



Executive Summary

Source: A Rapid Biological Assessment of the Atewa Range Forest Reserve, Eastern Ghana: 13

Published By: Conservation International

URL: <https://doi.org/10.1896/054.047.0104>

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Executive Summary

INTRODUCTION

Across West Africa, forest cover has been reduced to less than 30% of its potential extent (Bakarr 2001). The highly fragmented forest patches that remain continue to be degraded or completely lost at an alarming rate. Based on high levels of species endemism, coupled with intense and ongoing threats to their survival, the remaining West African forests have been designated as one of 34 global hotspots of biodiversity (Mittermeier et al. 2004).

Montane habitats are extremely restricted in extent within this region. Long-term geological erosion has turned West Africa into a mostly flat landscape with significant tracts of montane forest limited to the Upper Guinea Highlands. These montane forest areas constitute unique ecosystems with exceptional species richness and high levels of endemism (Bakarr et al. 2001, 2004). Between the Upper Guinea and Cameroon Highlands, only the Atewa Range in Ghana, the Volta Highlands between Ghana and Togo, and the Jos Plateau in Nigeria harbor significant upland forest patches. Among these three, Upland Evergreen Forest is found only in the Atewa Range. The Atewa Range Forest Reserve (hereafter referred to as 'Atewa') is one of only two forest reserves in Ghana where Upland Evergreen Forest occurs (Hall and Swaine 1981, Abu-Juam et al. 2003), the other being the Tano Ofin Forest Reserve, which is already highly degraded.

Ghana has lost roughly 80% of its forest habitat since the 1920s (Cleaver 1992) and Atewa represents one-third of the remaining closed forest in the Eastern Region of Ghana (Mayaux et al. 2004, Chapter 11). Atewa is known to hold numerous endemic and rare species, in part due to the unique floristic composition of its Upland Evergreen forest generated by the misty conditions on top of the plateaus (Swaine and Hall 1977). In addition, several butterfly species are strictly endemic to the Atewa Range (Larsen 2006). Seasonal marshy grasslands, swamps and thickets on the tops of Atewa's plateaus are also thought to be nationally unique (Hall and Swaine 1981).

Atewa has been officially classified in various ways over the past 90 years, with changes due mainly to new programs and designations assigned by the Government of Ghana and not to any changes in Atewa's biodiversity or ecological values. Atewa was declared a national forest reserve in 1925, then was classified as a Special Biological Protection Area in 1994, as a Hill Sanctuary in 1995 and, finally in 1999, as one of Ghana's 30 Globally Significant Biodiversity Areas (GSBAs) (Abu-Juam et al. 2003) based on its high botanical diversity. Designation as a GSBA is equivalent to IUCN's Category IV designation: a protected area designated mainly for conservation through management intervention (IUCN 1994). In 2001, Atewa was listed as an Important Bird Area (IBA) by BirdLife International, one of 36 such areas in Ghana (Ntiemoa-Baidu et al. 2001).

Historically, Atewa has been recognized as a nationally important reserve because the Atewa Range provides the headwaters of three river systems, the Ayensu River, the Densu River and the Birim River. 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. Thus, the Atewa forests protect and provide a clean water source for much of Ghana's human population and for key elements of the country's biodiversity.

SCOPE OF PROJECT

In addition to high biodiversity, Atewa is known to harbor mineralogical wealth including both gold and bauxite deposits. The Government of Ghana opened several forest reserves for mining in 2001, but Atewa was not included. However, the Government granted an exploration license to ALCOA to prospect for bauxite deposits in Atewa.

Due to the fact that Atewa had been classified as a Globally Significant Biodiversity Area (GSBA), ALCOA entered into an agreement with Conservation International (CI) to assist them in better understanding the biodiversity context of Atewa in order to incorporate biodiversity into the company's risk assessment and Environmental Impact Assessment of the project, should it proceed. This partnership involved applying CI's Initial Biodiversity Assessment and Planning (IBAP) methodology to increase understanding of an area's ecosystems and socio-economic dynamics and to provide recommendations for incorporating biodiversity considerations in the earliest stages of decision-making. This partnership was formed in the spirit of providing significant gains for biodiversity conservation and industry, as well as for the government and people of Ghana.

Previously, ALCOA and CI had partnered successfully to utilize the IBAP methodology and conduct biodiversity surveys in Guinea (West Africa) and Suriname (South America). For Atewa, CI first worked with partners to conduct desktop and preliminary field research on Atewa's biodiversity in 2005, followed by a Rapid Assessment Program (RAP) survey in June 2006 to assess a wide range of taxa, as well as potential threats to and opportunities for conservation in Atewa. Following the RAP survey, a consultative workshop was held at the Palace of Paramount Chief Okye-hene in Kibi on June 26, 2006 with participation from local community members and Chiefs, representatives from ALCOA and several NGOs, and several of the RAP scientists (see Appendix 11 for complete list of participants).

RAP EXPEDITION OVERVIEW AND OBJECTIVES

Conservation International's Rapid Assessment Program (RAP), a department within the Center for Applied Biodiversity Science (CABS), was founded in 1990 in response to the increasing loss of biodiversity in tropical ecosystems. RAP is an innovative biological inventory program designed to generate scientific information to catalyze conservation action in tropical areas that are under imminent threat of habitat conversion.

Together with CI's Ghana program and Center for Environmental Leadership in Business (CELB), RAP organized a rapid biological survey of Atewa in June 2006. Prior to the RAP survey, most biological research had focused on plants and butterflies, with little data available for other taxonomic groups. The primary objective of the RAP survey was to collect scientific data on the diversity and status of species within Atewa in order to make recommendations regarding

their conservation and management. The specific aims of the expedition were to:

- Derive a brief but thorough overview of species diversity within Atewa and evaluate the area's relative conservation importance;
- Undertake an evaluation of threats to this biodiversity;
- Provide management and research recommendations for this area together with conservation priorities; and
- Make RAP data publicly available for decision-makers as well as members of the general public in Ghana and elsewhere, with a view to increasing awareness of this ecosystem and promoting its conservation.

RAP CRITERIA

Criteria generally considered during RAP surveys in order to identify priority areas for conservation across taxonomic groups include species richness, species endemism, rare, new to science, and/or threatened species, and critical habitats. Measurements of species richness can be used to compare the number of species per area among areas within a given region. Measurements of species endemism indicate the number of species endemic to some defined area and give an indication of both the uniqueness of the area and the species that will be threatened by degradation or loss of that area's habitats (or conversely, the species that will likely be conserved through protected areas). Describing the number of critical habitats or sub-habitats within an area identifies sparse or poorly known habitats within a region that contribute to habitat variety and, therefore, to species diversity.

RAP scientists use the IUCN Red List of Threatened Species (IUCN 2007) to determine if species are globally threatened. Categories, from most to least threatened include: Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC). Assessment of rare and/or threatened species that are known or suspected to occur within a given area provides an indicator of the importance of the area for the conservation of biodiversity. The presence or absence of such species also aids assessment of their conservation status. Many species on the IUCN Red List carry increased legal protection, thus giving greater importance and weight to conservation decisions.

RAP TEAM AND FOCAL TAXONOMIC GROUPS

The RAP survey's 20-member, multi-disciplinary team included representatives from the Wildlife Division of the Forestry Commission, Water Research Institute, the Faculty of Renewable Natural Resources, the University of Ghana, the Kwame Nkrumah University of Science and Technology, the Forestry Research Institute of Ghana, l'Université d'Abobo-Adjamé (Côte d'Ivoire), University of Liège (Bel-

gium), University of Ulm (Germany), Natuurhistorisch Museum Naturalis (Leiden, The Netherlands), and Harvard University (USA).

The RAP team, comprising experts specializing in West Africa's ecosystems and biodiversity, examined selected taxonomic groups to determine the area's biological diversity, its degree of endemism, and the uniqueness of the ecosystem. RAP expeditions survey focal taxonomic groups as well as indicator species, with the aim of choosing taxa whose presence can help identify a habitat type and its condition.

