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An efficient method for defining plant species under High Conservation Value (HCV) criterion 1 based on the IUCN Red List criteria: A case study using species endemic to Gabon

Nicolas Texier [a,b,c,*], Gilles Dauby [d], Ehoarn Bidault [c,e], Porter P. Lowry II [c,e], Davy U. Ikabanga [c,f], Tariq Stévart [b,c,g]

[a] Faculty of Sciences, Evolutionary Biology and Ecology, Université Libre de Bruxelles, CP160/12, 50 Av. F. Roosevelt, 1050, Brussels, Belgium
[b] Herbarium et Bibliothèque de Botanique africaine, CP 265, Université Libre de Bruxelles, bd du Triomphe, B-1050, Brussels, Belgium
[c] Missouri Botanical Garden, Africa & Madagascar Department, 4344 Shaw Blvd., St. Louis, MO 63110, USA
[d] AMAP, Univ Montpellier, CIRAD, CNRS, INRAE, IRD, Montpellier, France
[e] Institut de Systématique, Évolution, et Biodiversité (ISYEB), Muséum National d'Histoire Naturelle, Centre National de la Recherche Scientifique, Sorbonne Université, École Pratique des Hautes Études, Université des Antilles, C.P. 39, 57 rue Cuvier, F-75005, Paris, France
[f] Laboratoire d'Ecologie Végétale et de Biosystématique, Département de Biologie, Faculté des Sciences, Université des Sciences et Techniques de Masuku, B.P. 941, Franceville, Gabon
[g] Jardin botanique de Meise, Nieuwelaan 38, 1860, Meise, Belgium

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ABSTRACT

The High Conservation Value (HCV) concept, developed by the Forest Stewardship Council to promote sustainable forest management, is widely employed for certification of forestry and agriculture concessions, and has been adopted by many logging and palm oil companies. HCV criterion 1, which deals with "endemic, and rare, threatened or endangered species", is rarely used in certification, mainly because lists of these species are incomplete, especially for plants, and performing threat assessments is time-consuming. The IUCN Red List Categories are often suggested as a suitable basis to define threatened taxa for the application of HCV1, but this requires the rapid and efficient assessment of large numbers of species. Using the plants endemic to Gabon as a case study, we propose a rapid, two-step procedure to identify HCV1 species. First, based on 3,298 verified and geo-referenced herbarium records, we used GIS layers and an automated computational workflow in the R environment to identify potentially threatened species using an approach aligned with IUCN Red List criteria A, B, and D. Ninety percent of the automated assessments correctly indicated the risk of extinction; errors involved incorrect assessments of species whose habitat is in reality not threatened, or occurred during the calculation of the number of locations (*sensu* IUCN) when a single threat impacts large areas. In a second step designed to correct these issues and comply with the Red List guidelines, we performed species-by-species verification of the automated assessments, taking into account the ecology and habitat of each species and the nature of the threats it faces. Of the 389 endemic taxa analyzed, 86 % were identified as threatened (83 CR, 171 EN, and 80 VU); of these, only 35 % are recorded from at least one National Park, but most are found in logging/oil palm (72 %) or mining (55 %) concessions, underscoring the need to improve the application of the HCV concept. To strengthen the use of HVC subcriterion 1.2 (rare, threatened or endangered species), we propose an explicit method for identifying rare species based on a quantitative threshold of the Extent of Occurrence (20,000 km^2), and we examine the concept of endemicity with respect to the application of HVC subcriterion 1.3 (endemic species). The proposed methodology addresses an urgent need to develop a national interpretation of the HCV concept in Gabon, adopted as a national standard for logging concessions, and offers an efficient, reliable approach for the application of HVC1 elsewhere in Central Africa.

* Corresponding author at: Faculty of Sciences, Evolutionary Biology and Ecology, Université Libre de Bruxelles, CP160/12, 50 Av. F. Roosevelt, 1050, Brussels, Belgium.
E-mail address: Nicolas.Texier@ulb.be (N. Texier).

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1. Introduction

The High Conservation Value (HCV) concept was developed by the Forest Stewardship Council (FSC) in 1999 to support sustainable forest management worldwide. Based on six standardized criteria, HCV takes into account biodiversity (from species to ecosystem-scale), ecosystem services, social needs, and cultural values (Brown et al., 2013). The HCV concept is used to identify and manage social and environmental values in production landscapes (Forest Stewardship Council, 2015). Initially focused on forest management (under the HCVf label; Jennings et al., 2003), it is currently also employed in other sectors such as agricultural exploitation (e.g. certification of palm groves under the Roundtable on Sustainable Palm Oil (RSPO) process) and aquaculture, and could be applied to sectors such as mining.

The methodology for implementing the HCV concept calls for interpreting each of its six standardized criteria at a national level, thereby ensuring that it is aligned with the specific context of the country in question. HCV criterion 1 (HCV1) deals with "concentrations of biological diversity including endemic species, and rare, threatened or endangered species, that are significant at global, regional or national levels" (Forest Stewardship Council, 2015). An area can be designated as HCV1 because of the presence of a protected area (subcriterion 1.1) and/or rare, threatened or endangered species (subcriterion 1.2) as well as endemic species (subcriterion 1.3), or because it has spatial or temporal concentrations of species (subcriterion 1.4) (Brown et al. 2013). Regarding plant species, the interpretation of the HCV concept mainly involves subcriteria 1.2 and 1.3. Despite this apparently clear description of HCV1, there is in fact neither an accurate definition nor a precise methodology to determine which species are regarded as endemic or as rare, threatened or endangered. To date, only a few countries, mostly in south-east Asia (e.g. Papua New Guinea, Malaysia, and Indonesia), have adopted a national interpretation of the HCV concept that uses, for instance, the Categories and Criteria of the IUCN Red List (IUCN, 2012) or Appendix I of the Convention on the International Trade of Endangered Species (CITES) to identify these species. In Central Africa, Gabon was the first country to attempt an interpretation of the HVC concept in 2008, but this effort revealed a lack of fundamental data to interpret and implement sub-criteria 1.2 and 1.3, especially for plants (Stewart and Rayden, 2008). The Democratic Republic of the Congo developed a framework for a national interpretation in 2012 (World Wildlife Fund, 2012), in part using the IUCN Red List Categories and Criteria to define HCV1. However, reporting based on this national interpretation likewise highlighted the lack of information concerning endemicity and conservation assessments for plant species. More recently, Cameroon formulated general guidelines to inform stakeholders, but they only recommend that expert advice be used, without any further details on how to identify HCV1 (World Wildlife Fund, 2016) or to use threatened species according to the IUCN Red List, Cameroon's national list of threatened species, or those appearing in the CITES appendices (Daïnou et al., 2016). The Republic of the Congo similarly proposed to use threatened species according to the IUCN Red List, species protected at the national level, and CITES-listed species, but the number of taxa assessed was very limited and endemics were defined very broadly to include species limited to Lower Guinea (Forêt Ressources Management, 2016; White, 1979). No Central African country has yet formally adopted a national interpretation of the HCV concept for plant species that has been validated by the FSC, mainly because of a lack of data and of an appropriate methodology.

In Gabon, a largely forested country (with an estimated cover of 89 % according to Mayaux et al., 2004), most of which is situated within logging or oil palm concessions (63 %; based on data from World Resources Institute, 2009), the application of the HCV concept is a potentially valuable management tool for the country's second most important economic activity, forestry. This is especially so given that the FSC approach was formally adopted in 2020 to manage logging concessions at a national scale. Although a few logging and palm oil companies operating in Gabon have adopted some of the HCV criteria while developing their concessions, crucial data are lacking in order to apply the concept fully, such as lists of endemic plant species and of rare, threatened or endangered species (HCV1) (Stewart and Rayden, 2008). As a consequence, the distribution of such species within the country, while constituting a key element for conservation planning, remains poorly known. This lack of knowledge has, unfortunately, led some actors to ignore or disregard plants when considering the application of the HCV approach and conducting initial trials for its application, despite the fundamental importance of plants as key biodiversity elements and as the main structuring component of forest ecosystems.

The IUCN Red List is a comprehensive and widely employed tool to define species conservation status at a global scale and is regularly used by researchers, investors, funding agencies, and policymakers (Bennun et al., 2018) to define threatened species, which are classified into three categories, Critically Endangered, Endangered and Vulnerable (IUCN, 2012). The Red List approach provides a suitable basis for defining HVC subcriterion 1.2, i.e., threatened species (which by definition include 'endangered species'). Gabon harbours a high level of plant diversity, with 5,175 described vascular plant species (Lachenaud et al., 2018), but published Red List assessments are available for only 1,082 (21 %) of them (IUCN, 2020), most of which are out of date because they did not include data from recent intensive botanical inventory work conducted in the country or because they were prepared using older criteria (84 taxa were assessed before the current criteria were adopted in 2001). In an attempt to overcome the difficulties associated with the time-consuming process of assessing a large number of species according to the Red List Categories and Criteria, several authors (e.g. Darrah et al., 2017; Miller et al., 2012; Pelletier et al. 2018) have proposed methods for the rapid identification of species that are potentially threatened. These approaches are, however, generally not consistent with IUCN guidelines, which significantly limits their use. More recently, the Preliminary Automated Conservation Assessments (PACA) approach was developed by Stévart et al. (2019) for the rapid identification of large numbers of species that are likely to be threatened using a method that is explicitly grounded in key elements of the IUCN process. However, the PACA method is not suitable for application of HVC1 because it only indicates whether a species is potentially or likely threatened, without assigning it to a particular IUCN threat category, as required to determine the concentration of Critically Endangered (CR), Endangered (EN), and/or Vulnerable (VU) species needed to define HCV1 areas.

The goal of this paper is to present a novel, practical, two-step methodology for conducting reliable preliminary Red List assessments and identifying species that correspond to HCV criterion 1, and to determine the endemic (HCV subcriterion 1.3) and rare or threatened (HCV subcriterion 1.2) plant species of Gabon. For the first step, our methodology is mainly based on the PACA automated approach (Stévart et al., 2019), but goes farther by proposing a preliminary conservation status with an assigned IUCN category based on three of the five criteria of the IUCN Red List (namely A, B, and D) and using all currently available data. This new, automated method for assigning preliminary IUCN categories enables a comparison of the results with assessments published on the Red List (IUCN, 2020), as well as preliminary assessments provided in taxonomic revisions and papers describing new species, or available on the internet (Stévart et al., 2021; https://www.bgci.org/threat_search.php). In a second step, we perform a taxon-by-taxon verification procedure that takes into account the ecology of each species and the threats faced by each of its sub-populations, thereby providing a verified risk of extinction category and, if necessary, formulating a proposed update of the currently published conservation status. This two-step methodology provides a robust foundation for: (i) compiling a list of HCV1 species based on subcriterion 1.2; (ii) tracking the evolution of the conservation status of these species over time; and (iii) expanding the Red List to include many additional species. Due to the large number of species in Gabon, we based our case study on a significant and well-defined portion of the flora, i.e. the species

considered endemic to the country. We also used these endemic species as a test group for the application of HCV subcriterion 1.3.

The application of HCV subcriterion 1.2 is complicated by the fact that 'rare species' are not clearly defined in the HCV concept. We adopted an interpretation based on Extent of Occurrence (EOO), as defined by the IUCN, because it is a widely recognized geographical parameter used for risk of extinction assessments under Red List criterion B (IUCN, 2012). EOO is calculated using a standardized approach detailed in the IUCN guidelines, and is both widely accepted (International Finance Corporation, 2019) and applicable to all major biodiversity groups.

In addition to presenting our new methodology, this study also aims to provide: (i) an updated checklist of plant species endemic to Gabon; (ii) preliminary assessments of the conservation status of Gabonese endemics based on the two-step procedure outlined above (automated and verification); and (iii) an overview of the distribution of endemic plant taxa within Gabon's National Parks network and the country's forestry, oil palm and mining concessions to lay the foundation for the national interpretation of HCV1. Finally, we discuss the broader applicability of the proposed method and its potential use in developing a more explicit framework for utilizing the HCV1 elsewhere in Central Africa and beyond.

2. Material and methods

2.1. Study area

Gabon is located on the Atlantic coast of Central Africa, at the heart of the Lower Guinea subcentre of plant endemism (Droissart et al. 2018; White, 1979). The country covers 267,667 km^2 and, with 5,175 vascular plant species recorded to date (Lachenaud et al., 2018), has one of tropical Africa's most diverse floras (Kier et al., 2005; Sosef et al., 2017). Moreover, Gabon is one of the most significant centres for plant endemism of Africa (Linder, 2001b). Despite the importance of its biodiversity and a recent effort to increase the number of botanical collections available (Lachenaud et al., 2018), Gabon's flora and the threats it faces remain insufficiently known. Indeed, even though Gabon has one of the best-documented floras in tropical Africa, with ca. 104,000 herbarium collections, yielding an average density of nearly 39 collections per 100 km^2, new discoveries are regularly made (Lachenaud et al., 2018) and the sampling effort has been very heterogeneous (Sosef et al., 2017), with large parts of the country remaining under-collected and some totally unexplored (Fig. 1).

Although Gabon's human population density is very low (8 inhabitants per km^2) and the vast majority resides in the capital city of Libreville, the country's expansive forest cover faces increasing pressure. As of 2009, 62.5 % of Gabon's land area was contained in logging, oil palm and mining concessions (World Resources Institute, 2009), which encompassed more than 75 % of the forested area (Fig. 1). There is a high probability that these areas will be exploited during the next 30 years, which will potentially have a significant impact on the country's biodiversity, directly or indirectly threatening many plant species. Moreover, the continuous expansion of urbanization in the three main cities (Libreville, Port-Gentil, and Franceville, in decreasing order of size) contributes to the conversion of important natural habitats in these areas, directly threatening endemic, rare, and/or threatened plants (Walters et al., 2016). While not particularly widespread in Gabon compared to adjacent countries, shifting agriculture poses another threat to the country's flora, although it is limited to the surroundings of villages, concentrated along the main roads since the 1960s (Dauby, 2012). In an effort to mitigate the consequences of threats to the fauna and flora, the Gabonese government established a large network of protected areas in the 2000s comprising 13 National Parks, which encompass 29,893 km^2, i.e., 11 % of the land area. The establishment of these protected areas was, however, largely based on the abundance of large mammals and did not include any information on the presence of endemic or threatened plant species.

2.2. Data and selection of species endemic to Gabon

The checklist of the vascular plants of Gabon (Sosef et al., 2006) is the most recent compilation of the country's flora, including taxa that are endemic to the country. However, during the last fifteen years, extensive inventory work and a global effort to digitize herbarium

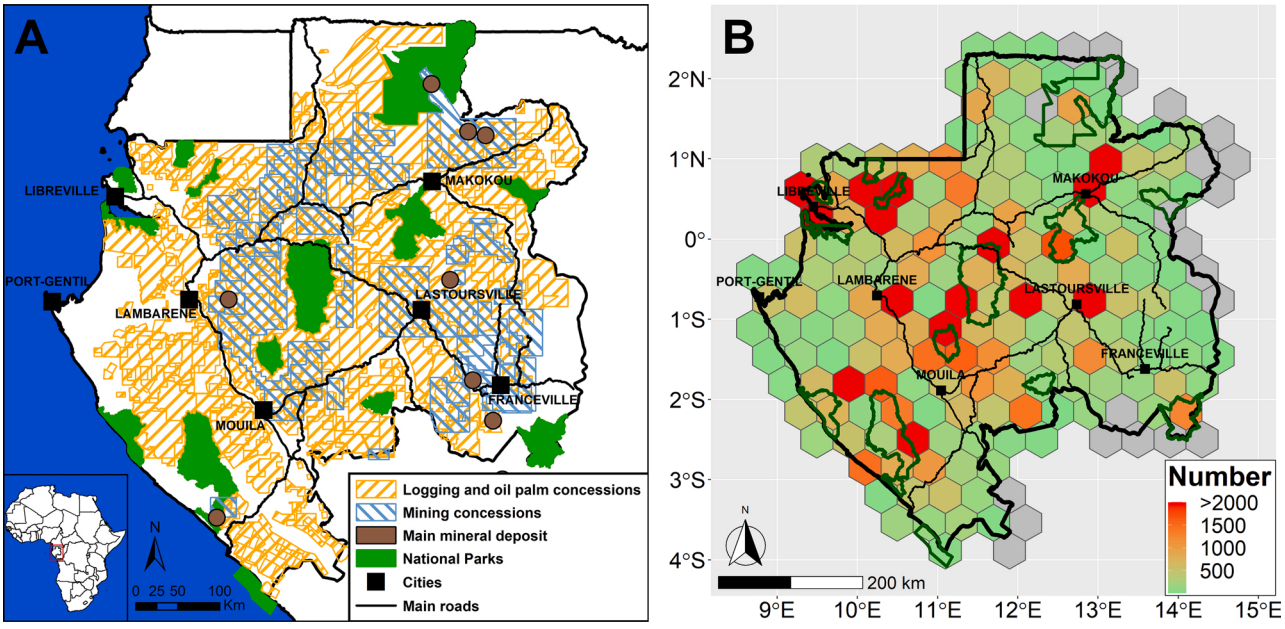

Fig. 1. Distribution of industrial concessions and Gabon's National Parks network (A) and density of botanical sampling (B). Main cities are represented by squares, main roads by black lines, National Parks in green colour (A) or delimited by lines (B). A. Distribution of logging, oil palm, and mining concessions in 2009 (World Resources Institute, 2009) and main mineral deposit (Milesi et al. 2006). B. Botanical sampling effort as of January 1, 2019. The colour gradient represents the number of herbarium collections made per hexagonal grid cell (each cell side = 0.4°; total collections = 103,944; grey cells = 0 collections) (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article).

collections have significantly increased the available knowledge base, necessitating an update of the list of endemics. The most comprehensive and accurate database available to date on the distribution of vascular plants endemic to an area centred on Gabon was recently compiled (Texier et al., 2021) in order to produce an updated checklist of Gabonese endemics based on the distribution of all known material. Following the generally accepted definition of endemism (Anderson, 1994; Crisp et al., 2001; Noroozi et al. 2019), a taxon was considered endemic to Gabon if its known distribution is strictly limited to the country. If a collection lacked precise locality data but clearly came from another country, such as the Republic of the Congo, the taxon to which it belongs was excluded from the list of Gabonese endemics. Taxa with specimens from areas near the border of Gabon lacking a clear indication of country were not removed from the provisional list of endemics and were annotated "taxon likely sub-endemic" (Appendix A). The taxonomy and distribution of all taxa mentioned as endemic in the checklist of the vascular plants of Gabon (Sosef et al., 2006) were checked. Those taxa no longer considered to be endemic are presented in Appendices B and C, with notes on why they were excluded. Taxa still regarded as endemic but that belong to groups under revision or within which there is substantial taxonomic uncertainty were retained on the list but were not used in the analyses presented here. Family names for angiosperms were standardized following the APG IV system (The Angiosperm Phylogeny Group, 2016). Names of species and infraspecific taxa generally follow the African Plant Database (African Plant Database, 2021), except for one case in which another name is accepted (i.e. *Renzorchis pseudoplatycoryne*).

All specimens whose geographical coordinates were precise to within 10 km were used to assess conservation status, along with records that lack precise data but clearly represent distinct subpopulations from which no other collections have been made. For instance, historical collections from the Libreville area, which generally lack precise locality information, were used only if they were interpreted to be the sole representatives of a distinct subpopulation. Specimens with unreliable or vague locality data were excluded. Historical collections from Gabon (i.e. made between 75 and 170 years ago) were considered for the conservation status assessment procedure because (i) they indicate the occurrence at a given time of a species that could be still present today (but see the methodology presented below to infer when an occurrence has been excluded), and (ii) they constitute, for some species, the only known distribution data. In total, 3,298 georeferenced herbarium collections were used.

