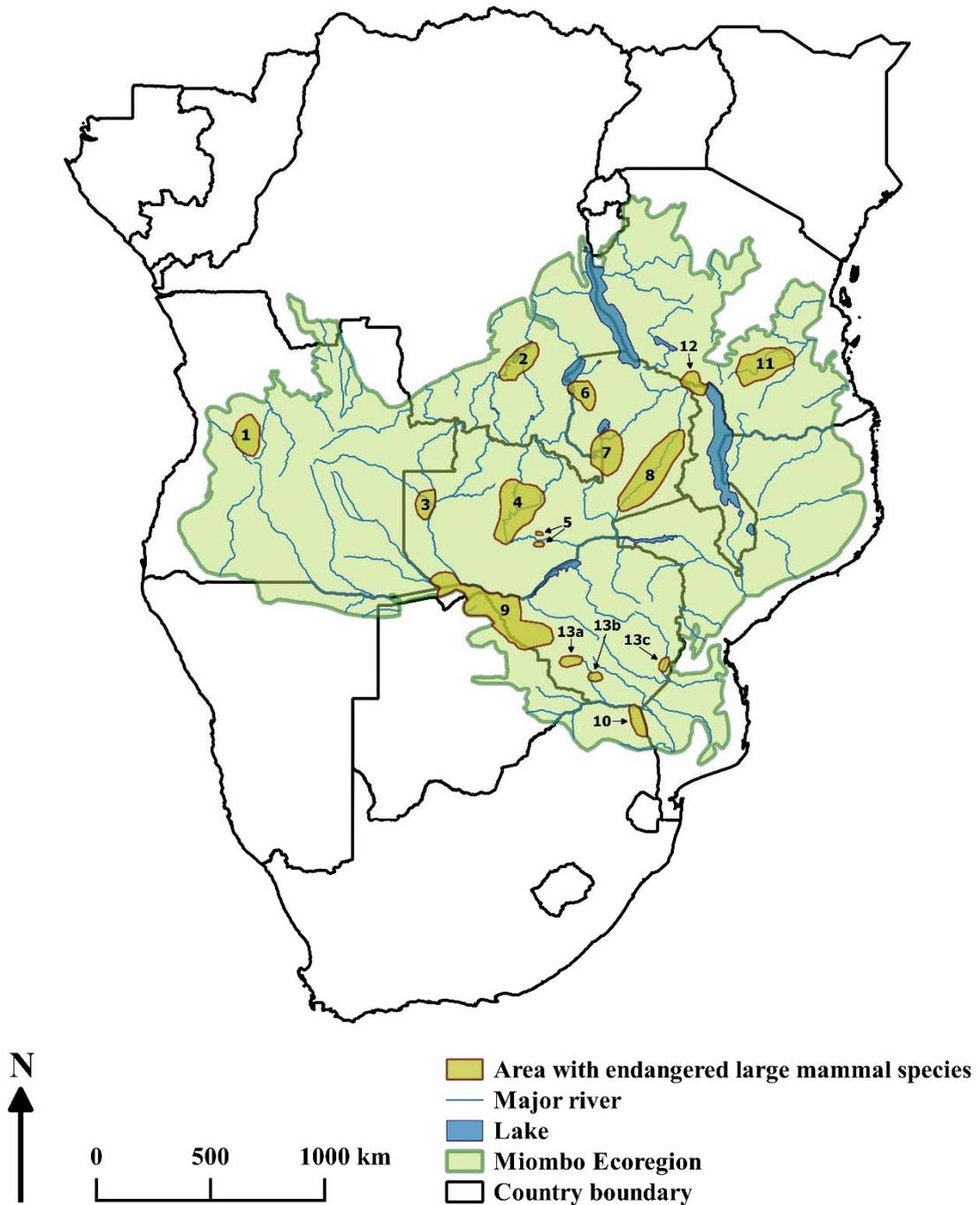
0 500 1000 km

-  Area of large mammal endemism
-  Major river
-  Lake
-  Miombo Ecoregion
-  Country boundary

## Map 8. Areas with Endangered Large Mammal Species

1. **Luando.** *Hippotragus variani*, *Kobus "leche"*.
2. **Upemba National Park.** *Kobus* sp.
3. **Liuwa Plain.** *Hippotragus equinus*, *Damaliscus lunatus*.
4. **Kafue – Lunga – Busanga.** *Hippotragus equinus*. Roan antelope have undergone radical decline through 20th century. The populations in Kafue and adjacent GMAs have collapsed in the past two years.
5. **Kalungwishi – Lavushi Munda.** *Kobus robertsi* (presumed extinct).
6. **Bangweulu – Kasanka – Katanga pedicle.** *Kobus smithemani*, *Damaliscus* sp., Bangweulu Tsessebe, *Kobus vardoni*, *Hippotragus equinus*.
7. **Luangwa Valley.** *Giraffae thornicrofti*, *Connachaetes cooksoni*, *Kobus senganus*, *Cercopithecus moloneyi*, *Hippotragus equinus*, *Diceros bicornis*.
8. **Lochinvar and Blue Lagoon National Parks.** *Kobus kafuensis*.
9. **Sioma – Luiana – Caprivi – Chobe – Hwange.** *Damaliscus lunatus*, *Kobus vardoni* (Chobe), *Diceros bicornis* (Sinamatella), *Ceratotherium simum*, *Hippotragus equinus*.
10. **Kruger National Park.** *Hippotragus equinus*, *Damaliscus lunatus*, *Diceros bicornis*.
11. **Kilombero – Ruaha.** *Kobus 'senganus'*, isolated population in Kilombero valley. The Uzungwa Red Colubus *Piliocolobus gordonorum* is endangered.
12. **Northern Malawi Rift – Vipya Plateau.** *Cercopithecus francescae*.
13. **Southern Zimbabwe.** (a) Matopos National Park, (b) Bubiana Conservancy, (c) Save and Malilangwe conservancies; *Diceros bicornis*.
14. **Matusadona National Park & Omay communal land.** *Hippotragus equinus*, *Diceros bicornis*.

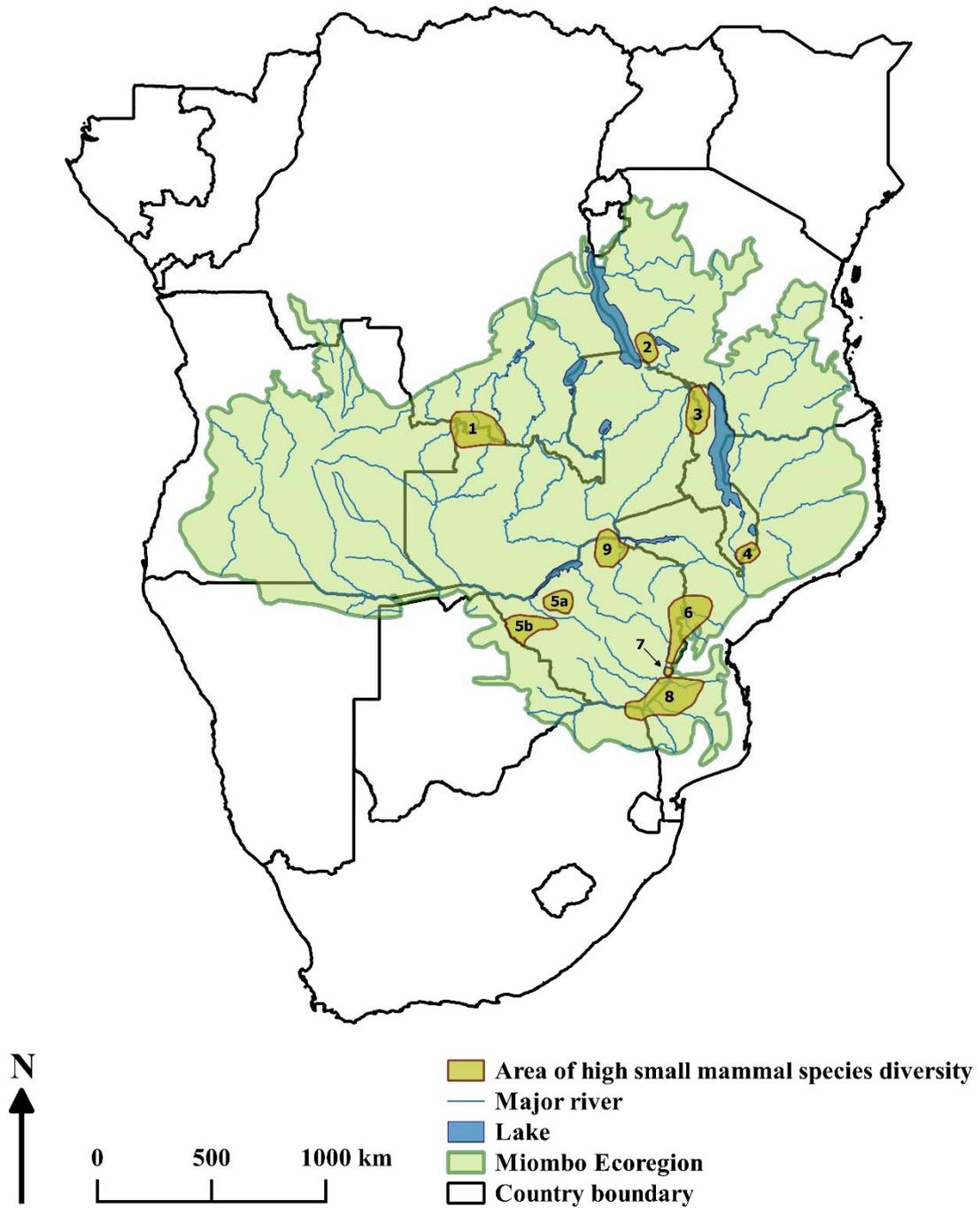
**Map 8. Areas with Endangered Large Mammal Species**



## **Map 9. Areas of High Small Mammal Species Diversity**

1. **Mwinilunga – Ikelenge Pedicle – Solwezi.** All taxa.
2. **Ufipa Plateau.** Rodents.
3. **Misuku Mountains & Nyika Plateau**
4. **Mlanje – Ruo – Chiromo.** Chiroptera.
- 5a. **Sebungwe.** Chiroptera, rodents.
- 5b. **Sinamatella – Bumbusie – Gwayi Valley.** Chiroptera.
6. **Eastern Highlands – Chimanimani – Gorongosa.** Chiroptera.
7. **Chirinda Forest.** Rodents, Chiroptera.
8. **Pafuri – Gonarezhou – Banhine – Zinave.** rodents, Chiroptera.
9. **Chewore – Dande.** Chiroptera.

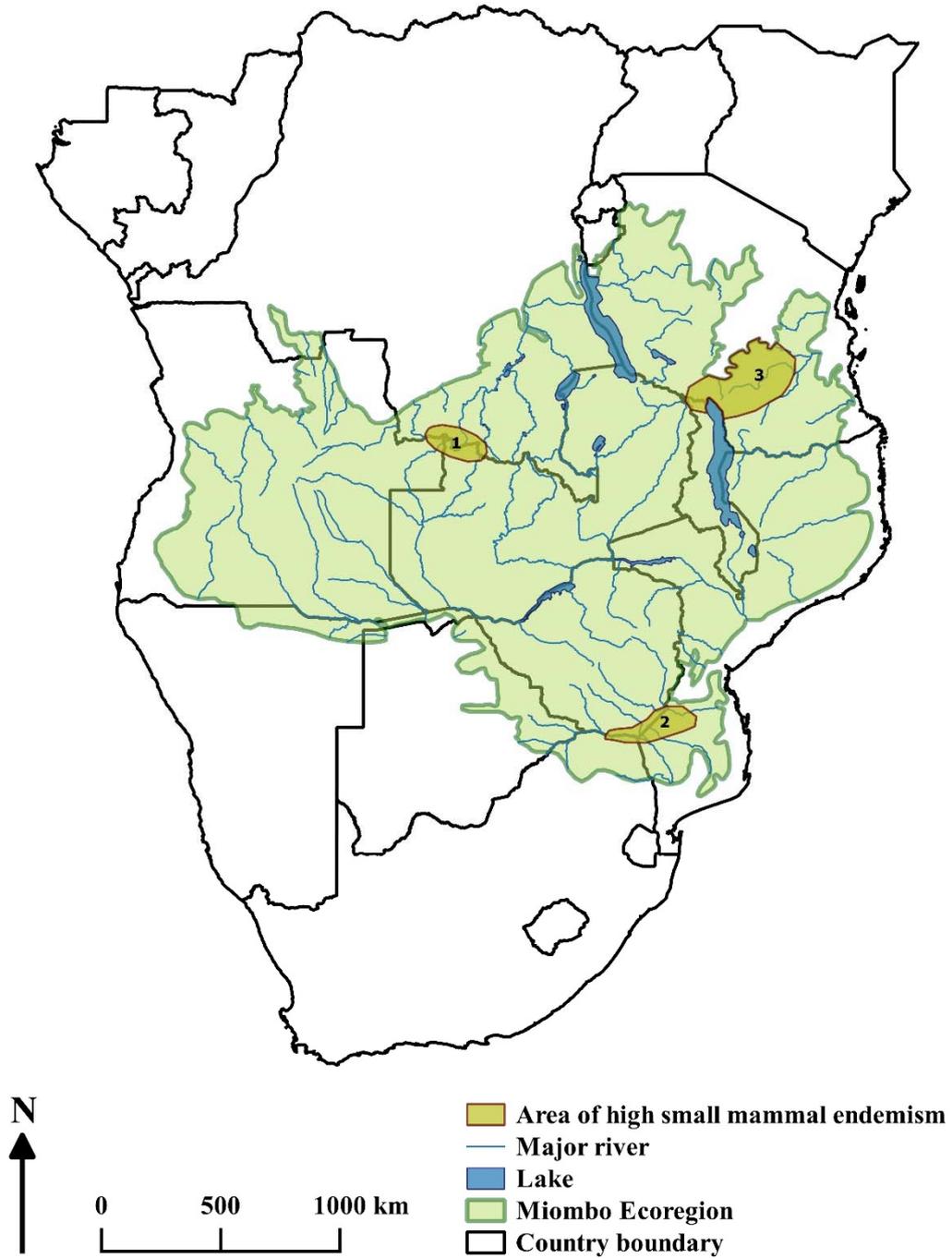
**Map 9. Areas of High Small Mammal Species Diversity**



## **Map 10. Areas of High Small Mammal Endemism**

- 1. Mwinilunga – Ikelenge Pedicle – Solwezi.** *Crocidura ansellorum*, *Malacomys australis*, *Rhinolophus* sp., *Graphiurus monardi*, *Graphiurus* sp.
- 2. Gonarezhou – Banhine.** *Calcochloris obtusirostris* (in part), *Gerbillurus "paeba"*, *Tatera brantsi*.
- 3. Northern Mozambique – SE Tanzania.** Galagos, *Paraxerus lucifer*, *Paraxerus flavovittis*.

**Map 10. Areas of High Small Mammal Endemism**



## **Map 11. Areas with Endangered Small Mammal Species**

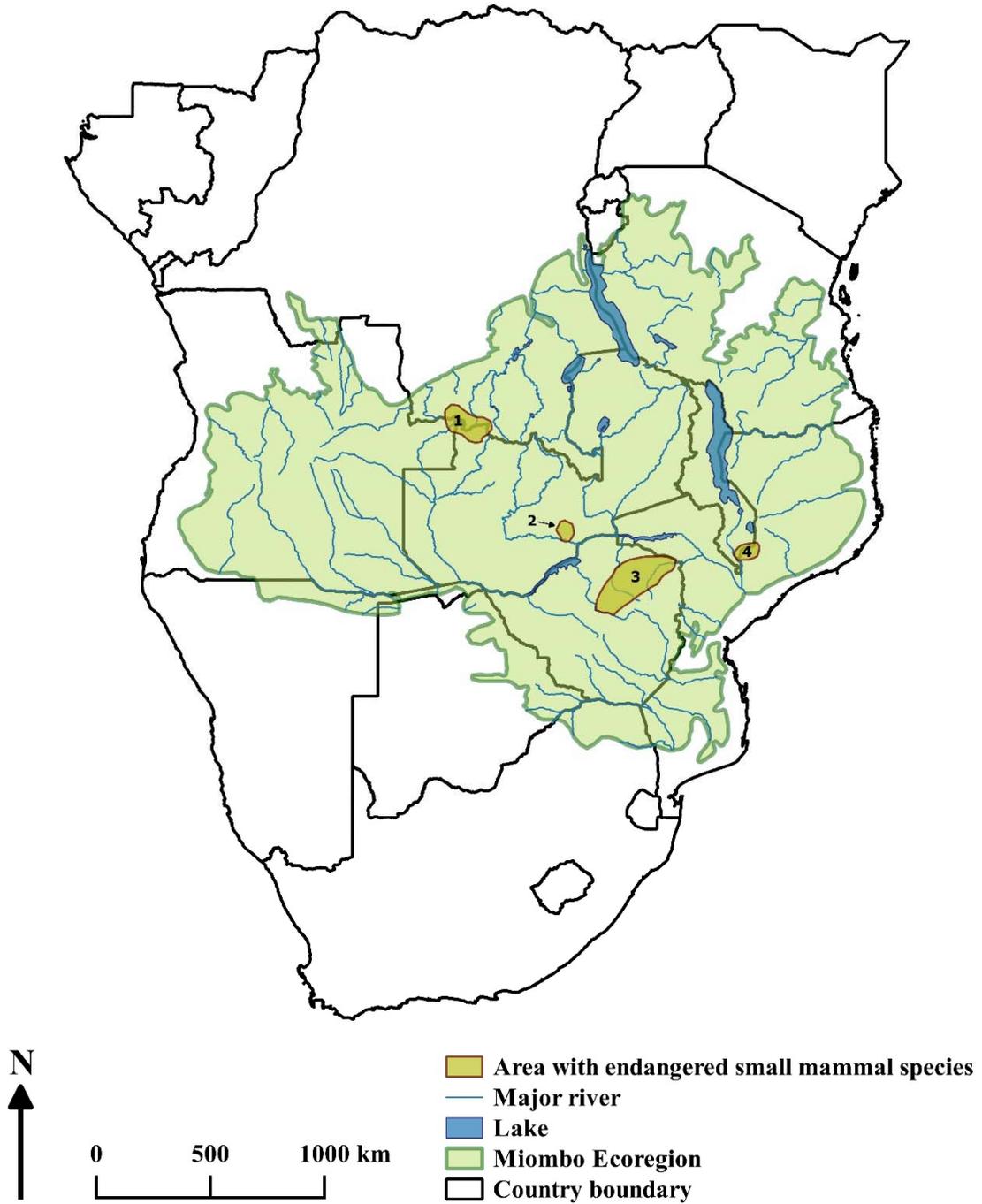
**1. Mwinilunga – Ikelenge pedicle – Solwezi.** Large mammals have been extirpated with the exception of some private lands, notably Hillwood Farm. Biodiversity, including small mammals, is threatened by destruction of gallery forests. Local bushmeat consumption threatens all mammals.

**2. Lusaka.** Dolomite/limestone caves; Chiroptera. Roosts, especially in large dolomite caves, are sensitive to disturbance by humans.

