

Review Article

Diversity, Structural Dynamics, Regeneration Potential, and Endemism of Moist Evergreen Afromontane Forests in Ethiopia

Worku Misganaw Tebabal ^{1,2}, Getinet Masresha Kassa ² and Yalew Yiblet Mekonen ³

¹Department of Biology, Debark University, Debark, Amhara, Ethiopia

²Department of Biology, University of Gondar, Gondar, Amhara, Ethiopia

³Department of Biology, Mekdela Amba University, Tulu Awuliya, Amhara, Ethiopia

Correspondence should be addressed to Worku Misganaw Tebabal; workumisganaw4@gmail.com

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The moist evergreen Afromontane forest (MEAF) in Ethiopia is characterized by unique species diversity and serves as the center of origin and diversity for *Coffea arabica*. A systematic review of MEAF in Ethiopia was conducted following the PRISMA 2020 protocol. Searches covered Scopus, Web of Science, AJOL, PubMed, and Google Scholar, supplemented by manual reference screening, using Boolean queries for ecosystem, geographic, and thematic terms related to floristic diversity, forest structure, woody species, endemism, conservation, and regeneration. Only peer-reviewed primary research with sufficient methodological detail was included; non-peer-reviewed works were excluded. Data were extracted using a standardized Excel form capturing species richness, diversity indices, growth forms, basal area, stem density, IVI, regeneration status, and ecological pressures. Diameter at breast height (DBH) data were standardized, and results were synthesized narratively. A total of 20 articles representing 26 forest patches were included. Across these patches, 951 plant species were recorded from 567 genera and 131 families, with Asteraceae (78 species), Fabaceae (55), and Orchidaceae (50) being the most species-rich. MEAF harbors 72 endemic species, including critically endangered taxa such as *Acalypha marissima* and *Ceropegia sobolifera*. Shannon–Wiener diversity and evenness ranged from 1.54 to 4.18 and 0.31–0.89, respectively. DBH and height classes exhibited an inverted J-shaped pattern, with a mean basal area of 40.94–142.6 m²/ha, indicating healthy regeneration with abundant younger individuals. However, the review also reveals substantial research gaps, as several forest patches show missing values for key ecological parameters and inconsistencies in the reporting of structural and regeneration metrics, highlighting the need for standardized methodologies in future MEAF research. The synthesis emphasizes a clear conservation gradient, classifying forest patches as Relatively Intact, Moderately Disturbed, or Critically Degraded. To address ecological vulnerabilities, a conservation strategy focusing on multisite networking, standardized monitoring, and protection of critical habitats is recommended to safeguard MEAF diversity and resilience.

Keywords: Afromontane forest; *Coffea arabica*; endemism; evergreen; hotspots

1. Introduction

Ethiopia displays remarkable topographical diversity, ranging from 125 m below sea level (m.b.s.l.) in the Danakil Depression to 4533 m above sea level (m.a.s.l.) at Ras Dashed [1, 2]. This extreme elevation variation has created diverse agroclimatic conditions, soils, and microclimates that have fostered the development of distinct habitats supporting the

evolution and survival of numerous plant and animal species [3]. The topographic settings of the country encompass valleys, steep gorges, flat-topped plateaus, mountains, and aquatic and wetland habitats [4], establishing Ethiopia as one of the world's most ecologically significant regions. It ranks among the top 25 biodiversity-rich countries and the five major global centers of floral diversity [5, 6] and contains two recognized biodiversity hotspots: the Eastern Afro-

Montane and Horn of Africa Regions [5, 7, 8]. The flora alone comprises an estimated 6500–7000 vascular plant species, of which about 12% are endemic [9].

Within this broader ecological context, moist evergreen Afromontane forests (MEAFs) represent one of the most ecologically significant natural systems. Globally recognized as vital biodiversity reservoirs and climate-regulating ecosystems, MEAFs harbor exceptionally high levels of endemism and ecological specialization, particularly within tropical montane regions [10, 11]. Their multilayered canopy, dense understory, and year-round leaf retention create stable microclimates that sustain diverse assemblages of plants, animals, fungi, and microorganisms. Beyond their biological richness, MEAFs provide indispensable ecosystem services, including carbon sequestration, watershed regulation, soil stabilization, and climate buffering, making them critical not only for conservation but also for the ecological and socioeconomic well-being of surrounding communities. At the national level, they stand out as one of Ethiopia's biologically rich and economically valuable forest types, supporting diverse species assemblages and providing critical ecological functions and livelihood contributions for local communities [12]. In addition to their biodiversity value, MEAFs act as vital ecological corridors in Ethiopia, linking isolated patches of dry evergreen Afromontane forests (DEAFs) and Afroalpine forests [13, 14]. This connectivity allows for the movement and genetic flow of species between these fragmented forest types, helping maintain biodiversity and ecosystem resilience [15]. Thus, MEAFs serve both as biodiversity reservoirs and as key transitional habitats along elevational gradients.

To ensure clarity in terminology and to align with contemporary vegetation science, it is important to note that MEAFs have been described using various names such as “Afromontane Rainforest” [16], “Moist Montane Forest,” and “Moist Montane Evergreen Forest” [17–19]. In this review, the term MEAF is consistently adopted. Advances in Ethiopia's vegetation classification from altitude-based schemes [20, 21] to integrated bioclimatic frameworks [22, 23] now provide a stronger ecological basis for delineating MEAF boundaries and identifying climate-vulnerable ecotones and conservation-priority zones. These updated systems highlight the need for standardized classification, particularly where climate and anthropogenic pressures intersect.

Despite this ecological importance, Ethiopia's forest cover remains only 23.6% today [24], accompanied by an alarming annual deforestation rate of 92,000 ha [25]. The major drivers are agricultural expansion, settlement growth, and limited livelihood alternatives for local populations [26] that have led to severe fragmentation of the once-continuous MEAF belt. Today, these forests persist mainly in sacred groves, protected areas, steep landscapes, and inaccessible locations, marking a dramatic reduction from their former extent [25, 26]. Furthermore, MEAFs hold unique global value as the natural habitat of wild *Coffea arabica*, the genetic source of one of the world's most economically important crops, yet they continue to face escalating pressures from plantation development, agricultural encroachment,

settlement expansion, and unsustainable resource extraction [27, 28].

Although numerous studies have investigated specific aspects of MEAF floristic diversity, structure, or regeneration, a comprehensive synthesis that integrates information on diversity, structural dynamics, regeneration status, and endemism at a national scale remains lacking. Moreover, recent findings reveal substantial geographic variation in MEAF distribution (1500–2600 m.a.s.l.), distinctive climatic–edaphic controls including consistently high rainfall, moderate temperatures, moisture-retentive nitosols, and complex vertical stratification supporting highly specialized flora. These emerging insights reinforce the need for a unified synthesis capable of capturing regional variability while identifying the common ecological signatures that define MEAF across Ethiopia.

Therefore, this review is organized around four major ecological pillars: (i) floristic and faunal diversity; (ii) structural dynamics; (iii) regeneration potential; and (iv) endemism, which collectively serve as key indicators of forest ecosystem status and resilience [29]. It also summarizes the major threats and conservation challenges facing MEAFs to provide a holistic understanding of their current ecological condition and management needs. Special emphasis is placed on synthesizing emerging evidence on species richness gradients, frequency and diameter at breast height (DBH) distribution patterns, and the conservation status of endemic taxa patterns that increasingly reveal both high resilience potential and alarming vulnerabilities within these forests.

Overall, the aim of this review is to synthesize the current scientific knowledge on the diversity, structure, regeneration, and endemism of MEAFs in Ethiopia; integrate recent ecological findings such as their climatic–edaphic determinants and structural attributes; identify critical gaps in methodology and reporting (e.g., nonstandardized DBH thresholds and missing diversity indices); and inform science-based conservation planning, policy development, and sustainable forest management initiatives.

