An Ecological, Socio-Economic and Conservation Overview of the Atewa Range Forest Reserve, Ghana

Source: A Rapid Biological Assessment of the Atewa Range Forest Reserve, Eastern Ghana: 35

Published By: Conservation International

URL: https://doi.org/10.1896/054.047.0106

Chapter 1

An ecological socio-economic and conservation overview of the Atewa Range Forest Reserve, Ghana

As one of the world's 34 Biodiversity Hotspots (Mittermeier et al. 2004), the Guinean Forests of West Africa hotspot encompasses the lowland forests of West Africa, stretching from Guinea and Sierra Leone in the west to the Sanaga River in Cameroon in the East and incorporating areas of Liberia, Côte d'Ivoire, Ghana, Togo, Benin, and Nigeria, as well as four islands in the Gulf of Guinea. Two distinct sub-regions make up the hotspot. The first sub-region, the Upper Guinea Forest, stretches from southern Guinea into eastern Sierra Leone and through Liberia, Côte d'Ivoire and Ghana into western Togo. The second sub-region, Nigeria-Cameroon, extends along the coast from western Nigeria to southwestern Cameroon. The Guinean Forests hotspot represents a range of distinct vegetation zones varying from moist forests along the coast, freshwater swamp forests, and semi-deciduous forests inland with prolonged dry seasons. The hotspot also supports important montane regions, including the Cameroon and Nimba Highlands.

THE UPPER GUINEA FOREST

At its greatest extent following the peak of the last glaciation (approximately 18,000 years B.P.), the Upper Guinea Forest is estimated to have covered as much as 420,000 km^2. Centuries of human activity however have resulted in the loss of at least 70% of the original forest cover (Bakarr et al. 2001). Current biodiversity patterns and high levels of plant and animal endemism in the Upper Guinea Forest are most likely the result of repeated climatic changes during the Pleistocene epoch (10,000-1.9 million years B.P.) when dry conditions in the tropics created isolated forest refugia. Today however, the Upper Guinea Forest is restricted to a number of more or less disconnected forest reserves and a few national parks acting as man-made refuges for the region's biodiversity. Nevertheless, these remaining forests still contain exceptionally diverse ecological communities, distinctive flora and fauna, and several forest types harboring a substantial number of endemic and restricted-range species.

Ghana

Ghana lies along the Gulf of Guinea in West Africa and covers an area of about 239,000 km^2. Along with the rest of West Africa, Ghana belongs geologically to the ancient (570 to 4,600 million years) Precambrian Guinean Shield of the former supercontinent Gondwana and can be divided into several broad natural regions: the coastal or *low plains*, comprising a broad belt along the Gulf of Guinea; the *Ashanti highlands* to the northwest; the *Akwapim-Togo Mountains* in the East; and the Volta basin and terraces of the *high plains* in the north of the country. Ghana can also be divided into several biogeographical zones: the Guineo-Congolian, including the wet evergreen and moist semi-deciduous forests of the southwest; the Guineo-Congolian-Sudanian transitional zone in the middle and the south-east; the Sudanian in the north; and the Sub-Sahelian in the north-eastern corner (Ministry of Environment and Science 2002). About 35% of southwestern Ghana, corresponding to the Guineo-Congolian zone, is located within the Upper Guinea Forest sub-region.

Two rainy seasons occur in Ghana, the first from April to June and the second from September to November, separated by a short dry season of about six weeks during July and August. This pattern corresponds to the movement of the Intertropical Convergence Zone (ITC) over the African landmass (Ojo 1977). Annual rainfall ranges from about 750 mm in the northern forests to over 1,750 mm in the southwestern forests (Hall and Swaine 1981).
In economic terms, Ghana has roughly twice the per capita output of the poorest countries in West Africa but remains heavily dependent on international financial and technical assistance. Major sources of foreign exchange include gold, timber, and cocoa, while the domestic economy is heavily reliant on subsistence agriculture, which accounts for 37% of GDP and employs 60% of the work force, mainly small landholders. GDP is estimated to be $2,700 USD (2006 est.) per capita (purchasing power parity) with 31.4% (1992 est.) of the population living below the poverty level (CIA World Factbook 2007).

