Steps Toward Sustainable Forest Management in Central Africa

Report of an Exploratory Visit to Timber Concessions in the Republic of Congo and Gabon

A Contribution to CARPE, the Central African Regional Program for the Environment (USAID)
http://carpe.umd.edu/

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Cover: The inset photo is by Frédéric Glannaz of Congolaise Industrielle des Bois, Pokola, Congo. The image shows a large Sipo *(Entandrophragma utile)*. Another view of the same tree is shown in Photo 1 on page *vi* of this report. The cover background photo of a logging road in Gabon is by Dennis Dykstra.

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Acknowledgements

Representatives of the two companies whose sites were the focus of the visit, **CIB** (Pokola, Congo) and **SBL** (Lastoursville, Gabon), were tremendously helpful and gracious in supporting the field visits. Persons met from the two companies included the following:

CIB (Société Congolaise Industrielle des Bois), Pokola, Congo

Yves Dubois, Director General
Christian Guyonvaro, Production Coordinator
Frédéric Glannaz, Management Planning Specialist
Denis Decheneaud, Forestry Chief, Pokola Forest Management Unit
Achille Tsieta, Deputy Forestry Chief, Kabo Forest Management Unit
T. Maurin, King Air Pilot
A. Moubouha, Medical Doctor

The visit to **CIB** was greatly facilitated by **Robert Hunink**, Senior Executive Officer, tt Timber International AG, Basel, Switzerland, who was personally present throughout the visit to Pokola. At his invitation we were able to fly on the **CIB** plane from Douala to Pokola and later from Pokola to Libreville via Port Gentil.

Also in Pokola we were able to meet with **Paul Elkan**, Program Manager of the Nouabalé-Ndoki Project of the Wildlife Conservation Society, who is based in Kabo, the industrial site of one of **CIB**'s three concession areas. The Nouabalé-Ndoki National Park adjoins the northern boundary of **CIB**'s Kabo concession area.

SBL (Société des Bois de Lastoursville), Libreville and Lastoursville, Gabon

Heiric Cheneau, **SBL** Director General, Libreville; and President of SYNFOGA, the Union of Timber Producers and Wood Industries of Gabon. Mr. Cheneau provided us with considerable background on the social and economic situation in Gabon and facilitated our visit to Lastoursville by making arrangements with the field personnel and providing air tickets.

Louis Faucheur, Director of Production
Frank Stenmanns, Management Planning Specialist
Daniel Dubeaux, Forestry Chief, Koulamoutou Unit

Other persons met

James A. Graham, CARPE Project Manager, USAID Washington DC, who briefed us on the CARPE Project and provided useful insights into the political and economic background of the countries visited.

Nadine T. Laporte, University of Maryland (met in Washington DC), who is involved with the CARPE Project as a remote sensing specialist.

Leon Pascal Embon, Government of Congo counterpart in forest management planning.

Jean Michel Ngongo, Government of Congo counterpart in forest management planning.

Alain Nonouka-Gomat, leader of the Government of Congo's UPARA unit in Pokola. UPARA is the Pilot Unit for Planning, Reforestation, and Agroforestry.

Nicolas Bayol, Forest Management Consultant, Rougier Gabon, Libreville; and Forêt Ressources Management, Montpellier, France. Met in Libreville.

Rob Solem, CARPE Focal Point–Gabon, BSP/WWF Gabon Field Office, Libreville.

Telephone Conference Call

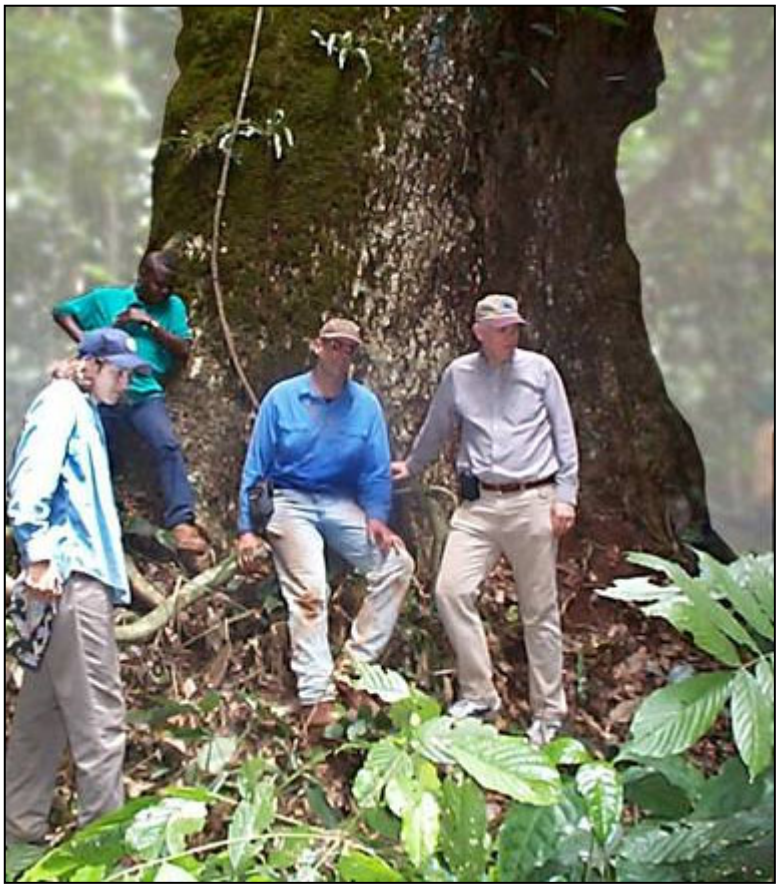
Hinrich Stoll, President Director General, **CIB**; and Hinrich Feldmeyer GmbH & Co. KG, Hemsbünde, Germany. From the Forest Service International Programs Office in Washington DC, we held a telephone conference call with Mr. Stoll on April 17 prior to departing on the trip to Central Africa. The discussion was helpful to put the visit in perspective and to learn of **CIB**'s intention to have its timber concession in Congo certified as a sustainably managed forest.

Photo 1. Trees in Central Africa can grow very large, as indicated by this specimen, known locally as the "Sequoia du Congo".

This giant Sipo (Entandrophragma utile) is maintained by CIB (Société Congolaise Industrielle des Bois) as a "forest monument" in a portion of the company's timber concession in northern Congo where logging has been completed. The tree's diameter at breast height is 350 cm, and its girth exceeds 11 m.

To show the outline of the tree trunk more clearly the background of the photo has been artificially blurred and brightened.

In the photo, from left, are: Melissa Othman, Jean Michel Ngongo, Rick Toupin, and Dennis Dykstra.



Fred Glannaz

Trip Schedule

Date	Description of Activities
Monday 16 April	**Dennis Dykstra** and **Richard Toupin** travel by air from Portland, Oregon to Washington DC
Tuesday 17 April	Meetings at USDA Forest Service International Programs Office: **Alex Moad**, Assistant Director for Technical Cooperation **Mike Benge**, USAID Senior Forestry Advisor **Melissa Othman**, Africa Program Coordinator **Cheryl Burlingame**, Africa Program Assistant **Gary Man**, Asia-Pacific Program Coordinator **Kelli Young**, Asia-Pacific Program Assistant **Jan Engert**, Latin America Program Coordinator **Catherine Carr**, Latin America Program Specialist **Michelle Zweede**, Latin America Program Assistant **Liz Mayhew**, Russia, NIS, and Europe Program Coordinator **Nadine T. Laporte**, University of Maryland (remote sensing of the **CIB** concession area and Nouabalé-Ndoki National Park) **Jack Putz**, University of Florida (development of financial models for the assessment of reduced-impact logging alternatives) Briefing by **James A. Graham**, USAID, CARPE Project Manager *Evening:* departure of **Melissa Othman**, **Dennis Dykstra**, and **Richard Toupin** by air to Douala, Cameroon via Paris
Wednesday 18 April	*Afternoon:* arrival in Douala, met by a staff member from **CIB**'s Douala office; installation at Hotel Méridien Arrival of **Robert Hunink** and family by **CIB** plane from Pokola *Evening:* dinner meeting with **Robert Hunink** to discuss plans for the field visit
Thursday 19 April	Departure by **CIB** plane to Pokola Arrival in Pokola; installation at **CIB** Guest House Meeting at **CIB** main office with Robert Hunink, Yves Dubois, Christian Guyonvaro, Frédéric Glannaz
Friday 20 April	Field tour of the northern portion of the Pokola Forest Management Unit, accompanied by **Robert Hunink**, **Yves Dubois**, **Christian Guyonvaro**, **Frédéric Glannaz**, and **Denis Decheneaud** • Eco-Guards and controlled-hunting areas • Felling, with discussion of **CIB**'s tree prospection system • Skidding with Caterpillar 528 skidder assisted by Komatsu D85 bulldozer • Inspection of primary and secondary forest roads • Visit to the village of Ndoki I Return to Pokola • Tour of the **CIB** log sorting yard • Tour of the mechanical shops, dry kilns, and molding mill • *Evening:* tour of the **CIB** sawmill

Date	Description of Activities
Saturday 21 April	Field tour of the Kabo Forest Management Unit, accompanied by **Christian Guyonvaro**, **Frédéric Glannaz**, and **Ashiel Tsieta** • Inspection of bridges and dikes constructed over swampy areas • Felling • Skidding with Caterpillar 545 skidder assisted by Komatsu D85 bulldozer • Inspection of closed secondary roads and old skidtrails • Visit to giant tree • Visit to the village of Ndoki II Return to Pokola • Visit to forest nursery and research site operated by the Government of Congo • Visit to the **CIB** dispensary, hospital, and pharmacy in Pokola • Tour of the town of Pokola • *Evening:* discussion with **Paul Elkan**, Wildlife Conservation Society
Sunday 22 April	Discussion at **CIB** office on forest inventory, management planning, and use of remote imagery and geographical information systems, followed by: • Wrap-up meeting with **Robert Hunink**, **Yves Dubois**, **Christian Guyonvaro**, **Frédéric Glannaz**, and **Paul Elkan** • Further discussion with **Paul Elkan** regarding **WCS/CIB** collaboration • Tour of fish farming and chicken farming projects supported by **CIB** • Visit to **CIB** "farm" and residence of **Frédéric Glannaz**
Monday 23 April	Early-morning departure by **CIB** plane to Libreville via Port Gentil, with **Robert Hunink** staying in Port Gentil to visit another subsidiary of the corporate group Arrival in Libreville; initial discussion with **Heiric Cheneau**, Director General of **SBL**; installation at Hotel Inter-Continental Okoumé Palace
Tuesday 24 April	Flight from Libreville to Koulamoutou on Air Gabon Arrival in Koulamoutou, met by **Frank Stenmanns** of **SBL**; transfer by car to Lastoursville; installation in the **SBL** Guest House Initial meeting with **Louis Faucheur** and **Frank Stenmanns** Visit to Lastoursville railroad yard and viewing of small-scale sawmilling operations to recover waste timber
Wednesday 25 April	Field visit to **SBL**'s Lastoursville Chantier, accompanied by **Louis Faucheur** and **Frank Stenmanns** • Felling techniques • Discussion of placard system for keeping track of trees found by the prospection crews, trees felled, logs skidded, and logs loaded on trucks • Skidding with Caterpillar 527 tracked skidder assisted by Komatsu D65 bulldozer; opening of skidtrails by D65 • Landing operations: log grading, bucking • Inspection of primary and secondary roads and drainage systems • Tour of the **SBL** mechanical shop and sawmill
Thursday 26 April	Field visit to **SBL**'s Koulamoutou Chantier, accompanied by **Louis Faucheur**, **Frank Stenmanns**, and **Daniel Dubeaux** • Skidding with Timberjack 480 skidder assisted by Komatsu D65 bulldozer