**3. Lomagundi.** Dolomite/limestone caves and NE Zimbabwe granite shield; Chiroptera. Roosts, especially in large dolomite caves, are sensitive to disturbance by humans.

**4. Mt Mulanje – Ruo – Chiromo.** Chiroptera. Rich bat fauna threatened by habitat destruction.

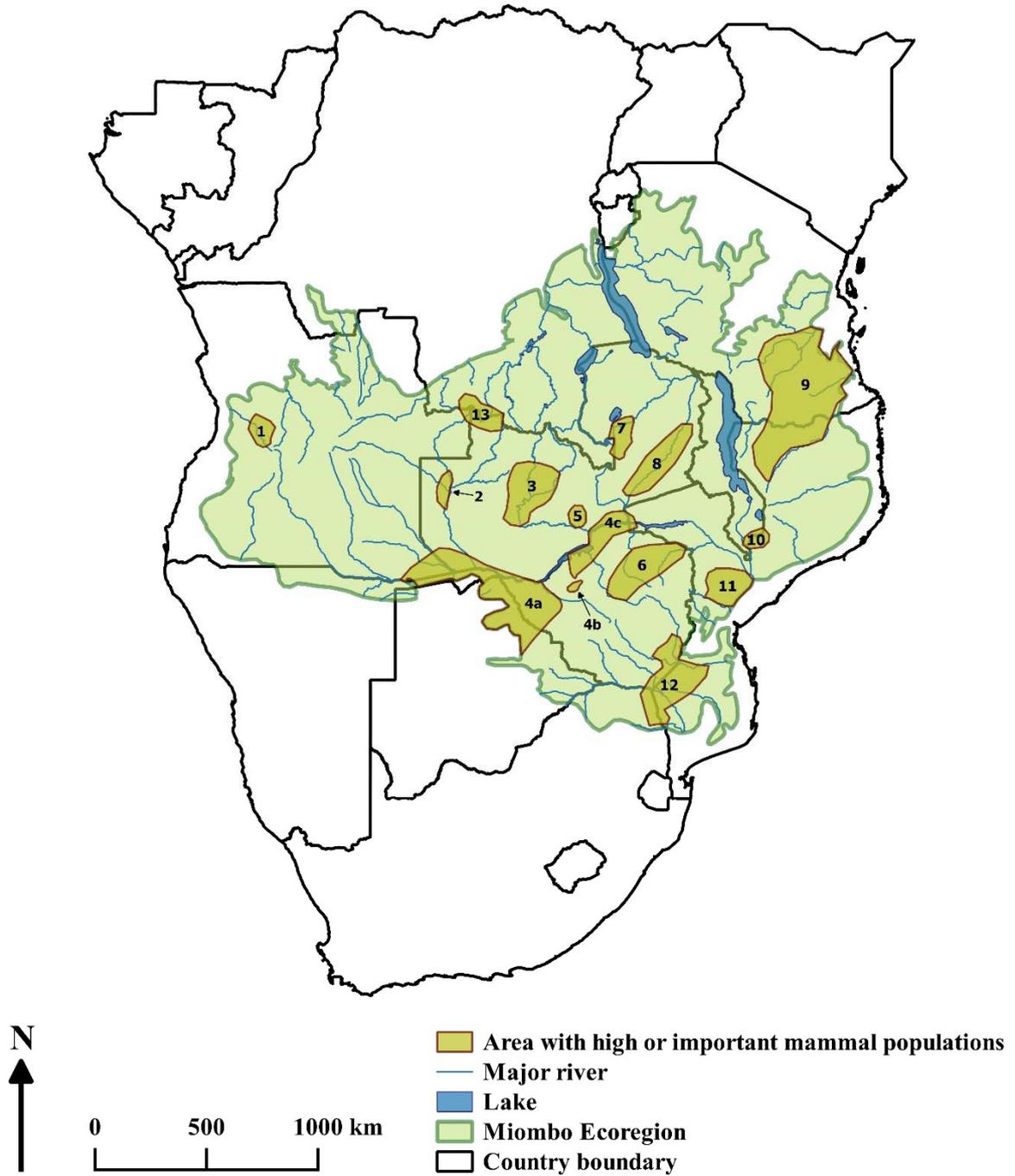
**Map 11. Areas with Endangered Small Mammal Species**



## Map 12. Areas with High or Important Mammal Populations

1. **Luando.** Bovids.
2. **Liuwa Plains.** Bovids, carnivores.
3. **Kafue – Lunga – Busanga.** Bovids, carnivores.
4. **Sioma – Luiana – Caprivi – Chobe – Hwange – Sebungwe – Middle Zambezi.** Bovids, carnivores, small mammals.
5. **Lusaka.** Dolomite/limestone caves; Chiroptera.
6. **Lomagundi.** Dolomite/limestone caves and NE Zimbabwe granite shield; Chiroptera. High daylight roost availability with very high concentrations of bats. Complemented by roost availability in miombo woodlands.
7. **Bangweulu – Kasanka – Katanga pedicle.** Bovids and Chiroptera (*Eidolon helvum*). A huge seasonal camp of *Eidolon helvum* in Kasanka National Park.
8. **Luangwa.** Primates, bovids, carnivores. Locally high concentrations of bats in mopane and miombo woodlands.
9. **Niassa – Selous – Kilombero.** Bovids, carnivores, primates.
10. **Mt Mulanje – Ruo – Chiromo.** Chiroptera.
11. **Gorongosa – Cheringoma – Marromeu.** Bovids, carnivores, primates.
12. **Kruger – Gonarezhou – Banhine – Zinave** (including SE lowveld conservancies). Bovids, carnivores, primates, small mammals.
13. **Mwinilunga - Ikelenge pedicle - Solwezi** – Locally high concentrations of small mammals in miombo woodlands and gallery forests.

**Map 12. Areas with High or Important Mammal Populations**



## **Map 13. Important Areas for Mammal Migration or Movement**

**1. Liuwa Plains.**

**2. Kazuma – Chobe and Caprivi – Luiana – Sioma.**

**3. Mid-Zambezi Valley.**

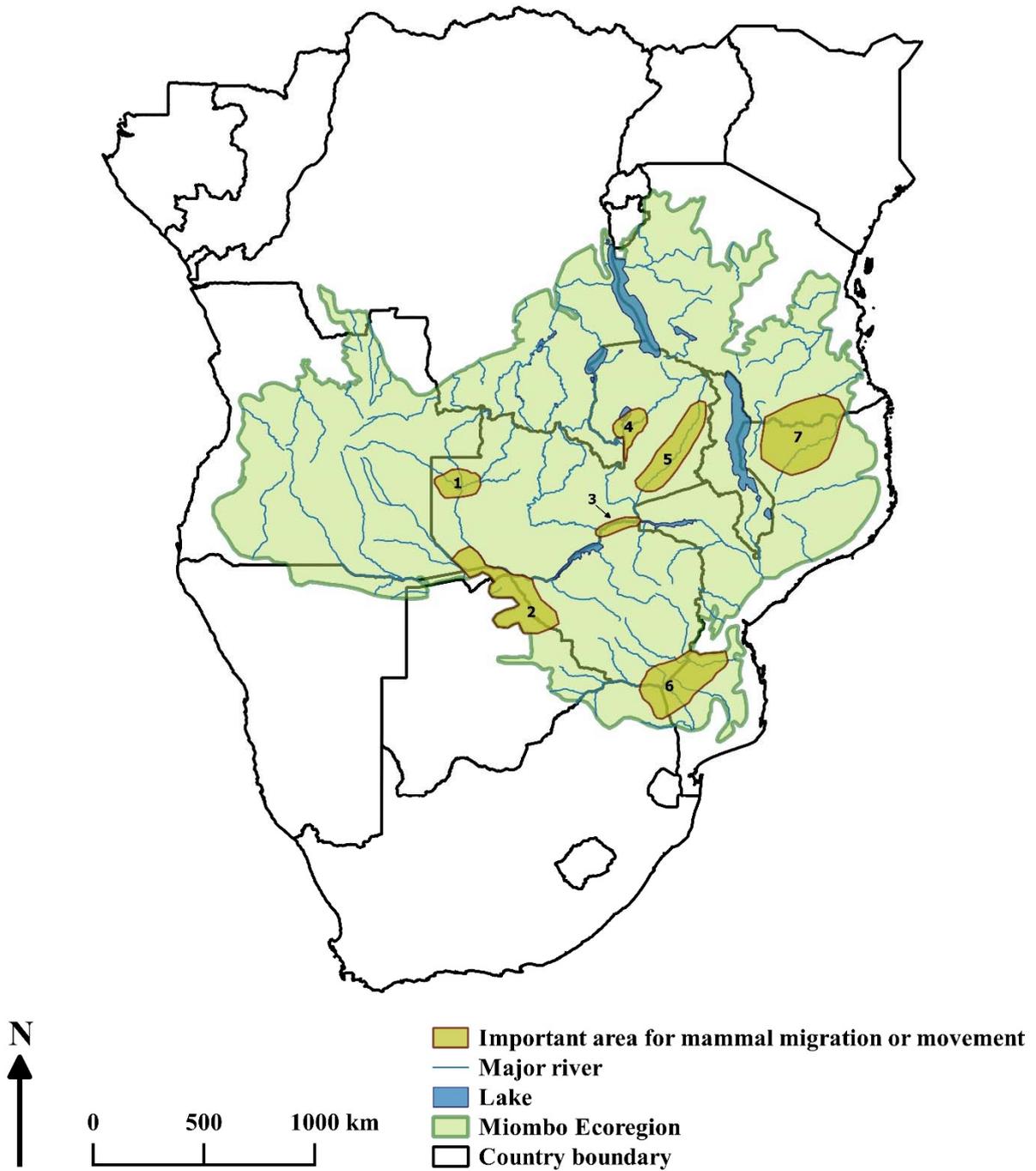
**4. Bangweulu – Kasanka.** Some movements of large mammals (black lechwe and Bangweulu tsessebe) across Bangweulu floodplain. A massive colony of the straw-coloured fruit bat, *Eidolon helvum* gathers seasonally in Kasanka National Park.

**5. Luangwa Valley.**

**6. Kruger – Gonarezhou – Banhine – Zinave.**

**7. Niassa Reserve and adjacent Tanzania** [tentative]. Movement of large mammals considered to occur between northern Mozambique and southern Tanzania. Certainly within the wildlands in these countries.

**Map 13. Important Areas for Mammal Migration and Movement**



## Map 14. Areas of High Bird Species Diversity

The criterion of "high" is taken as being 401 species or more in a defined area. The area could be a whole game reserve, e.g. the Selous at 75,000 km<sup>2</sup> and 427 species on its list, or as small as a quarter-degree square (QDS; c.750 km<sup>2</sup> in area). A few areas could be even smaller, such as some of the parks listed below.

**1. Robert Mcllwaine Recreational Park** (Harare, Zimbabwe). Area of 35 km<sup>2</sup> with a checklist of nearly 460 species. Such a high number is certainly because the local bird club has been visiting the place every month for nearly 50 years (Canto & Canto 1998).

**2. Liwonde National Park** (S Malawi). Area of 548 km<sup>2</sup> with "one of the most impressive days birdwatching anywhere in the world". The park has more than 400 species of birds, probably about 440.

**3. Selous Game Reserve** (S Tanzania). An area with 427 recorded species (in 1993), including 52 species of raptor.

**4. Owambo** (N Namibia). Part of the Owambo region in N Namibia, covering perhaps 30,000 km<sup>2</sup> with a list of 420 species (in 1993), including 55 species of raptor.

**5. Hwange National Park** (W Zimbabwe). Area of 14,600 km<sup>2</sup> with a list of 410 species (in 1986), including 63 species of raptor.

**6. Kazungula** (NW Zimbabwe). The Zambezi River from Kazungula to just downstream of Victoria Falls, an area of about 1,600 km<sup>2</sup> with a list of about 425 species, including 57 species of raptor.

**7. Lochinvar National Park** (SC Zambia). On the Kafue Flats on the south side of the Kafue River, an area of 410 km<sup>2</sup> with probably more than 400 species. It seems to be the best waterbird site in Zambia (at least 79 species) and hosts 59 species of raptor.

**8. Chobe – Linyanti** (NE Botswana). Centred on the eastern end of the Caprivi Strip. The area is known from the bird atlas period (up to 1992) to hold 437 bird species, including 59 species of raptor.

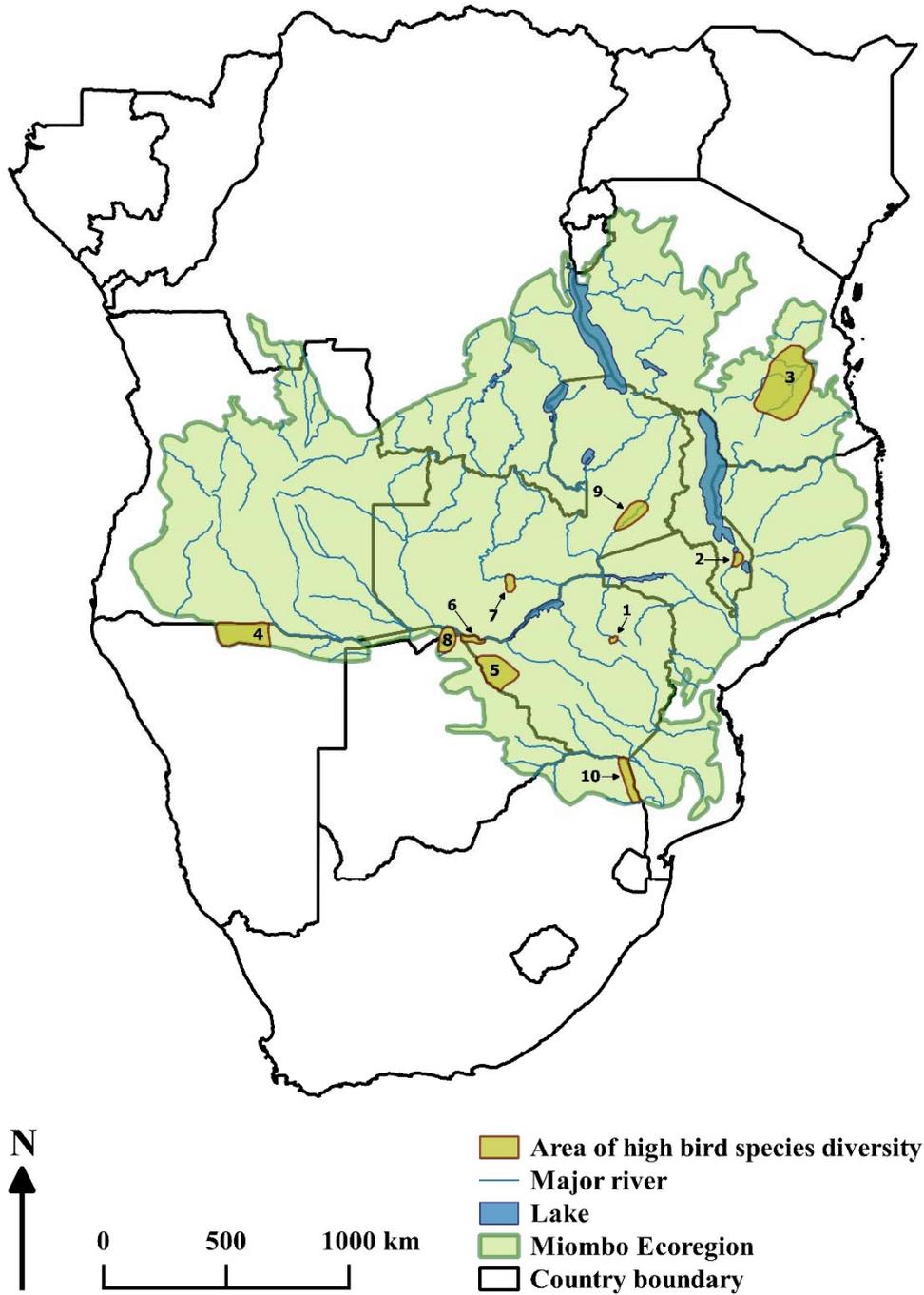
**9. South Luangwa National Park** (E Zambia). A large area that is expected to have more than 400 species.

**10. Kruger National Park** (NW South Africa). The northern half of the Kruger National Park, with an area of about 10,000 km<sup>2</sup>, hosts at least 433 species (from bird atlas data up to 1992), of which 61 are raptors.

### Notes

No birdwatching or atlasing has been done in Angola or the D.R. Congo in recent decades. As yet, Angola, D.R. Congo, Malawi, N Mozambique, Tanzania and Zambia do not have atlases published, or even available. By default, emphasis is thus put onto areas located in southern Africa, though species numbers generally increase towards the equator.

**Map 14. Areas of High Bird Species Diversity**



## Map 15. Important Bird Areas

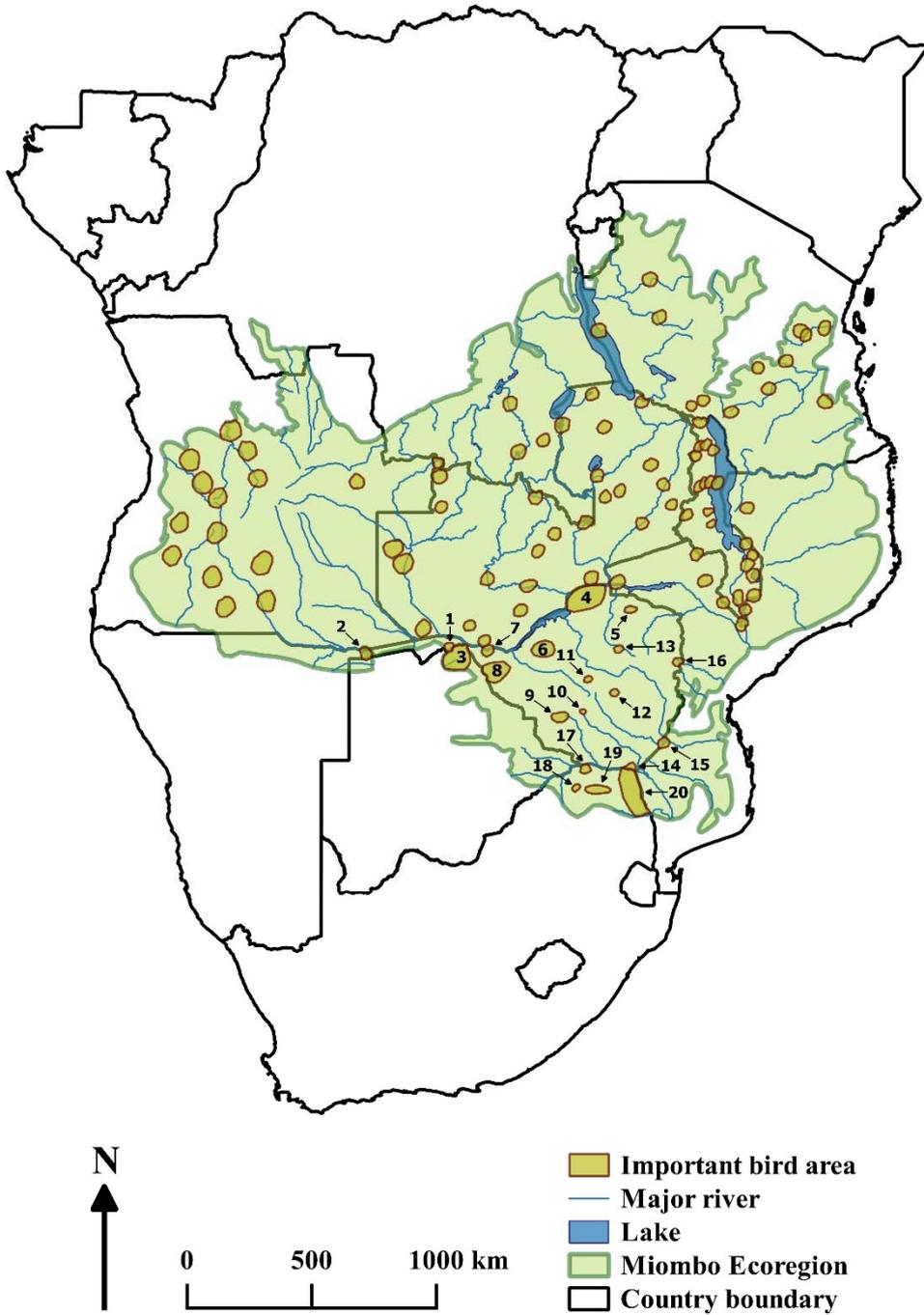
Launched in 1993, the Important Bird Area (IBA) programme of Birdlife International was published in October 2001. Twenty IBAs (numbered on the accompanying map) shown from Zimbabwe, Botswana, Namibia and Zimbabwe fall within the Miombo Ecoregion (Barnes 1998). There are about 113 IBA sites from the Miombo Ecoregion as a whole (shown as X on the map).

