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CONSERVATION AND MANAGEMENT OF TROPICAL FORESTS
AND BIOLOGICAL DIVERSITY IN LISERIA

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Mr. Nyle C. Brady
Senior Assistant Administrator
for Science and Technology
Agency for International Development
Washington, D.C. 20523

Dear Mr. Brady:

I am pleased to enclose herewith a copy of a report titled "Conservation and Management of Tropical Forests and Biological Diversity in Liberia". This report was prepared to give us a current understanding of the problems relating to tropical forest and biological diversity and to address the provisions of Sections 118 and 119 of the U.S. Foreign Assistance Act.

Sincerely,

Michael A. Rugh

Mike Rugh
Acting Director

Best Available Document

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EXECUTIVE SUMMARY

This analysis was prepared specifically to evaluate 1) the actions necessary to conserve tropical forests and biological diversity in Liberia and 2) the extent to which the USAID/Liberia portfolio meets those needs, in accordance with the provisions of Sects. 115 and 119 of the U.S. Foreign Assistance Act. In addition, it describes past, present and probable future trends in the status of Liberia's tropical forests and biological diversity, and suggests alternative actions which the mission might undertake within the framework of its existing portfolio to conserve these resources.

Tropical Forests. Liberia is strategically located from the biogeographical perspective, being situated near the center of the West African lower Guinean rainforest belt. This belt is of considerable biological and conservation interest due to a high level of endemism, and Liberia is of particular importance due to its location near the center of this forest zone and due to the continued existence of substantial remaining rainforest blocks there.

About 95% of Liberia was originally covered by tropical rainforest and by 1982 about 50% of this rainforest still remained. Deforestation rates vary highly throughout the country, but the current national rate is probably on the order of about 1.0%/year. Even at this low rate, however, it is likely that by the year 2075 primary and mature secondary rainforest will be found in Liberia only in effectively protected national parks and reserves.

Most high forest is currently found in two regions in Liberia, one in the northwest and one in the east and southeast of the country. About 30% of this forest is currently accorded some protection through national forest or national park status, although several significant blocks remain which are essentially unprotected. The capacity of the government of Liberia to effectively manage and conserve its forest resources is currently considered to be very limited. Virtually all significant national forest land is under concessional arrangement with commercial logging interests, and for all practical purposes on-site management responsibility falls to those concessionaires.

The principal source of deforestation impact in Liberia has historically been smallholder (i.e., subsistence and small scale monetarized) agriculture, which accounted for over 95% of all national high forest clearing as of 1982. The agricultural sector in Liberia is heavily weighted towards subsistence

agriculture, but there is both an increasing shift out of the agricultural sector and a gradual shift from subsistence to partial cash crop production. Both of these phenomena have and should continue to draw down deforestation rates over what they would otherwise be. Other sources of direct deforestation impact are plantation agriculture (3.5%) and urbanization, mining and miscellaneous sources (0.8%). Charcoal production is also an increasing source of direct impact locally, particularly in the vicinity of larger towns and the capital of Monrovia.

Liberia's population is low and unevenly distributed. Although the national growth rate is currently at about 3.3%, the rural growth rate is expected to average only about 1.7% through the year 1999. Moreover, existing rural population densities in the three counties with the greatest remaining blocks of relatively unimpacted forest average only about 6.5/km² at the present time. This accounts for the low to very low deforestation rates currently found in these areas, a trend which is expected to continue to prevail in the short to mid run unless some factor or factors intervene to increase rural population growth rates substantially there.

Road development, including construction of logging roads, has had a highly variable impact on deforestation in Liberia. In regions characterized by high economic opportunity and high net immigration potential (e.g., the Monrovia-Nimba corridor), such roads have probably led regionally to significant increases in deforestation rates and extents by providing "land hungry" populations better access to forest lands. Conversely, in areas characterized by generally low economic opportunity and high net outmigration (e.g., eastern Liberia), the impact of such roads appears to be largely one of redistributing regional impact, increasing it in road corridors and drawing down impact in non-corridor areas. The ecological effect of redistributing impact in such cases will therefore depend on the distribution of important ecological resources in relation to areas of increasing or decreasing population density. However, even here rapid deforestation following road construction may occur along certain road segments.

Deforestation impact in Liberia can be mitigated, and better forest resource conservation and management achieved, through both direct and indirect means. Direct measures have the potential to be far more effective than indirect measures, and include 1) expanding forest protection to select areas not currently under protection; 2) improving monitoring and enforcement of existing forest resource use regulations; and 3) phasing out commercial logging operations in portions of a few select national forest concessions. Enforcement of existing forest regulations, especially against smallholder encroachment, is by far the most important of the three.

Given prevailing economic and institutional realities in Liberia, however, a mission strategy of implementing more indirect measures to conserve these resources through its existing portfolio is probably more feasible, practicable, appropriate and perhaps effective.

Indirect measures to draw down deforestation impact include 1) development of activities encouraging more intensive agricultural production, a shift to tree crop production and a movement from shifting to more sedentary production systems; 2) provision of employment alternatives to agriculture and encouragement of movement out of the smallholder agriculture sector; 3) reduction of population growth rates (especially in rural areas); 4) effecting increases in population clustering patterns; and 5) development of alternatives to use of charcoal as a prime energy source in urban areas.

Biological Diversity. Liberia today has far more diverse vegetation types than it had in presettlement times when rainforest covered virtually the entire land area of the country. Many species of plants and animals are therefore present that were previously absent, and deforestation has therefore served on the one hand to significantly increase national biological diversity. However, these species are of little significance to regional, African and global biological diversity concerns because of their generally broad ranges and high population sizes. Conversely, there are 26 U.S. federally-listed threatened or endangered species found in Liberia today and in addition the 50% deforestation that has occurred to date has probably resulted in local and perhaps global extinction of some lesser known plant and invertebrate species. More importantly, this deforestation has effectively separated the western and eastern portions of west Africa's Guinean lowland rainforest, and has further isolated and reduced the effective block size of most remaining forests. These effects have had and are expected to continue to have significant impact on rainforest diversity in the future. The biogeographical situation and deforestation patterns prevailing today in the west African rainforest argue strongly for designation of specific remaining forests, particularly certain of those occurring in large blocks between the St. John River in Liberia and the Sassandra River in Ivory Coast, as areas of top priority concern from the rainforest and diversity conservation perspectives.

At the current time, only one of thirteen areas proposed for inclusion into a national system of parks and nature reserves has been established in Liberia. Three other areas are expected to be developed in the near term, but at least three additional areas of very substantial value remain of relatively low official priority due to resource use conflicts and other reasons (the Lofa-Mano, Cavally Valley and Cestos-Senkwen areas).

The two principal sources of adverse impact to biological diversity in Liberia are clearing of rainforest by smallholder agriculturalists (discussed above) and hunting pressure. Hunting is both pervasive and intensive, and the capacity of the GDL to enforce hunting regulations and offtake is extremely limited. It appears that adequate legislation has been proposed to protect the flora and fauna of Liberia although that legislation has not yet been passed and GDL capacity to enforce it is currently considered minimal.

Six broad measures which could be implemented to mitigate adverse biological diversity impact in Liberia include 1) protecting representative and unique ecosystems, especially rainforests, through a system of national parks, refuges and nature reserves; 2) inventorying national plant and animal species and critical habitats; 3) improving regulation, monitoring, enforcement and control over offtake of plant and animal species; 4) promoting screening and organic and inorganic chemical analysis of plants and animals for medicinal and other commercially important properties; 5) developing public awareness and public conservation education programs addressing the role and importance of national biological resources; and 6) expanding training opportunities in the natural sciences and in forest and park management.

The USAID/Liberia Mission Portfolio. A review of the USAID/Liberia mission portfolio reveals that there are no ongoing activities which directly affect, either positively or negatively, tropical forests or biological diversity in Liberia. Certain project activities (i.e., rural health care and reduction of infant and maternal mortality) may ultimately have a slight indirect adverse impact on deforestation by increasing rural population growth rates in the short to mid term and an ultimate positive impact as population growth rates decline. Several other activities, including training, research and extension, loan provision to those in the non-agricultural sector, radio education, and support for monitoring and enforcement of regulations related to the flow of taxable goods, may ultimately have a positive indirect impact on forest and biological diversity conservation in the country.

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CONSERVATION AND MANAGEMENT OF TROPICAL FORESTS AND BIOLOGICAL DIVERSITY IN LIBERIA

1.0 BACKGROUND

This analysis of conservation and management of tropical forests and biological diversity in Liberia was prepared to fulfill the requirements of Sections 118 and 119 of the Foreign Assistance Act (FAA) of 1951, as amended, as those sections were revised by PL 99-529 in 1986. Specifically, Section 113 of the FAA was revised to require preparation of an analysis of "1) the actions necessary to achieve conservation and sustainable management of tropical forests, and 2) the extent to which the actions proposed for support by the Agency meet the needs thus identified." Section 119 of the FAA was similarly revised to require preparation of an analysis of "1) the actions necessary in (the) country to conserve biological diversity, and 2) the extent to which the actions proposed for support by the Agency meet the needs thus identified." Prior to analyzing these issues, and to put them into perspective, this document first evaluates past, present and probable future trends in the status of Liberia's tropical forests and biological diversity.

2.0 TROPICAL FORESTS

2.1 PRESETTLEMENT CONDITIONS AND BIOGEOGRAPHICAL BACKGROUND

Tropical rainforests are some of the most productive and biologically diverse ecosystems on earth, and the rationale for their conservation on economic and certain other grounds is strong. The relict Guinean lowland rainforest belt of west Africa, which in historical times stretched unbroken from Sierra Leone on the west to central Ghana on the east, is of particular importance. This is because isolation from the central African Congolese rainforest block since the last glaciation, and subsequent high speciation, has resulted in its development as a center of unusually high biological endemism. Liberia's specific importance from both the tropical forest and biological diversity perspectives has come to assume

greater proportions in recent years because of the continued existence of large and relatively unimpacted forest blocks in the country, and because of the relatively low deforestation rates here in comparison to other portions of the Guinean lowland rainforest zone.