Date	Description of Activities
	• Landing operations: log grading, bucking, loading of trucks • Road construction with Komatsu D85 bulldozer • Discussion of **SBL**'s efforts to exclude hunters from concession area • Inspection of closed secondary roads and skidtrails *Evening:* wrap-up meeting with **Louis Faucheur** and **Frank Stenmanns**
Friday 27 April	Final discussions with **Frank Stenmanns** Late afternoon: departure to Libreville via Port Gentil on Air Gabon *Evening:* arrival in Libreville; installation in Hotel Inter-Continental Okoumé Palace
Saturday 28 April	Meeting with **Heiric Cheneau** of **SBL** Meeting with **Rob Solem**, CARPE Focal Point in Gabon Meeting with **Nicolas Bayol**, forest management planning consultant for Rougier Gabon *Evening:* departure to Paris by Air France
Sunday 29 April	*Early morning:* arrival in Paris *Afternoon:* departure to US *Evening:* arrival at US destinations

1. Overall Assessment and Recommendations

The objectives of the two-week field visit summarized in this report were two-fold:

- To assess current logging practices at two locations in Central Africa in an effort to determine the degree to which technical assistance on logging and forest management might be effective in reducing environmental impacts or improving wood utilization
- To consider how the USDA Forest Service might optimally direct its technical cooperation efforts on sustainable forest management in Central Africa

In an effort to achieve these objectives we visited two timber concessions in Central Africa: **CIB (Société Congolaise Industrielle des Bois, Pokola, Republic of Congo)** and **SBL (Société des Bois de Lastoursville, Lastoursville, Gabon)**. At each site we spent two full days in the field, plus an additional one or two days discussing forest management planning and forest policy issues with professional staff members. We also spent two days in Libreville, Gabon, where we met with officials of two timber companies and the country focal point in Gabon for CARPE, the Central African Regional Program for the Environment, an initiative of USAID.

It is important to note that our purpose in undertaking the company visits was *not* to judge the two companies' logging practices, but rather to develop a general understanding of the practices being used and an appreciation for the physical and socio-political conditions under which the companies are operating. In a short visit of this nature it is impossible to observe the full range of conditions faced by the logging companies or to fully understand either the constraints that limit their options or the opportunities that might be available to them. Although the observations and recommendations in this report are offered in the spirit of constructive criticism, it is important to recognize that they are based on a very limited overview of the two operations visited and therefore cannot in any sense be authoritative.

1.1 Management Planning

Both **CIB** and **SBL** are at an early stage in the process of developing comprehensive forest management plans for their timber concessions. Both have hired full-time staff members to carry out forest inventories and develop management plans. Inventories to establish the current volume of growing stock at all age classes will be carried out on a 1% sampling basis by both companies. (Regeneration surveys will be conducted at a lower sampling rate.) This information will be combined with physical information on roads, streams, topography, and other features to develop both operational and long-term management plans. Such plans are required under new forestry legislation in both Congo and Gabon, and are also a prerequisite for certification as well as a necessity for long-term management decisions.

1.2 Forest Regeneration

One important issue related to management planning, and to the long-term sustainability of both the forests and the forest enterprises that depend on them, is that of forest regeneration. This is particularly true when future timber crops depend upon the success of natural regeneration, as is the case with the type of selection harvest practiced by both **CIB** and **SBL**. We were surprised to learn that neither company has carried out comprehensive regeneration surveys in the past, even to determine the degree to which the important timber species are regenerating successfully after harvesting. As a result of its own limited surveys, the Wildlife Conservation Society has raised concerns about whether Sapeli, the principle species

currently being harvested on the **CIB** concessions, is regenerating satisfactorily. On the **SBL** concession one of the major species being harvested, Moabí, is highly prized by forest elephants and other wildlife as a source of fruit. Wildlife experts often express concern about extensive harvesting of this species because of potential impacts on wildlife populations and migration patterns. If the species is regenerating adequately this may not be a significant problem, but at present this appears to be unknown.

Both **CIB** and **SBL** have now initiated regeneration surveys as part of the management planning inventories mentioned under Section 1.1. This will be an essential step in determining whether the tree species being harvested are regenerating in sufficient numbers to ensure that they will be present in large enough concentrations to ensure future economic viability of the enterprise. It seems likely that research will also be needed to determine the conditions that favor adequate regeneration of the species mixes that are being harvested on the two quite different concession areas by **CIB** and **SBL**.

1.3 Control of Hunting and Bushmeat Trade

Efforts by both **CIB** and **SBL** to control hunting and bushmeat trade appear to be having a positive effect, as officials of both companies report an increase in the availability of beef and poultry in local markets where previously bushmeat was the primary source of protein. **CIB**'s involvement with Eco-Guards, through a partnership with the Wildlife Conservation Society and the Government of Congo, appears to be particularly effective. No such system is available in Gabon. **SBL**'s efforts to control hunting by limiting vehicular access to its concession areas and by enforcing restrictions on its own employees are therefore particularly important. Judging by the number of hunters' huts observed along **SBL**'s logging roads, such efforts are needed urgently.

Rick Toupin

Photo 2. Hunters' hut located near a logging road outside the town of Koulamoutou, Gabon.

1.4 Sawmills and Wood Utilization

In an effort to increase both the number of species and the range of log grades that can be utilized, both **CIB** and **SBL** have invested in sawmills in their concession areas. **CIB**'s sawmill is substantially larger than that of **SBL**, and **CIB** has also installed dry kilns to increase the economic viability of producing sawnwood and additional value-added products for export.

Rick Toupin

Photo 3. *Planer section in the CIB sawmill at Pokola, Congo.*

Conversion ratios at both companies' sawmills are low, averaging around 30%. This is partly because the best logs are exported as roundwood, leaving only lower quality logs as inputs for the sawmills. In addition, domestic markets for sawnwood are limited and prices are low, so the focus is on producing lumber that can be exported. Because only the higher grades of lumber are attractive to overseas buyers, the fraction of sawnwood rejected (and thus wasted) is high. For both companies, the long transportation distance to markets is a significant obsta-

cle to increased utilization of lower quality sawnwood. **SBL** has an advantage in this respect because of the railroad yard at Lastoursville.

The sawmills are of major importance to both **CIB** and **SBL**. Without them, a lower-quality log recovered as the second log from a tree with a first export-quality log would be wasted, and the number of species that could financially be utilized would be much lower than at present.

1.5 Utilization of Additional Species

Both **CIB** and **SBL** indicated that their long-term strategies include efforts to increase the number of species they are able to utilize from their respective forest areas. **CIB**'s new dry kilns, combined with marketing efforts to educate sawnwood purchasers about lesser-known species, have increased the company's ability to utilize species that previously were economically unattractive. **SBL** is currently considering investments that might allow it to double, from 30 to 60, the number of species that the company can potentially utilize from its concession area.

It is generally recognized that by increasing the number of species utilized, the area of forest entered each year in order to obtain a given harvest volume can be reduced, perhaps significantly. In addition, the kilometers of roads and skidtrails needed per unit of timber volume harvested may be substantially reduced and thus the fixed costs of infrastructure development will decrease. As a collateral effect, the negative aspects of roads on wildlife should also decrease. On the other hand, utilization of additional species may result in much more opening of the canopy in harvested areas, changing local microclimates and possibly encouraging the growth of pioneer vegetation, altering wildlife habitat, and affecting forest regeneration[1]. Increased harvesting intensity may also result in greater damage to residual vegetation, including future crop trees. If roads and skidtrails are not planned carefully it can also result in a greater density of disturbed and compacted soils and an increase in soil erosion. Finally, increasing the number of species utilized may make it economically attractive for the concession holder to re-enter areas that have been harvested previously in order to recover the newly utilized species. This can cause higher impacts, especially if the re-entry occurs before the previously harvested area has had time to recover from the initial operation. During such re-entries it is essential to utilize the same roads and skidtrails that were used for the initial harvesting operation and to take extra care to avoid damage to residual vegetation, particularly during felling.

Dennis Dykstra

Photo 4. As shown here at SBL, both CIB and SBL mark logs as part of a comprehensive inventory system to ensure that the chain of custody can be tracked until the logs are sold or converted into products.

On balance, utilizing a greater number of species would probably be beneficial on both the **CIB** and **SBL** concessions. However, care must be taken to ensure that roads and skidtrails are planned carefully and that both felling and skidding operations are conducted in ways that will limit damage to soils and to residual vegetation.

[1] The effect may be either positive or negative, depending on the species. Some tree species utilized for timber require an open canopy to regenerate well, whereas others regenerate better in more shady conditions.

1.6 Observations and Recommendations on the Logging Operations

Overall, we were favorably impressed with the state of logging operations at the two timber concessions we visited. By comparison with many logging operations we've observed in Southeast Asia, the Amazon Basin, and several other parts of Africa, the two operations visited in Congo and Gabon are relatively better planned, better supervised, and are carried out by more competent personnel at all levels. One possible reason for this is that the logging is done by company crews rather than by contractors, as is commonly the case in Southeast Asia and the Amazon Basin. The use of company logging crews provides an opportunity for better control and supervision and enables the company to actively manage issues such as training and labor turnover, which are often major problems in logging.

Detailed descriptions of the **CIB** and **SBL** logging operations are provided in Sections 3.8 and 4.6 of this report. Here we offer some observations and recommendations that may be useful to the two companies. It must be emphasized that logging practices on the **CIB** and **SBL** sites differ because of significant differences in tree species, the density of merchantable timber, topography, distance from markets, and the capabilities of the two companies' respective sawmills. Any comparisons made here should therefore *not* be viewed as judgments—their only purpose is to help clarify our impressions.

1.6.1 Road Clearing Widths

A common practice throughout the tropics is to provide "daylight" clearings along roadways to help the road surface dry out quickly after rain. While such clearings are no doubt effective, they are expensive to clear and result in a considerable area of forest taken permanently out of production (and which must be maintained in a permanently cleared state). Road engineers generally contend that wide clearings are unnecessary, *if an adequate drainage system is provided to drain excess water away from the roadway*. These engineers assert that providing an adequate drainage system is generally cheaper and easier to maintain than wide roadside clearings (although there are exceptions to this rule, as noted below).

Rick Toupin

Photo 5. A secondary logging road on the CIB concession, passing through an area of relatively open canopy known as "Marantaceae Forest" after an understory plant family whose members form unusually dense thickets.

Our overall impression was that some road clearings at **CIB** may be wider than necessary. Those at **SBL** were not as wide, due to the fact that **SBL**'s concession is located in hilly topography where clearing along the roadside is more expensive than in the flat terrain of the **CIB** concession.

We recommend that **CIB** consider reducing the width of clearings along its haul roads where it appears feasible to do so. A total clearing width of 30 m should be adequate for most forest roads, assuming that an improved road drainage system can be provided. We recognize that in the flat, swampy terrain of the **CIB** concession it is often difficult to drain water away from the road and that wider roadside clearings will be needed than would be required in more hilly topography. Ditches may silt up quickly in swampy areas, so that the cost of maintaining the drainage system can also be higher than in hill forests. This will tend to make wider clearings the lower-cost solution. We also understand from company personnel that the roadside clearings we observed near Pokola are especially wide because of the high volume of truck traffic and the need to ensure public safety, always the most important consideration in populated areas.

