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BELIZE
TROPICAL FORESTRY ACTION PLAN

Report to the
Government of Belize

by a team provided by the

United Kingdom Overseas Development Administration
Canadian International Development Agency
United States Agency for International Development
Food and Agriculture Organization of the United Nations

Overseas Development Administration, London

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PREFACE

In November 1987 the Government of Belize informed the Food and Agriculture Organization (FAO) of its interest in having a study of the country's forest sector carried out under the Tropical Forestry Action Plan (TFAP), and invited the United Kingdom Overseas Development Administration (ODA) to lead the donor input into the exercise. Following a visit to Belize in February by the team leader nominated by the ODA, terms of reference were agreed upon for a sector study; which was to be carried out with the assistance of consultants provided by ODA, the Canadian International Development Agency (CIDA), the United States Agency for International Development (USAID), and FAO.

The terms of reference (Appendix 1) reflect the particular characteristics of the forest sector in Belize, and the priorities the Government of the country place on the developmental contributions that might result from action in the sector. As one of the most heavily forested and lightly populated countries, most importance attaches to forest industries and conservation of forest cover. In contrast to most other tropical countries, supplies of wood fuels are not a significant problem.

The field work for this study was carried out in Belize during the period 2 May to 17 June, by a team made up of the following:

J.E.M. Arnold (ODA), team leader, 2 to 31 May
 F.B. Armitage (CIDA), land use, 2 to 31 May
 W.L. Bender (USAID), forest industries, 18 May to c. 10 June
 N.V.L. Brokaw (USAID), conservation, 18 May to 7 June
 H. Hilmi (FAO), institutions, 14 to 27 May
 J.R. Palmer (ODA), forest management, 2 May to 18 June
 S.L. Pringle (CIDA), forest economics, 2 May to 1 June

Working with Forest Department staff, the first part of the period was devoted to field visits to all parts of the country, and the remainder of the time to development of the team's preliminary analysis of the situation, in consultation with a wide range of government and non-government authorities (Appendix 2).

Reports were prepared by each of the subject matter specialists in the team during July and August. These were reviewed at a meeting held in September at the Oxford Forestry Institute, and attended by all team members and the Acting Chief Forest Officer. At that meeting it was agreed that further work was needed to try and assemble more information about the forest resource. This was carried out by Forest Department staff and Mr J.R. Palmer during December 1988 and January 1989.

The present report has been prepared by the team on the basis of the information assembled through these field visits and meetings, and the subsequent analysis of the resulting data. The report is now being submitted to the Government as a discussion draft for review.

The team wishes to express its gratitude to the many people and organisations in Belize who contributed to its work. In particular we wish to thank Mr H. Flowers, the Chief Forest Officer, and Mr O. Rosado, the Principal Forest Officer, and their colleagues in the Forest Department, for their unstinted help and guidance at all times.

We would also like to thank the British High Commission, in particular Miss J. Martlew, Third Secretary (Aid), for the excellent arrangements and support services provided; and the British defense services for providing a helicopter flight over parts of the country which could not have been inspected adequately from the ground.

The study was organised by GDA through the Oxford Forestry Institute, and thanks are due to the staff at that Institute for the data processing, cartographic and other work they carried out in the course of the preparation of the report.

EXECUTIVE SUMMARY

Present situation

General

Belize is an unusually heavily forested country. Although there was extensive Mayan agriculture up to a millennium ago, widespread selective logging for the past 300 years, and more recently a spread of shifting and settled agriculture, the greater part of the land area is still under forest. Moreover, most of the forest remains ecologically intact.

Over most of the country's history, the forest sector has been the mainstay of the economy. Mahogany and logwood were Belize's major exports until the turn of this century. Logging continued to maintain a dominant position in the economy for some time, with rapidly increased production of mahogany and other hardwoods. Timber production peaked in 1952, and subsequently declined quite rapidly until very recently. By the latter part of the 1950's, agricultural crops exceeded forest products in value of output, and by the 1960's sugar had gained the lead in commodity export values. Recently, citrus and banana exports have been growing in importance, as have garments and fish exports (Appendix 3C). The Government is seeking to diversify the economy, and has identified forest based industries and tourism as two priority areas.

Current population is estimated at 176,000. Approximately half the population lives in the 7 largest urban centres, while the dispersed rural population makes up little more than 5% of the total. In 1986, per capita GDP (Table 2.2) was equivalent to US\$1,560. GDP net growth from 1980 to 1986 averaged 1.7% annually, somewhat less than the net population increase of 2.0%.

The forest estate

Though 93% of the area of the country is classified as "forest land", this is best viewed as an indication of the potential in the absence of human influence. The most recent estimates of original vegetation cover include 74% of closed broadleaved forest and 5% of open pine forest. The actual extent of forest cover at present is unclear.

Because of early privatisation of the more accessible and richer areas of the country, the permanent forest estate is largely restricted to the less accessible and higher lands, plus the southern coastal plain and swamps. The area of reserved forests totals 2,545 square miles (659,200 ha) or 30% of the land area. The greater part of the 2,531 square miles (655,700 ha) of other Crown (National) Lands and the 3,241 square miles

(839,700 ha) of privately owned land is also forested (Table 3.8).

About a fifth of the reserved forest area is regarded as protection forest, intended for the maintenance of environmental stability, although no areas are specifically designated for management for this purpose. In 1987, the Forest Reserves accounted for 39% of total log output, and private lands for 48% (Table 3.18).

The transfer of land from forest to agricultural uses has been accelerating. The transfers are mainly on Private and National Land, but in recent years several thousands of acres/hectares have also been transferred out of Forest Reserves. There are indications that some recent agricultural expansion has taken place on low productivity sites where it may be unsustainable, such as citrus developments on the problem Puletan soils of the south-central plains where a number of past crop development projects have failed. A sound legal framework exists for the allocation of land to the most appropriate use, but in practice land allocation is at present conducted in a largely ad hoc, piecemeal manner.

Production and trade

Output of forest products (Appendix 5) was initially predominantly in the form of logs for export; this declined rapidly from about 1950 and by 1970 had practically ceased. Production of mahogany and pine sawnwood expanded until the mid-1950s, and output of the other hardwoods as a group has continued to grow erratically until the present.

The country's 46 sawmills (Appendix 17) are mostly vintage band mills or old portable circular mills. Some 75% of the country's lumber production comes from only 5 or 6 mills. Two veneer mills are under construction.

As late as 1967, forest products still accounted for nearly 10% of the export trade value. In 1987, the export value of forest products was in excess of BZ\$ 5 million (Table 3.1), almost 3% of total export value. By the mid-1960s, a larger proportion of production was supplying the home market; and in value terms domestic consumption is now more than twice as large as exports. Over the past decade, the sector has accounted for 1.7-3.3% of GDP (Table 3.2).

In 1980 and 1981 imported sawnwood of all species (Table 3.17) actually exceeded sawnwood exports, by over 50%. Subsequently, imports have been substantially reduced, largely by the with-holding of government import permits.

A heavy dependence on mahogany and pine is still evident; the two species, plus cedar, accounting for 58% of sawnwood production in 1986-87. However, depletion of these commercial timbers has certainly occurred. In the broadleaved forest, the repeated combing for only mahogany and cedar has reduced the populations of large trees of these species. Their share of the harvest has fallen from 92% in 1928-29 (2.5 million cu ft) to 20 to 30 % in recent years (350,000 cu ft annually in 1983-87). Pine output fell from a peak in 1952 of 4.0 million ft (69% of the total) to 76,000 ft in 1980, but has increased again from this level subsequently.

Though it cannot yet be documented quantitatively, there is good reason to believe that even present levels of mahogany and pine production cannot be supplied indefinitely, at least under present management and harvesting systems. The limited amount of information about the forest areas in private hands, which with unreserved land in 1987 accounted for 77% of mahogany production (table 3.10), strongly indicates that these are essentially being mined for their remaining stock of commercial species. The pine resource, in contrast, is mainly in reserved forest areas, but are declining on the Southern Coastal Plain because of burning and transfer of land to agricultural use; elsewhere the main stands are immature and of poorer quality.

Conservation

Belize is fortunate to have an environment in good condition, containing a range of intact ecological systems. The low density of selective logging, and the almost total lack of other forms of exploitation, have left much of the country in a natural state. Wildlife species and ecosystems endangered or extinct elsewhere in Central America are fairly common in Belize.

The importance and value of conserving biological diversity and environmental integrity are appreciated in Belize. Laws for the establishment of conservation reserves and for protection of wildlife and other aspects of the environmental resource have been enacted, and a modest system of 11 completely protected areas has already been established.

There is a direct connection between the current healthy state of the environment and the country's important tourism industry. In 1987, 55,000 tourists visited Belize. An increasing number of natural history tourists are attracted to the forested interior.

Institutional framework

Responsibility for most aspects of forestry and conservation rests with the Ministry of Agriculture, Forestry and Fisheries, and within that with the Forest Department. The Forest

Department has temporarily delegated responsibility for the management of protected areas to the Belize Audubon Society.

The Forest Department in Belize has considerably fewer personnel, at all levels, in relation to the size of the forest estate under management and in use, than is normally accepted as being necessary. In addition, there is no formal training scheme for forestry staff in the country.

Following a report in 1959 on the country's economy, which recommended a major reduction in investment in forestry, the Forest Department has had little in the way of capital inputs. As a consequence, little has been done to replenish the depletion of the forest capital brought about by upwards of 300 years of continuous logging of the prime commercial species. Even the limited area of plantations established earlier has been neglected. In recent years, the recurrent expenditure allocations for the Forest Department (BZ\$1,996,377 in 1988/89) have also shown a downward trend; while actual recurrent expenditures have been below these budgeted levels, in compliance with government instructions (Table 3.4).

Development strategy

The forests of Belize are clearly of immense importance to the country. Directly and indirectly they are critical to the nation's continuing economic and environmental prosperity. The government seeks to develop two dimensions of the forest sector in particular: forest industries and conservation.

A realistic strategy for further development of the forest sector must be based on the recognition of a number of salient facts:

- 1) Over a large part of the forest area timber production needs to be excluded or limited in favour of environmental outputs. Yet other areas will have to be transferred to agricultural use.
- 2) Output from the diminishing resource of mahogany and other sought after timbers needs to be directed to those outlets which maximise the value added to the Belize economy; and not dissipated as at present in low value applications.
- 3) The bulk of the of the available resource is in secondary hardwoods; which though technically usable are presently not widely accepted either on domestic or export markets.
- 4) The timber production potential of the forest reflects

the long periods of continuous or repeated exploitation. If Belize is to continue to be able to draw upon this important resource it will be necessary to invest in measures to maintain and rebuild its productive potential.

5) The sector needs to be managed to yield improved returns; including increased public revenues.

6) The Forest Department needs to be substantially strengthened if it is to successfully undertake the range of tasks assigned to it.

Alternative development scenarios for the forestry sector to the year 2000 are suggested, corresponding to two assumptions of GDP growth - 3% and 6% (see page viii). Domestic consumption is somewhat arbitrarily assumed to be 10 and 12 million board feet (23,600 and 28,300 m³) respectively, which implies growth rates at roughly half that of GDP. For each general growth scenario, two policy alternatives for the forest sector are considered. The first assumes a continuation of past forest policies and trends in supply, domestic use patterns and exports. The second assumes a more aggressive forest policy and programme, as well as additional government supported incentives for industrial development.

Under the trend assumption, domestic use of mahogany and cedar increases while exports decrease correspondingly. Other hardwood consumption grows only modestly, while pine consumption increases considerably. The very valuable hardwoods continue to be exported in relatively small quantities, and some expansion of export of other hardwoods in the form of veneer will occur. Imports of manufactured wood and paper products will increase.

Under the aggressive forest policy alternative, other hardwood species are promoted for local use, while mahogany/cedar consumption declines modestly. The amount available for more highly processed exports increases; thus export value increases substantially. Domestic requirements are increasingly met by supplies of "other hardwoods" and smaller dimension pine processed by more appropriate equipment. This alternative foresees the replacement of much of the imported plywood with a domestic product. Some very high valued logs will continue to be exported.

Policy measures

Economic policy

To move activities within the forest sector in the directions outlined in the above strategy, economic policies and policy tools need to be deployed which encourage increases in value added and export earnings, and replacement of imported

manufactures of wood with domestic products. The main policy tools for doing so are royalties and other public forest changes, control prices and trade barriers.

The present royalty structure has a number of weaknesses, notably the following: (1) the lack of any differential reflecting relative ease of logging and transport to the mill; (2) the lack of adequate differential between species to reflect selling price differences; (3) the opportunity for the logger to maximize unit volume profits by "creaming" stands; (4) the lack of a deliberate policy to use royalties as a management tool to discourage/encourage cutting of particular species. An in-depth review is recommended, which inter alia should consider the following tentative proposals:

- 1) Major licenses offered for sale be allocated a minimum purchase price.
- 2) The royalty for cedar and mahogany be substantially increased.

Development Alternatives for the Forest Sector

		1925-84 Ave.		2000		2000	
				Lower Growth	Higher Growth		
Population	Thousands	119		242		242	
Labour Force	Thousands	54		81		81	
GDP (1925/1984 Prices)	Million \$25	249		534		812	
GDP Growth to 2000	% per annum			3		6	
GDP per capita	\$25	2088		2215		3355	
<u>Logs, Lumber, Veneer & Plywood</u>							
Production	Million M. Ft.	9.5	Trend 11.4		Agressive Policy 13.1	Trend 13.0	Agressive Policy 14.1
Mahogany & Cedar	Million M. Ft.	2.1		2.5	2.5	2.5	2.5
Other Hardwoods	Million M. Ft.	4.2		4.8	6.0	5.3	7
Pine	Million M. Ft.	3.0		4.1	4.6	5.2	4.6
Domestic Consumption	Million M. Ft.	8.0	Trend 10.7		10.0	Trend 12.0	12.0
Mahogany & Cedar	Million M. Ft.	1.3		1.5	1.0	2.0	1.0
Other Hardwoods	Million M. Ft.	3.8		4.5	5.0	5.0	6.5
Pine	Million M. Ft.	2.9		4.0	4.0	5.0	4.5
Average Domestic Prices	\$25 per Thousand M. Ft.	913		925	910	908	929
Mahogany & Cedar	\$25 per Thousand M. Ft.	1200		1200	1600	1200	1550
Other Hardwoods	\$25 per Thousand M. Ft.	700		700	700	700	700
Pine	\$25 per Thousand M. Ft.	500		800	1000	800	1100
Value of Domestic Consumption	Million \$25	7.3	Trend 9.1		9.1	Trend 10.9	11.2
Mahogany & Cedar	Million \$25	1.6		1.8	1.4	2.4	1.7
Other Hardwoods	Million \$25	3.4		4.1	3.5	4.5	4.6
Pine	Million \$25	2.3		3.2	4.0	4.0	5.0
Exports	Million M. Ft.	1.3	Trend 1.4		2.1	Trend 1.0	2.1
Mahogany & Cedar	Million M. Ft.	1.2		1.0	1.5	.5	1.5
Other Hardwoods	Million M. Ft.	.11		.3	.5	.3	.5
Pine	Million M. Ft.	0.1		.1	.1	.2	.1
Average Export Prices	\$25 per Thousand M. Ft.	1500		1521	1537	1660	1537
Mahogany & Cedar	\$25 per Thousand M. Ft.	1660		1500	1600	1500	1600
Other Hardwoods	\$25 per Thousand M. Ft.	3000		1700	1500	1700	1500
Pine	\$25 per Thousand M. Ft.	1400		1200	1200	1200	1200
Value of Exports	Million \$25	2.1	Trend 2.1		3.3	Trend 1.5	3.3
Mahogany & Cedar	Million \$25	1.7		1.5	2.4	.8	2.4
Other Hardwoods	Million \$25	.33		.5	.1	.5	.8
Pine	Million \$25	0.1		.1	.1	.2	.1
<u>Value Other Exports</u>							
Pine Stumps	Million \$25	.5	Trend .7		1.1	Trend .4	1.1
Manufactured Wood & Furniture	Million \$25	.2		.3	.3	.3	.3
<u>Value Total Sector Exports</u>	Million \$25	2.8	Trend 2.8		4.4	Trend 1.9	4.4
<u>Value of Imports (Lumber, Paper)</u>	Million \$25	1.0	Trend 2.0		1.5	Trend 2.5	1.5
<u>Estimated Employment in Sector</u>	Man-Years	600	Trend 750		900	Trend 850	950
Share of Labour Force	Percent	1.07	Trend .93		1.11	Trend 1.05	1.17

- 3) Royalties on most "other hardwoods" should not be increased under present conditions.
- 4) Royalties on private lands should be abolished as such and replaced by a special fee for scaling timber to be cut.

The present system of control pricing is not effective, and if enforced is likely to discourage future production. The prevention of lumber imports appears only to worsen the situation by further distorting price anomalies and limiting possible supplies of conifers which might provide a short-term solution to supply problems, until domestic pine production can be appropriately increased. A structure is needed which will encourage greater returns from the high valued primary and luxury hardwoods, allow a temporary supply relief for conifers and promote fuller use of secondary hardwoods. It is therefore recommended that, either price controls on lumber be abolished or, if it is politically necessary to maintain them, control prices for all species be increased to encourage overall production, and those on mahogany and cedar be very substantially increased to discourage local demand.

It is recommended that prohibiting or restricting either exports or imports be limited to very special and carefully examined cases, e.g., possibly retaining all ziricote production for the use of domestic craftsmen. Protection for potential industry is already provided for but consideration should be given to additional, but temporary, tariff protection for potential establishment of plywood production for the domestic market, as well as some manufacture of paper products based on imported paper stocks. It is proposed that other existing incentives for encouraging industrial establishment be maintained.

Land Use Policy

In view of some recent agricultural developments on soils of doubtful suitability, and the question of the appropriate balance within the forest sector between the area of Reserved Forest and forests in other land ownership categories, there appear to be good grounds for an objective review of the forest estate, and overall land use. It is recommended that the Government should formulate an overall land use policy and plan, using existing land capability information extended as and when necessary, and taking into account the needs of environmental conservation, to define land use zones. The mechanism recommended to coordinate and supervise such measures is an Inter-Departmental Forest Land Allocation Committee, acting upon the technical work, including analyses, of a professional Task Force.

While these provisions are being made, it is recommended that

there should be a temporary moratorium on changes in the permanent forest estate boundaries. Subsequently, proposals for transfer of land out of Reserved Forests for agricultural use should be justified by the protagonist as to scientific appropriateness, economic feasibility and sustainability, and the cultural methods to be used. The Land Allocation Committee should be satisfied that no alternative land suitable for the proposed development is available. Cases of illegal settlement of Reserved Forest by encroachment should not be settled by excising the land and granting lease or title to it (this would need to be accompanied by expeditious settlement of those seeking land).

Forest Management

The goal of management of the Forest Reserves should be to sustain, or enhance, the proportion of preferred species, and to achieve a more efficient use of the available utilizable resource. Since there is substantial ecological diversity in the Belize forests it follows that no single management or utilization model will suit all circumstances. The Forest Department needs to consider each area in turn, as to its present state and most appropriate management regime. In most cases, changes in management will be gradual because substantial areas of the permanent forest estate have been given out under 5 and 10 year long-term forest licenses in 1986 and 1987.

There is a considerable base of information from past inventories on which to plan management, but the data needs to be reprocessed as each area is brought under active management. It is worth emphasizing that inventories show that the broadleaved Forest Reserves are still recovering from the 1961 hurricane damage.

The current polycyclic management system is entirely inappropriate for Belizean forests. Observational evidence indicates that the majority of the commercial species are rather intolerant of shade, after the seedling stage, and not well represented through the diameter classes. This is to be expected, where Mayan agriculture, hurricanes, and to a minor extent, past logging have combined to favour tree species which are relatively light-demanding and fast-growing, factors conducive to simple monocyclic management systems. The pines are an extreme case of this pioneer-type ecological tendency.

It is recommended that a monocyclic system be progressively introduced, accompanied by more intensive logging. Under the traditional system the forest remains stocked with technically acceptable species and the reduction in basal area is too small to justify silvicultural measures in favour of the few primary species which have been logged. Loggers should be required to work systematically through the forest by demarcated blocks, and

exploitation should be as heavy as possible, consistent with maintaining site productivity. A post-logging inspection should carry enforceable penalties for such transgressions as damage to regeneration.

Management needs to be incorporated in formal working plans. All existing working plans were nullified by the 1961 hurricane, though subsequent draft plans do exist for 4 Forest Reserves. Given the inventory and growth data which exist for the Mountain Pine Ridge, it would be appropriate to start the preparation and implementation of more suitable working plans there.

It is recommended that more detailed standard conditions for the issue of permits and licenses be prepared, giving the Forest Department the necessary powers to direct the use of the resource in a sustainable manner. A revision of forest legislation would be desirable, and should separate those aspects which require Ministerial decisions into the Ordinance and those which can be decided by the Chief Forest Officer into the Forest Rules. Present fees and penalties seem to have little rational basis, while a differentiation into a forest land management fee and a royalty on natural products is long overdue. The various permits and licenses are mostly too vague to inform concession holders of their obligations or to secure a prosecution for forest offenses.

The quality and quantity of research to support management needs to be improved. The absence of yield plots or experiments in the broadleaved forest is the largest gap in the research programme. For the Mountain Pine Ridge, the gaps in growth data need to be identified, formal trials should be established for spacing and thinning, and prescribed burning trials should be reactivated. Yield plot data for pine from the Southern Coastal Plain should also be analysed. Plantations should be a low priority for the Forest Department, given the potential for enhancing production more efficiently from the existing resource; but selected trials could be appropriate to provide an information base for possible future commercial plantations on land cleared for agriculture. The introduction and adaptation of agroforestry systems is recommended, and a research initiative should be promoted by the Forest Department.

Forest Industries

The potential for expansion of forest industry lies mainly in making better use of the limited supplies of mahogany and other prime species, and channelling them into those outlets which will generate the greatest value added and return on investment, and in introducing greater volumes of secondary hardwood timbers into local usage and export markets. Market surveys indicate that the latter must be viewed in terms of finished and semi-finished products. Within the logging and

processing industry attention needs to be concentrated on increasing the efficiency of operation through upgrading skills, equipment and equipment and market intelligence.

With the exception of grading of export mahogany lumber, skills need to be improved at every stage of production. The lack of expertise in logging operations, at all levels, is of particular concern. It would appear that the most effective way of developing such skills would be through a logging extension service. It is also recommended that a case study of one of the larger operators be made, to see to what extent the operators are correct in their assessment that they can only log in the dry season.

A full-time sawmill extension service is also needed; to concentrate on helping the 40 smaller mills. A seminar or course in the use of drying kilns should be given at the new kiln in Belmopan, to alert mill operators to their advantages and start education in their use.

Some sawmills could be improved by acquiring used equipment made available as plants in North America and Europe re-equip. However, most sawmillers in Belize are in no position to consider buying a new mill. For many, small improvements could be the answer to upgrading the quality of their production, such as carbide tip inserted saw teeth, stellite application to saw teeth and sprinkler systems. Although the lumber volume gain from replacing circular saws with band saws is likely to be largely offset by increased investment and higher labour and operating costs, a search for the most appropriate band saw for Belizean conditions should be undertaken.

There is little information related to market intelligence, and there is clearly some need for improved statistical control locally and for a flow of information from external markets. The latter could be facilitated by the creation of an effective association of timber producers and exporters, and it is strongly recommended that such a Timber Association be set up. In addition to establishing contacts with associations in market countries, an active Timber Association could benefit producers in such areas as negotiations with government, transportation, improvement of training/skills and quality control. Industry has not taken full advantage of the services offered by the Government's Belize Export and Investment Promotion Unit (BEIPU). A forest industry board could also be set up to monitor the prospects for additional new industries, such as the feasibility of plywood production.

Environmental Conservation

With growth in population, and the consequent expansion of

agriculture, parts of the forest area which provide essential protection against erosion, flooding and disruption of water supplies are coming under threat. Deterioration of the forest environment would equally threaten tourism and the growing value of the country's increasingly unique ecosystems.

It is recommended that the Government establish an Office of Conservation within the Forest Department, to provide a badly needed institutional capability for pursuing conservation planning and management: incorporation within the Forest Department will permit close coordination with other agencies with major responsibility for land use. The Office's responsibilities would include overseeing: management of ^{protected areas} reserves and wildlife, enforcement of ^{national} parks and wildlife laws, research on the environment and maintenance of a conservation data base. The Office would take over only a small part of the conservation work currently done by the energetic and effective non-governmental organizations in Belize, which should continue to play a major role. In order to draw on the different constituencies with a concern with environmental matters it is recommended that a Conservation Advisory Board be set up.

The goal of conserving biological diversity is best accomplished by a systematic, comprehensive analysis of habitats and organisms not included in the reserve system. Proposals for new reserves should be based on the sound reasoning of gap analysis, based in turn on a thorough inventory and mapping of habitats and a comprehensive plan. Some sites already proposed are so clearly important, or threatened, that designation need not await a comprehensive plan.

It would be impractical and undesirable to put enough land in strict reserves to meet conservation goals. Fortunately, other land uses are compatible with the aim of preserving biological diversity. For example, sustained yield management for timber of the Forest Reserves will maintain suitable habitat for most forest species. The areas surrounding some small reserves should be managed as multiple use a "buffer zone". All land uses should be evaluated inter alia in terms of their impact on biological diversity. Much can be done to enhance the mutualism between conservation and tourism, such as improved accommodation and services.

Improved information is needed for ^{protected area} ~~reserves~~, wildlife and watershed management. Long-term research studies in the major habitat types on basic ecological processes are especially informative. There is an immediate need for a "broad brush" habitat analysis as a basis for the gap analysis that is central to decisions on land use. Floral and faunal inventories, periodic censuses and basic ecological studies on selected species are needed in the reserves. Land uses adjacent to ~~reserves~~ should be monitored to anticipate potential effects on

^{protected areas}

Reserve habitats and wildlife, and information is needed about the impact of forest harvesting to clarify uncertainties regarding multiple use management. Water quantity and quality monitoring should be undertaken in one or two key catchments.

The National Parks System Act provides a firm legal basis for the establishment of parks and ^{national} resources, but should be strengthened in some respects. It is recommended that provisional protective status be created to apply to land under consideration for reservation, to forestall their pre-emptive exploitation. A body of regulations for particular habitats is also needed. The intention to regulate use of mangroves is supported, and it is recommended that protection and management of this resource be identified as a specific responsibility of the Forest Department. Other legislative recommendations concern an extension of the moratorium on commercial trade in wildlife and additional control of internal trade, at least partial protection from hunting for several species not currently protected, and protection for particular plants, amphibians and freshwater fishes. Belize should also investigate the advantages of joining ^{relevant} certain international conservation conventions. These require commitments, but would also qualify Belize for technical and financial assistance from them.