Conservation in Ghana

Significant deforestation across Ghana was first noted as early as 1908 (Thompson 1910). Shifting agriculture has undoubtedly occurred for centuries, but the rate of deforestation accelerated early in the last century, as a result of the growing demand for timber required for gold mining, the development of communications infrastructure, and an increase in the land area converted to agricultural production, including cash-crops such as cocoa (Hawthorne and Abu Juam 1995). As a result, Ghana has lost roughly 80% of its forested habitat since the 1920s (Cleaver 1992), with about one-third of its forests disappearing in just 17 years between 1955 and 1972 (Hall 1987). Between 1990 and 2005, the deforestation rate in Ghana remained high (2.0%) compared to other countries in West Africa, resulting in the further loss of 25.9% (19,310 km^2) of forest cover (FAO 2006, see Table 1.1).

Virtually all forests remaining in reasonable condition in Ghana today were designated as forest reserves over the course of the past century by the Forest Services Division of the Forestry Commission. Many of these forests have retained much of their integrity, in the sense that the boundary lines laid down decades ago are still respected, regularly cleared and quite prominent. A forest ordinance was first established in 1927 granting powers to a newly formed Forestry department to reserve areas for management by the state, in some cases by agreement with chiefs to whom the forests belonged (Hawthorne and Abu-Juam 1995). At this time, reserves were defined in all major hills and watersheds, with barrier and shelterbelt reserves established to reduce damage from fires and to maintain local rainfall and humidity levels. Today, there are over 280 forest reserves in Ghana covering about 11% of Ghana's land surface. Many of these reserves are production forests and most are exploited for timber and non-timber forest products including fuel wood, herbal medicines, cane and rattan.

Table 1.1. Area of forested and other wooded land in a number of African countries with annual change rate calculated for the periods 1990-2000 and 2000-2005 (FAO 2006).

Country/area	Forest							Other wooded land		
	Area (1 000 ha)			Annual change rate				Area (1 000 ha)		
	1990	2000	2005	1990–2000		2000–2005		1990	2000	2005
				1 000 ha/year	%[a]	1 000 ha/year	%[a]			
Côte d'Ivoire	10 222	10 328	10 405	11	0.1	15	0.1	2 675	2 662	2 626
Democratic Republic of the Congo	140 531	135 207	133 610	-532	-0.4	-319	-0.2	83 277	83 277	83 277
Equatorial Guinea	1 860	1 708	1 632	-15	-0.8	-15	-0.9	5	22	31
Gabon	21 927	21 826	21 775	-10	n.s.	-10	n.s.	-	-	-
Gambia	442	461	471	2	0.4	2	0.4	170	140	125
Ghana	7 448	6 094	5 517	-135	-2.0	-115	-2.0	0	0	0
Guinea	7 408	6 904	6 724	-50	-0.7	-36	-0.5	5 850	5 850	5 850
Guinea-Bissau	2 216	2 120	2 072	-10	-0.4	-10	-0.5	293	241	236
Liberia	4 058	3 455	3 154	-60	-1.6	-60	-1.8	0	0	0
Nigeria	17 234	13 137	11 089	-410	-2.7	-410	-3.3	9 717	6 902	5 495
Rwanda	318	344	480	3	0.8	27	6.9	175	61	61
Saint Helena	2	2	2	0	0	0	0	0	0	0
Sao Tome and Principe	27	27	27	0	0	0	0	29	29	29
Senegal	9 348	8 898	8 673	-45	-0.5	-45	-0.5	5 301	5 101	5 001
Sierra Leone	3 044	2 851	2 754	-19	-0.7	-19	-0.7	765	511	384
Togo	685	486	386	-20	-3.4	-20	-4.5	1 246	1 246	1 246
Total Western and Central Africa	**300 914**	**284 608**	**277 829**	**-1 631**	**-0.6**	**-1 356**	**-0.5**			
Total Africa	**699 361**	**655 613**	**635 412**	**-4 375**	**-0.64**	**-4 040**	**-0.62**			