1.6.2 Road Drainage

Dennis Dykstra

Photo 6. A primary logging road on the SBL concession in Gabon. The arrows trace evacuation ditches that divert water from the road surface and roadside ditches into the undisturbed forest.

Good drainage requires the use of roadside ditches with evacuation drains cut into the forest at regular intervals to divert water away from the road. In areas with topographic relief, cross drains may also be needed occasionally to drain water from the ditch on the uphill side of the road. The use of both ditches and cross drains was clearly evident at **SBL**, where the topography dictates that such structures be provided in order to prevent road failures due to fast-moving mountain streams. Ditches were also evident along most roads at **CIB**, although we observed fewer instances of evacuation drains being cut into the forest. **We therefore recommend** that **CIB** make a greater effort to provide evacuation drains for its roads, where possible. Admittedly this is difficult in an area where the road is at essentially the same elevation as the surrounding forest. Such drains will greatly facilitate road maintenance, however. They can be constructed either with road graders or with backhoe excavators.

1.6.3 Stream Crossings

Stream crossings at both **CIB** and **SBL** appear to be of generally high quality, with log culverts being used for smaller streams and bridges for larger waterways. **CIB** faces a particularly difficult situation because of the broad swampy areas adjacent to several of the rivers that flow through its concession, but its practice of building dikes through the swamp, supplemented by bridges to cross channels with flowing water, appears quite effective. The stream crossings we inspected at **SBL** also appear to be well constructed, permitting water to continue flowing in its natural course without impediment.

Dennis Dykstra

Photo 7. Log bridge at CIB. The approaches to the bridge have been built up as dikes in order to cross an extensive area of swamp.

Note the use of laterite. This surfacing material is used on nearly all of CIB's roads to reduce road damage during rainy periods.

Rick Toupin

Photo 8. Log bridge in the hilly terrain of the SBL concession.

1.6.4 Felling

Felling is perhaps the most important single activity in logging because it imposes limits on the maximum value that can be obtained from the tree. At **SBL** the felling crews have been trained by an expatriate felling specialist, and it is evident that for the most part they are using the techniques they have learned. However, it is likely that additional training will be needed on a continuing basis, as several recent stumps we saw showed evidence of tree splitting *(Photo 9)*. Although **CIB**'s felling crews seem experienced and competent, many of the stumps we inspected showed evidence of fiber damage, suggesting that the fellers lack an understanding of some of the principles of felling for quality. The company is, however, making a strong effort to encourage better quality and has developed a *prime de qualité* payment system to promote better practices.

Rick Toupin

Photo 9. Improper felling can damage timber so much that it becomes unusable. Such practices are also hazardous to the feller and to other workers, and are expensive for the timber company.

We strongly endorse CIB's decision to hire a full-time specialist to train the company's felling crews. This should significantly reduce wood wastage associated with felling and crosscutting and should also improve felling safety.

1.6.5 Landings

Because they are sites of significant soil disturbance, landings are often a major source of soil erosion. They may also become deeply compacted and this will delay the revegetation process. The landings we visited at **CIB** appeared generally to be somewhat larger than necessary, although company officials told us that using landings at all is the exception at **CIB**; rather, wherever possible the company prefers to deck logs at roadside. Landings we observed at **SBL** were smaller, most likely because of the steep terrain, which makes large clearings very expensive.

Rick Toupin

Photo 10. Caterpillar 545 skidder delivering a large log to a roadside landing on the CIB concession.

1.6.6 Skidtrails

In general, the skidtrails we visited at both **CIB** and **SBL** seemed adequate without being excessively wide. Those at **CIB** were perhaps slightly wider, probably because of the common practice there of using both a skidder and a bulldozer in tandem, with the skidder pulling the log and the bulldozer pushing the log from behind with its blade. Even so the skidtrails were

not excessively wide and at both companies it was evident that care was being taken to avoid damaging residual trees alongside the skidtrails.

Soil compaction. An issue related to skidtrails (as well as landings) that is often of concern to foresters is that of soil compaction. In areas where soils tend to become compacted due to the passage of heavy equipment, revegetation may be inhibited and subsequent growth rates of trees growing in the former skidtrail may be greatly reduced by comparison with trees growing on undisturbed soils. One way of dealing with this problem is to restrict both the number and width of skidtrails so that the maximum area of forest is retained in a relatively undisturbed state. **We recommend** that both **CIB** and **SBL** consider ways to minimize both the density and width of skidtrails on their operations.

Skidtrails on steep slopes. One skidtrail we visited at **SBL** was far steeper than is generally advisable. We measured the slope at 50% along one pitch, whereas 30% is generally considered a reasonable maximum slope on skidtrails. In addition, there was no way for water running down the skidtrail to be evacuated into the forest. Such skidtrails are likely to become deeply channeled and a source of serious soil erosion unless they revegetate very quickly. **We recommend** that **SBL** make a greater effort to avoid skidtrails on such steep slopes. Where this cannot be avoided the skidtrails should traverse across the slope rather than running straight up or down the slope.

Use of water bars. In hilly topography, forest engineers generally recommend that "water bars" be used to reduce soil erosion by diverting water from skidtrails after logging has been completed. Water bars are also commonly recommended on roads that have been closed. A water bar consists of an earthen dike built at an angle across the skidtrail or road, with a corresponding ditch adjacent to the dike on its uphill side (see *Figure 1*). A common rule of thumb is that the diversion angle **D** shown in *Figure 1* should be about twice the gradient of the skidtrail or road but at least 30° and no more than 60° (some engineers recommend limiting the angle to 45°). Recommended spacing between water bars, **S**, varies from 10 to 100 m depending on the soil type and the gradient of the skidtrail (see *Table 1*).

We recommend that **SBL** consider constructing water bars on skidtrails after logging has been completed, and on roads that have been closed, using the guidelines in *Figure 1* and *Table 1*.

Although the topography over most of the **CIB** concession does not necessitate the construction of water bars, **we recommend** that **CIB** adopt this practice whenever terrain is encountered that will require building skidtrails or temporary roads on slopes of 5% or more.

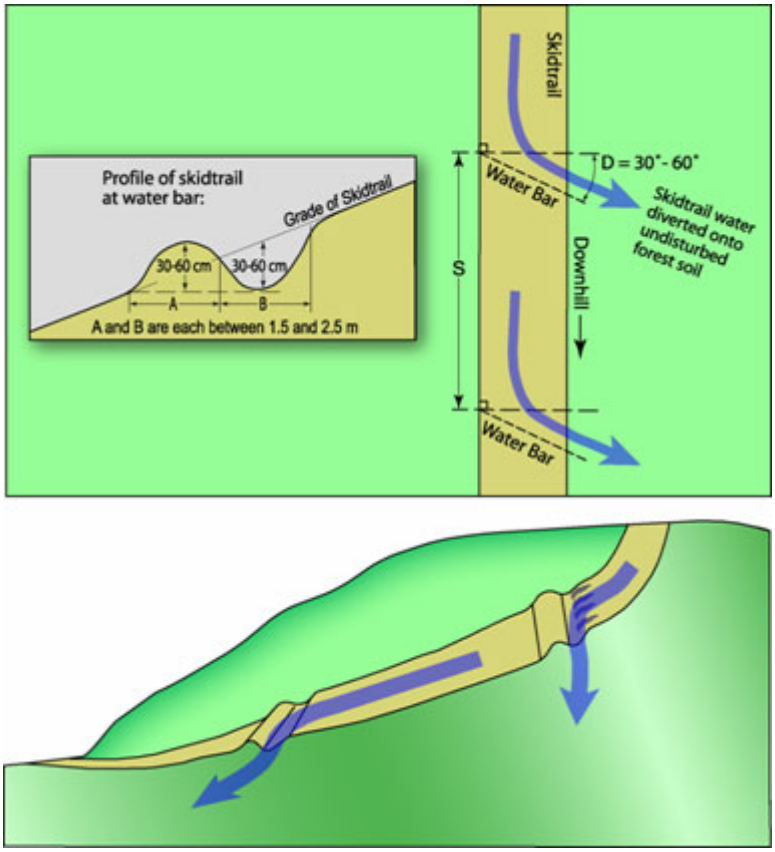


Figure 1. Use of water bars in hilly terrain to remove running water from skidtrails in order to reduce soil erosion.

Upper image: Plan view of a skidtrail and two water bars, with an inset showing the typical skidtrail profile at a water bar.

Lower image: Sketch of a skidtrail traversing a hillside, with two water bars diverting water off the skidtrail.

Table 1. Recommended spacing of water bars on skidtrails and closed roads. Adapted from APFC (1998).

Gradient of road or skidtrail (%)	Stable Soils	Erodible Soils
0-4	Not required	100 m
5-9	100 m	50 m
10-19	60 m	35 m
20-24	20 m	15 m
25-29	15 m	12 m
30+	10 m	10 m

Notes on terminology used in the table:

***Stable soils** include coarse rocky soils, gravels, and some clay soils.*

***Erodible soils** are fine, friable soils such as silt and fine sands.*

1.7 Recommendations to the USDA Forest Service

In considering how the USDA Forest Service might best direct its technical cooperation efforts related to sustainable forest management in Central Africa, we attempted to evaluate what we had learned during this field visit in the context of technical expertise available within the Forest Service and its partner organizations. We also considered important policy-level issues that had been brought to our attention and to which the Forest Service might contribute.

- **We recommend** that the USDA Forest Service work with its CARPE partners and other organizations to promote technical training and demonstrations in reduced-impact logging for both the private sector and for government agencies in Central Africa. Several organizations are already working on reduced-impact logging in Central Africa, both in research and to a lesser extent in training and development. The following is a partial list of organizations known to have expertise and activities on reduced-impact logging. This is not a complete listing but may serve as a starting point for the USDA Forest Service in considering cooperative partnerships.

  (a) Consulting Companies: Forêt Ressources Management (Montpellier, France; active in Gabon); **SYLVAFRICA** (Libreville), the Central African consulting unit of the International Department of **ONF**, the French Office National des Forêts; and **TWE**, Tropical Wood Environment (Libreville). These companies are known to be assisting concession holders in the region to develop forest management plans; other consulting companies may also be active in the region.

  (b) Intergovernmental Organizations: ATO, the African Timber Organization (Libreville); the Forest Products Division of **FAO**, the Food and Agriculture Organization of the United Nations (Rome, Italy); **ITTO**, the International Tropical Timber Organization (Yokohama, Japan); and the **World Bank** (Washington DC).

  (c) International Non-Governmental Organizations: IUCN, the World Conservation Union (Gland, Switzerland); **WCS**, the Wildlife Conservation Society (New York); **WRI**, the World Resources Institute (Washington DC); **WWF**, the Worldwide Fund for Nature (Gland, Switzerland); **WWF-Belgium** (Brussels); **WWF-CARPO**, WWF's Central African Regional Programme Office (Libreville).

  (d) International Research Institutions: CIFOR, the Center for International Forestry Research (Bogor, Indonesia with an office in Yaoundé, Cameroon); **CIRAD-Forêt,** the Forestry Department of the French Centre de Coopération Internationale en Recherche Agronomique pour le Développement (Montpellier); and **Tropenbos,** a tropical forestry research foundation (Wageningen, Netherlands).