The most important tool for conservation decisions is a conservation data centre, a system and institution for gathering, cataloguing and supplying the information on Belize's biological diversity. A good deal of information is already available, but it needs to be assembled and organized for use.

Institutional Strengthening

Belize's existing forest policy is sound and well-balanced. However, it would seem appropriate for the Government to develop and issue a new statement of forest policy, setting the latter in the context of the country's present situation and long-term goals. The short-term development proposals for the sector should figure prominently in the next five-year development plan.

There is a need to review and harmonize forest sector and conservation legislation, for more effective management of the forest resource and environmental base. The legislation should be made clearer and more equitable, and regulations to give effect to forest and conservation laws need to be formulated and enacted.

The Forest Department needs substantial strengthening if it is to be able to bring the forest under more active and effective management, and to build up the conservation component. Given the Government's constraints on increasing staff and expenditure in the public sector, careful review is needed of how best to

allocate scarce skilled manpower resources within the forestry administration, and of the tasks that should fall to the public sector within the forest sector. The Forest Department's present responsibilities for the operation of logging and manufacturing facilities clearly reduces the staff resources it can commit to its essential forest management role. As this also leads to understandable complaints by the private sector of unfair competition, it would appear that the Department should withdraw from a continuing operational role in logging and sawmilling; but continue research, development and training in woodworking.

To achieve optimum deployment of trained forestry staff, forest management should be carried out by the Field Foresters, Divisional Forest Officers (DFOs) and the Forest Rangers, while administrative matters should be left to administrators.

It is estimated that the following staffing would be needed in order to provide the existing territorial structure of reserved forests and protected areas with sufficient staff for active forest and conservation management, together with headquarters and support services:

Professional		
Headquarters	4-5	
Forest management & research	4	
Conservation management	2	
	<u>10-11</u>	10-12
Technical	16-20	25
Forest guards/park wardens	40-45	90

This estimate includes the proposed Office of Conservation, with 2 professionals, 3 divisional officers and 6 game wardens.

These numbers, which would need to be increased if National Land unsuitable for agriculture was to be incorporated into the permanent forest estate, compare with the present strength of the Forest Department of 6 professionals, 16 technical personnel and 24 forest guards. In order to allow for continuig expansion, and for turnover and loss of staff, provision needs to be made for training considerably larger numbers of personnel over the next 10-12 years.

This strengthening and expansion calls for early and sustained action to develop staff. A prompt start to training is particularly important in the conservation field, as no Belizeans have the training to fill the positions of the proposed Office of Conservation. At least 7 forestry and conservation professionals should be trained on scholarships abroad as soon as possible. Forester training would also continue to be provided abroad, through bilateral scholarships. There are now good prospects of providing initial Forest Ranger training through a 2-year Diploma Course at the Belize Agricultural college. Forest Guards should continue to be trained on the job, supplemented by short in-service training courses. Further training of serving staff, should also be considered.

Growth in Forest Department responsibilities and activities should include greater involvement in extension and public relations. An extension programme needs to be established, in collaboration with the Department of Agriculture extension service. Sustained efforts need to be made to create public and political awareness of the role of forests and conservation in national development, and of their importance in human welfare. The involvement of the mass media is crucial, while for long-term purposes the national education system must become fully committed and actively engaged. Special courses and educational materials for teachers need to be provided, and school curricula in environmental education expanded and improved considerably. Associative and voluntary organizations, including women's organizations, can also be mobilized to serve forestry interests in ways similar to those of schools. In all of this the non-governmental organisations should continue to play a leading role.

The proposed action plan

The different proposals and recommendations which have been developed and put forward in the course of the study are brought together in the two following pages to show how they might be phased over a period of about 10 years in order to implement the strategy suggested. First priority is attached to actions needed in order to proceed with the substantive interventions. They include the policy decisions required; short course training in key areas; assembly or analysis of selected data needed in order to plan subsequent actions; and preparation for the recruitment and training programme to build up the Forest Department.

Most of the recommendations fall into the category of actions which should be initiated as soon as such preparatory measures are in place. Some are concerned with further strengthening the basis for change through studies, preparation of plans and legislation and setting up of additional institutional mechanisms - such as the proposed Land Allocation Committee. Others are designed to put in place the related changes; such as the rationalization of land use, improvements in forest management, and the monitoring and assembly of more accurate information about various aspects of forest sector activity.

The main focus of most of what is proposed is on first strengthening and improving the management and performance of the large part of the country's forest estate which is in the public sector. This is likely to be a necessary prerequisite to introducing better management of forests on private lands.

The outline of the proposed action programme is followed by a summary of a series of proposals which indicate possible inputs from the donor community which could facilitate the preparation and implementation of the measures which have been recommended in this report for Belize's Tropical Forestry Action Plan. Given the acute shortage of trained staff for forestry, forest industries and wildlife and protected area management, the highest priority for external assistance would appear to be to

provide education and training; both abroad, and by supporting existing facilities and developing new training programmes in Belize. A complementary area of high priority would be to provide short term expert assistance to help build up a stronger information base, to carry out analyses needed for policy and planning decisions, and to start the process of putting improved management systems in place, during this period when progress is unavoidably restricted by shortage of trained and experienced Belizean personnel. A third priority area would be that of funding infrastructure and equipment expansion and upgrading.

RECOMMENDATIONSURGENTSOONBEYONDLAND USE

- short courses on land use for staff of the Forestry, Agriculture and Lands Departments;
 - complete LRS/ODNRI surveys in rest of Belize;
 - temporary moratorium on changes in forest estate boundaries;

- establish Land Allocation Committee;
 - formulate Land Use policy, guidelines and plan;
 - rationalization of land use;
 - review and revise Land Use legislation;
 - develop and promote appropriate agroforestry systems;

- continues;

- continues;

CONSERVATION/PROTECTION

- establish Office of Conservation and Advisory Board;
 - short courses and start long term training in conservation;
 - extend moratorium on commercial trade in wildlife;
 - mangrove inventory;

- establish Conservation policy;
 - inventory of ecosystems and wildlife (compile results in Conservation Data Centre);
 - gap analysis to define critical areas;
 - develop comprehensive plan for wildland and wildlife management;
 - promote basic and applied research on wildlife and ecosystems;
 - monitor water quality;
 - monitor effects of logging;
 - establish criteria for definition of protection;
 - support and improve education in conservation;

- continues;

- continues;

- continues;

FOREST MANAGEMENT

- rework forest resource inventory, growth and harvesting data for long and short term land use, forest and industry planning;
- short courses in forest management;

- improve monitoring to provide better estimates of forest dynamics;
- improve estimates of values of forest products and services;
- rationalize intensity, scales and techniques of management;
- revise terms for concession agreements;
- update forest legislation and regulations and harmonise with other legislation;
- improve monitoring of production from national and private lands;

- continues;
- application of forest management to national lands suitable for forestry;
- promote better practices on private land;

- continues;

FOREST INDUSTRY

- collect and improve mill input-output data;
- develop Timber Association;
- help producers and BEIPU promote products of secondary species;
- clarify role of Forest Department in industrial production;

- provide extension to help industry improve woods operations (logging plans, etc.);
- provide extension to help the milling industry (improve production and maintenance, etc.);
- explore opportunities for import substitution;

ECONOMIC POLICY MEASURES

- undertake in-depth appraisal of royalties, other forest charges, control prices on lumber, and import and export taxes;

- revise policies, strategies and pricing/charge structures to encourage greater return from high quality woods, fuller use of secondary species in domestic markets, increased public revenue, import substitution, and greater expenditures on forestry;

INSTITUTIONAL STRENGTHENING

- restatement of national forest policy and development of strategies for its fuller implementation;
- draft forestry section of the 1989-94 development plan;
- plan necessary infrastructure development;
- plan Forest Department staff development;
- identify candidates and funding for training of professionals;
- negotiate expanded future Forest Department establishment;
- execute programme of training at professional, technical and vocational levels;
- develop necessary infrastructure;
- strengthen forest research activities;
- develop public and political awareness;
- continues;
- continues;
- continues;

POSSIBLE EXTERNAL ASSISTANCE

ACTIVITY	G.O. BELIZE INPUT	DONOR INPUT
Establish Land Use Committee	Part time of Lands, Agriculture and Forestry staff	US\$230,000; 15mm consultant services
Mangrove inventory	Forestry/Fishery officers, 6mm Inventory crew, 3 times 2m	US\$250,000; 12 mm
Agroforestry	Forestry officer (research)	US\$50,000; 3mm
Water quality monitoring	Forestry officer (research)	US\$100,000; 3mm
Conservation training	Reserves officer, 36m Wildlife officer, 36m 3 District officers, 12m each 6 game wardens, 3m each	US\$410,000
Establish Conservation Data Centre	Conservation officer, 12m	US\$400,000; 12mm
Forest management	2 Forest officers, half time for 6m each; Field crew, 12m 2 study tours, 2m each	US\$185,000; 12mm
Mill data collection	Forester, 3m	US\$35,000; 3mm
Industry extension	Forest officer/Forester (utilization), part time 36m	US\$510,000; 42mm (3 consultants)
Develop Timber Association	Chief Forest Officer; Forest officer (utilization); BEIPIU	US\$120,000; 6mm
Secondary species promotion	Forest officer (utilization), 1m	US\$60,000; 3mm
Revise fiscal policies	Chief Forest Officer; Forest Officer (planning); Ministry of Economic Development Ministry of Finance	US\$90,000; 6mm
Revise forest and related legislation	Chief Forest Officer; Attorney General's Office	US\$150,000; 12mm

Forest Department staff development, 1983-94	7 Forest officers, 4 years each; 10 Foresters, 12 ^m each; 2 instructors, 6 ^m each; 45 rangers (in country)	US\$2,500,000. (2 instructors each for 4 years)
Public education in forestry and conservation	Forest Department staff; Ministry of Education	US\$230,000; 18 ^{mm} (2 consultants)
Development of infrastructure	Public Works Dept.	US\$3,000,000
TFAP Adviser	Chief Forest Officer	US\$350,000; 36 ^{mm}

GLOSSARY

BAS	Belize Audubon Society
BCB	Banana Control Board
BEB	Belize Electricity Board
BEC	Belize Estates and Produce Company
BEIPU	Belize Export and Investment Promotion Unit
BSI	Belize Sugar Industry
CARICOM	Caribbean Common Market
CATIE	Tropical Agriculture Research and Training Centre
Cay	Sand and/or mangrove island, on a coral reef substrate
CBI	Caribbean Basin Initiative
CCT	Correlated Curve Trend
CDB	<i>Caribbean Development Bank</i>
CDC	Commonwealth Development Corporation
Chicle	Latex from <u>Achras</u> tree species
CITES	Convention on International Trade in Endangered Species of Fauna and Flora
DFO	Divisional Forest Officer
EFG	Economic Forestry Group
ESNACIFOR	National School of Forestry Science
FAO	Food and Agriculture Organization
FD	Forest Department
GDP	Gross Domestic Product
GOB	Government of Belize
HOD	Head of Department
IHPA	Imported Hardwood Products Association
INPA	National Institute for Agricultural Research
IICA	Inter-American Institute for Agricultural Sciences
IUCN	International Union for the Conservation of Nature

and Natural Resources

LTFI	Long-Term Forest Licence
MADELENA	Multipurpose Trees Project
Milpa	Rotational farming system used by the indigenous Maya people
NGO	Non-Governmental Organization
NLMA	National Lumber Manufacturers Association
ODA	Overseas Development Administration
ODNRI	Overseas Development Natural Resources Institute
OECD	Organization for Economic Cooperation and Development
ROCAP	Regional Office for Central American Programmes (USAID)
SCP	Southern Coastal Plain
SITC	Standard International Trade Classification
TFAP	Tropical Forestry Action Plan
TRADA	Timber Research and Development Association
TVUB	Total Volume Under Bark
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development

Amish)	
Creole)	
Ladino)	
Maya)	Ethnic and/or
Mennonite)	Religious Groups.
Mestizo)	
Milpero)	
Mulatto)	

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2.0 COUNTRY BACKGROUND

2.1 PHYSICAL GEOGRAPHY

2.1.1 Main Features

Belize lies between 15°53' and 18°30' north and 87°15' and 89° 14' west. It is bounded on the north and northwest by Mexico, on the west and south by Guatemala, and on the east by the Caribbean. It is 174 miles (280 km) from north to south and 68 miles (109 km) from east to west. The area, including inland waters and lagoons, is 8,855 miles² (22,963 km²).

The northern half of the country and the eastern fringe of the southern half comprise a plain of low relief; in the north and northwest derived from calcareous materials on an ancient limestone shelf, and down the east coast from coastal plain sediments. The Maya Mountains, 985-3,280 ft (300-1,000m) in altitude, occupy the south centre and dominate much of the remainder of the country. They rise steeply to a maximum of 3,675 ft (1,120m) at Victoria Peak in the Cockscomb Range, and they slope down to the Vaca Plateau (some 1,640 ft, or 500m) in the west. The third major physiographic feature comprises karst landscapes, sometimes hilly and sometimes rolling, on the north and west of the Maya Mountains with prominent discontinuous foothill ranges in the southern interior and comprising much of the hinterland of the Toledo District. There are numerous streams and rivers, many of them navigable over short distances by shallow draught vessels. There is a dearth of deep water port sites.

Belize has a great diversity of coastal and marine ecosystems, including coral reefs and approximately 450 sand and mangrove cayes. The reefs include the second longest barrier reef in the world. The cayes, of which 11 types have been identified (based on location, substrate and vegetation), range in size from ephemeral sand spits to permanent islands capable of supporting settlements. Much of their natural vegetation has been disturbed, particularly for coconut plantations.

For administrative purposes the country is divided into six Administrative Districts: Corozal in the north (principal town, Corozal), Orange Walk in the northwest (Orange Walk), Belize in the northeast centre (Belize City), Cayo in the west centre (San Ignacio), Stann Creek in the southeast centre (Dangriga) and Toledo (Punta Gorda) in the south. The capital is Belmopan, 50 miles (80 km) south west of Belize City. The principal roads are the Western Highway from Belize City past Belmopan to San Ignacio, and connecting with the Guatemalan road system at Melchor de Mencos; the Hummingbird Highway from the Western Highway near Belmopan to Stann Creek; the Southern Highway thence to Punta Gorda in the south, and the Northern Highway from Belize City northwards to Orange Walk Town, Corozal Town and from Santa Elena across the Mexican border to Chetumal.

2.1.2 Climate

Belize lies in the outer or sub-tropics. Mean monthly minimum temperatures range seasonally from 62-64F (16-17C) to 95F (33C), the coolest season being November to January. In the mountains the mean annual temperature is about 74F (22C); night temperatures in winter can be as low as 42F (5C).

In most areas atmospheric humidity is not oppressive for long. Along the coast where it tends to be highest (averages of 83% to 88%) it is mitigated by sea breezes. The dry season extends normally from January/February to May. The rainy season peaks in July. A dry period frequently occurs in August. Mean annual rainfall in the north and west is about one third that in the far south, e.g. 51 inches (1,320mm) in Corozal and 59 inches (1,500mm) in Orange Walk compared with 165 inches (4,230 mm) in Punta Gorda. Wide variations occur in length of rainy season, number of rain days and monthly totals.

Prevailing winds from February to September are from the east and southeast. Stronger, cooler winds blow from the north and northeast during the winter. Belize is subject to occasional devastating hurricanes. Those most frequently mentioned occurred in 1931, 1955, 1961, 1974 (2) and 1978. They occur within the period August to October with a peak (43%) in September. They originate east of 60°E and mostly maintain a strong westerly track.

2.2 NATURAL RESOURCES

2.2.1 Forest Cover

Despite extensive use of limestone soils for agriculture by the Maya over the ages and more recent selective logging, Belize retains extensive forests, including distinctive climax secondary forest around Maya ruins. Only in areas of slash and burn agriculture in S. Toledo and W. Cayo, in settled agricultural areas in the north and southeast, and in strips along most roads outside Forest Reserves has there been significant deforestation.

The flora of Belize is estimated to include 4,000 native flowering plant species. There are strong affinities with the Yucatan Peninsula flora. The absence of natural barriers has restricted endemism. A summary of the grouping of the principal of the 34 vegetation types that have been recognized (Wright et al, 1959), and their variants, and of their aerial extent, is shown in Table 2.1.

Table 2.1: Principal Natural Vegetation Types in Belize.

Broad Vegetation Type	Variants	Acres	(Ha)
Broadleaf forests:			
-rich in lime loving species	14	1,366,710	(553,100)
-moderately rich in lime loving species	2	79,570	(32,200)
-with occasional lime loving species	3	222,640	(90,100)
-with few or no lime loving species	10	652,590	(264,100)
Transitional broadleaf forests	14	572,280	(231,600)
Transitional low broadleaf forest	7	244,130	(98,800)
Shrubland with pine	3	45,470	(18,400)
Pine forests and orchard savanna	7	596,500	(241,400)
Marsh and swamp communities	12	715,350	(289,500)
Coastal formations:			
-mangroves	3	184,830	(74,800)
-other	2	68,690	(27,800)
Cohune palm forest	1	307,890	(124,600)
	Total	5,056,650	(2,046,400)

2.2.2 Ecological Zones

Six life (ecological) zones have been defined (Hartshorn et al 1984), which can be summarised as follows:

- (i) The Subtropical Moist Forest Zone includes the northern lowlands, the lower, western part of Mountain Pine Ridge, the upper reaches of the Macal River and the Vaca Plateau, i.e. all of Landform 5 (Map 3.2) and parts of 3 and 6. These subtropical moist forests are rich in lime loving species. They include the pine savanna north of the Western Highway and in the western Mountain Pine Ridge.
- (ii) The Subtropical Lower Montane Moist Forest Zone covers an area of rain shadow induced floristic change, and is characterized by Quercus spp. and Pinus patula subsp. tecunumanii (formerly classified as Pinus oocarpa).
- (iii) The Subtropical Lower Montane Wet Forest Zone covers the windward ranges of Mountain Pine Ridge and upper Maya Mountains. Pinus patula subsp. tecunumanii is characteristic of the former, the mountain cabbage palm and two tree fern species of the latter.

- (iv) The Subtropical Wet Forest Zone occurs below 1970 ft (600m) on the windward side of the Maya Mountains. Rainfall is 98-156 inches (2,500 - 4,000 mm). The zone includes Upper Stann Creek Valley, Cockscomb Basin and much of Toledo District, and extends to the coast. Characteristic tree species include banak, quamwood, yemeri, Santa Maria and rosewood.
- (v) Tropical Moist Forest Zone. The average rainfall is 78-105 inches (2,000-2,700 mm). It lies south of the Western Highway in a lowland arc round the northern and northeastern foothills. Pinus caribaea is a conspicuous woodland component. Broadleaved forest is characteristic only of floodplains. Elsewhere low fertility and impeded drainage result in a range of types from mixed pine-broadleaved to sparse pine savanna. The palmetto Paurotis wrightii is common on the seasonally flooded, often burnt flatlands.
- (vi) The Tropical Wet Forest Life Zone is the wettest area of Belize: rainfall is 156-179 inches (4,000-4,600 mm). Impressive tree height is a distinctive feature. Swamp forest is extensive. Complex plant communities, some relatively open and of low stature, occur on Karst terrain near Belmopan.

Mangroves are a major feature of the coastal and marine ecosystem. They occupy most of the coastal fringe and many cayes.

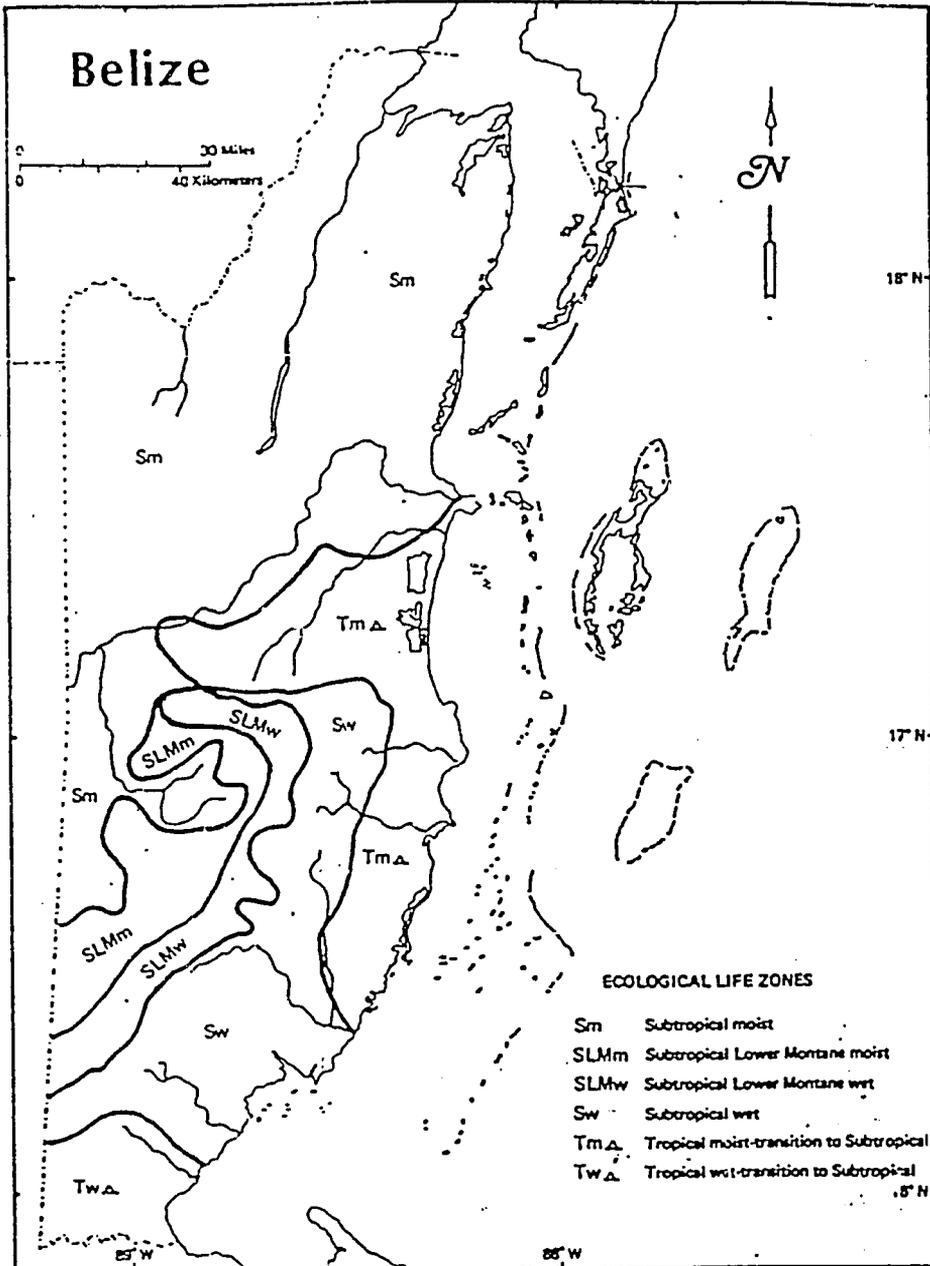
2.2.3 Water and Mineral Resources

Abundant supplies of fresh water are available from perennial streams, rivers and water-table and artesian aquifers. At present, less than 5% of the water available for potable and industrial purposes is used.

The numerous streams draining the eastern and south eastern slopes of the mountains have dense branching patterns and straight, steep courses with small catchments. As they emerge onto the coastal plain they become progressively more sluggish. Near the coast lagoons, mangrove swamps and river mouth bars are frequent.

The Belize River drains 27% of the country, including a large area of high relief. North of the Belize River the main rivers receive much of their flow from underlying limestones. Over a large area in the north the land is less than 50 ft (15 m) above sea level so that drainage is mainly internal: fresh as well as brackish lagoons abound.

Non-commercial traces of bauxite, barite, gold, cassiterite and oil have been found on the mainland and, in the case of oil, offshore as well. Hopes of finding workable deposits of the



Map 2.1: Ecological zones of Belize. Determined from latitudinal region, altitudinal belt, humidity, evapotranspiration and precipitation. On the ground the zones are recognized by vegetation. From Hartshorn *et al.* (1984).

first two and of oil persist. Dolomite and limestone are the most important mineral deposits, being valuable as road and other construction materials and for agricultural use.

2.3 HISTORICAL DEVELOPMENT

Archaeological ruins attest to extensive early socio-economic development in Belize. There is evidence of habitation as early as 2,500 BC. From about the first century AD, a Mayan civilization flourished for more than 1,000 years. During the so-called Classic Period (250-900 AD) the Mayan population within the boundaries of present Belize has been estimated to have been between 400,000 and one million. For reasons that are still unclear, this civilization subsequently declined dramatically.

Mayans practised sophisticated agricultural systems on the limestone soils more than 1,000 years ago. Milpa farming (periods of fallow alternating with seasonal corn or bean cropping) was a notable part of these activities. They also included more intensive procedures that enhanced soil fertility: terracing of foothill slopes; constructing raised beds to trap alluvium; adding organic supplements. Evidence of these ancient practices are frequently to be found.

There was little if any development during the period of the Spanish Conquest; the population having shrunk to a size too small to be worth enslaving by the Spaniards. European settlement was initiated early in the Seventeenth Century in a transitory manner by English-speaking buccaneers and cutters of logwood (Haematoxylum campechianum) which was greatly valued for dyeing. With the waning of the logwood trade in the mid Eighteenth Century, came the development of export of mahogany (Swietenia macrophylla) from along the coast and inland rivers. The colonial economy depended on these commodities - and on imported food - for almost 300 years.

During the latter part of the Eighteenth Century there was a considerable influx of escaped and freed slaves from other parts of the Caribbean. Following the general emancipation of slaves in 1833, there was greater dispersion of the population. A census in 1861 showed a population of more than 25,000. From 1880 to 1980, population increased five-fold from less than 30,000 to more than 145,000. Current population is estimated at about 176,000. Approximately half of the population lives in the seven largest centres. The great bulk of the remainder live in small communities. The dispersed rural population makes up little more than 5% of the total.

The historic development of the country has resulted in a diverse population of Creoles (mulattos and Africans), Caribs (mixed Caribbean natives and African slaves), Ladinos or "mestizos", East Indians, Mayas and Europeans. In recent decades, Mennonites have developed a number of communities. In recent years, political and economic difficulties in adjacent

areas have given rise to an increased influx of Ladinos. At the same time there has been an outflow, predominantly of educated Creoles, emigrating to the United States.

Mahogany and logwood continued to be the major exports until the turn of this century, despite both a temporary decline in the demand for mahogany and serious efforts to broaden the base of agricultural exports. As late as 1927 it was estimated that four-fifths of the country's wealth was derived from its forests. By this time, chicle from the sapodilla tree had become a major export for the production of chewing gum. Logging continued to maintain a dominant position in the economy for some time, with rapidly increased production of pine lumber more than replacing the gradually declining production of mahogany and other quality hardwoods. Timber production peaked in 1952. Subsequently, production declined quite rapidly until very recently.