2. Methodology

2.1. Search Strategy. This systematic review followed a pre-defined and reproducible protocol guided by the PRISMA 2020 framework to ensure transparency and comprehensive evidence capture (Figure 1). A broad and inclusive search strategy was employed to identify all relevant peer-reviewed studies on MEAFs in Ethiopia. The review implemented an expanded search across Scopus, Web of Science (WoS), African Journals Online (AJOL), PubMed, and Google Scholar, thereby ensuring balanced coverage of both internationally indexed and regionally published literature. The search strategy applied structured Boolean queries combining ecosystem descriptors (“Moist Evergreen Afromontane Forest,” “Afromontane rainforest”), geographic identifiers (“Ethiopia”), and thematic terms (“floristic diversity,” “forest structure,” “woody species,” “endemic plants,” “conservation status,” “regeneration status”). The unified search string (“Moist Evergreen Afromontane

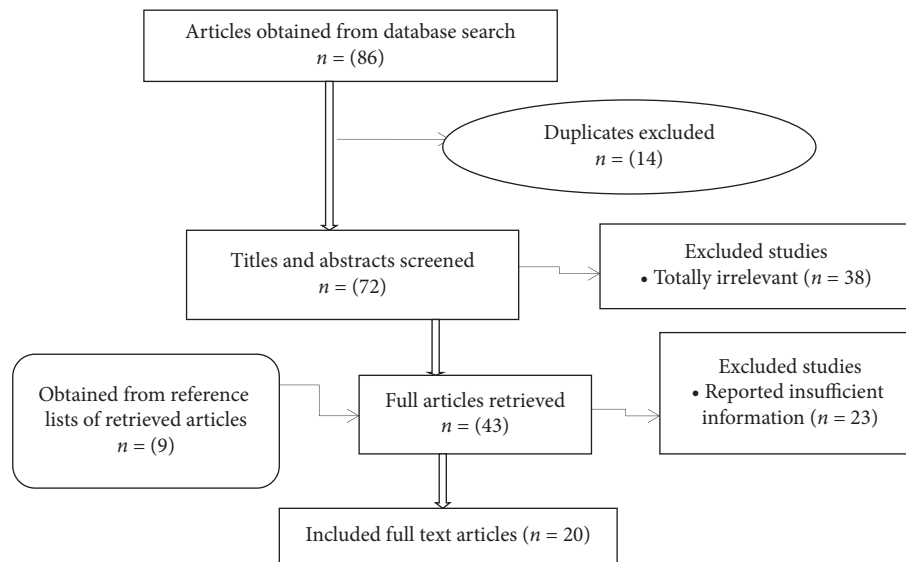


FIGURE 1: Flow diagram of study selection (source: Kahale et al. [30]). Tailored PRISMA 2020 flow chart for systematic reviews.

Forest” OR “Afromontane rainforest”) AND (Ethiopia) AND (“floristic diversity” OR “forest structure” OR “woody species” OR “endemic plants” OR “conservation status” OR “regeneration status”) was applied consistently across all databases. To ensure that the review reflects the most current knowledge base, the publication window was extended to include all studies available up to 2024. Additional articles were identified through manual screening of reference lists, and ResearchGate was consulted solely for accessing full-text versions of already-identified studies.

2.2. Study Selection and Eligibility Criteria. All retrieved records were imported into EndNote for systematic deduplication and screening in accordance with the PRISMA 2020 process (Figure 1). The search identified 86 studies, of which 14 duplicates were removed, leaving 72 unique records for preliminary evaluation. Title and abstract screening excluded 38 studies due to irrelevance to MEAF ecology. Manual reference screening contributed an additional 9 studies, resulting in 43 full-text articles assessed for eligibility. Of these, 23 studies were excluded for lacking sufficient methodological detail, quantitative vegetation data, or clear classification of forest type. Ultimately, 20 studies representing 26 forest patches met inclusion criteria and were incorporated into the final synthesis.

Studies were eligible for inclusion if they were (i) peer-reviewed primary research articles; (ii) conducted within recognized MEAF patches in Ethiopia; and (iii) provided adequate methodological detail to enable the extraction and standardization of ecological metrics. To facilitate comparability across differing methodologies, all stem density and richness values were standardized to a per-hectare basis. Non-peer-reviewed works such as theses, dissertations, and technical reports were excluded to ensure consistency in scientific rigor.

2.3. Data Extraction and Synthesis. Data extraction was performed using a standardized form developed in Microsoft Excel to ensure consistency and reliability. Extracted variables included forest patch name, species richness (S), Shannon–Wiener diversity index (H'), evenness (J), growth forms, basal area, stem density standardized to individuals ha^{-1} , importance value index (IVI), regeneration status categories, and reported ecological pressures. When multiple studies reported results from the same forest patch, the most recent or methodologically comprehensive study was prioritized to avoid duplication. For studies using differing DBH classes, DBH distributions were harmonized by converting values into standardized class intervals (2–10, 10–20, 20–30 cm, etc.). The synthesis followed a structured narrative approach, integrating quantitative summaries with thematic qualitative interpretations, enabling systematic comparison of floristic attributes, structural parameters, regeneration patterns, and conservation indicators across all included studies.

2.4. Taxonomic Verification and Conservation Assessment. Consistent with the original methodology, all scientific names were verified and updated using the World Flora Online (WFO) database [31]. Species endemism and conservation status were cross-referenced with Vivero et al. [32], Awais [29], the IUCN Red List online database, and Ayalew et al. [33] ensuring taxonomic accuracy and continuity with the original approach.

2.5. Data Presentation. The results are presented through tables, figures, and narrative explanations to illustrate species diversity patterns, structural attributes, regeneration dynamics, and conservation indicators across MEAF patches. This integrated presentation style enhances clarity, facilitates comparison across studies, and provides

a comprehensive overview of MEAF ecological characteristics at the national scale.

3. Result and Discussion

3.1. Geographic Distribution and Key Characteristics of MEAF in Ethiopia. The classification of Ethiopia's vegetation has undergone progressive refinement across generations of research, moving from simple altitudinal frameworks to integrated bioclimatic systems. Initial efforts by Pichi-Sermolli [20] established 24 vegetation types using elevation as the sole determinant, while subsequent work by Mengist [21] condensed the number to 13 types while retaining the altitude-focused approach. The most significant conceptual advancement came with Demissew et al. [23] and Ib Friis et al. [22], who introduced climate variables to develop more ecologically robust classifications of 8 and 12 types, respectively (Figure 2). This methodological progression yields three critical advancements for MEAF conservation: (1) the identification of climate-vulnerable ecotones; (2) the delineation of critical transition zones between forest types; and (3) the optimized spatial prioritization of conservation efforts. Notably, our synthesis reveals two pressing knowledge gaps: The lack of standardized protocols for incorporating modern remote sensing data into these classification systems and insufficient understanding of how anthropogenic disturbances interact with climatic shifts at vegetation boundaries. We recommend prioritizing longitudinal studies that track boundary shifts using Ib Friis et al. [22] framework as a baseline, while emphasizing the need to integrate traditional ecological knowledge with these scientific classification systems.

Ethiopia's MEAFs represent ecologically vital systems that occur along the southwestern escarpments at elevations of 1500–2600 m a.s.l. [23], with three core distribution areas: the southern Bale Mountains [35], northern Borana (Sidama Region), and western highlands (Wollega, Illubabor, and Kefa). These forests are distinguished by their perpetual moisture retention and specialized montane adaptations within Ethiopia's diverse topography [23], while their global conservation priority status reflects both exceptional endemic biodiversity and escalating anthropogenic threats [16, 36, 37].