  (e) Regional Associations: ATIBT, l'Association Technique Internationale des Bois Tropicaux (Paris); **IFIA**, the Inter-African Forest Industries Association (Paris); and **SYNFOGA**, the Syndicat des Producteurs et Industriels du Bois du Gabon (Libreville).

  (f) Regional Non-Governmental Organization: ADIE, the Association pour le Développement de l'Information Environnement (Libreville).

  (g) Technical Training Institutions: IPC Groene Ruimte, an international vocational training center (Arnhem, Netherlands); **FORM Ecology,** a consulting company (Hattem, Netherlands), which has worked closely with IPC Groene Ruimte on reduced-impact logging and improved forest management); and **TFF**, the Tropical Forest Foundation, a non-governmental organization based in Washington DC whose primary focus has been on training and demonstration of reduced-impact logging. To date TFF has not been involved in Central Africa but its Board of Directors

has expressed interest in applying the organization's expertise to Central Africa. TFF's most notable work has been in Latin America, especially Brazil, and the organization recently set up a regional office in Indonesia to promote the adoption of reduced-impact logging in Southeast Asia.

All of these organizations are promising as partners with which the Forest Service and CARPE could collaborate to facilitate both reduced-impact logging and improved forest management in Central Africa. In our view, the Forest Service would be more effective supporting partnerships with organizations like those listed above that already have strong track records on reduced-impact logging in French-speaking Africa, rather than attempting to undertake direct technical cooperation on its own. Although the Forest Service has an abundance of technical experts on logging and forest management planning, few are fluent in French or have strong backgrounds in Central Africa. Forest Service experts could, however, provide technical consulting services to the partner organizations on an as-needed basis.

- **We recommend** that the Forest Service work with its CARPE partners to organize a series of workshops for Central African countries on forest policy issues, including topics such as reduced-impact logging, forest certification, forest regeneration, and ways to control hunting and the marketing of bushmeat. The workshops would optimally be directed at a combination of government officials and individuals from the private sector. It is our impression that government forestry officials in particular need to be more fully informed about these issues, but it is also important that government officials and people from the private sector come together in the kind of neutral forum that such workshops could provide.

- **We recommend** that the Forest Service promote research to determine the current status of forest regeneration in Central Africa. Several individuals we encountered during the visit noted that little is known about the regenerative capacity of many Central African timber species, and that there have been no comprehensive surveys to determine whether logged-over forests are regenerating satisfactorily in species that are valued for timber.

- **We recommend** that the Forest Service move ahead with a proposal it is currently considering to develop computer simulation software for analyzing financial considerations related to reduced-impact logging. Financial issues are perhaps the most commonly cited reason given by logging companies for choosing not to adopt reduced-impact logging techniques. The proposed software would help loggers and policy-makers recognize the often hidden cost savings associated with planning and supervision of logging operations and improved training of forest workers. Properly designed so that it could be applied under a variety of timber and terrain conditions, the simulation model should help overcome loggers' reluctance to adopt new logging methods. This is important because logging is by far the most costly of forest interventions in terms of both direct and indirect impacts as well as short- and long-term costs. The software should also be designed to improve clarity on the part of all stakeholders about the real costs of both conventional and improved timber harvesting practices. Field tests of the simulation model, conducted under a variety of situations including those prevailing in Central Africa, will be needed in order to validate the model, and the Forest Service could work with its CARPE partners to arrange such tests with collaborating timber companies in the region.

2. General Background on Congo and Gabon

Together, the Republic of Congo and Gabon (*Figure 2*) comprise much of the northwest corner of the Congo Basin, a heavily forested area that until recently was largely untouched by industrial forest operations except for areas near ocean ports. As indicated in *Table 2*, both Congo and Gabon are substantially covered by forest, and because of relatively low population densities (12.8 persons/km^2 in Congo and 5.5 persons/km^2 in Gabon), both retain large areas of forest per capita. One consequence of this is that population pressures in most areas of the two countries are low, giving rise to low rates of forest cover change (*i.e.,* deforestation) during the past decade, both in comparison to Africa as a whole and in comparison with the rest of the world.

Figure 2. Map of Africa showing Congo and Gabon.

Table 2. Land and forest statistics for Congo and Gabon.
Data for all of Africa and the World are also provided as points of comparison.

Country or Region	Land Area	Total Forest 2000			Forest Cover Change 1990-2000		Total Forest Plantation Area	Average Timber Volume	Average Forest Biomass
		Area		Area per capita	Annual change				
	000 ha	000 ha	%	ha	000 ha	%	000 ha	m^3/ha	t/ha
Congo	34 200	22 060	64.5	7.7	-17	-0.08	83	230	213
Gabon	26 767	21 826	81.5	18.2	-10	-0.05	36	222	137
Africa	3 008 412	649 866	21.6	0.9	-5 264	-0.81	8 036	124	109
World	13 182 522	3 856 159	29.3	0.7	-9 045	-0.23	186 760	126	92

Source: FAO (2001)

Although both Congo and Gabon are oil-producing nations that depend to a considerable extent on oil revenues, the timber industry ranks as the second most important industry in both countries. As oil reserves become exhausted over the next 5-20 years, it seems likely that forestry will assume an increasing role in the economy of these two countries. Table 3 summarizes data on production, export, and consumption of industrial roundwood and of sawnwood and panels in both countries. Data for Africa as a whole and for the World are provided as points of comparison. Estimated consumption data for fuelwood and charcoal are also indicated in the table. Note that for Congo this constitutes nearly 80% of all roundwood use. In Gabon, where the GNP/capita is six times that in the Congo, fuelwood and charcoal represent only 52% of total roundwood use, about the same as the worldwide average for all countries.

Production and export of logs, sawnwood, and panels all increased significantly during the 1990s in both Congo and Gabon, although the Asian economic recession in the latter part of the decade resulted in a slowdown in both production and exports. By 1999 the timber markets had recovered most of the volume lost as a result of the Asian recession, although prices remained well below the mid-decade peak.

Table 3. Production and consumption of forest products in Congo and Gabon, 1999.

Country or Region	Fuelwood and Charcoal 000 m3	Industrial Roundwood 000 m3			Sawnwood and Panels 000 m3		
	Consumption	Production	Exports	Consumption	Production	Exports	Consumption
Congo	2 423	646	207	439	96	82	14
Gabon	2 975	2 775	2 338	437	365	270	95
Africa	519 884	67 931	7 439	61 168	10 969	1 698	14 414
World	1 864 760	1 489 530	119 963	1 492 939	579 030	157 344	574 707

Source: FAOSTAT Forestry Database (2001)

Important non-timber forest products in both Congo and Gabon include wild fruits, forest vegetables, medicinal plants, construction materials, and bushmeat. Several environmental organizations (see for example WCS 2001, Sizer and Plouvier 2000, and Global Forest Watch 2000) have identified bushmeat trade as the single most important conservation problem in this part of Africa because it poses a serious threat to faunal biodiversity and to the survival of some animal species.

New forestry laws in both Congo and Gabon have put in place policy frameworks that should facilitate improved forest management. The Congolese forestry law, numbered 16-2000, dates from 20 November 2000 when it was adopted by the National Transition Council and signed into law by the President. In Gabon, the Parliament is expected to approve that country's proposed new forestry law in mid-2001. The full text of the draft legislation can be found online at http://www.gabon-forests.org/images/codeforestier.pdf.

3. CIB—Société Congolaise Industrielle des Bois, Pokola, Congo

3.1 Background—Republic of Congo

The Republic of Congo is heavily forested with around 65% forest cover (*Table 2*). Dense equatorial forest blankets significant portions of the country, particularly the northern half and the southwest. The forests, which comprise approximately 10% of Africa's dense tropical forest, are maintained by relatively high annual rainfall, ranging from 1500-2000 mm, which comes in two wet seasons (roughly September-November and April-May). The forests are mainly semi-deciduous formations in the north, littoral forests in the west, and swamp forests in the northeast. Savannah occupies much of the center and south of the country, where most of the forest plantations have been established. Congo has a significant network of protected areas comprising two national parks and around 10 other reserves. Almost 5% of Congo's forests, and 11% of the total surface area of the country, lie within these protected areas. This represents a substantial commitment to ecological conservation by the Government of Congo. One of the national parks, Nouabalé-Ndoki, is immediately north of CIB's Kabo Forest Management Unit and immediately west of the company's new (and as yet undeveloped) Loundougou Forest Management Unit.

Congo is a significant producer of tropical hardwood timber. In addition to export logs, the country produces both sawnwood and plywood for domestic and export markets. Forest products account for a large percentage of Congo's exports. Though commercial logging began in the 1920s in Congo, the country has only recently become a major source of timber. Congo has over 300 tree species suitable for commercial timber production, but only 25 or 30 are commercially exploited, most in very small quantities. This is partly due to long transport distances, which make utilization of less valuable species financially risky.

3.2 Overview of Pokola Operations

CIB's timber holdings are clustered to the east and south of the Nouabalé-Ndoki National Park in the northern part of the Congo (*Figure 3*). The company has operated in this area since the mid-1980s, when it initiated operations in the Pokola Forest Management Unit. At that time the village of Pokola had fewer than 1,000 occupants. Its population has now grown to approximately 9,000. In addition, several smaller villages with a total population of about 6,000 are scattered through the timber concession. CIB is the sole economic entity in the area, so the entire population of 15,000 persons is essentially dependent upon this one timber company.

To the north of the Pokola unit (*Figure 3*) is the Kabo Forest Management Unit, and further to the northeast is a new operating area, the Loundougou Forest Management Unit, which has not yet been developed. Both Kabo and Loundougou share boundaries with the Nouabalé-Ndoki National Park.

CIB's main facilities are located at the town of Pokola. In addition to a headquarters office and housing for both expatriate and Congolese employees, CIB operates a log sort yard where logs are graded and prepared for export; a relatively large sawmill, which will be expanded further this year; dry kilns; a mechanical-repair and maintenance shop; a woodworking shop; and a dock facility for barge transport to Brazzaville.

Figure 3. Map of the Republic of Congo, showing CIB's forest management units (Pokola, Kabo, and Loundougou) and the Nouabalé-Ndoki National Park.

All boundaries and areas are approximate and are intended only to give an impression of the approximate size and general location of the units.

3.3 Community Development

As the only sizeable employer in the vicinity of its timber concession, CIB has made substantial investments in housing for employees and their families, schools, a market, a medical dispensary and hospital (with a full-time doctor paid by the company), and a pharmacy. The primary community investments have been made at Pokola, although housing, schools, field dispensaries, and wells have also been built in Kabo, as well as Ndoki I and Ndoki II. The latter two are smaller villages where logging and forestry crews reside with their families.

Dennis Dykstra

Photo 11. Employee housing at Ndoki II.

Currently, CIB is attempting to encourage local entrepreneurs to develop fish farms as a means of providing non-bushmeat protein for the market in Pokola. The company has donated bulldozer time to construct tanks and is also providing technical advice to assist with the startup of the fish farming. Tilapia are being raised on a pilot basis, with full-scale production expected to start in the near future.

CIB is also encouraging the development of poultry production on a modest scale and has contributed materials to local entrepreneurs to help them construct poultry sheds and other facilities.