Prior to the onset of human impact in Liberia, virtually the entire country was covered by closed moist rainforest characterized by canopy cover at or near 100% and an absence or near absence of grass in the understory. Approximately 98.9% of Liberia was at that time covered by high forest on drylands, about 0.2% was under freshwater swamp forest, and about 0.2% was under mangrove cover. The balance of the country consisted of non-forested swam (ca. 0.1%), savannah (ca. 0.4%) and grassland (ca. 0.2%) formations.

2.2 CURRENT FOREST TYPES AND EXTENTS

Estimates of the amount of forest remaining in Liberia began appearing in the early 1950's. Based largely on only partial aerial photographic coverage of poor to moderate quality, these estimates tended to focus on selected forest blocks in limited areas and to apply these and other data gathered by field survey methods to the entire country (FAO 1981; Hammermaster 1985; MICAT 1979). The result, as in much of the world's tropical forests, was a significant overestimation of the extent of land area which had been deforested and in Liberia these errors were compounded by confusion over the actual areal extent of the country. Estimates of national deforestation as high as 81.1% were proposed by the U.N. Food and Agriculture Organization (FAO 1981) as late as 1980, and original estimates of remaining forest cover of only 2.0 million hectares (ha) were proposed as late as 1934.

This confusion was largely resolved by publication in 1995 of the findings of the Liberia Forest Development Authority's (LFDA) analysis of national forest resources using 100% aerial photographic coverage of the country (Hammermaster 1985). Those data give a total areal extent of high forest alone in the country as of 1979/82 of over 4.767 million ha, or 49.6% of the total national land area. Nonetheless, as late as 1986 some widely distributed references (e.g., WRI 1986) were still giving a closed forest cover figure for Liberia of well under half the true figure, presumably based on earlier FAO and other estimates.

The LFDA data were based largely on 1979 and 1982 color infrared (IR) and black and white IR photographic coverage, supplemented by some additional earlier coverage at scales ranging from 1:40,000 to 1:70,000; these data are summarized in

Table 1. Photoplanimetric analysis of the data sets was accomplished stereoscopically and had a minimum delineation area of approximately 12 ha on the photos proper and approximately 39 ha on the final 1:125,000 scale maps (Hammermaster 1985). The original aerial photos, the transparent overlays with delineated vegetation types, and the stereoscopic and other methodologies employed were all reviewed with LFDA technical personnel during the course of this analysis, and it is concluded that the resulting 1:125,000 scale vegetation maps and planimetrically-derived figures for land areas, water areas and vegetation types constitute by far the best and most technically accurate quantitative data base for Liberian vegetation currently in existence.

2.3 DEFORESTATION RATES

Deforestation rates for different portions of Liberia and other west African nations occurring in the Guinean lowland rainforest belt are summarized in Table 2, with the exception of Guinea and Guinea Bissau (the latter of which is disjunct) for which reliable data are not available. This table includes only rates based on at least one set of reliable baseline data derived from aerial photographic coverage and where only one such set of data are used, assumptions are noted.

The data in Table 2 reflect the highly variable nature of deforestation rates in the Guinean lowland rainforest belt, as well as several additional phenomena of importance. First, national deforestation rates are considerably lower in Liberia than in the Ivory Coast, Ghana and Sierra Leone. Second, it appears clear that Liberia's national deforestation rate is increasing significantly. This is reflected by the rate increase from .43% to .73% between the two base comparative periods (1953-1969 and 1969-1979/82) for the Bopolu, Nimba and Jinoe regions. These data, while probably not representative of the country as a whole, tend to corroborate data from the eastern 30% of Liberia indicating that deforestation in the latter region is increasing slowly but exponentially (Goodson 1986). At an estimated, current, mean annual deforestation rate of 1%/yr, high forest clearing in Liberia would therefore be resulting in conversion of approximately 46,000 ha annually in 1987. Afforestation has to date been a relatively minor mitigation source, offsetting deforestation by a total of 167,130 ha in rubber, oil palm, forest and other tree crops (Table 1).

The third phenomenon these data reflect is that deforestation rates in different regions of Liberia, as is the case in most of the world's tropically forested nations, are highly variable (a pattern which of course is reflected by the highly uneven spatial distribution of deforestation within the country). Of particular interest is the dramatic 405% increase in rate in the Bopolu region of Liberia as a result of agricultural

TABLE 1
VEGETATION OF LIBERIA 1979/1982

<u>Vegetation Type</u>	<u>Area (ha)</u>	<u>% Liberian Lands</u>
High Forest	4,767,649	49.6
Fresh Water Swamp Forest	22,431	0.2
Mangrove	18,748	0.2
Plantation	167,130	1.7
Farmland and Regrowth	4,541,259	47.2
Non-forested Swamp	7,832	0.1
Savannah	36,004	0.4
Grassland	20,870	0.2
Other (urban, mining, etc.)	36,199	0.4
Subtotal (Land Area)	9,618,122	100.0
Subtotal (Inland Water)	75,798	
CRAND TOTAL	9,693,920	

Source: Hammermaster 1985.

Definitions: High Forest is defined as "forest of a primary or old secondary nature occurring on drier sites with a closed or almost closed canopy exceeding 30 meters in height." Swamp Forest is "high forest but located on swampy or periodically inundated sites." Mangrove Forest includes "all areas covered by mangrove irrespective of canopy or tree height." Farmland and Regrowth includes "presently farmed lands for subsistence cropping and regrowth resulting from such previously farmed areas. In addition it includes regrowth arising from transitional changes to grassland and low palm/tree cover of coastal formations." Swamp includes "all lands permanently or seasonally inundated with water other than those supporting swamp forest or mangrove." Savannah includes "mixed tree/grassland formations with a continuous dense grass layer." Grassland includes "natural grass areas that contain less than 10% woody vegetation cover." Other includes urban areas, bare ground, non-wooded costal dunes, mining areas, etc.

TABLE 2

WEST AFRICAN DEFORESTATION RATES

<u>Location</u>	<u>Time Period</u>	<u>Rate(%/yr)</u>	<u>Reference/Data Base</u>	<u>Comments</u>
<u>Liberia</u>				
Bopolu Region	1953-1969	.39	Hammermaster (1985)	1675 Km2
Bopolu Region	1969-1979/82	1.58	"	"
Bopolu Region	1953-1979/82	.81	"	"
Nimba Region	1953-1969	.34	"	1986 km2
Nimba Region	1969-1979/82	.64	"	"
Nimba Region	1953-1979/82	.44	"	"
Sinoe Region	1953-1969	.58	"	2024 km2
Sinoe Region	1969-1979/82	.35	"	"
Sinoe Region	1953-1979/82	.46	"	"
All three of above	1953-1969	.43	"	5686 km2
All three of above	1968-1979/82	.78	"	"
All three of above	1953-1979/82	.55	"	"
E. 30% of Liberia	1953-1979/82	.78	Goodson (1986)	
W. of St. Paul R. and N. of 7°15' N. Lat.	1953-1976	.30	van Mourik (1979)	21,106 km2
E. 30% of Liberia	1800-1979/82	.11	Goodson (1986)	Assumes deforestation began 1800
Entire Country	1800-1979/82	.27	Hammermaster (1985)	Assumes deforestation began 1800
<u>Ivory Coast</u>				
All except SW-Region	1956-1966	2.58	Synnot (1977)	Derived in Goodson (1986)
SW Region	1800-1966	.10	Synnot (1977)	Assumes deforestation began 1800 Derived in Goodson (1986)
<u>Ghana</u>				
Entire Country	1800-1980	.42	OALS (1980)	Assumes deforestation began 1800
<u>Sierra Leone</u>				
Entire Country	1938-1976	2.30	FAO (1979)	Assumes FAO "40-50%" forest in 1938

development along newly developed roads (Hammermaster 1985), and the coincidental reduction in deforestation rates in the Sincé region between the same 1953-1969 and 1969-1979/82 periods which were documented on the basis of aerial photographic evidence. It is notable that similar coincidental rate increases and reductions have been documented for areas associated with agricultural impact along penetration roads in the Amazon (Fearnside 1986), and it is this phenomenon which renders analysis of national deforestation from the impact distribution and mass impact balance perspectives so important (Goodson 1986).

Finally, the data in Table 2 reflect very similar deforestation rates in areas with similar socioeconomic and demographic characteristics, even when these areas occur in different countries. Of particular interest from this perspective are the rates obtained for the eastern 30% of Liberia and the contiguous Tai Forest area in the southwestern Ivory Coast, and the national rates for Ivory Coast and Sierra Leone for the mid 20th century.

It is important to note with respect to deforestation rates that prediction of future rates and "no forest target dates" based on simple statistical trend analysis, while a common exercise, is in only very few cases technically supportable. This is due to the substantial impact that changing economic conditions, rural-urban and interrregional migration patterns, population growth and distribution characteristics, shifts between employment sectors, clearing incentive, clearing capacity, forest protection capacity and a range of other factors have on regional deforestation rates and extents. That there exists considerably more high forest in Liberia and that deforestation rates are considerably lower than was previously perceived are therefore important phenomena only insofar as they 1) better establish quantitatively the national rainforest resources still available, and 2) better establish a time frame within which conservation of these resources can reasonably hope to be effected.

In spite of the currently and historically low deforestation rates in Liberia, it is nonetheless a conclusion of this analysis that deforestation rates are and will probably continue to increase slowly but exponentially under a scenario wherein current national development patterns continue to prevail. Under such a scenario, primary and mature secondary rainforest by the year 2075 will probably be found in Liberia only in adequately protected national parks and reserves. Deforestation rates, however, like population growth rates, can ultimately be expected to level off as a function of declining returns on use of forest land, stabilizing population growth rates, unavailability of limited remaining forest areas and other factors. And as in many developed countries, the areal extent of forest may gradually rebound from such a nadir as

national populations and economies become predominantly reliant on industrial, commercial or other non-agricultural and non forest-reliant economic sectors. The highest forest conservation priority in Liberia in the interim, however, is maximizing the protection accorded to the most important of the remaining, relatively unimpacted high forest blocks.

