



CHAPTER 2 Approaches and Methods

Source: Africa's Gulf of Guinea Forests: Biodiversity Patterns and Conservation Priorities: 13

Published By: Conservation International

URL: <https://doi.org/10.1896/1-881173-82-8.13>

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

CHAPTER 2

Approaches and Methods



Biological survey team heading into the Oban Hills, Cross River National Park, Nigeria.

To meet our goals of mapping aspects of biodiversity in the Gulf of Guinea forests and analyzing the area's conservation needs, we created a single Geographic Information System (GIS) database with integrated information on animal and plant distribution, elevation and land cover, and the location of existing protected areas. We drew data from published literature and museum and herbarium specimens, as well as from existing databases, which are described in the following section. Distribution data were first examined for patterns of species richness and endemism, and then were combined with information on forest cover, and compared to existing and proposed protected area boundaries, and to patterns of human activity. We also evaluated the effectiveness of current protected areas at preserving patterns of biodiversity and gathered information on conservation challenges and options, drawing on fieldwork, local experts, and published literature.

During the initial research, conducted between September 2000 and August 2001, we were able to collate and map only a small part of the information on biodiversity patterns in the region between the Niger and Sanaga Rivers, and could only evaluate a portion of the region's existing and proposed protected areas. Therefore, after writing and circulating a draft report, we resumed data collection between February and August 2002, adding to our database for several taxonomic groups and analyzing Landsat imagery. Final data analysis and writing took place from September through November 2002.

LABORATORY-BASED BIODIVERSITY ANALYSIS

General approach

Geographic and distributional data were analyzed in the Department of Anthropology at Hunter College using ArcView™ GIS 3.2a, Spatial Analyst software (Environmental Systems Research Institute, Redlands, California), and WORLDMAP software (Williams 2000). Paul Williams (Natural History Museum, London) provided us with training in the use of WORLDMAP and created customized versions of the program for this project. Carsten Rahbek of the Zoological Museum, University of Copenhagen (ZMUC) allowed us access to ZMUC's African vertebrate database, and particularly to digital data on mammal, bird, snake, and amphibian distributions in our region of interest.

WORLDMAP software and the ZMUC database allowed us to view the importance of our project region in relation to other parts of Africa, in terms of patterns of species richness and endemism (a similar approach has been taken in a recent parallel study by Brooks *et al.* 2001, which also uses the ZMUC database). This "first cut" was one device we employed in deciding which taxa to focus on in a more fine-grained analysis; some selection was essential, given our limited time and resources. For instance, we used WORLDMAP, the ZMUC database, and the literature to identify taxa endemic to the Gulf of Guinea project area in selected groups. Only taxa entirely restricted to the project area (i.e., the forest zone between the Niger and Sanaga Rivers north to the Mambilla Plateau, and Bioko Island) were considered.

Base maps, protected area, and land cover mapping

Base maps for the GIS were constructed using published maps of the project region, collected during many years of research on West African primates and biogeography (see Oates 1988). Newer maps, especially of Cameroon and Bioko, were acquired during project fieldwork, and boundaries of protected area manually added to electronic files, with details clarified by experts in the region. Land cover data from several sources were examined, but many proved to be either highly inaccurate or incomplete for the Nigeria-Cameroon border area; sources included the United States Geological Survey Global Land Cover Classification (USGS GLCC), the Digital Chart of the World (DCW), the Tropical Ecosystem Environment Observations by Satellites (TREES) project, and the World Conservation Monitoring Centre (WCMC). We used the WCMC data

for this study because our field surveys ("ground truthing") suggested that it offered the most accurate and complete coverage for our project area.

Remote sensing analysis

Satellite images of the project area were generated using public-domain data from the Landsat 4 and 5 satellites (TM sensor). The selected scenes cover a range of dates between 1986 and 1988, together with one scene of the core of our study region from 2000. High prevalence of cloud cover in this region mitigates against the acquisition of cloud-free images for the entire area.

Landsat scenes were processed using standard image software (ERDAS), and then imported into the existing GIS in Arcview™ and mosaiced together. Landsat bands 3, 4, and 7 were assigned to the blue, green, and red wavelengths, resulting in maps where intact forest appears as dark green, degraded forest and farmland appear light green, and bare earth and urban areas are pink. Constraints of time and budget prevented us from conducting a formal land-cover classification from this imagery. However, familiarity with the area suggests that the simple classification we have used produces a quite accurate land-cover map.

Point locality mapping

The ZMUC database is relatively comprehensive, although it does not include Bioko data. However, it only provides distribution data in one-degree grid cells, and many of the maps used in the database are expected distributions based on interpretations from known occurrences. Because of the relatively small area considered by our project (relative to the large cells of the ZMUC maps), and the need to relate distributions to protected area boundaries, we moved to the acquisition of point-locality data for certain focal taxa identified in our initial research. Considering the availability of data, our own interests, and conservation concerns, we decided to focus on anthropoid primates, birds, amphibians, and trees, as each of these groups has distributions affected by different sets of environmental and historical factors. Locality data for these taxa were gathered from many sources (see below) and imported into the GIS along with data on protected area boundaries and land cover.