2.3. Preliminary assessment of conservation status

Preliminary conservation assessments of taxa endemic to Gabon (excluding those with taxonomic uncertainty) were conducted using the IUCN Red List Categories and Criteria (IUCN, 2012; IUCN Standards and Petitions Subcommittee, 2019). Three of the IUCN criteria were used to assess whether a species is likely to be threatened: (i) criterion A, dealing with the reduction of population size; (ii) criterion B, which concerns geographic range as defined by the Extent of Occurrence (EOO) and/or the Area of Occupancy (AOO); and (iii) criterion D, dealing with very small population size (number of mature individuals). In the absence of precise information on population size and distribution, which is commonly the case for plant taxa, standard practice calls for using estimates of geographic range obtained from occurrence records (e.g. georeferenced herbarium specimens) (Schatz, 2002; Willis et al., 2003). Nevertheless, occurrence records are not even remotely sufficient on their own to assess species under criteria C (i.e. small population size and decline), D (except for D2), and E (i.e. quantitative analysis of the probability of extinction), for which a precise estimation of the number of mature individuals (criteria C and D) or demographic and quantitative information (criterion E) are needed. These criteria were therefore not utilized in the present paper.

To assess the preliminary IUCN status for endemic taxa, we (i) performed an automated procedure to determine an initial preliminary conservation status and (ii) conducted a taxon-by-taxon Red List assessment using the standard IUCN procedure to confirm or refine the automated assessment, as needed.

2.3.1. Automated procedure

2.3.1.1. Criterion A (population size reduction). For most plant species occurring in Gabon, little if any information is available on population dynamics through time, which is generally required to calculate or estimate population size reduction. We have therefore adopted the approach and methodology of Stévart et al. (2019), which involves estimating population decline based in the past (IUCN subcriterion A2), future (subcriterion A3), or both past and future (subcriterion A4) by inferring the decrease in AOO (AOO_{DEC}) for each taxon using a human impact raster layer (Stévart et al., 2019) derived from the Africa land-cover map of Mayaux et al. (2004) and a map of the principal mineral deposits, where industrial mining activities are taking place or will likely take place in the near future (Durán et al. 2013; Edwards et al., 2014; Milesi et al. 2006; see the production of the map in Stévart et al., 2019). The land-cover map of Mayaux et al. (2004), specially designed for Africa, remains the most detailed map of land occupation for the continent. Moreover, the land cover types subjected to moderate to high levels of human impact are highly correlated with forest cover loss in Gabon between 2000 and 2019 (p-value < 0.001, Kendall correlation test; Hansen et al. 2013). We did not apply IUCN subcriterion A1 because we do not consider that the causes of population reduction (i.e., threats to plants in Gabon such as urbanization and logging) are clearly reversible and understood, and have ceased (IUCN, 2019). Therefore, we applied the thresholds for subcriteria A2, A3, and A4 and used condition (c) based on the inferred potential decline in AOO (AOO_{DEC}) in order to assign each taxon one of the following preliminary threat categories:

- Critically Endangered (CR): $AOO_{DEC} \geq 80$ %;
- Endangered (EN): $AOO_{DEC} \geq 50$ %;
- Vulnerable (VU): $AOO_{DEC} \geq 30$ %.

2.3.1.2. Criterion B (geographic range).
Assessing a species under IUCN criterion B relies in large part on two area subcriteria, EOO (IUCN subcriterion B1), defined as the smallest convex polygon that encompasses all known occurrences, and AOO (IUCN subcriterion B2), the area actually occupied by the species within the EOO, usually calculated using 2×2 km grid cells, as recommended by IUCN (2019). In order for a species to be assessed as threatened, elements or threshold values under at least two of three of the following conditions must also be met (IUCN, 2019): (a) number of locations, i.e. "a geographically or ecologically distinct area in which a single threat can rapidly affect all individuals of the taxon present" (IUCN, 2012) less than or equal to ten, or the species is considered to be severely fragmented, i.e. "its individuals are found in small and relatively isolated subpopulations" (IUCN, 2012); (b) inferred/projected decline in five parameters, including habitat quality; and (c) extreme fluctuation of populations (which is rarely used for plants). We used the ConR R package (Dauby et al., 2017; R Core Team, 2018) with default values to calculate EOO and AOO, and to estimate the number of locations [IUCN subcriterion (a)]. Considering a species as severely fragmented is generally based on habitat information and the availability of information on its dispersal strategy (IUCN, 2012). Given that most of the taxa endemic to Gabon grow in terra firme forest (Texier et al., 2021), an unfragmented habitat in Gabon, and that no map of detailed vegetation types exists for Gabon, we did not consider the condition of severe fragmentation for our automated procedure. Given that most of the forested area situated outside National Parks in Gabon (see Study area above) is located within logging or oil palm concessions (Fig. 1), we inferred that taxa occurring in unprotected dense forest have suffered

(Collomb et al., 2000) and/or will suffer from a decline in habitat quality [IUCN subcriterion b(iii)]. Using the land cover map of Mayaux et al. (2004), we tagged each collection locality that mapped to a land cover type subjected to a moderate to high level of human impact (see Stévart et al., 2019) in order to estimate inferred or projected decline in the number of mature individuals [IUCN subcriterion b(v)], which is frequently associated with a decline in habitat quality. Inferring or projecting a decline in EOO, AOO, and/or the number of locations or subpopulations [IUCN subcriteria b(i), b(ii), and b(iv), respectively] would require the complete extirpation of at least one subpopulation, a difficult assumption to make when using an automated procedure that cannot take into account the ecology of taxa or the ways in which threats impact subpopulations. Thus subcriteria (i), (ii), and (iv) were not considered when conducting preliminary assessments under criterion B.

2.3.1.3. Criterion D (very small or restricted population). IUCN subcriterion D2 is applied to taxa that are not currently assessed as threatened under other criteria but whose population size is very small (AOO < 20 km^2 or known from no more than five locations) and that face a plausible future threat (from human activities or stochastic events) that may lead rapidly to a status of Critically Endangered (CR) or Extinct (EX). Thus, for taxa that were not preliminarily assessed as threatened under criteria A or B but are known from only one or two locations, we assigned a preliminary status of VU D2, based on the assumption that they could quickly become CR or EX as a result, for example, of a stochastic event or the downgrading of a protected area, leading to the extirpation of one or both subpopulations.

2.3.1.4. Extinct (EX) status and Possibly Extinct (PE) tag. A taxon was assessed as Extinct (EX) when it was preliminarily evaluated as Critically Endangered (CR) under IUCN criteria A and/or B but is known only from a single subpopulation in the Libreville area that is documented exclusively by historical collections and has not been recorded during the last 100 years. The Libreville area has been highly urbanized in the last 50 years and is the most thoroughly collected part of Gabon. As required by the IUCN criteria (IUCN 2012), the Extinct (EX) status was assigned only when targeted survey work in all known or likely habitats has failed to relocate a taxon. When dedicated surveys have not yet been undertaken, species were tagged as Possibly Extinct (PE) and preliminarily assessed as Critically Endangered (CR).

We compared the parameters calculated for each taxon using the approach described above with the thresholds defined by the IUCN (2012) in order to infer whether it is threatened with extinction. In keeping with the IUCN standards, if different levels of threat were assessed for a taxon under different criteria (for example, EN under criterion A but CR under criterion B), the highest threat level was retained. For each taxon preliminary assessed as not threatened, we recorded its risk of extinction according to the three categories recognized by IUCN (2012): Near Threatened (NT), Least Concern (LC), and Data Deficient (DD).

2.3.1.5. Near Threatened (NT) status. A taxon was assessed as Near Threatened (NT) when, under criteria A, B, and/or D, it nearly qualified as threatened or is likely to qualify in the near future (IUCN Standards and Petitions Subcommittee, 2019). Using the layers for impact from human activities and mining (see Section 2.3.1.1. above), we inferred that occurrences situated within impacted cells could disappear in the near future, in contrast to the conservative approach used for conducting preliminary assessments under criterion B described in Section 2.3.1.2. After removing such occurrences, we reassessed risk of extinction for each taxon under criteria B and D; those that qualified as threatened based only on the retained occurrences were treated as Near Threatened (NT). This methodology was adopted to identify potentially threatened species that should be accorded special attention until full Red List assessments, including as part of environmental impact studies, can be conducted.

2.3.1.6. Least Concern (LC) status. A taxon was assessed as Least Concern (LC) when it did not qualify as threatened or Near Threatened under IUCN criteria A, B, or D.

2.3.1.7. Data Deficient (DD) status. IUCN indicates that the Data Deficient (DD) category should be used when "there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status" (IUCN, 2012). This can be the result of (i) taxonomic uncertainty and/or (ii) insufficient information. In the present study, because taxa belonging to groups in which there is taxonomic uncertainty had already been excluded, we only applied the DD category to taxa for which no georeferenced records were available.

2.3.2. Validation procedure

To evaluate the performance and validate the effectiveness of our automated methodology for assessing the risk of extinction of species endemic to Gabon, we compared the results from our automated procedure with published conservation assessments available in the literature or on reliable online sources, including the IUCN Red List (IUCN, 2020). This comparison is informative only when the data used for the published assessment were the same as those used for our automated assessment, i.e. when no documented subpopulations had been neglected in the published assessment and/or no new subpopulations had been recorded during botanical exploration work recently conducted in Gabon. Published assessments were obtained from four sources: (i) the IUCN Red List website (www.iucnredlist.org); (ii) the 'ThreatSearch' tool (https://www.bgci.org/threat_search.php) developed by Botanic Gardens Conservation International, which provides access to a compilation of conservation assessments from diverse sources; (iii) preliminary assessments published in peer-reviewed papers (e.g. descriptions of new species and taxonomic revisions); and (iv) preliminary assessments appearing on the Threatened Plant Species of Gabon website (Stévart et al., 2021).

Finally, to confirm or, when needed, to refine the preliminary conservation status obtained automatically, a procedure was used to compare the ecology and distribution of each taxon with land cover type and presence in protected areas as well as in mining, oil palm, and logging concessions. This was done in order to verify the number of locations estimated by the ConR package with respect to (i) the most serious plausible threat, in accordance with the requirements of Red List criterion B (e.g. two or more occurrences of a species, mainly threatened by forest exploitation, even separated by several kilometres, located in a single logging concession are counted as one location because forest exploitation represents a single event), and (ii) the threats inferred at each site, as a basis for estimating or projecting reduction or decline of its sub-populations. This procedure produces a verified preliminary conservation status assessment that is close to a full IUCN Red List risk of extinction assessment, and which meets the requirements of the HCV concept to delimit conservation areas.

It should be noted that the conservation status proposed in this paper for each plant species endemic to Gabon, while informative, must be regarded as "preliminary" because it does not fulfill all of the requirements of the IUCN Red List procedure. For instance, a complete Red List assessment must include a carefully articulated rationale to support the risk of extinction status assigned to a species.

2.4. Definition of rare species

There is significant ambiguity regarding the definition of rare species in the literature dealing with the identification of HCV. According to the HCV Resource Network (Brown et al. 2013), a species may be considered as rare if it occurs at a very low density or is at the limit of its natural

distribution, or if it has become rare because of human activities, but no guidance is provided on the definition of 'very low density' or the threshold for being regarded as 'rare' due to human impacts. The Forest Stewardship Council (2015) indicates that a species may be considered as rare if it is "uncommon or scarce" but not classified as threatened, which could be regarded as approximately equivalent to Red List category of Near Threatened (NT), without necessarily requiring the presence of an identified threat, although again, no precise definition is provided for the terms "uncommon" or "scarce".

There are, indeed, a large number of approaches available for defining the rarity of a species, which are generally based on three classes of attributes: geographic range, habitat specificity, and local abundance (Choe et al., 2019; Espeland and Emam, 2011; Rabinowitz, 1981). Recent studies have, for example, used the currently known number of records of species (i.e. a proxy for abundance) to define the rarest species, but this proxy is partly biased by the heterogeneity of botanical sampling effort in the studied area and by the completeness of the databases used (Enquist et al., 2019; Zizka et al., 2018). An accurate characterization of the habitat specificity of a species is limited by both our knowledge of its ecology, especially in the tropics, and the availability of detailed vegetation maps (Choe et al., 2019). Thus, geographic range is the most frequently used criterion in the literature to define rare species (Espeland and Emam, 2011). Finally, it should be keep in mind that rarity is a relative, rather than an absolute, concept, i.e. it is based on the choice of a quantitative threshold to define which species are rare compared to others (Flather and Sieg, 2007).

Because the definitions of rarity used in the HCV literature are qualitative and imprecise, and in order to facilitate the definition of rare species, we have chosen to recognize a taxon as rare when our preliminary assessment determined that it is not threatened but its Extent of Occurrence (EOO) is less than 20,000 km^2, i.e., below the threshold for Vulnerable (VU) status under IUCN Criterion B1.

2.5. Distribution within National Parks and logging/oil palm and mining concessions

Using GIS layers and R software (R Core Team, 2018), we investigated the occurrence of endemic and threatened taxa in Gabon's National Parks and in logging/oil palm and mining concessions in order to (i) estimate the number of locations (see IUCN criterion B) for each species, (ii) determine the proportion of taxa that are currently protected, and (iii) estimate the number of species that are potentially threatened by forestry, oil palm and mining activities. Determining the proportion of taxa currently protected by conservation areas or threatened by industrial activities is crucial for defining national conservation strategies and setting thresholds for the interpretation of HCV criterion 1 for a national application.

3. Results

3.1. An updated checklist of vascular plant taxa endemic to Gabon

A total of 426 taxa are considered endemic to Gabon, including 393 species (representing ca. 7.6 % of the 5,175 documented plant species) along with 14 subspecies and 19 varieties (Appendix A), of which 389 taxa, representing 3,298 georeferenced occurrences, were analysed in the context of this study (see Data section in Materials and Methods). A total of 239 taxa previously considered as endemic to Gabon in the checklist of Gabonese vascular plants (Sosef et al., 2006) are no longer regarded as endemic, including 92 taxa that have been synonymized or are still unpublished, and 147 taxa that have been determined to occur in other countries based on examination of herbarium records and/or on new identifications (Appendices B and C). On the other hand, 155 taxa have been added to the list of endemics to Gabon, most of which were described after the publication of the Gabon checklist (Sosef et al., 2006).

3.2. Performance of the automated preliminary conservation status procedure

Comparison of results from our automated preliminary conservation status assessment procedure with those available based on the full application of the IUCN Red List criteria (IUCN, 2012) revealed that they were in agreement for 174 (80.2 %) of the 217 comparable previous assessments. Among the 43 cases in which they differed, (i) 26 (12 %) published assessments were deemed to be correct whereas the automated procedure yielded an incorrect estimate of the threat or the number of locations, (ii) 15 (6.9 %) automated assessments proved to be more reliable than the published assessments, and (iii) in two cases (0.9 %) neither the automated nor the published assessments were accurate. Among the 172 automated assessments for which no comparison was possible due to the absence of a published assessment or because new sub-populations had been documented since the assessment was published, only 11 (6.4 %) were attributed a wrong IUCN category due to an incorrect estimate of the threat faced or of the number of locations, whereas 161 (93.6 %) were determined to be reliable according to our verification procedure. In total, 350 (90 %) of the 389 automated assessments reliably reflected extinction risk.

3.3. Endemic and threatened or rare plant taxa in Gabon

Among the 389 analysed taxa endemic to Gabon, 85.8 % (334) were preliminarily assessed as threatened, including 83 as Critically Endangered (CR), 171 as Endangered (EN), and 80 as Vulnerable (VU), and 2 taxa were assessed as extinct (EX) (Fig. 2 and Appendix A). A total of 13 (3.3 %) taxa were not found to be threatened according to the IUCN Red List Categories and Criteria but have an extent of occurrence (EOO) of less than 20,000 km^2 and were thus considered as rare (Appendix A), based on our interpretation of HCV1.

3.4. Distribution of endemics within Gabon's National Parks network and its forestry/oil palm and mining concessions

A total of 457 (14 %) herbarium collections of plants endemic to Gabon are recorded from National Parks (NP). In all, 159 (40.9 %) endemic taxa, including 117 (35 %) assessed as threatened, are present in at least one of the country's 13 NPs (Table 1 and Appendix A). However, when considering these figures, it is important to note that significant variation exists in the density of botanical collections within protected areas (Table 1). Overall, only a small proportion (21 %, 82 taxa) of Gabon's endemics have more than 20 % of their recorded occurrences within an NP, and most of them (85 %) are threatened (Fig. 3A). For instance, 13 taxa are known from only one location in an NP and have been preliminarily assessed as threatened under criterion VU D2 (Fig. 3A and Appendix A).

A total of 1,925 (58 %) herbarium collections of plants endemic to Gabon are recorded in logging/oil palm concessions, and 291 (74.8 %) endemic taxa, including 242 (72.5 %) threatened taxa, are present in at least one logging/oil palm concession (Appendix A). Furthermore, 87 (22 %) taxa (all but one threatened) are exclusively known from logging/oil palm concessions, including 51 (13 %) taxa that have been recorded in only a single concession. In total, 203 (52.2 %) taxa have more than 50 % of their known occurrences in logging/oil palm concessions (Fig. 3B).

Regarding mining activities, 234 (60 %) taxa, including 184 (55 %) threatened taxa, are recorded in mining concessions, of which 23 (6 %) taxa are present on a main mineral deposit, where there is a high probability of local extirpation in the near future (Appendix A). Two taxa, *Octoknema belingensis* (Octoknemaceae) and *Sabicea mabouniensis* (Rubiaceae), are exclusively known from such deposits and have therefore been preliminary assessed as Critically Endangered (Appendix A).

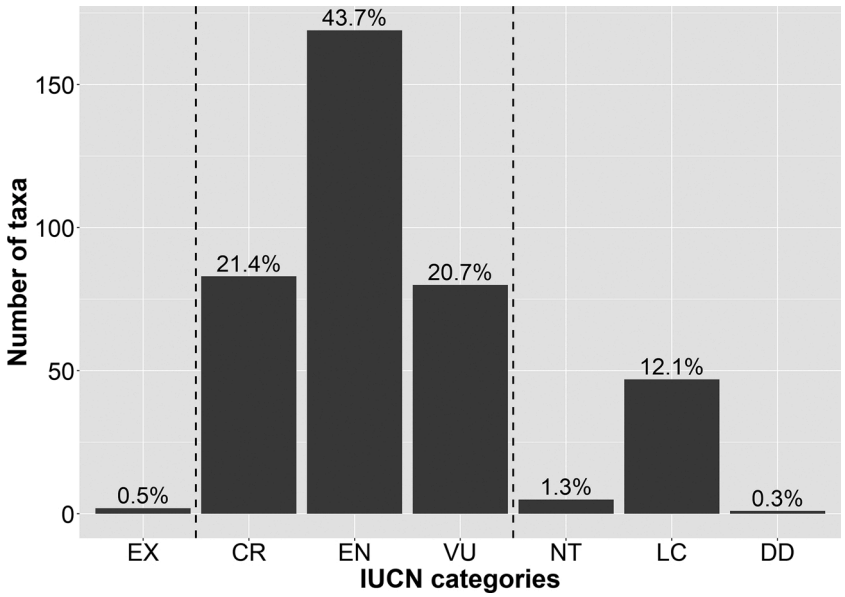

Fig. 2. Number and percent of preliminary conservation assessments (N = 389) according to IUCN Red List category. The categories between dashed lines (CR, EN, VU) correspond to threatened species.