Numbers of IBAs in the Miombo Ecoregion within each country are:

Angola	14	Botswana	1	DRC	3
Malawi	22	Mozambique	3	Namibia	2
South Africa	4	Tanzania	13	Zambia	31
Zimbabwe	20				

Some of these sites are montane, but none are East African coastal forest. Names and further information on each site are given in Fishpool & Evans (2001).

**Map 15. Important Bird Areas**



## Map 16. Important Areas for Globally Endangered Bird Species

**1. Angolan Escarpment** (SW Angola). Forests on the Angola scarp at Gabela:

- Gabela Bush-shrike *Laniarius amboimensis* (EN)
- Gabela Helmet Shrike *Prionops gabela* (EN)
- Gabela Akalat *Sheppardia gabela* (EN)
- Monteiro's Bush-shrike *Malaconotus monteiri* (EN)
- Pulitzer's Longbill *Macrosphenus pulitzeri* (EN)

**2. Kafue Mopane Woodlands** (S Zambia). Centred on mopane woodlands at Mulobezi, at the southern end of the Kafue National Park: Black-cheeked Lovebird *Agaporais nigrigenis* (EN).

**3. Uluguru Mountains** (C Tanzania). From 1300 m upwards: Uluguru Bush-shrike *Malaconotus alins* (CR).

**4. Njesi Plateau** (N Mozambique). In forest: Long-billed Tailorbird *Orthotomus moreani* (CR).

**5. Ndundla and Nyumbanitu Mountains** (Tanzania). Forests in the Udzungwa Mountains, from 1350–1900 m: Udzungwa Forest Partridge *Xenoperdix udzungwensis* (EN) (a newly discovered species, June/July 1991).

**6. Around Mount Mulanje** (S Malawi). Small mountains near Mt Mulanje at 1200–1700 m: Spotted Ground Thrush *Zoothera guttata* (EN) (also named *Turdus fischeri*).

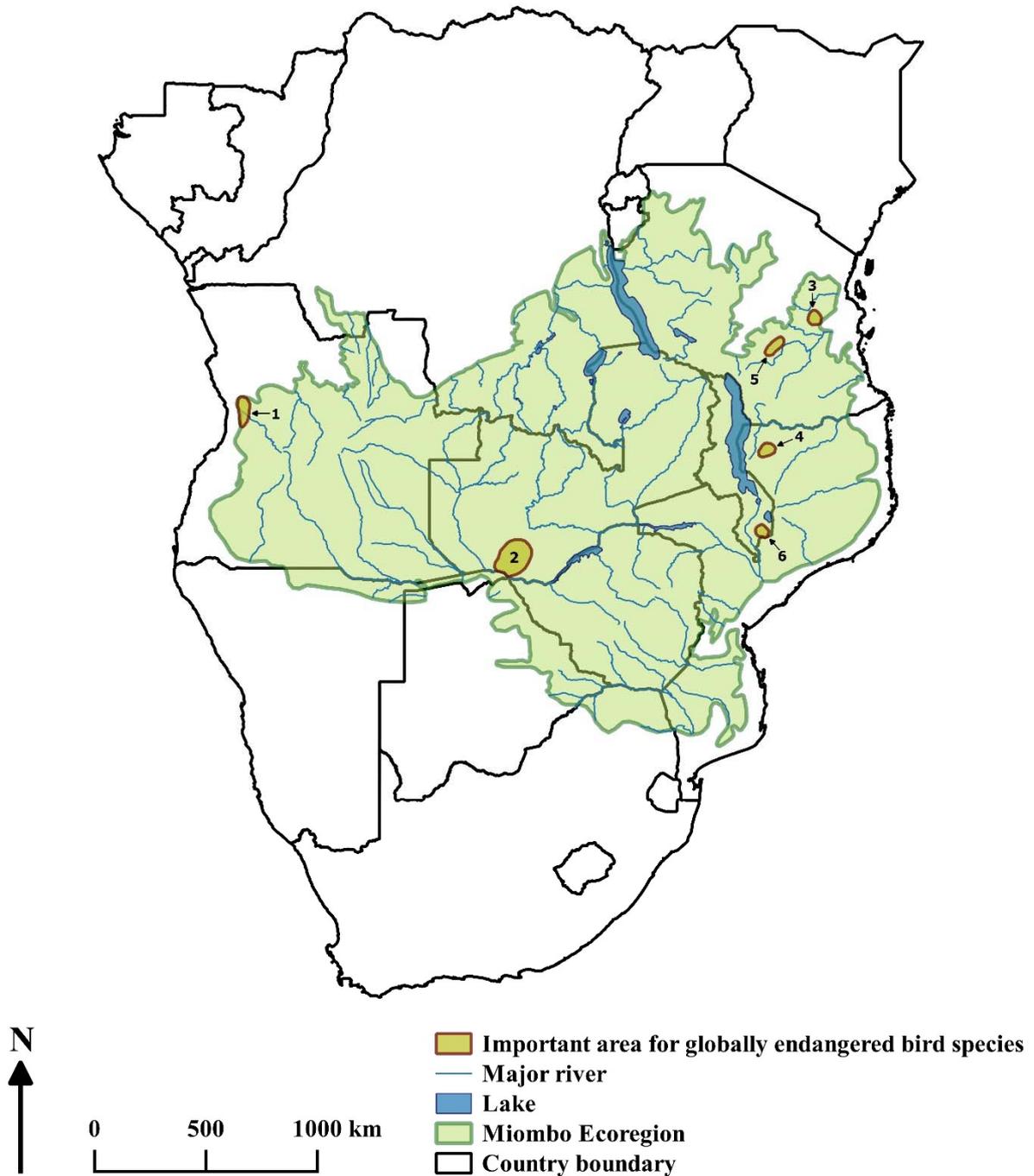
### Notes

Areas 1 and 3–6 are essentially montane, so strictly-speaking fall outside the Miombo Ecoregion.

CR = critically endangered (Collar *et al.* 1994)

EN = endangered

**Map 16. Important Areas for Globally Endangered Bird Species**



## Map 17. Areas with High or Important Bird Species Populations

**1. Kafue Flats** (SC Zambia). Lochinvar and Blue Lagoon National Parks on the Kafue Flats support huge numbers of waterfowl, waders and Wattled Cranes, consistently the highest numbers counted in Zambia's waterfowl censuses.

**2. Angolan Miombo Woodland** (C Angola). Reserva Natural Integral do Luando and west of the Cuanza River, OR the Cunene headwaters in the Huambo Highlands, are important areas for miombo endemics such as the Pale-billed Hornbill and Boehm's Flycatcher.

**3. Kasungu National Park** (C Malawi). Miombo woodland centred on Kasungu National Park on the border of Malawi and Zambia, is an important area for miombo endemics such as the Miombo Pied Barbet and Anchieta's Sunbird.

**4. Blouberg Mountain Nature Reserve** (N South Africa). Supports the world's second largest colony of Cape Griffons (approx. 800 pairs) and the largest in the ecoregion.

**5. Matobo Hills** (SW Zimbabwe). The Matobo National Park has a very high diversity and breeding density of raptors, including the densest known population of Black Eagles in Africa.

**6. Hwange National Park** (NW Zimbabwe). An area with a very high diversity of raptors (63 species) and some of the most important populations of Ostrich and Kori Bustards in the ecoregion (together with those in the Chobe National Park).

**7. Mana Pools National Park** (N Zimbabwe). An area with high populations of Carmine Bee-eater, Rock Pratincole, African Skimmer, Lilian's Lovebird, Pel's Fishing Owl and Livingstone's Flycatcher.

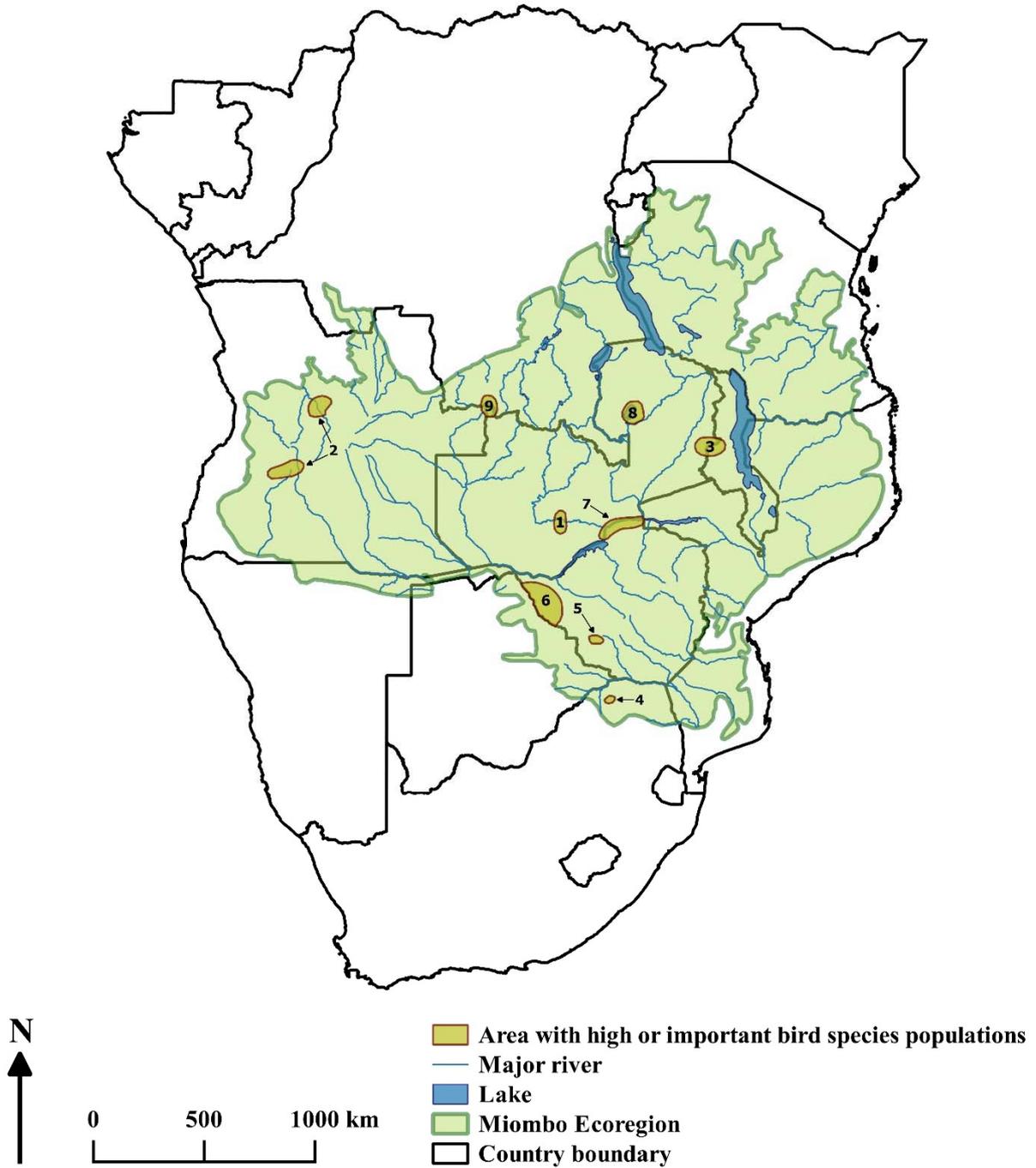
**8. Bangweulu Swamps** (NE Zambia). A Ramsar site area with important populations of the Shoebill Stork and Long-toed Flufftail, and high numbers of waterbirds.

**9. Zambezi River Headwaters** (NW Zambia). The wet evergreen forests across the Zambezi / D.R. Congo border, and north of Mwinilunga, are an outlier for many species of Congolian forest, for example African Wood Pigeon, White-bellied Kingfisher, Honeyguide Greenbul, Rufous Ant Thrush and Red-bellied Paradise Flycatcher.

### Note

There are 23 species of birds strictly endemic to the miombo biome, but no one place (or even country) has all of them, and another 29 species are restricted to miombo in the region but ranging outside (see Tables 1 and 2 in Benson & Irwin 1966). It would be worth mapping these 52 species comprehensively onto White's vegetation map to determine which specific areas may hold a majority of them.

**Map 17. Areas with High or Important Bird Species Populations**



## Map 18. Important Areas for Bird Migration or Movement

- 1. Shire River** (S Malawi). Used by Flamingos (pers. obs.) and probably other species as a conduit north and south.
- 2. Luangwa Valley** (E Zambia). Used by raptors (e.g. Greater Spotted Eagle) and others to migrate between East Africa and Southern Africa. It is not thought that flamingos take this route.
- 3. Lake Tanganyika** (SW Tanzania). The east side of Lake Tanganyika is used by raptors and possibly storks for movement. The birds use the hills and escarpment for updraughts.
- 4. Central Angola**. There is a known route over central Angola for Wahlberg's Eagle (*Aquila wahlbergi*) carrying a satellite transmitter, both ways.
- 5. Central Watershed Grasslands** (C Zimbabwe). An area of grassland centred on the Somabhula Flats and Debshan Ranch for Palaearctic harriers (*Circus* spp.) and kestrels (*Falco* spp.).

### Notes

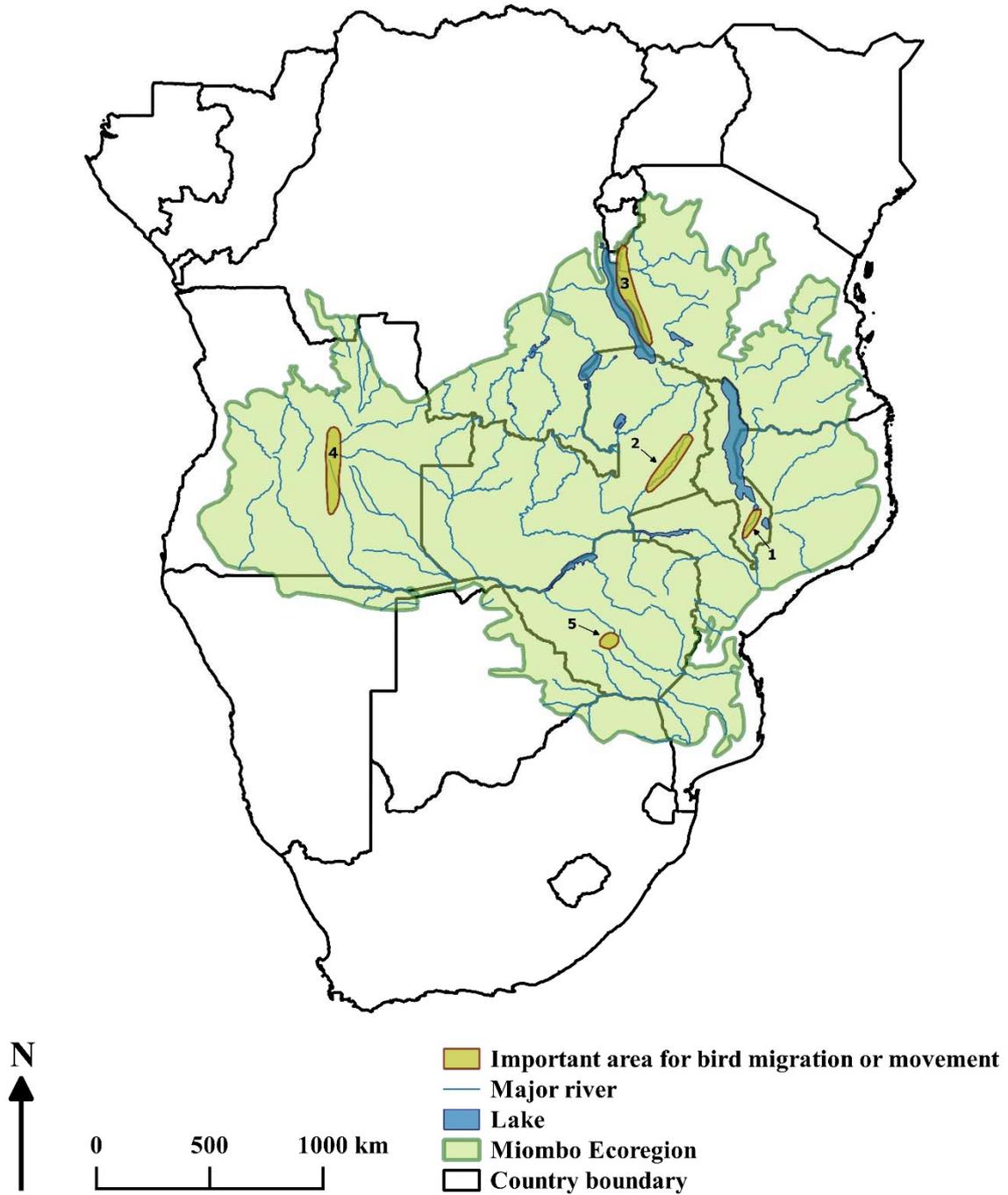
Many species of birds migrate to and fro through the region – there are perhaps 100 species of Palaearctic Migrants from the north (non-breeding or 'wintering') and 80 or so Afrotropical Migrants (from the equator, breeding). Many others, particularly waterbird species, will move around "nomadically". Most of the Palaearctic migrants migrate to where insect outbreaks are occurring (e.g. of locusts, termites).