2.4 CURRENT FOREST DISTRIBUTION

Most of the true forest remaining in Liberia occurs in two general regions separated by the Monrovia-Nimba County corridor, an area of near total deforestation. Approximately 30% of it occurs in the northwest of the country and is concentrated in Lofa and northern Grand Cape Mount counties. The balance is located to the east of the St. John River and is concentrated in Sinoe, Grand Gegeh, southern Nimba and eastern Grand Bassa counties. Very large blocks of relatively unimpacted high forest remain in Liberia, particularly in Lofa, Sinoe and Grand Seden counties, although these blocks are in the process of being dissected and/or encroached upon at the edges by shifting agriculture. Many relict forest patches of highly variable size also occur throughout the country; their distribution is irregular, however, largely reflecting regional variability in the magnitude of mid to late 20th century economic development.

2.5 PROTECTED AND HIGH PRIORITY CONSERVATION AREAS

Spatial and vegetational data on the eleven existing Liberian national forests and one existing national park are presented in Table 3. The administrative areas described contained approximately 1.431 million ha of high forest as of 1979/82, or about 30% of all high forest in Liberia (Hammermaster 1985); they encompass, however, most of the largest and least impacted blocks of high forest in the country. Other areas in Liberia not under national forest or national park protection, but which still include significant blocks of relatively unimpacted high forest and which are therefore of relatively high priority conservation concern, include areas in central Cape Mount County, northcentral Lofa County, southern Nimba County, eastern Sinoe County and northeastern Grand Gedeh County. It should be noted that the Liberian Forestry Development Authority (LFDA) is currently in the process of reworking the boundaries of the national forests to adjust those boundaries to current realities of agricultural encroachment and other resource use conflicts.

With the exception of the Sapo National Park, virtually all national forest lands are under concessional arrangement with commercial logging interests (Verschuuren 1983) and under the

TABLE 3

SUMMARY OF DATA ON LIBERIAN NATIONAL FORESTS AND PARKS

<u>Forest/(National Park)</u>	<u>Proclaimed Area</u>	<u>Actual Area (Acres)</u>	<u>Farmland/Regrowth</u>	<u>High Forest</u>	<u>% High Forest</u>
Gio	81,370	78,964	12,542	66,422	84
North Gio	10,976	10,985	4,932	6,053	55
West Nimba	32,400	21,697	947	20,750	95
East Nimba	71,000	24,636	6,793	17,843	72
Gola	511,485	500,725	15,743	484,982	97
Loma	107,500	95,854	5,530	90,324	94
North Loma	247,100	224,837	13,526	211,311	94
Gbi	150,656	151,104	3,064	148,040	98
Grebo	643,266	648,731	40,140	608,591	94
Kpelle	432,000	426,318	28,621	397,697	93
Krahn-Bassa	1,270,000	1,258,021	92,989	1,165,032	93
Sapo (N.P.)	323,075	323,075	3,737	319,338	98
GRAND TOTAL	3,880,828	3,764,947	228,564	3,536,383	94%
(hectares)	1,570,550	1,482,263	92,499	1,431,155	94%

Source: Hammermaster (1985).

provisions of these concessional arrangements, concessionaires hold the responsibility for protecting the concession from encroachment of shifting cultivation (LMPEA 1983). The effectiveness of this system is discussed in somewhat greater detail in Sect. 2.7.

2.6 SOURCES OF DEFORESTATION IMPACT

Data on direct sources of deforestation impact can be derived from LFJA (1985) statistics. As of 1979/82, 95.7% of all high forest clearing in Liberia was attributable to smallholder (i.e., subsistence and small scale monetarized) agriculture, 3.5% was attributable to plantation agriculture and about 0.8% was attributable to urbanization, mining and miscellaneous sources. Smallholder agriculture, accounting for over 95% of all deforestation in Liberia, must therefore be the overriding focus of any evaluation of deforestation patterns in the country.

The agricultural sector in Liberia is heavily weighted towards subsistence and small scale cash crop production. Some basic smallholder agricultural data for the country are presented in Table 4 and available data on fallow periods are presented in Table 5.

Four major types of smallholder agriculture are distinguished in Liberia, and are generally associated in increasing order with increasing population density and decreasing fallow periods. These are: 1) extensive shifting cultivation in areas of closed high forest; 2) intensive shifting cultivation using bush fallow rotation in areas of secondary forest and forest regrowth; 3) recurrent cultivation with some continuously cultivated gardens in areas of forest regrowth; and 4) almost continuous cultivation in densely populated areas, around towns, in savannahs, and in areas of forest regrowth of less than two years (van Mourik 1979; LMPEA 1983).

These four smallholder agricultural types also tend to be associated with increasing production of cash crops and increasingly monetarized agricultural systems. A slow but continuous shift of smallholders from purely subsistence to partial cash crop production, for example, is reflected by data on increases in the percentage of households cultivating coffee and cocoa (LMPEA 1983). Also in support of this thesis, MICAT (1979) cites 1) an increase in local market activities, 2) price increases of imported foodstuffs, 3) strong demand for rurally produced, cheaper items on the urban market, and 4) slow change from a traditional to a "low-level monetarized

TABLE 4

SELECTED LIBERIAN SMALLHOLDER AGRICULTURAL STATISTICS

<u>Parameter</u>	<u>Value</u>	<u>Source</u>
Working Population	743,460 (Co. Range: 41,810-155,355)	LMPEA 1983
Subsistence Farmers (1978)	572,967 (Co. Range: 21,100-137,000)	LMPEA 1983
Monetarized Farmers (1978)	44, 0 (Co. Range: 0-23,000)	LMPEA 1983
Number of Farms (1984)	167,000	Voros n.d.
Actively Farmed Land (1984)	270,336 ha (2.8%)	Voros n.d.
Farmland in Subsistence Production (No Date)	192,350 ha (2.0%)	LOC 1980
Farmland in Subsistence Production (1971)	(3.7%)	MICAT 1979
Farmland in Subsistence Production (1979)	(3.7%)	MICAT 1979
Farmland in Upland Rice (1975-6)	182,000 ha	FAO 1981
Farms in Swamp Rice Production	10,020 (6%+)	Voros n.d.
Farms in Upland Rice (1975-6)	130,000 ha (73%+)	FAO 1981
Farmland in Traditional Crops	40%	LOC 1980
Mean Farm Size	ca. 1.6 ha	Voros n.d.
	ca. 1.5 ha (0.2-2.2 ha)	MICAT 1979
	ca. 2.5 ha	LOC 1980
	ca. 2.0 ha (rice farms)	MICAT 1979
Land Needed by Mean Family of 6 for Exclusive Subsistence Use	12-16 ha	LOC 1980
Conversion Rate, Shifting Agr. (Conversion Rate, Logging)	ca. 60 m ² /ha/yr	LOC 1980
	ca. 0.64 m ² /ha/yr	LOC 1980
Cropping Period for New Land Plot Prior to Fallowing	2-4 years	LOC 1980
Cleared Area Returning to Forest Fallow	90%	FAO 1981
Cleared Area Reverting to State of Permanent Shrub Vegetation*	10%	FAO 1981
Type of Area Cleared for Upland Rice	20% 0-7 yr. bush	FAO 1981
	50% 7-12 yr. bush	
	30% high bush	
Farms Using Fertilizer	ca. 1%	LOC 1980

Note: Under some circumstances, ex-forest regenerates into a grassland or savannah rather than forest vegetation type; e.g., "elephant grass" is said to predominate on poorer coastal soils along the Monrovia-Barbel Highway that once supported high forest (Voros n.d.).

TABLE 5

SELECTED FALLOW PERIOD DATA

<u>Location</u>	<u>Fallow Period (years)</u>	<u>Source</u>	<u>Notes</u>
"Sparsely Populated Areas"	15-25	LOC 1980	
"Near the Coast"	2-4	LOC 1980	
Jaudee, Sinoe Co.	<u>5+</u>	Kundaeli 1985	"Old town;" Population ca. 700, "no severe degradation of vegetation and soil."
Northern Lofa Co. (rural)*	8	van Mourik 1979	"Densely population area of 2500 km ² ; local "shortage of land" calculated.
Northern Lofa Co. (near towns)	1	van Mourik 1979	ibid.
Near Monrovia and "the road north" (i.e., southern Monrovia-Nimba Corridor)	Not stated	LOC 1980	"Density too high; fallow periods below that required to yield at subsistence levels."

In the target study area in northern Lofa County, van Mourik (1979) estimated that land use could be broken down as follows: 3% cultivated in (upland) crops each year; 0.2% cultivated in lowland rice each year; 4% cultivated in permanent crops each year; and 92.8% in regrowth patches of forest area outcrops. He estimated that 45% of the land was unsuitable for agriculture due to soil or drainage problems; that 25% was marginally suitable on 7-15 degree slopes, and that 30% was suitable for agriculture. His conclusion that there is a "shortage of land" was based on figures of 650 km² "available for agriculture", 75 km² cultivated and an 8 year fallow period. This conclusion is not endorsed in this analysis.

subsistence economy" supported by money earned in urban areas and brought back to rural areas as "background for the assumption that only in the remote parts of Liberia does the old economic self-sustaining system exist-- that is, in the dense rainforest/woodland areas without accessible roads."

Such a monetarization shift in Liberian smallholder production is widely viewed as one of the best ways to indirectly draw down deforestation rates since farmers tend to become "more attached to their farms due to the investment required," and thus the extent and intensity of shifting cultivation is reduced (LMPEA 1983).

Related to this issue, and with respect to fallow periods, van Mourik (1979) notes that eight year fallow periods of arable upland crops under traditional management could be reduced to 1-4 years with improved traditional management and to no fallow (but with rotation) under intensive management. He also notes that lowland rice fallow of 3-5 years under traditional management could be reduced to one year under improved traditional management and to no fallow under intensive management. This tends to corroborate the prevailing opinion that better cropland management can reduce the pressure to clear additional forest land. However, he also notes that high forest clearing is preferred to fallow rotation because the first rice yield is higher than in secondary forest or with short fallow periods. Without improved traditional management, therefore, this would lead to the conclusion that high forest clearing incentive should continue to prevail in areas where fallow periods above about eight years cannot be maintained.

To properly evaluate the impact of smallholder agriculture on deforestation in Liberia, it is also necessary to examine some basic human population statistics for the country. Select national population data (Table 6) reflect several phenomena which are fundamental to evaluating regional variability in smallholder agricultural impact on deforestation. These phenomena include 1) a very low national population size; 2) very high rural-urban and interregional migration levels; 3) very low rural population densities; and 4) a very high concomitant disparity between urban and rural net population growth rates.