Monkey distribution data, drawn from a large existing hand-written database (1,782 individual records) assembled since 1980 (Oates, personal data) include point locality information for all West African forest monkeys collected from the literature, museum collections, and field observations. In this project, we updated and added ape distribution to these data records.

A list of endemic birds (along with primates, probably the best studied taxonomic group in the region) was compiled using both WORLDMAP (Williams 2000) and published literature (e.g., Jensen & Stuart 1984, Stattersfield *et al.* 1998). Locality data were acquired from the collections of the American Museum of Natural History, New York, and the Ornithology group, Natural History Museum, Tring, UK, and from a broad set of literature, including valuable compilations from Louette (1981) and Pérez del Val (1996).

After identifying species endemic to the project region from WORLDMAP-ZMUC data and the literature, locality data on anuran amphibians (frogs and toads) were gathered from museum collections and the literature. We consulted Amiet (1971, 1972a, 1972b, 1977, 1978, 1981, 1983), Gartshore (1986), Hofer *et al.* (1999), Lawson (1993), Parker (1936), Perret (1966, 1977), and Schiøtz (1963, 1966, 1999). Data were also compiled from collections at the Natural History Museum, London, as well as from the electronic databases of the Field Museum of Natural History, Chicago, the Museum of Natural History at the University of Kansas, and from the Natural History Museum of Geneva, Switzerland. At the time of our study, this list was likely the most complete compilation of data yet assembled for the amphibians of this region.

For plants, we examined the limited dataset already established for WORLDMAP by Jon Lovett at University of York in the UK. Because this dataset has an East African emphasis, we found that we needed to consult other sources to produce a list of endemics for our study region. As a first step in this process we consulted Cable and Cheek (1998); this publication on the plants of Mount Cameroon summarizes distribution records of plants not only collected on the mountain, but also growing in the lowlands in the mountain's vicinity. From Cable and Cheek it was possible to identify a list of 353 species known from the Mount Cameroon area that apparently had been recorded only in the Nigeria-Cameroon-Bioko area. This list was narrowed down to a set of 55 trees listed as reaching a height of at least 10 m, on which additional locality data were acquired from Keay *et al.* (1964), Hutchinson *et al.* (1954, 1958), and Sunderland *et al.* (2002), and from the herbaria of the Missouri Botanical Garden (MOBOT database provided to us electronically by R. Gereau), the New York Botanical Garden, and the Royal Botanic Gardens, Kew.

FIELD STUDIES

General approach

Following a planning trip to Nigeria in July 2000, field work took place at intervals between September 2000 and September 2002. The main aim of the field surveys was to visit existing or potential protected areas in southeastern Nigeria, southwestern Cameroon, and Bioko, to get first-hand impressions of the state of their fauna and flora and of human pressures on the areas. Most of this fieldwork was conducted by Oates, but Bergl visited two sites in Nigeria in January of 2001, and Bergl and Linder visited two sites in Cameroon in October and November of 2001.

Where possible field trips were made with other researchers, so that field work also provided an opportunity to learn about current research in the region. Discussions were also held with protected-area managers, representatives of non-governmental organizations (NGOs) devoted to conservation, and local residents. These discussions, and visits to the offices of a variety of government departments and NGOs, provided

important information on the challenges of protected-area management in the region. They also led to many useful resources including maps, publications, and databases.

In Nigeria, field work in 2000 was conducted in association with Edem Eniang and Ernest Nwufoh, in liaison with the management of Cross River National Park and the Cross River State Forestry Commission. In Cameroon, field work was conducted with the help of Jacqueline Sunderland-Groves, and staff of the Ministry of the Environment and Forests, the Wildlife Conservation Society, and the World Wide Fund for Nature. On Bioko, Oates joined expeditions organized by Gail Hearn and Wayne Morra of Arcadia University's Bioko Biodiversity Protection Program (BBPP) in association with the National University of Equatorial Guinea.

Most field excursions lasted between 3 and 10 days, although a few single-day or overnight trips were made. Extended excursions involved trekking into the forest with research associates and assistants and establishing base camps for further explorations. Formal line-transect censuses were used only on Bioko. More typically, surveys involved walking slowly for several kilometers along existing paths, making notes of vegetation, animals, and signs of human activity. Global Positioning System (GPS) receivers (specifically Garmin GPS-II Plus and GPS 12 units) were used to record position in the forest, and a barometric altimeter was used to estimate height above sea level because GPS readings of altitude were often not accurate.

Allocation of effort

Nigeria was a particular focus of this study in part because the authors were involved in several ongoing research and conservation efforts there, including a gorilla research project at Afi Mountain, Cross River State, and an associated program developing a wildlife sanctuary at Afi (in conjunction with the Cross River State Forestry Commission, Fauna and Flora International and the Pandrillus NGO). Other projects in Nigeria included the planning of a Cross River gorilla workshop (Calabar, April 2001), and supporting the development of an education center at Obudu Cattle Ranch. These involvements provided useful insights into conservation and research challenges, and so contributed to the larger project. Table 1 provides a schedule of field activities for the authors.