The criteria used to designate protected areas and forest reserves in Ghana have changed over time. Some of the more recent designations have included Special Biological Protection Areas (designated in 1994) and Hill Sanctuaries (1995). Most recently, in 1999, the Government of Ghana obtained the assistance of the Global Environment Facility (GEF) to implement the legal establishment of Globally Significant Biodiversity Areas (GSBAs) – reserves harboring a high concentration of biological resources of global conservation importance. Based on the results of a two-year extensive botanical survey across the high forest zone, the Forestry Department has designated GSBAs using an index of the concentration of rare plants within the forest community – the Genetic Heat Index (GHI). To calculate GHI, each plant species has been assigned to a star category, based on rarity. Black star species are internationally rare and uncommon in Ghana and therefore require urgent conservation attention. Thus a high GHI signifies that an area is relatively rich in rare, black star species such that loss or degradation of that area would represent a highly significant erosion of genetic resources from the world, and Ghana in particular (Hawthorne and Abu-Juam 1995). Thirty forest reserves have now been designated as GSBAs, where, in principle, no logging or hunting should take place.

In 1961 Ghana adopted the Wild Animals Preservation Act (Act 43) that regulated export and hunting of "wild animals, birds and fish" in Ghana, later strengthened by the Wildlife Conservation and Wildlife Reserves Regulations introduced in 1971. In 1965, the Game and Wildlife Department was established primarily to manage areas in order to promote animal diversity (Hawthorne and Abu-Juam 1995). Ghana then became a signatory to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1976. Finally, in 1999 and 2000, wildlife management in Ghana changed slightly as the Wildlife Department, at that time part of the civil service, was re-classified as an autonomous division of the Forestry Commission, alongside the Forest Services Division. Resulting changes to date include closer collaboration between the Forest Services Division and the Wildlife Division. Forest reserves controlled by the Forestry Division however often have so few staff that they have trouble maintaining boundary lines let alone maintaining adequate patrols to prevent poaching activities. Forest areas controlled by the Wildlife Division enjoy slightly more protection but often are not adequately patrolled either, with only minimal impact on illegal hunting activities. Patrol efforts are also poorly standardized and/or regulated and are often inefficient due to the use of wide patrol trails that are easily recognized (and subsequently avoided) by hunters (Kormos et al. 2003). It has been noted that hunting pressure in forest areas often increases dramatically within a few meters of a standard patrol trail (Magnuson 2002).

The Atewa Range

The Atewa Range is located in the Eastern Region of Ghana and consists of a range of hills aligned approximately north-south with steep-sided slopes and flat summits. The Range represents the remains of the Tertiary peneplain that once covered southern Ghana and is largely characterized by very ancient soils reputed to be bauxite laden.

The topography of the area is dominated by a dissected forest plateau. In the eastern region (i.e. within the Fanteakwa District) the plateau averages an elevation of about 350 m a.s.l. However, the northern region dips into the Voltarian Basin and the topography is much gentler. The central portion meanwhile is dominated by the Atewa-Atiwiredu ridge, with a general elevation of about 300 m a.s.l., but also containing the Atewa, Atiwiredu and Koto hills, with heights of 800, 723 and 711 m a.s.l., respectively. As the ridge stretches westwards into the Kwaebibirem District, average elevation declines to about 200 m a.s.l. However, from Apinaman towards the Eastern border of East Akyem District, the land rises sharply to about 500 m a.s.l. and culminates in the Atiwiredu hills at a height of about 800 m a.s.l. Geologically, the area is underlain by Birimian formations, and Voltarian metamorphosed sediments, rich in minerals such as gold, diamond, bauxite and kaolin.