At Atewa, the RAP team surveyed plants, Odonata (dragonflies and damselflies), Orthoptera (katydids), butterflies, fish, amphibians, birds, and mammals (including three mammal survey teams: small mammals, large mammals and primates).

STUDY AREA

Surveys of the 23,665 ha Atewa Range Forest Reserve were conducted over 19 days (6 - 24 June 2006) at the beginning of the rainy season. Each RAP site ranged from lowland and some gallery forest down in the valleys to highland forest in the upper elevation as a result of the plateau formations. The mountain range, which peaks at 842 m a.s.l. (SRTM90 data), runs roughly from north to south and is characterized by plateaus, which are remnants of a Tertiary peneplain. In addition to the three sites described below, the fish and dragonfly teams sampled streams and rivers (namely the Birim, Densu and Ayensu) and associated standing water habitats, with headwaters located within the reserve, as well as freshwater sites outside the reserve.

Atewa lies within two climatic zones: the dry and the wet semi-equatorial transition zone. The larger, northern portion of Atewa lies in the wet semi-equatorial climatic zone, which is characterized by high temperatures and a double maxima rainfall regime. It has a mean monthly temperature of between 24 and 29°C, and experiences a mean annual rainfall of between 120 and 1600 mm. The first rainfall peak occurs in May-July with the second one occurring in September-November.

The area also lies in two vegetation zones. The transitional climatic zone and the thicket vegetation is the result of human activities in the form of land cultivation, logging, and extraction of fuel wood. The vegetation cover also includes elephant grass, and the invasive "Siam weed" or "Acheampong weed" (*Chromolaena odorata*). North of this zone, and covering about 80% of the Akyem Abuakwa area is a moist deciduous forest. Unlike the evergreen forest, some of the trees in the moist deciduous zone shed their leaves during various periods of the year. However, trees of the lower layer of the zone remain evergreen throughout the year. About 17,400 ha of the reserve is Upland Evergreen forest. Atewa is one of only two forest reserves in the country in which this forest-type occurs, the second one being Tano Ofin, and these two reserves together hold approximately 95% of the Upland Evergreen forest in the country. The

diverse flora of Atewa contains submontane elements, with characteristic herbaceous species, and abundant and diverse epiphytic and terrestrial ferns; a number of plant species found here are not known to occur elsewhere in Ghana. The bowals (seasonal marshy grasslands on bauxite outcrops), swamps and thickets that occur here are also thought to be nationally unique.

Overall, Atewa is considered to have a forest condition score of 3 (on a scale of 1-6), which indicates that it is slightly degraded but has predominantly good forest with healthy and abundant regeneration of timber trees and other forest plants (Hawthorne and Abu-Juam 1995).

RAP camps were established at three sites within Atewa. The RAP sites were chosen to coincide with areas of high biodiversity and concentrated bauxite deposits (Atiwiredu, Asiakwa South and Asiakwa North) that had been earmarked for exploitation activities by ALCOA. The most southern part of Atewa was not surveyed because it is fairly degraded and was not a focus of ALCOA's activities at the time of the RAP survey.

Site 1 (Atiwiredu) was located at 6°12'24.7"N, 0°34'37.2"W, at an elevation 795 m, and sampling was conducted here from 6 - 10 June, 2006. This site had an extensive network of roads, and was subject to prospecting activity by ALCOA. Despite this activity, the forest condition was rated as 2 by the botanical team, indicating a low level of disturbance. Two plant species endemic to Upper Guinea, *Neolemonniera clitandrifolia* and *Aframomum atewae*, were present at the site, and the dominant trees were *Cola boxiana* and *Chidlowia sanguinea*. This site showed evidence of previous logging of economically important tree species. There were also indications of hunting (spent cartridges, snares, and hunting trails.)

Site 2 (Asiakwa South) was situated at 6°15'44.3"N, 0°33'18.8"W, at an elevation of 690 m, and sampling was conducted here from 11 - 16 June, 2006. This site, while not currently subject to prospecting activity, still contained an extensive network of roads from previous exploration activity, some overgrown with tall grasses. These roads appear to act as passages allowing the penetration of invasive elements, such as grasses or species of insects normally associated with open habitats, deep into the forest. The condition of the forest at this site was rated as 3, and the dominant tree species were *Rinorea oblogifolia* and *Hymenostegia afzelii*. This site showed evidence of hunting (spent cartridges, wire snares) and harvesting of chewing stick, sponge and cane. However, there were no signs of previous farming activities.

Site 3 (Asiakwa North) was located at 6°16'16.4"N, 0°33'52.8"W, elevation 769 m, and was sampled from 16 - 24 June, 2006. Most of the site was covered with tall, closed-canopy forest, with little underbrush and no open roads. Its condition was rated as 2, and the dominant tree species was *Rinorea oblongifolia*. There were few gaps in the forest, which

accounts for the low number of species associated with such habitats. The only gaps present were overgrown with tall, broad-leaved plants of the family Marantaceae. Of the three sites sampled, this site showed the most extensive evidence of hunting, with hundreds of spent cartridges, wire snares, and an extensive network of hunting trails.

RAP RESULTS

The results of this RAP survey confirm that Atewa is a site of extremely high importance for global biodiversity conservation and should be protected in its entirety. This forest reserve represents the last intact piece of Upland Evergreen forest in Ghana and is a critical source of clean water for the local people and many of Ghana's human population cen-

Table 1. Species of conservation concern recorded in the Atewa Range Forest Reserve during the RAP survey.

Taxon	Species name	Common name	Threat status*	Sites		
				Atiwiredu	Asiakwa S	Asiakwa N
Amphibian	<i>Conraua derooi</i>		CR		x	x
Amphibian	<i>Hyperolius bobirensis</i>		EN	x	x	
Amphibian	<i>Phrynobatrachus ghanensis</i>		EN	x		
Plant	<i>Neolemonniera citandrifolia</i>		EN / Black star			x
Amphibian	<i>Kassina arboricola</i>		VU	x	x	
Bird	<i>Bleda eximius</i>	Green-tailed Bristlebill	VU			
Bird	<i>Criniger olivaceus</i>	Yellow-bearded Greenbul	VU			
Bird	<i>Melaenornis annamarulae</i>	Nimba Flycatcher	VU			
Primate	<i>Colobus vellerosus</i>	Geoffroy's pied colobus	VU	x	x	x
Plant	<i>Sapium aubrevillei</i>		VU / Black star			x
Amphibian	<i>Amietophrynus togoensis</i>		NT	x		
Amphibian	<i>Acanthixalus sonjae</i>		NT	x		
Amphibian	<i>Afrixalus nigeriensis</i>		NT	x	x	
Amphibian	<i>Afrixalus vibekensis</i>		NT		x	
Amphibian	<i>Phrynobatrachus alleni</i>		NT	x		
Bird	<i>Bycanistes cylindricus</i>	Brown-cheeked Hornbill	NT			
Bird	<i>Illadopsis rufescens</i>	Rufous-winged Illadopsis	NT			
Bird	<i>Lamprolornis cupreocauda</i>	Copper-tailed Glossy Starling	NT			
L. Mammal	<i>Anomalurus pelii</i>	Pel's flying squirrel	NT	x		
Sm. Mammal	<i>Crociodura grandiceps</i>	Large-headed shrew	NT	x		
Sm. Mammal	<i>Scotonycteris zenkeri</i>	Zenker's Fruit Bat	NT	x	x	
L. Mammal	<i>Cephalophus dorsalis</i>	Bay Duiker	LR/nt	x	x	x
L. Mammal	<i>Cephalophus maxwelli</i>	Maxwell's Duiker	LR/nt	x	x	x
L. Mammal	<i>Cephalophus niger</i>	Black Duiker	LR/nt			x
L. Mammal	<i>Cephalophus silvicultor</i>	Yellow-backed Duiker	LR/nt / Sch. I			x
L. Mammal	<i>Neotragus pygmaeus</i>	Royal Antelope	LR/nt	x	x	x
Primate	<i>Procolobus verus</i>	Olive colobus	LR/nt		x	
L. Mammal	<i>Epixerus ebii</i>	Western palm squirrel	DD	x		x
Odonate	<i>Atoconeura luxata</i>		VU in WA			
L. Mammal	<i>Civettictis civetta</i>	African Civet	Sch. I	x	x	
L. Mammal	<i>Nandinia binotata</i>	African Palm Civet	Sch. I	x		x
L. Mammal	<i>Uromanis tetradactyla</i>	Long-tailed Pangolin	Sch. I			x
Plant	<i>Gilbertiodendron splendendum</i>		Black star	x		x
Plant	<i>Ixoria tenuis</i>		Black star		x	x
Plant	<i>Psychotria longituba</i>		Black star	x		
Plant	<i>Psychotria subglabra</i>		Black star	x		
Sm. Mammal	<i>Hypsugo [crassulus] bellieri</i>	Bellier's Broad-headed Pipistrelle	n.a.	x		x
Sm. Mammal	<i>Pipistrellus aff. grandidieri</i>	Grandidier's Pipistrelle	n.a.			x

