

Introduction

In the absence of detailed information about central Africa's rainforests, Global Forest Watch has undertaken to provide a coarse-scale picture of the region's *large tracts of low-access forest*—i.e., forests at least 2 kilometers (km) from public roads and in contiguous blocks of at least 1,000 km². To identify blocks of forest relatively undisturbed by commercial-scale activities, we assessed the degree to which these forest tracts were located in protected areas or in areas allocated for logging. This coarse-scale approach offers an indication of which forests are more or less impacted by development, but overall it underestimates human access into forests. Detailed data for Cameroon, unavailable for the rest of central Africa, allowed us to examine the extent to which logging roads and other newly constructed transport routes are opening access into previously remote forest tracts (i.e., those identified in the coarser-scale regional analysis). This two-tiered approach offers insight into the potential condition of forests in logging concessions region-wide and reveals the need for improved roads data.

Why Identify Low-Access Forests in Central Africa?

Forests are accessed by transportation routes including roads, railroads, and rivers that bring human populations into contact with forest ecosystems. In central Africa (Figure 1), new sources of forest access result primarily from road construction to support the logging industry. Access impacts forest ecosystems in two principal ways. First, transport routes have direct ecological effects, such as biomass loss, impeding the movement of animal species, microclimate changes, and other so-called edge effects that take place along the sides of roads. Second, access routes open the forest to human activity, including timber harvesting, bushmeat hunting, gathering of woodfuel, and agricultural conversion of forest land. The impact of access into forests depends largely on the scale of these activities.

In sparsely populated areas used only for subsistence-level human activities, these activities may prove more sustainable in the long run if population density remains low. In areas of high (or growing) population density and/or where access routes are constructed to serve commercial-scale extractive activities, the indirect impacts of access can be much more damaging. In these cases, the opening of access routes can, over time, lead to the hunting out of large forest areas, forest fragmentation (i.e., the breaking up of forest into remnants surrounded by land converted to other uses), and deforestation. In more densely populated areas such as southwest Cameroon, the eastern Democratic Republic of the Congo, and areas surrounding large cities fragmentation and deforestation are taking place on a large scale. In central Africa's low-access forest tracts,



population density is very low and, to date, deforestation has been limited. The primary adverse impact of forest access in these regions is widespread defaunation (i.e., removal of animals from the forest faster than their populations can recover) caused by commercial-scale bushmeat hunting.

Improved road networks benefit people, but may harm ecosystems. Improved road networks are essential to economic development and growth. They often indirectly harm the environment, however, as roads provide access to previously undisturbed forest. Road improvement increases opportunities for trade by reducing the time and costs required to transport goods to market. Roads can enable previously isolated communities to gain access to education and medical services as well as

markets (FAO and ATIBT 1999). While road networks are expanding rapidly in many areas of central Africa especially eastern Cameroon, the northern Republic of the Congo, and the southern tip of the Central African Republic in much of the Democratic Republic of the Congo, road infrastructure has declined as a result of years of civil war. Future expansion of road networks in central Africa is unavoidable and road improvements are a necessity for economic development, but, without appropriate interventions, environmental degradation will accompany roads wherever they are constructed.

A broad range of political, economic and cultural factors drive the damaging effects of increasing forest access. These include political and economic instability, foreign debt, corruption, poverty, poor law enforcement, and cultural traditions that place low priority on environmental protection. Such factors lead in turn to poor forest management, unsustainable logging practices, semi-open access to forests, and uncontrolled commercial-scale bushmeat hunting—all of which contribute to the indirect environmental damage observed in central Africa in association with the opening of new transport routes through the forest (Geist and Lambin 2001). The adverse impact of roads likely cannot be reduced without also addressing the broad underlying factors that contribute to environmental harm.

Access adversely impacts wildlife populations.

Forest animals vary greatly in their ability to tolerate roads, clearings, and agricultural areas that may separate forest areas. A landscape that serves as continuous habitat for one species may offer only a limited usable habitat area for more sensitive

species. Species living in the tropical rainforest tend to be intolerant of conditions outside intact forest, making them sensitive to the barriers that roads create. Roads, especially heavily traveled ones with a corridor of cleared vegetation on either side, may be a permanent barrier to the movement of some animals, such as understory birds or small mammals (Bierregaard et al. 1992, Forman and Alexander 1998, Turner 1996). Infrequently used roads may, however, attract predator species that travel or hunt along roads as well as foraging herbivores that graze on roadside vegetation (Forman and Alexander 1998).

For other species, the presence of human populations may be a more significant factor than the impact of roads per se. Forest elephants, for example, are attracted to areas of secondary growth, such as abandoned logging concessions, fields or villages, but hunted populations avoid coming within several kilometers of areas of current human activity (Barnes et al. 1991, Barnes et al. 1995, Wilkie and Morelli 1998). As road density increases, forests may become fragmented and forest species confined to smaller, isolated patches. In areas of increasingly dense human populations, forests begin to be converted to agricultural and other uses.

Forest access facilitates commercial bushmeat hunting.