It has to be emphasised that the routes they take are largely unknown. For a couple of species (e.g. White Stork *Ciconia ciconia* and Greater and Lesser Spotted Eagles *Aquila clanga* and *A. pomarina*) the paths taken are being determined by satellite telemetry. We don't even know the routes for the Red-billed Quelea.

Small songbirds probably migrate on a broad front, and at night by the stars. Many larger species probably also migrate on a broad front, as well as using rift valley features.

The considerable movements of waterbirds, including very large species such as pelicans, are known only from counts at sites. For example, 235 White Pelicans (*Pelecanus onocrotalus*) were seen at Mbaze Pan north of Nkayi in NC Zimbabwe.

**Map 18. Important Areas for Bird Migration or Movement**



## Map 19. Areas of High Reptile/Amphibian Species Diversity

1. **Ikelenge Pedicle.** This area has a rich herpetofauna (57 reptiles, 35 amphibians) due to the mosaic of different habitats. The Congo Basin forest reptiles that reach their southern limit here include a lacertid lizard (*Adolfus africanus*), the Forest Night-adder (*Causus lichtensteinii*), Jackson's Bold-eyed Tree Snake (*Thrasops jacksonii*), the Splendid Dagger-tooth Tree Snake (*Rhamnophis aethiopissa*) and the Forest Vine Snake (*Thelotornis kirtlandii*).

2. **Upemba National Park.** The very rich herpetofauna (c. 100 reptile and 50 amphibian species) with many endemics, is due to the wide range of habitats, including forests, grasslands, savanna, rock outcrops and extensive wetlands.

3. **Rovuma Centre.** WWF Ecosystem 52. Over 100 species of reptiles and nearly 50 amphibians have been recorded from southern Tanzania, but the southern sector in Mozambique is virtually unknown. This is very rugged country and many granite inselbergs have forest on their eastern slopes, so more endemic forms can be expected.

4. **Middle Zambezi Valley.** Includes about 75 reptiles and 23 amphibians, composed of many widespread plateau taxa and some lowland tropical forms which have come up the Zambezi valley. The only endemic is an amphisbaenian, *Monopeltis zambezensis*.

5. **Chicualaculala Centre.** This very dry area contains about 50 reptile and 30 amphibian species, including a number of endemics. There are also relict populations of some Kalahari forms, e.g. Spotted Scrub Lizard (*Nucras intertexta*), the amphisbaenian *Monopeltis leonhardi*, and peripheral populations of fossorial reptiles typical of the coastal alluvium, e.g. the Golden Blind Skink (*Typhlosaurus aurantiacus*), the amphisbaenian *Zygaspis vandami* and the blind snake *Typhlops fornasinii*.

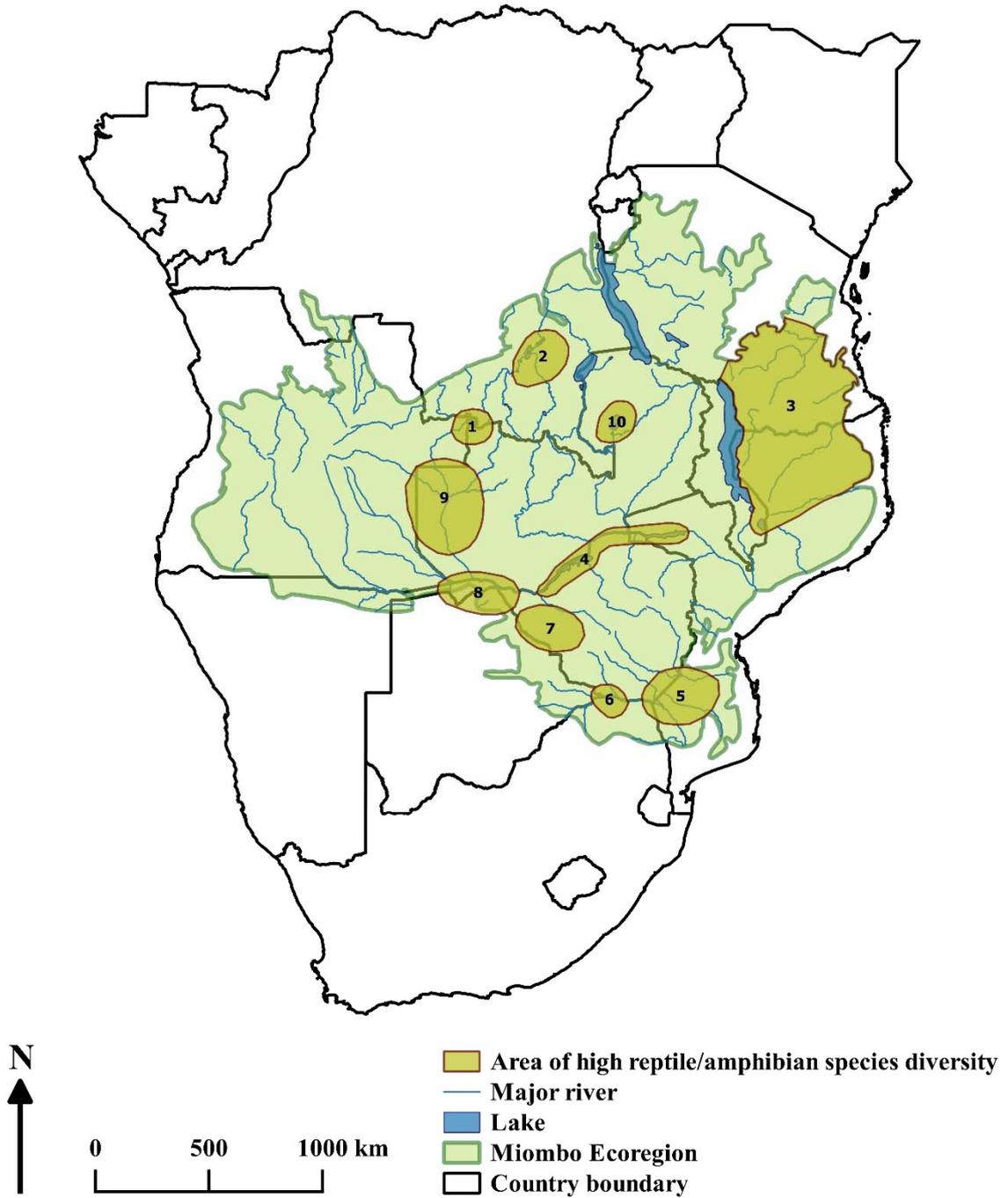
6. **Shashe – Tshipise Centre.** About 100 species of reptiles and 18 amphibians occur in this dry area. There are a number of relict populations of Kalahari species, including the Barking Gecko (*Ptenopus garrulus*) and the Horned Adder (*Bitis caudalis*).

7. **Hwange – Lupane Sandveld.** The area is largely covered with Kalahari sand but has a higher rainfall than the Limpopo Basin. 81 reptiles and 25 amphibians have been recorded. There are peripheral populations of northern Kalahari species, e.g. the limbless skink *Typhlosaurus rohani*, the Kalahari Plated Lizard (*Gerrhosaurus auritus*) and Anchieta's Cobra (*Naja anchietae*).

8. **Kazungula Centre.** The area contains 75 reptile and 30 amphibian species. Victoria Falls marks the downstream limit on the Zambezi for some aquatic reptiles such as the Okavango Terrapin (*Pelusios bechuanicus*) and Bangweulu Water Snake (*Limnophis bangweolicus*). As there are pockets of Kalahari sand overlying the basalt, many western fossorial reptiles also reach the falls, e.g. the burrowing gecko *Colopus wahlbergii*.

9. **Barotseland.** The rich herpetofauna comprises 70 reptile and 34 amphibian species, including some endemics. There are also Congolian elements entering from the north, Kalahari elements, and East African forms that have penetrated up the Zambezi valley.

**Map 19. Areas of High Reptile/Amphibian Species Diversity**



**10. Lake Bangweulu and environs.** The area is poorly known, but although only 23 reptile species are supported by voucher specimens, some Congo forest elements have been reported to occur in the swamp forests (*mushitus*), including Jameson's Mamba (*Dendroaspis jamesonii*) and the Nose-horned Viper (*Bitis nasicornis*). The amphibian fauna is virtually unknown, except that the peripheral swamps seem to harbour enormous populations of the Yellow Swamp Toad *Bufo lemairii*.



## Map 20. Areas of High Reptile/Amphibian Species Endemism

**1. Upemba/Kundelungu National Parks.** There are seven endemic reptiles – Upemba Hinged Terrapin (*Pelusios upembae*), Katanga Thick-toed Gecko (*Pachydactylus katangensis*), Upemba Rock Skink (*Mabuya pulcherrima*), Upemba Blind Snake (*Letheobia kibarae*), Mweru Centipede-eater (*Aparallactus moeruensis*), Leleup’s Water Snake (*Lycodonomorphus leleupi*) and Katanga Bush Viper (*Atheris katangensis*) – and six endemic amphibians – Upemba Dwarf Toad (*Bufo melanopleura*), Upemba Puddle Frog (*Phrynobatrachus anotis*), Upemba Dwarf Tree Frog (*Leptopelis parvus*), Mweru Tree Frog (*Leptopelis moeroensis*), Upemba Reed Frog (*Hyperolius kibarae*) and De Witte’s Shovel-snouted Frog (*Hemisis wittei*).

**2. Lake Tanganyika.** There are four endemic reptiles – a lacertid (*Ichnotropis tanganicana*, known only from the type), an amphisbaenian (*Loveridgea phylofiniens*), a blind snake (*Letheobia graueri*) and the Lake Tanganyika Water Snake (*Lycodonomorphus bicolor*).

**3. The Rovuma Centre.** There are 11 endemic reptiles – two limbless skinks (*Melanoseps rondensis*, *M. loveridgei*), a girdle-tail lizard (*Cordylus ukingensis*), five amphisbaenians (*Loveridgea ionidesi*, *Chirindia ewerbecki*, *C. rondoensis*, *Ancylocranium ionidesi*, *A. barkeri*), a blind snake (*Rhinotyphlops rondoensis*), a worm snake (*Leptotyphlops* sp. nov.), and Whyte’s Water Snake (*Lycodonomorphus whytii*). The four endemic amphibians are an earless toad (*Stephopaedes loveridgei*), Rees’ Toad (*Bufo reesi*), Red-nosed Cave Frog (*Spelaeophryne methneri*) and Rees’ Reed Frog (*Hyperolius reesi*). The two *Ancylocranium* are of particular interest as the only other two species in the genus inhabit Somalia.

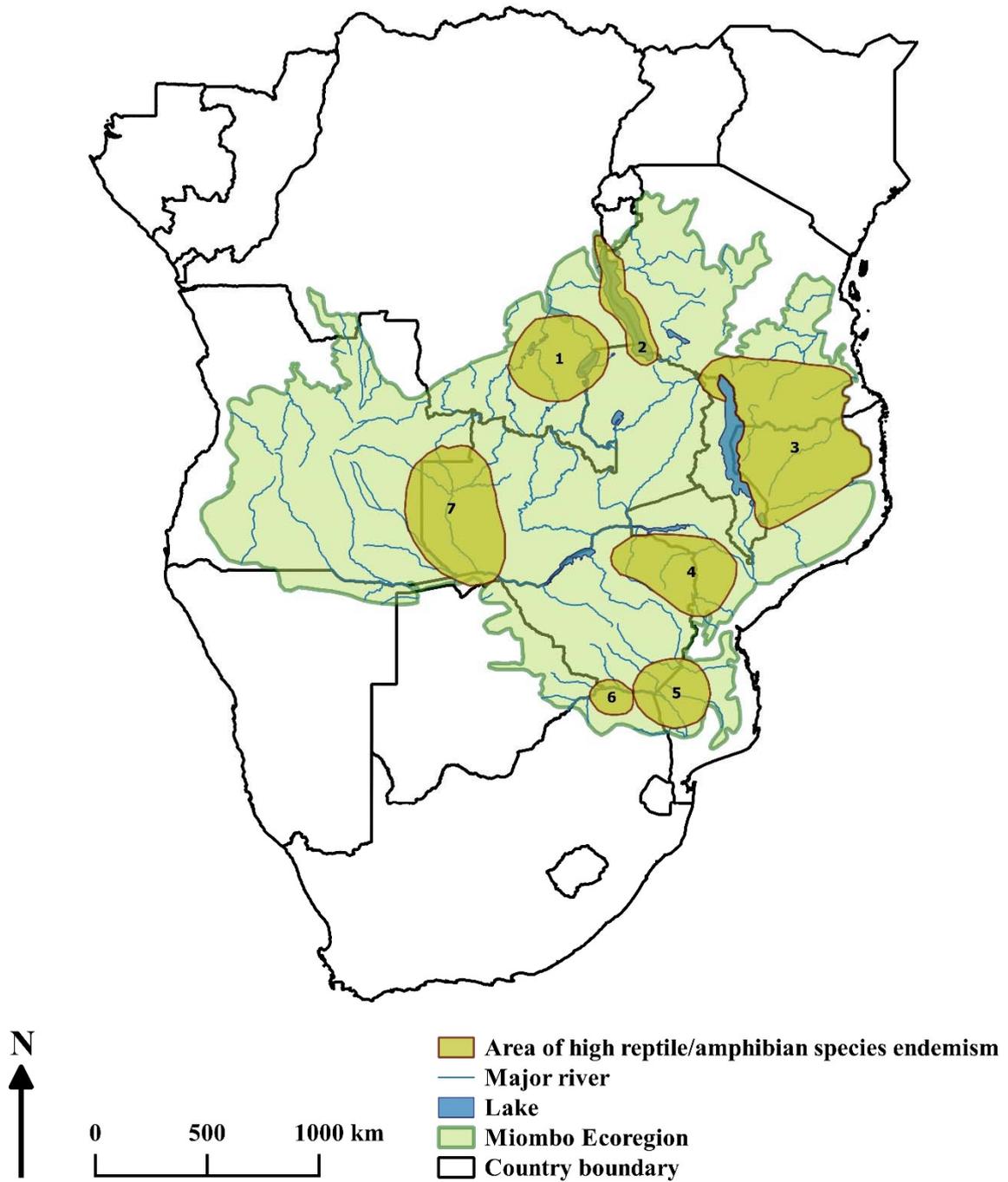
**4. Manica Centre.** This extensive area of granite/gneiss outcrops has seen much speciation in the endemic rupicolous flat-lizards of genus *Platysaurus*, i.e. *P. torquatus*, *P. pungweensis*, *P. subniger* and *P. imperator*, while the spectacular Regal Girdle-tail Lizard *Cordylus regius* occurs just south of Mutare.

**5. Chicualacuala Centre.** There are six endemic reptiles – Venda Blind Skink (*Typhlosaurus richardi*), FitzSimons’ Blind Skink (*Typhlosaurus fitzsimonsi*), Blue-tailed Scrub Lizard (*Nucras caesicaudata*), two amphisbaenians (*Chirindia langi* and *Monopeltis decosteri*) and the Save Quill-snouted Snake (*Xenocalamus sabiensis*).

**6. Shashe–Tshipise Centre.** There are four endemic reptiles – Muller’s Velvet Gecko (*Homopholis mulleri*), Waterpoort Blind Skink (*Typhlosaurus subtaeniatus*) and two species of Flat Lizards (*Platysaurus relictus* and *P. monotropis*).

**7. Barotseland.** There are 5 endemic reptiles – Gracile Lesser Blind Skink (*Typhacontias gracilis*); Japp’s Blind Skink (*Typhlosaurus jappi*), two amphisbaenians (*Zygaspis nigra* and *Dalophia ellenbergeri*), the Striped Beaked Snake (*Rhamphiophis acutus jappi*) and two frogs, Mapacha Grass Frog (*Ptychadena mapacha*) and Barotse Shovel-nosed Frog (*Hemisis barotseensis*).

**Map 20. Areas of High Reptile/Amphibian Species Endemism**



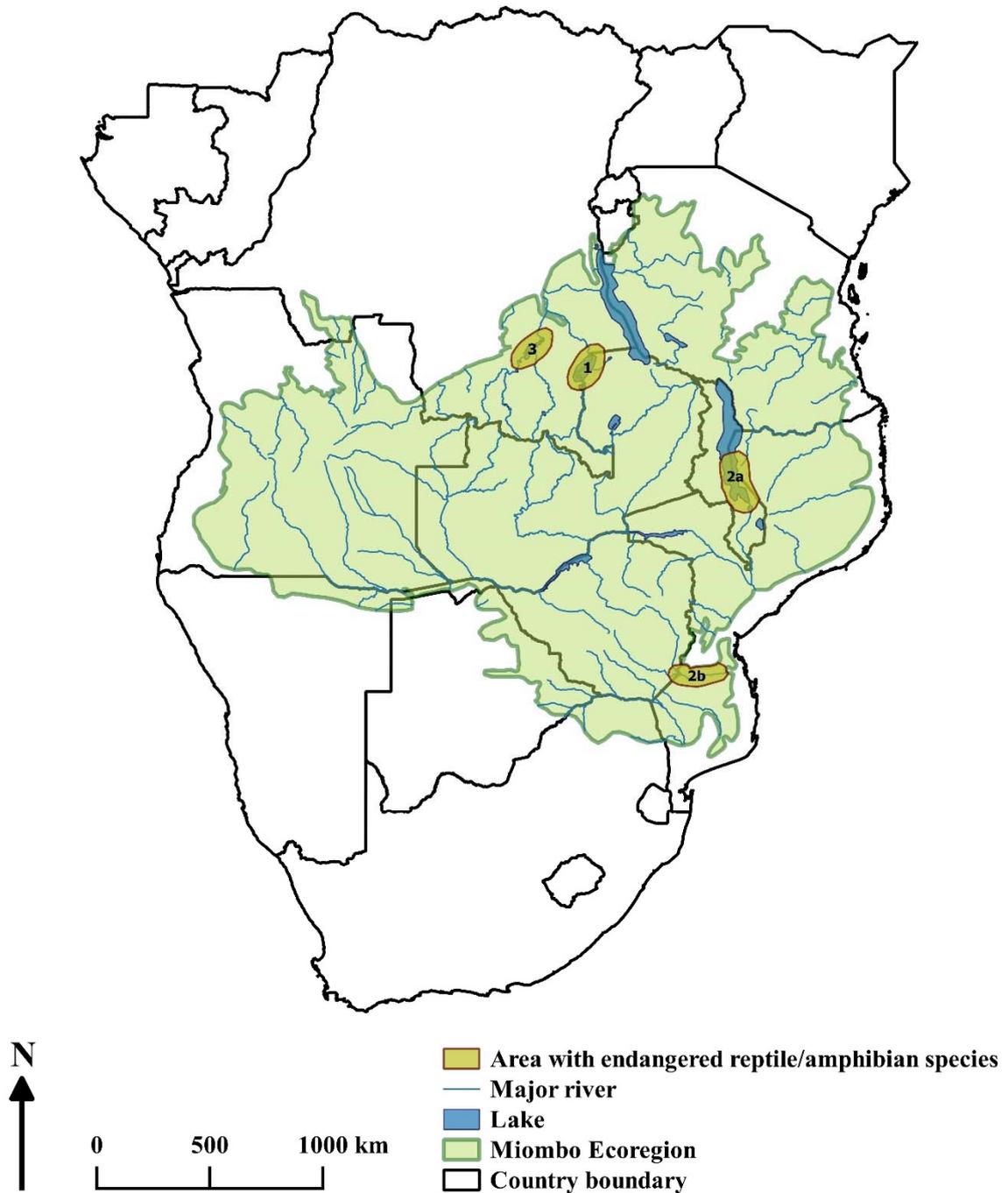
## Map 21. Areas with Endangered Reptile/Amphibian Species

**1. Lake Mweru.** This area apparently has the southernmost viable population of the Slender-snouted Crocodile (*Crocodylus cataphractus*), which is seriously threatened by the bush-meat trade throughout its extensive range in west and central Africa.