Table 1
Percentage of endemic taxa (total and threatened) to Gabon per National Park (NP), based on the 389 taxa analysed (i.e. those for which verified collection data are available).

National Park (NP)	Number of collection records	Number of taxa present in NP	Number (%) of endemic taxa in NP	Number (%) of endemic taxa in NP that are threatened
Akanda	212	160	10 (6.3 %)	8 (80 %)
Ivindo	4595	1402	22 (1.6 %)	17 (77.3 %)
Loango	1303	618	16 (2.6 %)	11 (68.8 %)
Lopé	3429	1225	36 (2.9 %)	19 (52.8 %)
Mayumba	35	30	1 (3.3 %)	1 (100 %)
Minkébé	1049	560	3 (0.5 %)	2 (66.7 %)
Monts Birougou	25	23	0 (0 %)	0 (0 %)
Monts de Cristal	3192	1078	65 (6 %)	43 (66.2 %)
Moukalaba-Doudou	3210	1372	43 (3.1 %)	29 (67.4 %)
Mwagna	0	0	0 (0 %)	0 (0 %)
Plateau Batéké	1378	521	2 (0.4 %)	2 (100 %)
Pongara	774	457	6 (1.3 %)	2 (33.3 %)
Waka	744	382	19 (5 %)	7 (36.8 %)

4. Discussion

4.1. A new, rapid, semi-automated procedure using the IUCN Red List Categories and Criteria for the application of HCV subcriterion 1.2

4.1.1. Defining threatened species

The interpretation we have developed for HCV subcriterion 1.2 (which pertains to "rare, threatened or endangered" species) is based on key elements of risk of extinction assessments according to the IUCN Red List Categories and Criteria (IUCN Standards and Petitions Subcommittee, 2019). The Red List method is widely regarded as the most objective and comprehensive approach for defining priorities for species conservation (Bennun et al., 2018; Callmander et al., 2005; Rodrigues et al., 2006) and has been used in several national interpretations of the HCV concept (Anonymous, 2016; Consortium for Revision of the HCV Toolkit for Indonesia, 2009; Daïnou et al., 2016; HCV Malaysia Toolkit Steering Committee, 2018; Papua New Guinea Forest Stewardship Council Incorporated, 2006; Rayden et al., 2006; World Wildlife Fund, 2012, 2016). The new methodology we have proposed here, based on an a priori exhaustive compilation and verification of currently available distribution data, as recommended by IUCN (2012), is a two-step procedure.

First, we produced preliminary assessments using the IUCN Red List categories by means of a rapid, automated process, which were then compared with full risk of extinction assessments performed according to the IUCN Red List procedure. This comparison revealed that 80 % of our automated assessments were consistent with the 217 published assessments based on comparable collection records and that a total of 90 % of the 389 automated assessments performed were considered reliable in terms of assigned risk of extinction category. This high rate of accuracy suggests that our automated method offers a rapid and effective procedure for identifying threatened taxa, while also indicating that a verification procedure is nevertheless crucial to ensure that the correct threat status is assigned.

A second step is then required in order to compensate for the fact that our automated method does not take into account the ecology and habitat of a taxon being assessed, nor the nature of the threats it faces. This step involves a manual check of both the number of locations estimated by the ConR package and the threats inferred at each site. Since 311 of our automated conservation assessments (80 %) are based on IUCN criterion B, the number of locations is a key parameter that must be evaluated accurately, but this process cannot be performed automatically by ConR because locations are defined with respect to a particular threatening event (IUCN, 2012). Including the delimitation of logging, oil palm and mining concessions in our verification procedure resulted in a refined risk of extinction category for 12 taxa (3 %) by improving the estimate of the number of locations. Accurately identifying threats at each site/location is also crucial for assessing risk of extinction under IUCN criteria A, B, and D. Our verification process showed that ten taxa (2.6 %) automatically assessed as threatened (CR, EN or VU) did not, in fact, appear to be subjected to any identifiable threat. These include (i) taxa that occur along forest edges and/or road corridors in habitats that are not considered to be threatened by human activities and that can tolerate a moderate amount of disturbance which thus does not constitute a relevant threat, and (ii) taxa that occur in forest areas that are not currently affected by humans and are not projected to be in the near future (e.g. submontane forests). By contrast, the number of locations was corrected through the verification procedure

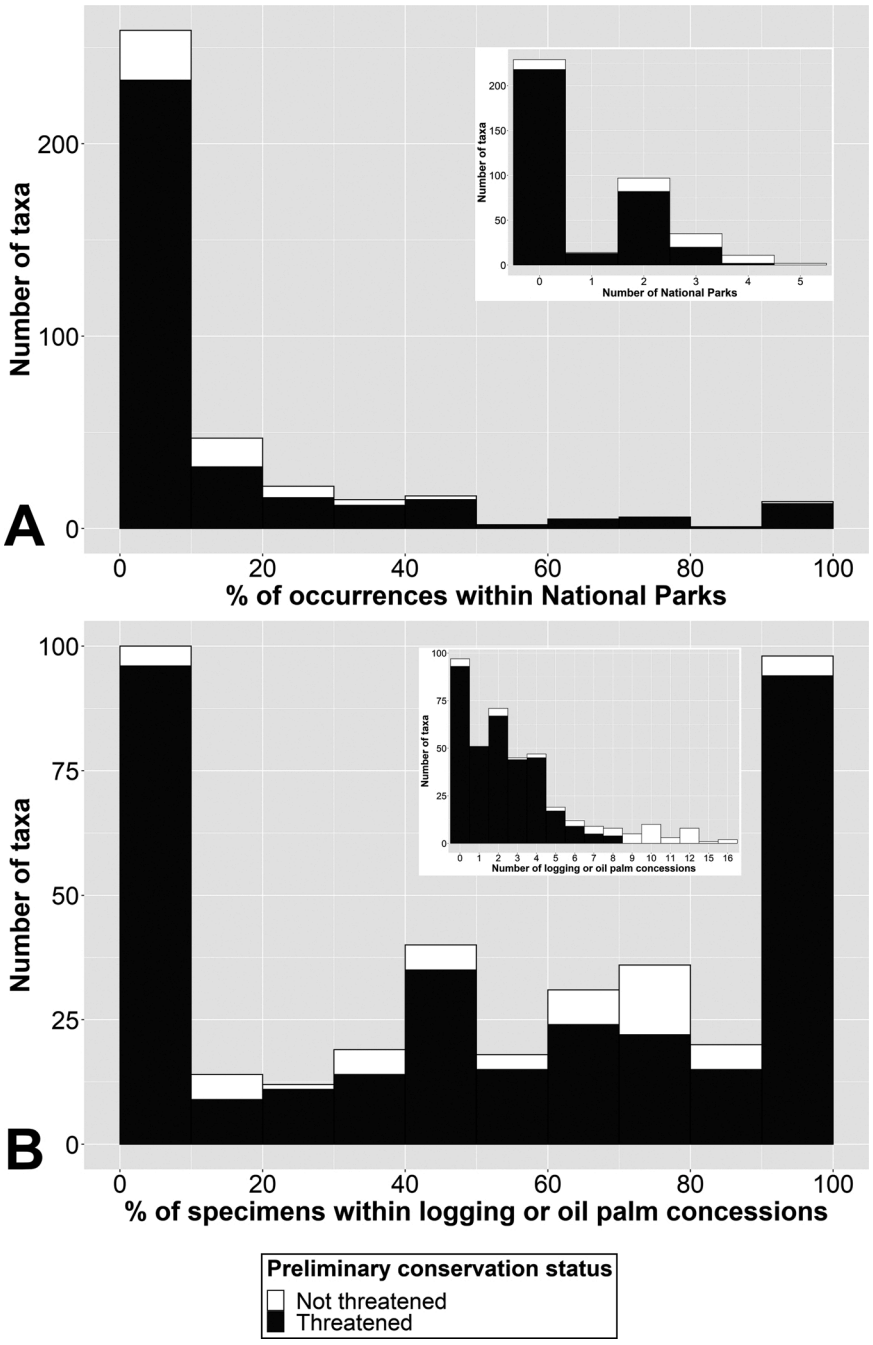

Fig. 3. Distribution of the number of endemic taxa within the National Parks and logging or oil palm concessions. A. Proportion of occurrences (in intervals of 10 %) within National Parks (threatened vs. not threatened taxa). The inserted histogram indicates the number of species that are not contained in any National Park, and the number contained in 1, 2, 3, etc. parks. B. Proportion of occurrences (in intervals of 10 %) in logging or oil palm concessions. The inserted histogram indicates the number of species that are not contained in any logging or oil palm concessions, and the number contained in 1, 2, 3, etc. concessions.

for four taxa that had been automatically assessed as not threatened but were instead found to be Vulnerable. Each taxon automatically assessed as threatened must therefore be carefully checked during the validation procedure, and so must all taxa initially assessed as not threatened (LC) but for which the number of locations only slightly exceeds the threshold value of 10 to qualify as threatened under criterion B.

While we are confident that the risk of extinction category assigned to each taxon in our study is correct because the verification procedure is consistent with the guidelines of the IUCN Red List, our method is not a substitute for a full evaluation based on the IUCN Red List Categories and Criteria, and our assessments should therefore be considered as preliminary. In particular, the local context associated with a given logging, oil palm, or mining concession in Gabon must be taken into account if and when available, and can greatly vary from one site to another. Notwithstanding these considerations, our method represents an efficient and reliable initial step towards conducting full Red List assessments and publishing them on the Red List website.

4.1.2. *Defining rare species*

The definition of rare species in the HCV concept literature is imprecise and is not based on any qualitative threshold, and should therefore be interpreted based on definitions already provided in the literature (e.g. Rabinowitz, 1981) and the available data. Since little or no information is generally available on local abundance and habitat specificity of tropical plant species, especially for those that are less common, we only used geographical range of species as a proxy to define rare species. This avoids biases associated with a lack of data required to apply the two other two criteria available for defining rare species (Choe et al., 2019; Enquist et al., 2019; Zizka et al., 2018). We have attempted to provide a practical and objective definition of rare species that can be

applied in the context of the HCV approach when only geographical (presence-only) data are available. For this, we propose employing the widely-used geographic parameter of Extent of Occurrence (EOO), and adopting a threshold EOO value of 20,000 km^2 to define rare species. Some international standards explicitly use EOO to define species of conservation concern, such as "range-restricted species", defined by the International Finance Corporation (2019) to include taxa whose EOO is less than 50,000 km^2. We have chosen to use a lower threshold of 20,000 km^2 to define rare species because this is the same value used to define Vulnerable status under IUCN criterion B1. This seems appropriate because it is more likely that a currently unthreatened species with an EOO of less than 20,000 km^2 will become threatened than a species with a larger EOO, since it already meets a key condition under Red List criterion B1. This approach reliably identifies narrowly distributed taxa that do not qualify as threatened but are nevertheless rare and should therefore be taken into account for land management. In cases where a species with an EOO that does note exceed 20,000 km^2 is identified as HCV1 based on its Red List status (CR, EN or VU), there is, however, no additional value in applying the notion of 'rare species', as defined here.

4.2. The concept of endemism: a cornerstone for the identification of the HCV subcriterion 1.3

By definition, endemism is always expressed with respect to a geographic area (Anderson, 1994) and in practice is often determined with regard to an administrative area, often a country. But political boundaries rarely correspond to natural or biological limits, and the level of endemism for a country situated within a continent is therefore often of only limited value for characterising the importance and significance of its flora. For a country such as Gabon, in which many types of vegetation extend uninterrupted into adjacent counties (such as evergreen rainforest, and the savanna/riparian forest mosaic of the Batéké plateaux), areas situated near the border often exhibit fewer endemic species per unit area than other parts of the country because, on average, a greater portion of the species with limited ranges will occur in more than one country.

Estimates of the number and percent of taxa endemic to countries such as Gabon are also subject to change as new data become available, notably from taxonomic revisions and botanical exploration, both within the country in question (e.g., the discovery of taxa new to science, which increases the number of country endemics) and in neighbouring areas (collection of taxa previously thought to be endemic to the country, which decreases the number of endemics). For example, the first list of species endemic to Gabon, provided in the checklist of Sosef et al. (2006), comprised 508 taxa, i.e., 10.8 % of the 4,710 taxa listed. However, it is unlikely that Sosef et al. (2006) systematically checked all of the available specimens from neighbouring countries (the Republic of the Congo, Cameroon and Equatorial Guinea) when characterizing the geographic range of each taxon in their list. By contrast, our results, based on a systematic effort to compile full distributional data from throughout the range of each taxon studied, show that the level of endemism indicated by Sosef et al. (2006) was a significant over-estimate. We found only 426 taxa to be endemic to the country, including 393 species (the remainder being infraspecific taxa), representing just 7.6 % of the flora, even though most of those described after 2006 are considered to be endemic.

Endemicity is often used as a basis for identifying conservation priorities and guiding legal actions (Bland et al., 2015; Brown et al., 2013; Myers et al., 2000), but when borders do not correspond to natural or biological limits, and in situations where there is significant spatial heterogeneity in botanical sampling, the value of endemism could legitimately be questioned. This is particularly true in continental Central Africa, where large areas are under-collected or totally unexplored (e.g. the Republic of the Congo is among the least known countries in terms of plant diversity in tropical Africa; Sosef et al. 2017) and where vegetation types are not constrained by borders. An alternative approach would be to consider species that are endemic to zones with geographically distinct assemblages of species and communities, generally referred to as areas of endemism (Harold and Mooi, 1994; Morrone, 1994, 2018). Areas of endemism are biogeographically coherent zones defined by the spatial congruence of at least two species that are endemic to that area and considered to have had a common history (Apodaca and Crisci, 2018; Crisp et al., 2001; Harold and Mooi, 1994; Linder, 2001a; Noguera-urbano, 2016). Taxa endemic to areas of endemism are (i) generally narrowly distributed, although their distribution can include two or more countries, (ii) key elements that characterise these areas, and therefore (iii) of significant conservation interest (Crisp et al., 2001; Hazzi et al. 2018; Linder, 2001a). In the context of the application of the HCV concept, these align perfectly with the characteristics of taxa that should be taken into account when delimiting areas for conservation under HCV criterion 1. We therefore propose that, in a continental country such as Gabon, a practical approach to defining HCV subcriterion 1.3 (endemic species) would be to use the taxonomic elements that characterise areas of endemism. The careful recognition and delimitation of areas of endemism require significant effort and they are rarely well defined in tropical countries (Colli-Silva et al., 2019; Hazzi et al. 2018). In Central Africa, several areas of endemism have been proposed but in each case they were based only on taxa belonging to a single family (Droissart, 2009; Lachenaud, 2019; Rietkerk et al., 1996; Robbrecht, 1996; Sosef, 1994). An analysis that takes into consideration the entire flora of the region is currently being undertaken by the authors of the present study in order to define the areas of endemism that occur in Gabon and thereby provide a list of species endemic to each of these areas (i.e. elements).

4.3. Towards a national interpretation of the HCV concept

The high proportion of species in Gabon identified as rare or threatened (HCV subcriterion 1.2) reflects, on the one hand, the nature of endemic taxa, which on average have narrower distributions than other taxa and could, therefore, be more easily threatened by a significant reduction in population size (IUCN Red List criterion A) or in key geographical parameters (criterion B), and, on the other hand, the fact that the flora of Gabon is threatened despite the country's low population density and low rate of deforestation (Hansen et al. 2013) due to the selective nature of forest exploitation (only ca. 20 tree species are currently being logged and on average less than one tree is felled per hectare). Threats to plant species can be direct, such as urbanization, which in Gabon is mainly concentrated around the three largest cities (Libreville, Port-Gentil, and Franceville), the establishment of palm oil plantations, the exploitation of mineral deposits in mining concessions, onshore oil extraction, and road building, or they can be indirect, such as from the range of impacts associated with selective forest exploitation and mining and oil exploration. Our study suffers from the absence of GIS layers for oil concessions, and in particular of operating sites. Indeed, the threats faced by a species present in an oil or mining concession but growing outside the actual zone of exploitation are almost nil, while they are very significant in places where extraction is taking place (exploitation can, for example, lead to the very rapid disappearance of the occurrence or subpopulation). Logging concessions, which cover 58 % of Gabon and 63 % of its forest area, affect most of the country, but mainly result in a reduction in the quality of the habitat of forest taxa, except for the species that are being actually exploited, which are also directly impacted. A total of 203 (52.2 %) taxa have more than 50 % of their known occurrences in logging/oil palm concessions, and 23 (6 %) taxa are present on a main mineral deposit. These results demonstrate the pertinence of using HCV1 to identify conservation priorities in the context of industrial activities and to develop meaningful measures that could enhance the protection of a significant proportion of Gabon's threatened endemic biodiversity, which is poorly (35 %) represented in the country's NP network.

Identifying which species could trigger HCV criterion 1 and where

they occur is a fundamental step towards a national interpretation of the HCV concept. Nevertheless, important political decisions will also need to be taken, in particular defining the thresholds for the presence and concentration of endemic, rare, or threatened species to be used when deciding whether to protect an area under HCV1. Such thresholds, necessarily based on the context of each country, will be particularly difficult to define in one such as Gabon, for which many endemic, rare, or threatened species are present in nearly all parts of the country. Thresholds should therefore be based on a consensus that factors in conservation requirements, as informed by scientific knowledge, and the needs of economic development. In order to speed up the consideration of threatened flora in the application of the HCV approach in Gabon, a national interpretation of HCV1 will be organised in 2021 for plants, to which all key involved stakeholders will be invited, the results of which will be published in another paper.

4.4. National Parks in Gabon: the need for better floristic knowledge to enhance conservation priorities

Considering the limited amount of botanical inventory work that has been conducted within the NPs of Gabon and its very heterogeneous coverage (Table 1), the proportion of endemic and threatened species present within the country's protected area network is very likely underestimated. Indeed, while some NPs appear to be relatively well-collected, such as Monts de Cristal NP, others are largely under-collected, including Akanda NP, Mayumba NP, Monts Birougou NP, and especially Mwagna NP, where no botanical collections have yet been recorded (Table 1). Furthermore, while the number of collections are fairly high for some parks, such as Ivindo, Lopé, Moukalaba-Doudou, and Monts de Cristal, most fieldwork has been conducted in just one or a few accessible parts of these protected areas while the remainder remains botanically unknown. For example, Ivindo NP is known to harbour 22 taxa endemic to Gabon, but this is almost surely a significant underestimate since only a small portion of the park has been explored by botanists. Recent botanical fieldwork in previously unvisited parts of Ivindo NP revealed the presence of several new endemic taxa that have not yet been described.

In order to improve our knowledge of the flora of these important areas and help inform conservation planning and decision making, intensive botanical exploration will be needed, both in under-sampled parks and in unexplored parts of those protected areas that are comparatively better collected. For example, Monts Birougou NP, among the least collected, is located in an area with high topographic heterogeneity and habitat diversity. Moreover, the Monts Birougou are thought to have served as a forest refugium during the Pleistocene glacial maximum (Maley, 1996) and may thus be a centre of endemism, with high floristic richness, particularly in endemic species, making it a high priority for botanical exploration. In addition, the NPs situated in the high plateaux of eastern Gabon are either botanically unknown (Mwagna NP) or exploration has been limited to only on a small area (Ivindo NP and Minkébé NP), although many endemic, threatened and/or rare species are found nearby, especially in the areas of Lastoursville and Bélinga. These three parks are also high priorities for future botanical exploration.