The Atewa Range represents some of the highest forest-covered hills in Ghana (along with the hills of the Southern Scarp and the Nyinahin Range (Swaine and Hall 1977)). Hence altitude, with its significant impacts on individual species' ecologies, plays an important role in making Atewa a rare and special place. Daytime air temperature declines consistently with increasing altitude, at a rate of 1° C to 160-170m on mountains in West Africa (Hall 1973), though cold air drainage may cause temperature inversions on clear nights. Reduction in atmospheric temperature and pressure with increasing altitude also leads to a corresponding increase in precipitation, even when the altitudinal increase is small (Schnell 1971). Increased cloudiness on mountains results in a general increase in humidity to the upper limit of the mist zone, which, together with the resulting fog-drip, represent the main causes of the greater luxuriance of epiphytes in upland areas (Swaine and Hall 1977). Langdale-Brown et al. (1964) for example have shown in Uganda that a decrease in annual evapotranspiration of up to 25% can occur with the increase in altitude from sea-level to 600 m.

The botanical uniqueness of Upland Forests in Ghana has been made clear through an extensive survey and ordination analysis of Ghana's forest vegetation (Hall and Swaine 1976). This analysis showed that forests occurring at higher elevations had a significantly different botanical composition to all other Ghanaian forests, rather than simply containing transitional elements of different vegetation zones as previously thought. In particular, these forests contain about 50 species of plant that are unknown elsewhere in Ghana (Hall et al. 1973) including many rare epiphytes with montane distributions in other regions of tropical Africa. The Upland

forests differ from surrounding lowland forests most obviously in possessing a lower proportion of deciduous canopy trees, lower canopy height, greater profusion of ephiphytes, and poorer stocking of commercial timber species (Swaine and Hall 1977). Atewa is particularly unique in harboring one of only two remaining areas in Ghana with significant Upland Evergreen forest cover (the other being Tano Ofin).

The Atewa Range lies within the dry and wet semi-equatorial transition zones. The larger northern portion of the Atewa Range lies in the wet transition zone, which is characterized by high temperatures and a double maxima rainfall regime. It exhibits a mean monthly temperature of between 24° and 29°C, and experiences a mean annual rainfall of between 1200 and 1600 mm. Atewa also lies within two vegetation zones: i) the transitional climatic zone and thicket vegetation resulting from human activities such as land cultivation, lumbering, and fuel wood extraction; ii) the moist deciduous forest zone that lies to the north of the transitional zone and covers about 80% of the Akyem Abuakwa area. Precipitation records taken from Atewa between April 1966 and May 1967 show higher precipitation, more rain days and a shorter dry season than in nearby lowland forest. Daytime observations in September 1974 showed temperatures on the Atewa plateau (at 750 m) to be approximately 4-5° C lower than those at neighboring Kibi (at 300 m) (Swaine and Hall 1977). Historically, the Atewa Range has been recognized as nationally important for providing the headwaters of three river systems in Ghana: the Ayensu, Densu and Birim rivers. These three rivers are the most important source of domestic and industrial water for local communities as well as for many of Ghana's major population centers, including Accra. The intact Atewa Range ecosystem acts to protect and provide a clean water source for much of Ghana's human population as well as the country's biodiversity.
The population of the Atewa area is growing at a relatively slow rate, possibly as a result of emigration by farmers and youth. With a decline in the cocoa industry around the Atewa Range, farmers have migrated to areas like Brong Ahafo where the cocoa industry is thriving, while many of the region's youth have migrated to urban areas. More than 40 settlements with an estimated population of about 75,180 are located within the vicinity of the Atewa Range, according to the 2000 National Population and Housing Census Report. The major economic activities of these communities include agriculture, small-scale collection of non-timber forest products (NTFPs), mining, logging and bushmeat hunting.

Conservation of Atewa

The Atewa Range Forest Reserve (Atewa) was originally established in 1926 under the Akyem Abuakwa State Native Authority by-laws. It was later reconstituted under Forest Ordinance Cap 157 of 1935. Ownership of the reserve is vested in the President of Ghana and held in trust for the Akyem Abuakwa Stool (Gazettment Supplement 1935, pg 1105). The entire reserve falls within the jurisdiction of the Akyem Abuakwa Traditional Area. The Atewa reserve includes 232 km^2 of forest – moist semi-deciduous at lower levels and Upland Evergreen at higher elevations.
Even though the Atewa forest was declared a protected area as far back as 1926, communal rights were granted to natives of the Akyem Abuakwa Traditional Area and individual owners of lands purchased prior to the establishment of the reserve. Included within these rights were: farming within the reserve (admitted farms); collecting forest products (including building materials, canes, vines, ropes, pestles, palm trees, snails, mushrooms, chewing sticks, medicinal plants, game and wildlife); receiving a share in timber royalties resulting from forestry on privately owned land; accessing sacred places; establishing hunting camps; and washing for gold.