**2. Southern Lake Malawi (A)** is the main stronghold of the Zambezi Flap-shell Turtle (*Cycloderma frenatum*) and the **Lower Save River (B)** harbours the southernmost breeding population. Villagers collect the eggs and fishermen eat any turtles caught in their nets. The only protected area is in the Zinave National Park.

**3. Upemba Lake.** The Upemba Hinged Terrapin (*Pelusios upembae*) is endemic to the Upemba lake system, most of which lies outside the western boundary of the Upemba National Park. It is not known how many terrapins are netted by fishermen and eaten.

**Map 21. Areas with Endangered Reptile/Amphibian Species**

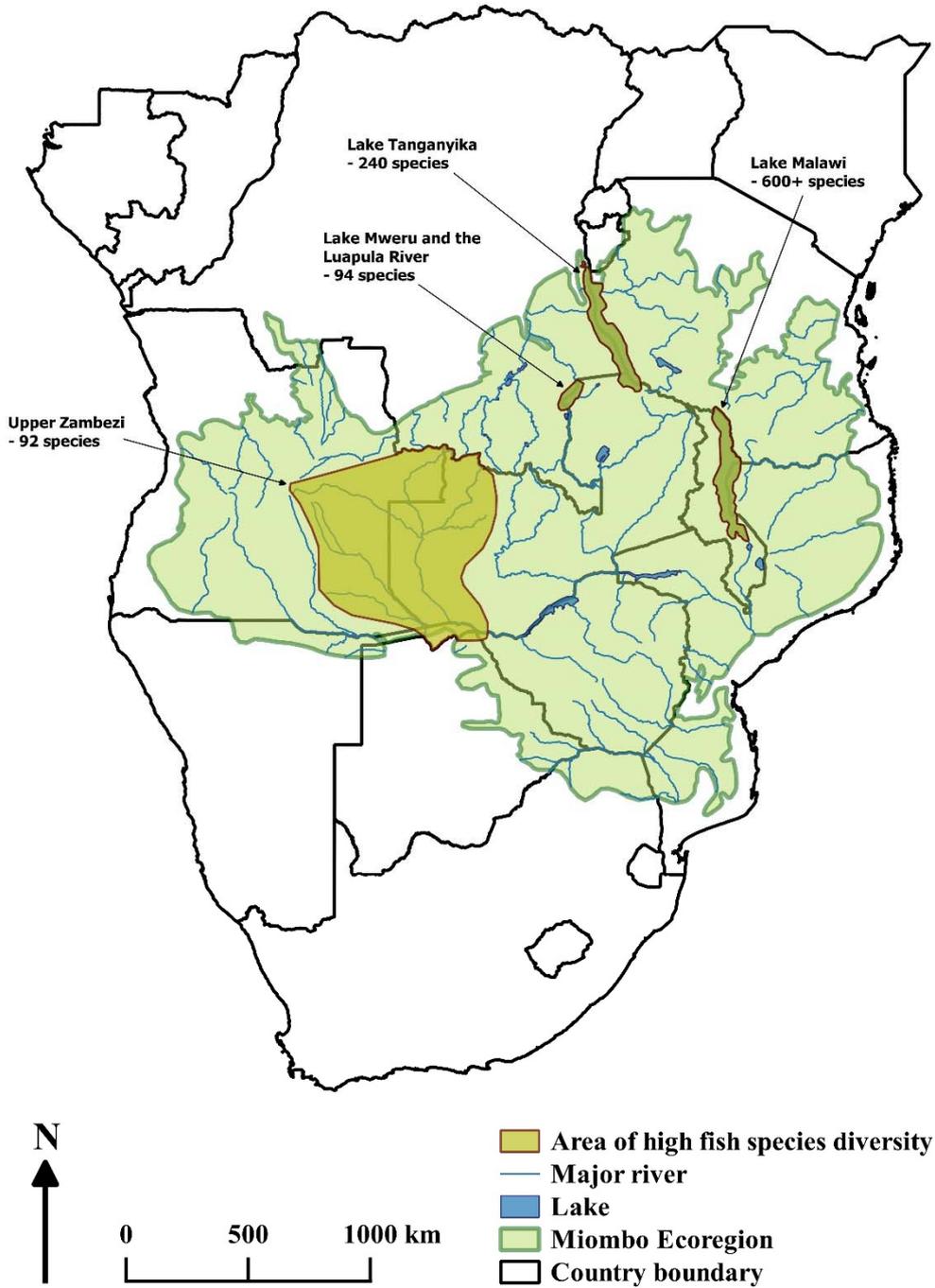


## **Map 22. Areas of High Fish Species Diversity**

There is a general gradient of diversity from the Congo system in the north to the Limpopo system in the south. This generally follows the pattern of rainfall which means that the northern areas are well-watered with large perennial rivers and wetlands, while the southern areas are semi-arid with highly seasonal rivers and no wetlands. There are four areas of outstanding fish diversity.

1. **Lake Mweru and the Luapula River**, with about 94 species.
2. **Lake Tanganyika**, with about 240 species, 60% of which belong to the family Cichlidae. Other families with small endemic species flocks include the Bagridae, Mochokidae, Centropomidae and Mastacembelidae.
3. **Lake Malawi** (Nyasa, Niassa) has the world's most diverse fish fauna. The exact number of species is unknown but is likely to exceed 600. About 90% of them belong to the family Cichlidae and 99% of the lake's fish species are endemic.
4. **Upper Zambezi**, with about 92 species.

**Map 22. Areas of High Fish Species Diversity**

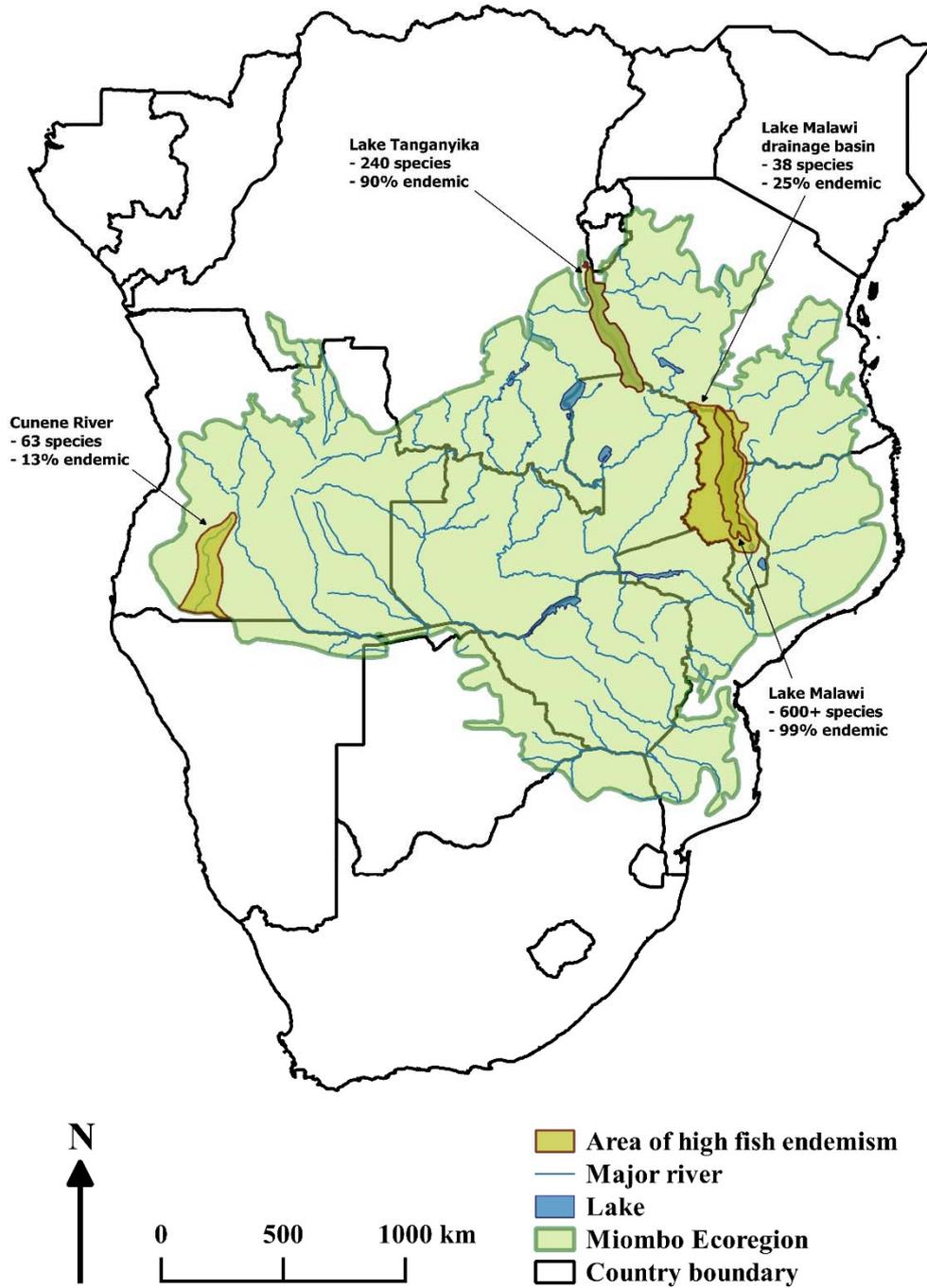


## **Map 23. Areas of High Fish Endemism**

There are four areas with a significant proportion of endemic fish species.

- 1. Lake Tanganyika** with about 240 species, 90% of which are endemic.
- 2. Lake Malawi** with about 600+ species, 99% of which are endemic.
- 3. Lake Malawi drainage basin** with 38 species, of which 25% are endemic.
- 4. Cunene River** with 63 species, of which 13% are endemic.

**Map 23. Areas of High Fish Endemism**



## Map 24. Areas of Globally Endangered Fish Species

A number of fish species, especially in the Congo system, are known from only a few specimens. These species have been excluded on the grounds that their status is unknown and they may not be endangered in spite of having an apparently limited distribution. Their apparent rarity may be an artefact resulting from a lack of collecting. The following are considered to be endangered species.

**1. *Opsaridium peringueyi*.** This minnow occurs in the semi-arid Save and Limpopo systems and some South African rivers. It may now be extinct over much of its range because of drought, dam building (i.e. habitat destruction) and water abstraction.

**2. *Nothobranchius furzeri*.** Known from a few pans in south-eastern Zimbabwe, it is a rare species that may be threatened by habitat destruction and the use of insecticides for tsetse control.

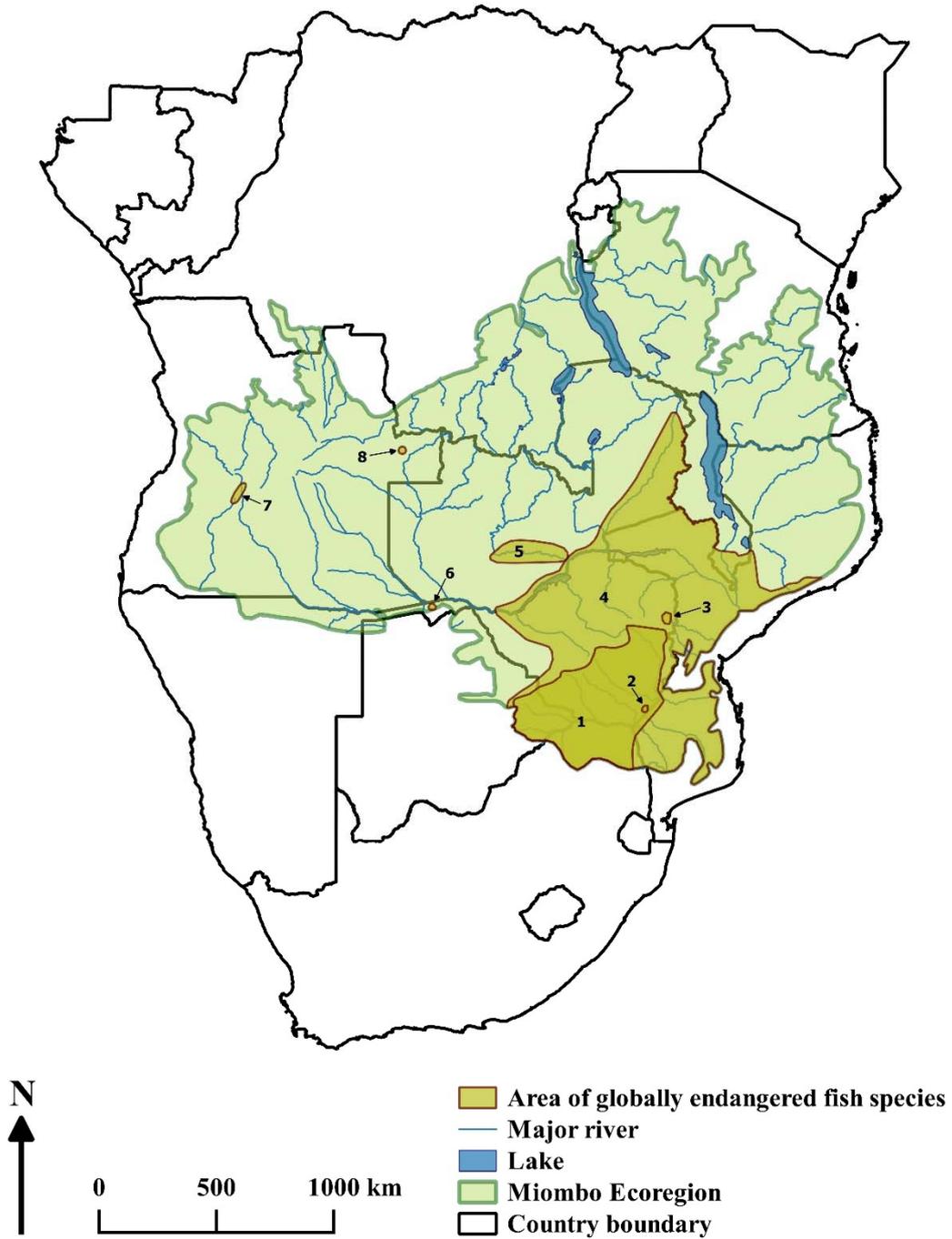
**3. *Chiloglanis emarginatus*.** A rare species with its main distribution in a small area of South Africa where it is threatened by habitat destruction, water abstraction and pollution. Two specimens have been collected at widely separated sites in Zimbabwe, and probably represent relict populations.

**4. *Oreochromis mortimeri* / *O. mossambicus*.** These fish (which may or may not be separate species) are the widespread tilapias of the middle and lower Zambezi, and the east coast rivers of Africa. Although still widespread and abundant they are under threat from the exotic *O. niloticus*, which is widespread in Zimbabwe and invading all its river systems. It is well established in Lake Kariba and the Zambezi River where it is displacing the native species.

**5. *Oreochromis andersonii* and *O. macrochir*.** The same thing is happening to these two species on the Kafue Flats where *O. niloticus* is widespread. These species are less threatened than *O. mortimeri* / *O. mossambicus* because they occur in the upper Zambezi and Okavango where the exotic species does not occur.

**6. *Nothobranchius* sp.** This killifish is restricted to some temporary waters in the Caprivi Strip, and is threatened by road-building and pollution.

**Map 24. Areas of Globally Endangered Fish Species**

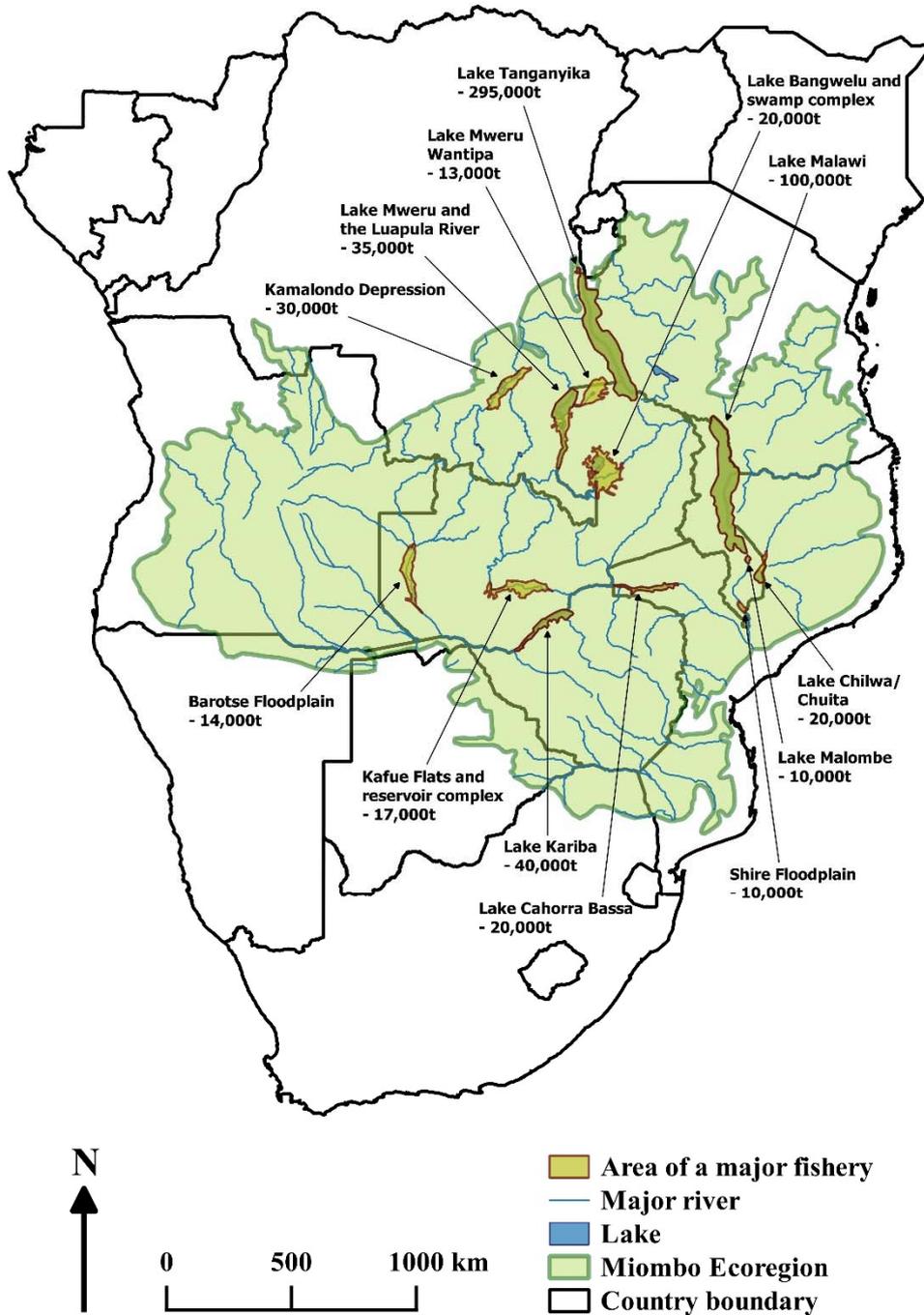


## **Map 25. Areas of Major Fisheries**

As might be expected, these fisheries are found in the major water bodies, although there are numerous small, highly productive fisheries throughout the region. Only those fisheries that have a potential yield estimated to be above 10,000 ton per annum (estimates given in brackets) are listed here.