Perhaps the most severe impact of road construction on wildlife populations in central Africa is the expanded movement of bushmeat hunters into remote forest. In this region, wild game contributes nearly all of the animal protein consumed by forest-dwelling people. It is also a favored food of city dwellers, who are willing to pay

premium prices for bushmeat relative to meat from domesticated animals. Bushmeat has become a substantial market commodity in cities throughout central Africa and trade in this commodity is becoming increasingly commercialized (Wilkie and Carpenter 1999, Wilkie et al. 2000). Increased access to forests by hunters may lead to the local extirpation or extinction of animals through direct defaunation (Redford 1992, Rudel and Roper 1997). Because of the significant threat to wildlife from over-hunting, many areas likely suffer from the “empty forest” syndrome (Redford 1992); i.e., though forest cover remains, much of the native fauna and flora may be locally extinct or in danger of extinction (Terborgh 1992, Rudel and Roper 1997, Saunders et al. 1991).

Logging facilitates bushmeat hunting by increasing access to formerly remote forest areas on newly built road networks. Improved access to such remote areas means that bushmeat can be transported to market by motor vehicle in a fraction of the time required to take out game on foot. Logging vehicles often provide transportation for bushmeat and hunters, and in many cases the concession employees themselves earn a significant portion of their income by hunting (Wilkie and Carpenter 1999). The present level of bushmeat hunting is unsustainable; unless the removal of animals in and around many logging concessions is scaled back, many species face local extirpation and potential extinction.

Forest access is linked to degradation and deforestation. Road construction, coupled with selective logging, is often the first step in a process leading to forest degradation, fragmentation, and eventual deforestation. Commercial logging causes direct

environmental damage; it also creates the first opening in the forest, facilitating further access via logging roads and exacerbating the initial damage. These roads draw in hunters and poachers as well as landless immigrants, who convert forest outside the concessions and along the sides of main roads to agricultural uses. Commercial logging operations employ many workers and pay relatively high wages, attracting large numbers of people into sparsely populated areas (Wilkie and Carpenter 1999, Wilkie et al. 2000). Logging thus often leads indirectly to further degradation and deforestation.

Poor management of forests, including those managed for timber supply as well as protected areas, threatens remaining low-access tracts. While central Africa retains a substantial share of the world's largest tracts of intact rainforest, these forests are becoming increasingly open to human access. Currently, unsustainable forestry practices threaten the ecological integrity of these forests and are incompatible with the conservation of biological diversity. (See Box 1.) Most logging operations lack basic safeguards, such as management plans and controls on wildlife hunting, to minimize forest degradation. In addition, illegal logging and forestry code violations are widespread in many parts of the region (Greenpeace 2000). Poor management plagues the region's protected areas system: many protected areas are no more than "paper parks," established in legislation, but with few or no resources or staff to protect forests from commercial bushmeat hunting, poaching of endangered species, illegal logging, and other damaging exploitation.

How This Analysis Was Conducted

This study was carried out using ArcView 3.2 and ArcGIS 8 geographic information systems (GIS) software and ERDAS Imagine 8.4 remote sensing software. Steps in the analysis are outlined below.

Regional analysis of forest access in central Africa

1. *Roads datasets were prepared and, where possible, updated.* Public roads data for the region-wide analysis depicted public access routes and did not include logging roads or other private roads, as these data are generally not available region-wide. Datasets were collected from various sources, including digital datasets, scanned topographic maps, and paper maps. (See Appendix: Technical Notes for more details.)
2. *Forest cover data were prepared to identify rainforest areas and to exclude from the analysis areas of secondary or degraded forest.* The TREES 2001 (EU Joint Research Centre, Ispra, Italy) forest cover dataset was used to identify areas of forest and nonforest. The 1-km-resolution TREES map was derived from 2000 NOAA AVHRR and SPOT VEGETATION satellite imagery, as well as ERS and JERS radar imagery.

Three classes of TREES data—lowland rainforest, mangrove, and swamp forest—were designated "forest" for the purposes of this analysis. To ensure that "forest" included only relatively intact areas, the "secondary forest and rural complex" class was removed. This class represents primarily degraded forest around

cities, along roadsides, and within small fragments of forest remaining in agricultural or savanna regions.

3. *A forest buffer was established.* Public roads datasets were buffered by 2 km and overlaid with the TREES map to exclude from the analysis forest within this buffering distance. The buffer size was selected based on the results of a study in eastern Cameroon, which found that 80% of all deforestation takes place within 2 km of a road (Mertens and Lambin 1997).

While a buffer of this size will segregate from the analysis most degraded and deforested areas, in some cases it will also remove forest classified by the TREES map as closed-canopy forest. Forests such as these, located on the boundaries of deforested areas, suffer from so-called edge effects, which may include microclimate changes, biomass loss, decline in species richness, increased susceptibility to fire, and invasion by exotic species, among other damaging impacts (Rudel and Roper 1997, Terborgh 1992, Lambin and Ehrlich 1997, Barnes et al. 1995). Excluding these edge forests from the analysis helps ensure that the large, low-access forest tracts described by this study better represent truly intact rainforest habitats.

This regional analysis does not consider the potential impacts of hunting, because the lack of region-wide data on logging roads provides an insufficient basis for a reasonable estimate. We have produced a national-level estimate of the