* **Threat status:**

IUCN Red List categories: Critically Endangered (**CR**), Endangered (**EN**), Vulnerable (**VU**), Near Threatened (**NT**), Lower Risk/near threatened (**LR/nt**), Data Deficient (**DD**) (IUCN 2007)

Sch. I Species wholly protected in Ghana and listed on Schedule I of the Ghana Wildlife Conservation Regulation

Black star Species ranked as internationally rare and uncommon in Ghana (Hawthorne and Abu-Juam 1995)

n.a. Not assessed by the last IUCN revision due to recent taxonomic results, but when assessed it will be added to IUCN Red List

VU in WA Listed by IUCN as regionally vulnerable for western Africa

ters, including Accra. Our results show that Atewa is still a uniquely important site that continues to harbor a number of rare and threatened species within an intact and unique habitat type (Table 1).

The results of the RAP survey not only corroborate previous designations of Atewa as an important site for biodiversity conservation (see below), but strongly suggest that the biological community present at Atewa represents a very rare example of a relatively intact West African forest, a highly unusual and (from a conservation perspective) highly significant finding. All taxonomic groups surveyed were found to include unique species assemblages that are representative of Upper Guinean rainforest fauna. Atewa harbors a high and unique diversity of dragonflies and butterflies, as

well as primates that are highly threatened throughout West Africa (Table 2).

The RAP results add to previous biological data in several ways, most notably by showing that Atewa is an important site for amphibians. An extremely high proportion of threatened amphibian species were recorded (almost one-third of recorded species are Red-Listed), including the Critically Endangered *Conraua derooi*, for which the Atewa Range is likely to hold the largest remaining populations. While this species is historically known from a number of sites close to the Togolese border, recent surveys have recorded it only from some of its previously known localities, where it is under extreme pressure from habitat destruction and consumption. Hence, Atewa could hold the last

Table 2. Number of species documented during the 2006 RAP survey in the Atewa Range Forest Reserve, Ghana and comparison of sites.

	Site 1: Atiwiredu	Site 2: Asiakwa South	Site 3: Asiakwa North	Total
Dates (June 2006)	6 – 11	12-17	18-23	
Elevation (m a.s.l.)	817	783	814	
Habitat	Roads have left habitats fragmented and there is evidence of previous logging	Forest canopy is open in places, especially along hauling roads. Human activities include small-scale harvesting of non-timber forest products and trapping and hunting wild game, particularly along the footpath leading to nearby communities.		
Plants	145 spp.; 3 black star	247 spp.; 1 black star	189 spp.; 4 black star (2 of these recorded only from this site)	314
Dragonflies				72
Butterflies	74 spp.	89 spp. This site appeared to be most disturbed with respect to this taxon.	57 spp.	143*
Katydid	26 spp.	50 spp. Highest species richness for Orthoptera, likely due to a strong edge effect created by dense network of roads	28 spp.	61
Fish				19
Amphibians	26 spp. While results indicate this area has already suffered some habitat degradation, it still harbors the only records for a number of forest specialists	23 spp. Fast-flowing forest streams here hold the Critically Endangered <i>Conraua derooi</i> .	6 spp. After rainfall, the Critically Endangered <i>Conraua derooi</i> was found here.	32
Birds				155
Small mammals	9 spp.	8 spp.	8 spp.	15
Large mammals	12 spp. Large mammal signs 1.41 times/hour Index of illegal activity: 1.07/hour	14 spp. Large mammal signs 2.9 times/hour Index of illegal activity 1.05/hour Clear evidence of excessive hunting including many spent cartridges and wire snares. High levels of non-timber forest product harvesting.	15 spp. Large mammal signs 2.67 times/hour Index of illegal activity 1.87/hour Likely to be the best refuge for large mammals in Atewa though shows evidence of excessive hunting.	22
Primates	3 spp.	4 spp. Includes the only records of the Olive colobus (<i>Procolobus verus</i>) from the survey.	4 spp.	6

* Includes 13 species recorded outside of RAP survey sites

remaining viable population of this Critically Endangered species and we urgently recommend additional surveys to determine if this is the case (see Conservation Recommendations). In addition, the Atewa population proved to be genetically distinct from the Volta populations and may hence be also biologically unique.

The unique and diverse species assemblages documented during the RAP survey, especially of amphibians, Odonata (dragonflies and damselflies) and fishes, all depend on the clean and abundant water that originates in Atewa for their survival. Millions of Ghanaians also depend on this water source, which is provided by the plateau formations that soak up rain and mist and then hold, clean and discharge the water for all to utilize.

The three sites surveyed during the RAP survey all contain significant biodiversity and important species (Table 2). The RAP team found Asiakwa North to be the most intact and undisturbed. This site may thus serve as a refuge for wildlife displaced from other areas, despite heavy hunting levels recorded here. Asiakwa South contains large populations of the Critically Endangered frog, *Conraua derooi*, as well as the only record of the Olive colobus primate during the RAP survey. Despite being the most impacted site with active mineral prospecting taking place during the RAP survey, Atiwiredu still harbors high biodiversity, including two black star plant species and a high diversity of amphibians.

The RAP results confirm the importance of Atewa for biodiversity conservation, which had already been recognized by many organizations including the Government of Ghana:

- Based on botanical diversity, the reserve was declared a Globally Significant Biodiversity Area (GSBA) in 1999 by the Government of Ghana,
- Based on avian diversity it was designated a globally significant Important Bird Area (IBA) by Birdlife International in 2001,
- As far back as 1926, when it was designated as a national forest reserve by the Government of Ghana, Atewa was recognized as critically important in maintaining important watersheds upon which many Ghanaians (and Ghanaian biodiversity) depend,
- Atewa has previously been recognized as the single most important site in Ghana for butterflies (Larsen 2006),
- The 1999 West Africa Priority Setting Workshop organized by Conservation International identified Atewa as an area of Very High priority for biodiversity conservation (Bakarr et al. 2001),
- Conservation International and partners have been designating Key Biodiversity Areas (KBA), which are sites of global significance for biodiversity conservation that are large enough or sufficiently interconnected to support viable populations of the species for which they

are important. KBAs represent discrete sites that are globally vulnerable and irreplaceable and are defined by the presence of threatened species (Eken et al. 2004). While KBAs have yet to be formally designated in Ghana, Atewa will undoubtedly qualify as a KBA when they are determined.

RESULTS BY TAXONOMIC GROUP

Plants A total of 71 plant families comprising 314 plant species were recorded during the RAP survey. An additional 30 leaf specimens were pressed for correct identification. At Atiwiredu, 145 plant species in 43 families were recorded, including three black star species *Gilbertiodendron splendidum*, *Psychotria longituba* and *P. subglabra*. At Asiakwa South, 247 species in 65 families were confirmed, including one black star species *Ixora tenuis*. A total of 189 species in 53 families were recorded from Asiakwa North, and among these were four black star species. Of these, two were recorded only from this site and are also listed on the IUCN Red List, *Neolemonniera clitandrifolia* (EN) and *Sapium aubrevillei* (VU).