- 1. Lake Tanganyika (300,000 t).**
- 2. Lake Mweru Wantipa (13,000 t).**
- 3. Lake Mweru and Luapula River (35,000 t).**
- 4. Kamalondo Depression (Lake Upemba and others) (300,000 t).**
- 5. Lake Bangweulu and swamp complex (20,000 t).**
- 6. Lake Malawi (100,000 t).**
- 7. Lake Malombe (10 000 t).**
- 8. Lakes Chilwa and Chiuta (20,000 t).**
- 9. Kafue Flats and associated reservoirs (17,000 t).**
- 10. Barotse floodplain (14,000 t).**
- 11. Lake Kariba (35,000 t).**
- 12. Lake Cabora Bassa (20,000 t).**
- 13. Shire floodplain (10,000 t).**

**Map 25. Areas of Major Fisheries**



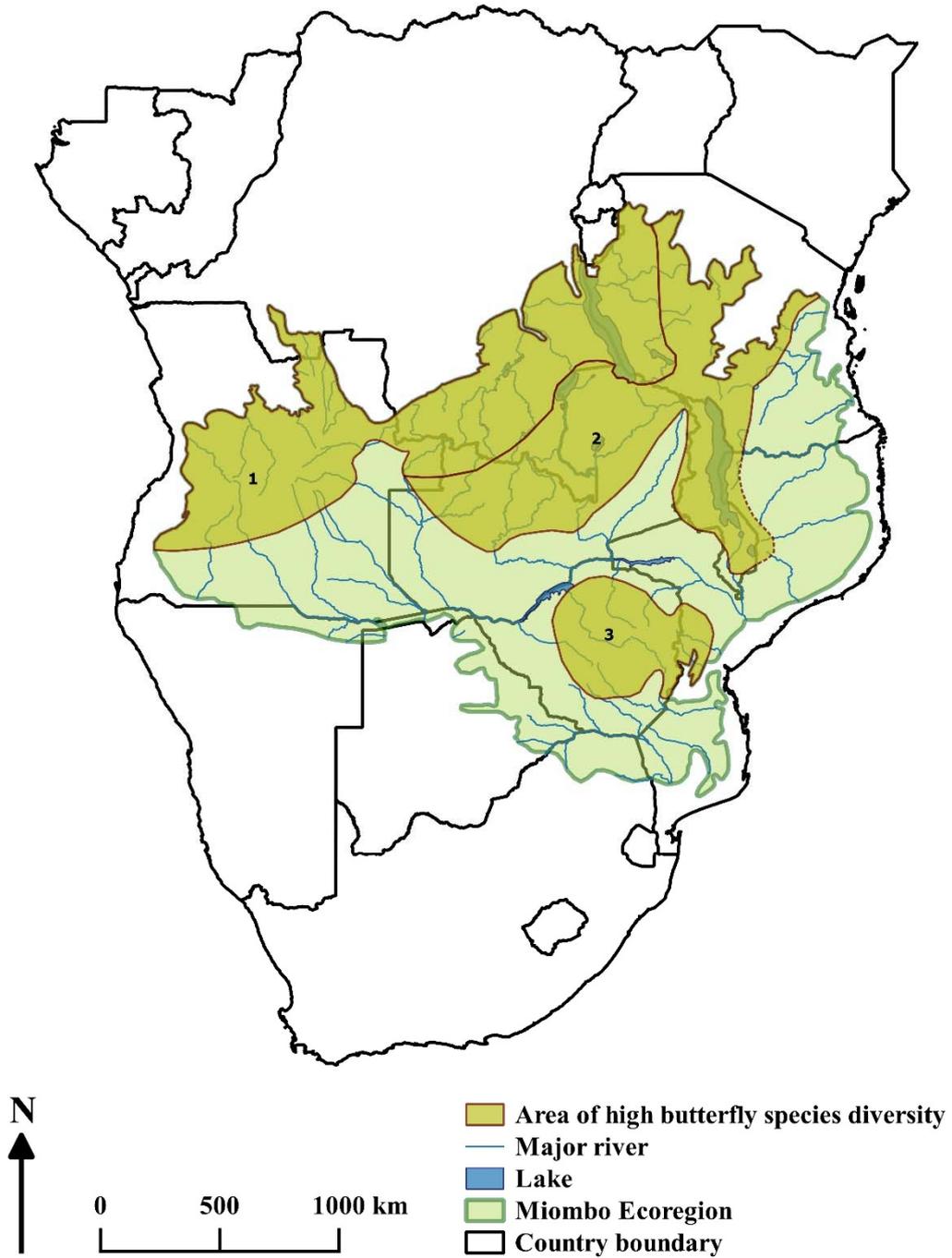
## **Map 26. Areas of High Butterfly Species Diversity**

- 1. North Zambesian.** The number of species that can be found at any one area (50 km radius) within this belt is about 600 species.
- 2. Central Zambesian, central & SW Tanzania and Malawi.** The number of species that can be found at any one area within this belt is about 400–500 species.
- 3. Zimbabwe Highveld.** The number of species that can be found at any one area within this belt is about 200–350 species.

### **Notes**

The butterfly maps have been drawn considering species associated with miombo woodlands or dambos. If the areas include montane environments this is because the species associated with miombo woodland occur on the sides of the mountains; it is not due to the unique fauna of the mountains. East African coastal areas have been excluded. For some areas there is not enough knowledge to draw clear distribution boundaries. For such areas the lines have been drawn dotted or discontinued.

**Map 26. Areas of High Butterfly Species Diversity**



## Map 27. Areas of High Butterfly Endemism

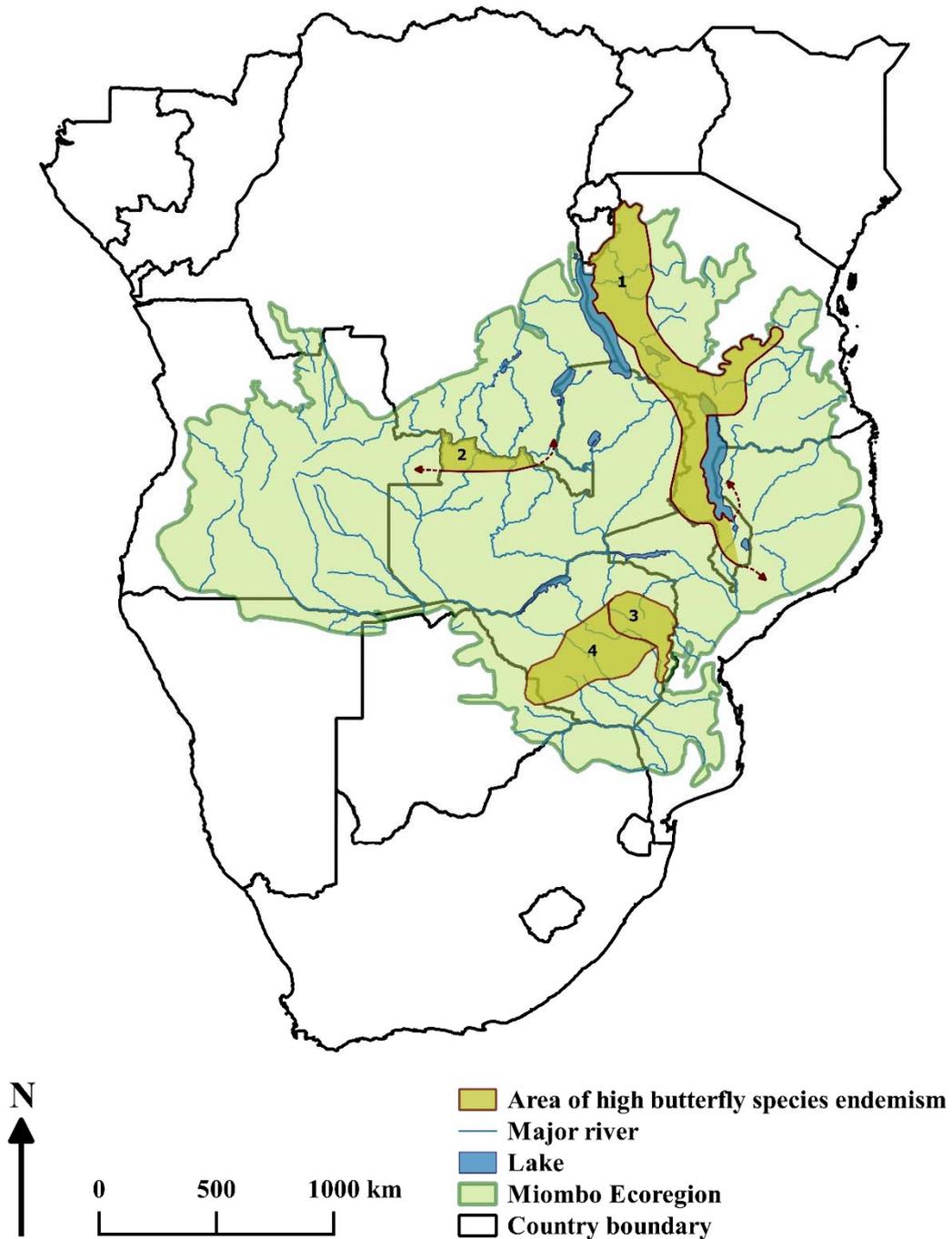
**1. Western & SW Tanzania and Malawi.** Many endemic species within this area, including *Metisella carsoni*, *Platylesches larseni*, *Charaxes gerdae*, *Alaena bjornstadi*, *Lachnocnema tanzaniensis*, *Spindasis tanganyikae*, *Iolus (Epamera) handmani* and *Cooksonia aliciae*.

**2. Northwestern Zambia.** Although the extent of endemism is not known, many species have only been caught in NW Zambia such as: *Euptera freyja*, *Spindasis pinheyi*, *Kedestes pinheyi*, *Eichochrysops pinheyi*, *Anthene* sp., *Lepidochrysops* sp. and *Virachola* sp.

**3. North and Eastern Zimbabwe Highveld.** Although there are less endemics than in areas 1 and 2 this area is important for *Chloroselas argentea*, *Deloneura sheppardi* and *Charaxes gallagheri*.

**4. Central & Southern Zimbabwe Highveld.** Endemics that occur in areas 3 and 4 are *Mashuna mashuna*, *Aslauga atrophifurca* and *Anthene arnoldi*.

**Map 27. Areas of High Butterfly Species Endemism**



## Map 28. Areas with Endangered Butterfly Species

Endangered species are defined according to the IUCN categories. For the distribution of endangered species only miombo-associated species have been taken into account.

**1. Sumbawanga, Kigoma** (W Tanzania). Endangered species: *Metisella carsoni*, *Platylesches larseni*, *Charaxes gerdae*, *Alaena bjornstadi*, *Lachnocnema tanzaniensis*, *Spindasis tanganyikae*.

**2. Madidibira, Mafindi** (S Tanzania). Endangered species: *Neita orbipalus congdoni* (the nominate subspecies is endemic to northern Tanzania), *Alaena madibirensis*, *Alaena* sp., *Stugeta mimetica*, *Anthene madibirensis*.

**3. Ikelenge** (NW Zambia). Endangered species: *Euptera freyja*, *Anthene* sp., *Lepidochrysops* sp., *Spindasis pinheyi*.

**4. Mongu** (W Zambia). Endangered species: *Erikssonia acraeina*.

**5. Chowe Village** (S Malawi). Endangered species: *Cooksonia aliciae*.

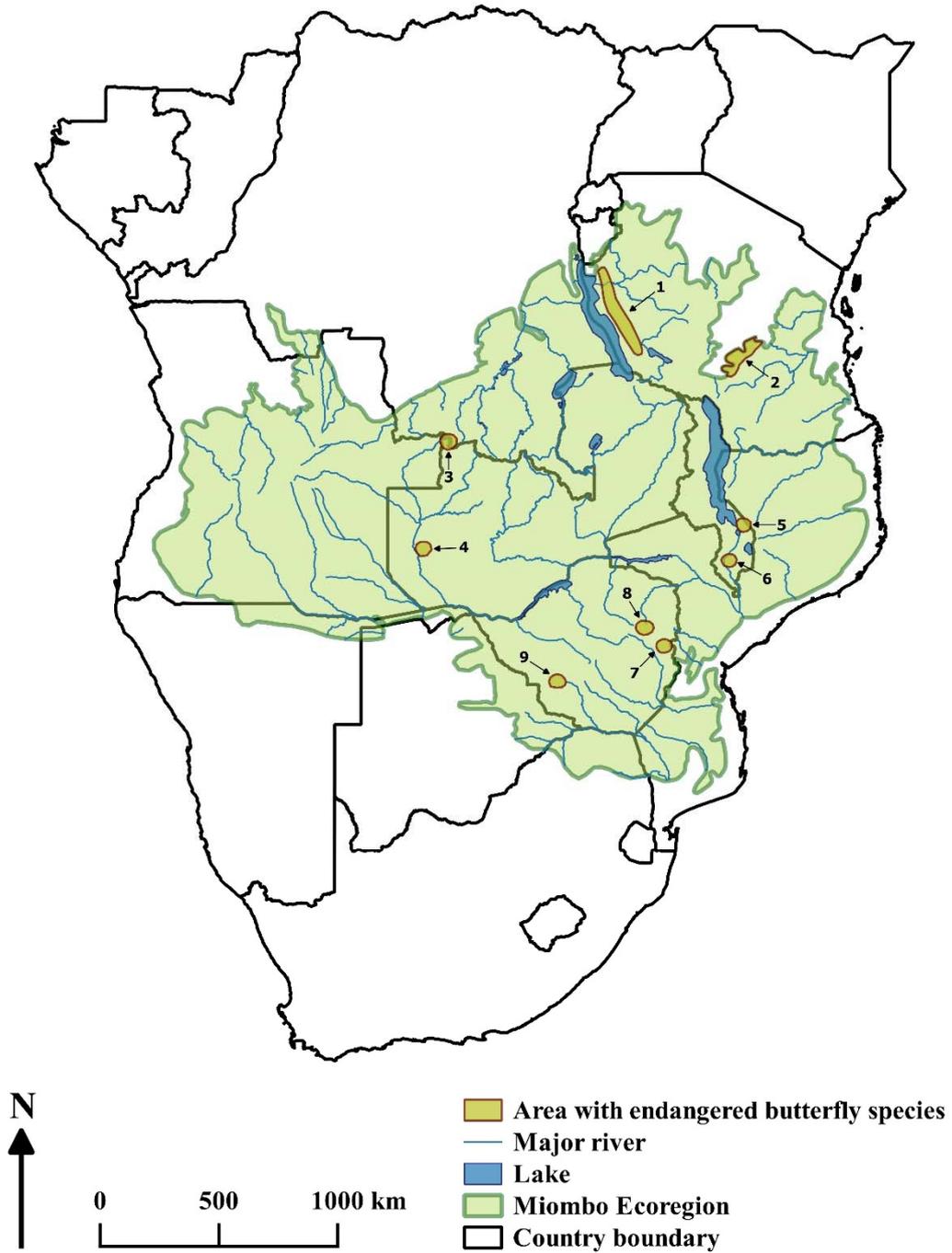
**6. Blantyre** (S Malawi). Endangered species: *Iolaus (Epamera) handmani*.

**7. Mutare** (E Zimbabwe). Endangered species: *Deloneura sheppardi*.

**8. Headlands** (C Zimbabwe). Endangered species: *Lepidochrysops chittyi*.

**9. Douglasdale / Hope Fountain** (W Zimbabwe). Endangered species: *Lepidochrysops chittyi*.

**Map 28. Areas with Endangered Butterfly Species**



## Map 29. Areas of High Odonata Diversity

**1. Zambezi Headwaters.** Over 250 species have been recorded from swampy areas along forested tropical streams throughout Africa. Mwinilunga, Zambia/Angola border and N Zambia have received far greater collecting effort than anywhere else, and as a result 178 species have been recorded. Of these, 55 species have a localised distribution within wet miombo vegetation and there are 27 endemics to the area. These numbers are probably a function of lack of collecting in similar habitats elsewhere.

**2. Katambora – Victoria Falls.** 88 species have been recorded from this small area along the Zambezi River; there are 6 known endemics. Many have a localized distribution in the rainforest area at Victoria Falls.

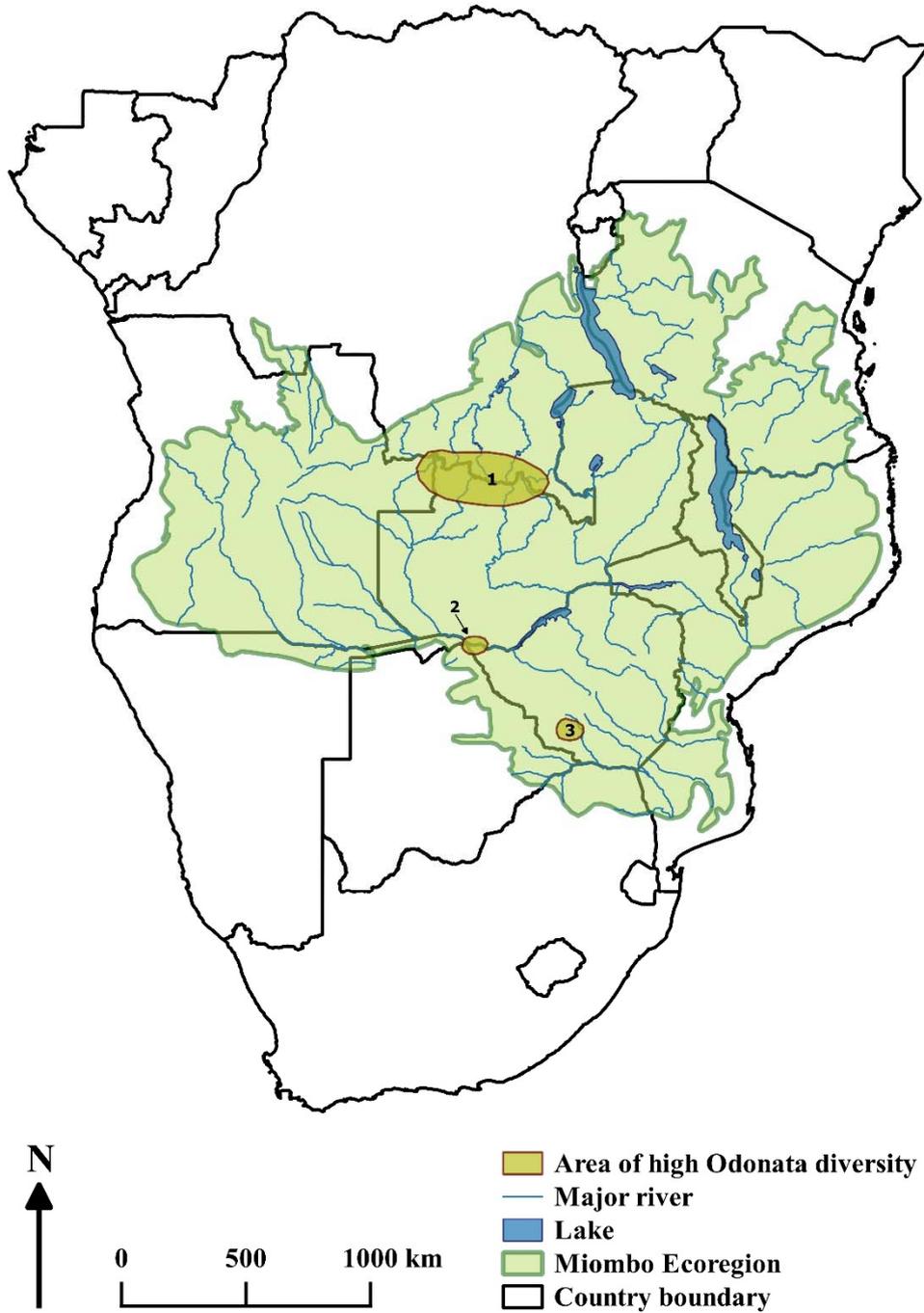
**3. Matobo Hills.** The area has been poorly collected with a total of 46 species recorded. Many streams and dams are permanent so it is likely the species diversity is far greater.