Organizing field research in southeastern Nigeria was hampered by the lack of a well-developed research infrastructure in the area. Much time was spent developing systems that could facilitate future field research in Cross River State. This work led to the launching of a new research program in September 2001, the Biodiversity Research Program, managed jointly by the Wildlife Conservation Society and the Nigerian Conservation Foundation, which includes a training component based at the University of Calabar.

Studying the bushmeat trade

Researchers recorded evidence of bushmeat trade as they came upon it, noting evidence of hunting at the field sites,

carcasses being sold at the roadside or in markets, and loads being carried on forest trails. We also gathered further information from our extensive discussions.

More comprehensive sampling was carried out at the bushmeat market in the Bioko capital of Malabo, the best-sampled bushmeat market in West Africa due to the studies of John Fa (Fa *et al.* 1995, Fa *et al.* 2000). Since the observations at this bushmeat market by Butynski in 1986 and by Fa and associates at intervals between 1988 and 1997, the market has shifted from its own location to become part of the Malabo central market.

Much of the wild game hunted on Bioko Island passes through the Malabo market, and market vendors are not especially obstructive to studies of their activities since they are rarely prosecuted. Quick surveys (10–15 minutes) of the bushmeat available were made by Oates on five days in January 2001 and on two days in January 2002, with one extended observation (of one hour). In 2001, additional data were gathered by students from a BBPP expedition, who visited the market at other times of day, or on other days. Particularly important were visits by Eric Lombardini, who was carrying out a study of parasites in market carcasses.

Table 1. Schedule of visits to sites outside state, provincial, or national capitals (all by Oates unless otherwise indicated).

Nigeria	
July 20–23, 2000	Obudu Plateau and headquarters of Okwangwo Division, CRNP
July 26–28, 2000	Ekonganaku area, Oban Division, CRNP
Sept 7–8, 2000	Obudu Plateau
Sept 11–14, 2000	Nkuesah Hills, Oban Division, CRNP
Sept 18–22, 2000	Ekonganaku area, Oban Division, CRNP
Dec 5–6, 2000	Okomu National Park, Edo State
Dec 11, 2000	Akamkpa headquarters, CRNP; visit to tourist circuit in south of Oban Division
Dec 14–17, 2000	Kanyang Field Station, Mbe Mountains, and Obudu Plateau
Jan 6–19, 2001	Mbe Mountains (Bergl)
Jan 24–27, 2001	Ekonganaku area, Oban Division, CRNP (Bergl)
Oct 11–13, Nov 16–19, 2001	Obudu Plateau
Dec 10–11, 2001	Ikom and Bunyia (Afi)
Jan 18–20, 2002	Obudu Plateau and Afi Mountain
June 10–14, 2002	Obudu Plateau
Sept 20–23, 2002	Boje (Afi) and Obudu Plateau
Cameroon	
Oct 24–26, 2000	Limbe, including Wildlife Centre and Botanical Garden
Oct 27–Nov 3, 2000	Mamfe and Takamanda Forest Reserve
Nov 3–6, 2000	Nguti and Banyang-Mbo Community Wildlife Sanctuary
Nov 7–8, 2000	Mount Kupé
Nov 8–13, 2000	Mundemba and Korup National Park
Nov 14–16, 2000	Limbe
Oct 19–31, 2001	Mundemba and Korup National Park (Bergl & Linder)
Nov 5–13, 2001	Bamenda Highlands, particularly Kenshi (Bergl & Linder)
Bioko	
Jan 6–18, 2001	Luba, Moraka Beach, and the Gran Caldera de Luba
Jan 2–10, 2002	Moeri, Moka, Riaba, and Pico Basile