3.4 Control of Hunting and Bushmeat Trade

Through a formal partnership with the Wildlife Conservation Society, CIB is making a considerable effort to control hunting within its concession area and especially to restrict trade in bushmeat. The company has worked with WCS and the Government of Congo to create a cadre of Eco-Guards, trained by the military, to inspect all vehicles (including logging trucks and crew-transport vehicles) that pass through the concession area. Drivers are not permitted to allow passengers in logging trucks, and any items of contraband discovered on the vehicles are confiscated. Drivers are subject to immediate dismissal and may also be fined if they infringe the rules. Although the Eco-Guards' primary objective is to intercept bushmeat, they also recover stolen tires, spare parts, fuel, and other items.

Dennis Dykstra

Photo 12. Gorilla tracks in the soft earth near a logging road, with a human hand shown for scale.

In addition to the Eco-Guard system, CIB has taken other initiatives to control hunting within its concession areas. In December 1999 CIB's workforce unanimously adopted a new *règlement intérieur* (internal regulation) defining rules for hunting within the concession. These rules define areas where controlled hunting by local people is permitted; other areas are "off limits" to hunting at all times. Within the controlled-hunting areas, hunting is permitted on specified days and under the supervision of forestry personnel. All CIB personnel agree to abide by these hunting rules, to hunt only when supervised, to wear an identification badge, and not to transport bushmeat outside the areas indicated on the badge.

Company officials report that their efforts to control trade in bushmeat appear to be having an effect, as beef is now appearing regularly in the Pokola market. Previously, beef was too expensive by comparison with bushmeat and seldom appeared in the market.

3.5 Wood Export and Utilization

Rick Toupin

Photo 13. Logs in the sort yard at Pokola.

Except for a small volume sent by barge to Brazzaville and then by rail to Pointe Noir, nearly all logs and sawnwood exported by CIB are transported by truck to Douala, Cameroon, a road distance of 1,200 km. To facilitate this operation CIB has installed a truck ferry across the Sangha River at Gatongo, 40 km northwest of Pokola, and has built or upgraded several hundred kilometers of road connecting to a highway across Cameroon to Douala. Logs and sawnwood transported over this route are exported from Douala. An individual truck can make two or three round trips

per month between Pokola and Douala. The long transport distance is a serious obstacle to increasing both the number of species and the range of product grades that can be utilized.

The highest-grade logs of exportable species such as Sapeli, Sipo, and Iroko are exported as roundwood. Lower-grade logs, as well as all logs of species for which the export price is too low, are processed in CIB's sawmill at Pokola. Certain species and grades are further processed in the dry kilns. Some of the lumber produced in the sawmill can be sold in domestic markets, but the focus is on export markets because of significantly higher prices. By working with overseas buyers, CIB has been able to develop markets for species that previously could not be exported at a profit. An example is Ayous, a whitewood species for which CIB has developed a substantial export market in kiln-dried sawnwood. CIB is also experimenting with further processing of several species, including the production of materials for window frames and moldings.

3.6 Logging Conditions on the CIB Concession

One of the major characteristics of the CIB concession is that it is almost without topographic relief. In some sense this results in easy logging conditions but it also brings many problems. The flat topography is subject to flooding, and along the rivers there are extensive areas of swamps. This has led to significant road construction problems where rivers have to be crossed. CIB's strategy of constructing dikes across the swampy areas, supplemented by bridges to cross channels with flowing water, appears quite effective.

The soils of the CIB concession are generally rather fertile and produce remarkably large trees over much of the area. Because so many of the trees are large, the logs are difficult to handle and require powerful machinery. Often two skidding machines work in tandem to transport a single log to the landing (see Section 3.8.5 for a description of this system). The most common merchantable species is Sapeli, but even so it only occurs at an average of about one mature tree per hectare. Other merchantable or potentially merchantable species include Acajou, Ayous, Bilinga, Doussié, Iroko, Limba, Padouk, Sipo, and Wenge. Several of these, including Azobe, Bilinga, Padouk, and Limba, are not currently commercialized by CIB because the high transport cost and low export prices make their utilization economically unattractive. Moreover, there is no demand for these species in the domestic market. Azobe is used within the timber concession for log bridges and culverts because of its density and resistance to decay, but it is not harvested on a commercial basis.

Dennis Dykstra

Photo 14. Many trees on the CIB concession are large, with clear boles for 30 m or more above the ground.

Section 3.8 of this report includes a detailed description of logging practices on the CIB concession.

3.7 Policy Issues Affecting CIB

As oil reserves in Congo become depleted, the government is turning increasingly to other industries for assistance in funding its development projects. This means that established timber concession holders like CIB are being asked to contribute materials, employees, and equipment in support of projects such as the construction of public roads. Environmental groups generally oppose such activities on the principle that new roads will open new areas to colonization. Nevertheless, every developing country faces intense pressure to open its territory, and building roads is the most common way of achieving this. When logging companies are asked to assist with road projects, however, they should be compensated by the government, either directly or as an offset against timber royalties. Otherwise such contributions become a hidden tax and over time the logging industry will become less profitable and less able to contribute to the country's economic development.

In addition to its already substantial investment in processing facilities at Pokola, a condition imposed upon CIB in return for the granting of the new Loundougou concession area (*Figure 3*) is that the company must construct a processing facility within the new concession area and an access road running northward through the concession. The Wildlife Conservation Society has raised concerns about the access road, worrying that it might eventually connect with a road to Bangui, Central African Republic. WCS is concerned that this could significantly increase population pressures on the forest area, both for agricultural clearing and for bushmeat hunting. Although this is a reasonable concern, the best approach might be to work with the government to ensure that the road will provide access only within the timber concession and that it will not become part of the country's public road system.

3.8 CIB Logging Practices

3.8.1 Reconnaissance and Survey

The first step in logging planning at CIB involves a prospection team, which makes a systematic search through the area where logging is being considered, carefully identifying all potentially merchantable trees and recording their diameters[2]. To facilitate the prospection survey, the entire operating unit is divided into 500 × 1000 m blocks, and the prospection team records the number of merchantable trees of each species found within each survey block. For purposes of control the number of trees within each survey block or along a specified route is indicated by carving notches on stakes, which are placed at points where the survey line intersects a road or skidtrail. Eventually the prospection team will map the locations of individual trees within the survey block but this is not currently done. When this procedure has been adopted it will facilitate planning of roads and skidtrails because the locations of individual trees to be harvested can be plotted on the company's geographic information system.

3.8.2 Logging Roads

Because the terrain is generally flat, logging roads and skidtrails follow approximately a rectangular grid, based on the frequency of merchantable trees found within the rectangular survey blocks. Prior to commencing road construction, a detailed study is undertaken with maps, aerial photographs, and ground survey. This is important in order to avoid swamps and large river crossings, and to ensure that roads are only placed in areas where a significant volume of merchantable timber can be found.

[2] Trees selected for harvest must meet the company's quality criteria and must also exceed a specified minimum diameter at breast height (Dbh), on the assumption that smaller trees are less likely to have produced viable seedlings. For species with buttress roots the minimum diameter is measured at a point on the bole just above the buttresses. The minimum Dbh varies by species but is generally 80 or 90 cm.

Road construction is done by specialized teams using Caterpillar D7/D8 or Komatsu D85 bulldozers. CIB follows a general policy of spreading laterite gravel on all primary haul roads and most secondary roads in order to ensure that it can continue operating during rainy weather. Roads are maintained by graders, with bulldozer assistance when needed.

3.8.3 Landings

Landings are usually located at points where skidtrails enter haul roads. They vary in size from negligible (when the normal roadside clearings are used for temporary placement of skidded logs) to quite large, when several skidtrails come together at a haul road. We saw several landings that we felt were larger than necessary and thus resulted in considerable soil disturbance. However, CIB personnel pointed out that their most common practice is to deck logs along the roadside and only use landings in rich patches of forest where a large number of trees is being extracted. Logs are loaded onto trucks with Caterpillar 966 front-end loaders.

3.8.4 Felling

Felling is done after the roads have been built but in most cases before the skidtrails have been opened. Although CIB's felling crews seem quite experienced, many stumps show evidence of fiber damage and splitting, suggesting that the fellers lack an understanding of some of the principles of felling for quality. CIB has hired a full-time felling specialist to train the felling crews, with the objective of significantly reducing wood wastage associated with felling and crosscutting. The felling trainer had not yet joined the operation at the time of our visit. Lianas were not a problem in the areas of the CIB concession that we visited.

Dennis Dykstra

Photo 15. Felling with chainsaw in CIB's "Marantaceae Forest", an area of dense undergrowth and relatively open tree canopy.

When possible, CIB follows a general practice of felling only during the descending moon (*i.e.,* during the period after the full moon and before the subsequent new moon). This practice is based on a conviction that during this period there is less sap within the bole of the tree as a result of tidal forces. According to CIB production personnel, felling during the descending moon reduces felling damage, insect damage, fungal staining, and splitting of logs prior to processing[3].

[3] The practice of felling timber during the descending moon is apparently based on observations that originated centuries ago in Europe. A brief description of the practice can been found on page 87 of the Farmers' Almanac (2000), which states that the best period for felling is the last quarter of the moon. More detailed recommendations are available on a French-language website from Switzerland (Economie Forestière Association Suisse 2001). Both sources state that many people believe this is an effective practice for improving wood quality and reducing insect or other pest problems in the felled timber.

3.8.5 Skidding


Rick Toupin

Photo 16. Skidtrail with little soil disturbance and good width control.

Skidtrails are opened by bulldozers, either Caterpillar D6/D7 or Komatsu D85, after being marked by the logging crew. This is generally done after felling has been completed. The skidtrails follow a roughly rectangular pattern and are generally less than 500 m in length.

Skidding is done by rubber-tired log skidders assisted by the bulldozers. All skidders are equipped with winches and tandem arches, although chokers are not used; instead, the main skidding line is hooked directly around the log. The skidders used at CIB are Caterpillar 528s, which appear to be somewhat underpowered for many of the large, heavy logs commonly found on the CIB concession. The company recently purchased a more powerful Caterpillar 545, but even that skidder is unable to move the largest logs without bulldozer assistance. For large logs, the bulldozer pushes from behind while the skidder pulls. This is a potentially destructive practice because it has a tendency to widen the skidtrails and because the blade of the bulldozer is likely to damage residual trees, including potential future crop trees. The blade may also damage the end of the log, resulting in wastage or a reduction in quality. Nevertheless, the power of the two machines working together is needed for the largest logs. Working without the bulldozer to assist would require more maneuvering by the skidder and might cause significantly more soil disturbance and deeper compaction. The key to optimizing this system is to work with the tractor operators so that they understand when the two-machine system is needed and when it can be avoided.


Rick Toupin

Photo 17. Komatsu D85 bulldozer pushing a log from behind to assist the skidder in bringing it to the landing.

3.8.6 Road Closures

When logging has been completed in a particular operating area, secondary access roads within that area are closed by placing large logs across them to prevent vehicles from entering. This eliminates access by hunting vehicles and also prevents the roads from being degraded by traffic during rainy periods. Roads that have been closed appear to revegetate quickly. This is especially true of skidtrails, which after a few years have become so filled with vegetation that they are difficult to follow.

4. SBL—Société des Bois de Lastoursville, Lastourville, Gabon

4.1 Background—Gabon

Gabon's per-capita wealth is four times that of most nations in sub-Saharan Africa (CIA 2000). This has to a large extent prevented extreme poverty in the country, but because of inequalities in the distribution of income a large fraction of the population remains poor. This is particularly true in rural areas.