Agriculture during the period from European settlement until late in the Nineteenth Century was limited to the traditional rotational shifting cultivation of the Mayas (milpa) and to "slash and burn" methods, a one-time use of land, practiced by most of the emancipated slaves. From the 1870's, official efforts to promote settled agricultural production met with some success, particularly in the Corozal and Orange Walk Districts. Many of these early schemes and land development projects failed, and it was 50 years before sustained successful development took place on any scale.

Export-oriented agriculture developed slowly until after World War II, despite establishment of banana production towards the end of the nineteenth century. By the latter part of the 1950's agricultural crops exceeded forest products in value of output. By the 1960's sugar had gained the lead in commodity export values. Other cash crops which have expanded rapidly are citrus fruit and bananas. Other crops, e.g. mangoes and vegetables, have had at best limited success. Export of fisheries products, especially of lobsters, has been successful and follows citrus and citrus concentrates as a major export earner. (See Appendix 3A).

Manufacturing production has been limited until quite recently. A garment industry has now become important. A modest tourism industry has been growing, based on beach resorts on the cayes which are adjacent to the barrier reef, and on travel to archaeological sites, forest and mountain areas. (See Appendix 3B).

2.4 THE ECONOMY

During the 1960's and 1970's, Belize sustained fairly rapid economic growth, despite some cyclical fluctuations. During this period, however, the balance of payments on international trade showed a generally increasing deficit, growing in relation to GDP. Current revenues on public accounts exceeded expenditures. In the early 1980's, GDP expanded more slowly or declined; trade deficits increased and the balance between public revenues and

expenditures declined and became negative. Considerable recovery occurred in the mid-1980's, due in large part to increased citrus and garment exports, and, to a lesser extent, shellfish and fish exports, as well as growth in the tourist industry.

GDP (at factor cost) in 1986 was BZ\$361.2 million, corresponding to a per capita GDP of BZ\$3,120 (US\$1,560). GDP net growth from 1980 to 1986 was a modest 1.7%, somewhat less than the net population increase of 2.0%. Primary production (predominantly agriculture) comprised 20% of the GDP; secondary production (predominantly manufacturing and construction) made up 19%, while tertiary activities (services including tourism, public administration, transport, finance and other services) accounted for the balance. Public administration comprises only 13% of total GDP. (See Table 2.2).

The active labour force is said to be 57,000, comprising 85% of the male population of working age as well as 43% of the working age females. Unemployment is in the order of 15%. A distinctive feature of recent economic development has been the creation of a substantial body of independent producers: cane producers, citrus farmers and fishermen. However, multinational sugar processors and foreign citrus factories still dominate these industries. The fishery industry has developed through cooperatives.

Trade (see Appendix 3C) is vitally important to Belize which has long depended on exports as a major revenue source and on imports for many essentials. Imports continue to exceed exports by around 50%. Trade is controlled through the issuing of trade permits.

Recently, sugar has accounted for a third or more of total exports. Citrus, garment, fish and banana exports have been growing in relative importance and in 1987 the first two each comprised about 15% of the total. Fish exports have for a few years made up about 8% while bananas reached 7% in 1987. In recent years, food products have comprised 20 to 25% of the import total, fuels a widely fluctuating 12 to 24%; manufactured goods 25 to 30%; land machinery and transport 18 to 21%.

Proximity to the large market and production sector of the USA makes that country by far Belize's most important trading partner. The Caribbean Basin Initiative (CBI), which came into effect in 1984, provides duty-free access to that country for specific goods, including citrus products, originating in Caribbean countries. In recent years, about half of the country's export value results from trade with the USA, although the 1987 figures showed some decline in the share. Imports from the USA have been growing rapidly both in value and relative share.

The United Kingdom is also a major export market, accounting in the past decade for from 20 to more than 40% of total value. By contrast, imports from the United Kingdom have been steadily declining and currently account for only 8% of the total.

Although Belize, as a member of the Caribbean Common Market (CARICOM), enjoys nearly complete tariff free entry to the EEC under the Lomé agreement, exports to other countries of the EEC are small. On the other hand, imports from these countries have recently accounted for 7 to 10 % of all imports, although 1987 showed a marked decline in share.

Table 2.2: Belize: Gross Domestic Product (GDP) by Sector at Constant 1984 Prices, 1980-86. (Million BZ\$).

	1980	1981	1982	1983	1984	1985	1986
<u>GDP at factor cost</u>	315.2	323.1	329.3	322.6	335.8	344.1	347.9
<u>Primary Activities</u>	72.5	71.6	76.0	71.5	73.7	72.4	69.3
Agriculture	55.7	55.6	58.3	54.5	55.6	54.6	53.9
Forestry	8.5	6.9	8.4	6.8	7.5	7.0	6.1
Fishing	7.5	8.3	8.5	9.4	9.8	10.0	8.5
Mining	0.8	0.8	0.8	0.8	0.8	0.8	0.8
<u>Secondary Activities</u>	64.7	63.7	62.9	64.5	64.5	64.2	66.9
Manufacturing	39.7	37.8	37.7	40.1	36.8	36.4	37.2
Electricity and Water	6.7	7.0	7.9	8.1	8.2	8.8	9.2
Construction	18.3	18.9	17.3	16.3	19.5	19.0	20.5
<u>Tertiary Activities</u>	192.0	202.0	203.8	198.9	210.0	220.6	224.7
Trade and Tourism	60.7	63.0	56.1	48.9	52.7	57.9	56.8
Transport	18.4	21.5	25.2	24.9	29.0	31.6	34.5
Finance	25.1	25.5	23.9	22.0	22.3	23.5	23.4
Real Estate	21.5	21.8	21.9	21.8	22.3	23.1	23.5
Public Administration	27.8	31.0	36.4	39.9	41.1	40.8	41.6
Other Services	38.5	39.2	40.3	41.4	42.6	43.7	44.9
<u>Less</u>							
Imputed Banking Service Charges	14.0	14.2	13.3	12.3	12.4	13.1	13.0
<u>Memo</u>							
GDP Growth		2.5	1.9	-2.0	4.1	2.5	1.1

Source: Ministry of Economic Development.

Exports to other CARICOM countries are surprisingly small and have fluctuated greatly, from less than 2% to nearly 15%. Trade with all other countries is predominantly on the import side, accounting in recent years for 22 to 37% of the import total (See Appendix 3D). Membership of CARICOM resulted, during 1986, in a significant increase in tariff rates affecting a considerable number of import categories. These tariffs, together with the devaluation of the Mexican peso, tend to encourage illegal cross-border imports of household items and fuel.

Taxes on international trade account for more than half of public revenue. The great bulk of this results from import taxes. Income taxes comprise about one-fifth of the total and taxes on goods and services another tenth. Property taxes are relatively insignificant. Various non-tax revenues make up yet another tenth or more.

Constraints to further rapid development include the high costs of transportation and electricity, related to the need for more and better highways and port facilities and the basic problem of very low population densities and the subsequent small tax base.

2.5 NATIONAL DEVELOPMENT OBJECTIVES

The country's developmental objectives are embodied in its "Five Year Macro-economic Plan for 1985-1989". The long term development strategy is "to promote exports as the engine of economic growth." Diversification of exports to avoid the dangers of a major dependence on one crop export is stressed. Import substitution is seen to emerge as an activity ancillary to development of exports. It is stressed that substantial investment funding must come from savings and from foreign capital.

Objectives in the current planning period emphasize capital investment, especially in infrastructure, and a necessary curtailment of consumption expenditures. A dynamic cooperative partnership of the private sector and government is seen as a necessity for providing political, economic and social stability and ensuring distribution of both benefits and sacrifices. In this context, the private sector is defined as including resident Belizean entrepreneurs, Belizeans migrant abroad, voluntary organizations and foreign private investors. Foreign investors will be especially encouraged to engage in export industries. Belizean participation will be both in smaller scale export industries and production for the domestic market.

In the medium term, the Government is committed to eliminating current account deficits, by both reducing expenditures and increasing revenues. In pursuit of this objective, marketing boards are to be made more efficient, eliminating their losses. More efficient handling of debt servicing, improved revenue collection machinery, a stable

exchange rate and careful use of loans (which should be preferably directed to foreign exchange generating activities) are part of the strategy.

Priority industries of the strategy are agro-industry, tourism, fisheries and mari-culture, forest-based industries and manufacturing. Development of local energy sources to relieve the impact of the cost of importing fuel on the total import bill is also a priority.

In agro-industry, the goal is to improve food security and move towards national self-sufficiency. In the tourism sector, the strategy is oriented towards modernization and expansion, greater use of local resources and greater net returns. In the fisheries sector, shrimp farming and research into deep sea fishing will be emphasized. In the forest sector, incentives will be offered to private investors prepared to revitalise and develop timber production and processing. In manufacturing, priority will be given to garment and electronics manufactures for export and to wood products for both domestic and export markets.

Government will be responsible for implementing export promotion through identification of potential export activities; market identification and analysis; investment encouragement through concessions and incentives, and assistance to investors during establishment; and promotion through trade fairs.

In the partnership between Government and the private sector the former assumes three principal responsibilities:

- 1) reorganization of the public sector to make more efficient use of its resources, and to improve its capacity for project implementation and management of the economy;
- 2) maintaining political and economic stability;
- 3) encouraging and facilitating production by the private sector.

The ultimate purpose of economic development is construed as improving the quality of life for Belizeans, with high priority placed on education and training and on health and satisfactory housing. Increasing social welfare of Belizeans through ensuring appropriate sharing in the benefits of economic growth is an obligation of government.

3.0 PRESENT SITUATION, POTENTIALS AND CONSTRAINTS

3.1 THE INSTITUTIONAL AND ECONOMIC FRAMEWORK

3.1.1 Forest Policy

An official national forest policy for Belize (British Honduras) was promulgated more than 30 years ago (See Appendix 4). This statement of policy remains in force today, and can be summarized as follows:

- 1) to create, maintain on a permanent basis, and develop a national forest estate, with recognition of the needs for agricultural development, forest products, (both industrial/commercial and local), the protection of the environment and of special nature reserves;
- 2) to improve the forest through regeneration techniques; and to increase production from the forest;
- 3) to improve the quality of exported products to achieve assured markets;
- 4) to promote good forestry practices on private forest lands;
- 5) to manage public lands outside the forest estate not yet used for agriculture;
- 6) to promote a public awareness of the importance of forests;
- 7) to maintain an adequately staffed and financed Forest Department to carry out the objectives of the forest policy.

An additional statement on wildlife policy declared the intention of including the identification and management of the wildlife resource.

In short, the official national statement declares a government policy of managing what is now an established forest estate, with appropriate investment to maintain and improve its productive condition in order to increase the value of its product output, and to ensure continuation of its environmental protection function for the soil and water needs of agricultural production and welfare of the people.

This forest policy is still an appropriate statement of national forestry objectives, and appears to be generally consistent with the national development objectives and strategy as described in the present 5 year development plan (1985-1989). However, some of the objectives of the policy appear by now to be to some extent at variance with actual events. This is particularly so with respect to capital formation and allocation and transfer of land out of forest use, as is discussed in the sections on these subjects.

3.1.2 Forestry's Contribution to the Economy (See Appendix 5)

Undoubtedly, the major contribution of forestry to the economy of Belize has been from the harvesting of its natural forests. These have provided a major capital asset, a substantial part of which has been drawn down in order to provide the country's major export trade for many decades. This depletion has provided a very considerable foreign exchange income, produced a sizeable positive net balance on government revenue/expenditure until the mid 1950's, and has brought about appreciable infrastructure development of waterways and of roads into forest areas.

However, the continuous harvesting of high valued mahogany, cedar and in due course pine eventually lead to a marked decline in timber output. (See Appendix 5). Production in the 1970's was at its lowest recorded level since the initial growth of the industry. Chicle exports, which reached peak levels in the early 1950's, paralleling pine exports, have virtually ceased as substitution by synthetics removed the market for this product. These declines, coupled with the rapid expansion of agricultural production and exports over the last three decades, have lead to a substantial drop in both the actual and relative contribution of forest products to the monetary economy.

Foreign exchange earnings

Nevertheless, as late as 1967, forest products still accounted for nearly 10% of the export trade value. This share subsequently declined rapidly to a level of only 1% in 1985 and 1986, when the export value of forest products stood at about BZ\$1.5 million. In 1987, however, came a marked recovery to nearly BZ\$5 million which made up close to 3% of total export value (See Table 3.1).

Table 3.1: Summary of Forest Products Exports, 1976-87.

Description (quantities)	Quantity given in Thousand Cu ft.											
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Logs and rough wood	50	53	41	97	49	29	31	23	10	12	219	266
Sawnwood	3,197	1,571	1,700	2,867	1,903	1,527	2,650	1,760	1,181	805	359	2,700
(values)												
Gums & Logwood	303	688	1568	1181	500	236	427	795	855	169	0	42
Logs & Roughwood	171	85	299	1580	1364	394	46	135	146	203	971	665
Sawnwood	3,143	1,799	1,792	3,396	2,335	2,413	3,727	2,706	2,011	1,056	491	4,227
Wood Manufactures & Furniture	10	19	16	57	36	66	123	55	85	59	222	262
Paper Manufact	25	0	29	0	0	0	640	645	568	0	88	0
TOTAL	3,652	2,592	3,704	6,214	4,235	3,109	4,963	4,336	3,665	1,487	1,772	5,196

Source: Derived from Annual Reports of the Statistics Dept. on Exports and Imports.

Additional exports of wood-based manufactures, as yet, add only marginally to the forest contribution. In the 1982-1984 period, exports of this category reached about BZ\$750,000, based largely on exports of sanitary papers produced from imported paper. This trade has now largely ceased. In the past two years, manufactures of wood in the form of a variety of products accounted for nearly BZ\$250,000 of exports.

GDP

In addition to exports, the forest has supplied and continues to supply substantial quantities of wood products to the domestic economy. The value of the main commercial forest products used locally are estimated for the current decade at from BZ\$4.4 million (1983) to BZ\$9.3 million (1987). In general, the domestic consumption value exceeds by two or more times the value of exports (as much as 5 or 6 times in low export years).

Export values of roundwood, lumber and chicle, together with the value of domestically used roundwood and lumber, are incorporated into the estimates of the forest sector contribution to the official calculations of GDP. Over the past decade, the contribution of the sector has accounted for 1.7 to 3.3% of GDP. The 1987 share was one of the highest of the decade at about 3% (See Table 3.2)

Table 3.2: Value Added in Forestry Sector, 1980-87. (Thousand BZ\$).

Value of Forest Products	1980	1981	1982	1983	1984	1985	1986	1987
Wood & Timber Exports	3,703	2,808	3,773	2,841	2,131	1,198	1,469	4,892
Locally Used Timber	6,125	5,576	5,258	4,433	6,347	7,163	5,566	9,345
Chicle Exports	456	0	262	741	847	169	0	0
Total Gross Output	10,284	8,384	9,293	8,015	9,325	8,530	7,035	14,237
Gross Value Added(80% G.O)	8,227	6,707	7,435	6,412	7,460	6,824	5,628	11,389
Net Value Added(98% G.V.A)	8,063	6,573	7,286	6,284	7,311	6,688	5,515	11,162
% of GDP in Forestry (current prices)	2.62	2.10	2.41	2.04	2.18	1.98	1.53	
Constant N.V.A(98% G.V.A)	8,299	6,737	8,283	6,658	7,312	6,846	5,974	13,111
% of GDP in Forestry (1984 prices)	2.63	2.09	2.52	2.06	2.18	1.99	1.72	3.45

Source: Department of Statistics, Belize; 1987 estimated by mission.

In general, the availability of supplies of wood for the local market has largely precluded the need for imports of lumber. The great bulk of housing is still predominantly of wood, despite a trend to the use of concrete. The 1980 census showed 70% of houses as made of wood, down from nearly 80% in 1970 (Appendix 6). Estimates derived from the census data would suggest that the share of wooden houses in current building might be as low as 50%. This, as well as other indications, suggests that full advantage is not being taken of the opportunities for supplying domestic needs for forest products. This will be further considered in the forest industry section.

The economy of Belize has a major subsistence sector. Official estimates of Gross Domestic Product exclude non-market transactions, such as the production for own consumption which typifies much of the agrarian sector. Thus, food grown and consumed by households is not estimated or included. Nor do estimates contain any element for wood fuel, either that harvested, collected or transported by households for autoconsumption or, apparently, that entering the market. Wood harvested for own use in building construction or as poles, other than that recorded for royalty payments, is also excluded.

The annual value of fuelwood production has been estimated in the course of the TFAP study at about BZ\$780,000. This estimate does not include the value of fuelwood for industrial uses such as lime-burning or cacao-drying. Nor has any attempt been made to estimate the amount or value of wood used by rural households for their own use in construction, fencing and a myriad of miscellaneous agricultural purposes. (The Forest Regulations do not require the measurement of wood harvested on private properties of less than 100 acres, or 40 ha). This harvest from small properties together with amounts of wood salvaged from milpa farm clearings is believed to be substantial.

Government revenue

Government revenue from the forest sector is of several types, some in common with other sectors. Export taxes on forest products are estimated to be, in recent years, from BZ\$1.5 to 2.3 million, about 6% of all export taxes. The private sector pays a share of land taxes and income taxes but a temporary tax holiday on new industry precludes a substantial portion of the sector from any payments of income tax. Royalties, the traditional form of government forest revenue in the country, have recently been at the level of BZ\$400,000 and have become relatively less important as a major revenue contributor. Royalty is a charge for cutting standing timber and serves as a sale price for the latter (see section 3.3.5). A newly expanded Forest Department Workshop has been bringing in revenue from sales of BZ\$ 40,000 to 70,000. Other direct Department revenue (lumber from Department sawmill, direct sale of logs, tree seed etc.) is in the order of BZ\$200,000, but against these must be set the so far uncalculated costs of production.

Employment

Employment in the forest sector is markedly seasonal. Almost all logging is carried out during the dry season. It thus becomes necessary to store logs for up to 9 months if sawing operations are to be conducted throughout the year; most mills run short because of a variety of storage problems. Hence, there is also a seasonality to sawmilling employment. Data available suggest employment in the sector at 120 man-years in forestry, 170 man-years in logging, 200 man-years in sawmilling and 250 man-years in secondary wood manufacturing. This would amount to a total of 740 man-years, about 1.6% of the work force (Appendix 7). However, the markedly short operational seasons would suggest an employment of as many as 500 people in logging and perhaps 300 in sawmilling, and a total of nearly 1,200.

Environmental values

Some of the principal contributions provided by the forest are not, and cannot be, readily recorded in a quantitative fashion. These include the environmental benefits derived from the presence of forest cover. Of great importance are the protection of soil and regulation of water flows resulting from the presence of the forest. In a country as well forested as Belize these are seldom even recognized, let alone valued.

The forest is also the habitat for a great variety of fauna, including small animals used for food, jaguars and many species of wild birds which provide major scientific and tourist attractions in reserves and sanctuaries. Forest trees and other plants supply a wide range of foods (fruits, nuts and other plant parts), and of medicinal products, for local use. The potential of this fauna and flora gene bank for possible future development and use is immense.

Capital formation

Capital formation in industrial sectors is most commonly considered to be the establishment of infrastructure and industrial plant. The forest sector is no exception. As has been said, in the development of the sector, logging and transport of logs and lumber have brought about very considerable development of roads and waterways. Some roads are still being built or extended. However, they are almost all seasonal hauling roads of use only in the dry period. Most logging and milling equipment is second hand and fairly old. Even some new establishments are making use of previously used equipment.

In practice, the greatest change in the sector's capital has been the depletion of growing stock capital by selective harvesting of higher value trees, by uncontrolled burning and by clearing for milpa farming and cash crops. There have been some limited attempts to restore lost capital by planting and forest management, and a quite successful effort to reduce capital losses in pine forests through improved protection against fire.

Much of the constraint on forestry capital formation has resulted from a 1959 report on the economy of British Honduras by Mr J. Downie, and from interpretations placed on that report. Passages from the report that relate to forestry are reproduced in Appendix 8. Mr. Downie questioned the amount of capital investment being directed in a poor country to the forest sector, for a programme that required a long period to yield returns. In so doing, he noted the suitability of Belize for forestry, accepted the potential for ultimate very large returns on forestry, and recognized the heavy past disinvestment in natural forest capital. He also recognized the need for, and recommended the maintenance of, forestry services adequate to sustain the capital value of the forest.

In retrospect, it appears that the impact of his report was not only to affect new investment in plantations but also to limit severely the input for maintaining the forest estate. Furthermore, the report and its effect on budgeting appeared to discourage the management and staff of the Forest Department from attempting to maintain a programme of replenishment of the forest estate; an attitude the results of which are still being felt.

Increased planting of pine, mahogany, cedar and a limited amount of teak was undertaken in the late 1950s and early 1960s but this programme was discontinued as a result of budget cuts resulting from the "Downie Report" recommendations. Some Gmelina arborea plantings were started in the early 1960s but were also discontinued. There was a very modest budget for "reafforestation" available in the 1970s and early 1980s but results were limited, and no funds have been allocated from the 1985/86 budget onwards.

Protection from forest fires in the pine forest was initiated in 1949 in order to maintain the extensive stands of regeneration initiated by the heavy cutting of the 1950s and 1960s. Unfortunately, financial constraints caused the fairly modest capital budgets for fire protection in the Mountain Pine Ridge and the Southern Coastal Plain to be discontinued in the mid 1980s. The lack of replacement of equipment, which had been provided by donors, eventually brought the programme practically to a halt.

Given the regrets often expressed over the lack of funding for new capital investment in the sector, especially for plantations, it is paradoxical that so little concern has been directed to optimizing the use of existing natural forest capital. This lack of concern is manifest in the unplanned alienation of forest land to other uses, the nearly ignored losses to milpa agriculture, the profligate use of high value woods for ordinary purposes, as well as the limited use, and hence waste, of many secondary species.

3.1.3 Laws relating to forests and forestry

The Forest Ordinance (Dickinson 1980, Cap. 176) provides the necessary powers to declare Forest Reserves, administer such reserves, set and collect royalties and make regulations for the protection and disposal of forest produce. It also defines the powers of forest officials and establishes penalties for forest offences. This is a strictly regulatory legal instrument as are the Forest Rules outlining its application.

The Forest Rules under this Ordinance specify the types of forest licences and permits to exploit forest produce. In addition, they regulate squatting, building, cultivation, grazing, hunting in Forest Reserves and lighting of fires in such Reserves and Crown Lands. They also provide for declaration of any road as a forest road for the extraction of forest produce or for access to a forest regeneration scheme. Finally, they prohibit the felling or removal of certain tree species and plants.

There is also a Forest Fire Protection Ordinance (Cap. 175) which allows for the preparation and implementation of a fire protection plan which may be necessary for the prevention of forest fires or bush fires or the extinguishing of such fires in any land held in freehold or by grant, prescription or any other form of acquisition or lease of Crown Land.

The Private Forests (Conservation) Ordinance (Cap. 179) deals with the removal and handling of forest produce from private lands. It sets restrictions on felling, the procedures for dealing with an application to fell, entry on land, seizure and forfeiture of trees, disposal of forfeited trees and penalties for offences against the Ordinance. It has no provisions for the proper management of private forests or for any extension services to owners. A tree under this Ordinance is either mahogany or cedar.

The National Parks System Act of 1981 provides for the preservation and protection of highly important natural and cultural features, for the regulation of their scientific, educational and recreational use and for all other matters connected with them.

The Wildlife Protection Act of 1981 provides for the conservation, restoration and development of wildlife, for the regulation of its use and for all matters connected with it.

The Mines and Minerals Bill of 1987 prohibits the granting of a mining licence to an applicant unless the programme of proposed mining operations takes proper account of environmental and safety factors. In deciding whether or not to grant a mineral right, it is incumbent on the Minister responsible to take into account the need to conserve the natural and cultural resources in or on the land over which the mineral right is sought, or in or on any neighbouring land. In this context, the Minister may require environmental impact studies to be carried

out. There may also be conditions included in a mineral right relating to the prevention, limitation or treatment of pollution; and the minimization of the effects of mining on adjoining or neighbouring areas and their inhabitants. The Act also provides for the reinstatement, levelling, regrassing, reforesting and contouring of any part of a prospecting or mining area that may have been damaged by prospecting or mining operations.

The Land Utilization Ordinance of 1981 provides for measures to govern the use and development of land and to introduce measures for conservation of land and watersheds. The Chief Forest Officer is a member of the Land Subdivision and Utilization Authority set up under section 9 of this Ordinance.

Under the Ancient Monuments and Antiquities Ordinance (Cap. 259, the Laws of Belize, 1980), the Minister of Education may, by order published in the official Gazette, declare:

(a) any area of unalienated Crown Land containing or adjacent to an ancient monument to be an Archaeological Reserve;

(b) any area of alienated Crown Land, title to which has reverted to the Crown containing or adjacent to an ancient monument to be an Archaeological Reserve; and

(c) any ancient monument acquired by the Minister under the provisions of this Ordinance, together with any land adjacent to it, to be an Archaeological Reserve.

The Pesticides Control Act of 1985 provides for the control of manufacture, importation, sale, storage and use of pesticides and for matters connected with, or incidental, to them. Environmental pollutants or carcinogens such as mercuric chloride, arsenates, arsenites and dieldrin are prohibited pesticides under this Act.

The Land Tax Act of 1982 provides the basis for taxing land and for matters connected with or incidental to it. Under this Act, all privately owned land outside towns is valued on the "Unimproved Value" principle.

Fiscal incentives for attraction of new investment in industries, including forestry, are processed by the Ministry of Economic Development. This Ministry plays an important role in all areas pertaining to industrial development. Aspects of personnel training and environmental protection are worked out and embodied in legal documents by the Ministry in consultation with the Forest Department.

The Ministry of Commerce, Industry, Tourism and Cooperatives is responsible for policy and legislation pertaining to the import and export of all commodities. In the case of forest products, the Ministry consults the Forest Department before decisions are taken on whether to include or exclude them from any list being contemplated. Commercial treaties, free-trade

zones and international agreements also fall within the competence of this Ministry.

Some of the Acts referred to above at present lack enabling regulations. The effectiveness of this body of legislation and regulatory measures, and of its application in practice to various aspects of the forest sector, is examined in the sections that follow; in particular 3.2.3 on the transfer of land out of forest use, 3.3.4 on forest management systems, and 3.5.2 on the institutional provisions for conservation and protection.

3.1.4 Public Forestry Administration

Institutional responsibilities

The forest sector in Belize includes forest management, forest industries, forest products marketing, national parks and wildlife management. It also encompasses environmental protection. Responsibility for most aspects of forestry rests with the Ministry of Agriculture, Forestry and Fisheries; and within that Ministry with the Forest Department. However, other Government agencies such as fisheries, archaeology and education, as well as non-governmental organizations such as the Belize Audubon Society, make an important contribution in this area.