REFERENCES CITED

- Achard, F., Eva, H., Glinni A., Mayaux P., Richards, T., & Stibig, H.J. 1998. *Identification of Deforestation Hot Spot Areas in the Humid Tropics*. Ispra, Italy: Joint Research Centre, European Commission.
- Aldrich, M., Bubbs, P., Hostettler, S., & van de Wiel, H. 2000. *Tropical Montane Cloud Forests: Time for Action*. Gland and Cambridge: WWF-IUCN-UNEP.
- Amiet, J.-L. 1971. *Leptodactylon* nouveaux du Cameroun (Amphibiens Anoures). *Ann. de la Fac. des Sciences du Cameroun* 7–8: 141–172.
- Amiet, J.-L. 1972a. Description de cinq nouvelles espèces camerounaises de *Cardioglossa* (Amphibiens Anoures). *Biologica Gabonica* 8: 201–231.
- Amiet, J.-L. 1972b. Description de trois Bufonidés orophiles du Cameroun appartenant au groupe de *Bufo preussi* Matschie (Amphibiens Anoures). *Ann. de la Fac. des Sciences du Cameroun* 11: 21–140.
- Amiet, J.-L. 1977. Les *Astylosternus* du Cameroun (Amphibia, Anura, Astylosterninae). *Ann. de la Fac. des Sciences du Cameroun* 23–24: 99–227.
- Amiet, J.-L. 1978. Les amphibiens anoures de la région de Mamfé (Cameroun). *Ann. de la Fac. des Sciences du Cameroun* 25: 189–219.
- Amiet, J.-L. 1981. Une nouvelle *Cardioglossa* orophile de la dorsale camerounaise: *C. schioetzi* nov. sp. (Amphibia, Anura, Arthroleptinae). *Ann. de la Fac. des Sciences du Cameroun* 28: 117–131.
- Amiet, J.-L. 1983. Une espèce méconnue de *Petroedetes* du Cameroun: *Petroedetes parkeri* n. sp. (Amphibia Anura: Ranidae, Phrynobatrachinae). *Revue suisse de Zoologie* 90: 457–468.
- Ayeni, J.S.O. & Mdaihlhi, M. 2001. The Cameroonian-German (MINEF-GTZ) project for protection of forests around Akwaya (PROFA), South West Province, Cameroon. In A.E. Bassey & J.F. Oates (eds.), *Proceedings of the International Workshop and Conference on the Conservation of the Cross River Gorillas*. Calabar, Nigeria: NCF and WCS.
- Booth, A.H. 1958. The zoogeography of West African primates: A review. *Bulletin de l'I.F.A.N.* 20, sér. A: 587–622.
- Brooks, T., Balmford, A., Burgess, N., Fjeldsa, J., Hansen, L.A., Moore, J., Rahbek, C., & Williams, P. 2001. Toward a blueprint for conservation in Africa. *BioScience* 51: 613–624.
- Butynski, T.M. & Koster, S.H. 1989. Marine turtles on Bioko Island (Fernando Poo), Equatorial Guinea: A call for research and conservation. Washington, DC: WWF.
- Butynski, T.M. & Koster, S.H. 1990. The status and conservation of forests and primates on Bioko Island (Fernando Poo), Equatorial Guinea. Washington, DC: WWF.
- Butynski, T.M. & Koster, S.H. 1994. Distribution and conservation status of primates in Bioko island, Equatorial Guinea. *Biodiversity and Conservation* 3: 893–909.
- Cable, S. & Cheek, M. 1998. *The Plants of Mount Cameroon: A Conservation Checklist*. Kew: Royal Botanic Gardens.
- Caldecott, J.O., Bennett, J.G., & Ruitenbeek, H.J. 1989. *Cross River National Park (Oban Division): Plan for Developing the Park and Its Support Zone*. Godalming, Surrey: WWF-UK.
- Caldecott, J.O., Oates, J.F., & Ruitenbeek, H.J. 1990. *Cross River National Park (Okwangwo Division): Plan for Developing the Park and Its Support Zone*. Godalming, Surrey: WWF-UK.
- Castelo, R. 1994. Biogeographical considerations of fish diversity in Bioko. *Biodiversity and Conservation* 3: 808–827.
- Castroviejo, J., Javier Juste, B., Castelo, R., & Pérez del Val, J. 1994. The Spanish co-operation programme in Equatorial Guinea: A ten-year review of research and nature conservation in Bioko. *Biodiversity and Conservation* 3: 951–961.
- Central Intelligence Agency. 2003. *The World Factbook 2003*. Online. Available: <http://www.cia.gov/cia/publications/factbook>.
- Cheek, M., Mackinder, B., Gosline, G., Onana, J.-M., & Achoundong, G. 2000. The phytogeography and flora of western Cameroon and the Cross River-Sanaga River interval. In E. Robbrecht, J. Degreef, & I. Friis (eds.), *Plant Systematics and Phytogeography for the Understanding of African Biodiversity*. Proceedings of the XVIth AEFTAT Congress, National Botanic Garden of Belgium.
- Collar, N.J. & Stuart, S.N. 1988. *Key Forests for Threatened Birds in Africa*. Cambridge: ICBP.
- Collins, S.C. & Larsen, T.B. 2000. Eight new species and five new subspecies of African butterflies (Rhopalocera) – an ABRI research paper. *Metamorphosis* 11: 57–70.
- deMenocal, P.B. 1995. Plio-Pleistocene African climate. *Science* 270: 53–59.
- Dieterlen, F. & Van der Straeten, E. 1992. Species of the genus *Otomys* from Cameroon and Nigeria and their relationship to East African forms. *Bonn. Zool. Beitr.* 43: 383–392.
- Dowsett, R. J. & Forbes-Watson, A.D. 1993. *Checklist of birds of the Afrotropical and Malagasy regions. Volume 1: Species limits and distribution*. Liege, Belgium: Tauraco Press.
- Ebin, C.O. 1983. An appraisal of the biotic and material resources of some game reserves and wildlife management in Nigeria. Lagos: Report to the Nigerian Conservation Foundation.
- Eeley, H.A.C. & Lawes, M.J. 1999. Large-scale patterns of species richness and species range size in anthropoid primates. In J.G. Fleagle, C. Janson, & K.E. Reed (eds.), *Primate Communities*. pp. 191–219. Cambridge: Cambridge University Press.
- Eisentraut, M. 1973. Die Wirbeltierfauna von Fernando Poo und Westkamerun. *Bonner Zoologische Monographien*, No. 3: 1–428.
- Elgood, J.H., Heigham, J.B., Moore, A.M., Nason, A.M., Sharland, R.E., & Skinner, N.J. 1994. *The Birds of Nigeria: An Annotated Check-List*. 2nd Ed. Tring, UK: British Ornithologists' Union.