4.2 Overview of Lastoursville Operations

From its field headquarters near Lastoursville, SBL manages a timber concession consisting of two forest management units: Lastoursville and Koulamoutou (*Figure 4*). The headquarters facility includes offices, housing for expatriate and local staff, a small sawmill producing about 700 m^3 of sawnwood monthly, and a machine shop and maintenance facility. An advantage of the company's location near Lastoursville is the presence of a railway station with a large log-handling facility. The railway connects Franceville in the southeast of Gabon with Libreville, the national capital and major port, in the northwest. Daily train service carries both freight and passenger traffic.

Figure 4. Map of Gabon, showing SBL's forest management units near Lastoursville and Koulamoutou.

The two forest management units are shown as shaded circles because definitive boundary data were not available at the scale of this map.

Although it is an important employer locally, SBL is not the sole economic force in Lastoursville, unlike CIB in Pokola. Another major timber concession is based near Lastoursville and several others are in the vicinity. The nearby town of Koulamoutou is a district capital and market center, supporting an airport with regular connections to Libreville.

4.3 Control of Hunting and Bushmeat Trade

Although it does not have a system of Eco-Guards as at CIB's operation in Congo, SBL is also making a serious effort to control hunting and bushmeat trade within its concession, in spite of what appears to be an ambiguous government position on bushmeat trade in Gabon. SBL is not able to prohibit hunting altogether within its concession areas because of government policy to the contrary. It can, however, prevent the entry of non-company vehicles and can impose regulations on its own employees. Gates have recently been installed at the entrances to both forest management units to prevent entry of non-company vehicles.


Rick Toupin

Photo 18. Elephant tracks along a sandy streamside adjacent to one of SBL's logging roads.

The gate at Koulamoutou is kept closed day and night because of heavy hunting traffic to supply markets in Koulamoutou town. At Lastoursville, where hunting pressure is much lower, the gate is closed only at night. Drivers of company vehicles have been informed that they are not permitted to allow passengers in logging trucks or to carry any form of produce other than logs. Supervisory personnel check vehicles on a random basis, and drivers who are found to have infringed the rule are subject to immediate dismissal. If this policy is backed by strict enforcement, then SBL could make a significant contribution to controlling the local bushmeat trade in the areas around Lastoursville and Koulamoutou. This appears to be an issue of some urgency, as we found snares in the forest and noticed a large number of hunters' huts along the logging roads in the Koulamoutou management unit.

4.4 Logging Conditions on the SBL Concession

The most obvious difference between the SBL concession and that of CIB in Congo is the terrain. As opposed to the flat terrain in CIB's concession, the area around Lastoursville is quite hilly, with rather steep slopes and deeply incised watercourses. The highest point on the concession rises to over 800 m from a base elevation of around 200 m. Topographic considerations affect all of SBL's decisions and in some sense these constraints have had a positive effect, forcing the use of careful road location and construction techniques, including the development of an good-quality road drainage system.

The two most common tree species on SBL's concession, Okoumé and Moabí, do not occur at all on the CIB concession. While large, these trees do not attain the impressive size of the trees on the CIB concession. As a consequence, fewer skidding problems occur in relation to the need to handle big, heavy logs. Instead, problems at SBL are related more to topography and the abundance of small to medium-sized streams throughout the concession area. SBL harvests an average of 2-3 trees/ha with an average total volume of about 8 m^3/ha. The total average monthly production is around 8,000 m^3, with about 2,000 m^3 going to the sawmill and the remainder being sent as logs by train to Libreville, either for export or for sale to SNBG (see Section 4.5).

Section 4.6 of this report includes a detailed description of logging practices on the SBL concession as observed during our two-day field visit.

4.5 Policy Issues Affecting SBL

SNBG Monopoly. An important consideration for timber concessions in Gabon is the fact that a state agency, Société National des Bois du Gabon (SNBG), holds a legal monopoly on the sale of Okoumé and Ozigo, the two most commonly exploited tree species in the country. Other species, referred to as "Bois Divers", can be sold directly by concession holders but Okoumé and Ozigo must be sold to SNBG at controlled prices. In addition, depending on market conditions quotas may be imposed on the production of these species in order to avoid accumulation of large inventories at the SNBG yard in Libreville.

New Forestry Law. As mentioned under Section 2 of this report, a new forestry law is expected to be approved by Gabon's Parliament by the middle of this year. The new law will require concession holders to develop and implement comprehensive forest management plans, and the larger companies have already begun the process of developing plans in anticipation of this requirement (one company has actually completed the plan for its concession and several others are in advanced stages in the development of their plans). SBL has hired a full time management-planning specialist, who has initiated inventory work as the first step toward developing the comprehensive plan.

Smaller Concession Holders and the New Forestry Law. One unintended and possibly negative consequence of the new forestry law has been raised by Mr. Heiric Cheneau, Director General of SBL and President of SYNFOGA, the Union of Timber Producers and Wood Industries of Gabon. Because the development of management plans is an expensive process, smaller companies are likely to have difficulty meeting this requirement and may therefore default on their concession agreements. This could be significant for the country because around three-quarters of all logging companies operating in Gabon fall in the small- to medium-sized category, and these smaller companies control perhaps half of the area under timber concessions in the country. Thus, unless a considerable effort is made to assist these companies with the preparation of management plans, Gabon faces major difficulties within its industrial forest sector over the next few years. A study is currently underway by SYNFOGA to identify possible remedies to this situation.

Bushmeat. Although the new forestry law is reported to be a model of forestry legislation, the Government of Gabon appears to be somewhat hesitant to confront the issue of bushmeat trade. Congo's more proactive approach, involving Eco-Guards and partnerships with organizations such as the Wildlife Conservation Society, seems likely to be more effective.

4.6 SBL Logging Practices

4.6.1 Reconnaissance and Survey

At SBL, where the terrain is hilly and rather broken, a reconnaissance team or individual makes a preliminary search through a potential logging area, recording the number of trees found of commercial species that meet the minimum diameter criterion[4] and are judged to be of merchantable quality. This survey is usually conducted by an expert tree spotter walking along ridgetops, sometimes assisted by additional tree spotters working along the lower slopes.

If a sufficient number of merchantable trees is found during the reconnaissance survey, a prospection team makes a systematic search through the same area, carefully identifying all commercial trees

Dennis Dykstra

Photo 19. Updating wooden plaques that serve as the basis for SBL's in-woods timber inventory system.

[4] In addition to quality criteria, trees selected for harvest must exceed a specified minimum diameter at breast height, generally 60 or 70 cm. The minimum Dbh is generally smaller than in Congo because the trees in Gabon do not attain such large sizes and are reportedly capable of regenerating successfully when smaller.

and recording their diameters. As with CIB, prospection will eventually include mapping the locations of individual trees within the survey block in order to facilitate road and skidtrail planning. SBL has developed a detailed tracking and inventory system using wooden plaques on which information is recorded about each tree found during the prospection survey. The plaque is posted along a road, skidtrail, or landing and is updated when the tree is felled, when the logs are skidded, and when the logs are loaded onto a truck for transport to the mill or log yard.

4.6.2 Logging Roads

Because of the hilly topography, SBL's first step in road planning is to utilize topographic maps to identify a preliminary route. Then a road prospector walks out potential road lines, deciding where roads and skidtrails should be placed in order to minimize construction problems while providing access to the merchantable trees identified by the prospection team. Because of the rough topography on SBL's concession this step is particularly important and requires a skilled technician.

Dennis Dykstra

Photo 20. Bulldozer constructing a logging road on the SBL concession.

Road construction is done by specialized teams using Caterpillar D7/D8 or Komatsu D85 bulldozers. SBL's policy is to use laterite surfacing only on adverse haul sections or in areas where the soils tend to remain saturated for long periods. This is partly because laterite is difficult to find in the hilly country of Gabon, and partly because its general use is judged to be an unnecessary expense. One consequence of this policy, however, is that the logging crews are occasionally idled by wet weather. Road maintenance is done with graders, assisted when necessary by bulldozers.

4.6.3 Landings

Dennis Dykstra

Photo 21. At a landing on the SBL concession, a front-end loader places a log on a logging truck.

Landings are usually located at points where skidtrails enter haul roads, or at the end of a secondary road. The landings we visited were generally well constructed and adequate in size to permit safe working conditions without excessive soil disturbance, typically with a diameter of around 30 m. Because of the hilly topography, any clearing is expensive and landings are thus kept as small as possible while providing adequate room to sort, measure, and crosscut logs and to permit trucks and the loading machine to maneuver. SBL's logging crews deck logs at roadside whenever this is feasible in order to avoid the cost of landing construction. The company is also considering the possibility of using self-loading trucks to

Dennis Dykstra

Photo 22. Logging truck fully loaded and ready for the trip to the railroad log-sorting yard in Lastoursville.

avoid the necessity of having a separate loading machine available at all times. The logs on SBL's concessions are probably small enough to make this feasible, whereas most logs on the CIB concession in Congo would probably exceed the capacity of the crane on a self-loading truck.

4.6.4 Felling

Felling is done after the roads have been built and in most cases before the skidtrails have been opened. The felling crews have been trained by an expatriate felling specialist, and it is evident that they are using the techniques they have learned. However, it is likely that additional training will be needed on a continuing basis. Lianas are a problem in some areas of SBL's forest, and in those areas the practice is to cut the lianas prior to felling in order to reduce damage to non-harvest trees.

4.6.5 Skidding

Skidtrails are opened by bulldozers, either Caterpillar D6 or Komatsu D65, after being marked by the logging crew. This is generally done after felling has been completed. Because of the rough topography, a lower density of skidtrails is used than at CIB and it is common to skid as far as 1500 m with occasional skidding distances of 2000 m.

Skidding is done by log skidders assisted by bulldozers such as Caterpillar D6 or Komatsu D65. The skidders are equipped with winches and tandem arches. As at CIB, chokers are not used; instead, the main skidding line is hooked directly to the log. At SBL, where the logs are generally smaller than on the CIB concession in Congo, we were told that it is seldom necessary for the bulldozer to directly assist the skidder. Instead, the bulldozer is used to open the skidtrail and then to skid logs from the stump to the skidtrail. The skidder then moves them the much longer distance to the landing. Two types of skidders are used: Timberjack 480s, which are rubber-tired skidders, and Caterpillar 527s, which are tracked skidders.

Dennis Dykstra

Photo 23. In addition to Timberjack 480 rubber-tired skidders, SBL also uses Caterpillar 527 high-sprocket tracked skidders as shown here.

4.6.6 Road Closures

When logging has been completed in a particular operating area, the access road to that area is closed by placing a large log across it to prevent vehicles from entering. In one case we observed a road that had been closed by removing a stream-crossing structure, making the closure even more complete. Roads and skidtrails that have been closed appear to revegetate quickly and after a few years skidtrails become difficult to find. Most skidtrails we observed were so narrow that nearly all of the crown cover was retained except in gaps where trees were felled.

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Annex: Information on major tree species utilized by CIB and SBL

Primary information sources: Forestworld.com (2001)
US Forest Products Laboratory (2001)

ACAJOU, AFRICAN MAHOGANY – *Khaya ivorensis* (Meliaceae)

Distribution The species is reported to be found in all the timber producing areas of West Africa, from Ivory Coast to Gabon, and is primarily found in the Ivory Coast, Ghana, and Nigeria. Unlike other *Khaya* species, which do not require much rainfall, it is reported to grow in the rain forest in low-lying areas within its range.