The Forest Department was established in 1936. Its precursor was the Forest Trust which was established in 1923 as a self-governing body. The function of the Trust was defined as "the development and maintenance of the Crown forests of the colony".

Under the colonial system of government, the Head of Department (Conservator of Forests until 1965) was directly accountable to the Colonial Secretary, who in turn was directly responsible to the Governor. With the implementation of the ministerial system by virtue of British Honduras Letters Patent 1964-1979, the Forest Department came under the aegis of the Ministry of Natural Resources, with the Chief Forest Officer as Head of Department reporting to the Permanent Secretary. Subsequently, the Forest Department came under the aegis of the Ministry of Trade and Industry, then the Ministry of Natural Resources and now the Ministry of Agriculture, Forestry and Fisheries.

In its functioning, the Forest Department interacts with the Ministry of Finance; the Ministry of Economic Development; the Ministry of Commerce, Industry, Tourism and Cooperatives; the Establishment Department of the Ministry of Home Affairs; the Ministry of Natural Resources (on land leases and grants of land); the Ministry of Education (on ancient monuments, antiquities and archaeological reserves) and with the Belize Audubon Society.

The Forest Department collaborates with the Ministry of Commerce, Industry and Tourism in the formulation of legislation regulating the trade in timber, wood products and wildlife. It

also assists by maintaining tourist shelters and sites in Forest Reserves. It has, in addition, a coordinating role in the management and development of National Parks under an arrangement by which the Belize Audubon Society assists directly in the management of two wildlife sanctuaries, one national park and one national monument, until such time as the Department acquires the financial and human resources to manage them. The Department has also promoted the formation of a Sawmillers' Association to cooperate with the Ministry of Agriculture.

The Department of Lands has jurisdiction over unreserved forests on leased Crown Lands pending the grant of title under the Crown Lands Ordinance. However, the Forest Department regulates all felling or removal of trees on such lands, including leased land, pending their conversion to agricultural land. Felling of cedar and mahogany on private lands over 100 acres (40 ha) in area is also controlled by the Forest Department. However, the Department collects royalties for these species at half the rates applicable to them in the Forest Reserves.

The administered estate

At present, there are 2,548 square miles (636,800 ha) of reserved forests. In addition, the greater part of the 2,531 square miles (655,700 ha) of other Crown Lands and the 3,241 square miles (839,700 ha) of privately owned land is forested.

Forest utilization is largely carried out by the private sector. Most of the forest permits and licences are issued for one year at a time with an option for renewal if performance is satisfactory. However, some licences are issued for periods of up to 5 years or even 10 years with an option for further renewals, again subject to satisfactory performance. Awards, except for petty permits, are made by the Minister responsible for forestry on the advice of the Chief Forest Officer. The forest licences contain clauses which the licence holder must adhere to and which serve as guidelines for control by the Forest Department.

There are 479,295 acres (193,968 ha) of private forest land under licence, but the area of Crown Land under licence has not yet been established. However, it is estimated that some 620,000 acres (250,000 ha) of Crown Lands are now under various types of forest licences and permits.

Organization of the Forest Department

The organization chart of the Department is given in figure 3.1. The Department is subdivided into three functional Divisions (Management, Research and Utilization) and two territorial Divisions (the Southern and Western). Each Division is headed by a Divisional Forest Officer (DFO). The post of DFO (Research) is now vacant but the DFO (Management) looks after maintenance and periodic measurements in the research plots. The functions of DFO (Utilization) are now being carried out by a

Technical Cooperation Officer under a bilateral arrangement with the United Kingdom Government. The two territorial DFOs are assisted by a Forester each. The Southern and Western Divisions are subdivided into two Ranges each (Melinda and Savannah in the Southern Division, and Augustine and San Ignacio in the Western Division).

Belmopan, Belize. Orange Walk and Toledo Ranges are administered by the Forest Department Headquarters in Belmopan. Augustine and Belmopan Ranges have a Conservation Officer each. Because of shortage of staff, management in the Ranges is not very intensive and there is, in particular, an insufficient number of Forest Guards in some areas. In consequence, neither protection nor management of the forest can be carried out effectively. The Belmopan Woodworking Workshop is presently in the charge of the Principal Forest Officer who reports to the Chief Forest Officer. There is also one Senior Mechanic at Augustine, responsible for the repair and maintenance of vehicles and other mechanical equipment (the equivalent post at Melinda is presently vacant).

One consequence of the shortage of staff, and budgetary constraints, has been a lack of continuity in forestry research since 1983. When possible, research work has covered areas such as increment plots, thinning, forest tree improvement, ecological studies and provenance trials. Insofar as studies on timber properties and markets are concerned, the Department has had to rely on such institutions as the Forest Products Laboratory, Madison, USA, and the Timber Research and Development Association (TRADA), High Wycombe, United Kingdom.

The budget is prepared by the Chief Forest Officer with the assistance of all the professional forestry staff and the Accounting Section of the Ministry of Agriculture. The Department does not have a programming officer, but there is some interaction with the Policy Analyst of the Ministry of Agriculture. Control of operations is carried out, at various levels, by the Chief Forest Officer, the Principal Forest Officer and other professional staff. There is no organization and methods unit in the Forest Department but any relevant improvements in this area are made in consultation with the Permanent Secretary of the Ministry and senior staff of the Department.

Forest Department staff

Forest personnel administration is normally handled by the Assistant Secretary in the Ministry in consultation with the Chief Forest Officer. Specimen job descriptions for the posts of Chief Forest Officer, Principal Forest Officer, Forest Officer, Forester, Forest Ranger, Conservation Officer and Forest Guard are given in Appendix 9. As can be seen from these descriptions, there is a system of pay scales for different categories of personnel. Promotion to the various levels is on the basis of educational qualifications, experience, aptitude and other personal attributes. However, appointments to professional and

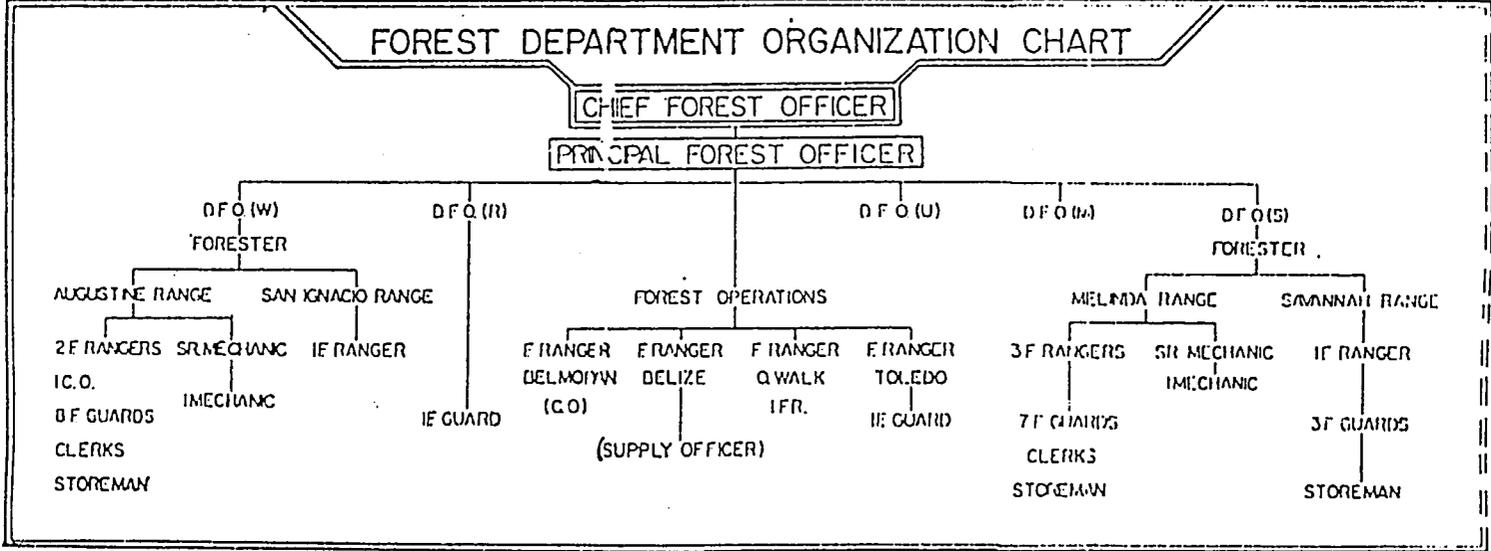


Figure 3.1: Forest Department Organization Chart.

Forester posts are made on the basis of educational qualifications.

By comparison with public forestry administrations in other tropical countries, Belize has considerably fewer personnel, at all levels, in relation to the size of the forest estate under management and in use than is normally accepted as being necessary. Nor has there been much increase in numbers in recent years. The staffing situation of the Forest Department since 1965 has been as follows:

Table 3.3: Staffing Situation since 1965.

<u>Category of Personnel</u>	<u>1965</u>	<u>1966-72</u>	<u>1980</u>	<u>1981-85</u>	<u>1988</u>
1. <u>Professional</u>	<u>4</u>	<u>5</u>	<u>5</u>	<u>6</u>	<u>6</u>
a) national	2	3	3	4	5
b) expatriate	2	2	2	2	1
2. <u>Technical</u>	<u>32</u>	<u>33</u>	<u>34</u>	<u>35</u>	<u>36</u>
a) trained	5	2	3	3	3
b) untrained	27	31	31	32	33
3. Admin. and Clerical	12	19	17	12	16
4. Miscellaneous	10	-	-	-	-
5. Permanent Labour	115	167	134	133	150 (1)

(1): 133 Field Workers, 17 Woodworking Workshop.

There is no formal training scheme for forestry staff in the country. Forest Rangers and Forest Guards are normally trained on the job, but some have taken short courses in Honduras (Siguatepeque) - in seed procurement, fire protection and sawdoctoring. Assistance is expected to be provided by the United Kingdom in setting up local training facilities in-service. A small number of promising technical staff have been trained on scholarships in Cyprus, the United Kingdom and Trinidad.

At present, there are two students receiving professional education in the United Kingdom. One of them is expected to return with a degree in Forestry this year, while the other is studying wood technology. Formerly, professional foresters were also trained in Canada and the USA and more recently in Mexico (Durango). The choice of country depends largely on which one offers the training opportunity. Two professional foresters have

Table 3.4 Forest Department Budget and Expenditure.

CAPITAL BUDGETS

ITEM	1979	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	198/89
Local Sources				BZ\$						
Reafforestation	45000	75000	80000	95000	95000	95000	0	0	0	
Continuation-Fire Protection (MPR)	40000	55000	60000	75000	75000	75000	0	0	0	
Replacement of Vehicles	37000	60000	0	0	0	0	0	0	0	
Plant & Equipment - Forestry	25000	25000	25000	30000	30000	0	0	0	40000	
Building - Forestry	40000	50000	0	45000	45000	0	0	0	0	
Fire Protection Programme - Coastal Plain	25000	30000	40000	50000	50000	0	0	0	0	
Continuation: Mango Farm/Monkey Town Road	30000	40000	0	0	0	0	0	0	0	
Fire Tender					40000	0	0	0	0	

Overseas Supported Programmes

1987/88

Pine Seeds

31000

(project Cost - BZ\$51000)

No Budget for 1986/87 or 1985/86 in this category

	BUDGET					Expected XXXXXXXX ACTUAL XXXXXXXXXXXXXXXX				
	1988/89	1987/88	1986/87	1985/86	1984/85	1987/88	1986/87	1985/86	1984/85	1983/84
REVENUE										
Import Duties Est. Forestry	33200000	29000000	28000000	30000000	29000000	33176000	28995500	25900000	26651375	26711222
						2284000	1777000	1498000	1536600	
						6.88	6.13	5.78	5.73	
Export Duties Est. Forestry	2050000	1200000	1600000	2350000	2200000	2037000	1871896	1639000	2230595	2268356
						247000	73000	71600	151000	182000
Royalties Forest Products (from Forest Department)	400000	370000	330000	300000	250000	350000	359438	404000	408448	439143
						273233	327335	426129	410270	
Permit Fees: Crown Lands	2000	1000	1000	8000	8000	1000	14982	1000	54440	9824
Forestry Revenue Producing	70000	200000	150000	180000	150000	75000	236357	182000	208792	185641
Woodwork Shop	30000	60000	80000	100000	100000	20000	67900	50000	75295	41274
Subtotal Forestry	100000	260000	230000	280000	250000	95000	304257	232000	284099	288735
EXPENDITURES										
FORESTRY	1996377	2321000	1917000	2015147	1904458	1884000	1856374	1851201	NOT	1830329
Forest Operations	258335	272000	264000	259335	238093	266000	230687	215237	AVAILABLE	467621
Forest Management	79739	107000	74000	85000	86000	80000	74803	75667		75243
Western Division	512108	622000	547000	570252	536263	480000	532469	547034		363243
Southern Division	501892	578000	483000	515000	437778	495000	504222	501915		368347
Research Division	50976	78000	74000	81560	81324	59000	47671	67497		46098
Mechanical Division	208208	229000	185000	205000	205000	169000	191203	185298		224715
Belaopan Woodwork Shop	222339	265000	140000	149000	148000	135000	130868	118954		111579
Seed & Lumber Production	162780	170000	150000	150000	150000	150000	144451	139599		152863

Source: Estimates of Revenue and Expenditure, as presented to the House of Representatives annually

attended in-service courses in project planning in Belmopan, organized recently by the Caribbean Development Bank. Others have benefited from USAID study tours and participated in US international forestry seminars on organization and management.

In 1987, 36,000 man-days were worked by forest workers employed by the Forest Department. Since 1983, there has been a decreasing trend in overall employment in forestry due to decreasing budget allocations for capital expenditure.

Forest Department budget

The sums allocated for the recurrent expenditure budget of the Forest Department for 1987/88 and 1988/89 were BZ\$ 2,321,000 and BZ\$ 1,996,377 respectively. As is shown in Table 3.4 above, budgetary allocations have not been increasing and in real terms have shown a downward trend. Also, actual recurrent expenditures have been below the budgeted levels in recent years, in compliance with government instructions. Capital budgets have also fallen (see Table 3.4). In fact, since 1984/85 no further capital funds have been allocated for forestry, apart from BZ\$ 40,000 allocated in 1987/88 for the replacement of plant and equipment.

The Department has well over 120 dwelling houses, offices and other buildings to maintain. In addition, it possesses six caterpillar tractors, most of which are old and require frequent maintenance and overhauls. There are also six wheeled tractors of which three are obsolete. In addition, the Department owns six lorries of which all but one are old. There is one new motor grader and two old ones for road maintenance and some twenty personnel vehicles (Land Rovers and Pickup trucks). However, all but four of these are old and need replacement. A new FM radio network has been recently installed. This has considerably improved communications between the main forest stations. Most of this capital equipment has been provided through external aid projects, and its present poor condition is largely due to the lack of provision in the budget, or accounting procedures, for their replacement.

The Forest Department is thus unusually small in relation to its responsibilities, and has been further hampered by a lengthy period of budgetary stringency. The implications of these constraints on public management and control of the forest sector are examined further in the following sections of this report.

3.2 FORESTRY AND LAND USE

3.2.1 The Land Base

Geology

Geologically (see Map 3.1), Belize is a complex of limestone rocks overlain by alluvium on the east and surrounding the Maya Mountain massif in the south centre. The steeply sloping mountains, which are intersected by fault lines, comprise a block of metamorphosed Palaeozoic shales and sandstones with intrusive granites.

Extending to the north, west and southwest is an extensive area of Cretaceous and Jurassic limestones. It comprises much of the country between 200 and 2,490 ft (60-760m) above sea level. Early Coban limestone is overlain by younger Campur and Lacandon beds that give rise to rugged Karst landscapes, characterized by "tower and hollow" topography, sinkholes, caverns and underground rivers. East of the mountains the limestone is buried under sediments. In the south the limestone tract forms the interior uplands of the Toledo District.

Eocene limestones occur over most of the area north of the mountains as the Santa Amelia and Buena Vista formations. The former is confined to the west where it forms low elevation Karst topography and a series of low, steep sided, east facing scarps. These and the narrow, 50 ft (15m) deep New River Lagoon as well as the shallow Crooked Tree Lagoon, are manifestations of slumping of limestone which has resulted from the development of the Yucatan Trough off the northeast coast.

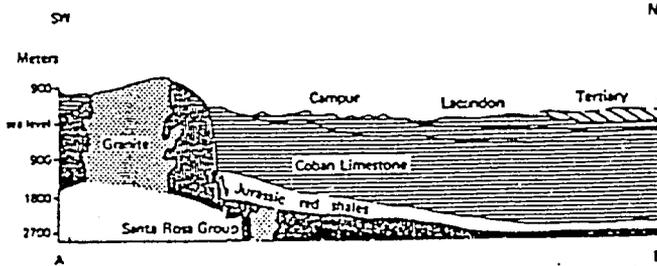
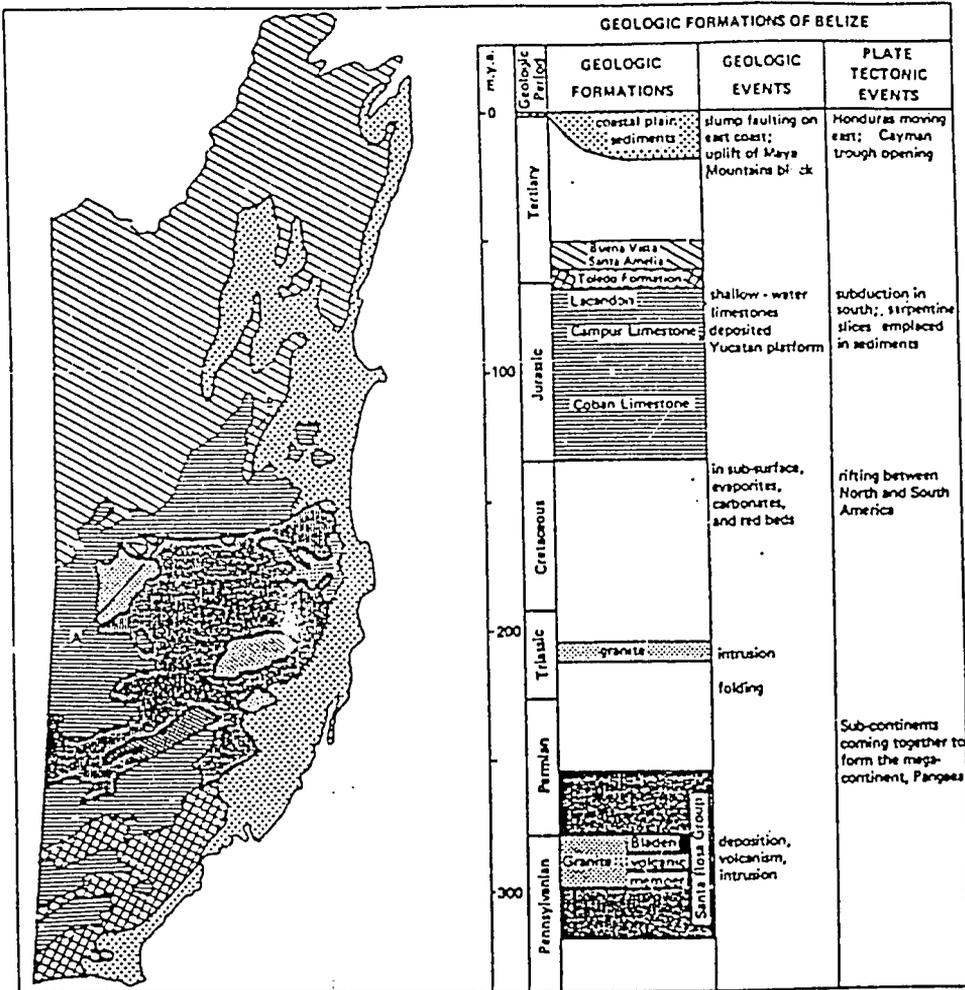
The coastal plain is of low elevation and has little relief. In the extreme south a narrow strip of Belize lies within a tectonically active zone that otherwise covers extensive areas of Honduras and SE Guatemala.

Soils

The soils of Belize were comprehensively studied for the first time in 1952-54. The results, supported by 1:250,000 soil, vegetation and potential land use maps, were published by A.C.S. Wright, D.H. Romney, R.H. Arbuckle and V.E. Vail in 1959. The team identified, mapped and gave acreages for 70 soil types and 230 sets within them. They described them with reference to profile characteristics, topography, altitude, parent material, rainfall, natural vegetation, present land use and limiting factors.

In general, limestone soils preponderate in the northern, northeast, west and west centre of the country and in western Toledo District. Those derived from quartz-rich rocks or which have been formed under conditions of continuous acid leaching, occupy much of the higher country (which otherwise comprises

Map 3.1: Geology of Belize.



Source: Baldwin, B. 1979. Geology in Belize, in Hartshorn *et al.* (1984).

skeletal soils) as well as large areas in Toledo. Recent soils, including sand and alluvium, are prominent in the north centre and in a band down the eastern side of the country. Since the pattern of soil variation is typically detailed and intricate, there are few large areas of uniform soils.

Lack of fertility in most lowland soils is traceable directly to lack of base-rich minerals in the quartz-rich rocks of the mountains. The other chief soil forming rocks are limestones which occur abundantly. They are among the most fertile in the country. They have a high content of expandible clay, dark coloured topsoil, near neutral pH, high levels of base saturation and cracking surfaces. They vary widely morphologically, in step with changing topography: shallow and stony on steep slopes; deeper and more variable on gently sloping plains around hills and on limestone outcrops as in parts of the Southern Coastal Plain.

The soils of the Toledo Lowlands fall into two fairly distinct groups. The Temash soils are mainly fine textured, acidic, leached and imperfectly drained. The Machaca Plain soils contain higher proportions of calcareous and arenaceous materials. They tend to be better drained.

The alluvium derived Puletan soils of the lowland "Pine Ridge" have coarse to medium textured top soils overlying strongly mottled, compact, subsoils. They are leached, acid and have low base status. These features, combined with their impermeable subsoils, seasonally saturated topsoils and dry season moisture deficits, create a difficult plant growth environment. The characteristic cover of pine and grass savanna manifests these conditions. No proven permanent agricultural use has yet been found for these soils.

Potential land use

Wright *et al.* (1959) related the 70 soil types and 230 sets within them that they defined to the most appropriate of 13 land use classes and 33 sub-classes, reflecting an assessment of best potential use and broad cultural practice. A detailed area statement was then given, indicating for 24 sub-regions comprising the country, the extent of each land use (i.e. crop type) class and sub-class. The results of this analysis, based partly on the team's extensive direct field observations, are shown in Table 3.5.

A more detailed land resource survey of the Toledo District, based in part on the use of satellite imagery, was published by ODA's Overseas Development Natural Resources Institute (ODNRI) in 1986. The survey and assessment framework in this case was a series of land units that strongly reflected the underlying geology and landforms which, with warm temperatures and high rainfall, give rise to highly complex soil patterns, as noted by both Wright *et al.* (1959) and the ODNRI team. A similar survey of Stann Creek District was in progress in 1988.

Table 3.5: Area Summary for Land Use Classes
Defined by Wright et al (1959).

Broad use category	Crop Type	Crop or cultural sub-types	Acres	Area (Ha)	%
Forest	Protection forest	-	1,272,318	(514,900)	27
	Mahogany forest	3	760,080	(307,600)	16
	Pine forest	4	575,990	(233,100)	12
Agriculture	Orchard	4	260,691	(105,500)	6
	Long rotation pasture	3	734,628	(297,300)	15
	Short rotation pasture and arable	7	971,597	(393,200)	20
	Swamp rice	2	62,516	(25,300)	1.3
	Market gardening	-	5,930	(2,400)	0.1
	Bananas	-	13,343	(5,400)	0.3
	Sugar cane	4	109,218	(44,200)	2.3
Total			4,766,311	(1,928,900)	100

In 1984 Wright re-grouped the soil types identified and land use recommendations made in 1959 using a system of seven major landforms, each with two or more sub-divisions. The results, with approximate ODNRI equivalents in Toledo District added, are shown in Table 3.6, the landforms being depicted in Map 3.2. They provide a useful overview of the classification into landforms and their subunits, the principal soil series within them as well as major soil limitations and recommended land use.

The summary of the analysis by Wright et al. (1959) in Table 3.5 indicates that the survey team considered that 3,371 miles² (8,733 km²), (45% of the land they classified) was potentially suited to agriculture while 7,446 miles² (19,289 km²), (55%), was potentially suited to forestry. After allowing for limitations of drainage, shallowness, inherent infertility and lack of moisture in the dry season, some 1,737 miles² (4,500 km²) of land, i.e. 55% of the foregoing area of 3,371 miles² (8,733 km²) of potential agricultural land, was classified as potentially mechanisable without high financial and technical inputs. However, the more recent ODNRI land resourcement assessment surveys (King et al 1986, King et al 1988), drawing on subsequent experience in Belize and elsewhere in the tropics, suggest that the area which can be successfully put under sustainable agriculture is probably considerably less.

3.2.2 Present Land Use

Land Ownership

The mainland land ownership pattern is depicted on Map 3.3. The approximate areas of the categories shown are summarized in Table 3.7.

Table 3.7: Distribution of land in Belize, in miles² (km²), by Ownership Categories.

Category	Area	
	Miles ²	(Km ²)
Reserved Forest (1)	2,548	(6,368)
National Land	2,400	(6,219)
Reservations in Toledo District	109	(282)
Private Land	3,241	(8,397)
Conservation Areas	22	(56)
Sub-total ("Forest Land") (2)	8,230	(21,322)
Agribusiness (BSI) Lands	44	(113)
Towns and Cities	46	(120)
Total	8,342	(21,555)

(1): Forest Department figure; see Table 3.9.

(2): This area is officially classified as "Forest land".