- Fa, J.E. & Castroviejo, J. 1992. Equatorial Guinea. In J.A. Sayer, C.S. Harcourt, & N.M. Collins (eds.), *The Conservation Atlas of Tropical Forests: Africa*. pp. 161–167. London: Macmillan.
- Fa, J.E., Juste, J., Pérez del Val, J., & Castroviejo, J. 1995. Impact of market hunting on mammal species in Equatorial Guinea. *Conservation Biology* 9: 1107–1115.
- Fa, J.E., Yuste, J.E.C., & Castelo, R. 2000. Bushmeat markets on Bioko Island as a measure of hunting pressure. *Conservation Biology* 14: 1602–1613.
- Figueiredo, E. 1994. Diversity and endemism of angiosperms in the Gulf of Guinea islands. *Biodiversity and Conservation* 3: 785–793.
- Fraser, P.J., Hall, J.B., & Healey, J.R. 1998. *Climate of the Mount Cameroon Region; Long and Medium Term Rainfall, Temperature and Sunshine Data*. University of Wales, Bangor, School of Agricultural and Forest Sciences Publication No. 16. 56 pp.
- Gadsby, E.L. 1989. *Cross River Basin Primate Survey: Stubbs Creek Forest Reserve*. Calabar: Unpublished report, 10 pp.
- Gartlan, J.S., Newbery, D.McC., Thomas, D.W., & Waterman, P.G. 1986. The influence of topography and soil phosphorus on the vegetation of Korup Forest Reserve, Cameroon. *Vegetatio* 65: 131–148.
- Gartshore, M.E. 1984. The status of the montane herpetofauna of the Cameroon highlands. In S.N. Stuart (ed.), *Conservation of Cameroon Montane Forests*. pp. 204–240. Cambridge: International Council for Bird Preservation.
- Gautier-Hion, A., Colyn, M., & Gautier J.-P. 1999. *Histoire naturelle des Primates d'Afrique Centrale*. Libreville, Gabon: ECOFAC.
- Green, A.A. & Rodewald, P.G. 1996. New bird records from Korup National Park and environs, Cameroon. *Malimbus* 18: 122–133.
- Grubb, P. 1990. Primate geography in the Afro-tropical forest biome. In G. Peters & R. Hutterer (eds.), *Vertebrates in the Tropics*. pp. 187–214. Bonn: Museum Alexander Koenig.
- Hall, J.B. 1981. Ecological islands in south-eastern Nigeria. *African Journal of Ecology* 19: 55–72.
- Hamilton, A.C. 1982. *Environmental History of East Africa: A Study of the Quaternary*. London: Academic Press.
- Harcourt, A.H., Stewart, K.J., & Inaharo, I.M. 1989. Gorilla quest in Nigeria. *Oryx* 23: 7–13.
- Hart, T.B., Hart, J.A., & Murphy, P.G. 1989. Monodominant and species-rich forests of the humid tropics: Causes for their co-occurrence. *American Naturalist* 133: 613–633.
- Hearn, G.W. & Morra, W. 2000. *Annual report (July 1999–June 2000) on Beaver College's Bioko Biodiversity Protection Program*. Glenside, PA: Beaver College Biology Department.
- Hilton-Taylor, C. 2000. *2000 IUCN Red List of Threatened Species*. Gland: IUCN.
- Hofer, U., Bersier, L.-F., & Borcard, D. 1999. Spatial organization of a herpetofauna on an elevational gradient revealed by null model tests. *Ecology* 80: 976–988.
- Holland, M.D., Allen, R.K.G., Barton, D., & Murphy, S.T. 1989. *Cross River National Park, Oban Division: Land Evaluation and Agricultural Recommendations*. Chatham, Kent: ODNRI.
- Hugueny, B. & Lévêque, C. 1994. Freshwater fish zoogeography in west Africa: Faunal similarities between river basins. *Environmental Biology of Fishes* 39: 365–380.