Product Sources Although the species makes up most of the African mahogany on the international market, it is usually sold in a mixture with other Khaya species including *K. anthotheca*, *K. grandifoliola*, and *K. senegalensis*. Origin of consignment can sometimes help identify specific *Khaya* species. This may be valuable since differences in some properties can be appreciable. Supplies in the lumber form are reported to be quite abundant, and can be found in a wide range of sizes at moderate prices. They are also available in plywood form from many lumber suppliers. African mahogany is reported to be frequently used to replace American mahogany because it is cheaper and more abundant, and can also be used for the same applications.

Tree Data The tree is reported to reach heights of 110 to 140 feet (33 to 43 m), with trunk diameters of up to 6 feet (1.8 m). The tree usually develops straight, well-formed boles that measure about 40 to 80 feet (12 to 24 m) above strong buttresses that are reported to be up to 8 feet (2.5 m) high.

Sapwood Color The sapwood is described as creamy-white or yellowish in color, and is not always distinct from the heartwood. It is usually about 2 inches (5 cm) wide.

Heartwood Color Color is reported to change from light pinkish-brown when freshly cut to a dark reddish shade, usually with a purplish cast, upon exposure. The yellowish-brown color that is present in the paler shades of American mahoganies is reported to be very rare.

Grain The grain is typically interlocked, but is sometimes straight. Interlocked grain usually produces a striped figure on quarter-sawn surfaces. Swirl and crotch figures are also reported to be common.

Odor There is no distinct odor or taste.

Natural Durability Trees and logs are reported to be vulnerable to attack by forest longhorn and Buprestid beetles, and the sapwood is easily attacked by powder-post beetles and the common furniture beetle. The wood is reported to be resistant to termite attack in West Africa and heartwood resistance to decay is rated as moderate.

Resistance to Impregnation The heartwood is reported to be highly resistant to preservative treatment, and the sapwood is moderately resistant.

AYOUS – *Triplochiton scleroxylon* (Sterculiaceae)

Distribution The species is reported to be widely distributed in tropical West Africa, from Guinea to the Democratic Republic of Congo. It is found mainly along waterways, on abandoned farmlands, and in transition zones between humid evergreen and semi-deciduous forests. The species is reported to be especially common in the drier and more disturbed types of forests within its range.

Product Sources The International Tropical Timber Organization (ITTO) reports that the species is recognized as a very important source of timber for export. The timber is considered too soft for general joinery use, but it is reported to be highly suitable for small accurate moldings. Ayous is reported to be readily available in both veneer and lumber forms. The timber is usually available in large sizes, which allows it to be used for the mass production of

cabinets and kitchen furniture. Prices are reported to be in the inexpensive range.

Tree Data The trees are reported to be very tall and slim. They reach heights of 150 to 180 feet (45 to 55 m), with average trunk diameters of 36 to 60 inches (90 to 150 cm) above large buttresses. Boles are cylindrical, and the palmate leaves and winged fruits are said to resemble those of the North American maples and European sycamores.

Heartwood Color The wood is pale straw, yellow-brown, creamy white, or pale yellow in color. Heartwood and sapwood are not clearly differentiated, and the latter is reported to be up to 6 inches (15 cm) wide.

Grain The grain is usually interlocked, producing a faint but characteristic striped figure on quarter-sawn surfaces.

Odor There is usually an unpleasant odor when freshly cut, but the smell disappears after the wood is seasoned.

Natural Durability The heartwood is not resistant to attack by termites and other insects and is susceptible to attack by pinhole borers, longhorn beetles, and sap stain fungi. The sapwood is prone to powder-post beetle attack. A die-back fungus, *Botryodiplodia theobromae*, which reduces most mechanical properties, is sometimes present in this species. Prompt removal of logs from the forest, as well as conversion is reported to be essential since the species is susceptible to insect and fungi attack.

Natural Growth Defects Brittleheart may be present in some trees.

Resistance to Impregnation The heartwood is reported to be resistant to preservative treatment. The sapwood is permeable.

Toxic Constituents Sawdust from machining operations is reported to cause asthma in some individuals.

Strength Properties The species usually produces clean timber of exceptional length. Wood is reported to be very resilient for its density. It has rather low bending and crushing strengths, and is not suitable for applications where strength is a factor.

AZOBE, IRONWOOD – *Lophira alata* (Ochnaceae)

Distribution West Africa and extending into the Congo Basin; occurs in evergreen and moist deciduous forests, in freshwater swamp forests, and close to riverbanks.

Tree Data May attain a height of 160 feet (50 m) with a long clear bole to 100 feet (30 m); trunk diameters 5 to 6 feet (1.5 to 1.8 m); normally without buttresses but lower portion of the bole sometimes swollen.

General Wood Characteristics Heartwood dark red, chocolate brown, or purple brown with conspicuous white deposits in the vessels; sapwood up to 2 inches (5 cm) wide, pale, well defined. Texture coarse; grain usually interlocked; luster low; no characteristic odor or taste.

Drying and Shrinkage Very difficult to season without excessive degrade, particularly surface and end checking; dries slowly. Kiln schedule T2-C2 is suggested for 4/4 stock and T2-C1 for 8/4. Shrinkage green to oven-dry: radial 8.4%; tangential 11.0%; volumetric 17.0%. Movement in service is rated as medium.

Working Properties Very difficult to work with hand and machine tools; severe blunting effect if machined when dry; can be dressed to a smooth finish; gluing properties usually good.

Durability Heartwood is rated as very durable but only moderately resistant to termite attack. Resistant to acids. Good weathering properties. Resistant to teredo attack.

Preservation Heartwood is rated as extremely resistant to preservative treatments and the sapwood resistant.

Uses Heavy durable construction work, harbor work, heavy-duty flooring, parquet flooring, railroad crossties, log bridges.

BILINGA – *Nauclea diderrichii* (Meliaceae)

Distribution The natural range of the species is reported to extend from Sierra Leone to the Congo region and eastward to Uganda.

Product Sources The International Tropical Timber Organization (ITTO) reports that timber from this species is produced in rather low quantities. The timber is currently being promoted for export. Supplies are reported to be plentiful, and good-sized material of excellent quality is reported to be readily available at fairly expensive prices.

Tree Data The tree reaches heights of up to 160 feet (49 m) and trunk diameters of 36 to 72 inches (90 to 180 cm). Boles are reported to be of good form and are clear to 80 to 100 feet (24 to 30 m).

Sapwood Color The sapwood is reported to be often uniformly pink, but may also be pale yellow or gray in color. It is clearly demarcated from the heartwood.

Heartwood Color The heartwood is orange-brown, orange, or golden-yellow in color, with a copper luster, and darkens upon exposure. The striking color of the wood, together with the figure is reported to give it a very attractive appearance.

Grain The grain is usually interlocked or irregular, and produces an attractive ribbon or rope figure.

Odor Freshly cut wood is reported to have a slightly fragrant aroma, which becomes indistinct when the wood is seasoned. Taste is described as slightly bitter.

Natural Durability The sapwood is reported to be susceptible to attack by powder post beetle, but is moderately resistant to attack by termites in West Africa. The heartwood is rated as very durable.

Weathering Characteristics The wood has good weathering properties.

Resistance to Impregnation The heartwood is fairly treatable and the sapwood is permeable to preservatives.

Toxic Constituents The wood contains an alkaloid that is reported to be toxic to some individuals.

Strength Properties The wood has good wearing properties, and its strength properties are reported to compare favorably with most imports. Density, strength and other properties of the species vary with site, but the wood is generally moderately hard and heavy. The species is reported to be 15 to 20 percent stronger than teak (*Tectona grandis*)

DOUSSIÉ – *Afzelia bipindensis* (Caesalpiniaceae)

Distribution The species is reported to occur in West, Central and East Africa in dense evergreen forests from southwestern Nigeria to Uganda and Angola. It is also common in the savannah and coastal forests of East Africa.

Product Sources The International Tropical Timber Organization (ITTO) reports that the species is a regular source of timber for export.

Tree Data The tree attains a height of over 100 feet (30 m), with a trunk diameter of 36 to 48 inches (90 to 120 cm) above buttresses that are usually about 3 feet (1 m) high. Stem is often straight and well formed, and is clear of branches to about 65 feet (20 m).

Sapwood Color Sapwood is pale straw or pale yellow to whitish and is sharply demarcated from the heartwood.

Heartwood Color The heartwood is reddish-brown in color and is sharply demarcated from the sapwood.

Grain Grain is straight to moderately interlocked, or irregular.

Odor The wood is without distinctive odor or taste.

Natural Durability The wood is reported to be naturally resistant to attack by decay fungi and other wood destroying organisms.

Resistance to Impregnation The heartwood is extremely resistant to impregnation. The sapwood is reported to be moderately treatable.

Toxic Constituents Sawdust produced from machining operations has been reported to cause irritation in some individuals.

Strength Properties The species has very high bending strength, and is much stronger than teak in the air-dry condition (about 12 percent moisture content). It has exceptionally high maximum crushing strength (compression parallel to grain) in the air-dry condition. It is hard – harder than teak, and does not mar or dent easily. The weight is very high. The wood is very dense.

IROKO – *Milicia excelsa* [formerly *Chlorophora excelsa*] (Moraceae)

Distribution Reported to be distributed across the width of tropical Africa; occurs as far east as Tanzania, where it is commonly known as Mvule.

Product Sources The International Tropical Timber Organization (ITTO) reports that the species is a regular source of timber. Timber export is regular except in the Ivory Coast where exportation of the material in log form is prohibited. Iroko is reported to be available in moderate quantities in long lengths, wide boards, and in the form of veneers on the European market are priced in the same range as the lower cost hardwoods. Availability in the U.S. is rather limited, but Iroko is reported to be sold at comparatively inexpensive prices when available. Iroko is reported to be substituted for teak (*Tectona grandis*) in many applications, since it performs just as well as Teak and is less expensive.

Tree Data The tree is reported to attain heights of up to 160 feet (49 m) and trunk diameters of up to 120 inches (300 cm). The boles are reported to be found occasionally over small buttresses and are straight, cylindrical, and clear to about 80 feet (24 m).

Sapwood Color The sapwood is yellowish-white in color.

Heartwood Color The heartwood is golden-orange to brown in color. Lighter vessel lines are conspicuous on flat sawn surfaces. Large deposits of calcium carbonate, with darker colored surrounding material are usually present. Yellow bands of soft tissue are reported to form a zigzag pattern on all surfaces.

Natural Durability The heartwood is reported to be naturally resistant to decay but is susceptible to attack by drywood insects. The sapwood is susceptible to attack by powder-post beetle, but has been reported to be highly resistant to termite attack in Africa.

Weathering Characteristics The material is reported to possess adequate weathering properties to allow it to be used in exterior applications.

Resistance to Impregnation The heartwood is reported to be highly resistant to impregnation, but the natural durability of the wood is reported to make preservative treatment unnecessary in most cases.

Toxic Constituents Wet sawdust has been associated with dermatitis in some individuals.

LIMBA – *Terminalia superba* (Combretaceae)

Distribution The species is reported to be widely distributed from Guinea to Angola and the Democratic Republic of Congo. It grows in rain forests and savannahs, and is reported to be a good plantation species in West Africa.