Odonates (Dragonflies and Damselflies) A total of 72 species were found in the streams and rivers that have their headwaters within the reserve (and associated standing water habitats), although only 31 (43%) were found strictly within the reserve's boundaries. Eight species were recorded in Ghana for the first time, of which six (75%) were recorded inside the reserve. Of these, *Atoconeura luxata* is the most significant discovery because: 1) it had not been described at the time and material taken during the RAP was included in its recently published description; 2) it is the only regionally threatened dragonfly in western Africa that is found in Atewa (VU); and 3) it confirms the nationally unique 'montane' character of the site.

Butterflies Overall, 143 species belonging to 55 genera in five families were recorded during the Atewa RAP survey. The composition of butterfly species is plainly indicative of a good forest habitat. The suspected presence of *Tetrarhania baralingam*, *Neaveia lamborni* and *Bicyclus auricruda* in Atewa were confirmed during this survey. At present, *N. lamborni* and *B. auricruda* have not been recorded from any protected area in Ghana. Almost half of the 17 rare species recorded during the RAP survey are known either exclusively from Atewa or from just one other protected area in Ghana. Four of these rare species (*Mimeresia cellularis*, *Heteropsis peitho*, *Vanessula milca* and *Euphaedra splendens*) have been recorded exclusively from Atewa.

Interesting *Catuna* forms were noted, perhaps an indication that new (sub)species of the genus may be residing on the reserve. The RAP survey documented 16 endemic species of which two (*Euphaedra mariaechristinae* and *Ceratrichia maesseni*) are endemic to Ghana. The remaining are endemic

to the West Africa sub-region. Atewa provides a haven for many West African endemics. Ten such endemic species are so far known in Ghana only from the Atewa Range and might well be limited in Ghana to this reserve. The very high index of biodiversity, the presence of many endemic species, and several other species known from nowhere else in Ghana, and the pan-African rarity status of many of those species present in Atewa combine to indicate that its conservation importance is of the highest priority.

Orthoptera (Katydids) A total of 61 species of Tettigoniidae were collected, the highest number of katydids known from a single location anywhere in Africa. Of these, at least 8 are new to science, and 36 are new to Ghana. Site 2 (Asiakwa South) showed the highest species richness (50 spp.), likely due to a high edge effect created by a dense network of roads. The high diversity of sylvan katydids (Pseudophyllinae) and the mecopodines (Mecopodinae) (21 species total) indicate a low level of disturbance of the forest habitats within Atewa. However, the extensive network of roads in the reserve is already allowing for penetration of savanna species (*Ruspolia* sp.) into the reserve.

Other Invertebrates A new species of spider tick (order Ricinulei, Arachnida) was discovered within Atewa. This new species represents only the 58th known species of this ancient, relict group of organisms, known only from a few sites in the northern part of the Neotropics and West Africa. This is also the largest known species in this group. Its presence at Atewa indicates that this site may play a role of a refuge to organisms that have vanished from surrounding areas due to habitat loss and/or climate change. In addition, 68 ant species were documented during the RAP survey (Appendix 5).

Fishes The freshwater ecosystem studied during this RAP survey included the streams of Atewa, an area protecting the headwaters of the Ayensu, Birim and the Densu river basins, and from which these basins originate. A total of 15 streams within the Atewa forest and at sites just emerging out of the forest were surveyed and their fish fauna documented. Nineteen species of freshwater fish were recorded during the RAP survey, belonging to nine genera of five fish families: Mormyridae, Characidae, Cyprinidae, Cyprinodontidae and Cichlidae. All species encountered in the present study have been recorded in river basins in West Africa, but *Epiplatys chaperti spillamanni*, which we recorded in the Ayensu system, was previously known only from Côte d'Ivoire.

Amphibians We recorded a total of 32 species, but predict that overall species richness of the area can be expected to reach 40-50 species. The amphibian community of the Atewa Range is exceptional in comprising a) almost exclusively forest species, indicating an intact forest ecosystem, b) a very high percentage of species that are endemic to the Upper Guinea forests or even much smaller parts of these forests, and c) an extremely high proportion of threatened species (almost one-third are ranked as threatened on the IUCN

Red List). For one Critically Endangered species (*Conraua derooi*) the Atewa Range is likely to harbor the largest remaining population in the world. The occurrence of other rare, endangered, or undescribed species at Atewa is likely.

Birds During 16 days of field work in Atewa, 155 bird species were recorded. Of these, six are of conservation concern, amongst which three are classified as Vulnerable and three as Near Threatened. Six of the 11 species restricted to the Upper Guinea Forests Endemic Bird Area and 115 (or 64 %) of the 180 Guinea-Congo Forests biome species now known from Ghana were observed during the study. A song, heard and partly tape-recorded, was thought to be from the Nimba Flycatcher *Melaenornis annamarulae*, a Vulnerable species not previously found in Ghana; this record has since been confirmed and constitutes a major eastward range extension. The site, listed in 2001 as an Important Bird Area, was found to have a remarkably rich avifauna, with relatively large mixed-species flocks being a particularly conspicuous feature. Some species, such as Green-tailed Bristlebill *Bleda eximius* and Yellow-bearded Greenbul *Criniger olivaceus*, are at the eastern limit of their known range here. Several species that are rare in Ghana and uncommon to rare in their global range also occur in the reserve.

Small Mammals A total of 12 bat species were recorded. Composition of bat species clearly reflects a forest assemblage, with no savanna species being observed. Two rarely recorded bat species (*Hypsugo crassulus bellieri* and *Pipistrellus* aff. *grandidieri*) are reported for the first time for Ghana, raising the total number of species for this country to 86. Together with specimens from five localities in West Africa, *Pipistrellus* aff. *grandidieri* from Atewa might represent a species new to science. *Hypsugo* [*crassulus*] *bellieri* is endemic to the Upper Guinean forests. Zenker's fruit bat *Scotonycteris zenkeri* is ranked by the IUCN Red List as Near Threatened (IUCN 2007). The three terrestrial small mammal species recorded during the survey are likewise forest-dependent and include two West African endemics: Edward's swamp rat *Malacomys edwardsi* and the shrew *Crocidura grandiceps*. The latter is ranked as Near Threatened by the IUCN Red List and had not been recorded from Ghana since its description. The overall species composition of small mammals indicates high habitat integrity of Atewa, which constitutes the most significant block of Upland Evergreen forest in Ghana.

Large Mammals Altogether, 22 species were found at the three RAP sites with 12, 14 and 15 species recorded from Atiwiredu, Asiakwa South and Asiakwa North respectively. Of the species recorded, Pel's flying squirrel (*Anomalurus pelii*) is ranked as Near Threatened, Yellow-backed duiker (*Cephalophus silvicultor*), Black duiker (*Cephalophus niger*), Bay duiker (*Cephalophus dorsalis*), Maxwell's duiker (*Cephalophus maxwellii*) and Royal antelope (*Neotragus pygmaeus*) are classified as Lower Risk/Near Threatened, and West palm squirrel (*Epixerus ebii*) is listed as Data Deficient on the IUCN Red List. In addition to these

Table 3. Numbers of Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) amphibians, birds and mammals recorded during RAP surveys of 16 West African sites. # IUCN refers to species listed under the above categories plus Near Threatened (NT) and Data Deficient (DD). *preliminary results

