



The Future of the Biodiversity of the Gran Caldera Scientific Reserve

Translating Science into Policy to Develop an Effective Management Plan for the Gran Caldera Scientific Reserve



Version 1.0 - May 2015



Front Cover: (Clockwise from left) Aerial view of the Gran Caldera de Luba (Photo by Tim Laman, National Geographic); BBPP Forest Patrol Leader, Cirilo Riaco, instructs students from la Universidad Nacional de Guinea Ecuatorial and Drexel University on the use of the Cybertracker data collection program near Playa Moraka; Schoolchildren in Ureca show off their handiwork during a marine turtle educational outreach program.

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For more information about the island of Bioko and its wildlife, visit the BBPP website:

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Executive Summary

Bioko Island, Equatorial Guinea (Fig. 1), has long been recognized as one of the most important places in Africa for biodiversity conservation due to its species richness and high number of endemic species across taxonomic groups, including primates, birds, and sea turtles. Much of this diversity is contained within two protected areas, Pico Basilé National Park (PBNP) and the Gran Caldera de Luba Scientific Reserve (GCSR), which together encompass roughly 40% of the island (Fig. 1).

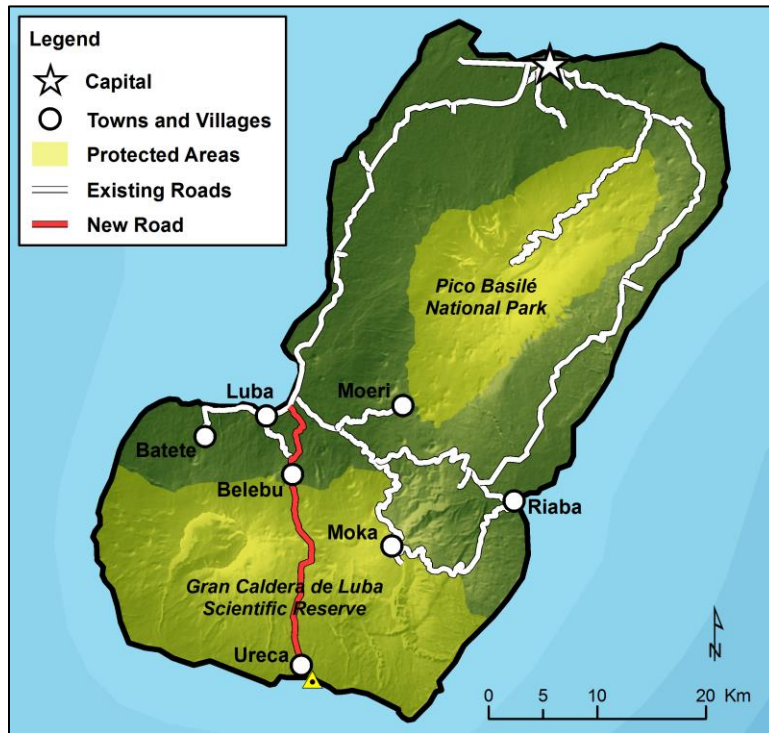


Figure 1: Bioko Island, Equatorial Guinea: The new road bisecting the GCSR has opened previously inaccessible areas and created new opportunities for illegal exploitation of wildlife and forest resources, stimulated new interest in development activities at Ureca, and facilitated establishment of (unregulated) tourism in the south. Critical sea turtle nesting habitats, indicated here with a yellow triangle, are now directly accessible by the new road.

The GCSR, which covers the southern 25% of the island, encompasses two volcanic peaks, the Gran Caldera de Luba and Pico Biao, and covers an elevation range from sea level to 2,261 m. Due to its relative inaccessibility, the GCSR is among the last of the unspoiled natural habitats not only in EG, but in the whole African continent. Work conducted in the area over the last three decades, mostly by Asociación Amigos de Doñana from 1985 through 1998, and by the Bioko Biodiversity Protection Program (BBPP) since 1997, suggests that the number of species of plants and animals described to date in the GCSR is probably an underestimate. As such, the International Union for Conservation of Nature (IUCN) considers the GCSR a top priority reserve.

Unfortunately, the commercial bushmeat trade that has operated on Bioko for decades has severely decreased diurnal primate populations in PBNP as well as localized areas of the GCSR (Albrechtsen et al. 2007; Cronin 2013, 2014). Furthermore, the construction of a new road (Fig. 1), which bisects the GCSR, has only exacerbated the situation in the south. Unless measurements are taken promptly, the future of the



ecosystem of the GCSR and the well-being of the inhabitants that rely on the natural resources it offers are in very serious jeopardy.

To mitigate these threats, the Bioko Biodiversity Protection Program (BBPP) is convening a 2-day participatory Science & Policy workshop in Malabo in on 11-12 June 2015 that will engage all stakeholders (civil society, policy makers, scientists, educators, NGOs, and government ministries) in Equatorial Guinea that are working towards the conservation of Equatorial Guinea's natural resources in order to build a solid foundation for developing an evidence-driven management plan for the GCSR.

Developing and establishing a GCSR management plan, is necessary for the protection and long-term survival of the unique species found in the GCSR, and to ensure the livelihood, wellbeing, and traditional values of the communities within and surrounding it. Without a management plan, development and exploitation within the GCSR will occur on a haphazard basis, with little consideration as to the implications for the future. The result is likely to be lost opportunities, both environmental and socioeconomic, and irreversible damage to GCSR's resources and values.

The expected outcomes of the Science & Policy Workshop are:

- Creation of a detailed framework for a GCSR management plan;
- Production of a strategy to secure Ministerial approval of the GCSR management plan; and
- Development of a document detailing the potential recognition of the GCSR as a World Heritage site and Biosphere Reserve by UNESCO, as well as a framework for the development and submission of an application to UNESCO in order to achieve this goal.

Justification for the Workshop

Bioko Island, Equatorial Guinea (Fig. 1), has long been recognized as a hotspot for faunal species richness and endemism across taxonomic groups (Myers et al. 2000; Brooks et al. 2001). Bioko is home to 11 species of primates (Table 1) and has been ranked as the single most important place in Africa for the conservation of primate diversity (Oates 1996). In addition, the Mount Cameroon and Bioko montane forests ecoregion is considered among the most globally important regions for the conservation of forest-dependent bird species (Buchanan et al. 2011). The southern coast of Bioko, with its roughly 19 km of sandy beaches, has been classified as one of the most important sea turtle nesting areas within the Gulf of Guinea (Butynski 1996; Fretey et al. 2007; Tomás et al. 2010) (Table 1). Species richness of plants (>2,000 species), birds (198 species), reptiles (52 species) and amphibians (32 species) are also high, and are all believed to be underestimates of the total number of respective taxa found in the region (Eisentraut 1973; Figueiredo 1994; Myers et al. 2000; Perez del Val 2001; Oates et al. 2004; Velayos et al. 2013).

Table 1: The primates and sea turtles of Bioko Island, Equatorial Guinea and their degree of threat status at the species and subspecies levels IUCN (2014d). Taxonomic classification of primates follows (Grubb et al. 2003), except for Preuss's monkey, which is allocated to the genus *Allochrocebus* following Grubb (2006). Table adapted from Butynski et al. (2009).

Vernacular name	Binomial name	Red List Category	
		Species	Subspecies
Bioko black colobus*	<i>Colobus satanas satanas</i>	Vulnerable	Endangered
Bioko red colobus*†	<i>Procolobus pennantii pennantii</i>	Crit. End.	Endangered
Bioko drill*	<i>Mandrillus leucophaeus poensis</i>	Endangered	Endangered
Bioko Preuss's monkey*	<i>Allochrocebus preussi insularis</i> ††	Endangered	Endangered
Bioko red-eared monkey*	<i>Cercopithecus erythrotis erythrotis</i>	Vulnerable	Vulnerable
Crowned monkey	<i>Cercopithecus pogonias pogonias</i>	Least Concern	Vulnerable
Bioko putty-nosed monkey	<i>Cercopithecus nictitans martini</i>	Least Concern	Vulnerable
Bioko Allen's galago*	<i>Sciurocheirus alleni alleni</i>	Least Concern	Endangered
Bioko needle-clawed galago*	<i>Euoticus pallidus pallidus</i>	Least Concern	Endangered
Demidoff's galago	<i>Galagoides demidovii</i>	Least Concern	n/a
Thomas's galago	<i>Galagoides thomasi</i>	Least Concern	n/a
Leatherback turtle	<i>Dermochelys coriacea</i>	Vulnerable	n/a
Green turtle	<i>Chelonia mydas</i>	Endangered	n/a
Olive Ridley turtle	<i>Lepidochelys olivacea</i>	Vulnerable	n/a
Hawksbill turtle	<i>Eretmochelys imbricata</i>	Crit. End	n/a

* Recognized by Grubb et al. (2003) as subspecies endemic to Bioko. †Recognized by Groves (2007) as a species (*Ptilocolobus pennantii*) endemic to Bioko. ††Allocated to the genus *Allochrocebus* following Grubb (2006).

Much of this diversity is contained within two protected areas, Pico Basilé National Park (PBNP) and the Gran Caldera de Luba Scientific Reserve (GCSR), which together encompass roughly 40% of the island (Fig. 1). PBNP, in the northern half of the island,



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encircles Pico Basilé with a total area of 330 km² and ranges from approximately 800 m to the summit. The GCSR, covers the southern 25% of the island (510 km²), encompasses two volcanic peaks, the Gran Caldera de Luba and Pico Biao, and covers an elevation range from sea level to 2,261 m.