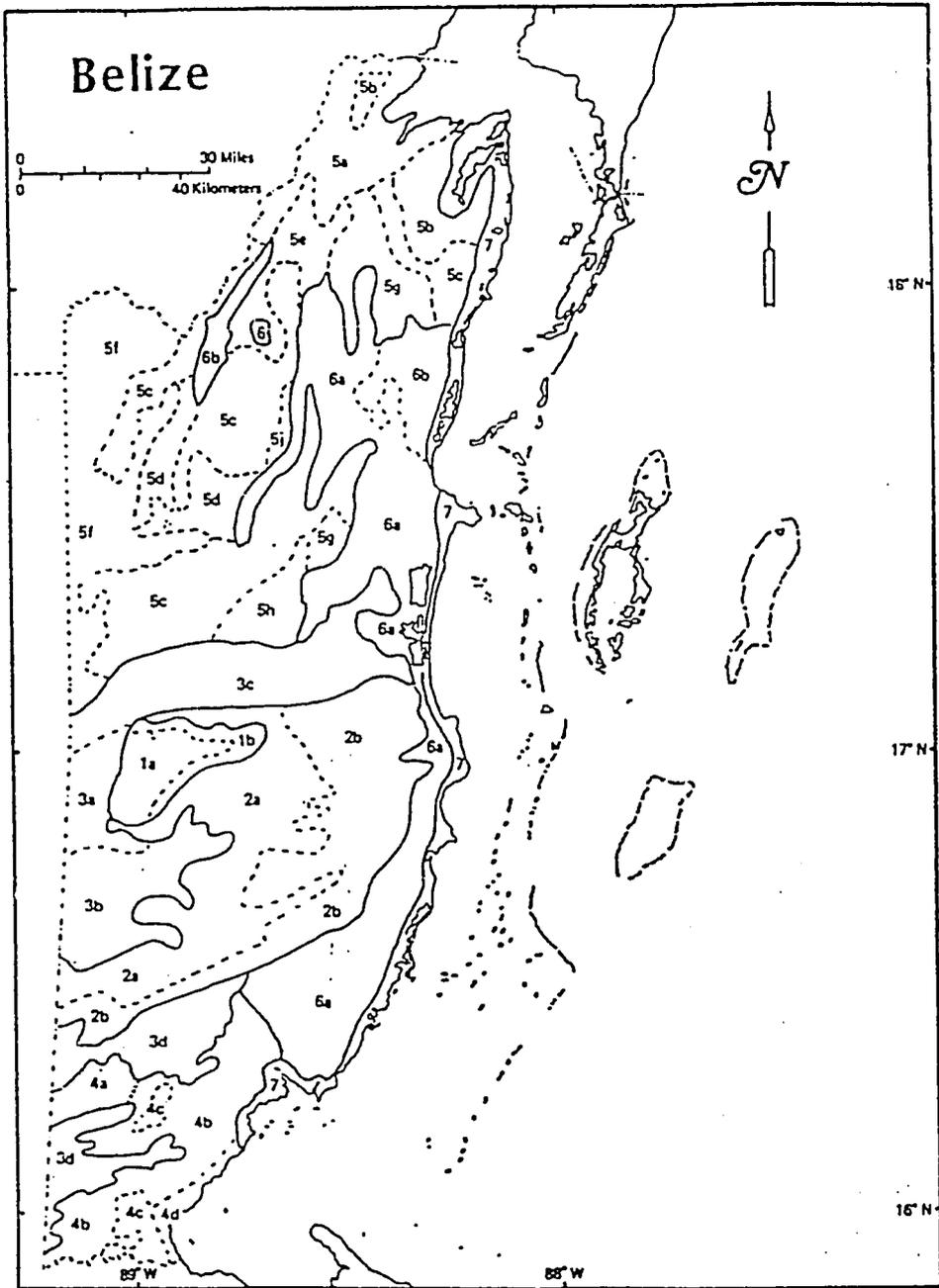
All land other than that classified as agribusiness land (44 miles², or 113 km²) or urban land (46 miles², or 120 km²) is officially designated as forest land (8,397 miles², or 21,322 km²). The latter thus accounts for 93% of the land area of Belize, and is essentially distributed among three ownership categories: Permanent Forest Reserve, Unreserved Forest Land (also referred to as National or Crown Land) and Private Land. This distribution is summarized, by type of vegetation cover, in Table 3.8, which is taken from Hartshorn *et al* (1984), where it was derived by recalculation from FAO (1978).

Agriculture

As has been noted earlier, agriculture is one of the two most important sectors of the country's economy. The sector is the Government's top development priority, being promoted through arrangements enabling acquisition of land for resettlement, improved access to credit, provision of access roads and improvements in marketing arrangements.

Milpa farming is still practised, mainly in the Toledo district, but small family farms using slash-and-burn methods are

Map 3.2: Principal Landforms of Belize Based on Major Soil Features.



From A.C.S. Wright in: Hartshorn et al. (1984) with approximate ODNRI equivalents in Toledo District added.

Table 3.6: Soil Features of the Principal Landforms of Belize.

MAP CODE	SOILS	AREA (km ²)	PRINCIPAL SOIL SERIES	LAND LIMITATIONS	RECOMMENDED LAND USE	ECOLOGICAL LAND SYSTEM
1. Alluvial Soils of The Northern Plateau (128 km² x 1.41)						
1a	Lowland Terrace	428 (2.3)	Pinol	Droughty; low fertility	Production Forestry	
1b	Lowland Swamps	255 (1.2)	Jalpa	Shallow; low fertility; highly erodible	Protection Forests	
2. Alluvial Soils of The West Coast (137 km² x 1.73)						
2a	Uplands (steep)	1,868 (8.4)	Espeque, Cochacomb, Chaporal, Richardson Peak	Shallow; low fertility; highly erodible	Protection Forests	Richardson Peak Mountains; Chiquibul Valley
2b	Uplands (strongly rolling)	(included above)	Curason, Chiquibul, Palmasito, Grandero	Shallow; low fertility;	Protection Forests	Palmasito Plateau
2c	Lowlands (steep)	1,114 (5.1)	Swamp, Tiger	Shallow; low fertility; highly erodible	Protection Forests	Stagger Escarpment with Plain
2d	Lowlands (shaly)	(included above)	Stagger, Curason, Osney Sivil, Esperanza, Grandero	Low fertility; highly erodible	Production Forestry; Permanent Tree Crops	
3. Alluvial Soils of The West Coast (137 km² x 1.73)						
3a	Northern Karst Uplands (Pala Plateau)	428 (2.0)	Totinalha	Plastic when wet; accessibility	Production Forestry; Permanent Tree Crops	
3b	Southern Karst Uplands (Chiquibul)	327 (1.3)	Cobra, Chacalte, Combe	Slow internal drainage; accessibility	Production Forestry; Pasture; Agriculture	
3c	Northern Karst Foothill Swamps	1,122 (5.2)	Sunatunich, Gaa, Hummingbird	Steep	Production Forests; Permanent Tree Crops; Pasture; Milpa Agr.	
3d	Southern Karst Foothill Swamps	310 (1.4)	Epitilha	Droughty; some shallowness	Milpa Agr.; Pasture; Rice	Epitilha Hills
4. Volcanic Soils of The Western Lowlands (147 km² x 1.91)						
4a	Toledo Foothills	392 (1.8)	Agucate, Manfredi, Metaltit	Low fertility	Milpa Agriculture	Toledo Uplands
4b	Toledo Lowlands	1,058 (4.9)	Tomah, Manfredi, Clara Sanjaniha, Kionatoo	Poor physical structure; clay pan	Permanent Tree Crops; Rice	Kachaca Plain, Tomah Plain
4c	Toledo Inland Swamps	182 (0.8)	Cavay	Flooding; poor drainage	Some Rice	Toledo Swamps
4d	Toledo Coastal Strip	63 (0.3)	Barraco	Clay pan; lack phosphorus	Permanent Tree Crops	Toledo Strand Plain
5. Alluvial Soils of The Northern Lowlands (147 km² x 1.91)						
5a	Soils from Coral Rubble, Limestone Limestones and Beach Sands and Gravel	452 (1.9)	Sotano	Steep; shallow; droughty	Permanent Tree Crops; Sugar Cane; Milpa Agr.	
5b	Soils similar to 5a but with Volcanic Ash Minerals	528 (2.4)	Zabo	Steep; shallow; phosphorus deficient	Sugar Cane; Fruit Crops; Vegetables	
5c	Soils from Hard Limestone Conglomerate	2,222 (10.4)	Pulucan Yoo	NONE	Intensive Agr.; Milpa Agr.	
5d	Soils similar to 5c but with Volcanic Ash Minerals	255 (1.2)	Chaloun	Phosphorus deficient	Pasture; Mechanized Agr.	
5e	Soils from Soft Siliceous Limestone	419 (1.9)	Louisville	NONE	Mechanized Agr. with Pasture Rotation	
5f	Soils from Calcarenous Marl and Gravel	2,588 (12.3)	Jalpa	Droughty	Production Forestry	
5g	Soils from Hard Siliceous Limestone with Flints	447 (2.1)	(Jalpa)	Low fertility; slow internal drainage	Agriculture with Fertilizer and Crocifer	
5h	Soils from Hard Siliceous and Chertiferous Limestone	558 (2.6)	(Jalpa)	Plastic clay	Permanent Tree Crops	
5i	Soils from Alluvium and Colluvium over Marl or Hard Limestone	1,058 (4.9)	Rangrat	Flooding	Rice	
6. Alluvial Soils of The Coastal "Belt" (147 km² x 1.91)						
6a	Without Limestone Outcrops	2,411 (11.3)	Palatan	Low fertility; clay pan	Aquiculture Ponds; Production Forestry	Palatan Plain, Gomezar Plain
6b	With Limestone Outcrops	329 (1.5)	Rockstone, Felipe, Tah	Low fertility; rock outcroppings	Pasture; Production Forestry	
7. Alluvial Soils of Coastal Swamps and River Banks (104 km² x 1.37)						
	Fresh Swamp and Duck Soils	822 (3.8)		Poor drainage	Production Forests	Toledo Saline Swamps
	Sandy Soils (including cars)	201 (1.4)	Turnoff, Shipstern	Infertile; fragile	Permanent Tree Crops	

From A.C.S. Wright in: Hartshorn et al. (1984) with approximate ODNRI equivalents in Toledo District added.

more common. (Milpa is used here to denote a rotational farming system; by contrast, slash-and-burn is non-rotational). Permanent agricultural developments, though subject periodically to discouraging marketing and infrastructural factors, are expanding: sugar cane and pasture in the north; mechanized beans and small grains in the west; cacao and citrus in the east, centre and south; rice in the south. A limited area of potentially productive soils awaits development. There is an influx of immigrants from more heavily populated countries in the region as well as demonstrated interest on the part of larger, financially stronger concerns from abroad.

As typically practised in Toledo District, the traditional milpa farming system is characterized by simple, low input technology and the use of family labour with communal effort to deal with peak work periods. Each year an area of woodland is cleared and, along with some of that used during the previous year or two, planted with maize (for subsistence) followed later in the season, on the same ground, by beans or rice (the cash crop). A second, dry season ("matahambre") corn crop is grown late in the season on fertile levee land as an insurance against any failure of the early season crops. Each annually cleared area is fallowed after 2 or 3 years, for up to 15 years, i.e. long enough for the soil to recoup its organic matter content and structure and for weeds to be suppressed by woody regrowth. By this means a family produces its food requirement, and some produce to sell, from 5-7 acres (2 to 3 ha) per annum.

Milpa succeeded in the area as long as it was applied as a subsistence activity and there was sufficient land to sustain it. However, population increases (e.g. by 44% in the Toledo area between 1970 and 1985) resulted in progressive shortening of the fallow period. Groups of villages, together with immigrants, moved to new areas; e.g. in the Stann Creek, Southern Highway, Santa Cruz and San Antonio areas. Some encroached into Columbia River Forest Reserve, part of which (including the greater part of a mahogany plantation which these farmers had established under the taungya system) was excised by Government for use by milperos.

During the 1970s the Government initiated a research and extension programme to modernize agriculture around lowland rice cultivation. This was designed to raise rice production for the domestic market, improve living standards for the milpero, regulate land use, and integrate the Maya more closely into the cash economy and national development. Based on an earlier change that Mayans in the north had made from milpa to settled sugar cane farming, an attempt was therefore made from 1979, through the Toledo Research and Development Project, to replace traditional maize milpa with settled, partly mechanized 40-acre (16 ha) lowland rice farms, which might have the additional advantage of increasing rice production from the region.

Before long, recognition of the economic, technical and, particularly, social implications of this initiative led to a change of research focus to emphasize development of farming

systems through incremental changes more in keeping with the Maya outlook and experience. This entailed introducing improved crop varieties and methods of husbandry to improve production from both the upland and lowland annual crops and introducing perennials, e.g. cacao and citrus, into the former, so that both would be sources of cash as well as food. In addition, leguminous cover crops were introduced to shorten the fallow period. Some of these innovations have been quite widely adopted, such as the cultivation of cacao, but progress towards settled farming and a cash economy is now seen to be necessarily slow.

Settled or commercial farming is practised by three distinct groups: small, medium and large landowners. Small farmers with 5-50 acre (2-20 ha) holdings using permanent fields are located principally in Corozal, Orange Walk, Stann Creek and north western Cayo. They are the largest group in the sector. They produce much of the locally consumed food as well as 60% of the sugar cane and some citrus for export. Most milpa and slash and burn farmers work holdings in this size range, or smaller. However, apart from those on Reservation land in Toledo District, the great majority use leased National or private land, or Location Ticket land. The Government has recently sponsored a settlement scheme for immigrant Salvadoreans near Belmopan, and has set aside 135,900 acres (55,000 ha) of National Land north of the Belize River in the same general area for the same purpose. A few farmers clear and cultivate land illegally, e.g. in Mountain Pine Ridge and Columbia Forest Reserves.

Medium sized farms of 50-500 acres (20-200 ha) are mostly operated by Mennonites in Cayo, Corozal and Orange Walk Districts. They are relatively productive, compared with unmechanized small farms, and supply the domestic market with most of its poultry and eggs, milk, cheese and vegetables.

Large holdings account for some 60% of the country's agricultural land. They are concentrated in the north and southeast centre. Many of them, particularly in the north, are not developed, some are partially developed with pastures, some farmed on a small scale, while parts of others are rented to small farmers. The largest individual holdings of (mainly undeveloped) private land, situated in Orange Walk and north western Belize Districts, formerly comprised a single block of 938 miles² (2,430 km²) held by the Belize Estates and Produce Company, which was recently subdivided into several holdings. There are several substantial developments for production of sugar cane in the north, and for citrus, bananas and mangoes in the east and south centre. Agricultural development is constrained, particularly in the southern third of the country, by costs of transport.

Sugar cane has in recent years occupied more than half the active crop land, even though the industry is at present in a depressed state. The areas under sugar cane are predominantly in the north of the country.

Commercial production of citrus is concentrated in Stann

Creek District, and there are some groves in Cayo. Of some 360 citrus growers, 90% grow less than 20 acres (8 ha). The area under citrus has recently been expanded, and further new groves are under development. This has occasioned a number of recent excisions from Forest Reserves to make land available for the purpose.

In contrast to the earlier groves, which were primarily on soils in the Stann Creek Valley, much of the new development is on Puletan Soils in the Puletan Plain and Stann Creek Coastal Plain land systems where citrus has not been grown over an extended period before. As has been pointed out in the report of the ODNRI land resource assessment survey (King *et al* 1988), these soils - which are sandy, acidic, low in essential plant nutrients, high in active aluminium, and frequently with one or more strongly compacted soil horizons - are not generally considered suitable for citrus. There is therefore a danger that they will prove uneconomic or fail, as has happened to most other agricultural developments on these soils in the past.

The Banana industry has had a chequered history. Earlier plantations in the Stann Creek Valley have twice been discontinued; the first time because of drought, hurricane, disease and management problems; the second time because of high costs of production, low quality bananas and hurricane damage. Banana production is presently concentrated on parts of the Toledo and Stann Creek Floodplains, and faces managerial, shipping and credit constraints. A programme is under way to sell plantations to employees who demonstrate managerial skills. The Banana Control Board (BCB) estimates that 3,950 acres (1,600 ha) of plantations are necessary to make the industry economically sound. Hurricanes caused severe damage to plantations in 1974 and 1978.

As has recently been pointed out (King *et al* 1988), even with a high standard of technical support and management, much of the land under bananas is only moderately or marginally suitable, because of seasonal invasion of cool northerly fronts, and the high cost of inputs relative to constantly changing external prices.

Commercial production of Cacao began relatively recently, in the Sibun valley. Expansion of the area under this crop is under way, with support from USAID and Hummingbird Hershey Limited. Belize is self supporting in rice production, half of it being produced by milpa farms in Toledo District.

The country's suitability for livestock production has been rated highly by USAID. Wright *et al.* (1959) stated that, in the long term, beef production on land converted to pastures, particularly in the Northern Lowlands landform, would be one of the most durable forms of land use; though its profitability in subsequent market conditions has been questioned. In 1978 land in cattle operations totalled 250,000 acres (100,000 ha) of which 45% was pasture. Some 76% of the herd of 48,700 head was on 375 farms larger than 100 acres (40 ha). Pig production is

traditionally a small farmer enterprise, a major part of the activity being centred among milpa farmers in Toledo district.

Forest and woodland

The classification of 93% of the area of the country as "forest land" is perhaps best viewed as an indication of the potential extent of the forest cover in the absence of human influence (as shown in Table 3.8). The extent of actual cover of forest is unclear. Several estimates exist, with quite widely different results, but without sufficient information about their origins to make it possible to judge between them. The available information is presented and discussed in Appendix 10, and the most recent of the estimates are summarized in the discussion that follows.

The natural distribution of forest types is determined partly by climate but mainly by the soil. "Unquestionably, soil development is the key to the variation in the plant cover" (Wright et al. 1959, page 30). The role of fire in establishing or maintaining tropical pine forest seems to vary. Lightning-caused fires plus a heavily leached soil on a very ancient land surface appear to favour the conifers on the Mountain Pine Ridge and other isolated upland sites. On the coastal plains and in the north of Belize, the "pine ridge" seems to be confined to heavily leached sandy soil, and sustained by burning.

Table 3.8: Distribution of Land in Belize by Ownership and Original Vegetation Cover, in miles² (kms²), (1).

Forest Land Category	Permanent Forest Reserve	Unreserved State Land (2)	Private Land	Total
Closed forest (broadleaved)	2,040 (5,286)	1,686 (4,367)	2,377 (6,159)	6,103 (15,812)
Open forest (woodland/pine)	248 (642)	81 (210)	52 (134)	381 (986)
Mangrove and swamp	10 (26)	376 (974)	543 (1,408)	929 (2,408)
Open and grassland	160 (414)	388 (1,006)	381 (986)	817 (2,116)
Total	2,548 (6,368)	2,531 (6,557)	3,241 (8,397)	8,230 (21,322)

(1). Agribusiness lands totalling 44 miles² (113 km²), and 46 miles² (120 km²) of cities and towns, are not included in the above table.

(2). Includes Indian Reservations in Toledo District.

The broadleaved closed forest category occupied in 1981 about 6,103 miles² (15,812 km²), mangrove and swamp a further 929 miles² (2,408 km²), while open forest and pine covered only 381 miles² (986 km²) (Hartshorn et al. 1984). The sparsity of rain gauges makes extrapolation hazardous (Walker 1973) but the tropical pines seem not to be found where the average annual rainfall is more than 78 inches (2,000 mm), (up to 117 inches, or 3,000mm, on the southern coastal plain). However this does not imply that the vegetation under lesser rainfall will be open and pine forest; fire and soil conditions then determine whether conifer or broadleaved forest will prevail.

By the time that the Forest Department was created in 1922 a good deal of the northern half of Belize had been alienated. The Haematoxylum forests were privatised at an early stage of European settlement. Later, the easily accessible mahogany areas covering practically the whole of the north and part of the south left the Crown estate (Stevenson 1938). The Land & Survey Department's property map shows the great extent of the areas assigned as "mahogany works", all through the lowland areas of the country.

The establishment of the permanent forest estate, in accordance with the recommendations of the Hummel report in 1921 (Hummel 1925), was very largely restricted to the less accessible and higher lands of Belize, plus the southern coastal plain (pine and grass savanna) and swamps. The imposition of land tax caused relinquishment of some private holdings and consolidation of others. However, the proportion of privately-owned land in Belize in 1988 has altered less than 0.5% from the 45% in 1938. The Forest Department has not been able to obtain a permanent foothold in the rich mahogany forests north of the Belize River, except for Freshwater Creek Forest Reserve.

According to 1988 Forest Department figures, which allow for the recent declaration of Cockscomb Basin as Reserved Forest, and for excisions since the compilation of the figures shown in Table 3.8, there are 16 Reserved Forests, totalling 2,545 miles² (6,592 km²), or 30% of the land area. These are listed in Table 3.9, and are described individually in Appendix 11. Nearly one third of the Reserved Forests area is classed as "inaccessible". About one fifth of the Reserved Forest area, much of it inaccessible is regarded by the Forest Department effectively to be protection forest. Therefore, assuming that about one half of the area regarded as protection forest is also included in the inaccessible category, in effect the area of Reserved Forest that has been used for production of wood amounts to about 1,500 miles² (3,900 km²). As was noted earlier, production has taken the form of repeated selective felling of the larger trees of a few commercially sought after species.

Plantations of Pinus caribaea (some 5,000 acres, or 2,000 ha), mahogany (over 1,000 acres, or several hundred ha), Cedrela adorata (1,250 acres/500 ha) and Tectona grandis were established in Forest Reserves during the 1940s and 1950s, followed by about

2,500 acres (1,000 ha) of Gmelina arborea in the 1960s.

The one fifth of the Reserved Forest area which is regarded as protection forest is intended to serve the requirement of the forest policy for the maintenance of environmental stability, particularly through water catchment protection and wildlands conservation. However, no areas are specifically designated in management plans for catchment protection.

Wildlands Conservation is currently represented by a number of areas declared and identified for conservation under the National Parks System Act, the Crown Lands Ordinance and the Fisheries Ordinance. These are described in section 3.2.4. Five of the eight areas, covering a total of 21.7 miles² (56.2 km²), are in Forest Reserve and Unreserved State Forest Land. Areas designated under the National Parks System Act (1981) (national parks, nature reserves, wildlife sanctuaries or national monuments) fall within the jurisdiction of the Forest Department.

Unreserved forests on National Land, which are under the jurisdiction of the Lands Department, are available for lease under the Crown Lands Ordinance pending the grant of title. Under the Forest Ordinance, the Forestry Department issues licences to cut timber on National Land, including leased land, pending its conversion to agriculture. Royalty is charged for any timber cut for removal and conversion for sale.

Forests on private land comprise a significant part (30-40%) of the total forest resource. However, there is little publicly available information on forest in private hands. The exception is the forest of the former Belize Estate and Produce Co (BEC). This company, holding at one time nearly one fifth of the land area of Belize and reputedly the richest mahogany forest, was one of the few to take advantage of the creation of the Forest Department. For some years, Forest Department staff were seconded to the company to assist in management. The size of the estate was reduced over time but was still 980 miles² (2,538 km²) in 1984. The productive forest area of 754 miles² (1,953 km²) was inventoried in 1975. At that time it contained an average of some 21 ft³ per acre (1.5 m³ per ha) of exploitable mahogany and cedar.

The company estate is now split into several portions, some of which are under short-term forest licences and permits. The southern unit of 247 miles² (640 km²) is currently being selectively exploited. The remainder has been disposed of in various ways: of the large central block a small area will be converted to agricultural use, the future of the remainder being unknown at present; in the north-east a part has been purchased by Mennonites based at Blue Creek; a block of 234 miles² (607 km²) in the north is to be managed by the Programme for Belize as the Rio Bravo Conservation Area, eventually to go to the Government; of this area, 63 miles² (162 km²) were donated by the former owner, while the remainder is under agreement of purchase; the rest of the original tract, in the east-centre, is believed to be destined for citrus plantations.

Two other tracts of privately or community-owned land are dedicated and managed as conservation areas.

3.2.3 The Balance Between Forest and Agriculture

The transfer of land from forest to agricultural uses has been accelerating. Transfers are taking place mainly on private land and on National Land, but in recent years several thousands of acres/hectares of land have also been transferred out of Reserved Forests. Some of this has been for the development of agricultural tree crops, soem for shrimp farming, and some from Columbia River Forest Reserve for milpa farming. Other transfers are pending.

As was pointed out in the previous section, the suitability of some of the areas for agricultural use has been questioned. But, no mechanism is consistently used in Belize for scientific review of soil capability in areas proposed for conversion from forestry to agriculture, or to ascertain whether suitable alternative areas are available. Particular concern attaches to the impact of excising Reserved Forest areas on the productive and protective objectives set out in the national Forest Policy. Some people predict that, within five years, the remnants of many of the Forest Reserves in the Southern Coastal Plain will have been excised for agricultural use - despite the history of failed agricultural developments in the area.

The information available on this subject is discussed in the present section. Attention is directed not just to the choice between forest or agricultural use, but also to the integration of trees and crops, or livestock, in different land use and farming systems.

The mestizo and Yucatec Maya sugar-cane farmers of the north have retained a surprising amount of woodland, in the corners of fields and in areas which cannot be cultivated. They also have well-treed backyard gardens and living fence lines. So far as is known to the TFAP Mission, the remnant woodland is unmanaged and subject to continual degradation through the removal of house poles, firewood and other small items of forest produce. Some of the rural development projects in the north include an agroforestry component, but these seem to involve planting rather than active management of remnant woodland (which may be communal or of doubtful ownership).

The mestizo farmers in the west, near the border with Guatemala, have relatively small holdings and tend to practice the normal Central American slash and burn agriculture, with decreasing fallow periods. The boundary between forest and farmland creeps uphill and onto more marginal land each year. The cultural preference is to remove forest cover for the staple crops with C4-type photosynthesis. There are agroforestry possibilities for fence lines and backyards, and possibly trees in pastures on the larger holdings.

Mennonite farmers generally prefer complete forest clearance with de-stumping and burning followed by repeated cultivation, mostly mechanized, to control the regrowth of weeds. However, the small groups of self-sufficient Amish practice mixed farming, including horticulture of fruit trees and bee-keeping; a system more amenable to agroforestry improvement.

The citrus and banana farms in the south involve complete forest clearance. A single, new, enterprise proposes to clear natural pine on the Southern Coastal Plains and reforest on those Puletan soils which are unprofitable to ameliorate for citrus. Some carefully selected alluvial soils on the coastal plain grow satisfactory fruit crops. However, as was pointed out earlier, there are indications that some recent agricultural expansion has taken place on low productivity sites where it might not be sustainable and which would be more appropriately used for forestry. Examples are citrus developments on the problem Puletan soils and replacement of forest plantations with perennial agricultural crops.

Mango seems to fare better than citrus on more favourable sites in the Puletan soils area. However, even this crop on these soils is also questionable since it has to be fed frequently with lime and fertilizers, is subject to pests that are costly to control and is subject to uncertain market prospects for the fresh fruit. The latter factor applies also to citrus, plans for large scale development of which on the former BEC lands have been shelved, ostensibly for this reason. It is contended locally that the more appropriate use of problematic sites would be for lower input forms of forestry for which they are suited e.g. management of naturally regenerating pine through control of fire and deep drainage. In addition, based on early trials with Pinus caribaea in the Savanna area, phosphatic fertilizer applications deserve trial.

Some areas in Freshwater Creek Forest Reserve that have been converted to sugar cane are said to be on soils too sensitive for this use while some pastures developed on forest lands in Orange Walk have deteriorated because of poor drainage, leading to puddling or invasion by woody vegetation. In that region of complex soil and drainage patterns small farms are a better alternative to forestry than large permanent crop units.