5. Conclusion

To date, published Red List assessments are available for only 21 % of the species recorded in Gabon (IUCN, 2020), and many of them are out of date, yet risk of extinction assessments using the IUCN Red List Categories and Criteria (IUCN, 2012) represent a key element for public stakeholders and the private sector to identify conservation issues and priorities, in large part because Red Listing is the most widely accepted tool for identifying threatened species. Assessments based on the Red List approach also offer a reliable basis for implementing the High Conservation Value approach, through HCV criterion 1. The methodology proposed in this paper offers an efficient, semi-automated approach to determining the preliminary threat status of species using comprehensive, verified distributional data. It provides a useful tool for identifying species of potential conservation concern, even when the highest standards of environmental risk assessment are required, such as by IFC Performance Standard 6. This methodology can also streamline and facilitate the preparation and submission of full IUCN risk of extinction assessments that meet all of the requirements for publication on the IUCN Red List.

The definitions and approach developed here for identifying HCV under subcriteria 1.2 (rare, threatened or endangered species) and 1.3 (endemic species) are well suited to the formulation of a national interpretation of the HCV concept in Gabon and in other countries with large areas of humid tropical forest. In particular, the methodology we have developed could be deployed immediately to support the development of a strategy and guidelines to identify HCV for the flora of the entire Congo Basin, as required by the FSC in 2020. Moreover, the insights gained from applying the approach to HCV criterion 1 could be leveraged as a first step toward the identification of HCV criterion 3 (rare, threatened, or endangered ecosystems, habitats or refugia), since the presence of threatened, rare or endemic species is an obvious prerequisite to identifying priority ecosystems and habitats (Brown et al. 2013).

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Contributions

Nicolas Texier: Conceptualization, Methodology, Software, Formal analysis, Investigation, Data Curation, Writing - Original Draft, Visualization; **Gilles Dauby**: Methodology, Software, Writing - Review & Editing; **Ehoarn Bidault**: Formal analysis, Data Curation, Writing - Review & Editing; **Porter P. Lowry II**: Writing - Review & Editing, Project administration, Funding acquisition; **Davy Ikabanga**: Formal analysis, Writing - Review & Editing; **Tariq Stévart**: Conceptualization, Methodology, Writing - Review & Editing, Supervision, Project administration, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

Checklist of vascular plant taxa endemic to Gabon. Endemism status (see Material and Methods): 1=Strict endemic; 2=Likely sub-endemic; 3=Endemic according to the checklist of Gabonese vascular plant of Gabon (Sosef et al. 2006) but not evaluated here because the taxon is in need of taxonomic study or is under revision; APCA: automated preliminary conservation status category attributed by computerized procedure (CR: Critically Endangered; DD: Data Deficient; EX: Extinct; LC: Least Concern; NE: Not Evaluated; NT: Near Threatened; VU: Vulnerable); FPCA: final preliminary conservation status category after factoring in habitat and ecology of each taxon and threats faced at each site. The dagger (†) indicates taxa with an Extent of Occurrence (EOO) of <20,000 km^2 considered rare according to our interpretation of the subcriterion HCV 1.2; NP: number of National Parks in which the taxon is present, in brackets the proportion of occurrences recorded in National Parks; Logging/palm: number of logging and/or oil palm concessions in which the taxon is present, in brackets is the proportion of occurrences recorded in logging and/or oil palm concessions; Mining: number of mining concessions in which the taxon is present, in brackets is the proportion of occurrences recorded in mining concessions. An asterisk (*) indicates that a taxon is present on a main mineral deposit.

Endemism status	Family	Taxon	APCA	FPCA	NP (% occurrence)	Logging/palm (% occurrence)	Mining (% occurrence)
1	Acanthaceae	*Hypoestes potamophila* Heine	EN	EN	2 (33 %)	2 (33 %)	2 (33 %)
1	Acanthaceae	*Pseudocalyx aurantiacus* Benoist	VU	EN	0 (0%)	4 (86 %)	4 (86 %)
1	Acanthaceae	*Pseudocalyx macrophyllus* McPherson & A.M. Louis	EN	EN	2 (33 %)	2 (67 %)	2 (67 %)
1	Acanthaceae	*Pseudocalyx pasquierorum* Breteler	EN	CR	0 (0 %)	1 (100 %)	1 (100 %)
1	Acanthaceae	*Whitfieldia purpurata* (Benoist) Heine	CR	CR	0 (0 %)	1 (100 %)	1 (100 %)
1	Acanthaceae	*Whitfieldia rutilans* Heine	EN	EN	0 (0 %)	4 (100 %)	2 (50 %)
2	Achariaceae	*Dasylepis blackii* (Oliv.) Chipp	EN	EN	2 (40 %)	2 (20 %)	0 (0 %)
1	Anacardiaceae	*Sorindeia gabonensis* Bourobou & Breteler	LC	LC	2 (6 %)	16 (84 %)	8 (60 %)
1	Anacardiaceae	*Trichoscypha bracteata* Breteler	CR	CR	0 (0 %)	1 (100 %)	0 (0 %)
1	Anacardiaceae	*Trichoscypha debruijnii* Breteler	CR	CR	0 (0 %)	0 (0 %)	1 (100 %)
1	Anacardiaceae	*Trichoscypha imbricata* Engl.	NT	NT	3 (17 %)	0 (0 %)	0 (0 %)
1	Anacardiaceae	*Trichoscypha nyangensis* Pellegr.	CR	CR	0 (0 %)	1 (100 %)	0 (0 %)
1	Anacardiaceae	*Trichoscypha wilksii* Breteler	CR	CR	0 (0 %)	1 (100 %)	0 (0 %)
1	Anisophylleaceae	*Anisophyllea myriostictoides* Li Bing Zhang, X. Chen & H. He	EN	EN	2 (50 %)	2 (50 %)	0 (0 %)
1	Annonaceae	*Anonidium floribundum* Pellegr.	LC	LC	4 (24 %)	10 (52 %)	9 (72 %)*
1	Annonaceae	*Artabotrys crassipetalus* Pellegr.	EN	EN	2 (17 %)	4 (50 %)	3 (33 %)
1	Annonaceae	*Artabotrys lastoursvillensis* Pellegr.	EN	EN	2 (50 %)	2 (50 %)	0 (0 %)
1	Annonaceae	*Letestudoxa glabrifolia* Chatrou & Repetur	EN	EN	0 (0 %)	3 (100 %)	0 (0 %)
3	Annonaceae	*Mischogyne elliotianum* var. *gabonensis* Pellegr. ex Le Thomas	NE				
3	Annonaceae	*Monanthotaxis glomerulata* (Le Thomas) Verdc.	NE				
3	Annonaceae	*Monanthotaxis letestui* var. *hallei* (Le Thomas) Le Thomas	NE				
1	Annonaceae	*Monanthotaxis paniculata* P.H. Hoekstra	EN	EN	0 (0%)	2 (50 %)	0 (0%)
1	Annonaceae	*Pseudartabotrys letestui* Pellegr.	LC	VU	2 (4%)	3 (67 %)	0 (0%)
3	Annonaceae	*Uvaria cornuana* Engl. & Diels	NE				
3	Annonaceae	*Uvaria hispido-costata* Pierre ex Engl. & Diels	NE				
3	Annonaceae	*Uvaria lastoursvillensis* Pellegr.	NE				
3	Annonaceae	*Uvaria ngounyensis* Pellegr.	NE				
3	Annonaceae	*Uvaria psorosperma* Pierre ex Engl. & Diels	NE				
1	Annonaceae	*Uvariodendron molundense* var. *citrata* Le Thomas	EN	CR	0 (0%)	2 (71 %)	1 (100 %)*
1	Annonaceae	*Uvariopsis citrata* Couvreur & Niangadouma	VU	VU	1 (100 %)	0 (0%)	0 (0%)
1	Annonaceae	*Uvariopsis letestui* Pellegr.	EN	EN	2 (25 %)	3 (63 %)	2 (50 %)
1	Annonaceae	*Xylopia unguiculata* D.M. Johnson & N.A. Murray	EN	EN	2 (30 %)	0 (0%)	0 (0%)
1	Apocynaceae	*Alafia falcata* Leeuwenb.	EN	EN	0 (0%)	4 (75 %)	3 (50 %)
1	Apocynaceae	*Hunteria hexaloba* (Pichon) Omino	EN	EN	0 (0%)	0 (0%)	3 (50 %)
1	Apocynaceae	*Landolphia pyramidata* (Pierre) J. Pers.	LC	LC	2 (6%)	7 (44 %)	3 (17 %)
1	Apocynaceae	*Landolphia reticulata* Hallier f.	LC	LC	4 (17 %)	7 (39 %)	4 (17 %)
1	Apocynaceae	*Pleiocarpa brevistyla* Omino	EN	EN	0 (0%)	0 (0%)	0 (0%)
1	Araceae	*Amorphophallus canaliculatus* Ittenb., Hett. & Lobin	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Araceae	*Nephthytis hallei* (Bogner) Bogner	CR	EN	0 (0%)	2 (50 %)	0 (0%)
3	Araceae	*Pseudohydrosme buettneri* Engl.	NE				
1	Araceae	*Rhaphidophora bogneri* P.C. Boyce & Haigh	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Arecaceae	*Laccosperma cristalensis* Couvreur & Niangadouma	CR	VU	0 (0%)	0 (0%)	0 (0%)
1	Arecaceae	*Raphia gabonica* Mogue, Sonké & Couvreur	EN	EN	0 (0%)	2 (50 %)	3 (67 %)

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Endemism status	Family	Taxon	APCA	FPCA	NP (% occurrence)	Logging/palm (% occurrence)	Mining (% occurrence)
1	Aristolochiaceae	*Pararistolochia fimbriata* M.E. Leal & D. Nguema	EN	EN	0 (0%)	2 (50 %)	0 (0%)
1	Aristolochiaceae	*Pararistolochia incisiloba* (Jongkind) M.E. Leal	CR	EN	0 (0%)	0 (0%)	1 (100 %)
1	Asparagaceae	*Dracaena wakaensis* Damen & Quiroz	EN	EN	0 (0%)	4 (57 %)	4 (86 %)
1	Balsaminaceae	*Impatiens floretii* N. Hallé & A.M. Louis	EN	EN	2 (80 %)	0 (0%)	0 (0%)
1	Balsaminaceae	*Impatiens issembei* S.B. Janssens, Stévart & Eb. Fisch.	CR	CR	0 (0%)	0 (0%)	1 (100 %)
1	Balsaminaceae	*Impatiens letestuana* N. Hallé	EN	EN	0 (0%)	3 (57 %)	4 (71 %)
1	Balsaminaceae	*Impatiens nzabiana* S.B. Janssens & Dessein	CR	VU	0 (0%)	0 (0%)	2 (75 %)
1	Balsaminaceae	*Impatiens oumina* N. Hallé	EN	EN	0 (0%)	2 (60 %)	3 (60 %)
1	Balsaminaceae	*Impatiens pseudomacroptera* Grey-Wilson	LC	VU	2 (14 %)	4 (43 %)	3 (29 %)
1	Balsaminaceae	*Impatiens wilksiana* Stévart, S.B. Janssens & Eb. Fisch.	EN	EN	2 (40 %)	3 (60 %)	0 (0%)
1	Begoniaceae	*Begonia aggeloptera* N. Hallé	EN	EN	0 (0%)	2 (20 %)	2 (20 %)
2	Begoniaceae	*Begonia aspleniifolia* Hook. f. ex DC.	VU	VU	2 (14 %)	5 (43 %)	6 (57 %)
2	Begoniaceae	*Begonia auriculata* Hook. f.	LC	LC[†]	4 (39 %)	7 (42 %)	2 (10 %)
1	Begoniaceae	*Begonia dewildei* Sosef	VU	VU	1 (100 %)	0 (0%)	0 (0%)
1	Begoniaceae	*Begonia erectocaulis* Sosef	VU	VU	2 (6%)	5 (33 %)	0 (0%)
1	Begoniaceae	*Begonia erectotricha* Sosef	VU	VU	3 (76 %)	4 (18 %)	2 (6%)*
1	Begoniaceae	*Begonia ferramica* N. Hallé	EN	EN	0 (0%)	4 (93 %)	2 (71 %)*
1	Begoniaceae	*Begonia gabonensis* J.J. de Wilde	VU	VU	3 (50 %)	5 (30 %)	2 (5%)
1	Begoniaceae	*Begonia karperi* J.C. Arends	EN	EN	2 (50 %)	3 (25 %)	0 (0%)
1	Begoniaceae	*Begonia letestui* J.J. de Wilde	EN	EN	0 (0%)	7 (88 %)	2 (50 %)
1	Begoniaceae	*Begonia lopensis* M. Sosef & M. Leal	VU	VU	1 (100 %)	0 (0%)	0 (0%)
1	Begoniaceae	*Begonia minutifolia* N. Hallé	VU	VU	2 (4%)	4 (48 %)	0 (0%)
2	Begoniaceae	*Begonia peperomioides* Hook. f.	EN	EN	2 (38 %)	3 (25 %)	0 (0%)
1	Begoniaceae	*Begonia puberula* Sosef	EN	EN	2 (67 %)	2 (33 %)	0 (0%)
2	Begoniaceae	*Begonia scutulum* Hook. f.	LC	LC	3 (18 %)	8 (42 %)	4 (8%)
1	Begoniaceae	*Begonia sosefiana* J.J. de Wilde & Valk.	VU	VU	1 (100 %)	0 (0%)	0 (0%)
1	Begoniaceae	*Begonia vittariifolia* N. Hallé	EN	EN	2 (30 %)	3 (50 %)	2 (10 %)
1	Begoniaceae	*Begonia wilksii* Sosef	EN	EN	2 (25 %)	3 (50 %)	4 (60 %)
1	Burmanniaceae	*Gymnosiphon constrictus* Maas & H. Maas	EN	EN	2 (14 %)	3 (43 %)	2 (14 %)
3	Cardiopteridaceae	*Leptaulus zenkeri* var. *longipedicellata* Villiers	NE				
1	Celastraceae	*Pristimera mouilensis* (N. Hallé) N. Hallé	EN	EN	0 (0%)	2 (50 %)	2 (100 %)
1	Celastraceae	*Salacia annettae* N. Hallé	VU	VU	1 (100 %)	0 (0%)	0 (0%)
1	Celastraceae	*Salacia belingana* N. Hallé	EN	EN	0 (0%)	4 (80 %)	4 (100 %)
1	Celastraceae	*Salacia diplasia* N. Hallé	VU	VU	2 (18 %)	4 (64 %)	3 (55 %)
1	Celastraceae	*Salacia ferrifodina* N. Hallé	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Celastraceae	*Salacia subicterica* N. Hallé	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Celastraceae	*Salacia villiersii* N. Hallé	CR	CR	0 (0%)	1 (100 %)	0 (0%)
1	Celastraceae	*Simirestis klaineana* N. Hallé	EN	EN	0 (0%)	2 (7%)	0 (0%)
1	Celastraceae	*Thyrsosalacia viciflora* N. Hallé	EN	EN	0 (0%)	2 (100 %)	1 (100 %)
1	Celastraceae	*Wilczekra gabonica* Breteler	LC	LC	2 (47 %)	10 (39 %)	9 (40 %)*
1	Chrysobalanaceae	*Dactyladenia jongkindii* Breteler	VU	VU	2 (14 %)	4 (57 %)	3 (43 %)
1	Chrysobalanaceae	*Dactyladenia librevillensis* (Letouzey) Prance & F. White	EN	EN	0 (0%)	4 (85 %)	3 (15 %)
1	Chrysobalanaceae	*Dactyladenia ndjoleensis* Breteler	EN	EN	0 (0%)	3 (100 %)	4 (83 %)
1	Chrysobalanaceae	*Dactyladenia pierrei* (De Wild.) Prance & F. White	EN	EN	0 (0%)	0 (0%)	0 (0%)
1	Chrysobalanaceae	*Magnistipula bimarsupiata* Letouzey	LC	LC	3 (15 %)	7 (62 %)	5 (22 %)
1	Chrysobalanaceae	*Magnistipula devriesii* Breteler	EN	EN	0 (0%)	2 (100 %)	3 (67 %)
1	Clusiaceae	*Garcinia gabonensis* Sosef & Dauby	LC	LC	0 (0%)	11 (73 %)	6 (53 %)
1	Clusiaceae	*Garcinia obliqua* Sosef & Dauby	VU	VU	0 (0%)	5 (58 %)	4 (67 %)
1	Combretaceae	*Combretum adrianii* Jongkind	EN	EN	2 (50 %)	2 (50 %)	3 (67 %)
1	Combretaceae	*Combretum clarense* Jongkind	VU	VU	3 (38 %)	3 (25 %)	0 (0%)
1	Combretaceae	*Combretum erosum* Jongkind	VU	VU	3 (25 %)	5 (63 %)	6 (70 %)
1	Combretaceae	*Combretum esteriense* Jongkind	VU	VU	2 (10 %)	0 (0%)	0 (0%)
1	Combretaceae	*Combretum gabonense* Exell	EN	EN	0 (0%)	3 (100 %)	3 (67 %)
1	Combretaceae	*Combretum ivanii* Jongkind	EN	CR	0 (0%)	1 (100 %)	0 (0%)
1	Combretaceae	*Combretum longistipitatum* Jongkind	VU	VU	1 (100 %)	0 (0%)	0 (0%)
1	Combretaceae	*Combretum ndjoleense* Jongkind	EN	EN	0 (0%)	3 (67 %)	3 (100 %)
1	Combretaceae	*Combretum oudenhovenii* Jongkind	VU	VU	0 (0%)	4 (93 %)	0 (0%)
1	Combretaceae	*Combretum polyanthum* Jongkind	EN	EN	0 (0%)	5 (86 %)	6 (88 %)
1	Combretaceae	*Combretum rupestre* Jongkind & Texier	CR	VU	0 (0%)	1 (100 %)	0 (0%)
1	Combretaceae	*Combretum wilksii* Jongkind	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Commelinaceae	*Palisota alboanthera* Burg & E. Bidault	VU	VU	0 (0%)	8 (91 %)	2 (36 %)*
1	Commelinaceae	*Palisota leewhitei* Burg, O. Lachenaud & E. Bidault	CR	VU	0 (0%)	0 (0%)	0 (0%)
1	Commelinaceae	*Palisota stevartii* Burg & E. Bidault	VU	VU	2 (14 %)	3 (57 %)	2 (57 %)
1	Connaraceae	*Agelaea gabonensis* Jongkind	EN	EN	2 (9%)	5 (91 %)	0 (0%)
1	Connaraceae	*Cnestis uncata* Lemmens	VU	VU	0 (0%)	3 (21 %)	2 (7%)
1	Connaraceae	*Connarus gabonensis* Lemmens	CR	CR	0 (0%)	1 (100 %)	2 (100 %)
1	Convolvulaceae	*Bonamia ngouniensis* Breteler	CR	CR	0 (0%)	1 (100 %)	0 (0%)
1	Convolvulaceae	*Calycobolus heineanus* Lejoly ex Lisowski	CR (PE)	CR (PE)	0 (0%)	0 (0%)	0 (0%)
1	Convolvulaceae	*Dipteropeltis macrantha* Breteler	EN	EN	0 (0%)	2 (50 %)	2 (25 %)
1	Costaceae	*Costus gabonensis* Koechlin	LC	LC	3 (9%)	12 (66 %)	6 (38 %)
1	Costaceae	*Costus loangensis* H. Maas & Maas	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Costaceae	*Costus louisii* H. Maas & Maas	CR	CR	0 (0%)	1 (100 %)	0 (0%)
1	Costaceae	*Costus maboumiensis* Pellegr.	VU	VU	3 (17 %)	6 (67 %)	2 (8%)
1	Cucurbitaceae	*Coccinia gabonensis* Keraudren	EN	CR	0 (0%)	1 (100 %)	1 (100 %)*