The total population of Liberia in 1974 was about 1.5 million (15.6/km²) and the country is expected to average a net population growth rate of about 3.3% from 1974-1999 (LMPEA 1983). This is expected to result, however, in an estimated 1999 population of only about 3.5 million (37.5/km²). IBRD, moreover, estimates that a net reproductive rate of 1.0 in Liberia will be achieved by about the year 2040 (LOC 1980).

TABLE 6**SELECTED NATIONAL POPULATION STATISTICS**

<u>Parameter</u>	<u>Urban</u>	<u>Rural</u>	<u>Total</u>
Population (1974)	437,480	1,065,888	1,503,368
Projected Population (1999)	1,996,883	1,614,117	3,611,000
Percent (1974)	29.1	70.9	100.0
Projected Percent (1999)	55.3	44.7	100.0
Net Population Growth Rate (1974-99)	6.2%	1.7%	3.3%
National Population Density (1974)			15.6/km ²
National Population Density (1979)			37.5/km ²
Total Area Uninhabited (1974)			17.8%
Total Area with less than 2/km ² (1974)			33.8%
Total Area with less than 5/km ² (1974)			50.2%

Source: Derived or adapted from LMPEA (1983). Population density data are derived from the LMPEA population distribution map (1974) gridded into 50km² cells.

The very high rural-urban migration rates prevailing in Liberia are expected to partially account for an estimated urban population in 1999 comprising over 55% of the total national population, and past and projected rates can largely be seen as responsible for the rural population density patterns of particular importance to the deforestation issue. In 1974, about 18% of all national lands in Liberia were uninhabited, about 34% had a density of less than 2/km², and over half the land area of Liberia had a population density of only 5/km² or less, or about one family per 100 ha (derived from LMPEA 1983). Even these national statistics, however, do not adequately reflect the demographic situation in Lofa, Sinoe and Grand Gedeh counties, the three counties with the largest expanses of relatively unimpacted forest in the country. These data, summarized in Table 7, indicate that while these three counties contain nearly half the land area of Liberia, they contain only about one fifth of the population, they have a rural population density that currently averages about 6.5/km², and they had a net lifetime outmigration residual of nearly 87,000 persons.

It is no accident that patterns of high rural-urban migration, high regional outmigration, low net population growth and very low prevailing population densities tend to prevail in the remaining heavily forested regions of Liberia, nor that smallholder agriculture has had relatively little impact on gross regional deforestation here to date. Deforestation rates here should, moreover, remain low in the short to mid term in the absence of one or more forces causing substantial rural population increases although such rates can be expected to continue to increase slowly but exponentially.

In discussing the effects of rural-urban and interregional migration on deforestation distribution in areas where smallholder agriculture is the dominant impact source, it is important to note that the effect of population clustering (i.e., a decrease in the evenness or uniformity of population distribution) is generally to increase deforestation rates and extents in areas of increasing population density and to decrease deforestation rates and extents in areas of outmigration. Moreover, all other factors being equal, any action which serves to increase population clustering also tends to decrease regional mass deforestation rates and extents over "no action" conditions, since deforestation per person declines rapidly and exponentially with increasing population density (Goodson 1986).

While smallholder agriculture is almost universally perceived as the greatest direct cause of deforestation in Liberia, logging industry activities have also been cited as a major indirect source of impact via construction of logging roads into "previously inaccessible" areas. Commercial logging in

TABLE 7

SELECTED POPULATION AND DEMOGRAPHIC STATISTICS
LOFA, SINOE AND GRAND GEDEH COUNTIES

<u>Parameter</u>	<u>Lofa</u>	<u>Sinoe</u>	<u>Grand Gedeh</u>	<u>Total</u>
Area (km ²)	19,360	11,267	17,029	47,657
Percent of Liberia's Land Area	19.5	11.4	17.2	48.1
1974 Population	180,737	67,594	71,832	320,154
Percent of Liberia's Population	12.0	4.5	4.8	21.3
Urban Population Size	18,724	11,850	6,094	36,668
Rural Population Size	162,013	55,744	65,729	283,486
Percent Urban	10.4	17.5	8.5	11.5
Percent Rural	89.6	82.5	91.5	88.5
Total Population Density (#/km ²)	9.3	6.0	4.2	6.7
Rural Population Density (#/km ²)	8.4	4.9	3.9	5.9
Net Lifetime Migration Residual (1974)	-52,702	-22,967	-11,234	-86,903
Number of Farming Households (1978)	26,000	9,300	10,600	45,900

Source: LMPEA 1983.

Net Lifetime Migration Residual is equal to the number of persons born in County X but living in County Y, minus the number of people born outside of County X but living in County X at the time of the 1974 Census.

Liberia to date has, with the exception of some logging camps and staging areas, been exclusively selective cut and is not therefore considered a direct source of deforestation here except insofar as logging trunk roads may become permanently established as part of the national road transportation network or logging camps permanently established as population centers. Volumes removed by selective cut operations in Liberia are generally calculated to equal the gross volume over bark (VOB) plus twice the extracted volume (FAD 1981). Such selective extractive operations can be ecologically viewed as "accelerated windfall" plus offsite transport of the VOB, and in the absence of subsequent impact such selective cut areas can be expected to regenerate into young, closed canopy secondary forest within 8-10 years.

The issue of secondary impact along roads in recent years has apparently grown mainly out of lessons learned from impact measured in Amazonia, where an extraordinary "land hunger" situation (i.e., a very strong urban-rural and interregional migration tendency towards the rainforest) prevails. This has demonstrably resulted in rapid deforestation along new penetration roads in this area (Fearnside 1985), a phenomenon which has commonly and incorrectly been applied to road construction activities in rainforests worldwide. In the eastern 30% of Liberia, for example, spatial and temporal association data between roads and deforestation demonstrated that this phenomenon does not generally hold true regionally in areas where opposing forces prevail, i.e., in areas of low population density, high regional outmigration and high rural-urban migration. It does, however, clearly hold true for certain road segments even here. (Goodson 1986).

That analysis found 1) that road corridors have higher population sizes, higher population densities, are more deforested and are deforested faster than non-corridor areas, and 2) that deforestation decreases exponentially with distance from major roads to a greater extent than would be expected by chance. It also found, however, that 1) deforestation per capita in road corridors is less than half that of non-corridor areas, and 2) that there was no statistically significant regional correlation between road age and any corridor deforestation variable (deforestation extent, rate, extent per unit area or rate per unit area). If the Amazonian pattern were to indeed hold true for rainforests worldwide, then road age should be positively and significantly correlated with one or more deforestation parameters. In the case of eastern Liberia, however, there was no such correlation. The variables explaining the greatest amount of variability between road corridors in deforestation rate and extent were corridor population size and population density, and while road age was significantly and positively correlated with population size and density, both qualitative and quantitative information indicated that this phenomenon was at least as much a result of

prioritization of road construction in areas of preexisting population concentrations than it was a potential cause and effect phenomenon. Data indicated, moreover, that less than a third of the variation in population size and density parameters could be accounted for by road age (Goodson 1986).

These data indicating that secondary road impact levels fluctuate significantly as a function of demographic, social and economic incentive parameters were qualitatively corroborated in Liberia by LMPEA (1983), who stated that "in contrast to other countries, (encroachment or shifting cultivators and expansionistic pressure along roads) are limited to areas with high population densities. In the less populated areas, the process of establishing farms and settlements along the main logging roads has not yet commenced in force. While this trend exists, it seems to be limited." The road/deforestation patterns observed in eastern Liberia are of course not typical of the country as a whole, however, and similar analysis in and adjacent to the Monrovia-Nimba corridor could probably be expected to reflect a pattern along roads through time similar to that prevailing in southern Amazonia. That is, the current situation of near total deforestation in the corridor could be expected to have been significantly exacerbated by better access provided to a region of important economic growth attracting large numbers of immigrants.

(There are several reasons why the observed pattern of deforestation "following on the heels" of logging operations appears to occur even in regions of low population density, high rural-urban and regional outmigration, and high forest availability. One reason is because logging camps in concession areas (typically 30-500 houses) continue to rely on subsistence agriculture and about 50% of the workers translocate their families to the camps (LMPEA 1983). In addition, those farmers who go to work for concessions and have to pay contract farmers to prepare land for them in regions of high net outmigration tend to employ contract farmers recruited intraregionally. Another reason is that logging typically accounts for a larger share of the employment opportunities here, and this causes a movement of people to the concessions (which in turn causes a slowdown in farm production for the market (FOA 1986)). While some regional expansion of crop production probably occurs to accommodate the needs of concession workers arriving from outside of the region (expansional impact), only about 5% of FOB selling price generally remains in the concession area (LMPEA 1983) and even most foods are imported for extraregional immigrant workers. In addition, and as noted by FAG (1981), the "effect of opening up of new forest lands with logging roads is somewhat mitigated by a larger forest fallow area at the disposal of farmers." The principal effect of the concession camps therefore appears to be to concentrate population and deforestation impact around the camps, and to result in a perception that deforestation is

"following on its heels." In cases where the camps become permanently established population centers, this is clearly the case; in many instances, however, such effects are transitory.

(One way or the other, from the impact distribution perspective the effect of concessions is similar to that in road corridors, i.e., increasing impact in the concession area and drawing down impact in areas where workers and their families would otherwise have remained. From the mass balance perspective, however, the net regional deforestation impact will depend on whether the effect of the concession is to increase or decrease population clustering (i.e., whether the source of most workers is from areas of lower or higher population density, respectively) and the concession's net effect on clearing capacity, clearing incentive and forest availability.)

In essence, the indirect impact of roads on tropical deforestation can be viewed as an impact continuum along a transect defined by the extremes of 1) regions of high immigration usually characterized by high economic opportunity levels and 2) regions of high outmigration usually characterized by low economic opportunity levels. In the first case, that impact appears to be predominantly expansional, and in the second case it appears to be predominantly translocational. In any country with significant tropical rainforest resources, moreover, all points along that continuum can be expected to be represented somewhere and from the biological conservation perspective, the degree of adverse secondary impact of road construction on deforestation will therefore depend on the distribution of important ecological resources in relation to areas of greater and lesser demographic pressure and economic opportunity.