	Côte d'Ivoire				Guinea				Liberia				Ghana			
	Haute Dodo	Cavally	Pic de Fon	Déré	Diécké	Mt. Béro	Boke	North Lorma	Gola	Grebo	Draw River	Boi-Tano	Krokosua	Atewa	Ajenjua Bepo*	Mamang River*
Area (ha)		25,600	8,920	59,143	26,850	N/A	71,226	202,000	260,326	23,540 (GSBA 12,800)	12,850 (GSBA 3,300)	48,170	23,663	569	5,300	
# sites	1	2	1	2	1	3	1	1	1	1	1	1	3	1	1	
# survey days	8	11	3	8	6	18	6	7	5	5	5	5	16	7	5	
# IUCN	30	42	14	33	25	8	27	22	39	22	17	14	26	2	4	
# CR	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	
# EN	3	4	0	4	0	2	5	2	3	4	3	1	2	0	0	
# VU	7	8	3	5	6	0	4	5	10	5	5	2	5	0	1	

species of international conservation concern, the African civet (*Civettictis civetta*), African palm civet (*Nandinia binotata*), Long-tailed pangolin (*Uromanis tetradactyla*) and Yellow-backed duiker (*Cephalophus silvicultor*) are nationally protected in Ghana. Interviews in fringe communities indicated that four additional mammal species are possibly present in the reserve, while five others could now be locally extinct. Many illegal activities, especially related to hunting, were recorded during the assessment. It was also noted that deforestation along trail lines and occasional illegal farms could be a significant factor affecting the conservation of large mammals in Atewa.

Primates Overall, six primate species belonging to four families were identified in Atewa, including two families of nocturnal prosimians represented by the potto, *Perodicticus potto* and Demidoff's galago, *Galagoides demidovii*. Four diurnal simians belonging to two families were also identified, including two Red-Listed colobus monkeys: Geoffroy's pied colobus, *Colobus vellerosus* (VU) and Olive colobus, *Procolobus verus* (LR/nt) and as well as two cercopithecine monkeys: the lesser spot-nosed monkey, *Cercopithecus petaurista buettikoferi* and Lowe's monkey, *Cercopithecus campbelli lowei*. The RAP results suggest that Sites 2 and 3 appear to be the most important for primates in Atewa and particularly slopes and plateaus within these sites, at least during this season of the year. The least evidence of primates per environmental category was recorded in valleys. Nevertheless, observations of fruit remains suggest that, in terms of primate diet, the gallery forest found in valleys constitutes an important habitat. The primate populations of Atewa require the integrity of this mountainous biotope (including plateaus, slopes and valleys) to survive.

RESULTS FROM THE CONSULTATIVE WORKSHOP

Following the RAP biodiversity survey, a workshop was organized to discuss the findings of the survey with chiefs, elders and community members of Akyem Abuakwa Traditional area. The workshop was chaired by the Chief of Asiakwa and was attended by 70 participants including politicians, government agencies and local NGOs.

The objectives of the consultative workshop were to 1) Review the results of the Atewa RAP survey, 2) Identify current uses of Atewa's biodiversity and how these uses are perceived to impact the forest's biodiversity, and 3) Identify actions that can be undertaken to mitigate biodiversity impacts to conserve Atewa's biodiversity and benefit surrounding communities. Appendix 10 provides a summary of the biodiversity uses, users/stakeholders, impacts of use, and suggested actions for conserving Atewa's biodiversity assets as discussed by three working groups during the workshop.

The workshop concluded that there is need for consultation involving all government agencies and companies involved in making decisions about the future uses and protection of Atewa. The workshop participants acknowledged the initiatives taken by ALCOA and encouraged ALCOA

and others to continue to:

- a) Deepen the level of commitment to consultation, as the communities would like to see more direct interactions between themselves and others and to be better informed,
- b) Take traditional practices into consideration in every interaction with communities and the forest,
- c) Demonstrate social responsibility in hiring practices, hiring from local communities whenever possible,
- d) Relate and interact with all community chiefs during all project stages, and
- e) Strengthen monitoring of the forest and its exploitation.

Representatives from the Ministry of Lands, Forestry, and Mines and the Forestry Commission expressed their support for conducting community consultations and keeping communication open with local communities about the future of Atewa. The participants in the workshop are listed in Appendix 11.

REGIONAL COMPARISONS OF BIODIVERSITY

To evaluate relative conservation significance, the Atewa RAP survey results were compared with results from seven other West African RAP surveys, covering 16 West African forest reserves (McCullough 2004; Alonso et al. 2005; McCullough et al. 2005, in prep; Wright et al. 2006a, b; Hoke et al. 2007). Direct comparison between the 16 sites is difficult due to wide variation in sampling effort and habitat types. However a number of observations as to the relative conservation value of Atewa can be made.

Appendix 12 lists IUCN Red-listed amphibian, bird and mammal species recorded from the 16 reserves studied during West African RAP surveys (excluding Schulenberg et al. 1999) and Table 3 presents summary statistics on the numbers of threatened species within these taxa recorded from each site. Of all 16 sites, only Atewa was found to hold any species of these taxa listed by the IUCN as Critically Endangered, the highest threat level possible. The frog *Conraua derooi* was recorded in Atewa and it is thought that this area may harbor the most important remaining populations of this species. *Conraua derooi* was originally described from western Togo (Hulselmans 1971) and apart from there is only known from a few Ghanaian sites, close to the Togolese border (Schlötter 1964 as *C. alleni*). Until very recently it had never been found again, although numerous suitable habitats were searched (Rödel and Agyei 2003, Leaché et al. 2006). Sites at which this species has previously been recorded are all close to human settlements and hence the persistence of the species in these areas is uncertain (A. Hillers et al. unpubl. data). Hence, this is an extremely important finding.

Table 4 shows the number of bird species recorded during each survey, followed by the number of species of birds

Table 4. Number of bird species recorded during West African RAP surveys, including the number of species restricted to the Upper Guinea Endemic Bird Area (EBA) and Guinea-Congo Forest biome.

	Côte d'Ivoire			Guinea			Liberia			Ghana						
	Haute Dodo	Cavally	Pic de Fon ¹	Déré	Diécké	Mt. Béro	Boke	North Lorma	Gola	Grebo	Draw River	Boi-Tano	Krokosua	Atewa	Ajenjua Bepo	Maman River
# bird species	147	153	233	140	150	189	239	143	145	156	126	109	138	155	121	115
Upper Guinea EBA	8	7	6	4	7	6	n/a	7	6	9	4	3	5	6	1	2
% Guinea-Congo forests biome	61%	63%	68%	56%	67%	51%	n/a	53%	49%	62%	53%	46%	54%	64%	44%	43%

making up the Upper Guinea Forests Endemic Bird Area and number of Guinea-Congo Forest biome species recorded from each site. While the total number of bird species recorded at Atewa is not exceptionally high when compared to several other reserves in other parts of West Africa (in Pic de Fon, Guinea, 233 species were recorded in 11 survey days), Atewa shows the highest number of bird species recorded from any of the reserves surveyed during other Ghana RAP surveys, and a higher proportion of Upper Guinea Endemic Bird Area species and Guinea-Congo Forest biome species as well. Longer survey time at Atewa can partially account for these higher numbers, but the 2005 RAP survey of Draw River, Boi-Tano and Krokosua Hills covered the same number of survey days and recorded 170 species from all three sites. These sites covered a number of different habitat types with the first two sites located in Ghana's Wet Evergreen forest and the third site (Krokosua Hills) over 100 km to the north and in the Moist Semi-deciduous forest, north-west subtype. Additionally, survey methods in the 2005 survey included mist-netting which was not employed during the Atewa survey; this can be expected to increase the species list as well.