The culture of the forest fringe communities is inextricably linked with the existence of the Atewa reserve. The forest is regarded as the home of the ancestral spirits, who provide protection, success and progress for the Akyem Abuakwa people. Some animals are regarded as totems by certain clans. Taboos such as avoidance of farming activities along river banks are all indications of the socio-cultural significance of forest resources. Forest fringe communities also depend on the forest for non-timber forest products, some of which are extracted in large quantities for sale. Several streams and headwaters of major rivers like the Densu, Ayensu and Birim serve as important sources of drinking water to a large number of people within and outside the traditional area, including Accra and other urban areas. Many individuals, institutions and communities hold a stake in the continued existence of the reserve.

The reserve has been managed under the Protection Working Circle system of the then Forestry Department (now Forest Services Division) where an area is managed with the intention of protecting the watershed and no logging is allowed. Atewa was designated as a Special Biological Protection Area in 1994. In 1995 it was reclassified as a Hill Sanctuary under the Forest Protection Strategy proposals. In 1999, Atewa was again re-designated as one of the 30 Globally Significant Biodiversity Areas (GSBAs). It is also among the 36 Important Bird Areas (IBAs) in Ghana as designated by BirdLife International (Ntiamoa-Baidu et al. 2001). In 2003 the first management plan was prepared for the Atewa forest reserve with the main objectives of: protecting the headwaters of major rivers, namely the Birim, Densu and Ayensu and their tributaries; maintaining forest cover on the slopes of hills to prevent excessive erosion; and preventing the encroachment or conversion of the reserve to agriculture.

THREATS TO BIODIVERSITY IN THE ATEWA RANGE FOREST RESERVE

Cropping practices which encourage intensive use of the same piece of land over a prolonged period of time have led to leaching and loss of soil fertility in parts of Atewa. In local villages, deep channels have been created by surface water running over ground lacking plant cover. Within some of the villages, erosion has eaten away the foundation cover of houses, and in some cases washed away whole streets, bridges and other services. Illegal logging has been prevalent in Atewa, especially during the 1990s, leading to further problems with erosion throughout the area. Indeed in 2001, logging escalated so much that the Ghanaian army was called in to help protect the reserve from loggers (Hawthorne 2002). Unsustainable exploitation of forested areas, coupled with the relatively high prevalence of bush fires, has resulted in the depletion of important timber species. Trees such as mahogany, Odum, Obeche, and Emire, which were abundant before the 1960s are now locally rare. At least 954 ha (4.1%) of Atewa was converted to plantation through the taungya program between 1954 and 1975 (Hawthorne 2002). Most of these plantations have since been abandoned and remain as severely degraded areas covering most of the lower slopes of the reserve.

Mining activities by unlicensed individuals and groups are increasing and causing serious problems for communities. Major pollution occurs downstream from water bodies along whose banks mining takes place, as a result of improper mining practices. Most affected is the Birim River which suffers from pervasive sediment loading.

A 2001 bushmeat market survey targeting the major bushmeat markets in both Accra and Kumasi indicated that about 15 % of the bushmeat found in these markets comes from the Atewa forest (Conservation International-Ghana 2001, 2002). Most of the species sold are wholly protected in Ghana (i.e. Black-and-white colobus, Spotted palm civet, Giant and Long-tailed pangolins). In addition, the survey revealed that some traditional sacred animals (totems) such as Crested porcupine (totem of the Ashantis*)* are being hunted and sold. A number of bushmeat markets are in existence in close proximity to Atewa. The largest roadside bushmeat market in Ghana is at Anyinam, at the fringe of the Atewa, where bushmeat is sold throughout the year. Hunters illegally entering Atewa are known to use automatic rifles, poisonous chemicals, traps and fires.