- Hutchinson, J., Dalziel, J.M., & Keay, R.W.J. 1954. *Flora of West Tropical Africa*. Vol. 1, Part 1. London: Crown Agents.
- Hutchinson, J., Dalziel, J.M., & Keay, R.W.J. 1958. *Flora of West Tropical Africa*. Vol. 1, Part 2. London: Crown Agents.
- Hutterer, R., Dieterlen, F., & Nikolaus, G. 1992. Small mammals from forest islands of eastern Nigeria and adjacent Cameroon, with systematical and biogeographical notes. *Bonn. Zool. Beitr.* 43: 393–414.
- Hutterer, R. & Schlitter, D.A. 1996. Shrews of Korup National Park, Cameroon, with the description of a new *Sylvisorex* (Mammalia: Soricidae). In *Contributions in Mammalogy: A Memorial Volume Honoring Dr. J. Knox Jones, Jr.* pp. 57–66. Museum of Texas Tech University.
- Iremonger, S., Ravilious, C., & Quinton, T. (eds.). 1997. *A Global Overview of Forest Conservation*. CD-ROM. Cambridge: WCMC & CIFOR.
- IUCN. 2002. *2002 IUCN Red List of Threatened Species*. Online. Available: <http://www.redlist.org>. 14 August 2002.
- Jensen, F.P. & Stuart, S.N. 1984. The origin and evolution of the Cameroon montane forest avifauna. In S.N. Stuart (ed.), *Conservation of Cameroon Montane Forests*. pp. 28–37. Cambridge: International Council for Bird Preservation.
- Juste, J.B. & Fa, J.E. 1994. Biodiversity conservation in the Gulf of Guinea islands: Taking stock and preparing action. *Biodiversity and Conservation* 3: 759–771.
- Keay, R.W.J., Onochie, C.F.A., & Stanfield, D.P. 1964. *Nigerian Trees*, 2 vols. Ibadan, Nigeria: Federal Department of Forest Research.
- King, S. 1994. Utilisation of wildlife in Bakossiland, West Cameroon. *Traffic Bulletin* 14: 63–73.
- Kingdon, J. 1990. *Island Africa: The Evolution of Africa's Rare Animals and Plants*. London: Collins.
- Larsen, T.B. 1995a. *Butterfly Research in the Oban Hills, Cross River National Park*. Calabar: Oban Hills Programme, Second Interim Report.
- Larsen, T.B. 1995b. *A Provisional Annotated List of the Butterflies of the Obudu Plateau*. Obudu: WWF-CRNP Okwangwo Programme.
- Larsen, T.B. 1997a. Butterflies of the Cross River National Park – diversity writ large. Proceedings of workshop on *Essential Partnership – The Forest and the People*, Cross River National Park, Calabar, Nigeria. pp. 229–235.
- Larsen, T.B. 1997b. An annotated list of the butterflies known from the Obudu Plateau (eastern Nigeria). Proceedings of workshop on *Essential Partnership – The Forest and the People*, Cross River National Park, Calabar, Nigeria. pp. 213–228.
- Larsen, T.B. 1997c. *Korup Butterflies – Diversity Writ Large*. Report on a butterfly study mission to Korup National Park in Cameroon during January and February of 1997. Report to WWF-UK and Korup National Park.
- Lawson, D.P. 1993. The reptiles and amphibians of the Korup National Park Project, Cameroon. *Herpetological Natural History* 1: 27–90.
- Letouzey, R. 1968. Notes phytogéographique du Cameroun. *Encyclopédie Biologique* 49, 508. Paris: P. Lechevalier.
- Litt, A. & Cheek, M. 2002. *Korupodendron songweanum*, a new genus and species of Vochysiaceae from West-Central Africa. *Brittonia* 54: 13–17.