The Mopan and Ketchi Maya in the south have the legal protection of Indian Reserves in which they can practice traditional communal shifting agriculture. It has long been a concern of the government that rising population has caused encroachment onto government land outside the Indian Reserves and a shortening of the long-cycle fallow within the Reserves. Sociological studies in the Toledo rural development project in the early 1980s suggested that the short-cycle fallow had not been decreased, but some land was being removed from the fallow by being placed under perennial crops.

As was indicated above, the traditional social system of the Maya has not yet come to terms with individual ownership of land,

Maya has not yet come to terms with individual ownership of land, perhaps a necessity to justify family investment into perennial crops. However, small but increasing areas of cacao are established in fallow after farming, or in forest cleared of the understoreys. Bananas and some fruit trees are used for shade. There are possibilities for diversification of shade trees and improved horticulture but neither the Forest Department nor the Department of Agriculture are staffed to provide this extension effort. The Maya migrating north along the Southern Highway and closing on the eastern boundary of the Maya Mountains Forest Reserve seem to be interested only in staple crops at present, with part-time employment in the plantation estates.

The information reviewed in this section draws attention to what is often a fine line as to whether forestry or agriculture would be the most appropriate use in a particular instance, in the long as well as the short term. Although a general impression might be gained that there is no overall shortage of land for agricultural development, attempts to identify specific available parcels usually encounter difficulties. Moreover, numerous past crop development projects in Belize have failed. Some of the expansion currently taking place, particularly of commercial farming, is on marginal areas that are more suitable in the long term for forestry.

This underlines the importance of analysis of the alternatives using whatever soil and other data concerning the land, as well as economic and sociological data, are available. Agroecological data can be drawn from analogous zones in other countries pending the development of data in Belize. The analysis should of course take account of relative needs from the two sectors, implying the relevance of long and short term government sectoral and development policies.

Review of the present situation also underlines the opportunities for combining two or more sets of needs through the use, when appropriate, of agroforestry techniques. Such systems are needed in order to diversify and enhance overall production, stabilize milpa farming, sustain productivity and provide extra sources of cash.

A promising start has been made by introducing cacao in small farms along the Hummingbird Highway, while the Toledo Research and Development Project has introduced cacao, avocado and leguminous ground cover plants into the milpa regime with promising early results. Other potential opportunities involve the development of tree/agricultural crop systems of various designs, e.g. boundary rows, windbreaks, intimate mixes of trees and agricultural crops and trees in contour strips, to provide fodder, wood from fallow areas, fuelwood and light poles in tree-denuded areas, and fuelwood for lime burning in Karst country.

However, at present, with the partial exception of the southern Maya, farmers in Belize believe in the removal of forest cover for successful farming. There is little perceived need to conserve forest in farming areas. The Forest Department

education effort should have a broad basis, emphasizing the conservative multiple use of natural ecosystems. There should be special campaigns against wildfire to coincide with the farmers' burning season. Agroforestry should be more emphasized in the Belize College of Agriculture, making use of the abundant educational and promotional material from other tropical countries.

3.2.4 Allocation and Transfer of Land Out of Forest Use

Legal provisions and responsibilities

Subject to satisfactory definition and recording of any pre-existing rights, the Forest Ordinance empowers the Minister to declare any Crown Land to be Reserved Forest, and to vary or revoke any such order. The Ordinance empowers him to apply any of its provisions or regulations made under it to any private land and to revoke any such order. He may make regulations: (i) for its proper administration; (ii) applicable to any Crown or private land to regulate (including prohibit) the taking of forest produce, squatting, lighting fires, depasturing stock, hunting, clearing or cultivating land, quarrying, burning lime, and to control the use of any roads other than public roads. The Ordinance provides for the payment of royalty at specified rates (currently 50% of those for Reserved Forests) for trees felled on private land.

Under the National Parks System Act the Minister can declare any specified area of Crown Land to be a national park, nature reserve, wild life sanctuary or national monument. He may make rules for the proper conduct or management of such areas, the overall administration of which is the responsibility of the Chief Forest Officer. The Ancient Monuments and Antiquity Act, presently administered by the Minister of Education, vests the ownership of all ancient monuments and antiquities in the Crown and provides firmly for their protection.

The Crown Lands Ordinance (under which no Regulations have yet been made) applies to all lands (other than Reserved Forest) not already "located" or granted, including any lands acquired by or ceded to the Crown. They are classified as town, suburban, rural or mineral lands. This discussion relates to rural land. The Ordinance is administered by the Commissioner of Lands and Surveys on behalf of the Minister. Applications to purchase Crown land, supported by statements of intended use and plans for development, are sent to the Commissioner. The Minister may approve an outright land grant, conditional title, Location Ticket (as defined in section 8 and the second schedule of the Crown Land Act) or lease (usually the latter in the first instance), on such terms and conditions of occupancy (including stipulations as to cultivation) and at such rates or prices as he deems fit.

In the case of leased land, title is not usually given

before the expiry of two years in the case of Belizeans or three in the case of aliens. Non-fulfillment of the conditions (particularly regarding development and profitable occupation) of either leased or titled land can lead to cancellation in the case of the first or re-possession by the Government in the case of the latter. To encourage immigration, the Ordinance empowers the Minister to make free grants of land (not more than 20 acres (8 ha) per adult, or 10 acres (4 ha) per juvenile). The costs of land survey - usually done by the Department of Lands - are payable by the lessor or grantee of the land. All land grants, conditional freehold titles and Crown Land leases are recorded in Crown Land Books by the Registrar General, a fee being paid for this by the grantee. Although unlawful squatting is a punishable offence, squatters can, after stipulated periods, establish rights to the land they occupy.

Some areas of Crown Land in Toledo District have been declared Indian Reservations under the Ordinance, which permits such areas to be surveyed into lots to be held by individuals subject to good behaviour, leading to issuance by the Minister of free grants, leases or freehold title. The Ordinance gives the Minister power to treat unallocated portions of Reservations as Crown Land. The view is held in Belize that the Reservations will gradually fade away as the younger generation Maya develop a preference to have title to land as they develop settled systems of agriculture.

The Land Utilization Ordinance applies only to rural land. It is designed to strengthen government control over land use by introducing conditions when subdivisions are made. Like the Crown Lands Ordinance it lacks a policy or Rules to render it fully effective. It stipulates that any sub-division is subject to Ministerial approval in terms of the conditions he sees fit to impose. Application is made to the Commissioner with details of the proposal. This is considered by a Land Sub-division and Utilization Authority comprising the Commissioner, Chief Engineer, Chief Forest Officer, Chief Agricultural Officer (or their representatives), Assistant Secretary of the Ministry of Lands and Natural Resources (who is Secretary) and two persons appointed by the Minister responsible for lands. Following investigation and consideration the Authority submits it, with recommendations, to the Minister for approval. He may give this subject to any conditions deemed necessary, pertaining to the treatment of water catchment areas, clearing of forest or other vegetation, types of development in specific areas, tree felling and the like.

The Land Development Authority Ordinance is specific to agricultural development. The programme of the Authority set up under it has recently been placed in abeyance, presumably because it was at variance with the Government's declaration, in its 1986 Food and Agriculture Policy, that the development of the sector shall be rooted in a free enterprise economy. Nevertheless the main provisions are summarized here since, if actively applied, the wide powers it confers on the Authority could result in some lack of balance in the assignment of land to specific uses.

The Authority is administered by a Board comprising the Permanent Secretaries for Agriculture and Finance and 5 others appointed by the Minister. It is a body corporate with objectives and functions (subject to annually set programme policies) aimed at promoting agricultural development and improved production, through the acquisition of land, and the division and disposal of it by sale or lease, particularly to small farmers. It may enforce or restrict the forms of land use to be applied, improve infrastructure, engage in land development schemes, trade in fertilizers and other commodities required by the industry, own equipment for land development, acquire and provide development funds and generally advise, manage and assist development. On recommendations by the Board, the Minister may make regulations with respect to the control of erosion, water conservation, prohibition of cultivation by harmful methods and enforcement of conservation practices.

The Crown Land, Land Utilization, Forests, National Parks System and National Monuments and Antiquities laws represent a sound legal framework for allocation of land to the most appropriate uses, in accordance with Government's development priorities, in an organized, systematic manner. These laws also provide for controls to ensure proper land development practices. The interests of forestry, nature conservation and ancient monuments and relics are catered for. There is a clear implication that, before land is excised from Reserved Forest, it must revert in the first instance to Crown Land before being re-assigned to Private Land or any of the National Parks System categories. The implication of this is that since the overall transfer involves two steps, there could be two opportunities for any particular case to be examined before re-allocation is finalised.

Forest land transfer procedures in practice

Several departments and ministries, particularly Lands and Forestry, are concerned with land and its allocation and use. Both lack the staff and other resources to adequately perform even basic tasks that should be entailed. Above all, there is no overall land use policy or plan reflecting the concerns and interests of all departments involved in land use, and no mechanism for effective inter-departmental consultation. It is not therefore surprising that in practice land administration is conducted in an ad hoc, piecemeal manner. This situation has arisen in spite of, firstly, the good legal framework; secondly, a relatively rich literature of material relevant to land use, dating back many years and culminating more recently in the contribution of Wright et al (1959) and the ODNRI surveys; and thirdly, a relevant administrative framework, that although it exists does not function as it should.

Regulations to aid applications and administration of the existing legislation have not yet been promulgated in all cases. Thus, facilitating regulations have yet to be made under both the Crown Land and Land Utilization Ordinances. Similarly, though

the Land Development Authority Ordinance (currently apparently in abeyance) empowers the Minister to make regulations for soil and water conservation, no such regulations exist; nor is there an organization to enforce them. The lack of existence and enforcement of such mechanisms are deficiencies which should be rectified before too long in the interests of sustaining Belize's land developments, particularly in the agricultural sector.

The soil and vegetation survey and derived land capability classification of Wright et al (1959) is still used for most land use evaluation and decision making that is done. The more detailed recent up-dating by ODNRI for Toledo and Stann Creek Districts strengthens the basis for analysis of alternative land use in that area. It is desirable that it be augmented as soon as possible thereafter by a similar survey of northern Belize.

Good, detailed land capability information is an essential basis for sound land use policy, planning and allocation. For optimum effectiveness it is necessary however to extend the basic information in various ways, e.g. (i) the derivation of ecological zones such as the preliminary Life Zone scheme of Hartshorn et al (1984) (which requires refinement before it can be put to practical use), and (ii) economic analysis of returns from alternative uses. Until land capability information, with extensions of the types noted, is fully available for the formulation of land use policy and planning and the assessment of individual cases, its lack will be an impediment to development.

The Lands Department is severely hampered in applying the prescribed procedures, and carrying out the necessary analyses of land capability and use in a given situation, by shortage of professional and technical staff. For the same reasons, the Forest Department, which would expect to be fully consulted and involved in analysis of proposals to excise forest land, or transfer land from forest to alternative use, can do little but react in broad, general terms, without the depth necessary to ensure the soundness of land use decisions.

The current procedure regarding applications to lease Crown Land is for review by the most appropriate of many local Lands Committees that are scattered through the country (e.g. 19 in Corozal District alone). These are appointed by the Minister of Lands, usually at the request of local groups or the Department of Lands. They mainly comprise private citizens, with a secretary and a technical advisor from the Department. They meet approximately monthly. One or both of the Lands Department officials checks the parcel of land in question, as to the existence of squatters or any developments. The secretary checks the validity of the application and the local land registry records. Approved applications are sent to the Lands Department, checked against central records and then published in three consecutive issues of the Government Gazette. Such publication is not normally used as an opportunity for objections to be raised. Delays in grants of both leases and subsequent title are common since the Minister signs both himself.

Depending on location, it may take 6-12 weeks to secure a lease of Crown Land. Rentals are about 40% of the market rate for titled land. Conversion of a lease to title, once the conditions for land development have been complied with, takes only weeks. Lease holders usually desire to have clear title as early as possible.

Sub-division of private land (leasehold or titled) in rural areas is the responsibility of the Land Sub-Division and Utilization Committee, which is made up mainly of senior Government officials, with the Commissioner of Lands as Chairman. Since it lacks land use and development policy guidelines, technical staff support and a good information system, it tends to make ad hoc decisions. There is always a backlog of cases for consideration. Land survey is usually done by the Department, which charges for this service.

Under the Land Tax Act, 1982, an annual tax of 1% is payable on all privately owned rural land holdings exceeding 100 acres (40 ha), based on the principle of "unimproved value", i.e. the price that could be expected for it without improvements. Such valuations take into account location, land prices in the area, development potential, type of land, size of land and other relevant factors. It is designed (i) to raise revenue and (ii) to stimulate land development by raising the value of undeveloped land to that of developed holdings in the area. The tax is subject to review every 3 years, although the Minister can vary the rate at any time without notice. The level of the tax is low, and it has reportedly had no discernible effect yet on development, e.g. of large parcels of undeveloped agricultural land. The system therefore needs re-evaluation. When this is done, consideration might be given to some form of zonation to ensure equity in tax rates.

Thus, in practice, the process of transfer of land out of forest use and assignment to agricultural use is less subject to thorough analysis and scrutiny, and less systematic, than it ought to be. There is consequently a danger that opportunities to ensure that land is put to the most appropriate, sustainable use are lost. In recent cases of transfer of Reserved Forest land to agricultural use, the developers concerned identified the areas, in some cases already under tree plantations, as being suitable for their needs. They applied for leases to the Lands Department accordingly. In due course their proposals were passed to the Minister responsible for Forestry who had the authority to approve excision and presumably consulted appropriate officials before doing so. Although not necessarily in all cases incorrect in terms of land capability, the decisions appear to have been made without rigorous analysis and therefore arbitrarily.

Perhaps because of the lack of competition for land in the early days of the Forest Department, the procedure for reservation and dereservation now appears to be very arbitrary, with no provision for public inquiries. Because of the arbitrary procedures for reservation, the Forest Department has never been

called to justify the size of the permanent forest estate. The 1954 national forest policy gives direct justification for the maintenance of an estate for protection, the production of fuelwood and rough building and fencing materials, nature reserves, land unsuitable for permanent agriculture and land which is capable of producing a greater sustained financial return if retained as forest than if used for other purposes. The forest policy states that once constituted a Forest Reserve "will only be dereserved wholly or in part by the Governor in Council as a result of some over-riding public necessity".

As was indicated in the previous section, it was not clear to the TFAP Mission that recent decisions to excise parts of the forest estate have in fact resulted from some over-riding public necessity, nor that the released land has been developed so as to obtain a greater sustained financial return than if it had been retained under forest. Equally, the consequences of illegal encroachment, leading eventually to de facto legal excisions from Reserved Forest, are of growing concern. The extent of the areas involved may not always be large. However, the process is insidious and breeds disrespect of authority. Moreover, a helicopter flight during the TFAP Mission confirmed that Mayan farmers are actively increasing their encroachments in the Columbia River Forest Reserve and threatening invasion of the Maya Mountains Forest Reserve. Mestizo farmers are now dangerously close to the northern boundary of pine forest, inside the Mountain Pine Ridge Forest Reserve.

Decisions about the permanent forest estate must be based on hard data about its value compared with other forms of land use. Neither of the Departments of Agriculture or Forestry has given much emphasis to estimates of productivity from different soils, so neither is able to advise on changes in land use on agronomic grounds. Such information is essential if Government is to be able to assess the consequences of decisions to dereserve forest which had been under management and not to prosecute illegal encroachment.

3.3 FOREST MANAGEMENT

3.3.1 Extent and composition of the forest resource

Available information about the forest resource has been outlined in Section 3.2.2, and is discussed in detail in Appendix 10. As has been pointed out, the fact that 93% of the land area of Belize is classified as "forest land" is best viewed as an indication of the potential extent of the forest cover in the absence of human influence.

It will be recalled that several estimates exist of the extent and distribution of forest cover (see Appendix 10); but there is insufficient evidence to allow conclusions to be arrived at as to the actual situation. The most recent set of estimates of how the original forest cover was distributed across the different land use categories (Hartshorn et al 1984) are reproduced in Table 3.8. Table 3.9 shows the various estimates of areas for past and present Forest Reserves. (Information about individual Forest Reserves is to be found in Appendix 11).

Not all the Forest Reserves have been inventoried and only one area of private land has been sampled. The floristic composition of the forest resource varies according to the soil type, climate, hurricane and fire damage. At present, it would be misleading, indeed meaningless, to suggest an average composition and structure for Belizean forests.

However, over the years a substantial amount of field work has been undertaken in order to classify and map forest types, and to carry out inventories of the main Forest Reserve areas (see Table 3.9). There is thus a considerable base of information upon which usable estimates of the content, and potential, of the resource apparently could be based (see Appendix 10). This is discussed further in Section 4.3.1.

3.3.2 Changes in composition of the forest resource

For the Tropical Forestry Action Plan, the changes in composition of the forest resource are those which occur or could occur within a human generation. The slow alterations due to climatic change and soil development or degradation are mainly outside the influence of the Forest Department. The four factors which have a direct effect upon forest management are agriculture, fire, hurricane and logging. These are discussed in turn.

Agriculture causes the most dramatic changes in forest composition; mainly by removing the forest completely, either temporarily or permanently. The impact of different kinds of agriculture on tree cover has been described in Section 3.2.3, which describes the balance between forest and agriculture. As was noted then, there is little perceived need to conserve forest in farming areas. The direct effect of farming on the permanent forest estate is mainly through the destruction caused by escaping fires.

Table 3.9: Forest Reserves of Belize: Estimates of area and timing of inventory.

Forest Reserve	Admin. Div.	ForDept 1977 miles ² (km ²)	Hartshorn 1984 miles ² (km ²)	ForDept 1988 miles ² (km ²)	Dates of inventory fieldwork
Bocotora	Southern	(incl. in Manatee FR)			none
Chiquibul	Western	713.71 (1849.29)	713 (1849)	713.71 (1849.29)	1969-71
Cockscomb Basin	Southern	Not FR	154 (399)	154 (398.87)	1977
Columbia River	Toledo	160.84 (416.69)	161 (417)	160.84 (416.69)	1975-76
Commerce Bight	Southern	17.04 (44.15)	4.6 (12)	14.53 (37.64)	none
Deep River	Southern	227.9 (590.53)	228 (591)	227.9 (590.53)	Pine 1970 Hwd 75-76
Freshwater Creek	Northern	115.97 (300.45)	115 (300)	114.3 (296.20)	none
Golden Stream	Southern	(Dereserved in 1950)			none
Grant's Work	Southern	28.99 (75.11)	15 (39)	12.50 ? (32.40)	
Honey Jib Camp	Northern	(included in Freshwater Creek)			
Iguana Creek	Northern	(Dereserved in the 1960s)			none
Machaca Creek	Toledo	9.17 (23.78)	8.8 (23)	8.68 (22.50)	1981
Manatee	Southern	176.96 (458.44)	117 (459)	176.96 (458.15)	none
Mango Creek	Southern	102.90 (266.59)	103 (267)	55.6 (144.04)	1970
Maskalls	Northern	(Dereserved in 1950s?)			none
Maya Mountains	Southern	361.95 (937.69)	358 (927)	360.42 (933.74)	1975-76
Mountain Pine Ridge	Western	198.71 (514.78)	199 (515)	198.71 (514.78)	1970+80 +82
Sibun	Southern	165.88 (429.75)	166 (430)	165.88 (429.75)	none
Silk Grass	Southern	11.00 (28.49)	11 (29)	10.19 (26.41)	Gmelina78
Sittee River	Southern	146.71 (380.09)	147 (381)	146.47 (379.46)	none
Swazey-Bladen	Southern	23.99 (62.16)	24 (62)	23.99 (62.16)	1970
Vaca	Northern	(no information)			
Xcanha	Northern	(no information)			
Yalbac Creek	Northern	(dereserved in 1950s ?)			none

The influence of fire is clearly greatest where there is drought stress and a highly inflammable vegetation. In the early days of the Forest Department it was noted that fire kept broadleaved forest species from invading and replacing pine on soils which otherwise might have carried high forest. Pines are liable to be killed by fire when they are less than 10 ft (3 m) tall and are liable to damage at any age and size. The old-growth pines on the Southern Coastal Plain were frequently fire-scarred on the butt logs, internally and externally. The damage allows the ingress of wood-rotting fungi and termites and materially reduces the net yield.

Fire after logging of pine forests appears to stimulate seed production of the remaining seedbearers and certainly enhances the successful germination on bared ground. Controlled fire reduces the fuel loading and hence the danger of massive crown fires. It also helps to eliminate the hardwoods which are secondary hosts of Cronartium cone rust on the pines. Techniques for controlled burning were developed on the Mountain Pine Ridge and have been improved by subsequent work at ESNACIFOR in the Republic of Honduras (Wolffsohn 1981).

The Mountain Pine Ridge is still a relatively remote area and the fires are usually either avoidable or controllable, given adequately maintained and suitable equipment and a well motivated, trained and led work-force. On the Southern Coastal Plain (SCP) the Forest Department has had much less success in fire control, even in the pine plantations near the Savanna station. The great majority of the lowland fires on the SCP are caused by arson, by hunters after game. The staffing and equipment of the Forest Department have been so reduced that the SCP fire protection scheme (Johnson 1974) has never been implemented successfully. The priority areas for fire control outlined in the scheme have been so affected by wildfire that the stocking of healthy live trees appears to have been reduced below any level which would justify the expense. (However, this is a qualitative judgement of the TFAF Mission and does not concur with the view of the ODNRI land resource survey team; they were impressed by the stocking of living trees on the area of assisted natural regeneration northwest of the Savanna plantations.)

Fire in broadleaved forest is relatively rare. Wolffsohn (1967) suggested that about once in every five or ten years the dry season is intense enough to create hazardous conditions. The vegetation is generally too damp to burn easily. However, after hurricane damage there may be tangled masses of debris. Both Belize and the Republic of Honduras have experienced massive fires in broadleaved forest after big storms. These fires are usually started by farmers and may be accidental escapes from farm clearings. The debris is such that access and movement is very difficult. Consequently, these fires are difficult to suppress unless they can be reached at a very early stage. Fire in broadleaved forest may stimulate the regeneration of mahogany and cedar but more usually there is complete destruction of forest and replacement by persistent bracken, which is itself a

fire hazard (Johnson & Chaffey 1973).

Hurricanes are much less predictable than fires. Most hurricanes track across the country from east to west. The exceptionally devastating hurricane Hattie in 1961, with winds of over 185 mph (300 kph), affected the whole country and followed a northeast to southwest track. All the areas which received silvicultural tending in the 1920s to encourage mahogany regeneration and growth have been damaged or destroyed. All the Forest Department plantations have been more or less damaged.

A number of Forest Department reports, and publications from other tropical countries, indicate the changes in forest composition which hurricanes can cause. Damage generally increases with tree size. Heavily branched and heavily foliated species suffer more than those with light open crowns. However, trees with very light timber, though strong for their weight, can be completely destroyed. Trees which shed their leaves and small branches at relatively low wind speeds appear to suffer less damage and to be able to recover faster than those without these characteristics.

Since some forests of Belize still show the effect of hurricane Hattie, after more than a quarter of a century, a rapid and preliminary assessment of wind hazard has been made as part of the TFAP exercise. (The data sources are given in Appendix 12). Twenty hurricanes were recorded from 1787. Only five of these occurred in the century 1788-1883, at intervals of 14-37 years. It seems more likely that other storms occurred but were not recorded than that the frequency has changed in the following century. The risk analysis therefore takes the data from 1915 to 1987, 72 years with 15 hurricanes. The average interval is 5 years but intervals have varied from two in a single year to 11 years. The northern half of Belize has been struck less often, an average of once in 18 years; Toledo District, once in 14 years; Stann Creek, once in 12 years.

Hurricane Hattie in 1961 caused severe damage over a swathe 50 miles (80 km) wide. However, it seemed reasonable to take a lower figure of 15 miles (25 km) for the more common and less severe hurricanes. If a district is 45 miles (75 km) north to south and hurricanes conveniently strike at equal spacing without overlap, severe damage at any one place might be caused at intervals of $45/15$ ($75/25$) \times 15 = 45 years. This time is sufficient to grow a good-sized tropical tree. However, the repeated damage noted in the Forest Department's annual reports shows that there is overlap. The return period may be less than 45 years in some areas but the existence of very large trees in other parts of Belize shows that the risk is variable. Before investing in forest management in the Forest Reserves, or encouraging the private sector to manage forest on alienated land, the Forest Department needs to be sure that the risk is reasonable. There are some indications that coastal hills provide shelter, so that the Cockscomb Basin is a protected area, and that northwestern Belize has been free of hurricanes for over a century.

The Forest Department should obtain assistance from meteorologists to map the tracks and damage zones of known hurricanes, and to prepare hazard maps. High-risk areas should have only low-intensity forest management, and vice-versa.

The fourth major influence on forest composition is that of logging. As has been noted earlier, for over two centuries the major export from Belize was mahogany, as unprocessed logs. Although there are very occasional occurrences of "reefs" with as many as 10 trees per acre (25 per hectare), a "rich" mahogany forest in Belize contains one to two trees per acre (two to five per hectare). Manual log rolling was replaced by hauling with oxen and in this century at first by petrol and later by diesel tractors. The largest company built a railway but replaced it after a few decades with a road. The gradually increasing power of the logging machinery allowed the exploiters to penetrate further and further from the river banks. The widespread occurrence of mahogany on privately owned land, though at low stocking, and the ready market for the timber have combined to provide little incentive to broaden the range of timbers extracted.

The roads and tractor skid trails have been built mostly over earlier ox logging tracks and thus tend to run on the lowest and flattest ground. It is not surprising that the trails and roads bulldozed in vertisols without camber, drainage or surfacing are generally usable for only about 100 days per year.

In the broadleaved forest, the repeated combing of the forest for only mahogany and cedar has certainly reduced the population of large trees of these species. The approximate equality of yields recorded from forest of the Belize Estate & Produce Co., harvested over thirty years at decade intervals, has been possible only because the cutting girth limit has been reduced. The low density of logged trees and the repeated use of old trails has kept the damage from logging to a very low level. The wind-dispersed mahogany and cedar have benefitted from the openings caused by exploitation although it is not possible to say how sustained has been the improvement in the regeneration because there are no formal experiments or repeatedly measured plots.

Harvesting of the natural pine has taken place only in this century. Logging has been interrupted by hurricanes. After Hattie in 1961, when felling controls were removed, all the old-growth pine was felled, except for a few isolated trees. The retention of seed trees and a controlled burn after logging has usually given excellent natural regeneration; heavy seeding occurs naturally about one year in three. Logging followed by silviculture has thus been beneficial to the composition of pine forest.