Unfortunately, the commercial bushmeat trade that has operated on Bioko for decades has severely decreased diurnal primate populations in PBNP as well as localized areas of the GCSR (Albrechtsen et al. 2007; Cronin 2013, 2014). Furthermore, the construction of a new road (Fig. 1), which bisects the GCSR, has only exacerbated the situation in the south. Unless measurements are taken promptly, the future of the ecosystem of the GCSR and the well-being of the inhabitants that rely on the natural resources it offers are in very serious jeopardy.



The History of Conservation on Bioko and in the GCSR

The notion that there were unique natural areas on Bioko Island, and that they should be protected from excessive human development, dates back to Spanish colonial times when Pico de Santa Isabela Park (now Pico Basilé) was one of approximately five mandated protected areas in what is now Equatorial Guinea (EG).

After independence and with assistance from Spanish scientists, in particular Javier Castroviejo of the Doñana Biological Station, the EG government enacted Ley 8/1988 (Republic of Equatorial Guinea 1988), which created and delineated two protected areas on Bioko Island, Pico Basilé National Park and Gran Caldera Scientific Reserve. Although the organisms and ecosystems that comprise these two protected areas are legally protected by legislation, by executive decrees, and by international treaties, the EG government has yet to provide the necessary enforcement (Republic of Equatorial Guinea 2003; Albrechtsen et al. 2007; Republic of Equatorial Guinea 2007; Cronin et al. 2010; Cronin 2013). Faced with evidence of possible biodiversity loss, other organizations stepped in to assist, but only two organizations have been extensively involved in the protection of Bioko's biodiversity, especially the Gran Caldera Scientific Reserve: Los Amigos de Doñana (1985 – 1998) and the Bioko Biodiversity Protection Program (1996 – present).

Los Amigos de Doñana

Begun in 1985 as the Research and Nature Conservation Program in Equatorial Guinea, this ambitious program, which was administered by the NGO Los Amigos de Doñana and financed by Spanish foreign aid, lasted in its various iterations until January 1998. In its initial phase, summarized in a workshop (entitled “Biodiversity and Conservation of the Gulf of Guinea Islands”) held at the Jersey Wildlife Preservation Trust (JWPT) in June 1993, the Program reported substantial progress on almost all of its objectives (Castroviejo et al., 1994):

Increase scientific research: At least six Spanish scientists, all but one (Gonzalez Kirchner) directly affiliated with Doñana, had completed zoological studies on Bioko Island in the late 1980's and early 1990's:

- Ramon Castelo: 7 month study of fish Nov 1988 – June 1989, 1800 specimens, 43 species of 21 families, 18 of which were new records for Bioko.
- Castroviejo et al: intermittent 8 year observations on nesting sea turtles 1985 – 1994 (Castroviejo et al. 1994)
- Juste & Ibáñez: study of bats (Juste & Ibáñez 1994)
- Pérez del Val et al., 43 mo study of birds, 1989 – 1991 + Jan – July 1992, including 100+ days of mist netting at 400 m elevational gradients (Pérez del Val et al. 1994; Perez del Val 1996)
- Juan Pedro González Kirchner: study of primates 101 days of data collection on Bioko, Feb-Apr, 1990; Oct-Dec, 1990; and, July-Aug 1991 (González-Kirchner 1994; González-Kirchner 1995, 1996b, a, 1997, 2004)



Set up a Museum of Natural History: Intended for the city of Bata on the mainland, this objective was never realized.

Update environmental legislation & create a network of protected natural areas: Ley 8/1988 was the result of these objectives.

Promote EG's participation in international forums on the environment: EG's inclusion in the European Union's Central African Forest Ecosystems (COFAC) project and the designation of Monte Alén National Park as the EG demonstration project were results of this objective. Another result was the creation in 1996 of the EU-financed project "Conservation and Rational Use of Equatorial Guinea's ecosystems" (CUREF). Both of these accomplishments focused on Rio Muni rather than Bioko Island.

Train local personnel: Local personnel were trained either in specialized institutions in Spain or in situ. Some of these trained personnel remain active in conservation – related positions to this day.

Implement environmental education programs: This nation-wide initiative that included posters, stickers, conferences, radio and TV appearances by Doñana personnel, and meetings with government officials, was the first of many attempts to promote the concept of biodiversity conservation with the citizens of EG.

In a second phase, beginning in 1995, the Bioko Island initiatives of Doñana shifted from biodiversity research to biodiversity protection, community development and ecotourism with the greatest progress being made in 1996. By summer of 1997 many projects were abandoned apparently because of a reduction in funding.

Notable among the community development projects were attempts to raise bushmeat species (giant forest snails; cane rats) in pens in Batete. The community development projects also included establishing commissaries ("economatos") in villages (Ureca, Bocoricho, Belebu, Ruiche) that sold food and other commodities at Malabo market prices. The commissary in Ureca was resupplied every two weeks by cayuco, a system that also provided transport for villagers to and from Malabo. Educational outreach included a conservation course given to more than 20 local teachers and environmental educators.

As part of the ecotourism initiatives, three tourist lodges were established: one at Moka (the Basque-style Spanish vacation house at the edge of town); one constructed from local materials in the village of Ureca (now used as a military barracks), and a third, also constructed with local materials at Moraka Playa along the southern coast (washed away in storms across the following 15 years).

The activities sponsored by Los Amigos de Doñana were suspended indefinitely by the government of Equatorial Guinea in January 1998. A preliminary management plan for the Gran Caldera Scientific Reserve, mentioned in several sources [e.g. Amsallem et al. (2003)] dating from the years immediately after the departure, has never been located.



Bioko Biodiversity Protection Program

Begun in 1998, the Bioko Biodiversity Protection Program (BBPP) was designed as an academic partnership between the National University of Equatorial Guinea (UNGE) and initially Arcadia University (until 2007) and then later Drexel University (2007 onwards).

This partnership grew out of an initial research expedition to Bioko Island by BBPP founder, Gail Hearn, first in 1990 (to the Gran Caldera, led by Dietrich Schaaf and Tom Butynski) and again in 1992 (to Rio Epola, led by Dietrich Schaaf and Tom Struhsaker). Both trips were exploratory attempts by Zoo Atlanta to identify a drill monkey research site.

Building on Arcadia University's expertise in university study abroad, Hearn returned to Bioko Island in the 1996 dry season with five Arcadia students on an expedition to the Gran Caldera to determine the feasibility of an undergraduate research course based on the island's wildlife. The expedition was co-sponsored by the Philadelphia Zoo and co-led by Bob Berghaier. It was the first of 19 consecutive Gran Caldera Expeditions sponsored by BBPP. In each expedition, researchers, paying volunteers, university students and local guides trained by BBPP, worked in teams to repeatedly census a 26 km trail network in and around the Gran Caldera to determine the status of forest wildlife, especially Bioko's seven species of monkeys. When 1998 census results revealed a decline in wildlife, BBPP set up year-round forest patrols to conduct monthly surveys to monitor wildlife populations and to provide passive protection for wildlife in the GCSR Reserve.

The initiation of Arcadia University activities on Bioko Island coincided with the first setback suffered by Los Amigos de Doñana, a reduction in funding in the summer of 1997. The two remaining research programs sponsored by Doñana, a bushmeat enumeration study in Malabo led by John Fa of the Jersey Wildlife Preservation Trust and a nesting sea turtle tagging and enumeration project led by Valencia University graduate student Jesus Tomas Alguirre were both ceded to BBPP, first the bushmeat enumeration in fall 1997 and then after the permanent departure of Doñana in 1998, the turtle project in fall 2000. The resulting three long-running BBPP data collection projects (forest census, bushmeat market census and turtle census) have provided important measures of the status of wildlife on Bioko Island and have also provided part time or seasonal employment for more than 40 local people

A formal agreement between Arcadia University and UNGE was signed in 1999 establishing BBPP as the facilitating organization. With additional leadership from Arcadia economics professor, Wayne Morra, a coordinated program to promote biodiversity conservation on Bioko Island was initially funded by the Central African Program for the Environment (CARPE) through Conservation International. As part of these activities, BBPP worked in conjunction with personnel from the EG Ministry of Forests (INDEFOR) to mark the boundaries of both PBNP and the GCSR with bright yellow "No Hunting" signs.



In March 2002, Conservation International, BBPP and UNGE sponsored an ambitious “Bioko Biodiversity Roundtable” in Malabo. The 3 day conference included 26 representatives from 13 different institutions: CUREF, INAP, CICTE, Ministry of Forests, UNGE, BBPP, Arcadia University, Conservation International, Duke University, ECOFAC, Real Jardín Botánico, Museo de Ciencias Naturales, Universidad Libre de Bruselas, Universidad de Alcalá, and the Durrell Wildlife Conservation Trust. One of the actions recommended as a result of this conference was the creation of management plans for both of Bioko’s protected areas, but this recommendation was never pursued. Conservation International remained active in EG, with a headquarters in Bata until 2012. A second conference held 10 years later in both Bata and Malabo immediately before CI’s departure, was much smaller and more local in scale.