The climatic and edaphic conditions of MEAF create ideal environments for their remarkable biodiversity. These ecosystems thrive under stable annual temperatures (18°C–20°C) and abundant rainfall (1500–2000 mm) [16, 26, 38], with a distinct wet season from April to October that ensures consistent moisture availability. This unique climatic regime, coupled with moderate temperatures, fosters the development of exceptionally diverse floral communities.

In terms of soil composition, MEAF predominantly develop on acidic Dystric Nitisols (pH < 6), though Acrisols, Regosols, Vertisols, Fluvisols, and Cambisols also occur sporadically across the landscape. A key limiting factor is the soils' pronounced phosphorus deficiency [39, 40], which significantly influences forest productivity and species composition. These edaphic characteristics must be central

to any effective conservation or restoration strategy for these ecosystems.

The structural complexity of Ethiopia's MEAF creates a unique vertical zonation (Figure 3) [15], with four clearly differentiated strata supporting distinct ecological niches. The uppermost layer (30–40 m) forms a closed canopy of broad-leaved evergreens, followed successively by a sub-canopy of smaller trees, a dense shrub understory, and a diverse ground layer. This multilayered architecture harbors numerous commercially valuable timber species, particularly in the emergent and upper strata, where *Pouteria adolfi-friedericii* subsp. *usambarensis*, *Afrocarpus gracilior*, and *Celtis africana* dominate the forest profile [41]. Other ecologically significant canopy species include *Astropanax abyssinicum*, *Mimusops kummel*, and *Millettia ferruginea*, along with *Croton macrostachyus*, *Albizia gummifera*, and various *Ficus* species [41].

The understory of these forests comprises three distinct ecological compartments, each hosting specialized flora. The shrub and small-tree layer supports a biodiverse assemblage including medicinal species like *Maesa lanceolata* and *Bersama abyssinica*, along with ecologically important taxa such as *Ehretia cymosa* and *C. arabica* [15, 41]. Vertical connectivity is maintained through numerous liana species, particularly *Jasminum streptopus* and *Landolphia buchananii*, which form crucial links between forest strata [41]. At ground level, the herbaceous community is dominated by Acanthaceae representatives (*Thunbergia alata*, *Justicia ladanoides*) and the grass *Oplismenus hirtellus*, while the forest floor and tree surfaces host diverse ferns (*Adiantum poiretii*, *Asplenium* spp.) and epiphytes, including orchids [41].

3.2. Uses and Values of MEAF in Ethiopia. Ethiopia's MEAFs deliver essential economic and ecological services that support both local livelihoods and national development. These forests provide not only commercial timber for wood industries (sawlogs, plywood, and paper production), with historical records showing 57,987 m³ extracted from Gera (1982–1993), 6273 m³ from Belete, and 7701 m³ from Bonga forests [42], but also diverse nontimber products, including medicinal plants, wild foods, and honey that sustain rural communities [43], as well as vital ecosystem services by maintaining soil fertility for adjacent coffee/tea plantations and providing construction materials [42]. Notably, Harenn Forest alone yielded more than 30,000 m³ of timber between 1982 and 2000 [43], demonstrating the significant historical pressure on these resources.

These forest ecosystems play a critical global role in climate regulation through their remarkable carbon sequestration capacity, currently estimated at 27,579 Gg CO₂ annually [44]. This makes Ethiopia a net carbon sink with just 2596 Gg in net emissions [45], highlighting their importance for both local and global sustainability. Moving forward, developing sustainable harvest protocols and payment-for-ecosystem-services schemes could help balance economic needs with conservation priorities, while further research should examine climate change impacts on

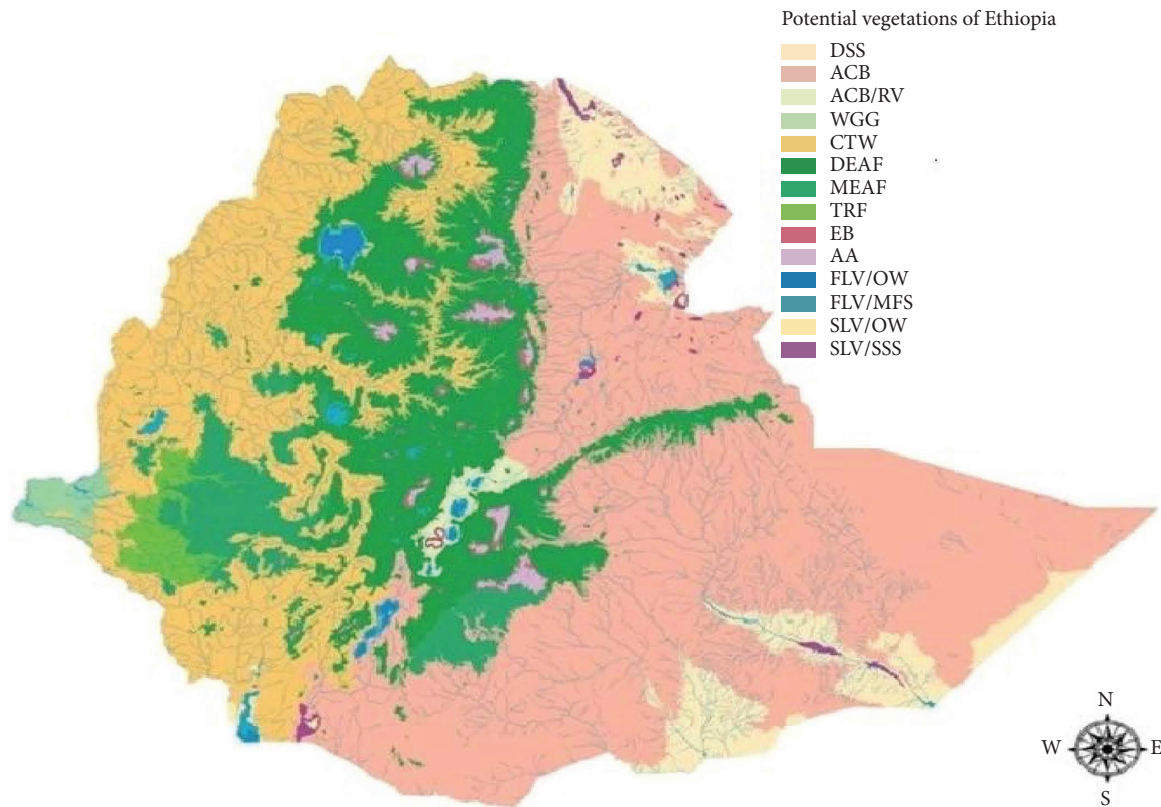


FIGURE 2: Vegetation types of Ethiopia (sources: Ib Friis et al. [22]). Atlas of the potential vegetation of Ethiopia (p. 307); Masresha and Melkamu [34]. The status of dry evergreen Afromontane forest patches in Amhara National Regional State, Ethiopia. International Journal of Forestry Research, 2022 (1), 8071761. DSS = desert and semi-desert scrubland, ACB = Acacia–Comiphora woodland and bushland, ACB/RV = Acacia wooded grassland of the Rift Valley, WGG = wooded grassland of the Western Gambela Region, CTW = Combretum–Terminalia woodland and wooded grassland, DEAF = dry evergreen Afromontane forest and grassland complex, MEAF = moist evergreen Afromontane forest, TRF = transitional rain forest, EB = ericaceous belt, AA = Afroalpine belt, FLV/OW = freshwater lakes open water vegetation, FLV/MFS = freshwater marshes and swamps, floodplain lakeshore vegetation, SLV/OW = salt lake open water vegetation, SLV/SSS = salt pans, saline/brackish intermittent wetlands, and salt-lake shore vegetation.

sequestration rates and establish science-based thresholds for resource extraction to ensure long-term forest health.