In 1999, the Government of Ghana implemented the legal establishment of Globally Significant Biodiversity Areas (GSBAs), designated based on the Genetic Heat Index (GHI) of a reserve's botanical species. For the purpose of prioritizing plant conservation in Ghana, each plant species has been assigned to a star category, based on rarity. Black star species are internationally rare and uncommon in Ghana and urgent attention to the conservation of these species is called for. A high GHI signifies that an area is relatively rich in rare, black star species such that loss or degradation of the area would represent a highly significant erosion of genetic resources from the world, and from Ghana in particular (Hawthorne and Abu-Juam 1995). Atewa has been designated as a GSBA, but Atewa's GHI is lower than that of both Draw River and Boi-Tano (though higher than Krokosua Hills). However, Atewa is considered to be of high conservation importance primarily because of its Upland Evergreen Forest vegetation (Hall and Swaine 1976, 1981) rather than due to the presence of a large number of endemic species. As far as is known, there are no endemic plant species found in the Atewa Range. However, several species from Atewa (like *Aframomum atewae*, *Epistemma assianum*, *Hymenocoleus multinervis*, and *Ixora tenuis*) are known from only a few other places and most of these other locations are threatened or already degraded.

Atewa is also extremely important for insects, which are key to healthy ecosystem functioning. The RAP survey revealed that Atewa harbors the highest number of katydids known from a single location anywhere in Africa. Of these, at least eight species are new to science, and 36 species are new to Ghana. In addition, Atewa has long been known as a center of butterfly diversity for Ghana and West Africa and is now known to harbor the highest diversity of butterflies in all of West Africa (Larsen 2006, Chapter 5). This is not due to higher levels of collecting effort at Atewa since Larsen has done intensive butterfly research throughout Ghana and

West Africa. Larsen has recorded a total of 575 butterfly species in Atewa and estimates that there are at least 700 species there (Chapter 5). This high diversity includes at least two species endemic to Atewa, many rare species that are not elsewhere in Ghana, and the magnificent *Papilio antimachus*, which has the widest wingspan of any butterfly in the world. Larsen has recently proposed ranking the Atewa endemic, *Mylothris atewa*, as Critically Endangered, the highest threat level on the IUCN Red List of Threatened Species.

CONSERVATION CONSIDERATIONS

Between 1990 and 2005, the deforestation rate in Ghana was very high (2.0%) compared to most other countries in West Africa, resulting in the loss of 25.9% (1,931,000 ha) of Ghana's forest cover over 15 years (FAO 2006). Degradation and depletion of forests through logging, bushmeat hunting, encroaching agriculture and mining activities has severely reduced and fragmented the country's forest cover. Only designated forest reserves still contain significant forest blocks that serve as source areas for a broad variety of animal and plant species, protect watersheds and maintain Ghana's climate, thereby providing essential goods and services for the human population of the country (Agyarko 2001). Atewa constitutes the largest and most intact patch of Upland Evergreen forest in Ghana, representing at least 75% of this habitat type countrywide. This forest reserve is distinguished by one of the highest levels of biodiversity in Ghana, for butterflies the highest in the country and in all of West Africa (Larsen 2006, Chapter 5).

Recent studies have stressed the importance of maintaining larger intact forest blocks like Atewa to protect the last strongholds of forest-dependent species in Ghana. A study of the effects of habitat fragmentation on birds in Ghana revealed dramatic influence of patch size on species composition with only the largest fragments harboring area-sensitive species (Beier et al. 2002). Negative effects of climatic alterations as a result of fragmentation were demonstrated by Hill and Curran (2003). Montane areas are a particular case: as a result of orographic precipitation (mist and rainfall on mountain slopes and plateaus) these areas have offered long-term environmental stability and acted as refuges during drier times in the past. In line with this argument, Ricketts et al. (2005) predicted that future extinctions will be mainly found in species that are restricted to mountains. Atewa is the only significant Upland Evergreen Forest that remains between the Upper Guinea Highlands in the West and the Cameroon Mountain Range in the East.

Struhsaker and Oates (1995) have long warned of the critical situation of Ghana's forest fauna and the potentially tragic consequences for primate diversity of continued forest exploitation. Amongst the ten forest species of monkeys occurring in Ghana, three species, all endemic to southwestern Ghana and eastern Côte d'Ivoire, are highly threatened by extinction (Oates et al. 1997). Given the particular context and history of Ghana, each forest fragment presently populated by primates, regardless of size, should be actively pro-

ected from further destruction and fragmentation. The rich and original upland ecosystem of Atewa is a relatively large and isolated forest fragment, which constitutes an irreplaceable refuge for six primate species including two threatened species of colobus monkeys (IUCN 2007).

CONSERVATION RECOMMENDATIONS

With an area of 23,663 ha, Atewa represents one of the largest remaining forest blocks in Ghana and one of the largest GSBAs. In Ghana there is no other place like Atewa. The only other Upland Evergreen forest, in the Tano Ofin Forest Reserve, is smaller and significantly more disturbed, and the mountains near the border with Togo have a much drier climate. Outside Ghana there are no upland forests with a similar combination of species.

It is clear from the results of the RAP survey and previous studies that the Atewa Range Forest Reserve is an extremely important site for global biodiversity conservation and should be protected to the fullest extent possible. However, at the same time, the livelihood of the communities around Atewa must be considered in order to ensure long-term protection of the forest.

In order to protect the integrity of Atewa and its biodiversity, we propose two principal recommendations:

- I. **Within Atewa, the Government of Ghana should delimit and establish an integrally protected area with high protection status, such as a National Park, that includes all remaining intact Upland Evergreen forest, especially on the plateaus. A buffer zone covering the more disturbed slopes and valleys of the reserve should be established surrounding the core protected area.**
- II. **To ensure the sustainable protection of Atewa, alternative incomes for the local communities, particularly in Kibi, must be developed to reduce or eliminate their dependence on extractive industries and forest products from Atewa.**

To elaborate:

I. We recommend that the entire Atewa Range Forest Reserve be protected to the fullest extent possible due to its: 1) High levels of biodiversity (documented during this RAP survey and previous studies), 2) Significant tract of rare Upland Evergreen forest, and 3) Importance as a clean water source for local communities and many of Ghana's metropolitan areas. We recommend that the legal status of the reserve be upgraded to prohibit all exploitative activities, including mining, logging, and agriculture in the reserve.

The entire extent of Atewa's Upland Evergreen forest must be protected because focusing conservation effort on only a part of the range (such as only the northern part)

would lead to greater fragmentation of this unique forest habitat, loss of its function as a biodiversity corridor, and, ultimately, the likely loss of many of its species due to microclimatic changes caused by diminishing forest coverage and invasion of savanna elements into the reserve. The value of Atewa lies not only in the presence of rare or threatened species within its borders and the multiple ecosystem services provided by this biotic community (including, but not limited to, being a significant source of water to surrounding areas), but also in being a unique and a very complex ecosystem, one with a combination of species found nowhere else on the planet.

Any alterations to its present, largely undisturbed state will likely lead to a more depauperate and homogenous biological community with a lesser value to global biodiversity and, on a local scale, the area will become a less effective provider of ecosystem services such as pollination of surrounding agricultures or provision of freshwater. Even selective clearing of the plateaus would undeniably affect headwaters of major rivers and could have long-term destructive consequences on the environment, principally by increasing soil erosion on surrounding slopes and disturbing the hydrographical net of the entire sub-region. Habitat loss would put a number of species under serious threat of local extinction.

Specific recommendations:

1. **Delimit and establish an integrally protected area with high protection status, such as a National Park, that includes all the remaining intact Upland Evergreen forest within Atewa, especially on the plateaus.** We agree with previous recommendations for Atewa (Hawthorne 1998) that many parts of the lower slopes are heavily over-used and degraded and that priority areas for protection should be the forests on the higher altitude plateaus, slopes, and ravines as well as the forest remaining on the steep slopes. All forests on the plateaus merit strict protection, including the 17,400 ha covered with Upland Evergreen forest.

Critical areas that must be included in the core area are: a) The entire northern part of the Atewa Range, which is most intact, including the Asiakwa South and North RAP sites, which have high levels of biodiversity, a critically endangered frog species, and the Olive colobus primate (see Table 4), b) The central plateau area, including Atiwiredu, which has two black star tree species and a high diversity of amphibians and butterflies, c) Any Upland Evergreen forest areas remaining in the reserve, and d) All plateau swamps and wetlands, which soak up the rainwater and provide the source of the Ayensu, Birim, and Densu rivers.
2. **Establish a buffer zone covering the more disturbed slopes and valleys of the reserve, particularly in the southern areas of the reserve, for use by local com-**

munities within the Akyem Abuakwa Traditional Area. We concur with recommendations by Hawthorne (1998) that there is great pressure on the lower slopes that will most likely result in continued land use. The lower slopes should be incorporated into a buffer zone surrounding the protected area, within which sustainable land use practices should be developed that will restore and reforest degraded land.