In the fall of 2002, BBPP utilized the extensive expertise of Arcadia University’s Center for Education Abroad and established a conservation-based semester of study abroad on Bioko Island for US university students, matching them in their classes and in the field with comparable UNGE students. In subsequent years, BBPP ran summer workshops at Arcadia for UNGE faculty and administrators, accompanied two UNGE faculty members to a sea turtle course in Venezuela, educated EG undergraduates, and provided graduate education (MA in Environmental Education; Ph.D. in Environmental Science) for two UNGE faculty members.

In fall 2007, Gail Hearn moved her affiliation to Drexel University’s Department of Biology, and a new partnership agreement was signed between Drexel and UNGE. The study abroad program transitioned to Drexel the following year. Drexel University offered the advantages of a much larger more research-oriented university, including doctoral students. Four PhD students and three MS students pursued in depth research investigations on topics including bushmeat market dynamics, drill monkey feeding ecology, red colobus behavior, anuran speciation, chameleon distribution and abundance, and West African conservation policy.

In 2008, BBPP opened the first biological field station in Equatorial Guinea in the village of Moka on the northern border of the GCSR. The Moka Wildlife Center was funded by ExxonMobil Foundation and housed in what had previously been Doñana’s tourist lodge. BBPP expanded the facility to include space for a field station manager, work areas for scientists and a small education center with an even smaller classroom and specimen collection. It served as the venue for the field methods and field research classes offered as part of the study abroad program.

BBPP has conducted many outreach programs, ranging from meetings with EG government officials and awareness meetings in villages to basket and jewelry-making enterprises in Ureca and Moka. The educational outreach to elementary school children based on environmental educator Heidi Rader’s award winning book “Moon Over Bioko” has been especially effective. Presented by a team of UNGE students from the Environmental Science department, the program has reached more than 1000 children on the Island.



BBPP has been fortunate in generating effective media coverage beginning with a 9-part series covering the 2005 Caldera Expedition by reporter Andy Maykuth in the Philadelphia Inquirer, and extending through a 22 page article in National Geographic Magazine following the participation of four photographers and well-known science writer Virginia Morell on the 2008 expedition. BBPP has also sponsored several video productions, most notably “The Drill Project” by Justin Jay.

Throughout its existence BBPP has cultivated a wide variety of funding sources: established conservation organizations including CI, Margot Marsh Biodiversity Fund, National Geographic conservation Trust, IPPL and Primate Conservation International, Los Angeles Zoo, Philadelphia Zoo and Minnesota Zoo; small foundations including Beneficia and the Tombros Foundation; federal and state sources including US Fish and Wildlife “Wildlife Without Borders” Program and the Pennsylvania Department of Education; energy companies operating on Bioko Island including ExxonMobil and Mobil Equatorial Guinea Inc., Hess, Marathon, Noble Energy, EGLNG, NOMECCO, etc.

BBPP moved to a new phase in fall 2014 when Gail Hearn retired as Director and Mary Katherine Gonder assumed leadership. New directions include increased emphasis on research, new academic connections with other institutions in nearby African countries, and expanded faculty development opportunities at UNGE.

Current State of the GCSR

This section summarizes the data that BBPP has been collecting on the GCSR, and describes the relationship between the local communities and the natural resources within the GCSR.

Forest Surveys

In order to investigate the impact of hunting on wild primate populations, targeted forest surveys were conducted throughout the GCSR at three sites representative of differing levels of human access and activity: Moraka Playa, Ureca, and Belebu (Cronin 2013). A significant negative relationship was found between primate abundance and shotgun hunting (Fig. 2), with primate encounter rates were lowest in areas of heavy hunting. A “hunting response index” (HRI) (Linder & Oates 2011) was developed in order to infer primate species-specific vulnerability to hunting. HRI values of less than one suggest that a species is vulnerable to hunting, while greater than one suggest the species may be resilient, and a value equal to one suggests no effect from hunting. Four of seven primate species exhibited vulnerability to hunting, as they were all encountered less in heavily hunted forests (Fig. 3). *P. pennantii* was most vulnerable to hunting, a trait it shares with many other highly threatened forms of red colobus across Africa (Struhsaker 2005). These data suggest that hunting is damaging to primate populations, and that it has the potential to lead to significant changes in primate community structure and even extirpation in some cases.

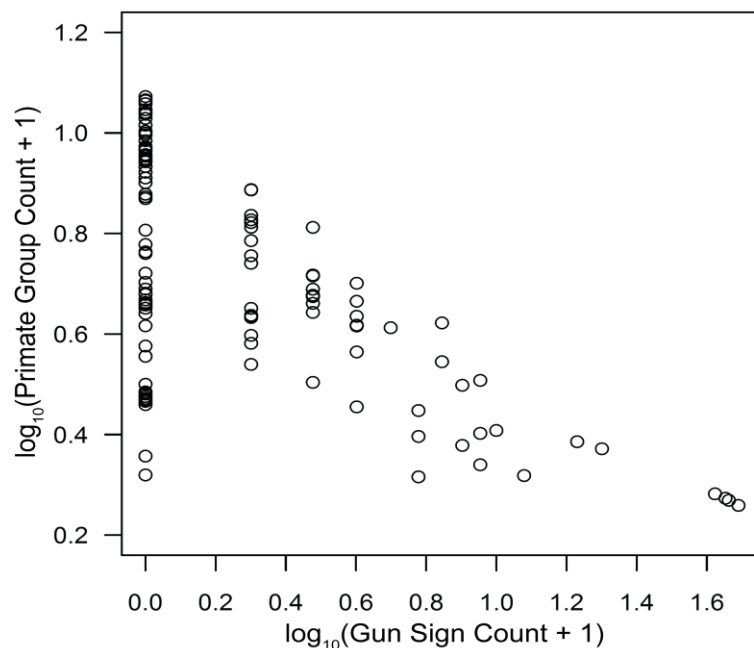


Figure 2: Negative binomial plot illustrating the relationship between counts of gun hunting signs and diurnal primates group. Primate abundance was highest in the absence of hunting and was negatively correlated with counts of gun hunting signs. Adapted from Cronin (2013).

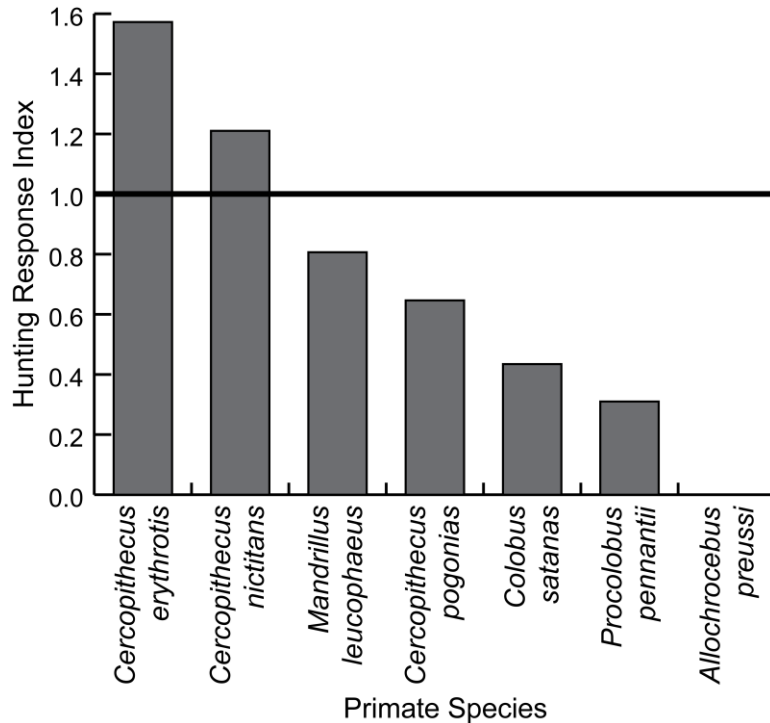


Figure 3: Hunting response index values (HRI) for six of the seven diurnal primate species on Bioko. *Allochrocebus preussi* was not encountered along transects used for in the HRI analysis, and was excluded from the analysis. HRI values above 1 suggest a relative tolerance to hunting pressure, while values below 1 indicate susceptibility of the species to hunting. Adapted from Cronin (2013).

Primates as Umbrella Species

Using the survey data collected between 2008-2012, the BBPP developed ecological niche models for each of Bioko’s monkey species (Fig. 4a). Results from these models indicate that for all monkeys except for Preuss’s guenon (*Allochrocebus preussi*), a primarily montane species, the GCSR holds the highest amount of, and in some cases all (e.g. Bioko red colobus [*Procolobus pennantii*]), of the existing suitable habitat on Bioko. Using the overall species richness derived from these models, it becomes clear that the GCSR is a hotspot for primates, especially the southwestern sector (including the Gran Caldera de Luba), as it is the only area on the island that holds all 7 species of monkeys (Fig. 4b).