3.3. Plant Species Composition and Diversity in MEAF Forests.

Ethiopia's MEAF represents a biodiversity hotspot of global significance, hosting 951 vascular plant species across 567 genera and 131 families. Supporting this pattern, Senbeta [15] documented 651 species (486 genera, 118 families) in five MEAF sites, with individual forests having between 146 and 374 species. This extraordinary floristic richness emerges from the interaction of diverse edaphic conditions (including Nitosols, Acrisols, Regosols, Vertisols, Fluvisols, and Cambisols) with stable, high-rainfall climates [38, 39]. These findings carry critical implications, as MEAF's biodiversity not only serves as a vital genetic reservoir but also provides key ecosystem services, while simultaneously highlighting three urgent needs: (1) establishing long-term species monitoring; (2) investigating soil–plant–microbe interactions; and (3) developing soil-specific conservation strategies, particularly for understudied Cambisols and Fluvisol areas.

Plant family composition analysis of MEAF reveals distinct taxonomic patterns, with Asteraceae emerging as the most diverse family (78 species), followed by Fabaceae (55), Orchidaceae (50), and Poaceae (49) (Table 1). This distribution closely corresponds with national-scale floristic patterns documented in the Flora of Ethiopia and Eritrea, where Asteraceae and Fabaceae consistently rank among the most species-rich families after Poaceae [9, 11]. The ecological predominance of these families appears driven by two key evolutionary advantages: Their possession of highly efficient dispersal mechanisms that promote successful colonization of new habitats and exceptional phenotypic plasticity that enables adaptation to varied environmental conditions, as observed in global and regional floristic studies [46–48]. Particularly noteworthy is Fabaceae's symbiotic nitrogen-fixation capacity, which may confer additional competitive benefits in these forest ecosystems. The prevalence of these plant families carries important ecological and conservation implications. First, their widespread distribution suggests potential utility as bio-indicators for forest health assessments. Second, Fabaceae

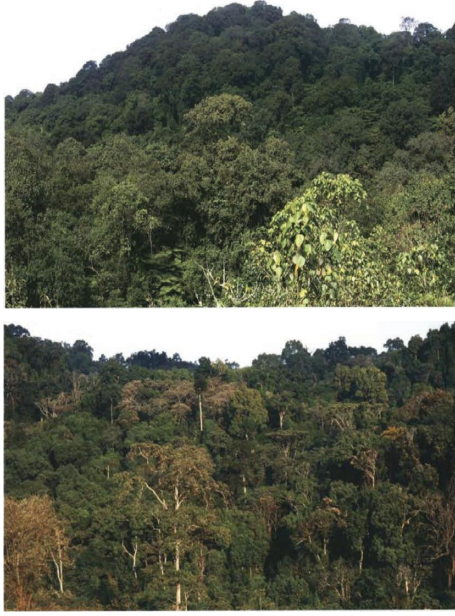


FIGURE 3: Closed stratum of Moist Evergreen Afromontane Forest of Ethiopia (source: Ib Friis et al. [22]). Atlas of the potential vegetation of Ethiopia (p. 307).

TABLE 1: Leading 10 families by species richness in MEAF of Ethiopia.

No.	Family	No. of species	Percent
1	Asteraceae	78	8.2
2	Fabaceae	55	5.8
3	Orchidaceae	50	5.3
4	Poaceae	49	5.2
5	Euphorbiaceae	39	4.1
6	Rubiaceae	38	4
7	Lamiaceae	35	3.7
8	Acanthaceae	29	3
9	Malvaceae	23	2.4
10	Asclepiadaceae	21	2.2
Total of leading 10 families		417	43.9
Other families total		534	56.1

Note: Bold values indicate the totals for the ten leading families and the remaining families.

species could play crucial roles in soil enrichment during restoration efforts. Third, the adaptive flexibility of these dominant families may enhance ecosystem resilience to environmental changes. However, critical knowledge gaps remain regarding how climate change might affect their dispersal dynamics and competitive interactions, warranting targeted investigation of these processes in MEAF ecosystems.

Our assessment of floristic diversity across 26 MEAF patches revealed striking differences in species richness, ranging from 47 taxa in both Bore–Anferara–Wadera and Wabero forests to 354 species in Berhan–Kontire forest (Table 2). This sevenfold variation across sites emerges from multiple interacting factors: habitat heterogeneity creates diverse microhabitats, differential disturbance histories alter community composition, and patch size and landscape connectivity affect

colonization opportunities, while successional stages and regeneration capacity influence species establishment [39, 69]. These patterns carry important conservation implications, as they demonstrate how both natural environmental gradients and human impacts collectively shape MEAF biodiversity. Priority research should now focus on quantifying threshold patch sizes for maintaining diverse communities, documenting how specific disturbance types affect species loss, and developing connectivity models to guide forest corridor restoration, particularly for species-poor sites like Bore–Anferara–Wadera that may require targeted interventions.

Assessing vegetation composition requires multidimensional analysis of biodiversity patterns, particularly through the lens of species diversity and evenness [70]. Typically ranging between 1.5 and 3.5 in natural communities (with values rarely surpassing 4.5), this index categorizes sites as high (> 3), medium (2–3), or low (< 2) diversity based on their ecological complexity [71]. Our analysis of MEAF patches reveals striking spatial variation in these metrics (Table 2), with Gebra Dima ($H' = 4.18$), Agama (4.04), and Wondo Genet (3.85) representing exceptional biodiversity hotspots. These high-performing sites contrast sharply with Maji forest (1.54), where combined anthropogenic and environmental pressures appear to have significantly diminished diversity [72].

Three critical implications emerge from these findings: First, the robust diversity observed in most MEAF patches ($H' > 3$) suggests strong ecosystem resilience and adaptive capacity [70, 71], though the exceptional values at Gebra Dima indicate unique conservation priority. Second, medium-diversity forests like Berhan–Kontire may represent transitional systems requiring monitoring. Third, severely impacted sites like Maji demand targeted restoration to rebuild ecological functionality. These patterns collectively underscore (1) the need for diversity thresholds in conservation planning; (2) the importance of understanding disturbance impacts on community structure. Future research should prioritize mechanistic studies linking specific management practices to diversity outcomes, particularly in low-performing forests where intervention could yield significant ecological benefits; and (3) the value of evenness metrics as early warning indicators of ecosystem stress [73].

3.4. Endemism and Their Conservation Status. Plant endemism patterns in Ethiopia’s MEAF reveal important biogeographical and conservation insights, with 72 endemic species documented across 32 families and 61 genera (Table A1). Asteraceae emerges as the most significant contributor, accounting for 30.6% (22 species) of recorded endemics, followed distantly by Fabaceae (6.9%) and Euphorbiaceae (5.6%) (Table 3). This taxonomic distribution aligns with national-scale patterns where Asteraceae and Fabaceae consistently show high endemic richness [9, 73]. The ecological drivers behind this concentration appear multifaceted: MEAF’s relatively stable microclimates, combined with topographic isolation in mountainous areas, create ideal conditions for speciation and species persistence compared to drier forest types [9].

Our threat assessment identifies urgent conservation priorities (Figure 4): Two critically endangered (CR) species (*Acalypha marissima*, *Ceropegia sobolifera*), four endangered

TABLE 2: Species richness (S), Shannon–Weiner species diversity index (H'), Shannon–Weiner evenness (J), density (D), and basal area (BA) of forest patches of MAF in Ethiopia.