### Notes

Odonata are always associated with water as their larval stage is aquatic. In areas where water is permanently available, and the river/stream and pool banks are undisturbed and have diverse vegetation cover, Odonata diversity is far greater than areas where water is seasonally available or water edges are disturbed and have little vegetation cover. Within the Miombo Ecoregion little collecting has taken place. There are 250 Odonata recorded over the entire ecoregion.

The major area adjacent to the Miombo Ecoregion that has been moderately well-collected and shows a high diversity of Odonata is the Okavango swamps with 84 species and 5 endemics. The montane forests of Zimbabwe and Malawi have over 135 species and 8 endemics, while the coastal forest and low-lying areas of Mozambique and Zimbabwe have over 140 recorded species and 9 endemics.

**Map 29. Areas of High Odonata Diversity**



## Map 30. Areas of Evolutionary Significance

This map cannot be depicted as an array of polygons as important evolutionary patterns in the region appear as zones and boundaries between more extensive areas. Two such notable barriers include escarpments (Eastern Highlands and Muchinga escarpment) and certain major wetlands. One such notable wetland was the former course of the palaeo-Chambeshi River. The source of this wide and shallow river was near the southern base of Lake Tanganyika. It flowed southwest across the Zambian plateau (including the modern Upper Kafue) as a major tributary of the inland Lake palaeo-Makgadigadi.

There are strong differences between aquatic and terrestrial landscapes. Important barriers are indicated separately (bold dashed lines with encircled numbers) from landscapes of evolutionary significance. The latter contain endemic assemblages or species.

### Biogeographical Barriers (numbers encircled)

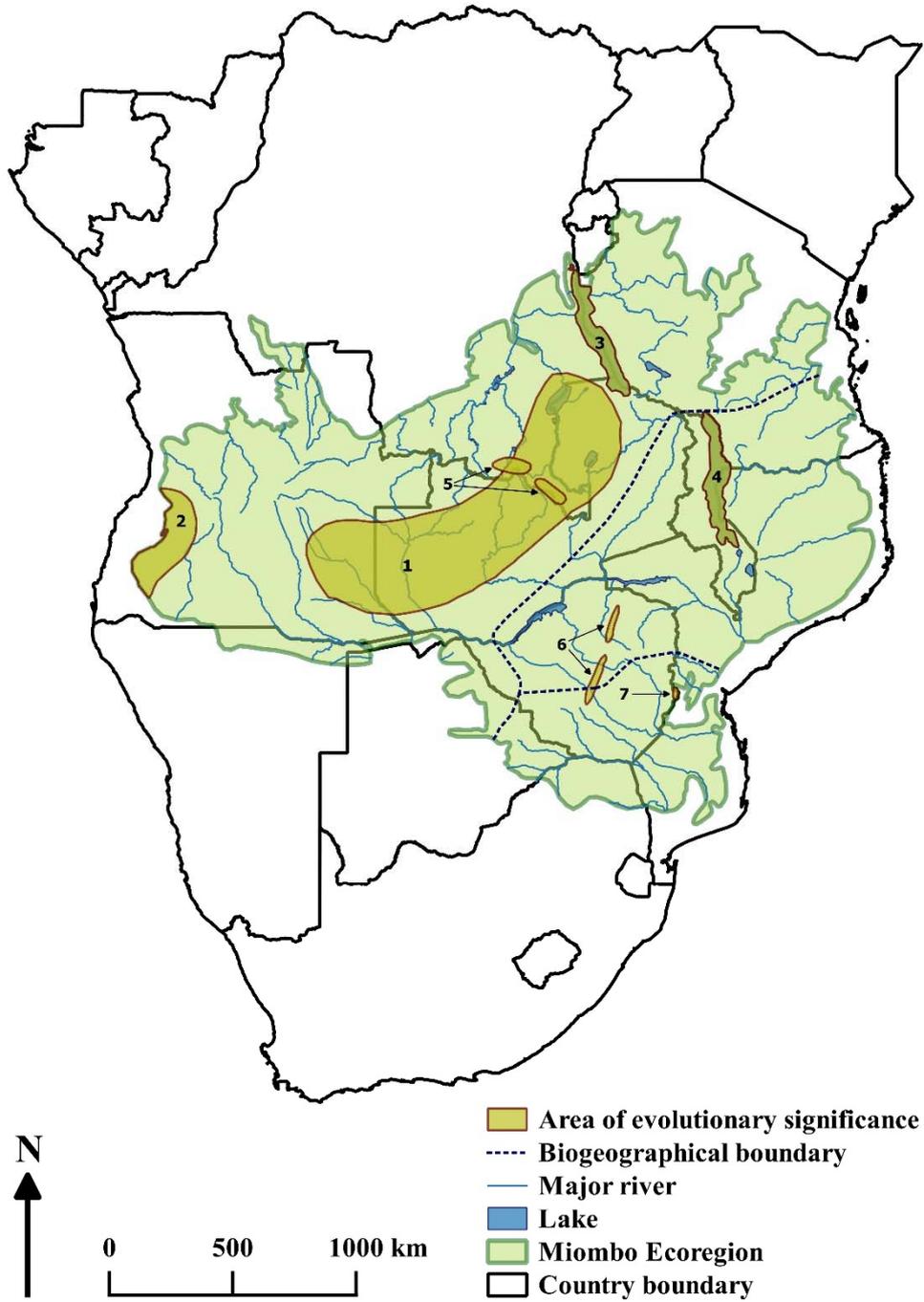
**1. Palaeo-Chambeshi River.** Also the mid-Zambezi and Muchinga escarpments. This delineation coincides with a geological axis of epeirogenic flexure – the Okavango-Bangweulu axis. This activity began in Mesozoic times and latterly have driven significant geomorphological changes through the Cenozoic. A notable landform was the palaeo-Chambeshi River subsequently beheaded into the palaeo-Kafue and Chambeshi. Major division between redivine antelopes (*Kobus vardoni* and *K. senganus*; *K. crawshawi* and *K. ellipsiprymnus*) and primates (*Papio* and *Cercopithecus*).

**2. Mid-Zambezi and Limpopo Watershed.** Corresponds to Okavango–Kalahari–Zimbabwe axis of epeirogenic flexure.

**3. Eastern Highlands.** Endemics characterized by its Afromontane biota, and also some partly associated with miombo landscapes. For mammals, these include: *Lissonycteris goliath*, *Chlorotalpa arendsi*, *Myosorex 'cafer'*, *Crocidura inyngai*, *Sylvisorex sheppardi*.

**4. Kibara – Mweru – Rukwa.** This barrier coincides closely with tectonic activity in the East African Rift valley. It separates the Rukwa, Chambeshi and Upper Luangwa (mid-Zambezi) drainage systems. Also bounds the terrestrial biota of NE Zambia.

**Map 30. Areas of Evolutionary Significance**



### **Map 31a. Evolutionary Areas – Aquatic Organisms**

- 1. Cunene River.** Fish.
- 2. Upper Zambezi.** Fish.
- 3. Bangweulu:** *Kobus smithemani*.
- 4. Kafue Flats:** *Kobus kafuensis*.
- 5. Lake Tanganyika.** Fish.
- 6. Lake Rukwa and internal drainage.** Fish.
- 7. Lake Malawi.** Cichlid fish.

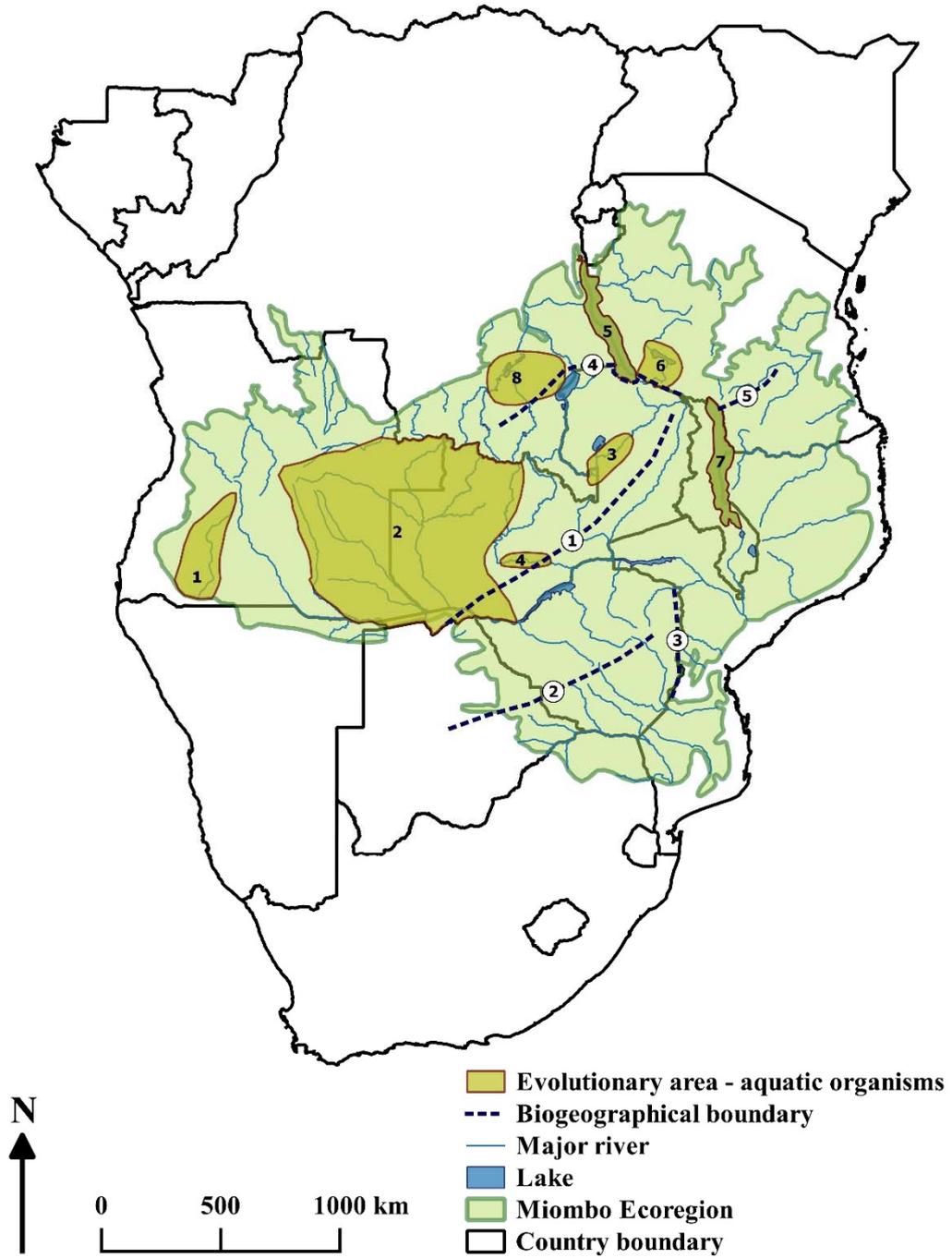
### **Map 31b. Evolutionary Areas – Terrestrial Organisms**

- 1. Mwinilunga.** Lepidoptera, Odonata, small mammals.
- 2. Upemba-Mweru-Bangweulu.** Plants, *Damaliscus* sp., *Kobus robertsi*. This region extends west into southern Katanga. A dichopatric population of red lechwe (*Kobus 'leche'*) is restricted to the environs of Lake Upemba, isolated by the Kibara mountains to east and south.
- 3. Luangwa and mid-Zambezi trough.** Plants, herps, large mammals.
- 4. Mid-Limpopo valley.** Herps, plants, small mammals (in part).
- 5. Livingstone Mountains.** Mammals.

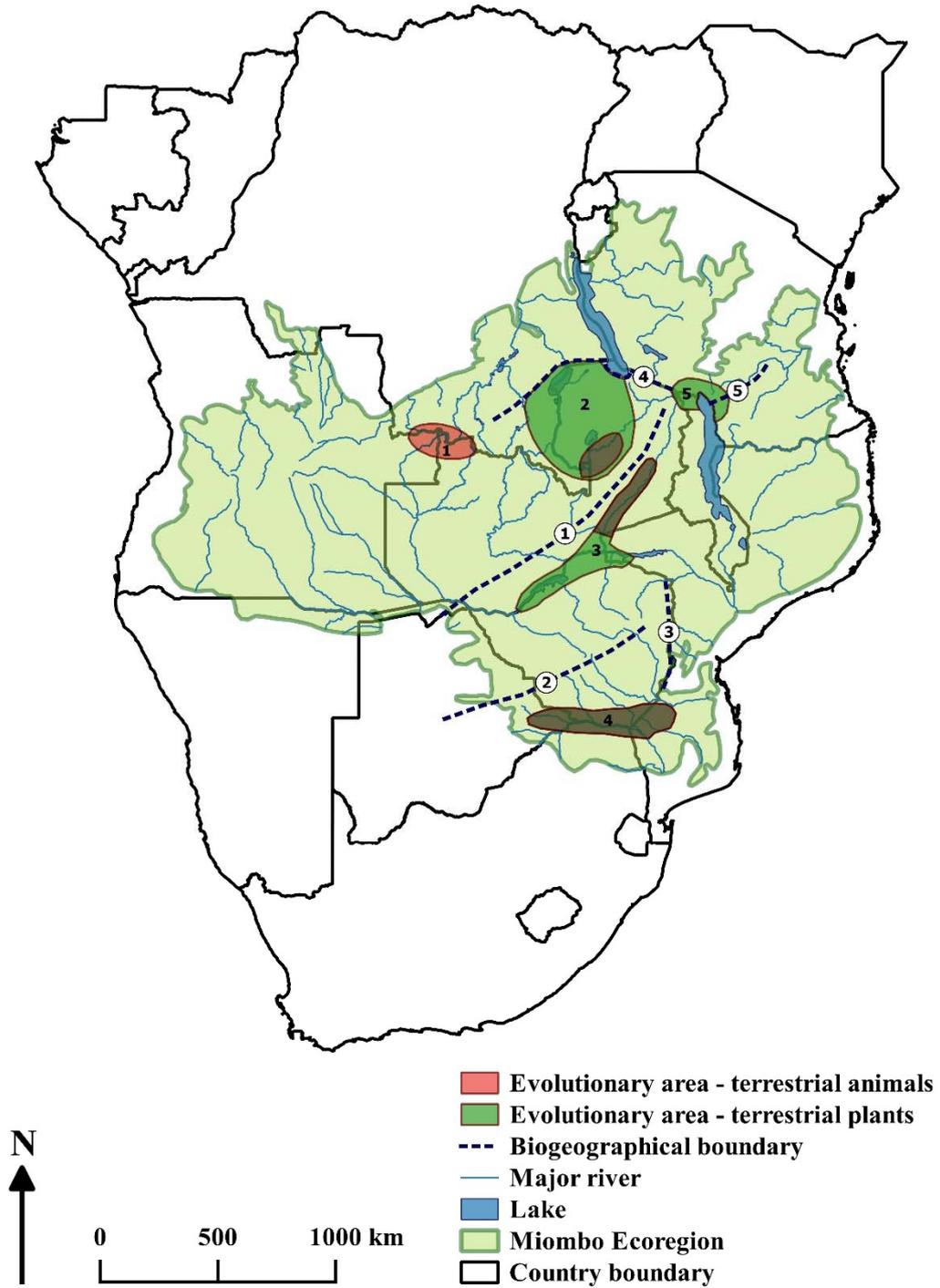
#### **Note**

The Zambian plateau is also a centre of evolutionary significance for molerats (*Cryptomys*). At least 4 species are known, and several more probably await formal discovery. Geological determinants are suspected to underlie this divergence, but geomorphological changes (especially of wetlands) may also have driven vicariance in these subterranean rodents.