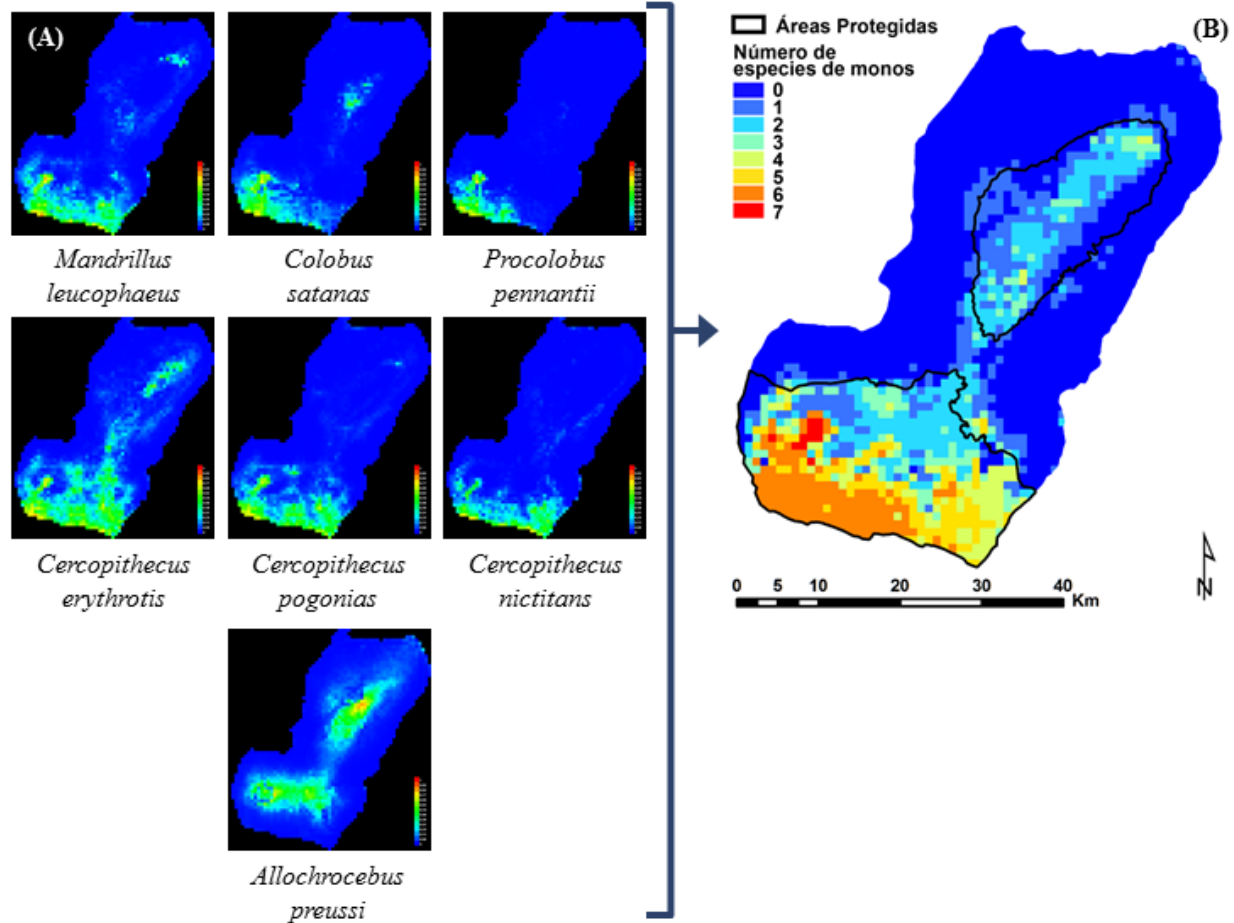


Figure 4: (A) Ecological niche models showing the distribution of each of Bioko's monkey species. (B) Overall primate species richness derived from the ecological niche model outputs. These summary data have allowed for the identification of primate hotspots, and furthermore, priority areas for conservation which highlight the importance of the GCSR to Bioko's primates.

The case of the Bioko red colobus (*P. pennantii*), perennially considered among the world's most endangered primates (Mittermeier et al. 2007; Mittermeier et al. 2010; Cronin et al. 2014a), illustrates the biological importance of the GCSR and the utility of using primates as umbrella species for conservation. Previous work has suggested that *P. pennantii* is the only species endemic to Bioko (Groves 2007; Oates 2011; Groves & Ting 2013), despite high subspecific endemism among the other 6 species (Oates 2011), and that it is also the species most vulnerable to the impacts of hunting (Cronin 2013). Forest surveys conducted by the BBPP (Cronin 2013; Cronin et al. 2013) have shown that the distribution of *P. pennantii* is almost half the size of previous estimates (Oates 2011; IUCN 2013), and that its entire extent is within the boundaries of the GCSR. Furthermore, the distribution of *P. pennantii* encompasses not only the areas with the highest species richness of monkeys on Bioko, but also much of the critical sea turtle nesting beaches (Figs. 4 & 5). Thus, if *P. pennantii* can be effectively conserved, it will serve as an umbrella for the conservation of many other wildlife species and habitats, including the Gran

Caldera and a large swath of contiguous forest along an elevational gradient from sea level to over 2,200 m.

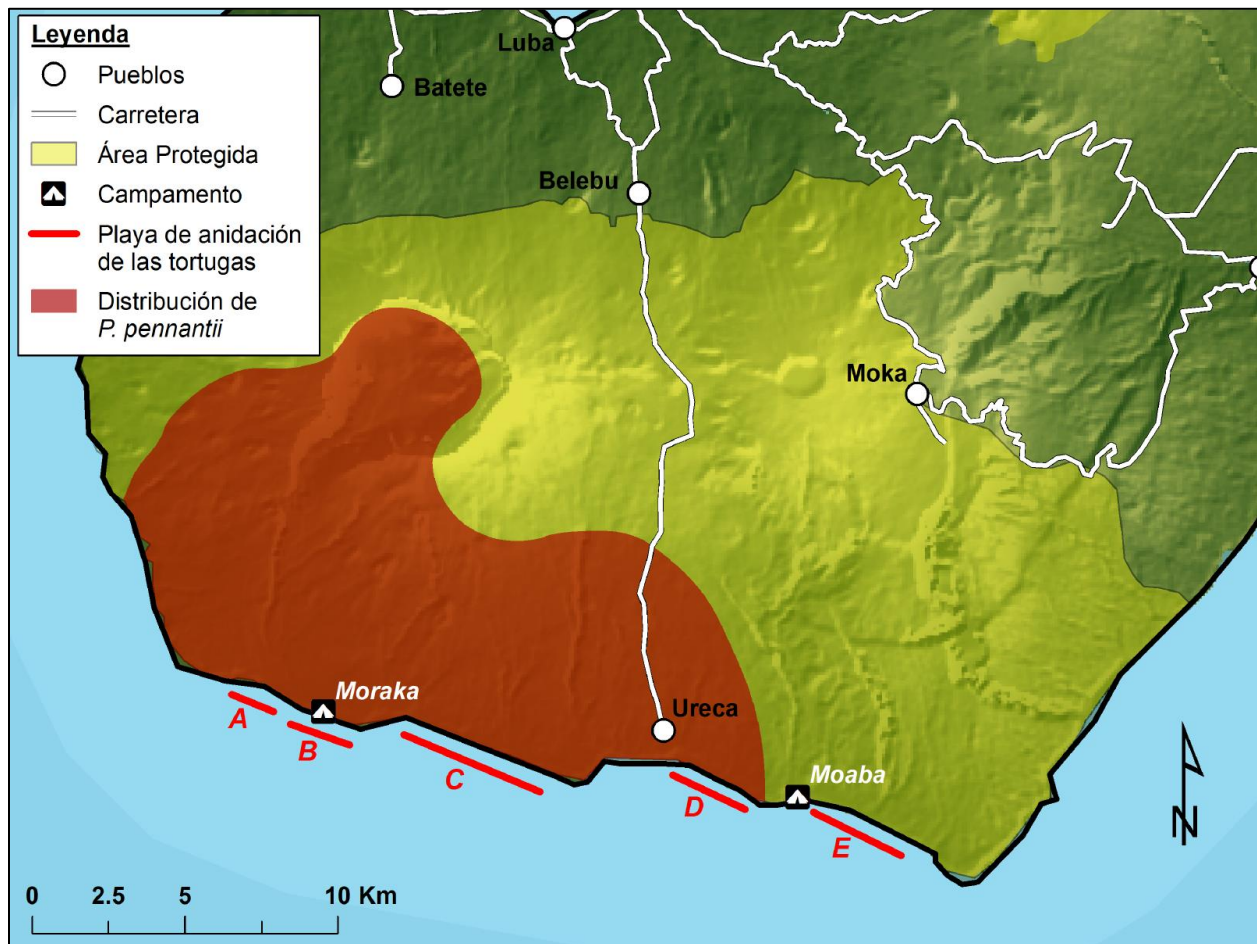


Figure 5: Map of the southern extent of Bioko and the GCSR illustrating the overlap between the estimated species distribution of *P. pennantii* derived from the ecological niche model and the five marine turtle nesting beaches along the southern coast.

Marine turtles on Bioko’s southern beaches

The southern coast of Bioko Island has approximately 19km of sandy beach (Fig. 5), and is considered among the most important marine turtle nesting sites in the Gulf of Guinea (Butynski 1996; Fretey et al. 2007; Tomás et al. 2010). Estimates suggest that that these beaches support the second highest nesting densities of green and leatherback turtles on the Atlantic coast of Africa, behind Guinea Bissau and Gabon, respectively (Fig. 6)(Rader et al. 2006; Fitzgerald et al. 2011; BBPP, unpublished data).

Similarly to the Gran Caldera primate populations, the nesting beaches on Bioko have remained relatively protected from human approach due to low human numbers, rugged topography, and a lack of a safe harbor for boats. However, the recent completion of the road between Luba and Ureca has removed any protection once offered by isolation (Fig. 1). This road bisects the GCSR, providing easy access to the beaches, and

dramatically altering human interactions with wildlife in this area, including the nesting sea turtle populations. With plans for development already underway in the area, the threats to Bioko's sea turtles will likely increase. The present challenge is to move quickly to prevent the rapid decline of these species on the island.