Forest patches	S	H'	J	D Stem (ha)	BA (m ² /ha)	Some dominant species listed in descending order	References
Chato	154	3.64	0.55	1568	65	<i>Afrocarpus falcatus</i> , <i>Pouteria adolfi-friederici</i> , <i>Mimusops kummel</i> , <i>Celtis africana</i> , <i>Ochna holstii</i>	[49]
Hareenna	287	2.6	0.51	18183	49	<i>Coffea arabica</i> , <i>Afrocarpus falcatus</i> , <i>Landolphia buchananii</i> , <i>Celtis africana</i> , <i>Jasminum abyssinicum</i>	
Maji	136	1.54	0.31	18183	53	<i>Coffea arabica</i> , <i>Trilepisium madagascariense</i> , <i>Celtis africana</i> , <i>Dracaena fragrans</i> , <i>Manilkara butugi</i>	
Yayu	205	2.8	0.63	69130	46	<i>Dracaena fragrans</i> , <i>Coffea arabica</i> , <i>Landolphia buchananii</i> , <i>Diospyros abyssinica</i> , <i>Albizia grandibracteata</i>	[15]
Bonga	285	3.17	0.67	19232	47	<i>Astropanax abyssinicum</i> , <i>Olea welwitschii</i> , <i>Coffea arabica</i> , <i>Syzygium guineense</i> , <i>Justicia schimperiana</i>	
Berhan–Kontir	354	2.83	0.54	18981	54	<i>Agromuellera macrophylla</i> , <i>Coffea arabica</i> , <i>Diospyros abyssinica</i> , <i>Whitfieldia elongata</i> , <i>Rothmannia urecliformis</i>	
Jibat	183	—	—	720.3	60.9	<i>Oldeania alpina</i> , <i>Bersama abyssinica</i> , <i>Ilex mitis</i> , <i>Myrsine melanophloeos</i> , <i>Brucea antidysenterica</i>	[50]
Belete	157	—	—	760.95	103.5	—	[51]
Gonbeso	62	3.65	0.88	5798	59.85	<i>Allophylus abyssinicus</i> , <i>Schefflera abyssinica</i> <i>Millettia ferruginea</i> , <i>Syzygium guineense</i> , <i>Dombeya torrida</i>	[52]
Berbere	61	—	—	355.2	87.49	<i>Warburgia ugandensis</i> , <i>Diospyros abyssinica</i> , <i>Afrocarpus falcatus</i> , <i>Combretum molle</i> , <i>Filicium decipiens</i> , <i>Ficus vasta</i>	[53]
Gebra–Dima	180	4.18	0.86	—	—	—	[54]
Wabero	47	—	—	21737	88.89	<i>Diospyros mespiliformis</i> , <i>Strychnos mitis</i> , <i>Podocarpus falcatus</i> , <i>Celtis africana</i> , <i>Coffea arabica</i>	[55]
Gendo	168	3.77	0.86	—	55.25	<i>Croton macrostachyus</i> , <i>Justicia schimperiana</i> , <i>Solanecio gigas</i> , <i>Albizia gummifera</i> , <i>Clausena anisata</i>	[56]
Gesha–Sayilem	300	3.56	0.85	—	—	—	[57]
Aba–Sena	69	3.76	0.62	819	51.68	<i>Ficus fur</i> , <i>Pouteria adolfi-friederici</i> , <i>Terminalia macroptera</i> , <i>Combretum molle</i> , <i>Ochna holstii</i>	[58]
Agama	162	4.04	0.88	6752	80.8	<i>Olea welwitschii</i> , <i>Elaeodendron buchananii</i> , <i>Olea capensis</i> , <i>Syzygium guineense</i> , <i>Schefflera abyssinica</i> , <i>Vepris dainellii</i>	[59]
Gera	132	3.50	0.84	1778	—	—	[60]
Gerged–Anflo	134	3.46	0.81	886.09	40.94	<i>Porcella abyssinica</i> var. <i>abyssinica</i> , <i>Pouteria adolfi-friederici</i>	[61]
Kenech	108	3.12	0.84	—	—	—	[62]
Komba–Daga	125	3.14	0.81	478.23	59.67	<i>Olea welwitschii</i> , <i>Vepris dainellii</i> , <i>Syzygium guineense</i> , <i>Chionanthus mildbraedii</i> , <i>Millettia ferruginea</i>	[63]
Komto	180	3.66	0.85	—	—	—	[64]
Mana–Angetu	211	—	—	841	94	<i>Vepris dainellii</i> , <i>Pouteria adolfi-friederici</i> , <i>Olea welwitschii</i> , <i>Syzygium guineense</i> , <i>Croton macrostachyus</i>	[65]

TABLE 2: Continued.

Forest patches	S	H'	J	D Stem (ha)	BA (m ² /ha)	Some dominant species listed in descending order	References
Masha	130	3.45	0.88	1681	142.6	<i>Pouteria adolfi-friedericii</i> , <i>Olea capensis</i> subsp. <i>macrocarpa</i> , <i>Astropanax abyssinicum</i> , <i>Dracaena afromontana</i> , <i>Oldeania alpina</i>	[66]
Sirso	74	3.47	0.81	—	—	—	[13]
Bore–Anferara–Wadera	47	3.84	0.78	1047	75.23	<i>Syzygium afromontanum</i> , <i>Pouteria adolfi-friedericii</i> , <i>Olea capensis</i> subsp. <i>macrocarpa</i> , <i>Macaranga capensis</i>	[67]
Wondo Genet	136	3.85	0.89	—	—	—	[68]

Note: A dash (—) indicates that the specific metric was not reported or calculable from the data provided in the original primary study.

TABLE 3: Thirteen plant families having ≥ 2 endemism.

Family	Number of species	Percent
Asteraceae	22	30.6
Fabaceae	5	6.9
Euphorbiaceae	4	5.6
Acanthaceae	3	4.2
Lamiaceae	3	4.2
Apiaceae	2	2.8
Araceae	2	2.8
Celastraceae	2	2.8
Orchidaceae	2	2.8
Phyllanthaceae	2	2.8
Poaceae	2	2.8
Ranunculaceae	2	2.8
Rubiaceae	2	2.8
Total	53	73.9
Other families	19	26.1

Note: Bold values indicate the total number of endemic species for thirteen plant families with two or more endemic species, as well as the total for the remaining endemic families.

(EN) taxa (*Polygala mooneyi*, *Rinorea friisii*, *Gymnosporia gracilipes*, *Wendlandia arabica*), and six vulnerable (VU) species (*Cirsium dender*, *C. arabica*, *Echinops kebericho*, *Phyllanthus limmuensis*, *Polyscias farinosa*, *Searsia glutinosa*) require immediate protection. While 24 species are currently of least concern (LC) and 31 remain unevaluated (NE), the presence of 5 near-threatened (NT) species suggests emerging risks. Three key management implications emerge: First, the CR and EN species demand habitat-specific protection plans. Second, the high proportion of unevaluated taxa (31 species) calls for accelerated Red List assessments. Third, the concentration of threatened endemics in MEAF compared to drier forests underscores their global conservation value. Critical research needs include population viability studies for CR species, monitoring protocols for NT taxa, and ecological niche modeling to predict climate change impacts on these range-restricted species.

Growth form distribution among Ethiopia's MEAF endemics reveals distinct ecological patterns, with herbs (36 species) and shrubs (18) dominating the endemic flora, while trees (5), tree-shrub intermediates (6), climbers (5), and herbaceous epiphytes (2) show more limited representation (Figure 5). This structural composition reflects the adaptive strategies of endemic species to montane forest conditions, where herbaceous forms likely benefit from consistent moisture availability in the understory. The prevalence of shrubs and herbs aligns with their greater evolutionary flexibility to occupy specialized niches in these topographically complex landscapes [69]. Three significant ecological implications emerge from this growth form distribution: First, the herb-dominated endemic community suggests particular vulnerability to ground-level disturbances like trampling or leaf litter removal. Second, the scarcity of endemic trees (5 species) indicates potential limitations in canopy-level speciation. Third, the minimal epiphyte representation (2 species) may reflect microclimatic constraints on aerial niche colonization. These patterns highlight the

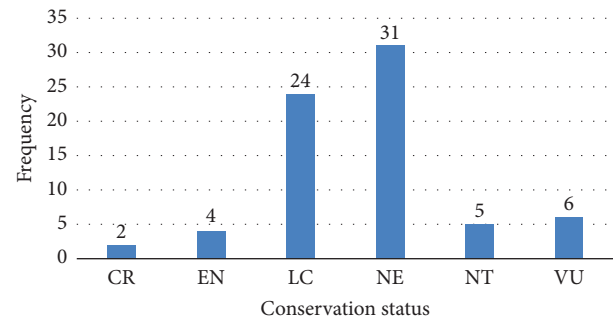


FIGURE 4: Conservation status based on IUCN category (vulnerable = VU, near threatened = NT, least concern = LC, and not evaluated = NE).