Another secondary or indirect impact of logging on smallholder clearing which has been noted by some technicians is the fact that selective cut logging removes some of the larger trees which might not otherwise be cut by smallholders during clearing operations. While it is currently undocumented whether smallholders prefer selectively cut lands over untouched forest lands for farm establishment in Liberia, selection of the former could be expected to result in easier farm plot clearing and perhaps a significant decrease in the species composition of the regrowth forest over that which would occur under a scenario of selection for uncut lands.

A final source of (direct) deforestation impact which is not reflected in the LFCA statistics relates to charcoal production. In Liberia, as in most of forested and wooded Africa relying on charcoal as the principal energy source, an expanding halo effect can be seen over time around urban areas. It is estimated that the average Liberian consumes about 2m³ of fuelwood products per year (Voros n.d.), but data

on the effect of population clustering on charcoal consumption is not available. If that effect is minimal, then the effect of population clustering on biomass offtake should be largely one of redistributing the impact. However, the impact on forest resources of such a redistribution can be expected to be adverse overall since in areas of higher population density the amount of biomass removed per unit area will increase in proportion to the human population size and therefore may exceed the net offtake limit a forest can accommodate without degradation. The expanding halc effect in Liberia is said at the current time to be starting to have a significant adverse impact on forests in several locations, most notably to the west of Monrovia.

2.7 ALTERNATIVE ACTIONS TO BETTER MANAGE AND CONSERVE TROPICAL FORESTS IN LIBERIA

It is possible to reduce deforestation rates and extents in Liberia, and to better manage and conserve forest resources, through both direct and indirect measures. Direct measures tend to be far more effective than indirect measures and generally involve better direct protection of forest lands.

A review of the legislative history of forest protection in Liberia, from the Forest Act of 1953 through the 1976 Forest Development Authority Act which provides the existing framework for the management of forest resources (McHenry 1986), suggests that adequate legislation currently exists to appropriately manage and conserve the nation's forest resources. There are therefore three principal means to directly reduce deforestation rates and extents.

The first direct measure is to expand protection of forests to areas not currently protected. As noted earlier, protected forest areas in Liberia include about 30% of the existing high forest resources of the country (about 15% of the total land area) but there exist other areas containing relatively large blocks of primary and mature secondary forest which should perhaps be included in the national forest system. While to some extent portions of these will probably be included in the revisions currently being made to national forest boundaries, others will likely be excluded due to agricultural, mining and/or other potential resource use conflicts. One specific way that the USAID/Liberia mission could support protection of additional forest lands would be to provide short term technical assistance (through, e.g., the African Manpower Development Project) and/or monetary support to the LFDA to

assist them with field reconnaissance activities in support of forest boundary delineation. The effectiveness of expanding the area of protected forest lands, however, occurs only in direct proportion to the effectiveness of monitoring and enforcement of forest use regulations.

The second direct measure is to improve monitoring and enforcement of existing forest resource use regulations. As noted earlier, concessionaires currently hold the responsibility for protecting their concessions from shifting agriculture. To date, this arrangement has not been particularly effective since concessionaires have neither the authority nor the power nor the inclination to forcibly remove subsistence farmers from the concessions. The LFDA is currently developing plans to establish a network of local hire guards to assist in protecting the national forests from illegal mining, hunting, settlement and agricultural encroachment. This activity would be funded using fees obtained from concessionaires, who are said to be cooperating with the proposal thus far. At the current time, it appears that the general logging outlook is sufficiently good in Liberia to permit establishment and ongoing indirect concessionaire funding of this system in the mid term. However, the LFDA currently has a staff capable of surveillance and enforcement which is in total underdisproportion to the forest conservation needs of the country. Moreover, the effectiveness of such a system would likely depend not only on maintaining a sufficient flow of funds from the concessionaires or other sources to support the system, but also on maintaining a critical mass of guards at priority forest conflict areas, development of a true commitment on the part of LFDA and the guards to enforce such restrictions, and development and maintenance of a capacity to enforce them. Currently, many believe that continued encroachment of smallholder agriculture into most of Liberia's remaining high forest is a foregone conclusion that will not likely be significantly mitigated by such a system given prevailing economic, agricultural and land use realities. Nonetheless, whether through this or an alternative system, monitoring and enforcement of existing regulations is considered in principle to be the best and perhaps the only potentially effective approach to achieve rainforest conservation in Liberia; if such a system becomes operational, it should focus principally on smallholder agricultural encroachment into selected high priority rainforests so as not to dilute scarce funds geographically. One specific way that USAID/Liberia could support such an activity would be to provide short term technical assistance to the LFDA to advise them on lessons learned from this and similar approaches to monitoring and enforcement of agricultural encroachment into rainforest areas in other parts of Africa.

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The third direct measure to reduce deforestation is to withdraw or phase out commercial logging concessions and road construction in select forest areas of particular conservation importance. While better access to forests by smallholders via road construction is primarily a source of impact in areas of high net immigration and high social and economic opportunity, such secondary impact also occurs more slowly and to a lesser extent in virtually all forest areas. If adopted, such a strategy should concentrate only on select portions of very high priority forest currently characterized by low population density and general inaccessibility. It should, moreover, only occur where there is a reasonably solid expectation that such areas can effectively be protected as national parks or reserves in the mid to long term. Two specific ways that USAID/Liberia could support such an activity would be to provide short term technical assistance to LFDA to firmly identify and delineate those areas fitting these criteria, and to provide the economic support required to make up for shortfalls in revenue which would be incurred through phasing out of the specific concessions.

Given prevailing economic and institutional realities in Liberia, however, a mission strategy of implementing more indirect measures to conserve these resources through its existing portfolio is probably more feasible, practicable, appropriate and perhaps effective. Indirect measures to decrease deforestation rates and extents in Liberia can generally be divided into those affecting agriculture, employment, population and energy. They are, therefore, significantly interconnected.

From the agricultural perspective, any action which serves to 1) increase profitability per unit area of farmland; 2) rehabilitate or improve fallow land; 3) extend the period of time that a plot of land can be cropped prior to fallowing; 4) result in a shift from subsistence to monetarized crop production; 5) expand smallholder planting of tree crops; 6) develop more intensive cultivation practices; 7) reduce incentive to remain or return to subsistence crop production; and/or 8) avoid increasing smallholder clearing capacity, will generally and indirectly tend to draw down deforestation rates and extents attributable to current shifting agricultural patterns over "no action" conditions. With respect to a shift from subsistence to cash crop production strategies, however, there are two potential adverse deforestation implications. The first is that land under tree crops cannot ever be expected to regenerate into natural high forest in the short to mid term as can lands under a traditional rotational crop/fallow system. The second is that once people are tied to a

particular piece of land through, e.g., significant investment in tree crop production, it is much more difficult and expensive to move them off of it if resettlement becomes an adopted strategy for forest conservation or management purposes.

From the employment perspective, any action which serves to provide employment alternatives to agriculture or otherwise increase movement out of the agricultural sector will also draw down deforestation rates. From the population distribution perspective any action which decreases population growth (especially rural population growth), inhibits immigration into forest areas, or increases population clustering (through, e.g., encouragement of rural-urban migration) can also be expected to decrease smallholder deforestation over "no action" conditions provided that it does not also increase agricultural incentive or clearing capacity. Finally, because an increasing amount of deforestation is occurring in expanding halos around major urban centers due to charcoal production activities, development of alternative energy sources for urban use can be expected to ultimately reduce deforestation due to this impact source except to the extent that such development directly or indirectly increases deforestation (e.g., by inundation of forests through hydropower development).

Specific agricultural actions which could serve to draw down deforestation rates in Liberia include 1) promotion of increasing use of fertilizers and appropriate pesticides; 2) promotion of swamp rice over upland rice production; 3) promotion of improved agroforestry techniques, including use of leguminous species on both permanent crop and fallow lands; 4) promotion of increased tree crop production among shifting cultivators through provision of credit and supplies; 5) promotion of improved crop genetic stocks; and 6) improvement of agricultural research and extension activities for all major crop species. Most of these activities could be effected within the framework of the existing Agricultural Research Project.

Specific employment-related actions which could serve to draw down deforestation rates and which also can be expected to increase or maintain population clustering patterns include 1) training in the industrial, manufacturing and construction sectors; 2) provision of small scale loans to businesses in those sectors; and 3) provision of technical marketing and production support to those sectors. For the most part appropriate activities in such an employment replacement strategy could also be implemented within the framework of the existing portfolio, through, e.g., the Small and Medium Enterprise Development and African Manpower Development projects.

Specific energy-related actions which could serve to draw down deforestation due to urban charcoal demand in Liberia include assessment of potential alternative energy sources appropriate to the Liberian urban environment, and promotion of development and use of those alternative sources. Short term technical assistance to review the available information and prepare an alternatives assessment could probably be funded through one or more centrally funded projects or through the AFR/TR-managed NRMS Project.

How the USAID/Liberia mission portfolio currently relates to these types of direct and indirect actions and impacts is addressed in Sect. 4.0 of this analysis.

3.0 BIOLOGICAL DIVERSITY

3.1 GENERAL DIVERSITY CONSIDERATIONS

For the most part, the issues of rainforest conservation and conservation of biological diversity cannot be separated within the Liberian context. It is nonetheless axiomatic in applied ecology that habitat diversity largely correlates positively with species diversity, and vegetation types and habitats in Liberia today must be considered far more diverse than in presettlement times when rainforest covered virtually the entirety of the country. At the same time that 50% of the country remains under tropical rainforest, deforestation in Liberia has resulted in establishment of 1) a derived, humid Guinean savannah/woodland mosaic; 2) vegetation types spanning all seral stages along the early fallow-mature rainforest continuum; and 3) development of a constantly changing array of ecotonal and "edge effect-generating" associations previously nonexistent in the country. Many plant and animal taxa must therefore occur in Liberia now that were previously absent, and deforestation has therefore served on the one hand to increase national biological diversity over presettlement conditions.