**Map 31a. Evolutionary Areas - Aquatic Organisms**



**Map 31b. Evolutionary Areas - Terrestrial Organisms**





## **Map 32. Areas of High Species Diversity**

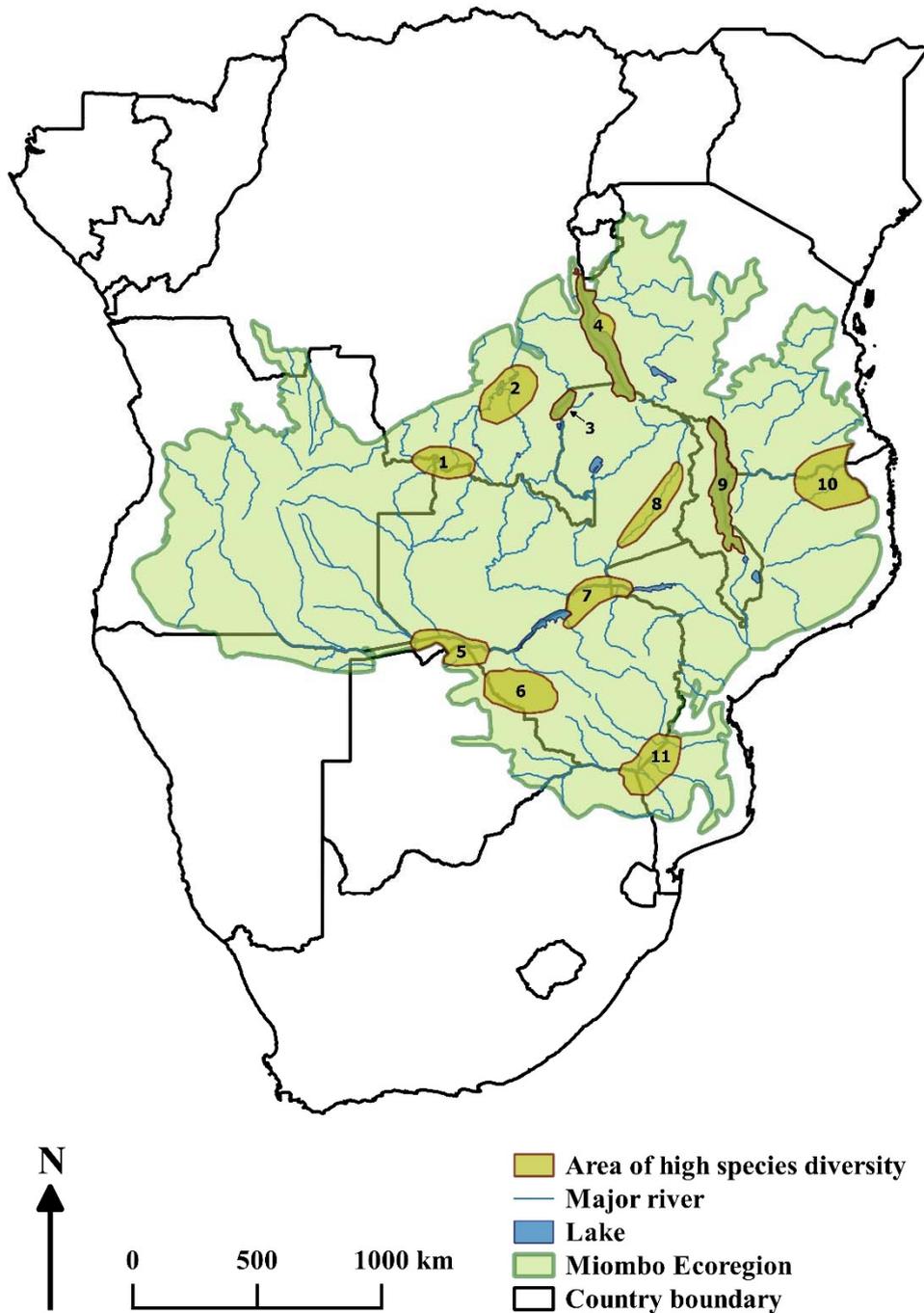
- 1. Zambezi Headwaters.** Plants, small mammals, herps, butterflies, Odonata.
- 2. Upemba.** Plants, large mammals, herps, butterflies.
- 3. Lake Mweru.** Plants, fish.
- 4. Lake Tanganyika.** Fish, molluscs.
- 5. Caprivi – Victoria Falls.** Birds, herps, fish, Odonata.
- 6. Hwange National Park.** Large mammals, small mammals, birds, herps.
- 7. Middle Zambezi.** Large mammals, small mammals, birds, herps.
- 8. Luangwa Valley.** Plants, large mammals, birds.
- 9. Lake Malawi.** Fish, molluscs.
- 10. Rovuma.** Plants, large mammals, herps.
- 11. Chicualacuala.** Plants, large mammals, small mammals, birds, herps.

### **Notes**

Generally, miombo and allied woodlands are not particularly species-rich. The most species-rich areas are those with high habitat diversity, usually associated with a marked change in topography such as the transition to mountainous areas, or with an interdigitation of forest, woodland, grassland and wetland.

The areas chosen and shown on the map are those where a number of group show high diversity, or where exceptionally high richness in one particular group (mostly fishes) is seen.

**Map 32. Areas of High Species Diversity**



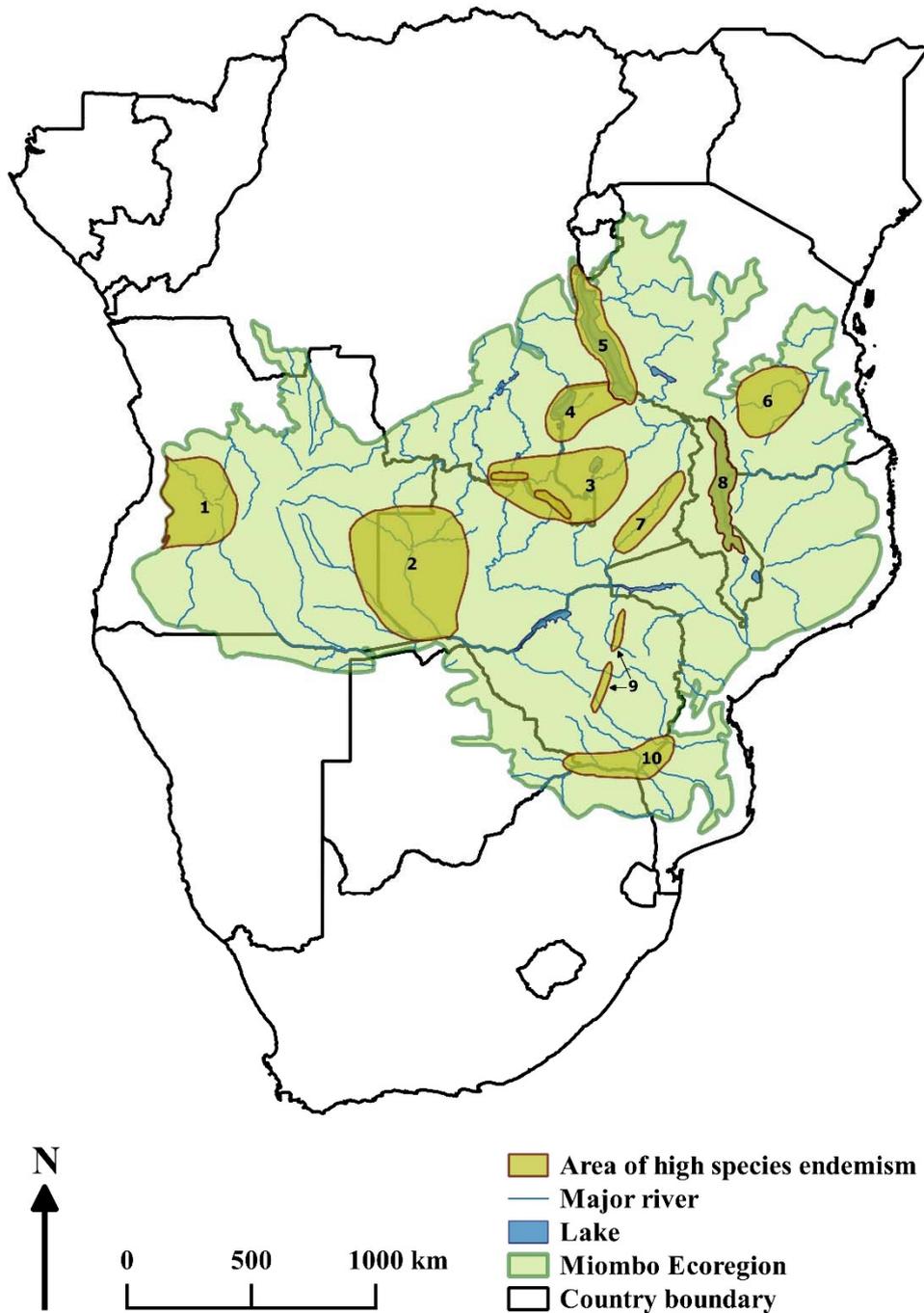
### **Map 33. Areas of High Species Endemism**

- 1. Angolan Highlands** (C Angola). Plants, antelope, birds.
- 2. Barotseland** (W Zambia). Plants (especially suffrutices), birds, herps.
- 3. Katanga/Bangweulu** (N Zambia). Plants, antelope, herps, butterflies. The plant centre of endemism of Kolwezi/Lubumbashi is included.
- 4. Mweru Wantipa** (NE Zambia). Plants, mammals, herps.
- 5. Lake Tanganyika** (S Tanzania). Fish (high levels of endemism), herps (in the immediate catchment).
- 6. Kilombero – Ruaha** (C Tanzania). Antelopes, monkeys, herps. Also plants in montane areas.
- 7. Luangwa Valley** (E Zambia). Plants, antelope, giraffe, monkeys.
- 8. Lake Malawi**. Fish (high level of endemism).
- 9. Great Dyke** (C Zimbabwe). Plants (high level of endemism).
- 10. Limpopo Lowveld** (S Zimbabwe/S Mozambique, N South Africa). Plants, small mammals, herps.

#### **Notes**

Areas shown are those with either endemism expressed in various different animal and plant groups, or those with a high level of endemism in only one group (e.g. plants). In most cases boundaries are approximate.

**Map 33. Areas of High Species Endemism**



### **Map 34. Areas with Significant Numbers of Globally Threatened Taxa**

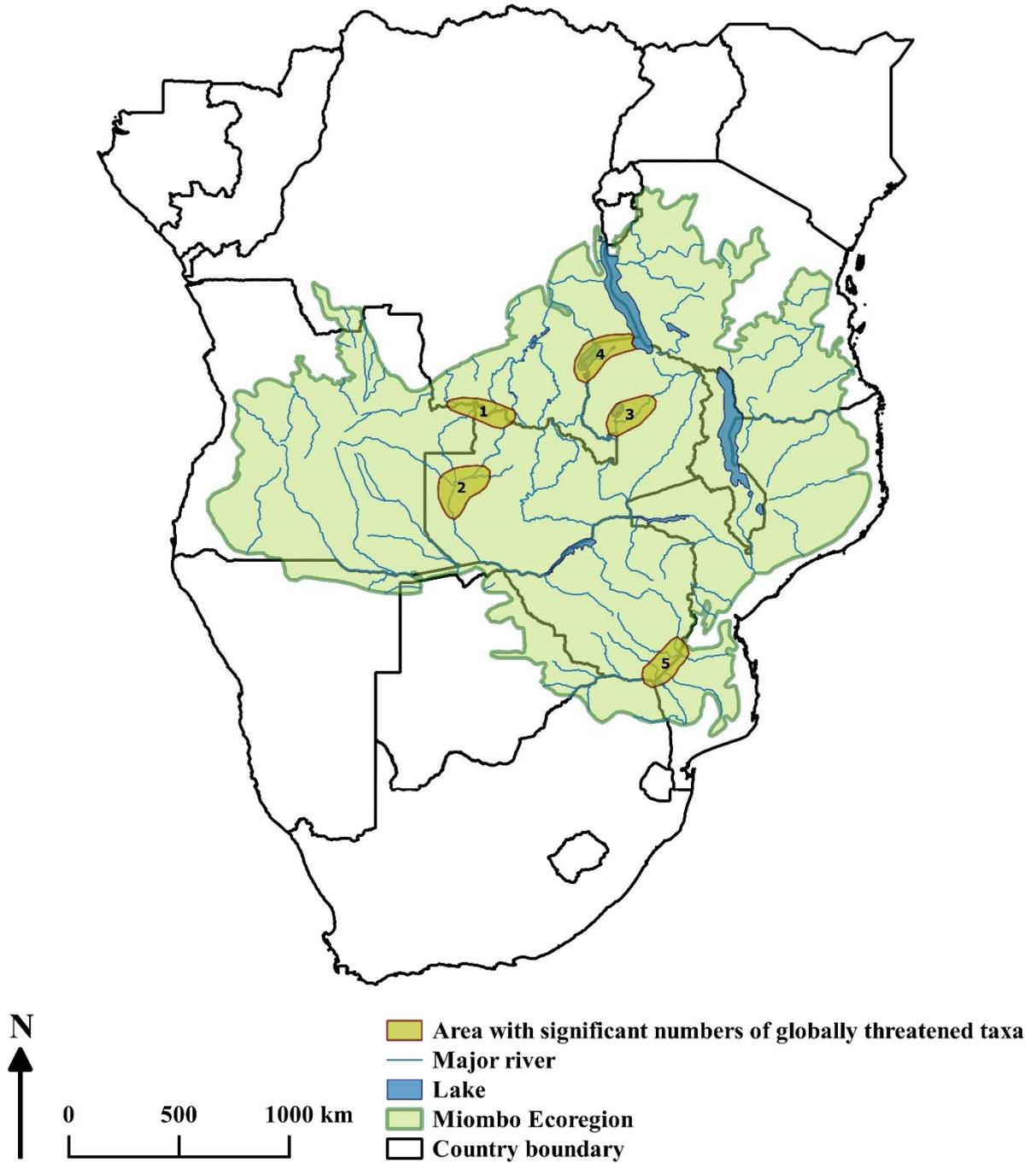
- 1. Zambezi Headwaters** (NW Zambia). Plants (Zambia RDL), small mammals, butterflies. Probably also Odonata.
- 2. Upper Zambezi** (W Zambia). Plants (especially *Cryptosepalum* forest species), antelope (Liuwa Plains), butterfly.
- 3. Bangweulu grasslands** (NE Zambia). Plants (Zambia RDL, especially mateshi forest), antelope.
- 4. Mweru Wantipa** (NE Zambia). Plants (Zambia RDL, especially Itigi-like thickets), crocodile.
- 5. Save–Mwenezi lowveld** (SE Zimbabwe/S Mozambique/NE South Africa). Plants (Zimbabwe RDL), antelope, rhino, turtle.

#### **Notes**

Information on the various groups is fragmentary and inconsistent. There are not many species which are "formally" globally threatened in the Miombo Ecoregion (i.e. listed in global Red Data Lists); most globally threatened species (Critically Endangered or Endangered) are from moist forests, grasslands or East African coastal forests.

The areas shown are those that appear to contain more than just very few threatened species, and in more than one group (i.e. not all mammals or plants).

**Map 34. Areas with Significant Numbers of Globally Threatened Taxa**



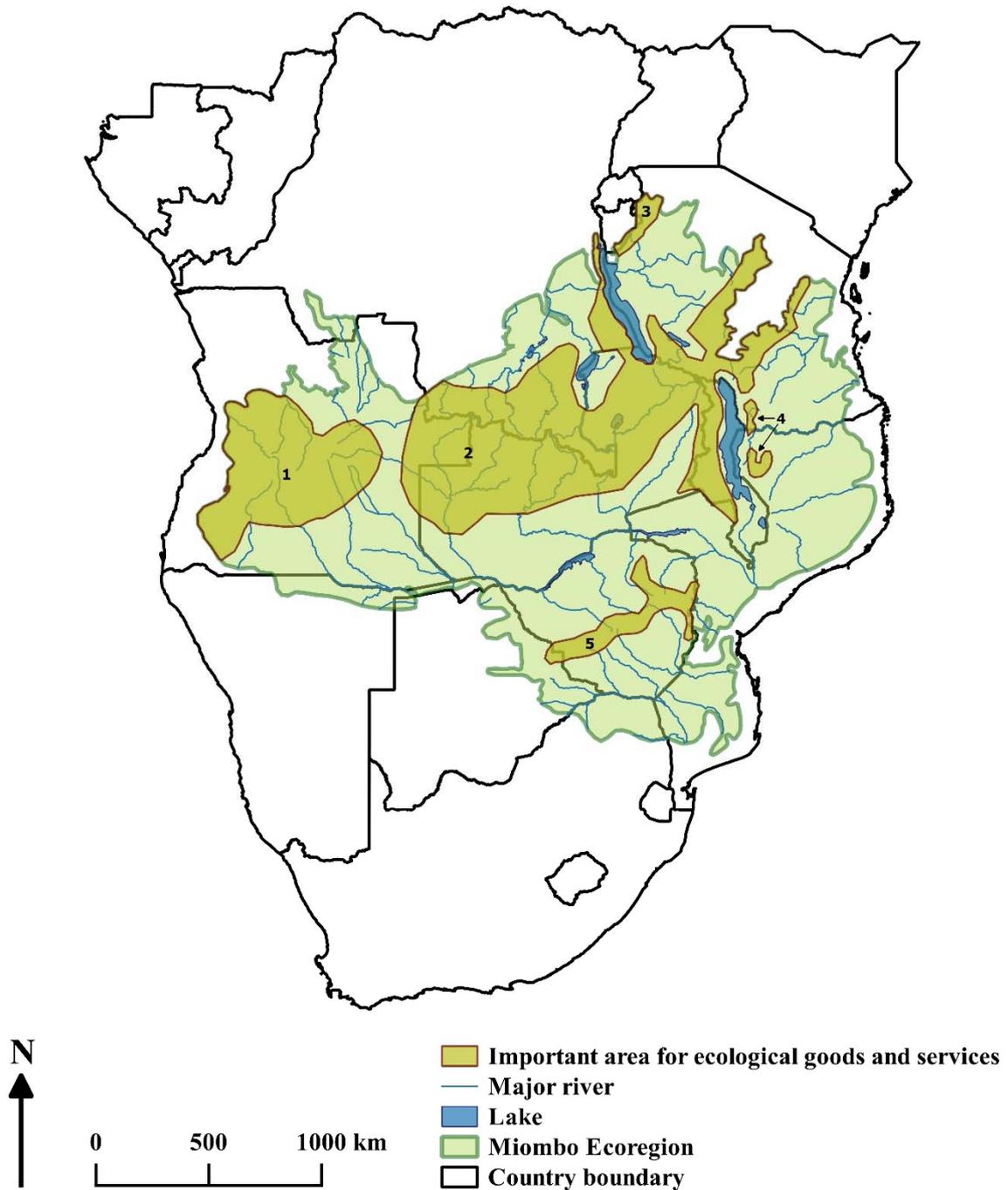
## Map 35. Important Areas for Ecological Goods and Services

1. **Angolan Highlands** (C Angola). Highlands (above 1800 m) and upland plateau; undulating. Headwaters of a number of rivers, including Kwando and Kavango, grasslands and moist woodlands.
2. **Zambezi-Congo Headwaters** (southern D.R. Congo, N Zambia, SC Tanzania). Highlands and upland plateau from 1000–2200 m. Moist woodlands, grasslands riverine/gallery forest, wetlands, floodplains. Headwaters of Zambezi, Congo, Kafue, Luapula and Luangwa rivers, and also catchment for lakes Malawi and Tanganyika.
3. **Kibondo Highlands** (S Burundi, NW Tanzania). Catchment for part of Lake Tanganyika.
4. **Lichinga Highlands** (S Tanzania, NW Mozambique). Two small areas of highlands above 1500 m. Part of the catchment of Lake Malawi.
5. **Zimbabwe central watershed** (C Zimbabwe). Central plateau above 1200 m and Eastern Highlands (1800–2200 m). Woodlands, grasslands and montane forest. Headwaters of Save and Pungwe rivers, and of a number of major tributaries of both the Zambezi and Limpopo.

### Notes

Many areas can be considered important for ecological goods and services, such as firewood, fishing, etc. The major feature underlying many of the services in the Miombo Ecoregion was thought to be hydrology and the low and sluggish drainage across an undulating landscape that characterises much of the Ecoregion. In addition, the large natural (and man-made) lakes are major focal points for human activity. The most important ecological service is regarded as good supply of good quality water. Hence, watersheds such as wooded high ground, are critical, as are floodplains and dambos. The present map focuses on these.

**Map 35. Important Areas for Ecological Goods and Services**



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