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Endemism status	Family	Taxon	APCA	FPCA	NP (% occurrence)	Logging/palm (% occurrence)	Mining (% occurrence)
1	Cyperaceae	*Cyperus brunneoalatus* (Cherm.) Huygh	EN	EN	0 (0%)	2 (33 %)	0 (0%)
1	Cyperaceae	*Mapania chevalieri* (Nelmes) Lye	EN	EN	2 (25 %)	3 (50 %)	2 (25 %)
1	Cyperaceae	*Mapania pallescens* Lye	VU	VU	1 (100 %)	0 (0%)	0 (0%)
1	Cyperaceae	*Mapania polystachya* (Cherm.) Lye	EN	EN	0 (0%)	2 (100 %)	1 (100 %)
1	Cyperaceae	*Mapania purpuriceps* (C.B. Clarke) J. Raynal	LC	LC	5 (26 %)	4 (16 %)	5 (26 %)
1	Cyperaceae	*Mapania sylvatica* subsp. *gabonica* (Cherm.) D.A. Simpson	VU	VU	4 (30 %)	6 (60 %)	3 (30 %)
1	Cyperaceae	*Mapania testui* Cherm.	LC	LC	0 (0%)	10 (85 %)	4 (54 %)
1	Cyperaceae	*Scleria aurantiaca* Lye	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Cyperaceae	*Scleria pedicellata* Bauters	EN	EN	3 (75 %)	0 (0%)	2 (25 %)
1	Dichapetalaceae	*Dichapetalum beilschmiedioides* Breteler	EN	EN	0 (0%)	4 (86 %)	2 (100 %)
1	Dichapetalaceae	*Dichapetalum berendinae* Breteler	LC	VU	2 (6%)	5 (78 %)	11 (88 %)*
1	Dichapetalaceae	*Dichapetalum findouense* Breteler	EN	EN	0 (0%)	0 (0%)	3 (50 %)
1	Dichapetalaceae	*Dichapetalum gassitae* Breteler	EN	EN	0 (0%)	2 (100 %)	1 (100 %)
1	Dichapetalaceae	*Dichapetalum geminostellatum* Breteler	VU	VU	2 (8%)	2 (8%)	0 (0%)
1	Dichapetalaceae	*Dichapetalum inaequale* Breteler	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Dichapetalaceae	*Dichapetalum leucocarpum* Breteler	VU	VU	2 (7%)	7 (79 %)	4 (57 %)*
1	Dichapetalaceae	*Dichapetalum lujae* var. *letestui* (Pellegr.) Breteler	NT	NT	0 (0%)	5 (31 %)	2 (38 %)
1	Dichapetalaceae	*Dichapetalum mathisii* Breteler	LC	LC	2 (6%)	10 (75 %)	9 (82 %)
1	Dichapetalaceae	*Dichapetalum neglectum* Breteler	EN	EN	0 (0%)	3 (67 %)	3 (50 %)
1	Dichapetalaceae	*Dichapetalum nyangense* Pellegr.	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Dichapetalaceae	*Dichapetalum petaloideum* Breteler	CR	CR	0 (0%)	1 (100 %)	0 (0%)
1	Dichapetalaceae	*Dichapetalum pierrei* Pellegr.	EN	VU	0 (0%)	4 (25 %)	3 (25 %)
1	Dichapetalaceae	*Dichapetalum rabiense* Breteler	EN	EN	0 (0%)	4 (83 %)	0 (0%)
1	Dichapetalaceae	*Dichapetalum ruficeps* Breteler	EN	EN	0 (0%)	2 (50 %)	0 (0%)
1	Dichapetalaceae	*Tapura arachnoidea* Breteler	EN	EN	0 (0%)	1 (100 %)	1 (100 %)
1	Dichapetalaceae	*Tapura neglecta* N. Halle & Heine	EN	EN	0 (0%)	2 (100 %)	0 (0%)
1	Ebenaceae	*Diospyros rabiensis* Breteler	LC	NT	2 (2%)	9 (91 %)	4 (51 %)*
1	Ebenaceae	*Diospyros subargentea* O. Lachenaud, Dauby & G.E. Schatz	VU	VU	0 (0%)	8 (100 %)	2 (18 %)*
1	Euphorbiaceae	*Argomuellera sessilifolia* Prain	VU	VU	2 (13 %)	5 (88 %)	0 (0%)
3	Euphorbiaceae	*Croton tchibangensis* Pellegr.	NE				
1	Euphorbiaceae	*Crotonogyne parvifolia* Prain	EN	EN	2 (13 %)	0 (0%)	6 (73 %)
1	Euphorbiaceae	*Macaranga letestui* Pellegr.	VU	LC[†]	0 (0%)	4 (50 %)	0 (0%)
1	Euphorbiaceae	*Macaranga pierreana* Prain	CR	CR	0 (0%)	2 (25 %)	0 (0%)
1	Euphorbiaceae	*Mareyopsis oligogyna* Breteler	LC	LC	4 (18 %)	10 (77 %)	5 (65 %)
3	Euphorbiaceae	*Pycnocoma thollonii* Prain	NE				
1	Euphorbiaceae	*Tetrorchidium gabonense* Breteler	EN	EN	3 (11 %)	4 (63 %)	2 (11 %)
1	Fabaceae	*Anthonotha mouandzae* Breteler	EN	EN	3 (43 %)	4 (57 %)	0 (0%)
1	Fabaceae	*Anthonotha pellegrinii* Aubrév.	EN	EN	0 (0%)	2 (100 %)	0 (0%)
1	Fabaceae	*Aphanocalyx pectinatus* (A. Chev.) Wieringa	VU	EN	2 (14 %)	4 (71 %)	5 (75 %)
1	Fabaceae	*Baphia cymosa* Breteler	EN	EN	2 (50 %)	0 (0%)	0 (0%)
1	Fabaceae	*Baphia megaphylla* Breteler	VU	VU	2 (27 %)	6 (73 %)	3 (27 %)
1	Fabaceae	Berlinia rabiensis *Mackinder*	EN	EN	0 (0%)	2 (100 %)	0 (0%)
1	Fabaceae	*Berlinia razzifera* Mackinder & Wieringa	EN	EN	2 (63 %)	0 (0%)	0 (0%)
1	Fabaceae	*Bikinia aciculifera* Wieringa	VU	VU	2 (9%)	8 (91 %)	2 (18 %)
1	Fabaceae	*Bikinia coriacea* (J.Morel ex Aubrév.) Wieringa	VU	VU	3 (46 %)	6 (54 %)	2 (8%)
1	Fabaceae	*Bikinia durandii* (F. Hallé & Normand) Wieringa	LC	LC	3 (23 %)	16 (61 %)	5 (30 %)
1	Fabaceae	*Calpocalyx brevifolius* Villiers	VU	VU	0 (0%)	3 (50 %)	2 (17 %)
1	Fabaceae	*Calpocalyx letestui* Pellegr.	LC	LC	2 (6%)	12 (88 %)	4 (50 %)
1	Fabaceae	*Crotalaria tchibangensis* Maesen	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Fabaceae	*Dalbergia adamii* subsp. *gabonica* O. Lachenaud	EN	EN	2 (20 %)	3 (40 %)	2 (20 %)
1	Fabaceae	*Dalbergia adiantifolia* O. Lachenaud	EN	EN	2 (67 %)	0 (0%)	0 (0%)
1	Fabaceae	*Dalbergia lastoursvillensis* Pellegr.	EN	EN	0 (0%)	2 (50 %)	0 (0%)
1	Fabaceae	*Dalbergia ngounyensis* Pellegr.	EN	EN	0 (0%)	2 (50 %)	0 (0%)
1	Fabaceae	*Dalbergia obliquifoliolata* O. Lachenaud	VU	VU	1 (100 %)	0 (0%)	0 (0%)
1	Fabaceae	*Dialium eurysepalum* Harms	VU	VU	2 (25 %)	0 (0%)	0 (0%)
1	Fabaceae	*Dialium lopense* Breteler	LC	LC	3 (29 %)	11 (62 %)	11 (43 %)
1	Fabaceae	*Didelotia minutiflora* (A. Chev.) J. Léonard	VU	VU	0 (0%)	4 (44 %)	2 (13 %)
1	Fabaceae	*Didelotia morelii* Aubrév.	CR	CR	0 (0%)	0 (0%)	1 (100 %)
1	Fabaceae	*Englerodendron brachyrhachis* (Breteler) Estrella & Ojeda	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Fabaceae	*Englerodendron hallei* (Aubrév.) Estrella & Ojeda	VU	VU	3 (76 %)	2 (6%)	2 (6%)
1	Fabaceae	*Englerodendron triplisomere* (Pellegr.) Estrella & Ojeda	VU	VU	3 (18 %)	6 (64 %)	4 (64 %)
1	Fabaceae	*Erythrina wieringae* Maesen	CR	CR	0 (0%)	0 (0%)	1 (100 %)
1	Fabaceae	*Gabonius ngouniensis* (Pellegr.) Mackinder & Wieringa	LC	LC	4 (5%)	15 (85 %)	4 (3%)
1	Fabaceae	*Gilbertiodendron barbulatum* (Pellegr.) J. Léonard	CR	CR	0 (0%)	0 (0%)	1 (100 %)
1	Fabaceae	*Gilbertiodendron breteleri* Burgt	EN	EN	0 (0%)	3 (83 %)	5 (93 %)
1	Fabaceae	*Gilbertiodendron imenoense* (Pellegr.) J. Léonard	VU	VU	0 (0%)	6 (100 %)	3 (29 %)
1	Fabaceae	*Gilbertiodendron maximum* Burgt & Wieringa	EN	EN	2 (33 %)	2 (67 %)	0 (0%)
1	Fabaceae	*Gilletiodendron escherichii* J. Léonard	CR	CR	0 (0%)	1 (100 %)	0 (0%)
1	Fabaceae	*Hymenostegia elegans* Wieringa & Mackinder	VU	EN	0 (0%)	3 (100 %)	4 (100 %)
3	Fabaceae	*Hymenostegia klainei* Pierre ex Pellegr.	NE				
3	Fabaceae	*Hymenostegia neoaubrevillei* J. Léonard	NE				
1	Fabaceae	*Hymenostegia robusta* Wieringa & Mackinder	EN	EN	0 (0%)	1 (100 %)	0 (0%)

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Endemism status	Family	Taxon	APCA	FPCA	NP (% occurrence)	Logging/palm (% occurrence)	Mining (% occurrence)
1	Fabaceae	Julbernardia hochreutineri *Pellegr.*	LC	LC	3 (7%)	12 (76 %)	8 (65 %)
1	Fabaceae	*Leptoderris gabonica* Breteler	EN	EN	0 (0%)	0 (0%)	0 (0%)
1	Fabaceae	*Leptoderris robusta* Breteler	CR	CR	0 (0%)	0 (0%)	1 (100 %)
1	Fabaceae	*Loesenera walkeri* (A. Chev.) J. Léonard	EN	EN	2 (20 %)	2 (20 %)	2 (20 %)
1	Fabaceae	*Millettia geerinckiana* O. Lachenaud	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Fabaceae	*Millettia klainei* Dunn	EN	EN	3 (80 %)	2 (20 %)	2 (20 %)
1	Fabaceae	*Millettia lastoursvillensis* Pellegr.	LC	LC	2 (11 %)	9 (71 %)	15 (81 %)
1	Fabaceae	*Millettia letestui* Pellegr.	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Fabaceae	*Millettia viridiflora* O. Lachenaud	EN	EN	0 (0%)	0 (0%)	6 (100 %)
1	Fabaceae	*Oddoniodendron normandii* Aubrév.	EN	EN	0 (0%)	3 (33 %)	0 (0%)
1	Fabaceae	*Oddoniodendron reitsmarum* Ngok & Breteler	EN	EN	2 (50 %)	0 (0%)	0 (0%)
1	Fabaceae	*Platysepalum bambidiense* Maesen	EN	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Fabaceae	*Rhynchosia gabonensis* Jongkind	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Fabaceae	*Schefflerodendron gabonense* Pellegr.	EN	EN	0 (0%)	3 (67 %)	0 (0%)
1	Fabaceae	*Tetraberlinia polyphylla* (Harms) J. Léonard	LC	LC	3 (12 %)	8 (71 %)	5 (24 %)
1	Fabaceae	*Xanthocercis rabiensis* Maesen	EN	EN	0 (0%)	3 (80 %)	0 (0%)
2	Gesneriaceae	*Streptocarpus mannii* (C.B. Clarke) Nishii & Mich. Möller	LC	LC	4 (17 %)	6 (44 %)	5 (28 %)
1	Lamiaceae	*Clerodendrum leucobotrys* Breteler	CR	CR	0 (0%)	1 (100 %)	0 (0%)
1	Lamiaceae	*Vitex gabunensis* Gürke	VU	VU	3 (20 %)	4 (50 %)	0 (0%)
3	Lauraceae	*Beilschmiedia paulocordata* Fouilloy & N. Halle	NE				
3	Lauraceae	*Beilschmiedia pellegrinii* Fouilloy & N. Halle	NE				
3	Lauraceae	*Beilschmiedia preussioides* Fouilloy & N. Halle	NE				
3	Lecithydaceae	*Brazzeia soyauxii* var. *acuminata* (Tiegh.) Letouzey	NE				
1	Lecythidaceae	*Napoleonaea cuneata* Jongkind	LC	LC	2 (7%)	10 (86 %)	8 (72 %)*
1	Lecythidaceae	*Rhaptopetalum belingense* Letouzey	EN	EN	2 (50 %)	2 (50 %)	2 (50 %)*
1	Lecythidaceae	*Rhaptopetalum rabiense* Kenfack & D. Nguema	CR	CR	0 (0%)	1 (100 %)	0 (0%)
1	Lecythidaceae	*Rhaptopetalum sindarense* Pellegr.	LC	LC	3 (9%)	10 (64 %)	4 (32 %)
1	Linderniaceae	*Torenia daubyi* Eb. Fisch. & O. Lachenaud	EN	EN	0 (0%)	2 (100 %)	2 (33 %)
1	Malpighiaceae	*Triaspis letestuana* Launert	EN	EN	0 (0%)	2 (20 %)	4 (67 %)
1	Malvaceae	*Cola glaucoviridis* Pellegr.	EN	EN	2 (25 %)	0 (0%)	4 (75 %)
1	Malvaceae	*Cola lissachensis* Pellegr.	LC	LC	2 (13 %)	10 (63 %)	5 (25 %)
1	Malvaceae	*Cola lizae* N. Hallé	VU	LC[†]	1 (100 %)	0 (0%)	0 (0%)
1	Malvaceae	*Cola moussavoui* Breteler	CR	CR	0 (0%)	1 (100 %)	0 (0%)
1	Malvaceae	*Cola stigmatosa* Breteler	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Malvaceae	*Cola tsandensis* Pellegr.	VU	VU	2 (14 %)	4 (57 %)	2 (57 %)
1	Malvaceae	*Grewia africana* var. *drummondiana* (Sprague) Burret	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Malvaceae	*Hibiscus minkebeensis* Burg	VU	VU	1 (100 %)	0 (0%)	0 (0%)
1	Malvaceae	*Hibiscus ngokbanakii* Burg	EN	EN	2 (50 %)	0 (0%)	0 (0%)
1	Malvaceae	*Megatritheca grossedenticulata* (M. Bodard & Pellegr.) Cristóbal	VU	VU	0 (0%)	4 (64 %)	3 (71 %)
1	Malvaceae	*Nesogordonia perpulchra* N. Hallé	EN	EN	0 (0%)	2 (100 %)	2 (50 %)
3	Malvaceae	*Scaphopetalum blackii* var. *letestui* (Pellegr.) N. Hallé	NE				
1	Malvaceae	*Scaphopetalum ngouniense* Pellegr.	EN	EN	0 (0%)	5 (100 %)	2 (33 %)
3	Malvaceae	*Scaphopetalum thonneri* var. *klainei* Pierre ex N. Hallé	NE				
1	Malvaceae	*Tarrietia densiflora* Aubrév. & Normand	LC	LC	2 (3%)	8 (51 %)	3 (11 %)
1	Marantaceae	*Hypselodelphys lopei* A.C. Ley	EN	EN	0 (0%)	2 (50 %)	3 (100 %)
1	Marantaceae	*Marantochloa alba* A.C. Ley	VU	VU	2 (15 %)	4 (31 %)	4 (21 %)
1	Marantaceae	*Marantochloa grandiflora* A.C. Ley	EN	EN	2 (8%)	2 (31 %)	0 (0%)
1	Marantaceae	*Marantochloa montsdecristalii* A.C. Ley	CR	CR	0 (0%)	0 (0%)	0 (0%)
2	Marantaceae	*Marantochloa sulphurea* (Baker) Koechlin	EN	EN	0 (0%)	3 (80 %)	0 (0%)
1	Marantaceae	*Thaumatococcus flavus* A.C. Ley	EN	EN	2 (22 %)	4 (33 %)	3 (22 %)
1	Melastomataceae	*Amphiblemma hallei* Jacq.-Fél.	VU	VU	0 (0%)	4 (64 %)	6 (82 %)
1	Melastomataceae	*Amphiblemma heterophyllum* Jacq.-Fél.	EN	EN	0 (0%)	3 (67 %)	0 (0%)
1	Melastomataceae	*Amphiblemma mvensis* M.E. Leal	CR	CR	0 (0%)	1 (100 %)	0 (0%)
2	Melastomataceae	*Amphiblemma setosum* Hook. f.	VU	VU	4 (36 %)	4 (36 %)	3 (21 %)
1	Melastomataceae	*Calvoa maculata* M.E. Leal	EN	EN	0 (0%)	3 (67 %)	2 (33 %)
1	Melastomataceae	*Dicellandra glanduligera* (Pellegr.) Jacq.-Fél.	VU	EN	0 (0%)	5 (88 %)	2 (50 %)
1	Melastomataceae	*Gravesia gabonensis* Jacq.-Fél.	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Melastomataceae	*Memecylon batekeanum* R.D. Stone & G.M. Walters	CR	VU	0 (0%)	0 (0%)	0 (0%)
1	Melastomataceae	*Memecylon mouririoides* Jacq.-Fél.	EN	EN	2 (50 %)	2 (50 %)	0 (0%)
1	Melastomataceae	*Memecylon salicifolium* Jacq.-Fél.	EN	EN	2 (20 %)	2 (20 %)	3 (80 %)
1	Melastomataceae	*Preussiella gabonensis* Jacq.-Fél.	CR	CR	0 (0%)	1 (100 %)	0 (0%)
1	Melastomataceae	*Tristemma vestitum* Jacq.-Fél.	EN	EN	0 (0%)	4 (75 %)	3 (50 %)
1	Melastomataceae	*Warneckea floribunda* Jacq.-Fél.	LC	LC	3 (17 %)	9 (78 %)	5 (28 %)
1	Meliaceae	*Heckeldora trifoliolata* J.J. de Wilde	VU	VU	3 (27 %)	3 (27 %)	0 (0%)
1	Meliaceae	*Pterorhachis le-testui* Pellegr.	LC	LC	3 (18 %)	12 (61 %)	9 (60 %)*
1	Menispermaceae	*Albertisia porcata* Breteler	EN	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Menispermaceae	*Triclisia hypochrysea* Diels	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Moraceae	*Dorstenia letestui* Pellegr.	EN	EN	0 (0%)	3 (100 %)	3 (40 %)
3	Moraceae	*Dorstenia mannii* var. *mongasii* Hijman	NE				
3	Moraceae	*Dorstenia mannii* var. *stipulata* (Rendle) Hijman	NE				
1	Moraceae	*Dorstenia oligogyna* (Pellegr.) C.C. Berg	LC	LC[†]	2 (7%)	10 (71 %)	4 (36 %)
3	Moraceae	*Dorstenia poinsettiifolia* var. *glabrescens* Hijman & C.C. Berg	NE				
1	Myrtaceae	*Eugenia breteleri* Jongkind	EN	EN	0 (0%)	2 (100 %)	0 (0%)