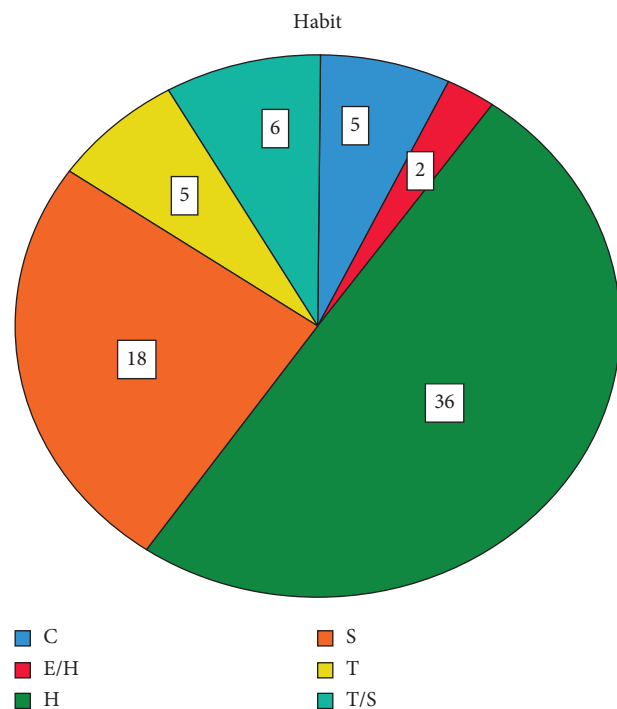


FIGURE 5: Growth habit of endemic species in MAF of Ethiopia (C = climber, E/H = epiphytic herb, H = herb, S = shrub, T = tree, and T/S = tree/shrub).

need for growth-form-specific conservation strategies, particularly for the ecologically restricted herbaceous epiphytes and the disproportionately scarce tree endemics.

3.5. Structural Dynamics of MEAF

3.5.1. Frequency Pattern and Its Ecological Implication. Frequency distribution analyses across MEAF patches reveal important spatial patterns in species occurrence, providing insights into vegetation homogeneity. Our assessment demonstrates that most forests, including Aba-Sena [58], Jibat [50], Agama [59], Chato [49], and Gonbeso [52], exhibit a strong predominance of species in lower frequency classes, with progressively fewer species appearing in higher

frequency classes. This pattern is particularly pronounced in five additional forests (Hareenna, Maji, Yayu, Bonga, and Berhane-Kontire), where rare species significantly outnumber common ones [15]. These frequency distributions carry three key ecological implications: First, the prevalence of low-frequency species indicates high floristic heterogeneity across sampling plots [74], suggesting complex environmental gradients or niche partitioning. Second, the scarcity of high-frequency species implies limited dominance by generalist taxa, a characteristic of relatively undisturbed ecosystems. Third, the consistency of these patterns across multiple forests points to fundamental structural similarities in MEAF vegetation organization. These findings highlight the need for expanded sampling in understudied forests to better understand frequency pattern investigations into the ecological traits differentiating rare and common species and the development of heterogeneity-based management strategies that account for the spatial variability of these diverse plant communities [73, 75, 76].

3.5.2. Stand Density (D). Forest structural analysis in Ethiopia's MEAF relies on complementary metrics of stem density (individuals/ha) and basal area (m^2/ha), which together characterize stand development and ecological function. These measurements reveal fundamental patterns of plant abundance, spatial distribution, and biomass allocation across forest patches [77]. Our data demonstrate striking structural variation (Table 2), with Yayu forest exhibiting the highest stem density [38], followed by Wabero [55] and Bonga, while Berbere shows notably sparse stands [53].

A critical finding of this synthesis is the enormous range in reported stem density, which spans two orders of magnitude from 355 stems/ha (Berbere) to 69,130 stems/ha (Yayu). This extreme variation is ecologically significant and is primarily attributable to methodological inconsistencies across the primary studies, particularly the lack of a standardized minimum DBH threshold for inclusion. Studies that enumerated all woody individuals, including seedlings and saplings down to 1 or 2 cm DBH, inevitably reported far greater densities than those that restricted counts to larger trees (e.g., > 10 cm DBH). This finding highlights a fundamental challenge in comparative forest ecology and underscores the imperative for adopting standardized DBH protocols in future research to enable robust, cross-site comparisons.

Such differences reflect underlying ecological gradients; high-density patches typically represent late-successional forests with closed canopies and optimal edaphic conditions, whereas low-density areas may indicate either early regeneration stages or environmentally constrained habitats [78]. Priority research directions should address (1) density-dependent mortality processes in high-density stands; (2) minimum area requirements for maintaining structural complexity; and (3) soil-vegetation feedbacks that influence stand development trajectories. Particular attention should focus on understanding why certain forests, like Berbere, maintain persistently low densities despite favorable climatic conditions.

3.5.3. DBH Distribution. Analysis of diameter-class distributions across Ethiopia's MEAF reveals consistent demographic patterns with important conservation implications. Our evaluation of 26 forest patches, including Belete [51], Jibat [50], Chato [49], and five other forest patches (Harrenna, Berhan-Kontire, Yayu, Maji, and Bonga) [15], demonstrates a predominant inverted J-shaped curve in stand structure. This recurring pattern characterized by abundant saplings (lower DBH classes) declining exponentially toward mature trees reflects two key ecological processes: successful natural regeneration supporting future canopy replacement and disproportionate removal of larger specimens, likely through selective timber harvesting [79–81]. While this structure suggests healthy reproductive potential, the marked scarcity of trees > 30 cm DBH in forests like Gerba Dima [54] and Gera [60] revealed potential recruitment limitations that could alter future species composition.

Three critical management considerations emerged from these findings: First, the widespread inverted J-distribution confirms MEAF's inherent capacity for self-renewal under current conditions. Second, the consistent deficit of large-diameter trees across multiple sites suggests historical logging has significantly modified stand structure. Third, the pattern's prevalence establishes it as a baseline for evaluating forest recovery. These insights highlight the urgent need for (1) diameter-limit harvesting guidelines to protect reproductive-sized trees; (2) long-term monitoring of recruitment trajectories in high-value species; and (3) targeted enrichment planting in forests showing extreme size-class imbalances. Future research should particularly investigate how current regeneration patterns may affect future timber yields and carbon storage potential in these ecologically and economically vital forests.

3.5.4. Forest Vertical Structure (Height) and Demographic Patterns. The vertical stratification of Ethiopia's MEAF exhibits consistent demographic trends across the 26 studied patches, mirroring the inverse J-pattern observed in diameter distributions. These parallel structural patterns in both height and DBH classes reflect fundamental ecological processes shaping stand development. The abundance of young regeneration in lower strata, coupled with progressively fewer individuals in taller height classes, demonstrates continuous population renewal through natural recruitment cycles [39]. This structural configuration emerged from three interacting mechanisms: successful establishment of shade-tolerant regeneration beneath the canopy, competitive thinning that eliminates less vigorous stems during stand development, and balanced transition rates between size classes in these multi-aged systems.