3.3.3 Imbalances between the resource and output

Changes in the structure of the output are necessary to halt the degradation of the growing stock, which is contrary to the national Forest Policy. The decline of the growing stock is caused partly by the preferential removal of a commercially valuable but small proportion of the floristic composition, and partly by the selective removal of large trees at frequent intervals. This section deals with the imbalance in species preference. The imbalance with the dynamic ecology and silvicultural system is dealt with in the following section.

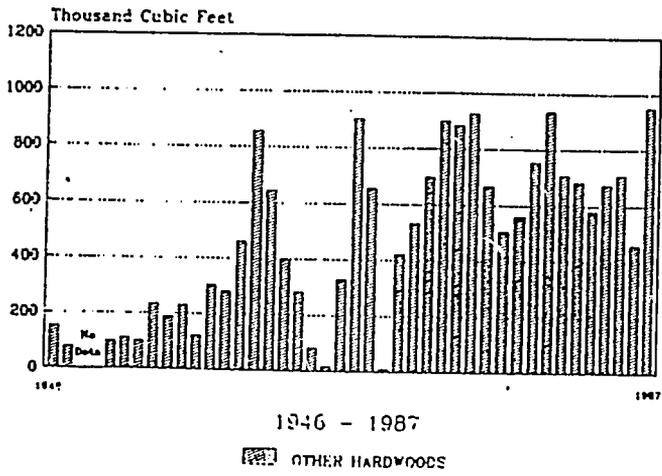
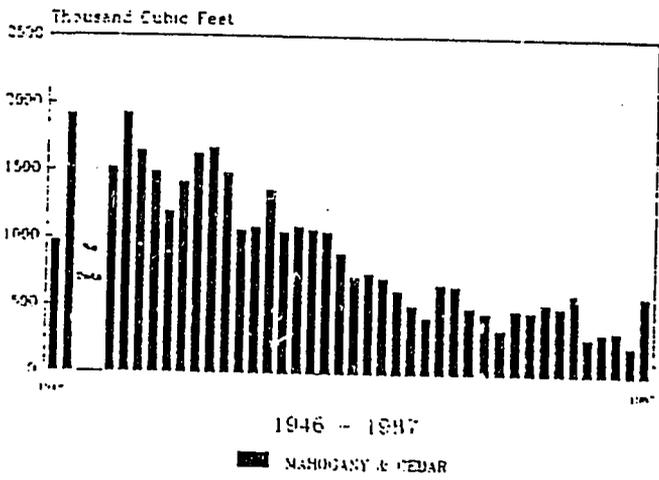
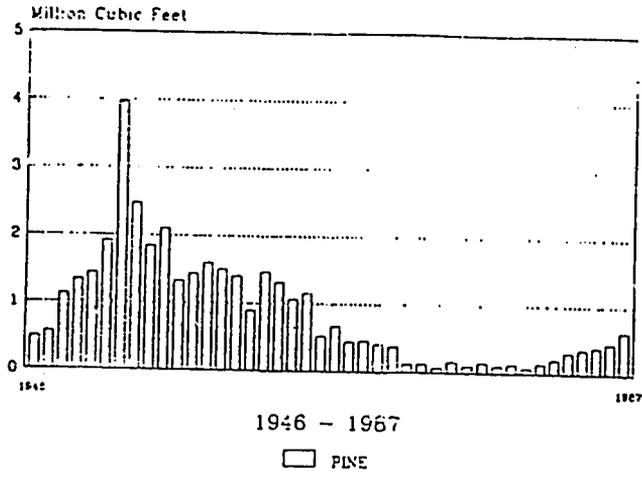
There have been major differences in the manner of recording, and numerous inconsistencies in various series of reports on, past log production. Nevertheless, a series showing log output trends has been derived in the course of the TFAP exercise. These data are compatible with most past reporting but have been adjusted for obvious errors and inconsistencies. They are shown in Appendix 5, and the trends are well illustrated in Figure 3.2. From this series some important shifts are evident.

In the late 1920s, total log harvest was in the order of 2.5 million ft³ (in excess of 70,000 m³). Data is lacking for the period from 1930 to 1945. In the immediate post World War II period, production recovered quickly to earlier levels, and grew rapidly to a peak of 5.7 million ft³ (160,000 m³) in 1952. Thereafter, production declined in a fluctuating but continuous manner to a low of 1 million ft³ (28,000 m³) in 1977. For a decade, output fluctuated from 1.1 to 1.5 million ft³ (31,000-42,000 m³) with no apparent trend. However, a rapid increase in 1987 brought production to nearly 2.2 million ft³ (62,000 m³), the highest level since 1967.

Changes in species composition are striking. The harvest in 1928/29 was 92% mahogany, with cedar, other hardwoods and pine making up about equal parts of the remainder. Cedar has never exceeded 8% of the total cut, but the pine harvest grew rapidly to a peak of nearly 4 million ft³ (112,000 m³) in 1952, when it comprised more than two-thirds of the total. Although pine output declined consistently and quite rapidly, it made up at least a third of the harvest until the mid 1960s. In the 1970's it fell to lows of less than 100,000 ft³ (2,800 m³) when it comprised as little as 5% of the total. In the 1980s pine production has recovered to more than 600,000 ft³ (17,000 m³) and nearly a third of output.

The combined share of mahogany and cedar has declined from more than half in the late 1940's and early 1950's to between 20 to 30% in recent years. The share of hardwoods other than mahogany and cedar grew modestly until the late 1950's and early 1960's, when it made up as much as one-quarter of the output. Santa Maria was an important species in this development. In the early 1970's, the share of this group increased rapidly and comprised more than one-half of the total, peaking in 1980 at 61%. Thereafter, with the recovering pine cut, the share has declined to nearly 40%. Nevertheless, the highest production

Figure 3.2: Log Production in Belize by Species Group.



volume recorded for hardwoods other than mahogany and cedar was in 1987. The large increase in 1987 is believed to be due to the lifting of import restrictions in Mexico and a consequent buoyant export market.

As the Forest Department does not keep files for activities in individual Forest Reserves, records were not available to show how much of the output has been coming from the permanent forest estate; or whether this part of overall production has been increasing, as intended by the forest policy. The data in Table 3.10 below, which were compiled especially for the TFAP exercise by the Forest Department, show output in 1987.

Table 3.10: 1987 Log Production in Thousand Cubic Feet (m³).

	Forest Reserves	Other land	Total
Mahogany	142 (4.0)	464 (13.0)	606 (17.0)
Cedar	---	11 (0.31)	11 (0.31)
Mahogany/Cedar	4 (0.11)	1 (0.03)	5 (0.14)
Ziricote	2 (0.06)	1 (0.03)	3 (0.08)
Other Hardwoods	144 (4.0)	809 (22.7)	953 (27.0)
Pine	559 (15.7)	44 (1.2)	603 (16.9)
Total	851 (23.8)	1,330 (37.2)	2,181 (61.1)

In that year, Forest Reserves accounted for 39% of the total, underlying the importance of Private and National Lands as sources of timber at present. Forest Reserves accounted for nearly all the pine; and pine made up 60% of all production from Forest Reserves. But more 77% of the mahogany and cedar, and 85% of the other hardwoods category, came from outside the Forest Reserves.

The information in Table 3.11 is presented to show the imbalance between resource composition and the structure of production. The table has been prepared from the 1975 inventory of 783 miles² (2,028 km²) of the Pelize Estate & Produce Co. (BEC), considered to be the richest mahogany forest in Belize, even after over a century of logging. Dbh is in cm; stocking is in trees per hectare; commercial volumes are in ft³/acre (m³/ha) and include about 7% defective timber.

If 23.5 inches (60 cm) dbh is taken, for the purpose of this discussion, as the cutting limit, then about 13% of the commercial timber volume (22 ft³ per acre, 1.5 m³/ha, or 4 trees per 25 acres/10 hectares) is in primary hardwoods. Large trees of mahogany and chicle dominate this forest. The latter provides the major component of the very hard dark timber, 65 ft³ per acre (4.5 m³/ha), at a stocking of 16 trees per 25 acres (10 ha). The total standing volume over 4 inches (10 cm) dbh is a low 520 ft³ per acre (36 m³/ha), with 8% in primary hardwoods. Nationally, the primary hardwoods comprise a third or more of the total log production. Since the BEC area is probably the richest commercial forest in Belize, logging of the primary hardwoods is

producing about three times the proportion of the primaries in relation to the secondary hardwoods in the forest resource. It is not possible to prove from the available data that the primary hardwoods are being overcut, because the remaining volume is unknown. However, the narrative information in reports from the 1920s onwards, plus the table of national annual log production, indicates that this must be so.

Table 3.11: BEC Inventory Data.

Species	dbh	stocking	vol/acre (ha)
Cedrela + Swietenia	60-<110	0.4	18.6 (1.3)
soft light	60-<110	0.2	11.4 (0.8)
medium soft light	60-<110	0.2	7.1 (0.5)
moderate hard	60-<110	0.0	5.7 (0.4)
hard light	60-<110	0.6	24.3 (1.7)
hard dark	60-<110	0.4	20.0 (1.4)
very hard dark	60-<110	1.6	61.4 (4.3)
others	60-<110	0.3	12.9 (0.9)
Total	60-<110	3.9	172.7(11.3)
Cedrela + Swietenia	110-<150	0.0	2.9 (0.2)
soft light	110-<150	0.0	1.4 (0.1)
medium soft light	110-<150	0.0	0.0 (0.0)
moderate hard	110-<150	0.0	0.0 (0.0)
hard light	110-<150	0.0	0.0 (0.0)
hard dark	110-<150	0.0	0.0 (0.0)
very hard dark	110-<150	0.0	2.9 (0.2)
others	110-<150	0.0	0.0 (0.0)
Total	110-<150	0.1	7.2 (0.5)
Cedrela + Swietenia	>=10	4.1	41.4 (2.9)
soft light	>=10	1.2	22.9 (1.6)
medium soft light	>=10	1.7	30.0 (2.1)
moderate hard	>=10	1.4	24.3 (1.7)
hard light	>=10	4.5	98.6 (6.9)
hard dark	>=10	4.9	70.0 (4.9)
very hard dark	>=10	13.0	168.6(11.8)
others	>=10	4.7	58.6 (4.1)
Total	>=10	35.6	514.4(36.0)

Similarly, the Forest Department's data does not permit a definitive statement that other hardwoods are being undercut. There are no yield plots in the forests presently being logged, the licensees and permit holders are not required to delimit logging blocks within defined annual coupes, and records are kept only for each licence area as a single entity. The recorded production from broadleaved Forest Reserves in 1987 is so small that no conclusion could be drawn. Nevertheless, the narrative

information again indicates a substantial under-use of secondary hardwoods.

The interpretation of what data does exist is complicated by the situation regarding forest on private land. There are a number of anomalies in the legislation, and the present position is unsatisfactory to both the landowner and the Forest Department. On private land, royalty is payable at half the rate levied in Forest Reserves. The cutting girth limit for logging operates on private land but there is nothing to stop a landowner from cutting and burning the whole forest on his estate. Indeed, the terms of a lease or development concession may encourage the wholesale removal of forest. Some of the primary hardwood logs are certainly coming from land being cleared for temporary or permanent agriculture but the Forest Department records do not provide any indication of the quantities involved.

The position concerning the pine forest is somewhat different. The old-growth pine was almost totally removed by the mid 1960s. The second-generation pine on the Southern Coastal Plain (SCP) has been progressively degraded by fire, which the Forest Department is less and less able to suppress. The SCP pine is not further considered here for management. In the Mountain Pine Ridge Forest Reserve, the new generation dates from the early 1950s onwards. The present growing stock has about 723 ft³/acre (50 m³/ha) and a growth rate of less than 29 ft³/acre (2 m³/ha) per year. The exploitation procedure is to log all trees as they reach the apparently arbitrary cutting limit of 14 inches (35 cm) dbh (42" girth at 18" agl), with the licensees being able to roam throughout the licence areas. An analysis of the Mountain Pine Ridge growing stock, and of the present management system, is given in Appendix 13.

3.3.4 Inappropriate and unsustainable management systems

Given the nature of the desirable species in the Belizean forests, the goal should be to sustain, or enhance, the proportion of species with preferred utilization characteristics by ensuring that the best phenotypes of such species are the predominant seeders. The current system, involving repeated re-logging of the largest trees by any one licensee, and repeated licensing of a given area of forest without allowing a period of recuperation, has the opposite effect.

A forest managed by girth limits without any area control of exploitation is implicitly under a polycyclic selection system. This type of silviculture can be practised under the following combination of circumstances:

- the commercial species are sufficiently represented throughout the diameter classes to replace continuously the trees removed as they reach the cutting size;
- sufficient undergirth trees are protected from logging damage to maintain the net output;
- the cutting cycle is matched to the growth rate so that the logger does not return to a stand until the trees have grown

to commercial size.

In practice, a polycyclic selection system in tropical rainforest depends on the presence of relatively shade-tolerant species and strict logging rules to minimize damage to the undergrowth trees.

In Belize, these conditions do not apply. Although experimental data are lacking, the observational evidence is that the majority of the commercial species are rather intolerant of shade, after the seedling stage, and not well represented through the diameter classes. This is indeed a common feature of tropical rainforest. It is particularly to be expected in Belize where Classic Mayan populations may have farmed intensively only a millennium ago, and where hurricane damage is always likely to increase the proportion of faster-growing light-demanding species which are ecological pioneers.

There are often relatively few trees of such species in the intermediate size classes because they grow rapidly and then cut off the light to succeeding cohorts of their own kind. The forests thus tend to contain a narrow spread of age classes. If the largest trees are repeatedly removed in a polycyclic selection system, those will be just those faster-growing specimens which should be the seed-bearers for improving the next generation and the less-desirable slower-growing trees will be left. Management for sustained or improved yield requires that one generation should be removed entirely to allow the next, seedling, generation to come through.

The pines are an extreme case of this pioneer-type ecological tendency. A polycyclic selection system is entirely inappropriate. The present practice in Belize of felling individual trees as they reach an arbitrary girth will remove the genetic traits for fast-growing trees from the population, and thus is absolutely contrary to the principle of sustained yield.

The girth limit system is thus not suitable for Belizean forests. The method used to decide on the cutting girths for different species is not clear; the TFAP Mission was unable to find any document which explained how the limits were devised. Any system without an obvious rational basis is liable to abuse and to be subject to political pressure for changes in favour of the logging companies.

The forest legislation does not give the Forest Department enough control over the exploitation system. Moreover, the Forest Department has been unable to deploy all the powers that the legislation does provide. For example, the forest licence for logging allows the Forest Department to direct the exploiter to log in a defined part of his licence area but, at least at the time of the TFAP, this power to define annual coupes and logging blocks was not being used. Even if the licensee reports his output, the Forest Department cannot associate the output with specific parts of the licence area and thus compare inventory volumes and sizes with output log volumes and sizes. Without block closing inspections and diagnostic samplings the Forest

Department cannot know the state of the forest after the logging.

There are no lists of obligatory tree species and sizes which must be removed by the licensee, with penalties for non-removal. Pre-exploitation marking of regeneration, as a warning to careless loggers, is not practised, nor are fines imposed for damaging regeneration. The powers in the legislation to direct and control road-building and skid-trail layout are not used. Charges for the use of Forest Department-constructed roads are minimal.

3.3.5 The "Royalty" issue

Basically, the only payment for timber removed from the licence area is the royalty¹, charged at a rate per cubic foot removed. Therefore, in striving to maximize profits, the concessionaire concentrates on those trees that will bring best returns per unit volume harvested rather than on per unit area harvested, provided he has subsequent access to other cutting areas. Thus, trees with positive marginal values may be left at time of cutting.

The variation in royalty rates between species is relatively small (Appendix 14), compared with the differences in the world market values of the timbers. The differences in the existing royalty rates do not adequately reflect the margin between (1) the wide differences in market values of different species and qualities, and (2) relatively uniform logging costs in a particular location. There is no price-size gradient, nor any difference in rates reflecting location or other aspects of the relative ease of the logging opportunity. As rates have not been changed since 1980, they fail to show any effect of inflation up to the present - or indeed of any real cost changes in logging or milling, or of price variation of logs or sawnwood on the international market.

In recent years, royalties have been in the order of 5% of estimated gross value of forest product output. It is apparent that the royalty rates are not any precise measure of standing tree value. This gives to royalty the aspect of a tax rather than a market price.

In short, as royalties have reflected only marginally the different values of woods of various species or grades and have not been related to the ease or difficulty of harvesting, they have not been effective as a tool to influence forest management, or sector development. As a result, the more desirable species, especially in more accessible locations have been nearly exhausted while secondary species have been harvested to only a fraction of their potential.

¹Royalty is thus a charge for cutting standing timber. In many countries charges of this kind are called "stumpage". Often stumpage is based on an estimate of the value of the standing timber.

Another important issue is the flow of royalty revenues. Much earlier, revenues went directly to the Forest Department, but for some time royalties have gone to the Rent and Royalty account of Government Recurrent Revenue. As a result there is no possibility of direct reallocation of these revenues to forest renewal. Rather this renewal, if done at all, must be done through the regular expenditure allocations. This causes the Forest Department to concentrate more on obtaining a share of this expenditure and less on optimizing revenue and management tool aspects of royalties.

Nor has the government maximized its direct revenue possibilities from forest output. Not only are royalty rates very low, but other potential sources of revenue have been neglected. No attempt has been made to raise revenue from tourism, although tourist access to Forest Reserves certainly imposes a cost on management, for road maintenance and fire suppression. As is noted later, sales of seeds of some tree species also have a substantial unexploited potential as a revenue earner.

3.3.6 Potentials for more appropriate management

Most of these characteristics of the present systems of managing the forest resource are of course well known. They are recanted here in order to facilitate discussion of ways of strengthening management. This will be the subject of Section 4.3 of the report. The present section just notes a number of factors which favour active management of the forest resource in Belize.

The land area covered by forest is still very large compared with the area under other forms of land use. The demand for forested land for temporary and permanent agriculture is quite small, from a small rural population. The logging companies are also few and small, and have little investment compared with the potential value of the forest products. The Forest Policy provides for the establishment and defence of a permanent forest estate. The forest legislation gives a reasonable legal basis for improved management.

The large area of forest already gazetted, and the low intensity of current and previous exploitation, together allow the Forest Department to devise the management systems which would be most appropriate for a sustained or increasing yield. The Forest Department has accumulated information on forest types and their distributions from the 1920s to the 1950s, and Belize enjoys a large volume of repeated coverage by aerial photography for updated and more extensive mapping. Although records about the location and quantity of extraction are weak, the low intensity of logging means that existing inventory data can be re-worked to provide a basis for forest management plans; the data have not been outdated by either logging or hurricane damage, since most of the inventories postdate the major devastation of hurricane Hattie in 1961. In the special case of the Mountain Pine Ridge, where logging removed the old-growth

pine forest almost completely, the state of the new generation has been surveyed in 1970 and 1980 and there are both yield plots and some experiments to provide a basic set of growth data.

Management plans have been prepared since the 1950s for the permanent forest estate and were in operation in that decade. Draft plans were prepared after the inventories of Forest Reserves in the 1970s and early 1980s and provide a basis for improved day-to-day management.

3.3.7 Plantation forests

Since the earliest days of the Forest Department there has been concern about the low stocking of the commercially desirable species in the Belizean forests. A variety of methods were attempted to increase the regeneration stocking of the primary hardwoods and to improve the rate of growth of adolescent trees in the natural forest. These empirical trials were supplemented by small-scale planting trials.

Pine was also planted from the 1940s on the Southern Coastal Plain, in an attempt to raise the stocking on non-agricultural land to the point where management would be economic. The interest of the Forest Department in pine was heightened by the increased demand for softwoods for reconstruction in Europe after World War II (Lamb 1988, personal communication). The pine plantings, still on an ad hoc basis and without formal experimentation, expanded considerably in the 1950s and were the particular target of criticism during the review of economic policy at the end of that decade (Downie 1959).

As was noted earlier, the objection of Downie was to the "investment of large sums of public money in the creation of forest capital" when there was, and is, an enormous amount of forest already in existence. Downie proposed the "expenditure on establishing plantations only if exceptional justification can be produced".

The rationale underlying these arguments would appear to be still relevant today. Belize with its population of 176,000 offers only a small revenue base for government expenditure. The demands on that base are considerable and growing. In this situation, the government is obviously concerned to satisfy the country's domestic and developmental needs for forest products in the most efficient way, and to invest in the forest sector to the extent that this is likely to be the best use of the scarce resources it will absorb.

Given the very large existing resource of forest capital, it is likely that these goals will be better achieved by investment in management of the existing forest than in creation of planted forest resources. Returns from the former would certainly materialize sooner, and are likely to be more efficient. At present the existing forest seem more than adequate in terms of extent and distribution to provide, if adequately managed, for

both the raw material and conservation requirements of the country.

A further consideration which militates against government involvement in the creation of plantations is the extended financial commitment which is required to bring them to maturity. Plantations are inherently unnatural and unstable, an attempt to arrest the progress of ecological succession and diversification. Weed growth will overwhelm them and fire destroy them unless there is sustained expenditure on maintenance. The tropics afford all too many examples of plantations begun in good faith and enthusiasm but neglected or abandoned when the operational budgets of forest departments have been reduced. Natural forests are more resilient and their much lower per hectare yields are compensated for by their much lower costs of maintenance. The failures of mahogany and, later, Gmelina plantations in Silk Grass Forest Reserve were due at least as much to neglect of maintenance as to defects in forestry technique.

Moreover, the relatively infertile soils and high cost of labour create a presumption against most forest plantations in Belize. An exception to this statement is suggested by the single successful Forest Department attempt at plantations: the taungya mahogany in Columbia River Forest Reserve, established by direct-seeding into the staple maize crops at wide spacing during 1955-1964. Even though these plantations have received negligible attention after the establishment phase, and 1,240 acres (500 ha) of the original 1,730 acres (700 ha) have been destroyed by later farming, the survival and growth of the remaining trees is remarkable. At minuscule expense to government, the taungya plantations at 23-33 years old in 1981 showed about ten times the volume per acre/hectare of mahogany which exists in the natural forest of the former Belize Estate & Produce Co. The underlying geology of the Toledo Beds provides a relatively gentle topography and an unusually fertile soil. The Forest Department could well promote such agroforestry among the Mopan and Ketchi Maya, both in the maize farms and in the cacao plantations.

This agroforestry need not be confined to mahogany. Evans (1983) argued that the high price paid by boat-builders for teak logs from experiments in Silk Grass Forest Reserve should favour teak over mahogany. Best trees in experiment SR-30 reached 16-18 inches (40-45 cm) dbh and 82 ft (25 m) total height at age 24 years. A considerable literature exists on teak taungya in the tropics, and there are current examples in Trinidad. The indigenous mahogany in Belize is always attacked to some extent by the indigenous pyralid shootborer Hypsipyla grandella, but so far the teak is pest-free. It would be prudent to repeat the Danish/Thai international teak provenance trials in the Columbia River Forest Reserve, since conditions there are appreciably different from those in Silk Grass Forest Reserve (trials SR-67 and SR-68, planted in 1979).

Moreover there may be opportunities for commercially viable

forest plantations on some of the areas being allocated to tree crops. Mention has already been made of one company which has announced tentative plans to grow pine on some parts of the estate it has acquired primarily to raise citrus. However, plantations which can attract private finance should not need to be funded or executed by government; though there could be a role for the latter in the area of research in the form of species trials.

The ambitious proposals of the Belize Estate & Produce Co. to build a power station to generate electricity from wood-fueled steam boilers were promoted in the early 1980s. The proposals did not come to fruition but raised a good deal of local interest in energy plantations. The Forest Department estimated a need for 10,000 acres (4,000 ha) with an MAI of 430 ft³/acre (30 m³/ha) per year; more realistically a scheme would need 30-37,500 acres (12-15,000 ha) at 145 ft³/acre (10 m³/ha) per year. The research activities of the Forest Department have been focused since the 1950s on trials for plantations for saw-timber, so results could not be applied directly to the wood energy proposals. However, there is now such a large quantity of work on species suitable for wood fuel in Central America (the ROCAP/CATIE regional fuelwood and alternative energy project 1980-85 and its successor MADELENA) that there would seem to be no need at present for adaptive research in Belize.

Where there has been substantial deforestation in an essentially rural area, there may be grounds for creating woodlots to supply the needs of rural communities if these cannot be met by on-farm agroforestry (trees in fence lines, pasture trees, windbreaks, etc.). Such woodlots are being promoted in Corozal District by NGOs with US-AID financial assistance. Woodlots would also be appropriate to supply fuel to the lime kilns beside the Hummingbird Highway, since this is a concentrated local demand for high-density wood.

3.3.6 OTHER FOREST PRODUCTS

Wood Fuels

Estimates of annual fuelwood consumption by the Forest Department and by FAO have been very general and have varied widely between roughly 3 and 26 ft³ (0.08-0.73 m³) per capita. Documented information of actual surveys appears very limited. Some evidence on household use is available from the Census of 1980 and from a household consumption survey of the same year.

According to Census data only 31.3% of households reported wood or charcoal as the type of cooking fuel used. Although less than 1% of households in Belize City use wood or charcoal as cooking fuel, the corresponding share for Toledo is nearly 68%. It should be pointed out that the five types of cooking fuel enumerated were mutually exclusive, i.e. the use of more than one

fuel type within a household was not noted.

Additional information is available from the household expenditure survey. In this survey, all divisions show a considerably higher percentage using wood than in the Census with its mutually exclusive categories (6% for Belize City and 81% Toledo). (See Appendix 15 for details of the two findings).

The annual national expenditure on wood fuel was estimated in the household consumption survey to be BZ\$ 373,000. This amounted to only 0.33% of total household expenditures. This figure, of course, reflects only purchased wood and does not include the much larger value of own production and consumption. Thus, Toledo, Cayo, Stann Creek and Corozal, which had the highest percentage of wood using households, had the smallest total expenditures on wood, the smallest per household expenditure, and also the smallest share of total expenditures on wood.

The average, national, annual per household expenditure was only BZ\$ 29, little more than the rural average. Orange Walk and Belize District (including Belize City), with lower percentages of wood users, had much higher expenditures, indicating a greater amount of purchased, rather than household harvested and transported, wood. If the average household expenditure of these districts (BZ\$ 61) were applied to the total number of households using wood, the total implied wood value would be BZ\$ 780,000.

Assuming an annual fuelwood consumption of 1,500,000 ft³ (42,000 m³), i.e. 10 ft³ (0.28 m³) per capita of national population or about 120 ft³ (3.4 m³) per wood using household, would imply an average value of BZ\$ 0.52 per ft³ (BZ\$18.57 per m³), or about one-eighth the control price of cull sawnwood.