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Endemism status	Family	Taxon	APCA	FPCA	NP (% occurrence)	Logging/palm (% occurrence)	Mining (% occurrence)
1	Myrtaceae	*Eugenia imbricato-cordata* Amshoff	EN	EN	0 (0%)	0 (0%)	1 (100 %)
3	Myrtaceae	*Eugenia librevillensis* Amshoff	NE				
1	Myrtaceae	*Eugenia ogoouensis* Amshoff	EN	EN	0 (0%)	4 (80 %)	5 (52 %)
1	Myrtaceae	*Eugenia thollonii* Amshoff	EN	EN	0 (0%)	0 (0%)	4 (67 %)
1	Ochnaceae	*Campylospermum gabonense* subsp. *australe* Bissiengou	VU	EN	3 (31 %)	3 (63 %)	0 (0%)
1	Ochnaceae	*Campylospermum gabonense* subsp. *gabonense* Bissiengou	LC	LC[†]	0 (0%)	12 (95 %)	4 (55 %)
1	Ochnaceae	*Campylospermum klainei* (Tiegh.) Farron	EN	EN	0 (0%)	0 (0%)	0 (0%)
1	Ochnaceae	*Campylospermum louisii* Biss. & Sosef	VU	VU	3 (18 %)	6 (55 %)	7 (54 %)
1	Ochnaceae	*Campylospermum occidentale* Biss.	VU	VU	0 (0%)	5 (58 %)	2 (17 %)
1	Octoknemaceae	*Octoknema belingensis* Gosline & Malécot	CR	CR	0 (0%)	1 (100 %)	1 (100 %)*
1	Octoknemaceae	*Octoknema klaineana* Pierre	EN	EN	0 (0%)	0 (0%)	0 (0%)
1	Octoknemaceae	*Octoknema ogoouensis* Malécot & Gosline	VU	VU	1 (100 %)	0 (0%)	0 (0%)
1	Olacaceae	*Strombosia fleuryana* Breteler	EN	NT[†]	0 (0%)	3 (40 %)	2 (20 %)
1	Oleaceae	*Jasminum mouilaense* Breteler	EN	EN	0 (0%)	2 (100 %)	2 (100 %)
1	Oleaceae	*Jasminum nardydorum* Breteler	EN	EN	2 (33 %)	0 (0%)	0 (0%)
1	Opiliaceae	*Urobotrya gabonensis* Jongkind	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Orchidaceae	*Angraecum biteaui* M. Simo & Stévart	EN	EN	2 (57 %)	2 (29 %)	0 (0%)
1	Orchidaceae	*Bulbophyllum pauwelsianum* Stévart & Droissart	EN	EN	0 (0%)	0 (0%)	3 (67 %)
1	Orchidaceae	*Conchograecum cribbianum* (Szlachetko & Olszewski) Szlachetko, Grochocka, Oledrzynska & Mytnik	CR	CR	0 (0%)	1 (100 %)	0 (0%)
1	Orchidaceae	*Conchograecum geerinckianum* (Stévart & Jecmenica) Szlachetko, Grochocka, Oledrzynska & Mytnik	EN	CR	0 (0%)	2 (100 %)	2 (50 %)
1	Orchidaceae	*Conchograecum gereauanum* (Stévart & Jecmenica) Szlachetko & Grochocka	CR	LC[†]	0 (0%)	0 (0%)	1 (100 %)
1	Orchidaceae	*Dinklageella villiersii* Szlach. & Olszewski	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Orchidaceae	*Polystachya kubalae* Szlach. & Olszewski	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Orchidaceae	*Renzorchis pseudoplatycoryne* Szlach. & Olszewski	DD	DD[†]			
1	Orchidaceae	*Taeniorrhiza gabonensis* Summerh.	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Orchidaceae	*Tridactyle pentalobata* P.J. Cribb & Stévart	VU	VU	1 (100 %)	0 (0%)	0 (0%)
1	Orchidaceae	*Vanilla hallei* Szlach. & Olszewski	CR	CR	0 (0%)	0 (0%)	1 (100 %)
1	Orchidaceae	*Vanilla heterolopha* Summerh.	EN	EN	2 (25 %)	3 (50 %)	3 (75 %)
1	Orchidaceae	*Veyretella flabellata* Szlach., Marg. & Mytnik	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Orchidaceae	*Veyretella hetaerioides* (Summerh.) Szlach. & Olszewski	EN	EN	2 (15 %)	3 (85 %)	2 (77 %)*
1	Pandaceae	*Microdesmis afrodecandra* Floret, Louis, & Reitsma	LC	LC	4 (11 %)	12 (70 %)	11 (68 %)
3	Pentadiplandraceae	*Pentadiplandra brazzeana* var. *valida* Pellegr. ex Villiers	NE				
1	Peraceae	*Chaetocarpus gabonensis* Breteler	VU	VU	2 (9%)	4 (45 %)	7 (79 %)
1	Phyllanthaceae	*Bridelia wilksii* Breteler	EN	EN	2 (20 %)	4 (80 %)	0 (0%)
1	Phyllanthaceae	*Cleistanthus bambidianus* Breteler	VU	VU	2 (8%)	4 (83 %)	4 (67 %)
1	Phyllanthaceae	*Cleistanthus ngounyensis* Pellegr.	LC	LC	3 (9%)	12 (74 %)	4 (47 %)
1	Phyllanthaceae	*Uapaca niangadoumae* Breteler	EN	EN	2 (14 %)	0 (0%)	0 (0%)
1	Picrodendraceae	*Aristogeitonia gabonica* Breteler	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Poaceae	*Eragrostis georgii* A. Chev.	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Poaceae	*Sporobolus indicus* var. *saxicola* Sosef & Ngok	CR	VU	0 (0%)	0 (0%)	1 (100 %)
1	Podostemaceae	*Inversodicraea boumiensis* (C. Cusset) Cheek	CR	VU	0 (0%)	0 (0%)	0 (0%)
1	Podostemaceae	*Inversodicraea thollonii* (Baill.) Cheek	EN	EN	2 (7%)	3 (60 %)	0 (0%)
1	Podostemaceae	*Ledermanniella boloensis* C. Cusset	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Podostemaceae	*Ledermanniella nicolasii* C. Cusset	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Podostemaceae	*Ledermanniella pygmaea* (Pellegr.) C. Cusset	EN	EN	0 (0%)	3 (67 %)	2 (33 %)
1	Podostemaceae	*Macropodiella hallei* C. Cusset	EN	EN	3 (67 %)	0 (0%)	0 (0%)
2	Polygalaceae	*Heterosamara mannii* (Oliv.) Paiva	EN	EN	2 (17 %)	2 (17 %)	0 (0%)
1	Primulaceae	*Ardisia bampsiana* Taton	VU	VU	3 (18 %)	7 (64 %)	7 (58 %)
2	Primulaceae	*Ardisia bracteata* Baker	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Primulaceae	*Ardisia lethomasiae* Taton	EN	EN	2 (17 %)	3 (67 %)	3 (83 %)*
1	Primulaceae	*Ardisia pierreana* Taton	EX	EX	0 (0%)	0 (0%)	0 (0%)
1	Putranjivaceae	*Drypetes verrucosa* Hutch.	LC	LC	0 (0%)	10 (75 %)	5 (35 %)*
1	Rhizophoraceae	*Cassipourea le-testui* Pellegr.	EN	EN	0 (0%)	4 (75 %)	3 (75 %)
1	Rhizophoraceae	*Cassipourea nana* Breteler	CR	CR	0 (0%)	1 (100 %)	0 (0%)
1	Rhizophoraceae	*Cassipourea pumila* Floret	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Rubiaceae	*Bertiera arctistipula* N. Hallé	LC	LC	4 (36 %)	9 (57 %)	4 (21 %)
1	Rubiaceae	*Bertiera lanx* N. Hallé	VU	VU	2 (11 %)	5 (44 %)	4 (44 %)
1	Rubiaceae	*Colletoecema gabonensis* Dessein & O. Lachenaud	EN	EN	0 (0%)	3 (100 %)	4 (75 %)
1	Rubiaceae	*Craterispermum deblockianum* Taedoumg & Hamon	EN	EN	2 (14 %)	3 (43 %)	5 (75 %)
1	Rubiaceae	*Craterispermum gabonicum* Taedoumg & De Block	LC	LC	3 (20 %)	11 (80 %)	4 (16 %)
1	Rubiaceae	*Gaertnera gabonensis* Malcomber	VU	VU	3 (13 %)	4 (75 %)	2 (6%)
1	Rubiaceae	*Ixora letestui* Pellegr.	CR	CR	0 (0%)	1 (100 %)	0 (0%)
1	Rubiaceae	*Pauridiantha crystallina* (N. Hallé) Smedmark & B. Bremer	LC	LC	5 (18 %)	8 (36 %)	4 (23 %)
1	Rubiaceae	*Pauridiantha gracilipes* O. Lachenaud & Ntore	EN	CR	0 (0%)	0 (0%)	0 (0%)
1	Rubiaceae	*Pauridiantha letestuana* (N. Hallé) Ntore & Dessein	LC	LC	2 (7%)	12 (74 %)	7 (62 %)
1	Rubiaceae	*Pauridiantha pleiantha* Ntore & Dessein	EN	EN	2 (83 %)	0 (0%)	0 (0%)
1	Rubiaceae	*Pauridiantha smetsiana* Ntore & Dessein	VU	VU	0 (0%)	5 (95 %)	0 (0%)
1	Rubiaceae	*Pauridiantha triflora* Ntore & Dessein	VU	VU	0 (0%)	8 (75 %)	6 (54 %)
1	Rubiaceae	*Pauridiantha uniflora* Ntore & Dessein	EN	EN	0 (0%)	2 (50 %)	4 (83 %)
1	Rubiaceae	*Psychotria accumulans* O. Lachenaud	CR	VU	0 (0%)	1 (100 %)	0 (0%)

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Endemism status	Family	Taxon	APCA	FPCA	NP (% occurrence)	Logging/palm (% occurrence)	Mining (% occurrence)
1	Rubiaceae	*Psychotria acutigemma* O. Lachenaud subsp. *acutigemma*	EN	EN	0 (0%)	3 (90 %)	2 (90 %)
1	Rubiaceae	*Psychotria acutigemma* subsp. *couvreuriana* O. Lachenaud	EN	EN	0 (0%)	0 (0%)	0 (0%)
2	Rubiaceae	*Psychotria bifaria* var. *pauridiantha* (Hiern) E.M.A. Petit	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Rubiaceae	*Psychotria bilineata* O. Lachenaud subsp. *bilineata*	EN	EN	0 (0%)	2 (50 %)	2 (50 %)
1	Rubiaceae	*Psychotria degreefii* O. Lachenaud	EN	EN	0 (0%)	2 (80 %)	0 (0%)
1	Rubiaceae	*Psychotria desseinii* O. Lachenaud subsp. *desseinii*	EN	EN	2 (10 %)	2 (30 %)	2 (50 %)
1	Rubiaceae	*Psychotria desseinii* subsp. *minor* O. Lachenaud	VU	VU	2 (14 %)	4 (71 %)	0 (0%)
1	Rubiaceae	*Psychotria flagelliflora* O. Lachenaud	VU	VU	0 (0%)	4 (36 %)	3 (100 %)
1	Rubiaceae	*Psychotria gaboonensis* Ruhsam	EX	EX	0 (0%)	0 (0%)	0 (0%)
1	Rubiaceae	*Psychotria gigantifolia* O. Lachenaud	EN	EN	0 (0%)	2 (75 %)	0 (0%)
1	Rubiaceae	*Psychotria heterosticta* subsp. *ivindoensis* O. Lachenaud	EN	EN	0 (0%)	0 (0%)	1 (100 %)
1	Rubiaceae	*Psychotria humifera* O. Lachenaud	EN	EN	0 (0%)	4 (100 %)	0 (0%)
2	Rubiaceae	*Psychotria infundibularis* Hiern	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Rubiaceae	*Psychotria janssensii* O. Lachenaud	EN	EN	0 (0%)	4 (100 %)	2 (50 %)
1	Rubiaceae	*Psychotria klainei* Schnell	EN	EN	3 (25 %)	0 (0%)	0 (0%)
1	Rubiaceae	*Psychotria koumounaboualiensis* O. Lachenaud	EN	EN	0 (0%)	2 (100 %)	0 (0%)
1	Rubiaceae	*Psychotria laticalyx* O. Lachenaud	EN	EN	2 (29 %)	4 (57 %)	2 (43 %)
1	Rubiaceae	*Psychotria magnistipula* O. Lachenaud	EN	EN	0 (0%)	2 (100 %)	2 (50 %)
1	Rubiaceae	*Psychotria orbicalyx* O. Lachenaud	EN	EN	0 (0%)	0 (0%)	0 (0%)
1	Rubiaceae	*Psychotria reitsmarum* O. Lachenaud	NT	NT	3 (22 %)	9 (78 %)	5 (56 %)
1	Rubiaceae	*Psychotria rosulata* Lachenaud	CR	CR	0 (0%)	1 (100 %)	0 (0%)
1	Rubiaceae	*Psychotria rubriflora* O. Lachenaud	EN	EN	2 (60 %)	0 (0%)	0 (0%)
1	Rubiaceae	*Psychotria solfiana* subsp. *fleuryana* (E.M.A. Petit) O. Lachenaud	VU	VU	0 (0%)	7 (70 %)	4 (40 %)
1	Rubiaceae	*Psychotria synactica* O. Lachenaud	VU	VU	0 (0%)	5 (100 %)	3 (83 %)
1	Rubiaceae	*Psychotria wieringae* O. Lachenaud	EN	EN	2 (13 %)	0 (0%)	0 (0%)
1	Rubiaceae	*Sabicea aurifodinae* (N. Hallé) Razafim., B. Bremer, Liede & S. Aham. Khan	EN	LC†	2 (40 %)	2 (20 %)	3 (40 %)
1	Rubiaceae	*Sabicea bigerrica* N. Hallé	EN	EN	2 (63 %)	0 (0%)	0 (0%)
3	Rubiaceae	*Sabicea caminata* N. Hallé	NE				
1	Rubiaceae	*Sabicea dichrosepala* O. Lachenaud, Zemagho & Sonké	EN	LC†	2 (20 %)	2 (20 %)	3 (40 %)
3	Rubiaceae	*Sabicea duparquetiana* var. *robbianella* N. Hallé	NE				
1	Rubiaceae	*Sabicea ezangae* Zemagho, O. Lachenaud & Sonké	CR	CR	0 (0%)	1 (100 %)	0 (0%)
1	Rubiaceae	*Sabicea golgothae* O. Lachenaud & Zemagho	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Rubiaceae	*Sabicea mabouniensis* O. Lachenaud & Zemagho	CR	CR	0 (0%)	1 (100 %)	1 (100 %)*
1	Rubiaceae	*Sabicea mapiana* Zemagho, O. Lachenaud & Sonké	EN	EN	0 (0%)	2 (100 %)	2 (67 %)*
1	Rubiaceae	*Sabicea ndjoleensis* Zemagho, O. Lachenaud & Sonké	CR	CR	0 (0%)	2 (100 %)	3 (100 %)
1	Rubiaceae	*Sabicea rubiginosa* O. Lachenaud, Zemagho & Sonké	VU	LC†	2 (7%)	6 (93 %)	4 (52 %)
1	Rubiaceae	*Sabicea sanguinosa* subsp. *sanguinosa* O. Lachenaud, Zemagho & Sonké	EN	LC†	0 (0%)	2 (29 %)	0 (0%)
1	Rubiaceae	*Sabicea sanguinosa* subsp. *viridis* O. Lachenaud, Zemagho & Sonké	EN	LC†	0 (0%)	0 (0%)	0 (0%)
1	Rubiaceae	*Sabicea sciaphilantha* subsp. *sciaphilantha* Zemagho, O. Lachenaud & Sonké	EN	EN			
1	Rubiaceae	*Sabicea uniflora* Zemagho, O. Lachenaud & Sonké	CR	VU	0 (0%)	1 (100 %)	1 (100 %)
3	Rubiaceae	*Schumanniophyton magnificum* var. *klaineanum* (Pierre ex A. Chev.) N. Hallé	NE				
1	Rubiaceae	*Sericanthe gabonensis* Sonké & Robbr.	EN	EN	0 (0%)	4 (94 %)	0 (0%)
1	Rubiaceae	*Sericanthe mpassa* Sonké & Robbr.	CR	VU	0 (0%)	0 (0%)	0 (0%)
1	Rubiaceae	*Sericanthe petitii* (N. Hallé) Robbr.	EN	EN	2 (44 %)	4 (33 %)	3 (20 %)
1	Rubiaceae	*Sericanthe testui* var. *pseudosalacia* (N. Hallé) Robbr.	EN	EN	0 (0%)	2 (100 %)	2 (50 %)*
1	Rubiaceae	*Sherbournia kiliotricha* N. Hallé	EN	EN	0 (0%)	2 (75 %)	2 (75 %)*
1	Rubiaceae	*Tarenna ogoouensis* Degreef	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
3	Rubiaceae	*Tricalysia pedunculosa* var. *walkeriana* (N. Hallé) Robbr.	NE				
1	Rubiaceae	*Vangueriella georgesii* Verdc.	EN	EN	0 (0%)	2 (100 %)	0 (0%)
1	Rubiaceae	*Virectaria salicoides* (C.H. Wright) Bremek.	VU	VU	1 (100 %)	0 (0%)	0 (0%)
1	Rutaceae	*Citropsis letestui* Pellegr.	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
3	Salicaceae	*Homalium ogoouense* Pellegr.	NE				
1	Salicaceae	*Mocquerysia distans* Breteler	EN	EN	0 (0%)	2 (100 %)	2 (33 %)
1	Salicaceae	*Oncoba ngounyensis* (Pellegr.) S. Hul	LC	VU	0 (0%)	6 (89 %)	5 (73 %)*
1	Salicaceae	*Phyllobotryon bracteatum* Hul	EN	EN	2 (33 %)	3 (67 %)	3 (67 %)
3	Sapindaceae	*Allophylus hallei* Fouilloy	NE				
3	Sapindaceae	*Allophylus imenoensis* Pellegr.	NE				
3	Sapindaceae	*Allophylus le-testui* Pellegr.	NE				
3	Sapindaceae	*Allophylus mayimbensis* Pellegr.	NE				
3	Sapindaceae	*Allophylus ngounyensis* Pellegr.	NE				
3	Sapindaceae	*Allophylus poungouensis* Pellegr.	NE				
1	Sapindaceae	*Aporrhiza lastoursvillensis* Pellegr.	EN	EN	2 (17 %)	3 (83 %)	4 (90 %)
1	Sapindaceae	*Bizonula letestui* Pellegr.	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Sapindaceae	*Chytranthus imenoensis* Pellegr.	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Sapindaceae	*Deinbollia rambaensis* Pellegr.	EN	EN	0 (0%)	2 (100 %)	2 (50 %)
1	Sapindaceae	*Pancovia le-testui* Pellegr.	EN	EN	0 (0%)	2 (50 %)	1 (100 %)
1	Sapindaceae	*Pseudopancovia heteropetala* Pellegr.	EN	EN	0 (0%)	2 (100 %)	0 (0%)
1	Sapotaceae	*Chrysophyllum ogoouense* A. Chev.	LC	LC	3 (26 %)	6 (13 %)	9 (31 %)