Biological diversity, however, cannot be perceived solely from a national perspective and from the point of view of regional (Guinean lowland rainforest), continental and global biological diversity conservation those species which have extended their ranges into Liberia by virtue of human impact on vegetation are generally species of very low diversity value due to large geographical ranges, extensive distributions and relatively high population sizes. Conversely, and while no vertebrates are definitely known to have become locally or globally extinct by virtue of Liberian deforestation, scientific knowledge of

invertebrate and minor plant taxa originally occurring in Liberia is minimal and it is difficult to imagine that extinction of some such Liberian species of very restricted range and distribution or very low population size could not have been eliminated from the country by the clearing of 50% of the rainforest. This is particularly true given the very high degree of endemism occurring in the Guinean lowland rainforest as a result of geographical isolation and speciation. Moreover, and in addition to deforestation proper, rainforest clearing has resulted in effective separation of the western portion of the Guinean rainforest from the eastern portion via the Monrovia-Nimba corridor (although a very limited connection may remain at the northern extreme of the block between Danane and Sipilou in the Ivory Coast-- an area of relatively minimal impact). This, as well as reduction of effective forest block sizes in most areas, can be expected to have had and continue to have a very significant and additional adverse impact on rainforest diversity due to well-established biogeographical (e.g., effective island size), population dynamic and genetic (e.g., drift) phenomena.

In 1976-7, a UNEP/IUCN-sponsored survey of the status and conservation of the biotic communities of west and central Africa appropriately concluded that Liberia and adjacent portions of the Ivory Coast constitute the center of biological diversity and endemism for the west African moist forest (i.e., the Guinean lowland rainforest). Later studies were to describe the Liberian portion of the Guinean belt as the most important of these areas since the forest "attains its most developed stage ecologically" here (Verschuren 1983). The biogeographical situation of and deforestation patterns within the Guinean rainforest today argue very strongly for designation of certain significant blocks of forest remaining, especially those between the St. John River in Liberia and the Sassandra River in the Ivory Coast, as areas of priority global concern from the biological diversity perspective.

3.2 PROTECTED AND HIGH PRIORITY CONSERVATION AREAS

Principal areas of high priority conservation concern occur almost throughout the country. They are, however, as a result of near total deforestation along the Monrovia-Nimba corridor, heavily concentrated in the western, northwestern, northeastern and eastern portions of the country. These areas are addressed individually below in the order in which they have been mentioned in the literature.

Mount Nituvi. This area was proposed for national park status by the old Forest Conservation Bureau in the 1960's. Located in the Mologizi Range in northwestern Liberia, it consists of the highest massif and dominant feature of that range. The

area apparently remains well forested although former big mammal populations are said to be mostly shot out. The Mount Wituvi area is not considered by the LFDA to be a high priority area for park development at the present time.

Bokoma. This area was also proposed for national park status in the 1960's. It consists of about 2950 ha with reportedly spectacular scenery, but Verschuren (1983) found that game populations were extremely low. Bokoma is also considered by LFDA to be a relatively low priority for national park status at the present time.

Iiappo. This area was originally planned in the 1960's to be the country's largest park. It consists of about 13,000 ha in southeastern Liberia but significant increases in shifting cultivation have occurred here in the interim and the prevailing opinion is that it is too late to reverse the trend.

Nimba Range. The Nimba Range straddles the Liberian, Guinean and Ivorian borders and is internationally known for its considerable zoological endemism. Curry-Lindahl (1969) wrote that 200 or more species of animals are found there which occur nowhere else in the world (most, however, must have been plants or invertebrates) and considerable zoological interest and research has focussed on the area. Contiguous parts of the range in the Ivory Coast and Guinea are protected to some degree, but the Liberian Nimba area has apparently been significantly degraded in recent years by hunting, deforestation and mining activities. As early as 1965-6, the Nimba was described as being "virtually devoid of large mammals" (Curry-Lindahl 1969). The current perception is that the area has become too small and competing resource concerns too great to expect that it will ever be protected within the Liberian national park system.

Cape Mount. The Cape Mount area is a coastal area in western Liberia encompassing about 22,404 ha. The site is notable for its rocky coastline (extremely rare in Liberia), and for its coastal forest on rocky soils (also rare) in one of west Africa's maximum rainfall zones (Verschuren 1983). In the late 1960's there was a considerable monkey population which is currently reported to be either exterminated or nearly so. One of the main attractions of the area is for potential future tourist development, and in fact it is currently considered likely by LFDA personnel that it will become the next or one of the next national parks.

Lofa Valley. The Lofa or Lofa-Mano area was first recommended for protection in the late 1960's (Curry-Lindahl 1969), and substantial subsequent attention was focussed on it well into this decade. The area finally proposed by Verschuren (1983)

for national park status included an area of about 230,000 ha between the Lofa and Mano rivers in western Liberia. The area is a prime conservation target area because of extremely low human population, nearly pristine tropical rainforest in probably the largest and most unimpacted block west of the Monrovia-Nimba corridor, and substantial remaining wildlife populations. However, the area also apparently contains substantial gold, diamond and timber resources and the national tradeoffs involved in "locking it up" as a national park are currently considered too high to expect establishment of a park in this region. There was, in addition, considerable planning conducted for construction of a reservoir to generate hydropower in the Mano River area. The reservoir length behind the dam was originally designed at 74 km, but apparently construction of the dam and reservoir is no longer under consideration due to funding and other constraints. While the area is currently somewhat protected by the fact that most of it lies within the Gola National Forest, it remains a very high conservation priority and efforts should be strongly encouraged to provide better protection. This could possibly be done within the multiple use framework of national forest management, but the area should be more closely surveyed and specific areas of highest biological diversity importance should be considered for exclusive protection as a national park or refuge.

Putu Range. The Putu Range in eastern Liberia was originally recommended for protection in the 1960's (Curry-Lindahl 1969) and is best known for its high game populations. However, in the interim a series of villages and some mining projects became established, and a major logging trunk road connecting the Zwedru-Greenville and Zwedru-Harper routes was constructed. This route may well become part of the established national road network given its advantages to transportation economics along the Greenville-Harper transit; it is a critical route to logging concessionaires since most logs currently have to be transported to Harper from the region north of Greenville for transshipment.

Cavally River. Forests adjacent to the Cavally River in the eastern extreme of Liberia are of extremely important biological diversity concern because they form an effective contiguous block with the UNESCO Tai Forest World Biosphere Reserve in the southwestern Ivory Coast (separated only by the Tabou-Tai-Guiglo road which currently carries relatively little traffic). The area was described by Curry-Lindahl (1969) as "probably the area of Liberia with the richest and best preserved animal life, because there are very few human inhabitants." Much of it lies within what is now the Grebo National Forest, and Verschuren (1983) describes it as an area "not directly threatened by concessions and where wildlife is still rather abundant." While LFDA personnel consider it

unlikely that the area will become a national park in the near future, this entire forest area should be considered as one of the highest if not the highest priority for national park status in Liberia. Its establishment would greatly expand the functional area of the Tai Forest, and together they could constitute under proper management conditions an international block of the Guinean lowland rainforest of sufficient size to ensure the survival of most vertebrate species characteristic of the ecosystem.

Swamp and Delta Areas. "Representative swamp and delta areas" were originally mentioned by Curry-Lindahl (1969) as appropriate for protection, although the coastal zone in Liberia does not hold any exceptional biological value (Verschuren 1983). Swamp and delta areas are of extremely limited areal extent in Liberia, and while inclusion of such areas into a national park system would be appropriate from the national perspective there are far better and more diverse coastal, estuarine and lagoonal systems in extensive portions of Ivory Coast to the east and Sierra Leone, Guinea and Guinea Bissau to the west. The Lake Piso area has been mentioned as being of some interest (IUCN 1979), however, and part of the proposed Cape Mount National Park would likely fall contiguous to that lagoon.

Sapo National Park. Sapo National Park was the first (and to date the only) Liberian national park established (1983). It covers an area of about 141,000 ha of primary forest adjacent to the Sapo River in the southeastern portion of the country. It is an area of considerable conservation importance, very low human population and relatively undisturbed rainforest. There remain threats to the park from both illegal concessional logging and poaching, but the area currently appears to have very broadbased support for its management as a park on the part of the GCL, local inhabitants and donor personnel. Peace Corps volunteers have been stationed there since about 1985, and a commercial river trip on the Sapo River and through a portion of the park has become well established.

Cestos-Sankwan. The Cestos-Senkwen area consists of about 145,000 ha of primary forest with a representative fauna, and includes an important transition area from inland forest to about the only littoral forest persisting in Liberia. It would protect the "extremely spectacular" Cestos River and would also include a stretch of coast (but one of many) practically untouched to date. LFDA personnel consider it to be a candidate for possible national park consideration in the future, although logging activities are currently reported to be significant. This area should also be accorded one of the highest national conservation priorities.

Mt. Wonegizi. The Mt. Wonegizi area consists of about 20,800 ha on the Guinean border consisting of lowland and semi-orophilian vegetation. There is said to be no more logging in the area and, although some encroachment from subsistence agriculture is occurring at the fringes, it is said to be under very close consideration for protection by LFDA in the near term.

Mt. Wologizi. Mt. Wologizi is another mountain located essentially adjacent to Mt. Wonegizi in the northern extreme of the country, and it also is under careful consideration along with adjacent forests for protection as a nature and game reserve in the near term.

3.3 THREATENED, ENDANGERED AND PROTECTED SPECIES

To date, there are approximately 130 mammal, 310 bird and 74 herpetozooan species which have been identified as occurring in Liberia (FDA 1986). Of all vertebrate species occurring in or off of Liberia, 26 are listed by the U.S. Department of Interior (DOI) as threatened or endangered. These include seven terrestrial mammals, seven aquatic mammals (six of which are whales), two birds, three freshwater or estuarine reptiles, five marine reptiles (all turtles) and two amphibians. Basic data on these taxa, including official (DOI) status and habitat type, are presented in Table 8. The list of threatened and endangered species in Table 8 is fairly typical of such lists worldwide in its mix of species. In general, these include 1) taxa with extremely limited geographical ranges; 2) taxa with extremely low population sizes; 3) taxa threatened due to commercial exploitation for food or species parts; and/or 4) taxa which have experienced significant decline due to unusual circumstances (e.g., pesticide effects on the Peregrine Falcon). Other species listed as protected in Liberia in the appendix to the Wildlife and National Parks Act are shown in Table 9. An additional 20-30 species not listed in either of these tables are believed to still be technically protected under the provisions of the 1968 African Convention on the Conservation of Nature and Natural Resources (Curry-Lindahl 1969).