3. **Re-evaluate then Implement and Enforce the Atewa Management Plan created by the Forestry Commission of Ghana.** Much thought and research has already gone into evaluating the importance of Atewa's biodiversity and watershed values, and in developing a management plan for its sustainable use (Abu-Juam et al. 2003). Based on the additional information from the RAP survey and other recent research, we recommend that Atewa be fully protected. If this recommendation is accepted and implemented, the Atewa management plan will likely need to be revised to incorporate management of a protected area and a buffer zone. A management plan should include the sustainable use of forest products (chewing sticks, fuel wood, etc.) in the buffer zone to ensure that they are not depleted. The new management plan should then be put into practice and enforced by the Government of Ghana in order to ensure that the area is protected.
4. **Implement a collaborative approach between public and private institutions,** including local communities, the Government of Ghana, international funding and aid agencies, the mining industry and environmental and social non-governmental organizations (NGOs) to address and halt the threats currently and potentially facing the reserve. Include scientific organizations and universities to improve our scientific knowledge of the area and to use these data for management of the protected area. The delineation and mechanism for protecting Atewa must take into consideration the high human population around Atewa, their relatively high level of poverty, as well as their dependence on the forests of Atewa for much of their livelihood.

II. Explore alternative income opportunities in and around Atewa for local communities to reduce their dependence on extractive industries and bushmeat hunting.

The people living around Atewa understand the need to conserve this treasured site. They have maintained this area, preserving its biodiversity for all these years. The government has also promulgated all the necessary legislation to the extent that Atewa is designated as a GSBA and the RAP survey and other studies have demonstrated its biological and ecological importance. The issue now at hand is the fact that there is bauxite available for exploitation whilst the people are impoverished. Cocoa, formerly the main economic base of the area, has now disappeared. The main road from Accra to Kumasi, which used to pass through the commercial

capital of the Atewa area, has been diverted to save time and short circuit the journey from Accra to Kumasi. The economy of the Atewa area is now in very poor condition. The employment opportunities offered by mining and other development of Atewa are very attractive to people who are in dire need of jobs. Even if the current development plans are abandoned, other development plans and groups will surface in the future. The key to preserving Atewa lies in building an economic base for the local communities that will be an alternative to the exploitation of the bauxite deposits and timber of Atewa.

Specific recommendations:

1. **Ecotourism** is likely the best option for bringing income to the region, particularly to Kibi, by transforming Atewa forest into world class ecotourism center, which will focus on the rare and beautiful species identified during the RAP survey and other studies. Atewa is located just a few hours drive from Accra and Kumasi, which makes it an ideal tourist destination for both local Ghanaian and international visitors. The attractions of Atewa could include birds, butterflies, insects, amphibians, primates, bats, the headwaters of the three rivers, the unique floral species, forest hiking, camp sites, swimming, and a retreat center. Tours could be run through a visitor center or Multi-Use Center (see below) and also through independent tour agents/NGOs operating out of Kibi and other local villages. Local hotels, restaurants, souvenir stands, and other shops will be needed to support a tourist industry.

To achieve this, a group of tourism and biodiversity experts should first develop a strategic plan with innovative experiential tourism design for the attractions, something unique comparable to the Kakum canopy walkway, which will attract people in great numbers to the site. The local community must be involved in approving and developing the plans, and eventually take over implementation of ecotourism activities. Alliances with international tour operators will bring additional international adventure and nature travelers to the area. Partnerships with NGOs, companies, and other organizations interested in ecotourism and the conservation of Atewa should be formed. Already, Butterfly Conservation Ghana has been promoting ecotourism visits to Atewa with an international partner, EcoTours (see <http://www.ecotours.hu/butterflies/butterflies00/ghana00>). Projects such as these should be supported and integrated into the Ecotourism plan for Atewa.

2. **To facilitate Ecotourism, establish a Multi-use Biodiversity Center near to Atewa.** The center should be based at the edge of Atewa so that visitors have easy access to the forest and can enjoy the cooler climate provided by the forest. It should also be located near to Kibi or other villages so they also benefit from tourist visits. The center could contain lodging, kitchen and

dining facilities, an educational center, classrooms, meeting rooms, laboratories, and a library. This center could also provide facilities for Christian or other religious communities to use as a spiritual retreat for prayer and meetings. Support for the center could come from the Christian community (both national and international), national government, international NGOs, private companies, and national and international universities. Most importantly, the center can be built, maintained, and staffed by local community members, thus providing long-term employment opportunities. This center could serve many functions including those listed below:

- a) **Research station** to facilitate research of Atewa and surroundings by Ghanaian and international scientists, promote collaborations, and train biology and natural resource management students;
 - b) **Tourist/visitor center** to bring ecotourism to Atewa and provide information about its biodiversity to visitors and residents;
 - c) **Education center** to raise awareness of the uniqueness and importance of Atewa: provide classes and training for local communities, jobs for local residents as interpreters and teachers, and opportunities for local and national school children to spend a night in the rainforest, Integration of a research and education center would provide opportunities for Ghanaian scientists and students to share their knowledge and research with tourists and local students;
 - d) **Spiritual retreat** for the Christian community and/or other local religions to have a place to get away to meet together; both Ghanaian and international Christian groups could use the center as a quiet and spiritual meeting place;
 - e) **Sustainable employment opportunity** for local community members as builders, managers, maintenance and housekeeping, tour guides, researchers, and research assistants.
3. **Investigate the possibility of a Payment for Ecosystem Services (PES) scheme** through which the users of the water provided by the watershed (e.g. Accra and other cities) pay the local communities around Atewa for protection of the forest and watershed. This would provide income to the surrounding communities in return for keeping the surrounding watershed and forest biodiversity intact. This type of PES scheme has been successfully implemented in many countries, most notably Costa Rica, by governments, NGOs, and private organizations. See McNeely (2007) for more information.
 4. **Investigate the current status and investments of international development/aid projects that are**

reported to be working in the Atewa area, including the GEF/World Bank/Government of Ghana Community Investment Fund Project, the GEF/World Bank-sponsored Promoting Partnership with Traditional Authorities Project (PPTAP) and the Government of Ghana sponsored Presidential Initiative on Tree Plantations Project on the communities around Atewa to support development of alternative incomes. Small grants can also be applied for through Conservation International's Verde Ventures program (www.verdeventures.org). There are many examples of successful ventures in all of the areas listed below that can be studied and consulted as models for developing such projects in the Atewa area.

5. **Other potential alternative-income industries:**

- a) **Butterfly farming** - for sale of live butterfly pupae to the global market,
- b) **Beekkeeping** - producing honey for local consumption and for sale,
- c) **Farming of native ornamental fishes** for aquarium trade,
- d) **Producing products for the tourist trade** such as baskets, Kente cloth weavings, wood carvings, etc.,
- e) **Alternatives to bushmeat hunting**, such as raising other types of animals for meat, including grasscutters and snails,
- f) **Orchards** of fruit trees and nitrogen-fixing crops (e.g. beans) on degraded land to provide food and also stabilize erosion and renew the soil.

RECOMMENDATIONS FOR MANAGEMENT OF ATEWA

I. Control hunting as it poses a significant threat to the large mammals and larger birds within the entire reserve. Hunting pressure is strong throughout Atewa, even in the northern areas where there are no roads. Evidence of hunting, including spent cartridges, snares and hunting trails was found at all three RAP sites (see Table 4). Healthy mammal and bird communities, as well as their associated invertebrate communities, are especially important for maintaining primary and secondary seed dispersal that are essential for plant regeneration and forest dynamics. Although hunting in the reserve currently mainly targets mammals, certain large bird species, such as Crested Guineafowl, Great Blue Turaco and large hornbills, are also illegally hunted.