Atewa is dissected by many rivers and their tributaries. However, human activities in the form of farming, deforestation, and to some extent mining have now polluted and silted up many of these waterways. The effluents of the many small-medium scale oil palm-processing factories in the area are also a major cause of water pollution. In order to secure adequate amounts of water for their operations, many of these factories are located on the banks of streams where water can be more easily obtained. Oily waste matter from the factories is then washed into the streams, especially at Kade, Boadua, Wenkyi and Mepom. Furthermore, the forests that shelter these waterways have been cleared, with many rivers and streams experiencing greater rates of evaporation for longer periods of the year. Hence, they are now increasingly unable to satisfy the water requirements of the communities they are supposed to serve.

Prior Research in the Atewa Range Forest Reserve

Due to the biological interest in Atewa as an Upland Evergreen forest and because of its proximity to Accra, more is known about Atewa than any forest reserve in Ghana (except perhaps Bobiri; Hawthorne 2002). Past botanical research has included Temporary Sample Plots (TSP) conducted during the National Forest Inventory between 1986-1992 (56 samples with 7235 plant records), and Rapid Botanic Survey plots (RBS) carried out in the early 1990s by Hawthorne and Abu Juam (16 samples with 1239 plant records; 1995). The butterflies of Atewa have also been extensively collected over the past 70 years (see Chapter 5 of this report). The institutions which have carried out research or are mandated to carry out research in Atewa include:

The Forest Services Division

The Forest Services Division (FSD) is responsible for the conservation, protection, management and utilization of forest resources in Ghana. In the past they maintained a research unit that was responsible for research and monitoring work in all forest reserves. Permanent Sampling Plots (PSPs), one-hectare sampling units, were established in almost all the forest reserves to monitor ecological trends. Eighteen PSPs were established in Atewa and 72,474 plant records from the monitoring program are stored at the Resource Management and Support Centre of FSD in Kumasi (Hawthorne 2002).

Forestry Research Institute of Ghana (FORIG)

The main mandate of FORIG is to conduct research and generate scientific information to support the management of forest reserves in Ghana. FORIG took over management of the 18 PSPs in Atewa but has since been unable to carry out any research or monitoring work in the area.

The Botany Department of the University of Ghana

The department is entrusted with the responsibility of training undergraduate and post-graduate level personnel in plant science and has used Atewa as a field laboratory to facilitate undergraduate and graduate research work. The Department has no formal research focus for the area. In the past, research scientists of the Botany Department of the University of Ghana established temporary research plots to conduct botanical surveys but these were abandoned after their objectives were accomplished.

ONGOING PROJECTS

A number of projects are being implemented at Atewa and within its vicinity. These include:

- Community Investment Fund Project: supports income-generating ventures aimed at improving livelihoods of forest fringe communities. This is being implemented as part of the GEF/World Bank/Government of Ghana program for all 30 GSBAs in Ghana.
- High Forest Biodiversity Project: part of the World Bank/Government of Ghana Natural Resource Management Program.
- GEF/World Bank-sponsored Promoting Partnership with Traditional Authorities Project (PPTAP)**:** aimed at unearthing the cultural, historical and ecological heritage and assets of the Akyem Abuakwa Traditional area.
- Ghana government-sponsored Presidential Initiative on Tree Plantations Project: seeks to rehabilitate degraded forest areas.

REFERENCES

Bakarr, M., B. Bailey, D. Byler, R. Ham, S. Olivieri and M. Omland (eds.). 2001. From the Forest to the Sea: Biodiversity Connections from Guinea to Togo. Washington DC: Conservation International.

Conservation International-Ghana. 2002. Endangered Bushmeat Species in Ghana, CI, Accra

Conservation International-Ghana. 2001. Assessment of Bushmeat Trade During the Annual Closed Season on Hunting in Ghana, (1st August- 1st December 2001). CI, Accra

CIA. 2007. The World Factbook. Online. Available: https://www.cia.gov/library/publications/the-world-factbook/geos/gh.html, July 26, 2007.