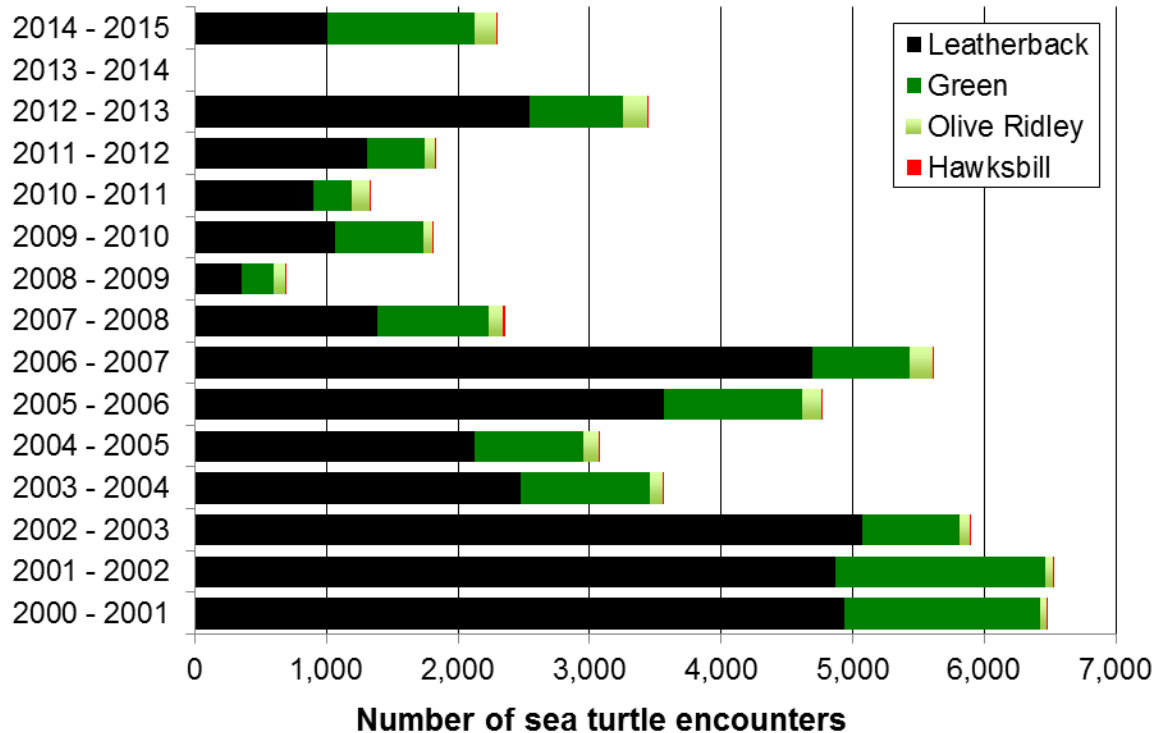


Figure 6: Number of sea turtle encounters on the southern beaches of Bioko Island from 2000-2015. Note, data from 2013-2014 are still being analyzed.

Impact on the local community

A number of villages currently rely, directly or indirectly, on the natural resources provided by the GCSR; particularly the villages of Ureca, located entirely within the GCSR, in the south of Bioko, and Moka, on the northeastern boundary of GCSR (Fig. 1). Inhabitants from these communities uphold many of their traditions and continue to maintain a constant, but potentially sustainable, trapping regime around their villages. This activity, although conducted on a small scale, represents a crucial source of nutritional and economic value, as their captures are not only a source of protein, but also a source of income, to be sold and traded within the community (Colell et al. 1994; Reid et al. 2005; Cronin 2013). Some wildlife products also have important cultural, spiritual and/or medicinal values (Castroviejo et al. 1994; Sunderland & Tako 1999; Fa 2000). Items may be consumed or displayed in specific ceremonies, or may be necessary to perform traditional ceremonies or cures (Sunderland & Tako 1999). In addition, for over 20 years, the GCSR has been the center of research and conservation activities on Bioko, from 1985 to 1998 by the Spanish NGO, Amigos de Doñana, and since 1996 by the BBPP. The BBPP in particular, has employed people from the village of Ureca to monitor wildlife populations in and around the Gran Caldera de Luba for over 18 years. Similarly, the research and monitoring of Bioko's four species of nesting



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sea turtles, which the BBPP has maintained since 2000, employs over 30 people each nesting season, from October through March, or over 35% of the total population of Ureca. This has represented a critical source of income that would otherwise have been unavailable. Developing and establishing a much needed management plan for the GCSR is necessary not only for the protection and long-term survival of the unique species found in the GCSR, but also to ensure the livelihood, well-being, and traditional values of the communities within and surrounding it.



What is a “management plan”?

A management plan is a document intended to guide the daily and long-term organization of a protected area. More specifically, it details the value of a protected area, identifies problems that exist or may arise within the area and provides strategies to solve them, clearly states the vision for the future of the area, and what specific activities, resources, and facilities are needed to achieve both short- and long-term objectives (Thomas & Middleton 2003). Objectives are a critical component of any management plan. They should be specific, so that they are not easily misinterpreted; measurable, to provide a mechanism to observe effectiveness; include a framework of time when possible; and must be achievable, realistic goals with respect to the constraints of the physical and financial resources available (Thomas & Middleton 2003). Management plans may also include related plans or documents, such as operational plans, zoning plans, development plans, etc., to provide the operational and legal means of achieving the goals set in the plan (Thomas & Middleton 2003). In planning for conservation and development around the world, protected areas are becoming increasingly run by non-governmental organizations, who, conscious of long-term adaptive management tactics, consider an area’s scientific value in addition to the social and economic needs of people who live near the protected area (Thomas & Middleton 2003).

According to the Guidelines for Management Planning of Protected Areas created by the International Union for the Conservation of Nature (IUCN), a successful management plan will: (1) provide guidelines for day to day operations and set long term objectives; (2) optimize efficiency in terms of financial and staff resources, indicating where more resources may be required and how those resources will be attained; (3) provide a mechanism for the accountability of the protected area managers and other organizations involved, allowing for a measure of proficiency among the workers while preventing corruption among park officials; and (4) facilitate communication between the principal organization, the stakeholders, the local or national governments involved, and the public in order to gain widespread support and cooperation. Finally, management plans are an important step in meeting requirements for a site to be considered for the United Nations Educational, Scientific, and Cultural Organization (UNESCO) World Heritage and Biosphere Reserve Lists (Thomas & Middleton 2003), which is ultimately the goal for the GCSR.

To be considered for a UNESCO World Heritage site, nominated sites should exhibit one or more of ten listed criteria that demonstrate Outstanding Universal Value. UNESCO defines Outstanding Universal Value as “cultural and/or natural significance which is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity” (UNESCO 2013). BBPP believes that the GCSR meets two of the criteria: “contains superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance” and “contains the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of Outstanding Universal Value from the point of view of science or conservation” (UNESCO 2013).



Creating a management plan in the context of becoming a Natural World Heritage Site can direct how the management plan is to be organized. For example, the plan should have a built-in basis for review and revision of the area's management based on the needs of the property and the resources available, as well as provide a realistic direction for the future of the property, including how inscription to the World Heritage List may provide new challenges or change the management of the park (Marshall et al. 2011).

The most important requirement of a management plan is that it involves participation from both the people who will be implementing the plan, and those who will be affected by it (Thomas & Middleton 2003). The interests of the stakeholders who will be supporting the project, local and national political bodies, and the people who live on the island who have deep-rooted cultural ties to the fauna and flora of Bioko's natural areas are all crucial components of the planning process and should be well represented in the document.

Because of the need for the involvement of these diverse groups, a management plan needs to be flexible, concise, and easy to understand. A management plan needs to have built in flexibility so that as certain management techniques or technologies improve, or if there is a significant change in legislation, the plan can be adapted accordingly. Flexibility often results from simplicity. Keeping the plan simple is typically more cost- and time-effective, will require fewer staff with lower levels of training during the initial period of implementation, and will be easier to understand; details and improvements can be made as the plan is reviewed and updated (Thomas & Middleton 2003). Finally, the management plan should be clear and accessible to all groups involved.

Context for operation of the plan:

The management plan must take many aspects of the protected area into account, including any policies or legislation currently in place and the socioeconomic development of locals. The management plan must adhere to national and local legislation and policies to optimize coordination between the governing body and the organization that is implementing the management plan (Thomas & Middleton 2003). According to the United Nations Development Program's (UNDP) Project Report No. 4185, Equatorial Guinea's National System of Protected Areas (SNAP), designed by Conservacion y Utilizacion Racional de Recursos Forestals (CUREF), is fairly well designed and thus provides a foundation on which to build a management plan for the GCSR. The SNAP is ecologically representative and encompasses 17% of the national terrestrial area of Equatorial Guinea, many of which are areas of the highest concentrations of biodiversity, and are habitats for populations of globally important species. There is also a proposed expansion plan that would include 20% more land (UNDP-GEF 2010). SNAP also accounts for resources that are important economically, culturally, scientifically, and spiritually. Room for improvement lies primarily within vital ecological corridors. Currently there is a deficit of connectivity between terrestrial and freshwater, terrestrial and marine, and freshwater and marine habitats, limiting the ability of ecological processes within these areas to occur (UNDP-GEF 2010).