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Endemism status	Family	Taxon	APCA	FPCA	NP (% occurrence)	Logging/palm (% occurrence)	Mining (% occurrence)
1	Sapotaceae	*Englerophytum ferrugineum* L. Gaut. & O. Lachenaud	EN	EN	2 (50 %)	2 (25 %)	0 (0%)
1	Sapotaceae	*Englerophytum gigantifolium* O. Lachenaud & L. Gaut.	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Sapotaceae	*Englerophytum somiferanum* Aubrév.	CR	CR	0 (0%)	0 (0%)	1 (100 %)
1	Sapotaceae	Lecomtedoxa biraudii *Aubrév. & Pellegr.*	EN	EN	0 (0%)	4 (93 %)	2 (7%)
1	Sapotaceae	*Lecomtedoxa nogo* (A. Chev.) Aubrév.	LC	LC	4 (44 %)	5 (16 %)	3 (8%)
1	Sapotaceae	*Lecomtedoxa saint-aubinii* Aubrév. & Pellegr.	EN	EN	2 (50 %)	0 (0%)	0 (0%)
1	Sapotaceae	*Manilkara letestui* Aubrév. & Pellegr.	CR	CR	0 (0%)	0 (0%)	1 (100 %)
1	Sapotaceae	*Neolemonniera ogouensis* (Pierre ex Dubard) Heine	EN	EN	0 (0%)	0 (0%)	0 (0%)
1	Sapotaceae	*Pseudopachystela oyemensis* Aubrév. & Pellegr.	CR	CR	0 (0%)	0 (0%)	0 (0%)
1	Sapotaceae	*Synsepalum fleuryanum* A. Chev.	VU	VU	2 (5%)	5 (68 %)	2 (14 %)
1	Sapotaceae	*Synsepalum gabonense* (Aubrév. & Pellegr.) T.D. Penn.	EN	EN	0 (0%)	3 (50 %)	0 (0%)
1	Sapotaceae	*Synsepalum le-testui* Aubrév.	EN	EN	2 (40 %)	3 (40 %)	0 (0%)
1	Sapotaceae	*Synsepalum nyangense* (Pellegr.) McPherson & L.J.T. White	EN	EN	2 (78 %)	2 (11 %)	0 (0%)
1	Sapotaceae	*Tulestea koulamoutouensis* Aubrév. & Pellegr.	EN	EN	0 (0%)	2 (50 %)	2 (50 %)
1	Sapotaceae	*Vincentella ogouensis* Aubrév. & Pellegr.	CR	CR	0 (0%)	0 (0%)	1 (100 %)
1	Simaroubaceae	*Iridosma le-testui* (Pellegr.) Aubrév. & Pellegr.	EN	EN	0 (0%)	3 (100 %)	2 (33 %)
3	Thymelaeaceae	*Craterosiphon soyauxii* H. Pearson	NE				
1	Violaceae	*Rinorea abbreviata* Achound. & Bos	CR	CR	0 (0%)	1 (100 %)	1 (100 %)
1	Violaceae	*Rinorea apertior* Achound. & Bos	EN	EN	0 (0%)	4 (78 %)	0 (0%)
1	Violaceae	*Rinorea breteleri* Achound.	VU	VU	0 (0%)	7 (86 %)	5 (63 %)
1	Violaceae	*Rinorea calcicola* R. van Velzen & Wieringa	EN	EN	0 (0%)	2 (33 %)	5 (100 %)
1	Violaceae	*Rinorea curtirama* Achound. & Bos	EN	EN	0 (0%)	5 (80 %)	0 (0%)
1	Violaceae	*Rinorea soyauxii* M. Brandt	EN	EN	0 (0%)	0 (0%)	2 (8%)
1	Vitaceae	*Cissus prunifera* Desc.	EN	EN	0 (0%)	4 (75 %)	2 (100 %)
1	Zingiberaceae	*Aframomum longipetiolatum* Koechlin	VU	VU	2 (27 %)	6 (67 %)	8 (65 %)
1	Zingiberaceae	*Aframomum rotundum* D.J. Harris & Wortley	EN	EN	0 (0%)	1 (100 %)	1 (100 %)

Appendix B

List of taxa no longer considered endemic to Gabon but indicated as such in the checklist of Gabonese vascular plant species (Sosef et al., 2006) and in treatments in the Flore du Gabon published thereafter. The "Notes" column provides and explanation why the taxon is no longer considered endemic. The "Reference" indicates relevant sources (including a list of specimens from outside Gabon provided in Appendix C).

Family	Taxon	Notes	Reference
Acanthaceae	*Adhatoda le-testui* (Benoist) Heine	Present in the Republic of Congo	Appendix C
Acanthaceae	*Asystasia fragilis*	Unpublished taxon	
Acanthaceae	*Dischistocalyx klainei* R. Benoist	Present in Cameroon and Equatorial Guinea	Appendix C
Acanthaceae	*Whitfieldia letestui* Benoist	Unpublished synonym of *Whitfieldia preussi*, present in Cameroon	Aurélie Grall (comm. pers.), ongoing revision
Anisophylleaceae	*Anisophyllea sororia* Pierre	Present in São-Tomé, Cameroon and the Republic of Congo	Appendix C
Annonaceae	*Anonidium letestui* Pellegr.	Present in Equatorial Guinea and the Republic of Congo	Appendix C
Annonaceae	*Artabotrys letestui* Pellegr.	Present in Equatorial Guinea and the Republic of Congo	Appendix C
Annonaceae	*Isolona letestui* Pellegr.	Present in the Republic of Congo	Appendix C
Annonaceae	*Letestudoxa lanuginosa* Le Thomas	Present in Cameroon	Appendix C
Annonaceae	*Monanthotaxis letestui* Pellegr.	Present in the Republic of Congo	Appendix C
Annonaceae	*Neostenanthera robsonii* Le Thomas	Present in Cameroon and Equatorial Guinea	Appendix C
Annonaceae	*Piptostigma glabrescens* var. *lanceolata* Le Thomas	Synonym of *Piptostigma glabrescens*, present in Cameroon, Equatorial Guinea and the Republic of Congo	Ghogue et al. (2017)
Annonaceae	*Piptostigma oyemense* Pellegr.	Present in Cameroon	Appendix C
Annonaceae	*Toussaintia hallei* Le Thomas	Present in Cameroon	Appendix C
Annonaceae	*Uvaria annickiae* Jongkind	Present in Equatorial Guinea	Appendix C
Annonaceae	*Uvaria klainei* Pierre ex Engl. & Diels	Present in Cameroon and Equatorial Guinea	Appendix C
Annonaceae	*Xylopia letestui* Pellegr. var. *letestui*	Synonym of *Xylopia letestui*, present in West Africa	Johnson and Muray (2018)
Annonaceae	*Xylopia rubescens* var. klaineana Pellegr.	Synonym of *Xylopia rubescens*, widely distributed in tropical Africa	Johnson and Muray (2018)
Apocynaceae	*Alafia* spec. nov.	Unpublished taxon	
Apocynaceae	*Alafia velutina* Leeuwenb.	Synonym of *Farquharia elliptica*, present in West Africa	Wieringa (2011)
Apocynaceae	*Baissea longipetiolata* Dilst	Present in Cameroon	Appendix C
Apocynaceae	*Brachystelma letestui* Pellegr.	Present in the Republic of Congo	Appendix C
Apocynaceae	*Landolphia axillaris* Pichon	Present in the Republic of Congo	Appendix C
Apocynaceae	*Landolphia noctiflora* J. Pers.	Present in Equatorial Guinea	Appendix C
Araceae	*Culcasia rotundifolia* Bogner	Present in Equatorial Guinea	Appendix C
Araceae	*Pseudohydrosme gabunensis* Engl.	Present in western Congo	Hetterscheid and Bogner (2013)
Arecaceae	*Podococcus acaulis* Hua	Present in the Republic of Congo	Appendix C
Asparagaceae	*Dracaena nyangensis* Pellegr.	Present in Cameroon	Appendix C
Aspleniaceae	*Asplenium hallei* Tardieu	Present in Cameroon and Equatorial Guinea	Appendix C
Asteraceae	*Erlangea plumosa* Sch. Bip.	Present in the Republic of Congo	Appendix C
Balsaminaceae	*Impatiens columbaria* Bos	Present in Equatorial Guinea	Appendix C

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Family	Taxon	Notes	Reference
Balsaminaceae	*Impatiens gongolana* N. Hallé	Present in Equatorial Guinea, need of taxonomic work (Steven Janssens, comm. pers.)	Appendix C
Begoniaceae	*Begonia atroglandulosa Sosef* subsp. *atroglandulosa*	Present in Equatorial Guinea	Appendix C
Begoniaceae	*Begonia sessilifolia* subsp. *ogoouensis*	Unpublished taxon	
Begoniaceae	*Begonia* spec. nov. 1	Unpublished taxon	
Burseraceae	*Dacryodes ebatom* Aubrév. & Pellegr.	Present in Equatorial Guinea	Appendix C
Celastraceae	*Salacia coronata* N. Hallé	Present in Cameroon	Lachenaud et al. (2018)
Celastraceae	*Salacia hallei* Jongkind	Present in Angola (Cabinda)	Appendix C
Celastraceae	*Salacia pierrei* N. Hallé	Present in Equatorial Guinea	Appendix C
Chrysobalanaceae	*Dactyladenia chevalieri* (De Wild.) Prance & F. White	Present in Equatorial Guinea	Appendix C
Chrysobalanaceae	Dactyladenia floretii Breteler	Present in the Republic of Congo	Appendix C
Chrysobalanaceae	*Dactyladenia laevis* (Pierre ex De Wild.) Prance & F. White	Present in Equatorial Guinea	Appendix C
Chrysobalanaceae	*Magnistipula* sp.n. aff. *bimarsupiata*	Unpublished taxon	
Combretaceae	*Combretum rabiense* Jongkind	Present in Equatorial Guinea	Appendix C
Commelinaceae	*Palisota bogneri* Brenan	Present in the Republic of Congo	Appendix C
Connaraceae	*Agelaea palmata* Jongkind	Present in the Republic of Congo	Appendix C
Connaraceae	*Jollydora pierrei* Gilg	Present in Equatorial Guinea	Appendix C
Convolvulaceae	*Bonamia gabonensis* Breteler	Present in the Republic of Congo	Appendix C
Convolvulaceae	*Calycobolus campanulatus* (K. Schum. ex Hallier f.) Heine var. *campanulatus*	Synonym of *Calycobolus campanulatus*, present in Cameroon, the Republic of Congo, the Democratic Republic of Congo, Angola (Cabinda) and Tanzania	Breteler (2015)
Convolvulaceae	*Calycobolus klaineanus* (Pierre ex Pellegr.) Heine	Synonym of *Calycobolus acuminatus*, present in the Republic of Congo, the Democratic Republic of Congo, Angola and Tanzania	Breteler (2015)
Convolvulaceae	*Calycobolus letouzeyanus* Lejoly & Lisowski	Synonym of *Calycobolus acuminatus*, present in the Republic of Congo, the Democratic Republic of Congo, Angola and Tanzania	Breteler (2015)
Convolvulaceae	*Calycobolus thollonii* Lejoly & Lisowski	Synonym of *Calycobolus acuminatus*, present in the Republic of Congo, the Democratic Republic of Congo, Angola and Tanzania	Breteler (2015)
Costaceae	*Costus fissiligulatus* var. *major* Gagnep.	Synonym of *Costus phyllocephalus*, widely distributed in Central Africa	Maas-van de Kamer et al. (2016)
Costaceae	*Costus violaceus* Koechlin	Synonym of *Costus phyllocephalus*, widely distributed in Central Africa	Maas-van de Kamer et al. (2016)
Dichapetalaceae	*Dichapetalum trichocephalum* Breteler	Present in Nigeria and the Democratic Republic of Congo	Appendix C
Erythroxylaceae	*Pinacopodium gabonense* (Cavaco & Normand) Normand & Cavaco	Unpublished synonym of *Pinacopodium congolense*, present in Angola (Cabinda)	Olivier Lachenaud (comm. pers.), ongoing revision
Euphorbiaceae	*Aubletiana macrostachys* (Breteler) J. Murillo	Present in the Republic of Congo	Appendix C
Euphorbiaceae	*Cleistanthus racemosus* Pierre ex Hutch.	Synonym of *Cleistanthus caudatus*, present in the Republic of Congo and the Democratic Republic of Congo	Breteler (2011)
Euphorbiaceae	*Croton loukandensis* Pellegr.	Unpublished synonym of *Croton longiracemosus*, present in Nigeria, Cameroon, the Republic of Congo and the Democratic Republic of Congo	Frans Breteler (comm. pers.), ongoing revision
Euphorbiaceae	*Crotonogyne gabunensis* Pax	Present in Cameroon, Equatorial Guinea and the Republic of Congo	Appendix C
Euphorbiaceae	*Macaranga klaineana* Pierre ex Prain	Present in Equatorial Guinea	Appendix C
Euphorbiaceae	*Macaranga tchibangensis* Pellegr.	Unpublished synonym of *Macaranga longipetiolata*, present in the Democratic Republic of Congo	Olivier Lachenaud (comm. pers.), ongoing revision
Euphorbiaceae	*Uapaca letestuana* A. Chev.	Synonym of *Uapaca vanhouttei*, widely distributed in Central Africa	Breteler (2013)
Fabaceae	*Anthonotha stipulacea* J. Léonard	Present in Equatorial Guinea	Appendix C
Fabaceae	*Anthonotha trunciflora* J. Léonard	Present in the Republic of Congo	Appendix C
Fabaceae	*Augouardia letestui* Pellegr.	Present in the Republic of Congo	Appendix C
Fabaceae	*Berlinia* spec. nov. 2	Unpublished taxon	
Fabaceae	*Bikinia le-testui* × *media*	Unpublished taxon	
Fabaceae	*Bikinia* spec.nov. Crystal Mts	Unpublished taxon	
Fabaceae	*Cynometra letestui* (Pellegr.) J. Léonard	Present in the Republic of Congo and Angola (Cabinda)	Appendix C
Fabaceae	*Cynometra nyangensis* Pellegr.	Present in the Republic of Congo	Appendix C
Fabaceae	*Dalbergia fouilloyana* Pellegr.	Present in Equatorial Guinea and the Republic of Congo	Appendix C
Fabaceae	*Dalbergia librevillensis* Pellegr.	Present in the Republic of Congo	Appendix C
Fabaceae	*Daniellia soyauxii* (Harms) Rolfe	Present in Cameroon and Equatorial Guinea	Appendix C
Fabaceae	*Englerodendron conchyliophorum* Breteler	Present in Nigeria, Cameroon, Equatorial Guinea and the Republic of Congo	Appendix C
Fabaceae	*Englerodendron gabunense* (J. Léonard) Breteler	Present in Cameroon	Appendix C
Fabaceae	*Gilbertiodendron limosum* (Pellegr.) J. Léonard	Present in the Republic of Congo	Appendix C
Fabaceae	*Gilbertiodendron ngouniense* (Pellegr.) J. Léonard	Present in Equatorial Guinea and the Republic of Congo	Appendix C
Fabaceae		Present in the Republic of Congo	Appendix C

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Family	Taxon	Notes	Reference
	Gilbertiodendron unijugum (Pellegr.) J. Léonard		
Fabaceae	*Julbernardia makandensis*	Unpublished taxon	
Fabaceae	*Leptoderris velutina* Dunn	Synonym of *Leptoderris brachyptera*, widely distributed in tropical Africa	Breteler (2016)
Fabaceae	*Loesenera gabonensis* Pellegr.	Present in the Republic of Congo	Appendix C
Fabaceae	*Millettia bibracteolata* Pellegr.	Synonym of *Millettia achtenii*, present in the Democratic Republic of Congo	Adomou et al. (2016)
Fabaceae	*Millettia klainei* var. *floribunda* Pellegr.	Synonym of *Millettia lecomtei*, present in the Republic of Congo, the Democratic Republic of Congo and Angola	Adomou et al. (2016)
Fabaceae	*Millettia lecomtei* Dunn	Present in the Republic of Congo, the Democratic Republic of Congo and Angola	Adomou et al. (2016)
Fabaceae	*Millettia mavangensis* Pellegr.	Synonym of *Millettia kennedyi*, present in West Africa	Adomou et al. (2016)
Fabaceae	*Millettia mavoundiensis* Pellegr.	Synonym of *Millettia letestui*	Adomou et al. (2016)
Fabaceae	Millettia nyangensis *Pellegr.*	Synonym of *Aganope* sp., probably *Aganope impressa*, present in Nigeria and the Democratic Republic of Congo	van der Maesen and Sosef (2016)
Fabaceae	*Millettia oyemensis* Pellegr.	Present in Cameroon	Appendix C
Fabaceae	*Millettia wieringae* A.C. Adomou	Unpublished synonym of *Millettia laurentii*, widely distributed in Central Africa	Olivier Lachenaud (comm. pers.), ongoing revision
Fabaceae	*Tessmannia bambidiensis*	Unpublished taxon	
Fabaceae	*Tessmannia nervosa*	Unpublished taxon	
Flacourtiacae	*Ophiobotrys gabonica*	Unpublished taxon	
Guttiferae	*Garcinia curvinervis* Vesque	Synonym of *Garcinia ovalifolia*, widely distributed in tropical Africa	Sosef and Dauby (2013)
Guttiferae	*Garcinia quadrifaria* (Oliv.) Pierre	Widely distributed in tropical Africa	Sosef and Dauby (2013)
Hernandiaceae	*Illigera cava* Breteler & Wieringa	Present in the Republic of Congo	Appendix C
Icacinaceae	*Chlamydocarya anhydathoda* Villiers	Synonym of *Pyrenacantha anhydathoda*, present in Equatorial Guinea	Byng et al. (2014), Appendix C
Icacinaceae	*Chlamydocarya soyauxii* Engl.	Synonym of *Pyrenacantha soyauxii*, present in Cameroon and Equatorial Guinea	Byng et al. (2014), Appendix C
Icacinaceae	*Desmostachys tenuifolius* var. *angustifolius* Pellegr. ex Villiers	Synonym of *Vadensea tenuifolia*, present in Nigeria, Cameroon and Equatorial Guinea	Jongkind and Lachenaud (2019)
Icacinaceae	*Pyrenacantha gabonica* Breteler & Villiers	Present in the Republic of Congo and the Democratic Republic of Congo	Appendix C
Labiatae	*Platostoma gabonense* A.J. Paton	Present in West and East Africa	Appendix C
Liliaceae	*Dracaena haemanthioides*	Unpublished taxon	
Linaceae	*Hugonia* spec. nov. (?) 1	Unpublished taxon	
Linaceae	*Hugonia* spec. nov. (?) 2	Unpublished taxon	
Linaceae	*Hugonia* spec. nov. (?) 3	Unpublished taxon	
Linderniaceae	*Torenia mannii* Skan	Present in Equatorial Guinea	Appendix C
Loganiaceae	*Strychnos retinervis* Leeuwenb.	Present in Equatorial Guinea	Appendix C
Malpighiaceae	*Acridocarpus caparados*	Unpublished taxon	
Malpighiaceae	*Acridocarpus vestitus*	Unpublished taxon	
Malvaceae	*Chlamydocola lastoursvillensis* (M. Bodard & Pellegr.) N. Hallé	Present in Equatorial Guinea	Appendix C
Malvaceae	*Cola crispiflora* K. Schum.	Present in Equatorial Guinea	Appendix C
Malvaceae	*Cola duparquetiana* Baill.	Present in Equatorial Guinea	Appendix C
Malvaceae	*Cola letestui* Pellegr.	Present in the Republic of Congo	Appendix C
Malvaceae	*Cola mayimbensis* Pellegr.	Present in Equatorial Guinea and the Republic of Congo	Appendix C
Malvaceae	*Pterygota augouardii* Pellegr.	Present in Equatorial Guinea	Appendix C
Marantaceae	*Megaphrynium gabonense* Koechlin	Present in the Democratic Republic of Congo and perhaps in Ivory Coast	Appendix C
Marantaceae	*Sarcophrynium villosum* K. Schum.	Present in Cameroon	Appendix C
Melastomataceae	*Amphiblemma cuneatum* Jacq.-Fél.	Present in Equatorial Guinea	Appendix C
Melastomataceae	*Calvoa jacques-felixii* Figueiredo	Present in Equatorial Guinea	Parmentier and Geerinck (2002)
Melastomataceae	*Dicellandra descoingsii* Jacq.-Fél.	Present in Equatorial Guinea	Appendix C
Melastomataceae	*Heterotis arenaria* Jacq.-Fél.	Present in Equatorial Guinea	Parmentier and Geerinck (2002)
Melastomataceae	*Memecylon collinum* Jacq.-Fél.	Present in Equatorial Guinea	Appendix C
Meliaceae	*Guarea ngounyensis* Pellegr.	Synonym of *Neoguarea glomerulata*, widely distributed in Central Africa	Koenen and De Wilde (2012)
Meliaceae	*Guarea oyemensis* Pellegr.	Synonym of *Leplaea thompsonii*, widely distributed in tropical Africa	Koenen and De Wilde (2012)
Menispermaceae	*Tiliacora gabonensis* Troupin	Present in Cameroon and the Republic of Congo	Appendix C
Menispermaceae	*Tiliacora klaineana* Diels	Unpublished synonym of *Tiliacora odorata*, present in Cameroon	According to notes by Troupin on the type of *T. odorata*, but never published. Ongoing revision.
Menispermaceae	*Tiliacora macrophylla* Diels	Present in Equatorial Guinea	Appendix C
Moraceae	*Utsetela gabonensis* Pellegr.	Present in the Republic of Congo	Appendix C
Ochnaceae	*Idertia axillaris* (Oliv.) Farron	Widely distributed in tropical Africa	Sosef and Bissiengou (2016)
Olacaceae	*Engomegoma gordonii* Breteler	Present in Cameroon, Equatorial Guinea and the Republic of Congo	Appendix C
Olacaceae	*Strombosiopsis sereinii* Breteler	Present in Equatorial Guinea	Appendix C
Opiliaceae	*Rhopalopilia hallei* Villiers	Present in the Republic of Congo	Appendix C
Orchidaceae	*Ancistrorhynchus obovata* Stévart	Unpublished taxon	
Orchidaceae	*Angraecopsis hallei* Szlach. & Olszewski	Unpublished synonym of *Rhipidoglossum paucifolium*, present in Liberia and Cameroon	João Farminhão (comm. pers.), ongoing revision
Orchidaceae	*Angraecum* aff. *aporoides* sp. nov. 1	Unpublished taxon	