- 1) **Prevent access to hunters along roads and trails.** Asiakwa North showed the most hunting evidence even though there are no roads there. There is access to the reserve through an extensive trail system used by local communities. Existing roads at Asiakwa South and Atiwiredu also provide easy access throughout the southern part of the reserve. Most of these trails and existing

roads need to be allowed to grow over and should be patrolled to prevent illegal access to the reserve. Regular use of trails by tourists and researchers will also deter illegal access and activities.

- 2) **Engage local people from communities in the area**, particularly the community of Kibi, in protecting the reserve and reducing hunting. Increase awareness of and pride in the biodiversity and watershed importance of Atewa among the local people through training. Involve local people in research (see below) and enforcement and provide education on the importance of conserving, rather than hunting, large mammals and on alternatives to bushmeat. Work with community Chiefs to establish hunting guidelines and to develop strategies based on their animal totems.
- 3) **Empower and fund the Wildlife Department and the Forestry Commission** of the Government of Ghana to protect the biodiversity of Atewa through increased monitoring and patrols, especially for illegal hunting (and logging). Enforce penalties for any illegal activities or trespassing.
- 4) **Make an alliance against hunting with all who have access to Atewa**, including local communities, government agencies, development agencies, and NGOs. This would help to control the distribution and sale of bushmeat from Atewa and educate local people on the importance of protecting globally threatened species that live in their forests.
- 5) **Conduct research to determine which larger mammal and bird species are targeted and most heavily impacted.** The population sizes of key species that are most heavily hunted and most highly threatened in this area can then be determined and used to inform more specific recommendations on conserving key species threatened by hunting.

II. Protect the headwaters of the Ayensu, Densu, and Birim rivers that originate within the Atewa Range.

The steady flow of clean water off the Atewa Range is determined by the capacity of the soil, swamps and forest on the plateaus and in the valleys to store and filter rainwater, and to buffer for spates and droughts. Both human and wildlife populations around Atewa depend on this healthy and reliable resource for their survival. The threatened frog species found on the range and the high diversity of dragonflies and damselflies rely on the watershed.

The RAP results indicate a healthy watershed in Atewa and the surrounding area, with limited pollution and streambed erosion. This is confirmed by the presence of forest species even in more disturbed landscapes. However, activities entailing the removal of vegetation

or mineral deposits from the range could seriously compromise its capacity to store, buffer and filter rainwater, jeopardizing the reliable discharge of freshwater into the region's rivers, an essential resource for millions of Ghanaians and a rich biodiversity.

- 1) **Protect the plateau forests in the upper catchment of the Ayensu, Densu and Birim rivers.** Control and restrict access to the forests and swamps, especially with regard to small-scale miners, loggers and shifting cultivation plots. Create a strict protected area on the plateaus as discussed above.
- 2) **Leave buffer zones of vegetation of at least 100 m around water bodies** (e.g., rivers, swamps and other inundation zones) if any activities are to take place in the reserve (including the Multi-use Station). Any removal of forest cover from stream banks must be rigorously controlled and monitored.
- 3) **Prevent sedimentation and runoff from mining, roads, and clearings**, which all have negative impacts on the water quality in the streams. Especially in the southern part of Atewa, human activities including logging, agriculture, hunting, and roads currently threaten the integrity of the aquatic ecosystems. These impacts are particularly high in the foothills.
- 4) **Initiate a water-quality monitoring program of the status of several key aquatic taxa** (including fishes, amphibians, plants, and selected invertebrate groups) as well as water quality and sedimentation to create a baseline and identify negative impacts to aquatic resources before they become irreversible. Monitoring specific responses to certain indicators is essential. We recommend following standard aquatic monitoring protocols at regular intervals (at least twice a year).
- 5) **Educate local communities on the benefits of preserving riparian flora and fauna** so that they understand the role that riparian vegetation plays in preserving the quality and quantity of their water, as well as preventing soil erosion.

- ## III. Maintain corridors and large tracts of forest to ensure survival of larger species and to maintain ecosystem processes.
- Linking patches of forest by corridors is important to addressing the increasing problem of habitat fragmentation, both within and outside of Atewa. Larger mammal species, such as the threatened primates, and many bird species need large tracts of forest for feeding and nesting. Threatened species have a much higher chance of going extinct in smaller forest patches that have no connection to additional habitat or that lack a large enough elevation range to allow species to adapt to changing conditions and human pressures.

- 1) **Maintain Corridors along the length of the Atewa Range** to allow for species migrations and adaptations to changes in habitat and human pressures. Keep the northern part of the reserve as intact as possible to maintain a large tract of forest and keep connections to the southern parts of the reserve.
 - 2) **Reforest roads, trails and clearings** that are no longer in use to reduce habitat fragmentation and human access to the forest and to discourage illegal logging, hunting of large mammals, and agricultural production. Trails and other access routes in all three areas should be minimized and regulated and roads should be blocked and reforested to prevent large-scale encroachment into the reserve. The few roads and trails necessary to provide access for ecotourism and research should be carefully maintained and patrolled to ensure the least possible impact.
 - 3) **Link Atewa to other forest reserves and patches of forest.** Outside of Atewa, the Kwahu plateau forested zone, about 15 km north from Atewa contains similar upland habitat and is consequently a good candidate to connect to Atewa. A feasibility study including assessment of diversity in Kwahu and landscape description should be carried out prior to such an action.
 - 4) **Promote and utilize biodiversity friendly land-use practices** in agricultural areas between forest reserves to maximize biodiversity in the areas surrounding Atewa and to provide a connection between Atewa and nearby forest reserves. This could include minimizing the use of pesticides and herbicides and other chemicals in agriculture, promoting crop rotation and natural pest control, and planting native tree species among crops to harbor wildlife.
 - 5) **Prohibit logging** in the core protected area on the plateaus and upper slopes and strictly control logging in the buffer zone on the lower slopes. Logging accelerates habitat fragmentation and habitat degradation.
 - 6) **Monitor several key species or groups that depend on intact forest** to ensure healthy populations and to detect changes as early as possible to prevent serious declines. Target groups should include large and small mammals, amphibians, and several insect groups. Since small mammals are highly dependent on forest structure for their survival and constitute a key component of the diet of large animals, monitoring small mammal diversity and abundance is a good way to track the integrity of the forest ecosystem.
- IV. Conduct in-depth studies focusing on threatened, rare and endemic species,** and during other seasons, and expand basic species surveys to include additional groups of organisms.
- 1) **Conduct studies of the Critically Endangered *Conraua derooi*** in Atewa and other areas where it is known to occur. While this species is historically known from a number of sites, recent surveys have failed to record it from some of its previously known localities. At other sites, it is under severe pressure from habitat degradation and consumption. Hence, Atewa could hold the last remaining viable population of this Critically Endangered species and we urgently recommend additional surveys to determine if this is the case. Areas holding 95% of the remaining population of a Critically Endangered species are eligible for consideration as Alliance for Zero Extinction (AZE) sites, a designation which would increase the significance of Atewa as a conservation target and could potentially increase available funding for conservation activities.
 - 2) **Survey during the dry season.** This RAP survey was conducted during the rainy season when the plants *Mapania bakdwinii* and *Leptapisi cochleata* form a carpet covering much of the forest floor making footprints, dung and other signs of animals difficult to see. Undertaking a similar survey during the dry season and sampling additional areas towards the periphery of the reserve would most likely increase the number of mammal species directly or indirectly encountered, thus adding to the confirmed species list for the reserve.
 - 3) **Conduct additional surveys for groups of organisms not included in previous surveys,** but having a high probability of including rare and/or new species, such as dung beetles, preying mantids, arachnids, or mollusks (both freshwater and terrestrial).

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