Cleaver, K. 1992. Deforestation in the western and central African rainforest: the agricultural and demographic causes, and some solutions. Pages 65-78. *In:* Cleaver, K., M. Munasinghe, M. Dyson, N. Egli, A. Penker and F. Wencelius (eds.). Conservation of West and Central African Rainforests. The World Bank/International Union for the Conservation of Nature, Washington, DC. 351 pp.

FAO. 2006. Global Forest Resources Assessment 2005. Progress Towards Sustainable Forest Management. FAO Forestry Paper N° 147. Rome. xxvii+320 pp.

Hall, J.B. 1973. Vegetational zones on the southern slopes of Mount Cameroon. Vegetatio 27, 49-69.

Hall, J.B. 1987. Conservation of forest in Ghana. Universitas. 8:33-42. University of Legon, Ghana.

Hall, J.B. and M.D. Swaine. 1976. Classification and ecology of closed-canopy forest in Ghana. Journal of Ecology 64:913-915.

Hall, J.B. and M.D. Swaine. 1981. Distribution and Ecology of vascular plants in a tropical rain forest. Forest vegetation in Ghana. Geobotany 1. Junk, The Hague. 383 pp.

Hall, J.B., J. Brookman-Amissah, D. Leston and R. Dodoo. 1973. Conservation and exploitation of Atewa Range Forest Reserve. C.S.I.R. Accra.

Hawthorne, W.D. 2002. Final report of the floral survey of the Biodiversity Component of NRMP. Forestry Commission, Biodiversity Conservation Component. Ministry of Lands and Forestry, Ghana.

Hawthorne, W.D. and M. Abu-Juam. 1995. Forest Protection in Ghana. IUCN/ODA/Forest Department Republic of Ghana, Gland, Switzerland, and Cambridge, UK, xvii + 203 pp.

Kormos, R., C. Boesch, M.I. Bakarr and T. Butynski (eds.). 2003. West African Chimpanzees. Status Survey and Conservation Action Plan. IUCN/SSC Primate Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.

Langdale-Brown, I., H.A. Osmaston and J.G. Wilson. 1964. The Vegetation of Uganda and its bearing on Land-use. Entebbe.

Magnuson, L.E. 2002. Distribution and Habitat Use of the Roloway Guenon (*Cercopithecus diana roloway*) in Ghana, West Africa. Master's thesis, Natural Resources: Wildlife Management, Humboldt State University. 68 pp.

Mittermeier, R.A., P. Robles Gil, M. Hoffmann, J. Pilgrim, T. Brooks, C.G. Mittermeier, J. Lamoreux and G.A.B. da Fonseca (eds.). 2004. Hotspots Revisited. Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions. CEMEX/Agrupación Sierra Madre, Mexico City.

Ministry of Environment and Science. 2002. National Biodiversity Strategy for Ghana. 55 pp.

Ntiamoa-Baidu, Y, E.H. Owusu, D.T. Daramani and A.A. Nuoh. 2001. Ghana. *In:* Fishpool, L.D.C. and M.I. Evans (eds.). Important Bird Areas in Africa and Associated Islands: Priority sites for conservation. Pisces Publications and BirdLife International, Newbury and Cambridge, UK. Pp. 473-480.

Ojo, O. 1977. The climates of West Africa. Heinemann, London, xvii+218 pp.

Schnell, R. 1971. Introduction a la phytogeography des pays tropicaux. Paris, Gauthier-Villars.

Swaine, M.D. and J.B. Hall. 1977. Ecology and conservation of upland forests in Ghana. 151-158. *In*: Laryea, A.M. (ed.). Proceedings of Ghana SCOPE's Conference on Environment and Development in West Africa. Ghana Academy of Arts and Sciences, UNESCO and Ghana Environmental Protection Council, Accra.

Thompson, H.N. 1910. Gold Coast: report on forests. Colon. Rep. Miscell. 66:1-238.