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Family	Taxon	Notes	Reference
Orchidaceae	*Angraecum* aff. *aporoides* sp. nov. 2	Unpublished taxon	
Orchidaceae	*Bulbophyllum pandanetorum* Summerh.	Present in Cameroon	Appendix C
Orchidaceae	*Bulbophyllum subligaculiferum* J.J. Verm.	Present in Cameroon	Appendix C
Orchidaceae	*Diaphananthe* sp. nov. 2	Unpublished taxon	
Orchidaceae	*Microcoelia* sp. nov.	Unpublished taxon	
Orchidaceae	*Nephrangis bertauxiana* Szlach. & Olszewski	Present in Cameroon	Appendix C
Orchidaceae	*Polystachya cussetei* Szlach. & Olszewski	Synonym of *Polystachya polychaete*, widely distributed in tropical Africa	Mytnik-Ejsmont (2011)
Orchidaceae	*Polystachya lejolyana* Stévart	Present in Cameroon	Appendix C
Orchidaceae	*Rhipidoglossum magnicalcar* Szlach. & Olszewski	Synonym of *Kylicanthe quintasii*, widely distributed in Central Africa	Descourvières et al. (2018)
Orchidaceae	*Tridactyle latifolia* Summerh.	Present in São-Tomé and Príncipe	Appendix C
Palmae	*Elaeis dybowskii* Hua	Synonym of *Elaeis guineensis*, widely distributed in tropical Africa	Govaerts and Dransfield (2005)
Palmae	*Sclerosperma walkeri* A. Chev.	Present in the Democratic Republic of Congo	Appendix C
Pandaceae	*Microdesmis klainei* J. Léonard	Present in Cameroon and Equatorial Guinea	Appendix C
Pandanaceae	*Pandanus gabonensis* Huynh	Synonym of *Pandanus candelabrum*, present in West Africa	African Plant Database (2021)
Pandanaceae	*Pandanus parvicentralis* Huynh	Synonym of *Pandanus candelabrum*, present in West Africa	African Plant Database (2021)
Pandanaceae	*Pandanus teuszii* Warb.	Synonym of *Pandanus candelabrum*, present in West Africa	African Plant Database (2021)
Passifloraceae	*Paropsia gabonica* Breteler	Present in Equatorial Guinea	Appendix C
Peraceae	*Pogonophora letouzeyi* Feuillet	Present in Equatorial Guinea and the Republic of Congo	Appendix C
Phyllanthaceae	*Cleistanthus gabonensis* Hutch.	Present in Equatorial Guinea and Central African Republic	Appendix C
Phyllanthaceae	*Cleistanthus willmannianus* J. Léonard	Synonym of *Cleistanthus caudatus*, present in the Republic of Congo and the Democratic Republic of Congo	Breteler (2011)
Poaceae	*Microcalamus convallarioides* Stapf	Synonym of *Microcalamus barbinodis*, present in Cameroon	Clayton and Renvoize (1986)
Podostemaceae	*Ledermanniella letestui* (Pellegr.) C. Cusset	Present in Equatorial Guinea	Appendix C
Polygalaceae	*Carpolobia* spec. nov.	Synonym of *Carpolobia gabonica*, present in the Republic of Congo	Appendix C
Primulaceae	*Ardisia belingaensis* Taton	Present in Cameroon	Appendix C
Primulaceae	*Ardisia letestui* Taton	Present in the Republic of Congo	Appendix C
Putranjivaceae	*Sibangea* spec. nov.	Unpublished taxon	
Rubiaceae	*Aulacocalyx pallens* subsp. *letestui* Figueiredo	Present in the Democratic Republic of Congo	Figueiredo (1997)
Rubiaceae	*Aulacocalyx* spec.nov. (Gabon)	Unpublished taxon	
Rubiaceae	*Aulacocalyx subulata* subsp. *glabra* Figueiredo	Unpublished synonym of *Aulacocalyx subulata*, present in Cameroon, Equatorial Guinea and the Republic of Congo	Olivier Lachenaud (comm. pers.), ongoing revision, Appendix C
Rubiaceae	*Aulacocalyx subulata* (N. Hallé) Figueiredo *subsp. Subulata*	Unpublished synonym of *Aulacocalyx subulata*, present in Cameroon, Equatorial Guinea and the Republic of Congo	Olivier Lachenaud (comm. pers.), ongoing revision, Appendix C
Rubiaceae	*Bertiera sphaerica* N. Hallé	Present in Equatorial Guinea	Appendix C
Rubiaceae	*Chassalia tchibangensis* Pellegr.	Present in Cameroon, Equatorial Guinea and the Republic of Congo	Appendix C
Rubiaceae	*Chazaliella longistylis* (Hiern) E.M.A. Petit & Verdc.	Present in Cameroon and Equatorial Guinea	Appendix C
Rubiaceae	*Coleactina papalis* N. Hallé	Synonym of *Leptactina papalis*, present in the Republic of Congo	De Block et al. (2015), Appendix C
Rubiaceae	*Craterispermum* spec. nov.	Unpublished taxon	
Rubiaceae	*Craterispermum* spec. nov. 2	Unpublished taxon	
Rubiaceae	*Cuviera latior* var. *evorombila* N. Hallé	Synonym of *Cuviera angolensis* subsp. *latior,* widely distributed in Central Africa	Verstraete et al. (2013)
Rubiaceae	*Cuviera letestui* Pellegr.	Present in Equatorial Guinea, the Republic of Congo and the Democratic Republic of Congo	Appendix C
Rubiaceae	*Cuviera pierrei* N. Hallé	Present in Equatorial Guinea	Appendix C
Rubiaceae	*Didymosalpinx konguensis* (Hiern) Keay	Present in Equatorial Guinea	Appendix C
Rubiaceae	*Ecpoma geanthum* (Hiern) N. Hallé	Present in Equatorial Guinea	Appendix C
Rubiaceae	*Ecpoma hiernianum* (Wernham) N. Hallé & F. Hallé	Synonym of *Sabicea hierniana*, present in Cameroon, Equatorial Guinea and the Democratic Republic of Congo	Zemagho et al. (2016), Appendix C
Rubiaceae	*Gaertnera spicata* K. Schum.	Present in Equatorial Guinea	Appendix C
Rubiaceae	*Heinsia crinita* var. *scitula* N. Hallé	Present in the Republic of Congo and the Democratic Republic of Congo	Appendix C
Rubiaceae	*Ixora* sp.'Waka'	Unpublished taxon	
Rubiaceae	*Pauridiantha micrantha* (A. Chev.) Bremek.	Present in Equatorial Guinea	Appendix C
Rubiaceae	*Pauridiantha siderophila* N. Hallé	Present in Equatorial Guinea and the Republic of Congo	Appendix C
Rubiaceae	*Pauridiantha venusta* N. Hallé	Synonym of *Pauriantha talbotii*, present in Nigeria, Cameroon, Equatorial Guinea and Príncipe	Ntore (2008)
Rubiaceae	*Pavetta spathulata* Bremek.	Present in Cameroon and the Democratic Republic of Congo	Appendix C
Rubiaceae	*Pavetta testui* Bremek.	Unpublished synonym of *Pavetta spathulata*, present in the Democratic Republic of Congo	Olivier Lachenaud (comm. pers.), ongoing revision
Rubiaceae	*Pentaloncha humilis* Hook. f.	Present in Equatorial Guinea and the Democratic Republic of Congo	Appendix C
Rubiaceae	*Pseudosabicea sthenula* N. Hallé		Zemagho et al. (2017)

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Family	Taxon	Notes	Reference
		Synonym of *Sabicea sthenula*, present in Cameroon and the Republic of Congo	
Rubiaceae	*Psychotria refractiflora* K. Schum.	Synonym of *Psychotria konguensis*, widely distributed in Central Africa	Lachenaud (2019)
Rubiaceae	*Psychotria rhizomatosa* var. *minor* E. M.A. Petit	Synonym of *Psychotria rhizomatosa*, widely distributed in Central Africa	Lachenaud (2019)
Rubiaceae	*Psychotria rubropilosa* De Wild.	Present in Equatorial Guinea	Lachenaud (2019)
Rubiaceae	*Rothmannia jollyana* N. Hallé	Present in the Republic of Congo	Appendix C
Rubiaceae	*Rutidea ferruginea* Hiern	Present in Cameroon and Equatorial Guinea	Appendix C
Rubiaceae	*Rutidea gabonensis* Bridson	Present in Equatorial Guinea	Appendix C
Rubiaceae	*Rutidea gracilis* subsp. *makokouensis* Bridson	Unpublished synonym of *Rutidea lujae*, present in the Democratic Republic of Congo	Olivier Lachenaud (comm. pers.), ongoing revision
Rubiaceae	*Sabicea duparquetiana* Baill. ex Wernham	Present in Equatorial Guinea	Appendix C
Rubiaceae	*Sabicea duparquetiana* Baill. ex Wernham var. *duparquetiana*	Present in Equatorial Guinea	Appendix C
Rubiaceae	*Sabicea duparquetiana* var. *impexella* N. Hallé	Unpublished synonym of *Sabicea duparquetiana* var. *duparquetiana*, present in Nigeria and Equatorial Guinea	Olivier Lachenaud (comm. pers.), ongoing revision
Rubiaceae	Sabicea fulva var. *clipeolaria* N. Hallé	Unpublished synonym of *Sabicea fulvipilis* (ined.), present in Equatorial Guinea and the Republic of Congo	Olivier Lachenaud (comm. pers.), ongoing revision
Rubiaceae	*Sherbournia myosura* N. Hallé	Present in the Republic of Congo	Appendix C
Rubiaceae	*Sherbournia streptocaulon* var. *situtunga* N. Hallé	Synonym of *Sherbournia streptocaulon*, present in Cameroon and Equatorial Guinea	Sonké and Pauwels (2005)
Rubiaceae	*Tarenna calliblepharis* N. Hallé	Present in the Republic of Congo	Appendix C
Rubiaceae	*Tarenna jolinonii* N. Hallé	Present in Equatorial Guinea	Appendix C
Rubiaceae	*Tricalysia breteleri* Robbr.	Synonym of *Empogona breteleri*, present in the Republic of Congo and the Democratic Republic of Congo	Tosh et al. (2009), Appendix C
Rubiaceae	*Tricalysia concolor* N. Hallé	Synonym of *Empogona concolor* present in Equatorial Guinea	Tosh et al. (2009), Appendix C
Rubiaceae	*Tricalysia idiura* N. Hallé	Present in Cameroon and Equatorial Guinea	Appendix C
Rubiaceae	*Tricalysia* sp. c	Unpublished taxon	
Rubiaceae	*Trichostachys le-testui* Pellegr.	Unpublished synonym of *Eumachia viridicalyx*, present in Cameroon, Angola and the Democratic Republic of Congo	Olivier Lachenaud (comm. pers.), ongoing revision
Rubiaceae	*Uragoga le-testui* De Wild.	Synonym of *Psychotria letestui*, present in Cameroon, Equatorial Guinea, the Republic of Congo and Angola (Cabinda)	Lachenaud (2019)
Rubiaceae	*Vangueriella glabrescens* (Robyns) Verdc.	Present in Ivory Coast and Equatorial Guinea	Appendix C
Rubiaceae	*Vangueriella letestui* Verdc.	Present in Cameroon and Equatorial Guinea	Appendix C
Rubiaceae	*Vangueriella rufa* (Robyns) Verdc.	Present in Cameroon, Equatorial Guinea, the Republic of Congo and the Democratic Republic of Congo	Appendix C
Rubiaceae	*Vangueriella soyauxii* (K. Schum.) Verdc.	Present in the Republic of Congo and Angola (Cabinda)	Appendix C
Rubiaceae	*Virectaria belingana* N. Hallé	Present in Cameroon and Equatorial Guinea	Appendix C
Rubiaceae	*Virectaria herbacoursi* N. Hallé	Present in Cameroon, Equatorial Guinea and the Republic of Congo	Appendix C
Rubiaceae	*Virectaria herbacoursi* var. *petrophila* N. Hallé	Present in Cameroon and Equatorial Guinea	Appendix C
Rutaceae	*Vepris gabonensis* (Pierre) Mziray	Present in Ivory Coast and Cameroon	Onana and Chevillote (2015)
Salicaceae	*Oncoba breteleri* S. Hul	Present in the Republic of Congo	Appendix C
Salicaceae	*Trichostephanus gabonensis* Breteler	Present in the Republic of Congo	Appendix C
Sapotaceae	*Englerophytum kouloungense* Aubrév. & Pellegr.	Invalid name	Sine description latin in Aubréville (1960)
Sapotaceae	*Englerophytum letestui* De Wild.	Invalid name	Sine description latin in Aubréville (1960)
Sapotaceae	*Lecomtedoxa heitziana* (A. Chev.) Aubrév.	Invalid name	Nomen nudum, probably synonym of *Lecomtedoxa nogo* (Lebrun and Stork, 1997)
Sapotaceae	*Omphalocarpum torosum* Baudon	Uncertain status	Not cited in Flore du Gabon despite the holotype is from Gabon. Lebrun and Stork (1997) consider that species as *Omphalocarpum* sp.
Sapotaceae	*Pachystela buluensis* (Greves) Aubrév. & Pellegr.	Present in Angola (Cabinda)	Appendix C
Sapotaceae	*Pseudopachystela lastoursvillensis* Aubrév. & Pellegr.	Present in the Democratic Republic of Congo	Appendix C
Sapotaceae	*Synsepalum congolense* Lecomte	Present in the Republic of Congo	Appendix C
Sapotaceae	*Tulestea tomentosa* Aubrév. & Pellegr.	Present in the Republic of Congo	Appendix C
Sapotaceae	*Zeyherella letestui* Aubrév. & Pellegr.	Synonym of *Englerophytum letestui*, present in Cameroon and the Democratic Republic of Congo	Borg et al. (2019), Appendix C, presence in the Democratic Republic of Congo (Laurent Gautier, comm. pers.)
Scytopetalaceae	*Brazzeia soyauxii* (Oliv.) Tiegh.	Present in Cameroon, Equatorial Guinea and the Republic of Congo	Prance and Jongkind (2015)
Sterculiaceae	*Cola flavovelutina* var. *idoumensis* (Pellegr.) N. Hallé	Invalid name	Invalid citation of the new combination in Hallé (1961): use of "var. nov." instead of "comb. et stat. nov."
Thymelaeaceae	*Dicranolepis* sp. A (Fl. Gabon)	Unpublished taxon	
Thymelaeaceae	*Dicranolepis* sp. B (Fl. Gabon)	Unpublished taxon	
Tiliaceae	*Desplatsia trillesiana* (Pierre ex De Wild.) Pierre ex A. Chev.	Unpublished synonym of *Desplatsia dewevrei*, widely distributed in tropical Africa	

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Family	Taxon	Notes	Reference
			All *Desplatsia trillesiana* material reidentified as *D. dewevrei* by J. Wellsow in November 2018 at P herbarium, ongoing revision
Urticaceae	*Myrianthus cuneifolius* Engl.	Present in Equatorial Guinea	Appendix C
Vitaceae	*Cyphostemma ukerewense* var. *gabonicum* Desc.	Present in Equatorial Guinea	Appendix C
Vochysiaceae	*Erismadelphus sessilis* Keay & Stafleu	Present in Cameroon and the Democratic Republic of Congo	Appendix C
Zingiberaceae	*Aframomum giganteum* var. *puberulifolium* Koechlin	Synonym of *Aframomum hirsutum*, present in the Republic of Congo, the Democratic Republic of Congo and Angola (Cabinda)	Harris and Wortley (2018)
Zingiberaceae	*Aframomum inversiflorum*	Unpublished taxon	
Zingiberaceae	*Aframomum makandensis* M.M. Dhetchuvi	Present in Nigeria and Cameroon	Harris and Wortley (2018)
Zingiberaceae	*Aframomum mannii* (Oliver & Hanbury) K. Schum.	Present in Equatorial Guinea	Appendix C
Zingiberaceae	*Aframomum sericeum* Dhetchuvi & D.J. Harris	Present in Cameroon, Central African Republic, Equatorial Guinea and the Republic of Congo	Appendix C

Appendix C. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.jnc.2021.126027.

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