- Louette, M. 1981. The birds of Cameroon: An annotated check-list. *Verhandl. Kon. Acad. Wetensch. Lett. Schone Kunst. Belg.* 43: 1–218.
- Maisels, F.G., Cheek, M., & Wild, C. 2000. Rare plants on Mount Oku summit, Cameroon. *Oryx* 34: 136–140.
- Maisels, F.G., Keming, E., Kemei, M., & Toh, C. 2001. The extirpation of large mammals and implications for montane forest conservation: The case of the Kilum-Ijim Forest, North-west Province, Cameroon. *Oryx* 35: 322–331.
- Maley, J. 1996. The African rain forest – main characteristics of changes in vegetation and climate from the Upper Cretaceous to the Quaternary. *Proceedings of the Royal Society of Edinburgh* 104B: 31–73.
- Maley, J. 2002. A catastrophic destruction of African forests about 2,500 years ago still exerts a major influence on present vegetation formations. In M. Leach, J. Fairhead, & K. Amanor (eds.), *Science and the Policy Process: Perspectives from the Forest*. pp. 13–30. IDS Bulletin, Vol. 33, No. 1.
- Maley, J. & Brenac, P. 1998. Vegetation dynamics, palaeoenvironments and climatic changes in the forests of western Cameroon during the last 28,000 years. *Review of Palaeobotany and Palynology* 99: 157–187.
- Maley, J., Livingstone, D.A., Giresse, P., Thouveny, N., Brenac, P., Kelts, K., Kling, G., Stager, C., Haag, M., Fournier, M., Bandet, Y., Williamson, D., & Zogning, A. 1990. Lithostratigraphy, volcanism, paleomagnetism and palynology of Quaternary lacustrine deposits from Barombi Mbo (West Cameroon): Preliminary results. *Journal of Volcanology and Geothermal Research* 42: 319–335.
- Moreau, R.E. 1966. *The Bird Faunas of Africa and Its Islands*. London: Academic Press.
- Newbery, D.McC. & Gartlan, J.S. 1996. A structural analysis of rain forest at Korup and Douala-Edea, Cameroon. *Proceedings of the Royal Society of Edinburgh* 104B: 177–224.
- Ngandjui, G. & Blanc, P.C. 2000. Biogeographie et biodiversité: Aires protégées et conservation des mammifères au Cameroun. *Biogeographica* 76: 63–77.
- Nichol, J.E. 1999. Geomorphological evidence and Pleistocene refugia in Africa. *Geographical Journal* 165: 79–89.
- Oates, J.F. 1986. *Action Plan for African Primate Conservation: 1986–90*. Stony Brook, NY: IUCN/SSC Primate Specialist Group.
- Oates, J.F. 1988. The distribution of *Cercopithecus* monkeys in West African forests. In A. Gautier-Hion, F. Bourlière, J.-P. Gautier, & J. Kingdon (eds.), *A Primate Radiation: Evolutionary Biology of the African Guenons*. pp. 79–103. Cambridge: Cambridge University Press.
- Oates, J.F. 1996. *African Primates: Status Survey and Conservation Action Plan*. Revised edition. Gland: IUCN.
- Oates, J.F. 1999. *Myth and Reality in the Rain Forest: How Conservation Strategies are Failing in West Africa*. Berkeley: University of California Press.
- Oates, J.F., McFarland, K.L., Groves, J.L., Bergl, R.A., Linder, J.M., & Disotell, T.R. 2003. The Cross River gorilla: Natural history and status of a neglected and critically endangered subspecies. In A.B. Taylor & M.L. Goldsmith (eds.), *Gorilla Biology: A Multi-disciplinary Perspective*. pp. 472–497. Cambridge: Cambridge University Press.
- Oates, J.F., White, D., Gadsby, E.L., & Bisong, P.O. 1990. Conservation of gorillas and other species. Appendix 1 to *Cross River National Park (Okwangwo Division): Plan for Developing the Park and Its Support Zone*. Godalming, Surrey: World Wide Fund for Nature, United Kingdom.
- Obot, E. 2000. Saving the green gold: Nigerian Conservation Foundation in Cross River National Park, Okwangwo Division. *Naturewatch* (NCF, Lagos) January 2000: 28–29.
- Parker, H.W. 1936. The amphibians of the Mamfe Division, Cameroons – I. Zoogeography and systematics. *Proceedings of the Zoological Society of London* (1936): 135–163.
- Pérez del Val, J. 1996. *Las Aves de Bioko, Guinea Ecuatorial: Guía de Campo*. León, Spain: Edilsa.
- Pérez del Val, J., Fa, J., Castroviejo, J., & Purroy, F.J. 1994. Species richness and endemism of birds in Bioko. *Biodiversity and Conservation* 3: 868–892.
- Perret, J.-L. 1966. Les amphibiens du Cameroun. *Zool. Jarhb., Abt. Syst.* 93: 289–464.
- Perret, J.-L. 1977. Les *Hylarana* (Amphibiens, Ranidés) du Cameroun. *Revue suisse Zool.* 84: 841–868.
- Petrides, G.A. 1965. *Advisory Report on Wildlife and National Parks in Nigeria, 1962*. Bronx, NY: American Committee for International Wildlife Protection.
- Powell, C.B. 1995. Wildlife Study I, Contract E-00019, Final Report. Submitted to Environmental Affairs Department, Shell Petroleum Development Company of Nigeria, Port Harcourt.
- Powell, C.B. 1997. Discoveries and priorities for mammals in the freshwater forests of the Niger Delta. *Oryx* 31: 83–85.
- Reid, G.McG. 1989. *The Living Waters of Korup Rainforest: A Hydrobiological Survey Report and Recommendations, with Emphasis on Fish and Fisheries*. WWF Report No. 3206/A8:1.
- Reid, J.C. 1989. Floral and faunal richness of Oban Division of Cross River National Park and list of flora and fauna of the Calabar Oban Area. Appendix 7 to *Cross River National Park (Oban Division): Plan for Developing the Park and its Support Zone*. Godalming, Surrey: WWF-UK.
- Richards, P.W. 1996. *The Tropical Rain Forest: An Ecological Study*. 2nd Ed. Cambridge: Cambridge University Press.
- Rodewald, P.G., Dejaifve, P.-A., & Green, A.A. 1994. The birds of Korup National Park and Korup Project Area, Southwest Province, Cameroon. *Bird Conservation International* 4: 1–68.
- Sarmiento, E.J. & Oates, J.F. 2000. Cross River gorillas: A neglected subspecies. *American Museum Novitates* no. 3304, 55 pp.
- Sayer, J.A., Harcourt, C.S., & Collins, N.M. (eds.). 1992. *The Conservation Atlas of Tropical Forests: Africa*. IUCN/Macmillan.
- Schiøtz, A. 1963. The amphibians of Nigeria. *Vidensk. Medd. Fra Dansk naturh. Foren.* 125: 1–92.
- Schiøtz, A. 1966. On a collection of Amphibia from Nigeria. *Vidensk. Medd. fra Dansk naturh. Foren.* 129: 43–48.
- Schiøtz, A. 1999. *Treefrogs of Africa*. Frankfurt am Main: Edition Chimaira.