Additionally, there are populations of certain important species which are not protected under SNAP (UNDP-GEF 2010). However, the more serious weaknesses of the legislation are not related to the ecological planning itself, but rather with the implementation and enforcement of it.

SNAP is not currently a functional entity, and its shortcomings effectively demonstrate the importance of a management plan in implementing successful policies. Much of Equatorial Guinea's environmental legislation is not clear, and in some cases is incomplete (UNDP-GEF 2010). Another major issue of SNAP is that it has inadequate resources to be successfully implemented; no secure, reliable source of financing exists, there is a lack of necessary infrastructure and equipment, and there are insufficient staff resources to carry out designated tasks (UNDP-GEF 2010). Finally, the structure of the administration is highly centralized, and the hierarchy tends to decrease the support and morale of the staff (UNDP-GEF 2010). In order to adequately protect the GCSR into the future, the purpose of the Science & Policy Workshop is to create a framework and a timeline for the completion and implementation of a management plan for the GCSR based on the IUCN Guidelines for Management Planning of Protected Areas (UNDP-GEF 2010). The aim is for the management plan to be created collaboratively, with input from all stakeholders, and for the result to be comprehensive, including clear objectives, detailing the sources and allotment of all physical and financial resources. However, the management plan must take into account the existing policies, as well as information on land ownership and land use regulations. Given that the current legislation provides a good starting point, we would like to leverage the existing legislation and stakeholder expertise to develop the management plan.

In addition to legal compliance, the management plan should also recognize the social and economic needs of the local people. Activities carried out by local populations, such as bushmeat hunting, are primary factors in the rapid decline of species (Albrechtsen et al. 2007; Morra et al. 2009; Cronin 2013). However, the problem is not that Equatoguineans do not value their resources. On the contrary, there is a well-developed understanding that many services provided by their forests are necessary for survival, and many have strong cultural ties to the land as well (Bocuma, unpublished data). Thus, awareness and understanding instead needs to be developed regarding the exhaustibility of such resources and more sustainable consumption of the resources in question. The other issue is that Equatorial Guinea's environmental policy as it exists currently does not have a proper enforcement framework of the measures in place to discourage unwanted environmental exploitation, and is often not well understood by the public.

What is a “scientific reserve”?

The IUCN defines a 'protected area' as a “clearly defined geographical space, recognized, dedicated, and managed through legal or other effective means to achieve the long-term conservation of nature with associated ecosystem services and cultural values” (Dudley 2008). After many years of thinking and planning, the IUCN published a system of naming categories of protected areas that consisted of six categories in 1994. Originally created for statistical purposes, the designation of these categories actually



began to influence how areas were managed worldwide and even began to change how protected areas are viewed in terms of the services they provide to society (Dudley 2008). After monitoring the success of the system, these categories were further developed at World Conservation Congress in 2008 (Dudley 2008). While the categories remained the same, the associated guidelines were made more standard and emphasized that the primary goal is nature conservation, rather than recreational or other uses (see Table 2).

As is the case with the Gran Caldera Scientific Reserve (GCSR), the category of a protected area may not reflect the national name for the area. The GCSR is in category Ib, which is what the IUCN calls a “wilderness area” and defines as a “usually large unmodified or slightly modified area, retaining its natural character or influence, without permanent or significant human habitation, protected and managed to preserve its natural condition.” (IUCN 2014a). Distinct features of category Ib protected areas that make it unique from other categories are that these areas are typically much larger than a category Ia and may house local communities, whereas a category Ia is usually small and uninhabited. Category II protected areas are similar in size and objectives to Ib, but include use by visitors, which requires accessibility often in the form of the addition of infrastructure. Category Ib, on the other hand, tends to be open only to those who have proper skills and equipment to survive and who could travel unaided (IUCN 2014a).

The land within the GCSR was originally gazetted as a protected area in 1988 (Republic of Equatorial Guinea 1988), and was updated in 2000 when it was designated as a Scientific Reserve (Republic of Equatorial Guinea 2000). The GCSR encompasses 510 km² of the southern part of Bioko. Distinct features within the reserve include the remains of a large volcano, the Gran Caldera de Luba, with dense vegetation and walls reaching 2,261 m; the crater lake of Pico Biao; the wet, lowland forests on the southern coast, and the black-sand beaches that are critical sea turtle nesting sites (Oates et al. 2004). The GCSR is characterized by a wide range of elevation, supporting high habitat diversity and thus significant levels of species richness and endemism. However, there is no management plan for GCSR, though it has the highest IUCN designation in Equatorial Guinea (Cronin et al. 2014b). Bioko’s protected areas, including the GCSR, currently lack management plans and only minimal infrastructure. Areas of higher elevation have remained relatively unaffected by anthropogenic activities only because the terrain makes it hard to access. Unfortunately, the region’s accessibility increased substantially when in the fall of 2009, clearing and construction began to create a road that cuts through the GCSR from north to south. The road has since been completed, allowing easier access to the reserve’s forests and the village of Ureca’s beaches. Thus, unregulated tourism in the south has put sea turtle nesting sites in danger. Poaching and even improper tourist activities, such as flash photography or flashlight use, have contributed to disturbance of nesting sites. In fact, during October 2014–February 2015, as many as 27 sea turtles were documented to have been killed on the beaches at the base of the road (Croce et al. 2015). Additionally, the escalation of bushmeat hunting in newly available areas has put the already vulnerable and endangered primate species in critical danger (Cronin et al. 2010).



An important consideration of the GCSR is how its IUCN category designation might change as a result of the construction of the road, which led to increased resource use and tourism. Though there is a pattern of growth regarding the number of protected areas globally, many protected areas have succumbed to protected area downgrading, downsizing, and degazettement (PADDD), which refers to a decrease in legal restrictions regarding human activity, a legal change in boundary causing a decrease in the size, and the loss of legal protection or removal of official status, respectively (Mascia & Pailler 2011). Since 1900, at least 89 instances of PADDD have occurred in 27 countries, for reasons including industrial extraction of resources and human expansion and development (Mascia & Pailler 2011). Though it is not clear how PADDD has impacted the conservation of such protected areas, it is a distinct possibility that the downgrading of the IUCN status of GCSR due to developments such as the road could lead to further environmental degradation.

Table 2: The definitions of the six IUCN protected areas categories (IUCN 2014a).

Category	Definition
Ia Strict Nature Reserve	“Strictly prohibited areas set aside to protect biodiversity and also possibly geological/geomorphic features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation value.”
Ib Wilderness Area	“Usually large unmodified or slightly modified area, retaining its natural character or influence, without permanent or significant human habitation, protected and managed to preserve its natural condition.”
II National Park	“Large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible, spiritual, scientific, educational, recreational, and visitor opportunities.”
III Natural Monument or Feature	“Protected areas set aside to protect a specific natural monument, which can be a landform, sea mount, submarine cavern, geological feature such as a cave, or even a living feature such as an ancient grove.”
IV Habitat/Species Management Area	“Protected areas that aim to protect particular species or habitats and management reflects this priority. Many need regular, active interventions to address the requirements of a particular species or to maintain habitats.”
V Protected Landscape/Seascape	“Protected areas where the interaction of people and nature over time has produced an area of distinct character with significant ecological, biological, cultural, and scenic value and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.”
VI Protected area with sustainable use of natural resources	“Protected areas that conserve ecosystems and habitats together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the area.”



Other protected areas in Africa with objectives similar to that of a scientific reserve have had notable success with conservation. The Lewa Wildlife Conservancy (LWC) in Kenya, for example, was originally started as a family-owned rhino sanctuary called Ngare Sergoi and eventually grew in size and was reestablished as the LWC (LWC 2015). In 2013, UNESCO extended the boundaries of the Mount Kenya National Park/Natural Forest World Heritage Site to include LWC and Ngare Ndare Forest, a testament to the successes of LWC's community-based conservation (CBC), education, and ecotourism (Greiner 2012; LWC 2015). There is a hope that similar activities in the GCSR devoted to conservation and educating the community will allow for recognition by UNESCO to become inscribed as a World Heritage Site and Biosphere Reserve.

The GCSR is significant for many reasons. In addition to the wealth of biodiversity and endemism, years of consistent research have also been conducted within the reserve. Since 1996, the BBPP has been conducting research and implementing conservation and education activities (with the official creation of BBPP in 1998), notably the annual three-week primate census. Since the early stages of this research, many developments have been made including partnership with UNGE and a study abroad program at Drexel University. The research conducted and connections made have led to an extensive collection of data on many species within the reserve, which can now be analyzed and used as evidence of the critical need for a management plan. Proper management and conservation of the GCSR could provide educational opportunities into the future, as well as set an example for other ecologically significant regions around the world.



Legal Framework for the GCSR

Law No8/1988 - Regulation of Wildlife, Hunting, and Protected Areas

The Republic of Equatorial Guinea created its first network of protected areas in the late 1980's, when the Law No8/1988 (Republic of Equatorial Guinea 1988), regulating hunting, wildlife and protected areas (PA) was enacted. It contains 93 articles, including a hunting moratorium attached to it. Four major PA categories (national park, scientific reserve, and wildlife refuge and wildlife sanctuary) are created under article 16. Furthermore, each one of these categories is well defined by articles 17, 18, 19 and 20. In the additional provisions section, all nine PA created by this legislation are listed, including the Grand Caldera Scientific Reserve (GCSR) which, under this law, has an extension of 60,000 ha. However, none of the created PAs are assigned to their respective categories and they are only referred to as zones. This law was eventually superseded with the passing of Law No7/2003.