3.5.5. Basal Area Dynamics and Ecological Significance. Basal area measurements across Ethiopia's MEAF reveal critical insights into stand productivity and developmental stages, with values ranging from 23 to $142.6 \text{ m}^2/\text{ha}$ (Table 2). Masha forest emerged as the most structurally developed site ($142.6 \text{ m}^2/\text{ha}$), followed by Belete ($103.5 \text{ m}^2/\text{ha}$) and Mana

TABLE 4: Conservation status assessment of MAF patches with key indicators and threats (S = species, BA = basal area).

Status category	Representative patches	Structural indicators	Primary threats	Regeneration status
Critically Degraded	Berbere, Gonbeso, Aba-Sena	$S < 70$, $D < 6000$ stems/ha, BA variable (51–88 m ² /ha), pioneer-dominated species	Agricultural expansion, overharvesting, fragmentation	Poor (seedling: sapling ratio < 0.5)
	Kenech, Sirso	$S < 110$, D data missing, low evenness ($J = 0.62-0.84$)	Habitat conversion, edge effects	Poor to fair
Moderately Disturbed	Jibat, Belete, Komba-Daga	$70 < S < 185$, $500 < D < 2000$ stems/ha, intermediate BA (60–104 m ² /ha)	Selective logging, moderate grazing	Fair (partial J-curve)
	Gera, Gergedā-Anflo	$S = 132-134$, $D = 886-1778$ stems/ha, mixed species composition	Localized timber extraction	Fair
	Mana-Angetu, Masha	$S = 130-211$, $D = 841-1681$ stems/ha, BA = 94–143 m ² /ha	Nontimber forest product harvesting	Fair to good
Relatively Intact	Bonga, Yayu, Agama	$S > 150$, $D > 6000$ stems/ha, BA > 45 m ² /ha, late-successional species dominated	Minimal current threats	Good (complete J-curve)
	Harennā, Berhan-Kontir	$S > 280$, $D > 18000$ stems/ha, high species richness	Limited anthropogenic pressure	Good
	Chato, Wabero	$S = 47-154$, $D = 1568-21737$ stems/ha, variable BA (65–89 m ² /ha)	Localized disturbances	Good
	Gesha-Sayilem, Gendo	$S = 168-300$, high H' (3.56–3.77), even canopies ($J = 0.85-0.86$)	Minimal current threats	Good
	Maji, Gebra-Dima	$S = 136-180$, $D = 18183$ stems/ha (Maji), high BA	Isolated disturbance events	Good to fair
	Komto, Wondo Genet	$S = 136-180$, high evenness ($J = 0.85-0.89$)	Potential future encroachment	Good
	Bore-Anferara-Wadera	$S = 47$, high H' (3.84), BA = 75 m ² /ha	Edge effects from surrounding land use	Fair

Angetu (94 m²/ha) reflecting their mature stand conditions with dominant canopy trees. In contrast, Gergeda Anflo's notably lower basal area suggests recurring removal of large timber specimens, demonstrating how anthropogenic pressures can alter forest structure. These measurements correlate strongly with photosynthetic capacity and carbon storage potential, with the highest values exceeding typical African forest ranges (23–37 m²/ha) reported by [74], indicating exceptional biomass accumulation in these Afro-montane ecosystems.

3.5.6. Conservation Status and Natural Regeneration Potential of MEAF Patches. The conservation status assessment of MAF reveals significant variation in structural integrity and regeneration potential across the 26 studied patches (Table 4). Forests categorized as relatively intact, such as Bonga, Yayu, and Agama, exhibit high species richness ($S > 150$), stem density ($D > 6000$ stems/ha), and basal area ($BA > 45$ m²/ha), dominated by late-successional species like *Olea welwitschii* and *Syzygium guineense*. These patches display strong regeneration capacity, evidenced by the classic inverted J-shaped population distribution, where seedling density exceeds saplings and mature trees, a pattern also observed in protected church forests [82]. Their structural complexity suggests resilience to minor disturbances, though long-term climate impacts remain a concern [15, 59].

Moderately disturbed patches (e.g., Jibat, Komba–Daga, and Mana–Angetu) show intermediate metrics ($70 < S < 200$, $500 < D < 2000$ stems/ha) and mixed species composition, indicating partial recovery potential. However, selective logging and edge effects have disrupted regeneration, resulting in inconsistent seedling-to-sapling ratios. Similar findings in fragmented Afromontane forests highlight how even limited anthropogenic pressure can alter recruitment dynamics [82]. Notably, patches like Masha ($D = 1681$ stems/ha) retain high basal area (142.6 m²/ha), suggesting that biomass recovery may precede species diversity restoration in moderately disturbed systems [66].

Critically degraded patches, particularly Berbere ($S = 61$, $D = 355$ stems/ha) and Gonbeso, exhibit severely compromised regeneration, with low seedling survival and dominance of pioneer species (e.g., *Combretum molle*). These align with studies linking agricultural encroachment and overharvesting to collapsed recruitment in fragmented forests [53, 82]. The case of Aba–Sena ($S = 69$, $D = 819$ stems/ha) underscores a potential density threshold (~800 stems/ha) below which natural recovery becomes unlikely without intervention [58].

The findings underscored the need for differentiated conservation strategies, prioritizing strict protection for intact forests (e.g., Bonga), assisted regeneration for moderately disturbed patches (e.g., Jibat), and active restoration

for degraded areas (e.g., Berbere). Future research should focus on quantifying ecological thresholds for forest recovery, assessing species-specific regeneration barriers, and evaluating the effectiveness of restoration techniques under climate change scenarios. Long-term monitoring programs and community-based adaptive management approaches are essential to balance biodiversity conservation with livelihood needs while addressing emerging environmental threats.

4. Conclusions and Recommendations

The MEAFs of Ethiopia are among the most ecologically significant and biodiverse ecosystems in the country, serving as crucial conservation sites and repositories of plant genetic resources, including many endemic and threatened species recognized by the IUCN. This review synthesizes existing studies into a tripartite conservation gradient, classifying forest patches as Relatively Intact (e.g., Bonga, Yayu, Agama), Moderately Disturbed (e.g., Jibat, Masha), or Critically Degraded (e.g., Berbere, Gonbeso), providing a clear framework for prioritizing conservation actions.

However, the review also revealed substantial research gaps, as several forest patches show missing values for key ecological parameters and inconsistencies in the reporting of structural and regeneration metrics. These limitations restrict full comparability among sites and highlight the need for standardized methodologies in future MEAF research.

Structural analyses indicate heterogeneity and a healthy, self-sustaining forest in many areas, as shown by inverted J-shaped DBH distributions and abundant younger individuals. Regeneration dynamics vary with disturbance: relatively intact forests maintain balanced age structures, whereas degraded patches exhibit skewed regeneration, compromising long-term viability. MEAF patches provide vital ecosystem services, including timber and nontimber forest products, agricultural resources, coffee and tea production, carbon sequestration, and raw materials for development.

To ensure long-term sustainability, a targeted, multi-tiered conservation network is recommended. Large, relatively intact forests should serve as core protected areas. Moderately disturbed patches should undergo assisted natural regeneration and sustainable management as secondary cores or buffers. Critically degraded patches require active restoration through enrichment planting, erosion control, and habitat rehabilitation. Establishing ecological corridors connecting cores and buffers is essential to facilitate genetic exchange, species migration, and ecosystem resilience under climate change.

This integrated approach combines scientific evidence with actionable strategies, enabling the effective conservation, restoration, and sustainable management of MEAFs in Ethiopia for current and future generations.

Appendix A

TABLE A1: List of endemic plants and their conservation status based on IUCN category.

