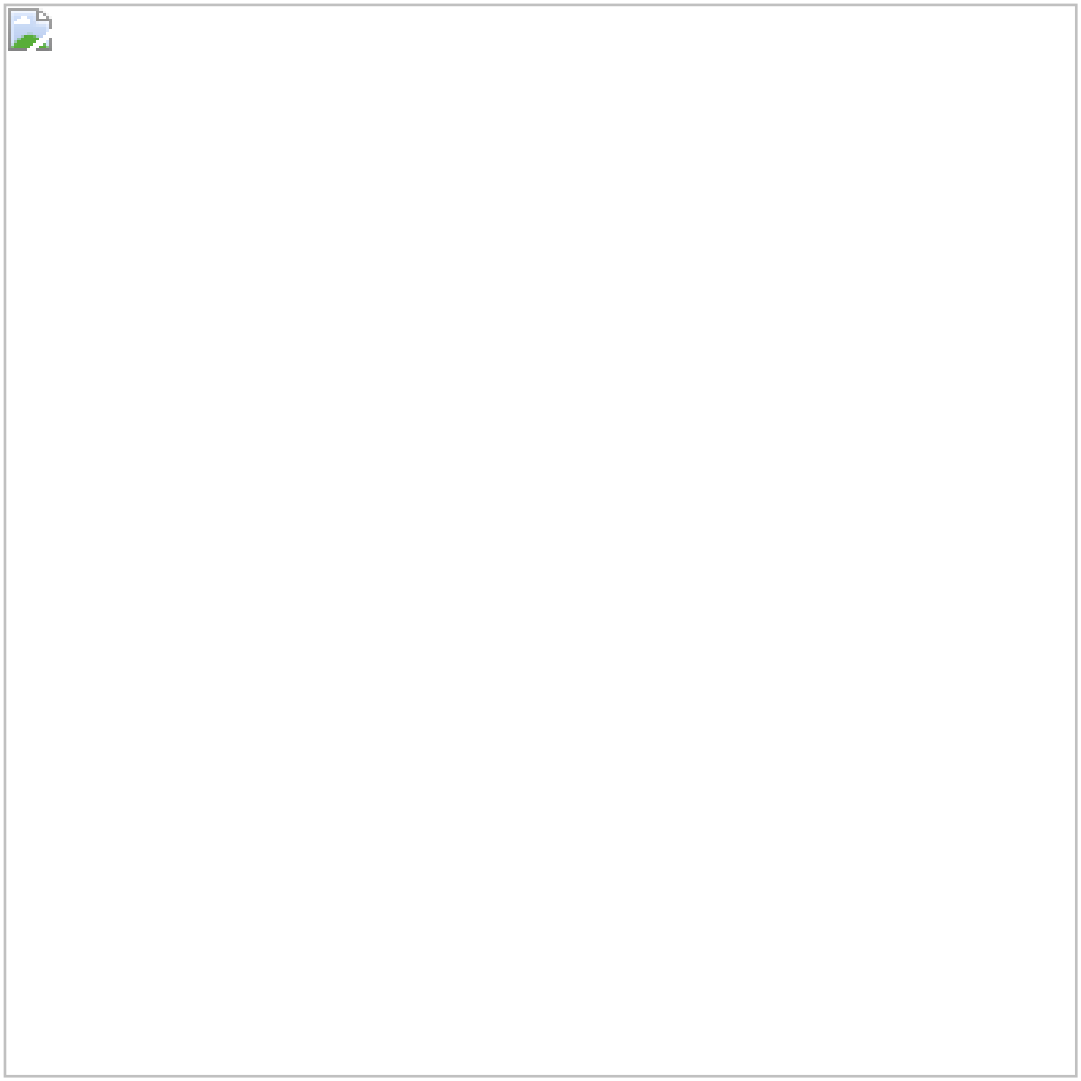

CHAPTER 2 Approaches and Methods

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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 nongovernmental 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 Wildife 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

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