- Schmitt, K. 1996. Botanical survey in the Oban Division, Cross River National Park. Calabar: Oban Hills Programme, Cross River National Park-WWF.
- Stattersfield, A.J., Crosby, M.J., Long, A.J., & Wege, D.C. 1998. *Endemic Bird Areas of the World: Priorities for Biodiversity Conservation*. Cambridge: BirdLife International.
- Stiassny, M.L.J., Schliewen, U.K., & Dominey, W.J. 1992. A new species flock of cichlid fishes from Lake Bermin, Cameroon with a description of eight new species of *Tilapia* (Labroidei: Cichlidae). *Ichthyol. Explor. Freshwaters* 3: 311–346.
- Struhsaker, T.T. 2001. Africa's rain forest parks: Problems and possible solutions. Report to Center for Applied Biodiversity Science, Conservation International, Washington, DC.
- Sunderland, T.C.H., Mboh, H., Comiskey, J.A., Besong, S., Fonwebon, J., & Dione, M.A. 2002. *The Vegetation of the Takamanda Forest Reserve, Cameroon*. Unpublished draft report to the Smithsonian Institution, Washington, DC.
- Terborgh, J. 1999. *Requiem for Nature*. Washington, DC: Island Press.
- Teugels, G.G., Reid, G.M., & King, R.P. 1992. Fishes of the Cross River Basin (Cameroon-Nigeria): Taxonomy, zoogeography, ecology and conservation. *Annales de le Musée Royal de l'Afrique Centrale. Sciences Zoologique* 266. 132 pp.
- Thomas, D.W. 1984. Vegetation in the montane forest of Cameroon. In S.N. Stuart (ed.), *Conservation of Cameroon Montane Forests*. pp. 20–27. Cambridge: International Council for Bird Preservation.
- Thys van den Audenaerde, D.F.E. 1967. The freshwater fishes of Fernando Poo. *Verh. K. vlaamse Acad. Wet. Lett. Sch. Kunst. Belgie (Wet.)*, Jg. 29, no. 100. 167 pp.
- Trewavas, E. 1974. The freshwater fishes of Rivers Mungo and Meme and Lakes Kotto, Mboandong and Soden, West Cameroon. *Bulletin of the British Museum (Natural History), Zoology* 26: 331–419.
- Trewavas, E., Green, J., & Corbet, S.A. 1972. Ecological studies on crater lakes in West Cameroon: Fishes of Barombi Mbo. *Journal of Zoology, London* 167: 41–95.
- Tye, H. 1984a. Geology and landforms in the highlands of western Cameroon. In S.N. Stuart (ed.), *Conservation of Cameroon Montane Forests*. pp. 15–17. Cambridge: International Council for Bird Preservation.
- Tye, H. 1984b. The climate of the highlands of western Cameroon. In S.N. Stuart (ed.), *Conservation of Cameroon Montane Forests*. pp. 18–19. Cambridge: International Council for Bird Preservation.
- Usongo, L. 1997. Annotated list of known mammals of Korup National Park. Unpublished report in library of Korup National Park, Mundemba, Cameroon.
- Verheyen, W.N., Hulselmans, J., Colyn, M., & Hutterer, R. 1997. Systematics and zoogeography of the small mammal fauna of Cameroun: Description of two new *Lophuromys* (Rodentia: Muridae) endemic to Mount Cameroun and Mount Oku. *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique. Biologie* 67: 163–186.
- Vick, G.S. 1999. A checklist of the Odonata of the South-west Province of Cameroon, with the description of *Phyllogomphus corbetiae* spec. nov. (Anisoptera: Gomphidae). *Odontologica* 28: 219–256.
- Walter, H. 1973. *Vegetation of the Earth in Relation to Climate and Eco-Physiological Conditions*. New York: Springer-Verlag.
- Waltert, M., Lien, Faber, K., & Mühlenberg, M. 2002. Further declines of threatened primates in the Korup Project Area, south-west Cameroon. *Oryx* 36: 257–265.
- Werre, J.L.R. 2000. Ecology and behavior of the Niger Delta Red Colobus monkey (*Procolobus badius epieni*). Unpublished Ph.D. thesis. NY: City University of New York.
- White, F. 1983. *The Vegetation of Africa*. Paris: Unesco.
- Whitmore, T.C. 1975. *Tropical Rain Forests of the Far East*. Oxford: Oxford University Press.
- Wieringa, J.J. 1999. *Monopetalanthus* exit. A systematic study of *Aphanocalyx*, *Bikinia*, *Icuria*, *Michelsonia* and *Tetraberlinia* (Leguminosae, Caecalpinioideae). *Wageningen Agricultural University Papers* 99–4. 320 pp.
- Williams, P.H. 2000. *WORLDMAP*. Vers. 4.20.12. London: Natural History Museum.