No.	Species name	Family	Habit	Status
1	<i>Acalypha marissima</i> M.G. Gilbert	Euphorbiaceae	S	CR
2	<i>Acanthopaleethio-germanica</i> Ensermu	Acanthaceae	S	NE
3	<i>Aeollanthus abyssinicus</i> Hochst.ex Benth.	Lamiaceae	H	LC
4	<i>Afroligusticum mattirolii</i> (Chiov.) P.J.D. Winter	Apiaceae	H	NE
5	<i>Afroligusticum piovanii</i> (Chiov.) Kljuykov & Zakharova	Apiaceae	H	NE
6	<i>Amorphophallus gallaensis</i> (Engl.) N.E.Br.	Araceae	H	NE
7	<i>Arisaema mooneyanum</i> M.G. Gilbert & Mayo	Araceae	H	NE
8	<i>Astragalus atropilosulus</i> (Hochst.) Bunge	Fabaceae	H	NE
9	<i>Baccharoides filigera</i> (Oliv. & Hiern) Isawumi, El-Ghazaly & B. Nord.	Asteraceae	S	LC
10	<i>Barleria ensermii</i> I. Darbysh.	Zingiberaceae	H	NE
11	<i>Bidens ghedoensis</i> Mesfin	Asteraceae	H	LC
12	<i>Bidens pachyloma</i> (Oliv. & Hiern) Cufod.	Asteraceae	H	NE
13	<i>Bothriocline schimperi</i> Oliv. & Hiern ex Benth.	Asteraceae	H	LC
14	<i>Brillantaisia grottanellii</i> Pic.Serm.	Acanthaceae	H	NE
15	<i>Ceropegia sobolifera</i> N.E. Br.	Apocynaceae	C	CR
16	<i>Chiliocephalum schimperi</i> Benth.	Asteraceae	H	NE
17	<i>Cineraria abyssinica</i> Sch.Bip. ex A. Rich.	Asteraceae	H	NE
18	<i>Cirsium dender Friis</i>	Asteraceae	H	VU
19	<i>Cirsium englerianum</i> O. Hoffm.	Asteraceae	H	NE
20	<i>Cirsium schimperi</i> (Vatke) C. Jeffrey in Cufod.	Asteraceae	H	NE
21	<i>Clematis longicauda</i> Steud. ex A. Rich.	Ranunculaceae	C	LC
22	<i>Clinopodium paradoxum</i> (Vatke) Ryding	Lamiaceae	H	NT
23	<i>Coffea arabica</i> L.	Rubiaceae	S	VU
24	<i>Conyza abyssinica</i> Sch.Bip. ex A. Rich.	Asteraceae	H	NE
25	<i>Crassocephalum macropappus</i> S. Moore	Asteraceae	H	NE
26	<i>Crotalaria rosenii</i> (Pax) Milne-Redh. ex Polhill	Fabaceae	H	NE
27	<i>Dalbergia lactea</i> Vatke	Fabaceae	T/S	NE
28	<i>Dombeya longebracteolata</i> Seyani	Malvaceae	T/S	NT
29	<i>Dorstenia soerensenii</i> Friis	Moraceae	H	NE
30	<i>Echinops kebericho</i> Mesfin	Asteraceae	H	VU
31	<i>Echinops longisetus</i> A. Rich.	Asteraceae	H	LC
32	<i>Erythrina brucei</i> Schweinf.	Fabaceae	T	LC
33	<i>Euphorbia dumalis</i> S. Carter	Euphorbiaceae	S	NE
34	<i>Euphorbia omariana</i> M.G. Gilbert	Euphorbiaceae	H	NE
35	<i>Flacourtia indica</i> (Burm.f.) Merr.	Salicaceae	T/S	NE
36	<i>Guizotia arborescens</i> Friis	Asteraceae	S	NE
37	<i>Gymnanthemum rueppellii</i> (Sch.Bip. ex Walp.) H. Rob.	Asteraceae	S	LC
38	<i>Gymnosporia addat</i> Loes.	Celastraceae	T	NT
39	<i>Gymnosporia gracilipes</i> (Welw. ex Oliv.) Loes.	Celastraceae	S	EN
40	<i>Hyparrhenia arrhenobasis</i> (Hochst. ex Steud.) Stapf	Poaceae	H	LC
41	<i>Impatiens rothii</i> Hook.f.	Balsaminaceae	H	LC
42	<i>Justicia bizuneshiae</i> Ensermu	Acanthaceae	H	NE
43	<i>Kalanchoe petitiiana</i> A. Rich	Crassulaceae	H	LC
44	<i>Laggera tomentosa</i> (A.Rich.) Sch.Bip. ex Oliv. & Hiern	Asteraceae	H	NT
45	<i>Liparis abyssinica</i> A. Rich.	Orchidaceae	E/H	NE
46	<i>Lippia abyssinica</i> (Otto & A. Dietr.) Cufod.	Verbenaceae	S	LC
47	<i>Mikaniopsis clematoides</i> (Sch.Bip. ex A. Rich.) Milne-Redh.	Asteraceae	C	LC
48	<i>Milletia ferruginea</i> (Hochst.) Hochst. ex-Baker	Fabaceae	T	LC
49	<i>Panicum ruspolii</i> Chiov.	Poaceae	H	NE
50	<i>Phragmanthera macrosolen</i> (Steud. ex A. Rich.) M.G. Gilbert	Loranthaceae	S	LC
51	<i>Phyllanthus dewildeorum</i> M.G. Gilbert	Phyllanthaceae	S	NT
52	<i>Phyllanthus limmuensis</i> Cufod.	Phyllanthaceae	C	VU
53	<i>Phyllanthus mooneyi</i> M.G. Gilbert	Euphorbiaceae	H	NE
54	<i>Pittosporum abyssinicum</i> Delile	Pittosporaceae	S	LC
55	<i>Polygala mooneyi</i> M.G.Gilbert	Polygalaceae	H	EN
56	<i>Polyscias farinosa</i> (Del.) Harms	Araliaceae	T	VU
57	<i>Polystachya caduca</i> Rchb.f.	Orchidaceae	E/H	NE

TABLE A1: Continued.

No.	Species name	Family	Habit	Status
58	<i>Pycnostachys abyssinica</i> Fresen.	Lamiaceae	S	LC
59	<i>Rinorea friisii</i> M. Gilbert	Violaceae	T/S	EN
60	<i>Scadoxus nutans</i> Scadoxus nutans (Friis & I.Bjørnstad) Friis & Nordal	Amaryllidaceae	H	NE
61	<i>Searsia glutinosa</i> (Hochst. ex A.Rich.) Moffett	Anacardiaceae	T/S	VU
62	<i>Senecio myriocephalus</i> Sch.Bip.	Asteraceae	S	LC
63	<i>Solanecio gigas</i> (Vatke) C. Jeffrey	Asteraceae	T/S	LC
64	<i>Solanum giganteum</i> Jacq.	Asteraceae	S	LC
65	<i>Solanum marginatum</i> L.f.	Solanaceae	S	LC
66	<i>Thalictrum minus</i> subsp. <i>maxwellii</i> (Royle) Hand	Ranunculaceae	H	NE
67	<i>Tiliacora funifera</i> Oliv.	Menispermaceae	C	NE
68	<i>Urtica simensis</i> Hochst. ex A. Rich.	Urticaceae	H	LC
69	<i>Vepris dainellii</i> (Pic.Serm.) Mziray	Rutaceae	T	LC
70	<i>Vernonia leopoldi</i> Vatke	Asteraceae	H	LC
71	<i>Vernonia yabelloana</i> Mesfin	Asteraceae	S	NE
72	<i>Wendlandia arabica</i> Deflers	Rubiaceae	S	EN

Data Availability Statement

The data used to produce this review article are available in the text and appendix; the remaining data can be obtained by contacting the corresponding author.

Disclosure

All authors reviewed and approved the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

Author Contributions

Mr. Worku Misganaw significantly contributed to data collection, formal analysis, and writing the original draft. Dr. Getinet Masresha provided essential support in developing the methodology and supervision. Mr. Yalew Yiblet played a key role in interpreting the findings.

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