3.4 SOURCES OF IMPACT

The two principal sources of adverse impact to plant and animal diversity in Liberia are deforestation of the remaining rainforests and hunting pressure. The first was described in earlier sections of this analysis and the sources

TABLE 8

USDOI-LISTED THREATENED AND ENDANGERED SPECIES OCCURRING IN LIBERIA

<u>SPECIES</u>	<u>STATUS</u>	<u>HABITAT</u>
<u>Mammals</u>		
Elephant	T	Forest, woodland and savannah; highest populations in woodlands and savannahs
Leopard	E	Forest, woodland and savannah; primary habitat is forest and dense woodland
White-collared Mangabey	E	Primary habitat forest, but also occurs in clearings
Diana Monkey	E	High forest, mainly in upper strata
Chimpanzee	T	Forest, woodland and savannah; highest populations in woodlands and savannahs
Jentink's Duiker	E	Forest habitat; very rare; probably restricted to Liberia and the Tai Forest area in Ivory Coast
Pangolin	E	DOI lists only <u>M. temmincki</u> , but taxonomic confusion exists; three species occur in Liberia
Manatee, West African	E	Freshwater, estuarine and marine; probably more numerous than once thought
Whales	E	Six species, all endangered, have ranges including marine waters off Liberia
<u>Birds</u>		
Peregrine Falcon	E	All habitats, tropics to arctic; nests primarily in ledges and cliffs, but also on high rise buildings in U.S urban areas.
White-necked Rockfowi	E	Rocky cliffs and caves
<u>Reptiles</u>		
Dwarf Crocodile	E	Primarily estuarine
Slender-snouted Crocodile	E	Primarily freshwater
Nile Crocodile	E	Freshwater and estuarine
Marine Turtles	E	Five species have ranges including marine waters off Liberia; all listed as endangered
<u>Amphibians</u>		
African Viviparous Toad	E	No available data
Cameroon Toad	E	No available data

Source: U.S. Department of Interior (20 July 1984) 50 CFR 17.11 and 17.12.
 E = Endangered; T = Threatened

TABLE 9

OTHER SPECIES LISTED AS PROTECTED IN LIBERIA

Mammals

Western Black and White Colobus Monkey (Colobus polykomos)
Red Colobus Monkey (Colobus badius)
Olive Colobus Monkey (Colobus verus)
Pygmy Hippopotamus (Choeropsis liberiensis)
Bongo (Boocerus euryceros)
Yellow-backed Duiker (Cephalophus silvicultor)
Zebra Duiker (Cephalophus zebra)
Ogilby's Duiker (Cephalophus ogilbyi)
Giant Forest Hog (Hylocherus meinertzhageni)
Golden Cat (Felix aurata)

Birds

All birds of prey of the families Sagittariidae, Falconidae,
Pandionidae and Strigidae, including all eagles, hawks, kites,
falcons, buzzards, vultures and owls.

Source: McHenry (1986).

of deforestation impact addressed there apply equally to the conservation and management of both rainforests and the diversity of biological resources which they contain.

Hunting is a far more selective source of impact than deforestation and therefore necessarily affects a much smaller subset of the country's biological resources, i.e., it is largely restricted to portions of the vertebrate population. While deforestation is a source of impact with much wider biological and diversity implications, and can be expected to result in far higher extinction rates overall in the mid to long run, rainforest destruction is not yet believed to have reached the point in Liberia where vertebrate species have been so affected. It is, rather, hunting pressure which currently appears to constitute the greatest threat to such species.

It has been estimated that the majority of the population of Liberia derives 70% of its animal protein from bush meat (LOC 1980), although this figure has been seriously questioned in some quarters (e.g., Verschuren 1983). While there are said to be fewer hunters along the coast due to lower game populations, game meat is sold openly throughout Liberia and meat prices are said to be increasing nationwide (Verschuren 1983). Bush meat is therefore important both as a source of protein and as a source of income. One indication of the importance of bush meat to the rural population is reflected by the fact that during discussions with local villagers on establishment of the Sapo National Park, the effect of park establishment on their ability to obtain bush meat was cited as a top priority concern (Kundaali 1985).

Hunting pressure for animal products is also significant, judging from the number of skins, animal-derived traditional medicinal products and amount of ivory on the open market. One could openly obtain leopard skins on the streets of Monrovia at the time of report preparation, and many of the skins available in the western Ivory Coast are said by vendors to come from eastern Liberia as well as from the Tai Forest region. The effect of demand for chimpanzees for biomedical research has also been mentioned as a significant source of impact for that species; it should be noted, however, that a very few chimpanzees originally captured in Liberia have been repatriated to the bush in the Ivory Coast (near the lower Sandama River) after biomedical experimentation.

Firearms have historically been sold freely in Liberia; it is estimated that there are currently about 100,000 rifles (Verschuren 1983), that about 20% of the male population owns shotguns (Voros n.d.), and that 6000 guns were imported in 1979 alone (Robinson and Peale n.d.). Local ammunition factories are also said to be widespread, although shell costs had increased to about 1\$ per shell as of November 1987, and trap hunting has been employed for centuries (Robinson and Peale n.d.).

- 7/2

The capacity of the GOL to effectively enforce regulations (not to mention smallholder encroachment into national forests) is currently considered to be minimal. As of 1983, the LFDA Wildlife and National Parks Division had one officer in charge and two technical assistants in the capital, and while there were a number of wildlife officers in the field, logistical support for them was considered to be generally poor (Verschuren 1983). Here as in much of the rest of Africa, the ability to enforce laws is constrained by inadequate numbers of enforcement personnel, low wages, poor infrastructure, inaccessibility of the terrain, high poaching incentive and a number of other factors.

3.5 ALTERNATIVE ACTIONS TO CONSERVE BIOLOGICAL DIVERSITY IN LIBERIA

As legislative background, Liberia became a party in 1978 to the African Convention on the Conservation of Nature and Natural Resources of 1968, and to the Convention on International Trade in Endangered Species of Wild Fauna and Flora of 1973 (CITES) in 1981. National legislation directly related to wildlife and national parks was passed in 1940 (licensing big game hunting); 1953 (conservation of wildlife through forest conservation); 1954 (limiting offtake for other than scientific purposes, restricting hunting and prohibiting dynamiting of fish); 1957 (providing that portions of national forests could be designated as wildlife refuges); 1973 (defining rights of concessionaires to use other concession resources besides timber); and 1976 (conferring upon the LFDA the authority to create, establish, administer and develop national parks). Other relevant legislation pertains to registration of firearms (1975) and the codification of penal laws for all offenses (McHenry 1986). More recently (1986), a consultant with FAO assisted in drafting a comprehensive Wildlife and National Parks Act very similar to those found in the United States and some European countries. This act, not yet officially passed, provides the framework for establishing policies and objectives, administrative structures, national park and nature reserve regulations, game reserves and hunting regulations, species protection provisions and enforcement provisions (McHenry 1986). Passage of this legislation should be very strongly encouraged.

As with deforestation, it is possible to reduce adverse impact to biological diversity in Liberia through both direct and indirect measures. Direct measures are again generally far more effective than indirect measures which, described in Sect. 3.7 of this analysis, apply equally to the issues of deforestation and biological diversity conservation.

Indirect measures to conserve general plant and animal diversity in Liberia can be broken down into six general recommendations (not necessarily prioritized). First, inventory priority national plant and animal species. Estimate population sizes, ranges and distributions within those ranges and establish and delineate critical habitats for rare species. This is a medium to long range activity which would best be supported through training of national technicians in zoology and botany. Typically, however, training in these fields for these purposes are only effective insofar as there are funds available to support field inventory and survey operations. An alternative approach would be to provide support to a local conservation PVO or NGO such as the Society for the Conservation of Nature in Liberia (SCNL) to prioritize and begin drawing together such information.

Second, maintain a mix of forest, woodland, savannah, swamp and other vegetation types in the country and expand protection through monitoring and enforcement of existing and proposed laws and regulations to both representative and unique ecosystems. Rainforest protection, particularly of the remaining large and relatively unimpacted blocks, should take first priority. Specific and potentially appropriate mission activities to support this are the same as those described in support of direct deforestation mitigation measures in Sect. 2.7.

Third, improve regulation, monitoring and control over offtake of biologically and commercially important species populations, both plant and animal. Specific activities which could support this might include provision of technical assistance, monetary assistance and/or training to appropriate LFDA personnel to support and improve current capabilities.

Fourth, promote screening and organic and inorganic chemical analysis of plants and animals for medicinal and other properties which may be of commercial importance. In particular, one could enter into consultation with the World Health Organization, large pharmaceutical companies and universities involved in chemical screening to evaluate alternative approaches to screening and development. An appropriate first step would be to obtain short term technical assistance to identify alternative approaches, target organizations of interest, and potential economic benefits to be gained from such screening.

Fifth, develop public awareness and public conservation education programs which address the role and importance of national biological resources to the country, Africa and the world. This could most appropriately be supported through the ongoing Rural Information System Project and/or through support for a local PVO to undertake such an activity.

Finally, expand training opportunities for technical and management personnel, especially in the fields of botany, zoology, wildlife management, forest management, national parks management, applied ecology and organic chemistry. This might perhaps be most appropriately effected through the Agricultural Research and Extension II and/or African Manpower Development II projects.

The most important of these measures by far is protection of tropical rainforests through national park establishment and monitoring and enforcement of forest resource use regulations, since most of these Liberian rainforest areas which are not conserved in the near future can be expected to largely disappear within the next 75-100 years. However, given prevailing economic and institutional realities in Liberia, a mission strategy emphasizing more indirect measures to draw down deforestation and better conserve and manage forest and biological resources through it's existing portfolio would appear to be more feasible, practicable, appropriate and perhaps effective.

4.0 THE USAID/LIBERIA MISSION PORTFOLIO

In FY 1987, the U.S. economic assistance program in Liberia reached a total of US\$ 36.5 million. This portfolio includes seven development assistance activities, two economic support fund activities and a PL-480 Title 1 program (USAID 1987). Each of these are addressed individually below, along with three proposed activities, and evaluated in terms of the type (direct vs. indirect) and magnitude of impact that they are expected to have on tropical forest and biological diversity conservation and management in Liberia.