Law No4/2000 - Protected Areas Law

Another environmental law was passed [Law No4/2000; Republic of Equatorial Guinea (2000)] in mid-2000 focused solely on protected areas in Equatorial Guinea. It has fewer protected area categories (scientific reserve, national park, natural monument and natural reserve) than Law No8/1988 (see article 9), but also adds four more PAs to the national system, increasing the total to 13. Law No4/2000 officially designates the GCSR as a scientific reserve for the "first" time; however, its extension was reduced by 15% from its original size. When Law No4/2000 was passed, Luba-Ureca road had not yet been built. As a result the status of the GCSR at its designation is likely considerably different. This law was also eventually superseded with the passing of Law No7/2003.

Law No7/2003 - Environmental Regulation Law in the Republic of Equatorial Guinea

In 2003, Law No7/2003 (Republic of Equatorial Guinea 2003) was enacted, regulating environmental law in Equatorial Guinea and establishing five protected area categories (natural parks, natural reserves, natural monument, protected landscapes and scientific reserves-see article 21). Each of these categories were subsequently detailed in articles 22, 23, 24 and 25; however, the category of scientific reserve and a specific definition for the designation were absent. This has a direct impact on the legality and management of the GCSR, since it was designated as a scientific reserve in 2000 by Law No4/2000, and is notably absent from this legislation. Detailed information about each of the existing protected areas is also lacking. The management and designation of future protected areas is attributed to the Ministry of Environment (MPyMA)(article 30). To assist with the implementation of Law No7/2003, the Institute for Environmental Conservation (INCOMA) and the National Fund for the Environment (FONAMA) were created (article 155). The text of Law No7/2003 goes on its "Additional Dispositions" (AD) section to acknowledge the existence of all previous regulations on protected areas (Law No8/1988 & Law No4/2000), but does so in the context of abolishing them and subsuming their responsibilities under its new regulatory power (see Third AD). Furthermore, this regulation lacks any discussion or development of implementation mechanisms (e.g. management plans, specific plans, operative plans, etc.).



Government entities tasked with the management and protection of protected areas in Equatorial Guinea

Law No7/2003 designates the MPyMA as the government body tasked with the management of the national system of protected areas and the authority to gazette future protected areas if necessary. However, Law No1/1997 (Republic of Equatorial Guinea 1997) regulates the use of and management of forests in Equatorial Guinea, and it details the creation of the National Institute for Forestry Development (INDEFOR), a body under the Ministry of Agriculture and Forestry, whose aim is to assure the development of a sustainable forest sector (see article 61). In 2002, the Decree No60/2002 (Republic of Equatorial Guinea 2002) created INDEFOR as an autonomous entity and expanded its role to include the management of protected areas as well, making it known henceforth as INDEFOR-AP.

As a result of this discrepancy in the laws governing protected area management, there exists some confusion on the ground in regards to specific roles and responsibilities. As the underlying goal of all parties involved is to conserve biodiversity in Equatorial Guinea, we hope that this discrepancy can be clarified in order to improve overall conservation outcomes.

Existing management plans in EG's System of National Protected Areas

A management plan was designed for Monte Alén National Park, located in the interior of Rio Muni, the continental sector of Equatorial Guinea. The management plan is composed of eight sections: 1) unique value of Monte Alén National Park; 2) characteristics of the PA; 3) desired conditions; 4) objectives; 5) guidelines; 6) micro-zones; 7) implementation schedule; and 8) monitoring. Upon analysis, however, it became clear that there were several areas in which the management plan could be greatly improved and thereby increasing the likelihood of its effectiveness. Furthermore, despite its existence, the management plan has yet to receive formal ministerial approval.

International and Domestic conventions and strategies for environmental protection ratified by Equatorial Guinea

The government of Equatorial Guinea, through the MPyMA, has made considerable progress in the international conservation community by agreeing to and ratifying several important international conventions and agreements to protect its natural history and environment (Table 3). Furthermore, the government of Equatorial Guinea has enacted comprehensive and progressive domestic environmental protection legislation (Table 4). Both international and domestic efforts have been hindered by a lack of execution, and there remains a real need to effectively translate these policies into a domestic context by elaborating specific plans and allocating necessary resources for their implementation.



Table 3: Notable international conventions ratified by the Government of Equatorial Guinea

Name and year	Responsible Party	
	MPyMA	INDEFOR-AP
Convention on the International Trade of Endangered Species, 1992	X	
Convention on Biological Diversity, 1994	X	
International Union for Conservation of Nature, 1997	X	
Ramsar convention on wetlands of international importance, 1997	X	
Marine Turtles of the Atlantic Coast of Africa, 1999	X	
Kyoto Protocol on Climate Change, 2000	X	
African Convention on the Conservation of Nature and Natural Resources, 2003	X	
Convention on migratory species of wildlife, 2009	X	
CMS Gorilla Agreement Action Plan, 2009	X	

Table 4: Notable national conservation decrees and strategies ratified by the Government of Equatorial Guinea

Name and year	Responsible Party	
	MPyMA	INDEFOR-AP
Decree No 171/2005 - Strategies and Biodiversity Conservation Action Plan	X	
Decree No172/2005 Regulating the Trade of Endangered Species of Wildlife in Equatorial Guinea	X	
Decree No72/2007 Prohibiting Hunting and Consumption of Primates in Equatorial Guinea	X	
National Environmental Strategies 2010-20	X	



Preliminary Management Recommendations

Securing the long-term future of the GCSR will require (i) development and implementation of an adaptive, evidence-based management plan; (ii) strengthening of the legal basis for protection of the GCSR; (iii) empowerment of the National Institute of Forestry Development and Protected Area Management (INDEFOR-AP) and Ministry of Fisheries and the Environment, the federal entities tasked with management of protected areas; (iv) increased law enforcement effectiveness; and (v) committed involvement from the Government of Equatorial Guinea in order to not only stop illegal hunting, but also to mitigate impacts from its development plans.

Given the task ahead, government led conservation efforts should be prioritized on Bioko. The principal tenets should be to “start small”, focus on both supply and demand, and to concentrate efforts where they are likely to have the greatest possible conservation benefit.

Short-term measures, such as enforcement of existing legislation, could be taken by the Government of Equatorial Guinea, which could significantly reduce the amount of primate hunting and put into effect barriers to the bushmeat trade. The primate hunting ban, for instance, includes prohibitive fines (100,000-500,000 FCFA/monkey) (Republic of Equatorial Guinea 2007) which, if enforced, would deter hunters by threatening a significant portion of their annual hunting income (~240,000 to 934,000 FCFA/year) (Fa et al. 2000; Grande Vega et al. 2013). Enforcement could begin at preexisting roadblocks on the two direct routes between catchment areas and Malabo, and may begin to control the transport of primate carcasses via confiscation and fines (Fig. 7) (Cowlshaw et al. 2005; Macdonald et al. 2012).

Perhaps the most practical short-term solution, however, would be the implementation of forest guards (Bennett 2011), which has been successful elsewhere in reducing hunting and improving the effectiveness of protected areas (Bruner et al. 2001; Rowcliffe et al. 2004; de Merode & Cowlshaw 2006; Hilborn et al. 2006; Corlett 2007; Campbell et al. 2011; Tranquilli et al. 2012). There are a number of sites throughout Bioko that serve as principal access points to Pico Basilé National Park (Basilé, Moeri) and the GCSR (Belebu, Moka, and Ureca) that could serve as effective “ranger bases” or “bushmeat checkpoints” (Fig. 7). In each of these villages there is already a military outpost, which in the case of Basilé, is a gated checkpoint for vehicular access to the summit of Pico Basilé. Intensive monitoring for bushmeat hunting could take place by forest guards (or in the immediate future, the military) stationed therein. By focusing on these natural choke points, guards may be more effective than with a more generalized enforcement scheme.

If the government was to implement forest guards, patrol efforts should be prioritized to maximize effectiveness across “Conservation Priority Zones” based on amounts of total coverage, as well as the estimated relative investment necessary to effectively patrol the area (Fig. 7).

The highest priority zone is the southwestern sector of the GCSH, which should be considered a “critical zone” (Milner-Gulland et al. 2003) in each of the following management strategies. Using patrols to make this area a no-take area could be enforced more easily than any offtake restrictions (Milner-Gulland et al. 2003), as it is already protected passively via isolation, hunting intensity is lowest, primate abundance is highest, and all seven monkey species are present (including the Gran Caldera de Luba) (Cronin 2013). The area holds the highest densities of *M. leucophaeus* and *C. satanas* on the island, as well as the entire population of *P. pennantii*. In addition to primates, conservation of this zone would protect most of the critical nesting habitat of the four species of marine turtle that nest on the island. Thus, by concentrating anti-poaching efforts in the region, guards may be able to maximize conservation benefits at minimal cost.



Figure 7: Using BBPP survey data and expertise, as well as local knowledge, a number of priority areas for primate conservation were developed which utilize existing infrastructure. Also designated were a series of “Ranger Bases,” at principal protected area access points that could serve as bushmeat inspection points, and two remote camps, Moraka and Moaba, from which forests guards could monitor two of most important beaches on the southern coast.