Product Sources Supplies are reported to be plentiful and the material is available in the form of veneers and lumber. Price is reported to be in the moderate range.

Tree Data The tree is reported to attain heights of 150 feet (46 m) at maturity, with trunk diameters of 4 to 8 feet (1.2 to 2.4 m) above broad plank-like buttresses. The tree develops boles that are often straight, well-developed and clear of branches to about 90 feet (27 m).

Heartwood Color Limba on the commercial market is reported to be either of two colors: uniformly cream, pale yellow or grayish brown sometimes with nearly black, irregular streaks, which give the wood an attractive appearance. Sapwood and heartwood are not clearly differentiated.

Grain Straight to irregular or interlocked.

Odor The wood has a mild odor, but no distinct taste.

Natural Durability The heartwood is reported to have little or no resistance to decay. It is readily attacked by termites, ambrosia beetles, and powder-post beetles. Felled trees require special preventive care to protect the heartwood against deterioration.

Resistance to Impregnation Heartwood is reported to be resistant to preservative treatment. Preservative penetration and retention in the sapwood are reported to be adequate.

Toxic Constituents Wood splinters are reported to cause inflammation of the skin in some individuals.

Strength Properties Strength properties of the timber are sometimes reduced considerably by the presence of brittleheart. The wood is weak and is reported to be rarely used in applications where strength is of major concern. Bending and crushing strengths in the air-dry condition (about 12 percent moisture content) are low. It is not hard, and has moderate weight and density.

MOABÍ – *Baillonella toxisperma* (Sapotaceae)

Distribution Found in the dense forests of Equatorial Africa, often in small patches on dry or moist soils.

Tree Data Reaches a height of 200 feet (60 m) with straight cylindrical boles to 100 feet (30 m); trunk diameter 6 feet (1.8 m), reaching to 10 feet (3 m); some butt swelling in older trees.

Uses Furniture, cabinetwork, decorative flooring, turnery and carving, decorative veneers, joinery, store fittings.

Wood—General Characteristics Heartwood pinkish brown, red brown, or a rich red; sapwood pinkish white or gray brown, rather well demarcated. Texture is fine and even; grain straight, sometimes wavy; has an attractive figure; dust may affect mucous membranes.

Working Properties Because of silica content there is a rapid dulling of cutters, otherwise works easily; glues and finishes well; has good steam-bending properties.

Durability Heartwood is rated as very durable, resistant to termite attack; and is reported to be rarely attacked by marine borers.

Preservation Reported to be not treatable (hot and cold bath).

OKOUMÉ – *Aucoumea klaineana* (Burseraceae)

Distribution The species is reported to occur on the west coast of Africa, especially in Gabon, Rio Muni, Congo-Brazzaville, Zaire, and Equatorial Guinea. It is reported to be abundant and is also widely planted within its natural growth range.

Product Sources The International Tropical Timber Organization (ITTO) reports that the species is an important and regular source for timber production and exportations.

Tree Data The tree is tall and large, with a normal height of 100 to 130 feet (30 to 40 m), sometimes up to 200 feet (60 m), and a trunk diameter of 36 to 96 inches (90 to 240 cm). It usually produces a slightly curved but cylindrical bole that is clear of branches to 70 feet (21 m) and above.

Sapwood Color The sapwood is white or pale gray, and not clearly demarcated from the heartwood.

Heartwood Color The heartwood is salmon pink to light pinkish brown, or reddish brown. Exposure to light is reported to bring a gradual change to the color, which eventually attains an appearance similar to the mahoganies.

Grain The grain is slightly interlocked or straight, though it may occasionally be curly or wavy, producing a striped or mottled figure on quarter-sawn surfaces.

Odor There is no distinct odor or taste.

Natural Durability Okoumé is reported to have very little natural resistance to decay, and the heartwood is susceptible to attack by marine borers. Logs are susceptible to forest longhorn beetle attack, and the sapwood is readily attacked by powder-post beetles.

Natural Growth Defects Cross-shakes or thunder shakes are reported to be rather common, and large logs sometimes have a brashy core.

Resistance to Impregnation The heartwood is reported to respond poorly to preservative treatment.

OZIGO – *Dacryodes buettneri* (Burseraceae)

Distribution Various species in the genus *Dacryodes* are reported to occur in West Africa, and can be found mainly in the rain forests.

Product Sources The International Tropical Timber Organization (ITTO) reports that the species is a regular source of timber for exportation.

Tree Data Mature trees usually attain a height of up to 120 feet (37 m). Most trees are not buttressed and are reported to develop straight and cylindrical boles, with trunk diameters of 24 to 60 inches (60 to 150 cm).

Sapwood Color The sapwood is not clearly demarcated from the heartwood.

Heartwood Color Generally gray buff in color.

Grain Varies from straight to wavy, or interlocked.

Odor There is usually no distinct odor or taste.

Natural Durability The wood is reported to be liable to attack by marine-borers and termites.

Resistance to Impregnation The timbers are reported to respond poorly to preservative treatment.

Silica Content *Dacryodes* timbers usually contain silica in enough quantities to affect some machining properties.

Veneering Qualities The timbers are reported to respond well to slicing and peeling.

PADOUK – *Pterocarpus soyauxii* (Papilionaceae, formerly Leguminosae)

Distribution The genus *Pterocarpus* is reported to occur throughout the tropical regions of the world. *P. soyauxii* is reported to be found in Central and tropical West Africa, extending from southwestern Nigeria to the Congo Basin. It often grows in small groups and is reported to be common in dense equatorial rain forests.

Product Sources The International Tropical Timber Organization (ITTO) reports that this species is frequent source of timber, which is exported in low quantities and only occasionally. African padauk is reported to be available in both lumber and veneer forms on the market in North America, but prices are typically in the high range. Availability in long lengths, wide boards, and in veneer form is reported to be rather limited on the European market, but prices are reported to be comparable to that of the lower cost hardwoods.

Tree Data The tree is reported to reach heights of 100 to 130 feet (30 to 40 m), with trunk diameters that are usually 24 to 48 inches (60 to 120 cm), but may sometimes reach 60 inches (150 cm). Boles are often straight and cylindrical, and are clear of branches to about 70 feet (21 m).

Sapwood Color The sapwood is white when freshly cut, but turns to brownish yellow or gray upon exposure.

Heartwood Color The heartwood is vivid reddish-orange initially, but it changes to bright red, red or coral pink, with dark streaks, or reddish- or purplish-brown or black over time. The color is reported to darken upon drying, but it eventually fades with age. Color variation between boards is reported to be slight.

Grain The grain is generally straight to somewhat interlocked.

Odor The wood has a faintly aromatic scent when freshly cut.

Natural Durability The heartwood is reported to be very durable and may last for more than 25 years in contact with the ground without any preservative treatment. It is very resistant to attack by termites.

Weathering Characteristics The timber is reported to possess excellent weathering properties.

Resistance to Impregnation The heartwood is fairly resistant to impregnation. The sapwood is moderately resistant to preservative treatment.

Toxic Constituents Sawdust from machining operations is reported to cause respiratory and dermatological problems in some individuals.

Strength Properties Strength properties are rated as generally high. Bending and crushing strengths in the air-dry condition (about 12 percent moisture content) are high. Stiffness strength is comparable to that of Oak (*Quercus*), and shock resistance is reported to be similar to that of Ash (*Fraxinus*). African padauk also resists dents well. It is a heavy wood, with density.

SAPELI, SAPELE – *Entandrophragma cylindricum* (Meliaceae)

Distribution The geographical range of Sapeli is reported to extend from the Ivory Coast to the Cameroon, eastward through Zaire to Uganda. It is reported to be found in different forest types, including deciduous, evergreen, and transitional zones.

Product Sources Sapeli is reported to be readily available as either veneer or lumber, with prices ranging from average to valuable. Specified grades of Sapeli are also reported to be easier to fill. Quartered Sapeli is reported to yield beautiful straight stripes. Flat cut wood produces attractive cathedrals and cantilevered hearts and Sapeli pommele, a wild blistered grain pattern present in some trees. Sapeli pommele is reported to be a highly popular veneer,

and is used by designers for architectural interiors, tabletops, and wall paneling. The best grades of Sapeli are reported to feature a fine pencil stripe of uniform width.

Tree Data Sapeli is a large rain forest tree from Africa. It is reported to grow to heights of 150 feet (45 m), with trunk diameters of 48 to 72 inches (120 to 180 cm). Boles are usually clear and cylindrical to heights of 80 to 100 feet (24 to 30 m).

Sapwood Color The sapwood is gray-pink or cream in color.

Heartwood Color The heartwood is pink when freshly cut, but it matures to a red-brown or purple-brown color.

Grain The grain is moderately interlocked or wavy. Quarter cut Sapeli is reported to yield a ribbon, regular stripe or bee's wing. Other cuts feature various desirable patterns, including fiddle backs, roe or a mottled design, especially in wood containing wavy grain.

Odor The wood has a cedar-like scent that remains even after long exposure.

Natural Durability The wood is reported to be susceptible to pinhole borer, and marine borer attack. The sapwood is reported to be readily attacked by powder post beetle, but it is moderately resistant to African termites.

Resistance to Impregnation The heartwood is nearly untreatable, while the sapwood is moderately resistant to preservatives.

SIPO – *Entandrophragma utile* (Meliaceae)

Distribution The species is reported to occur mainly in West and Central Africa, especially in the Ivory Coast. It is reported to grow in different forest types, including deciduous, dry subtypes, and transitional formations.

Tree Data The tree attains a height of 150 to 200 feet (45 to 60 m), with a trunk diameter of 30 to 72 inches (80 to 180 cm). Boles are often straight, of good form, and are free of branches to about 100 feet (30 m).

Sapwood Color The sapwood is light brown in color, and is well demarcated from the heartwood. It is reported to be up to 2 inches (0.50 cm) wide.

Heartwood Color The heartwood matures from pink-brown to deep red-brown or purple-brown in color.

Grain The grain is usually broadly interlocked, producing a ribbon figure or a wide, often irregular stripe on quarter-sawn surfaces.

Odor The wood has a faint cedar-like scent.

Natural Durability The wood is slightly resistant, or moderately durable, to durable. The heartwood is moderately resistant to termites and marine borers.

Resistance to Impregnation The heartwood is reported to be rather resistant to preservative impregnation.

WENGE, WENGUE – *Milletia laurentii* (Papilionaceae, formerly Leguminosae)

Distribution Southern regions of Tanzania and Mozambique westward to Congo. Found mainly in open forests. Wenge occurs in the Congo region in periodically inundated swampy forests.

Tree Data Varies between 60 and 90 feet (18-27 m); bole usually straight and unbuttressed; trunk diameters 35 to 50 inches (90-130 cm).

Wood Characteristics Heartwood dark brown to almost black with alternate layers of light and dark tissue forming a decorative figure; sapwood yellowish white, clearly demarcated. Texture rather coarse; grain straight.

Drying and Shrinkage Seasons well, although rather slowly, with little degrade or distortion.

Working Properties Sawing and machining somewhat difficult, rapid blunting of cutting edges occurs, turns well, difficult to glue if resinous.

Durability Heartwood is rated as very durable and resistant to termite attack.

Preservation Heartwood extremely resistant to impregnation; sapwood moderately resistant to permeable.

Uses Parquet or strip flooring, joinery, general construction, specialty items. Wenge is used as a hickory substitute in sporting goods, also for decorative veneer.