Rural Development Training II (669-0185). This activity is designed to support and refine vocational agricultural education at Cuttington University College through staff development, facility construction, managerial improvements and enhancement of the institute's long term financial viability. No direct impact, positive or adverse, on either tropical forests or biological diversity should occur. Some positive indirect impact should accrue through training in animal science (potential impact on bushmeat reliance); pest management (potential impact on non-target species); and agricultural economics (potential impact on improved farming methods, agricultural intensification and a shift to cash crop production).

Agriculture Research and Extension II (669-0183). This activity is designed to develop the capacity of the Central Agricultural Research Institute to conduct adaptive and applied research and communicate the results to extension agencies for transmission to farmers. It emphasizes adaptation of existing technologies to increase food production, principally rice and cassava, and concentrates on development of cropping systems that can be used economically as alternatives to traditional, shifting, slash and burn crop production methods. No direct impact, positive or negative, on tropical forests or biological diversity is expected to ensue. Significant positive indirect impact should result through research, extension and training in plant pathology, agricultural education, agronomy, extension entomology and cropping systems, and their potential impact on improved farming methods.

Nimba County Rural Technology (669-0163). This activity terminated on 27 June 1987 after having extended 621 loans to assist small scale industrial, manufacturing and construction enterprises in Nimba County. No direct positive or adverse impact on tropical forests or biological diversity should have resulted. Some positive indirect impact can be expected to have resulted, however, by supporting and encouraging development of the non-agricultural employment sector and reinforcing population clustering in urban areas.

Rural Information System (669-0134). This activity established the Liberian Rural Communication Network to transmit development-related programs by radio to rural inhabitants of Liberia in English and in thirteen local dialects. Programs address health, agriculture, child care, conservation and community development. No direct impact on tropical forests or biological diversity are expected to result, but substantial positive indirect impact may result from agricultural programs (improved farming methods and a shift to cash crop production) and conservation programs (deforestation and general biological diversity awareness).

Road Maintenance (669-0200). This activity was designed to rehabilitate 155 miles of laterite road between Zwedru and Harper to all weather standards, and to develop the construction capabilities of private contractors to perform road maintenance work. The activity went through intensive environmental review, including statistical analysis of historical road development and tropical deforestation patterns (temporal and spatial), and it was determined that the activity should have no direct and no significant indirect adverse impact on regional tropical deforestation rates and extents. It was anticipated that the activity would ultimately serve indirectly to somewhat increase deforestation in the target road corridors, draw down deforestation in regional non-corridor areas, and perhaps draw down regional deforestation rates and extents over "no project" conditions.

Primary Education (669-0166). This activity is designed to implement an effective primary level learning system nationwide through the use of low cost programmed instruction. The activity is expected to have no direct or indirect positive or adverse impact on either tropical deforestation or biological diversity in Liberia.

Economic and Financial Management and Training (669-0184). This activity is designed to develop the GOL's capacity to manage its financial resources more effectively through establishment of a new accounting system, partial automation of the GOL payroll system, design of a new procurement system and implementation of in-country training programs. The activity is expected to have no foreseeable direct or indirect positive or adverse impact on Liberia's tropical forests or biological diversity.

African Manpower Development II Project (698-0433). This project provides short and long term training for private and public sector individuals in appropriate development-related skills. It is not expected to directly impact, either positively or negatively, tropical forests or biological diversity. Some positive indirect impact may accrue through training in agriculture, natural resources management or related fields.

Primary Health Care (669-0165). This activity is designed to increase the proportion of rural Liberians with access to an appropriate mix of preventive, promotive and curative primary health care, and to strengthen the institutional infrastructure both centrally and in Sinoe and Grand Gedeh counties. Activities are carried out in both villages and towns. No direct positive or adverse impact on tropical forests or biological diversity are expected to result from the project. Indirectly, improvement of health care in rural villages in these areas will tend to sustain or increase rural population growth rates and remove a major attraction of larger towns, and may therefore indirectly serve to draw down rural-urban migration and regional outmigration from Sinoe and Grand Gedeh counties over "no project" conditions. Such activities, however, are expected to have minimal overall impact on migration rates in Liberia.

Combating Childhood Communicable Diseases (698-0421). This activity is designed to prevent childhood diseases amenable to vaccination, to decrease mortality and morbidity and to strengthen national capabilities to improve the health of children and pregnant women. It will not directly affect tropical forests or biological diversity, but by decreasing

mortality rates in the short run it can be expected to indirectly contribute to maintenance of higher national population growth rates both in urban and rural areas than would otherwise be the case. Net indirect impact in the short run, while probably minimal, is therefore expected to be adverse. In the long run, however, reduced mortality rates should be followed by reduced birth rates which should ultimately have a positive indirect impact on drawing down deforestation.

Small and Medium Enterprise Development (669-0201). This activity is designed to encourage the formation and expansion of small to medium sized industrial, construction, service and commercial enterprises by strengthening the institutional capacity of the Small Enterprise Financing Organization. Typical target businesses include furniture makers, food processors, metal workers, upholstery workers, construction materials manufacturers and restaurant and drug retail services. No direct positive or adverse impact should result from the project, but the activity should have a positive indirect impact on deforestation by supporting and encouraging non-agricultural sector employment and incentive to remain in larger population centers.

Increased Revenue for Development (669-0132). This activity is designed to increase the Ministry of Finance's capability to generate domestic revenue through customs and internal revenue components. No direct positive or adverse impact to tropical forests or biological diversity should result. Significant positive indirect impact may result, however, through better monitoring and enforcement of the flow of taxable goods (including animal products).

PL-480 Title I Rice Imports. In 1987-8, this activity will provide US\$ 10 million worth of rice to be sold on the local market, with income generated from these sales to be used to finance the GOL's development budget for over 40 projects. This activity will not directly affect tropical forests or biological diversity in Liberia, but the potential indirect impacts are difficult to gauge. On the one hand, if it serves as a disincentive to the rural farmer to produce more rice then it should indirectly serve to draw down deforestation rates. If, on the other hand, it serves to permit rural rice producers to improve their income from rice through legal or illegal exports to neighboring countries, then it may indirectly have the opposite effect.

PVO/NGO Organization Support Project (699-0211). This proposed activity is designed to establish a fund which local PVO's and NGO's may draw on to sustain their ongoing operations, especially in the areas of health, education and small

enterprise development. No direct impact to tropical forests or biological diversity should ensue. Evaluation of indirect impacts is impossible given the current absence of details on the specific PVC/NGO activities to be supported.

Economic Stabilization Support Project (669-0213). This proposed activity will fund 17 operational experts who will assist the GOL in bringing financial, budgetary and structural problems under control. No direct or indirect impact to tropical forests or biological diversity should result.

Commodity Import Program (669-0214). This activity is designed to encourage economic policy reform in Liberia, to address balance of payments problems to enable the private and public sectors to import essential commodities, capital equipment and raw materials, and to provide local currency to support a civil service reform program. No direct or indirect impact to tropical forests or biological diversity should result from implementation of this activity.

Agriculture Infrastructure Rehabilitation (699-0212). This activity is proposed for implementation in FY 1988. It is designed to rehabilitate critical road links between Liberia's most productive agricultural areas and their respective markets, and to develop the capacity of Liberian private sector contractors to undertake road maintenance work. No construction of new roads will be undertaken, and no direct impact on tropical forests or biological diversity are therefore expected to ensue. An examination of indirect impacts, both adverse and beneficial, to tropical forests and biological diversity in Liberia will be undertaken during project design and road segments with the potential to result in secondary adverse deforestation impact will be deleted.

In summary, the USAID/Liberia mission portfolio contains no activities directly affecting, either positively or negatively, tropical forests or biological diversity in Liberia. Project activities which in theory may adversely and indirectly affect tropical forests and biological diversity somewhat in the short run include 1) provision of primary health care to rural villages in Sinoe and Grand Gedeh counties and 2) reduction of mortality and morbidity rates among children and pregnant women. Conversely, project activities which may positively and indirectly affect tropical forests and biological diversity somewhat in the long run include 1) training in agriculture, animal science, pest management, plant pathology, agronomy, extension entomology, cropping systems and related fields; 2) agricultural research and extension in improved farming methods; 3) loans to small and medium scale industrial, manufacturing, construction, service and commercial enterprises; 4) transmittal of agricultural and conservation

education information by radio to rural communities; and 5) support for monitoring and enforcement of regulations related to the flow of taxable goods. Certain mission portfolio activities are considered to have either ambiguous or unknown indirect impacts on tropical forests and biological diversity in Liberia.

5.0 BASIS OF FINDINGS

This analysis was prepared at the request of USAID/Liberia by the Regional Science & Technology Advisor for West and Central Africa, REDSO/WCA, acting in his tandem capacity as Regional Natural Resources and Environmental Advisor. It is based on the findings of several months of Liberian field and analytical work in 1986; two weeks of additional field and analytical work in Liberia in 1987; a review of all technical documents listed in Appendix 1 of the analysis; and extensive discussions with technical and non-technical personnel employed by the U.S. Agency for International Development (USAID), the Government of Liberia (GOL), private voluntary organizations (PVO's), non-governmental organizations (NGO's), Peace Corps Volunteers (PCV's), logging concessionaires, and port and other transport infrastructure developers and managers.

The author has conducted reconnaissance level and/or in-depth field surveys by road of the southwest, central, northern and eastern portions of Liberia, including central Grand Cape Mount County; central, eastern and western Montserrado County; southern Lofa County; central Bong County; southern Nimba County; central and southern Grand Gedeh County; eastern Maryland County; southern and central Grand Bassa County; and northeastern Sinoe County. He has also conducted a low altitude aerial reconnaissance level survey of the coastal and near coastal zones of approximately 80% of the country between Monrovia and the Ivory Coast border, and has conducted reconnaissance level and in-depth field surveys by road of contiguous and extraterritorial ecosystems along the entire Liberia-Ivory Coast and most of the Liberia-Sierra Leonean border regions.

APPENDIX 1

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