The second priority zone is, in effect, just an extension of the first zone to include the entire southern extent of Bioko. This would be potentially more of an investment to monitor as it is a larger area, but delineation would be slightly less arbitrary than the first priority zone, and thus, may be easier to enforce. In Figure 6, this zone is delineated with a relatively straight line from east to west across the spine of the southern highlands, encompassing the northern rim of the Gran Caldera, but passing below the pastures on the slopes of Pico Biao. This conservation zone would contain the same faunal species assemblage, but would likely also encompass the entire range of *C. nictitans*. Protecting this zone would also conserve the unique monsoon forest habitat type as well as afroalpine formations on the two peaks.

The third priority would be to simply protect the currently delineated protected areas. This is, perhaps, the best place to start, as the protected areas already legally exist, and would require no new designation. This strategy is aided, like the previous two, by the fact that they were originally created since much of the terrain they encompass was deemed inferior for agriculture and overly difficult to access and exploit.



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- U.S. Fish and Wildlife Service
- U.S. Embassy Malabo



Appendix 1 - Management Planning Summary

Introduction

This following summary is based on the document, “Protected Area Management Planning in Latin America,” designed and published by Costa Rica’s Center of Tropical Agronomy, Research and Education (CATIE). It can be accessed and downloaded in Spanish and English online at their website (<http://catie.ac.cr/en/>). This handbook’s main approach is based on the Open Standards for the Practice of Conservation, in addition to other relevant sources on protected areas management planning, such as the Conservation Action Planning Handbook (CAP) (TNC 2007) and WWF Programme Standards. Five major topics are covered among which are 1) management plan development process, definition of focal objects, situational analysis, strategies, and implementation.

- Planning leaders & consultant: they are to distribute responsibilities to participants and oversee the entire management process.
- Government institutions (INDEFOR-AP & Ministry of Environment): representatives from these departments most advocate for public and government interest, serving as guidance for all legal and management related matters.
- Selection of a representative group of stakeholders: these groups most participate in pertinent discussions
- Focal objects (ecological, legal and government, cultural, management, socioeconomic and cultural): composition of working groups for the identification of problems and solutions within each type of FO.
 - Potential working groups:
 - Biodiversity
 - Legal/government and management
 - Socioeconomic and cultural
- Selection of key attributes capable of assuring long term survival of FO: this section is likely to be combined with the previous one that talks about solutions.
 - This item is part of the working groups’ task
- Analysis of threats and opportunities on selected attributes: this section can be put aside until the development of the management plan takes place.
- Assessment of land tenure matters related to the GCSR: government representatives (INDEFOR-AP/Ministry of Env) and local communities can report about this item during the workshop. Eventually, it will be necessary to undertake a more thorough assessment.
- Design management objectives and activities: objectives are framed based on proposed solutions and specific activities are listed towards their achievement.
- Implementation: assigning implementation responsibilities together with specific activities to pertinent stakeholders
 - Prioritize activities based on needs and available resources: what needs to be done in the short term? What needs to be accomplished in the long run? And, why?



- Development of short- term operative plans
 - Establishment of a strong network of strategic alliances nationally (Local Communities, ANDEGE, ECOTONO, TOMAGE, UNGE), regionally(Mefou Wildlife Sanctuary, Ebo Forest, the Last Great Ape, Korup National Park, Lope National Park) and internationally (Conservation International, World Wildlife Fund, Convention on International Trade of Endangered Species, Global Environmental Fund, IUCN, UNEP and CBD)
 - Periodic review of management plan: specify how often the management plan shall undergo a general review process.
 - Report findings to interested parties periodically: results shall be articulated in formats accessible to all stakeholders involved.



Appendix 2 – Report on the impact of the Luba-Ureca road completion on the conservation of sea turtles in southern Bioko

The project to build the stretch of road that connects the city of Luba to the village of Ureca and its nearby beaches was recently completed in October 2014. As expected, the highway facilitates greater access to southern extent of Bioko, greatly increasing anthropogenic pressure on the environment and wildlife of the area. Both the villagers of Ureca and BBPP researchers, who are undertaking studies on marine turtles since October 2014, have observed a large influx in the number of tourists and poachers. Unfortunately, tourists are not using proper headlights and are taking flash photographs, causing sea turtles to return to the sea without nesting. Poachers do not respect the existing legislation on the prohibition of illegal hunting of protected species, and have increased their activities on the southern beaches considerably following the completion of the road. Marine turtles are protected in Equatorial Guinea under two important conventions (**Convention on Marine Turtles of the Atlantic coast of Africa, 1999 and the Convention on Migratory Species of Flora and Fauna, 2009**) which the government has ratified. Interestingly, those acting in opposition to the law are a diverse group of individuals comprised of ordinary citizens and military personnel, who are, in reality, tasked with aiding in the implementation of the regulations. Recently, we have been able to document the following evidence of poaching (see Table 1). Furthermore, poachers have also brought fake permits which they claim are signed by government authorities, and which they claim to allow them to poach turtles in the area.

Table 1: Marine turtles illegally poached during the 2014-2015 nesting season

Activity	Turtle Species	Quantity
Poaching	Leatherback	12 individuals
Poaching	Olive Ridley	1 individual
Poaching	Green	14 individuals
Total		27 individuals

Based on the above, the BBPP hopes to garner government support in the search for effective solutions to deal with the problems raised by the unregulated access provided by the new road. The sooner that that appropriate measures can be taken, the better our chances to save some of the increasingly threatened biodiversity of the country.



Figure 1: Bioko Island, Equatorial Guinea showing all of the sites of BBPP activities, including the Playa Moraka and Playa Moaba research camps. The red letters signify the 5 beaches where the BBPP conducts marine turtle research. Note: With the new road, Playa D, a critical site for nesting Leatherback turtles, is now accessible by car.




Figure 2: The above image shows Beach D in 2012. The below image shows the same site in late 2014 after the completion of the new Luba-Ureca road, which ends directly alongside the beach.



Observations by BBPP Researchers

Volunteers began camping on Beach D from 22 JAN 2015 to deter the presence of hunters. Since 01 FEB 2015, they began to patrol the beaches at night, and since then, have not seen a turtle hunted on the beach.

Table 2: Details about the marine turtles illegally poached during the 2014/2015 nesting season

Date	Description
Beach D – Activities observed by BBPP investigators	
25/1/15	Hunter observe don the beach with a gun
2/2/15	Car observed at end of road. Hunters came down onto beach, but left after an interaction with BBPP investigators.
3/2/15	4 military who were previously stationed at Ureca encountered onthe beach were encountered on the beach with a Nile monitor which they had killed. An Urecano worker identified the military personnel as hunters who had previously killed a leatherback on Beach D. The 4 hunters were observed walking on the beach at 03:00 that night.
5/2/15	4 military from Ureca observe don the beach at 21:30 saying that they were hunting duikers and patrolling for Cameroonians.
6/2/15	1 hunter observed in the forest with a dead duiker
8/2/15	2 hunters from Malabo encountered on the beach at 21:00. 2 more hunters encountered later, but left after interacting with BBPP investigators.
9/2/15	1 Olive Ridley encountered overturned and hidden in the forest with a head injury. No poacher was observed.
10/2/15	Cayuco observed lighting a section of the beach for the duration of the night.
13/2/15	1 hunter observed in the forest hunting duikers
Beach D – Known turtles poached (11 in total)	
1/12/14	2 Leatherbacks overturned at the alongside the end of the Luba-Ureca road.
12/12/14	1 Leatherback encountered on the beach recently killed
	
28/12/14	2 Leatherbacks encountered dead and hidden in the forest near the beach

20/1/15

1 Leatherback encountered on the beach recently killed



2/2/15

1 Leatherback encountered just inside the forest recently killed





The Future of the Gran Caldera Scientific Reserve

3/2/15 1 Leatherback encountered just inside the forest recently killed

Beach C – Turtles poached (1/11/14-18/2/15)

15/2/15 1 Olive Ridley, 1 Leatherback, y 2 Greens killed by military personnel

31/1/15 2 Greens killed by a man from Luba named, “Herminio,” who was associated with the military.

11/2/15 An Urecano worker stationed on Beach C explained that he had observed 10 green turtles killed up to this date. All were killed by people who identified themselves as military personnel, and all came to the beach via the new road.

Beach E – Nighttime encounters with hunters – no hunting activities observed (1/11/14-18/2/15)

22/12/15 3 cayucos observed close to the beach. Each shined their lights extensively on the beach and on the BBPP investigators. The Cayucos did not reach the beach.

23/12/14 2 hunters observed in the forest just near the beach

27/12/14 2 hunters (suspected to be military personnel) encountered on the border of the forest alongside the beach claiming to be hunting duikers

26/1/15 2 hunters (suspected to be military personnel) encountered on the border of the forest alongside the beach shining bright white lights on nesting turtles

7/2/15 2 hunters (suspected to be military personnel) encountered on the border of the forest alongside the beach. Gunfire was heard near the site of encounter. During the previous day, the same hunters were observed hiding within small structures constructed by BBPP investigators to collect behavioral on drill monkeys. Shots were also heard shortly after this encounter as well.



**Bioko Biodiversity
Protection Program**

Avenida de los Parques de África
Barrio Caracoles
Malabo, Bioko Norte, Guinea Ecuatorial

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