Industrial uses of fuelwood appear to be limited. Since 1979, the production of burnt lime for the treatment of acidic soils in citrus plantation areas has started, especially along the Hummingbird Highway. There are at least 5 operations with 8 kilns and a capacity of 135 tons. These kilns use about one stere per ton of lime produced. Total consumption for all kilns for one firing would be 135 steres of fuelwood. If all the kilns were fired once a week during the demand season of about half a year, then the annual consumption would be about 3500 steres-worth, at a value of BZ\$ 3.33/stere, about BZ\$11,700. The lime burning operations draw their fuelwood from a 15 mile (24 km) area using any wood, but preferring bullet tree (Bucida buceras), button wood (Conocarpus erectus) and the Huano palm (Sabal morrisiana).

The Hershey cacao plantations use about 100 cords (362 steres) of fuelwood per year to dry cacao. In addition there are a number of bakeries in the larger towns that burn fuelwood, but in total the annual consumption of fuelwood for these industries at the most might be 10,000 steres.

Since 1980 several studies and proposals have been developed

for possible wood burning power plants of from 3 to 15 MW. Such larger units would require approximately 21,000 to 105,000 oven-dry tons of wood (42,000 to 210,000 m³ or 1.5 to 7.4 million ft³). If it materialised, such a development would represent a huge addition to the country's present annual production of roundwood of around 2 million ft³. However, the current view of the Belize Electricity Board (BEB) is that power generation from wood on such a scale would not be economic. The whole question of energy supply for Belize is currently being studied for the BEB, in an exercise due for completion in May 1989. That report will include a further assessment of the role of wood based energy, but present indications are that hydro power will be the preferred solution.

Chicle

The latex from Achras species, mainly A. zapota, was the original base for chewing gum. Very many products collected from tropical forests have entered industrial processes over the centuries but hardly any of them have sustained their place when industrial chemistry became able to provide a cheap and uniform substitute. This has certainly been true of chicle. During 1924-1927 the average annual export was 152 tons, contributing 10% of the total value of forest product exports. In 1928-1934 the average annual export increased to 235 tons, contributing 22% of forest product exports. By the late 1960s the quantity had declined to 50-60 tons and by 1985 the trade had decreased practically to zero. There are periodic rumours of possible upsurges in demand but the world trend in such products would be against any appreciable sustained increase.

Production of chicle was a labour-intensive and physically dangerous tapping process. The yield of 2-7 lb (1-3 kg) per tree was obtained at intervals of about 7 years from wild trees. The U.S.-based Chicle Development Corporation conducted trials of different methods of tapping in the Honey Jib Camp Forest Reserve, now part of Freshwater Creek Forest Reserve. The same area was used for silvicultural trials to enhance the density of chicle regeneration. The TFAP Mission was unable to find any results from these trials.

The earlier importance of chicle in the rural economy of Belize is shown by the attention devoted to it by Hummel in his policy paper of 1921 (Hummel 1925) and by the quantity of legislation which was passed to regulate tapping and preserve stocks. This is now of only historical importance.

Tree Seed

The general deforestation in Central America makes the Belizean forests an ever more important source of genetic material. The value of Pinus caribaea var. hondurensis for industrial forestry plantations has been recognized for over half a century and Belize has been the source of much of the original seed. More recently, the higher elevation pine on the Mountain Pine Ridge has been recognised as Pinus patula ssp. tecunumanii rather than P. oocarpa and has been a consistently superior

performer in international provenance trials.

The major tropical plantation schemes are now producing seed from their own landraces of P. caribaea. The continued demand for Belizean seed is likely to be restricted to smaller schemes, and to areas in the wetter tropics where the climate reduces pollen pressure to the point where the production of viable seed is negligible. Even under these conditions the interest has shifted to genetically improved seed, from seed stands and, increasingly, seed orchards. The world market for unimproved seed from Belize is thus likely to be small, but, with the difficulty of protecting other Central American provenances from destruction by peasant agriculture, not insignificant. Evans (1983) argued that there was no point in starting tree improvement of P. caribaea in Belize with a view to the overseas market; improved trees suitable for Belizean conditions would not necessarily have the genes required overseas so, in the absence of any local demand, it was better to sell seed representative of the whole wild population. However, he did mark 50 superior trees with yellow paint rings, in two stands along the Oakburn Line on the Mountain Pine Ridge.

Much better prospects exist for "tecunumanii" seed. Only small areas have been planted tropics-wide so far but interest is gaining as the differences between provenances in the international trials become more distinct with increasing age. Protection of other provenances in Central America is even more problematic than for P. caribaea so the value of the Belizean source is considerable. Genetic improvement is still at an early stage but the Republic of Honduras is undertaking some work. Belize itself has participated in the initial phase of the EEC-funded closed-cone pine project. In the Little Granite Basin of the Mountain Pine Ridge, 26 superior phenotypes were selected. Seed was collected in 1986 and has been stored in the ESNACIFOR seedbank in Honduras for exchange with other participating countries. The 26 trees have been paint-ringed distinctively to prevent accidental damage and location maps have been deposited with DFO (West). However, the trees are included in two current forest licence areas and the licensees do not seem to have been warned against cutting them, or the mapped and marked trees of P. caribaea.

The low increment of trees on the Mountain Pine Ridge, less than 29 ft³/acre (2 m³/ha) per year, means that only small expenditure on management can be justified. However, as discussed earlier, the fire hazard is high from milperos on the northern fringes of the Forest Reserve, from lightning strikes and from pyrotechnics used on military exercises. Increased income from seed sales would help to justify managerial expenses. The costs and benefits of seed management have been outlined by Robbins (1982). The better prospects now afforded by "tecunumanii" suggest that the Forest Department could obtain better financial results from managing the Mountain Pine Ridge for seed rather than timber. Seed sales were over 3 tons in 1970 but have been allowed to fall to zero. Central Farm can provide cold storage for seed, so the cost of a programme of seed collection and processing to OECD standards would be small.

3.4 FOREST INDUSTRIES

3.4.1 Trends in Timber Production and Use

Industrial output of timber and timber products was initially predominantly in the form of logs for export, although pine has been nearly all domestically sawn. From about 1950, however, the larger part of the log output was going to sawmills within the country. Thereafter, log exports declined rapidly and by 1970 had practically ceased, except for relatively small quantities for special trades - logwood for dyes and rosewood for veneer slicing in the market countries. Sawnwood production continued to expand for the major species (mahogany and pine) until the mid-1950's and for the other hardwoods, as a group, erratically until the present. By the mid 1960s, exports of sawnwood had begun to decline and a larger portion of production was supplying the domestic market. By this time, the other hardwoods group had become the major source of non-conifers for the domestic market. The species structure of output over the past decade is shown in the following table (Table 3.12).

Table 3.12: Roundwood Production-Yearly Averages by Species.
Thousand Cu FT - (% of Total)

Average	Mahogany/ Cedrela	Pine	Other Hardwood	Rose wood	Ziri- cote	Log wood	Total
10 year 1978-87	437 (31)	275 (19)	668 (47)	32 (2.3)	2 (0.1)	1 (0.05)	1,415 [39.6 (100) m ³]
5 years 1983-87	352 (24)	429 (29)	660 (45)	13 (1.0)	2.0 (0.1)	1 (0.04)	1,457 [40.8 (100) m ³]
2 years 1986-87	412 (24)	567 (34)	694 (41)	8 (0.5)	3 (0.2)	0.4 (0.02)	1,684 [47.2 (100) m ³]

The heavy cutting of pine primarily for export had led to a marked decline in output from a reduced growing stock and imports were used to supplement domestic production. In 1979 and 1980, imports of pine sawnwood exceeded domestic production. In 1980, imported sawnwood of all species actually exceeded by half or more the sawnwood exports. Subsequently sawnwood imports have been substantially reduced, in large part by the withholding of government import permits.

Production, trade and apparent consumption for recent years are shown in Appendix 16, and the species composition of consumption in figure 3.4. It should be pointed out that apparent consumption is not corrected for any change in stocks from year to year. Furthermore, sawnwood production has been derived by the use of general conversion factors which may not

correspond closely with actuality. Hence, some caution should be exercised against an over precise interpretation of these data.

Nevertheless, a number of aspects are readily noted for the period covered. A very substantial portion of mahogany and cedar production is exported - as much as four-fifths but as little as one-quarter in some years. A very small portion of the pine or other hardwood sawwood is exported. Such exports of the latter as have taken place have been predominantly the "precious" hardwoods such as logwood, redwood, rosewood, granadillo, jobillo, ziricote, and black poison wood that command higher prices than mahogany.

With the partial exception of Santa Maria (Calophyllum brasiliense), production and consumption of the wealth of readily available and secondary hardwoods suitable for utility uses has increased little, if any, over the past two decades. Pine production is recovering but cannot meet the current demand. The pine harvest is coming largely in the form of larger trees from still immature stands which developed following earlier cutting.

The pattern of present production and use of timber in Belize is summarized in graphic form in Figure 3.3.

3.4.2 Existing Forest Industries

Map 3.4 shows the locations of the existing and planned forest industry. There are 46 sawmills listed by the Forest Department; which are required to have a licence to operate from the Department of Trade and Industry. There are two veneer plants being constructed at the present time, a veneer slicing mill located at Iguana Creek, next to the Belize Timber Company's sawmill, in Cayo District, and a rotary peeling mill located on the Southern Highway at Swasey River in Toledo District.

The mills are located away from the main population centre, Belize City, which has about 32% of the country's population. Their distribution is as shown in Table 3.13.

Table 3.13: Wood Industry Plants By District.

District	Population (%)	Sawmills (No.)	Other Plants (No.)
Belize	40	6	0
Cayo	15	11	2
Corozal	13	1	0
Orange Walk	13	14	0
Stann Creek	12	4	0
Toledo	7	10	2

Sawmills

The sawmills are clustered around sources of log supply. Orange Walk town has 3 sawmills, another group of 4 are clustered around Shipyard, and another 5 between Shipyard and Blue Creek. There is one mill northeast of Orange Walk at Little Belize, another one south of Orange Walk at Carmelita and another one southeast of Orange Walk at Maskall. The town of Corozal has only one mill. West and northwest of Belize City, between and Hill Bank, Burrell Boom and Isabela Bank are another 5. In the West along the Western Highway between San Ignacio and Benque Viejo are 5, with another one on the Western Highway between Belize and Belmopan. There is one more along the Guatemala border south of the town of Benque Viejo, and another on the Vaca Plateau in Mountain Pine Ridge.

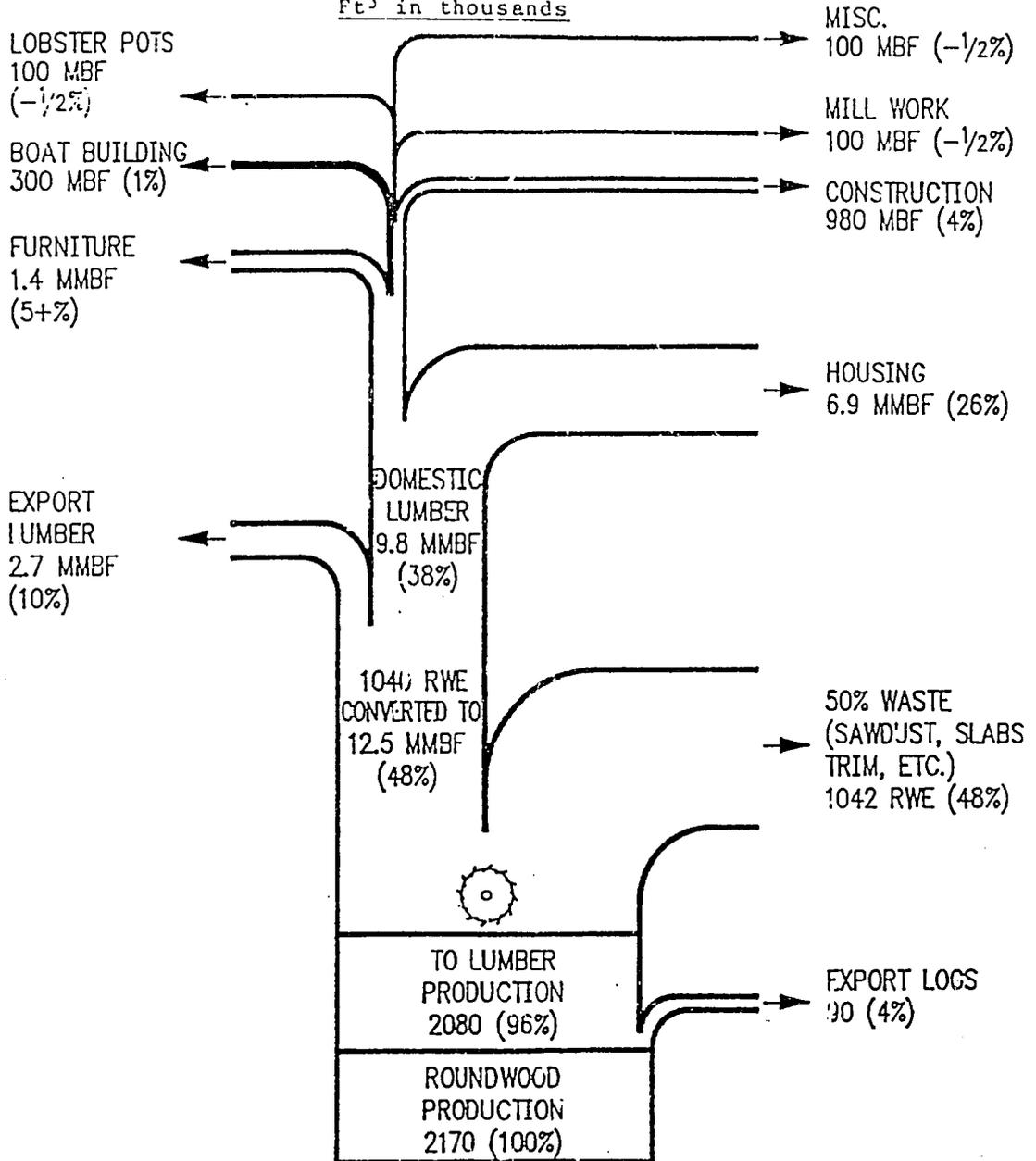
All of these mills are drawing on the northern hardwood forests, except the last two which are getting their wood from the Vaca Plateau. Some pine is cut at the mill at Sand Hill, and a little is cut at some of the other mills in the north, especially those on the eastern side of Belize. Much of this pine, growing on sandy ridges in a north and south direction, are on private lands and have been heavily cut over in the past. Three mills located in or near Mountain Pine Ridge cut mostly pine.

In the south, there are 5 mills scattered along the Southern Highway between Stann Creek and Deep River. There are 5 clustered around Deep River, and another 3 between Deep River and San Antonio. One other mill is located north of Punta Gorda near the coast at Seven Hills. Most of the mills cut a mixture of hardwoods and pine. The largest stands of pine lie east of the southern highway, while the best hardwood is usually west of the highway. There is no sawmilling in the extreme south between Punta Gorda and the Guatemala border.

Information which was assembled in the course of the TFAP exercise on the size, product, log source, ownership, type of equipment and condition of individual mills is given, in matrix form, in Appendix 17. Some sawmills do their own logging and others buy logs from contractors or on the open market. Approximately 18% of the log production in 1987 was produced by non-sawmillers.

Most sawmills are vintage band mills or old portable circular mills. Some 75% of the country's lumber production comes from 5 or 6 mills. New River Enterprise Co. of Orange Walk has a band mill (1987 production 1 million board feet, or 2,360 m³); Belize Timber, with a circular inserted tooth headrig and a band resaw, had a 1987 production of 3,300,000 board feet (9,350 m³); Sand Hill Industries also operates an inserted tooth circular saw mill and produced about 1 million board feet (2,630 m³); Harold Whitney cut 2 million board feet (4,720 m³) last year and is in the process of installing a gang saw. These mills are run fairly well, with the direct involvement of their owners,

Figure 3.3: Belize's Roundwood Consumption 1987.
 Ft³ in thousands



RWE - ROUNDWOOD EQUIVALENT
 MBF - THOUSAND BOARD FEET

SOURCE: FOREST DEPARTMENT
 ESTIMATE 8/88

Source: Belize Forest Department
 Estimate August 1988.

but many of the mill personnel lack training in sawmilling techniques.

Veneer Mills

There are two veneer mills being constructed at present. One, Belize Exotic Wood & Veneer, is next to Belize Timber's sawmill at Iguana Creek. This mill is to slice veneer and export it to North America; and intends to purchase logs or flitches from the adjoining sawmilling company, and from other suppliers as well. The other veneer mill being built is by Belize International Forest Products Ltd. of Laurel, Mississippi, at Swasey Creek on the Southern Highway. They have already constructed a sawmill and are producing lumber to obtain cash flow while the rotary veneer mill is being erected. They intend to use 4 woods (banak, ceiba, yemeri and prickly yellow) to produce core stock and face veneers for the export market.

Pole Treatment Plants

There is one treatment plant in Belize, located at Belmopan, which treats pine poles (as well as lumber). This plant was built by the Forest Department and is leased to a private individual who treats poles on demand, mainly from the utility companies. Poles are selectively logged from stands in the Mountain Pine Ridge Forest Reserve and trucked to Belmopan for processing. Poles are also produced in other pine regions of the country.

Secondary product industries

There are 10 main furniture plants in Belize and numerous small ones throughout the country. They vary all the way from one man wood working shops to a high speed mechanized plant producing wholly for export to the United States market. Local furniture makers almost exclusively use mahogany, even though prices are twice that of the other hardwoods.

There are a small number of boat building establishments. The largest is using mahogany for cosmetic covering on its pleasure craft; and "Belizian Teak" (which is really cabbage bark (Lonchocarpus castilloi)) for certain parts of the decking that are subjected to high wear.

A match plant was started 10 years ago. The species originally used was hog plum (Spondias mombin), but there was trouble with fungi and mold, so pine is used now. It is planned to expand the veneer part of the business and get into crate, container and box production.

Forest Department Woodworking Plant

This Government owned wood working plant at Belmopan has been in existence 17 years. Until a year or so ago it was only a

small installation with a wood fired dry kiln of 2,000 board feet (4.7 m³) capacity, and several wood working machines for small scale door and furniture making. Now a new dry kiln has been built - also fired by waste wood - which will dry 6,000 board feet (14.2 m³) of one inch (25.4 mm) lumber in a 7 day period.

In addition to the dry kiln, the United Kingdom has recently provided an elaborate group of wood working machines that will make siding, flooring, doors and furniture. It is planned to bring pine cants from Mountain Pine Ridge, produce 1 inch (25.4 mm) lumber for kilning with a 60" (1.5 m) Stenner band resaw, and process 220,000 board feet (520 m³) of siding and flooring through the plant annually.

3.4.3 Use of Processed Wood Products

Domestic consumption

Apparent consumption of sawnwood within the country has recently been between 5 and 10 million board feet (12,000-24,000 m³) annually (see Appendix 16). This is the equivalent of 35 to 56 bd. ft. per person per year (an average of about 0.1 m³ per capita); about two-thirds of the current European average. As is shown in figure 3.4, the consumption of mahogany and cedar appears to be continuing in long term decline, despite some recent recovery. Other hardwoods maintain a stable portion of consumption - roughly half. The trend of pine consumption is upwards.

Figure 3.4: Apparent Consumption of Lumber by Species Groups.



APPARENT CONSUMPTION OF LUMBER BY SPECIES GROUP

By far the largest use of sawnwood, and of plywood, is in house construction. Wood continues to be the primary house building material. However, its relative position is declining quite rapidly. It is being replaced by cheaper concrete block construction. This is most vividly illustrated by the nature of housing permits issued for Belize City since 1981 as shown below.

Table 3.14. Housing Permits in Belize City
by Building Types.

Year	1981	1982	1983	1984	1985	1986
	Percent of total					
Wood	48	14	17	11	13	10
Concrete Blocks	52	86	73	89	87	90

However, in concrete block housing, lumber is still used for framing, rafters and millwork. Imported plywood is frequently preferred for roof, floor and siding in place of local tongued and grooved sawnwood. The Housing and Planning Department reports that the average wood house is constructed with 6,456 board feet (15.2 m³) of lumber, while the average concrete block house requires 2,204 board feet (5.2 m³) for rafters and interior finish.

Information from the 1980 and 1970 Census reports provides further insight into the earlier shift from wooden housing for the country as a whole. This information is shown in some detail in Appendix 6. Wood construction in total housing stock declined from 79.2% in 1970 to 70.0% in 1980. These figures do not, of course, show the shift from year to year. As data was tabulated by year of construction, an approximate indication of housing starts by year and construction type is available, and are presented in the Appendix together with a derived trend, also shown in Figure 3.5.

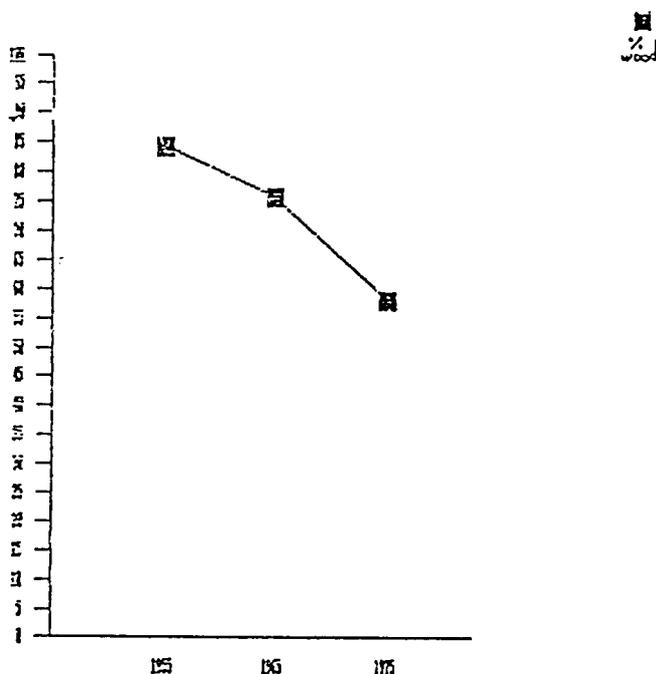
These shifts have undoubtedly been caused by a variety of factors including declining supplies of cheap wood building materials, the ease and economy of concrete block construction and, perhaps, some prestige value.

Because of a long and continuous supply, and because of its admirable properties, mahogany became the accepted wood for many uses. Indeed, its use has been profligate. It has been used for a wide variety of purposes, many of them of a utility nature. Ordinary simple furniture has been nearly all constructed with this luxury material. Local furniture manufacturers say that they must use mahogany lumber; that the market demands and will

pay for mahogany even though it is twice as expensive as pine or other hardwoods. Apparently their customers insist that other species are attacked by wood borers, will rot and have stability problems; and favour mahogany because it does not exhibit these defects. The boat manufacturers, while not consuming large quantities of mahogany, again insist they can use nothing else because of its characteristic of equal radial and tangential shrinkage.

A marked feature of wood products use in Belize is thus a profligate use domestically of the declining supplies of the high value mahogany - the Belizean timber most sought after on export markets.

Figure 3.5: Share of Houses Constructed in Wood.



Housing also appears to be the biggest consumer of imported wood based panels; both for construction (sheathing, sub-flooring, etc.) and interior decorative or finishing. This demand has grown to the point where imports of panels have been running around 180,000 ft³ (5,000 m³) annually in the period 1982-86. The largest use of paper products, all also imported, is as corrugated boxes, mainly for packing bananas for export.

Exports

The previously important chicle gum export ended in 1985,

after a consistent decline. Sawlog exports (some pine but largely rosewood) have also declined. An important trade in pine stumps for naval stores has recently been redeveloped. With this new trade, unprocessed wood products account for more than one-fifth of the total value of forest-based exports. Pine makes up more than one-fifth of the total value of unprocessed wood and sawnwood exports.

Forest product exports thus are presently dominated by outflows of sawnwood. Within this group, rough sawn mahogany dominates, followed by dressed mahogany and rough sawnwood of other hardwoods. Until fairly recently, manufactures and furniture of wood played a relatively small role. Since 1982, they have comprised more than one-tenth of forest product export values. However, their contribution has been variable, both in product type and total value.

Detail for the three years, 1985 to 1987, made available by the Statistics Department for the TFAP exercise, provides some insight into the export level of individual hardwoods (See Appendix 18). In log form, in addition to rosewood, there was some considerable shipment of logwood and ziricote. Santa Maria followed mahogany and cedar in export volumes of lumber, but made up little more than 1% of the total. The valuable rosewood and ziricote each comprised nearly 1%. As is shown in Table 3.15, nine other named species have been exported in small quantities, accounting for less than 1% of all hardwood sawnwood volumes exported.

Mahogany and cedar account for more than nine-tenths of the value of hardwood log and lumber exports. Rosewood (logs and sawnwood) follows in importance, but makes up only 3.5% of the total hardwood export value. Santa Maria, logwood and ziricote are next in magnitude but in combination comprise but 4%. Of the remaining nine named hardwoods, jobillo has the highest export value. A very substantial portion of the value of manufactured wood products exported has resulted from mahogany exterior doors.

Table 3.15. Lumber Exports 1985-87 in Board ft.

Precious Species		Secondary Hardwoods	
Rosewood	33,600	Santa Maria	48,500
Ziricote	28,600	Sapodilla	6,600
Granadillo	2,800	Bullet Tree	5,000
Jobillo	1,000	Cabbage Bark	4,700
		Yemeri	1,600
		Nargusta	1,400
		Cortez	1,300
Total	66,000		69,100
Yearly Average	22,000		23,000
	(52m ³)		(54m ³)

Table 3.16: Control Prices for Major Grades of Sawnwood by Species.

	1973	1974	1975	1977	1980
	BZ\$ per Board Foot (per .0024 m ³)				
Primary Hardwoods FAS (Mahogany & Cedar)	.61	.73	.80	.92	1.40
Pine (dressed)	.20	.32	.38	.45	.79
Pine (rough)	.175	.27	.32	.40	.70
Secondary Hardwoods (dressed)	.25	.32	.38	.45	.86
Secondary Hardwoods (rough)	.225	.27	.32	.40	.77
Luxury Woods:					
Rosewood					3.00
Bastard Rosewood					2.50
Mayflower					1.20
Cypress					1.20
Salmwood					1.20
Jobillo					1.10
Cortez					1.10
Black Poison Wood					1.10

Increased buying from Mexico has stimulated the production dramatically. Mexican trucks come to many of the sawmills in the north and buy mill run lumber at substantial prices.

It is very clear that at present the secondary species are not of great importance in the export market. It is interesting to note that in the 1950s the sawn exports of Santa Maria were 10 to 20 times their current levels.

Controlled prices and trade restrictions

For some time, lumber prices, in common with a number of other consumer prices, have been controlled or "fixed". These control prices were increased considerably during the 1970s as may be seen in Table 3.16, which shows controlled prices for the specified grades. Lower grades and shorts have lower control prices, while larger flitches of pine and secondary hardwoods have premium prices. For the primaries, the price has more than doubled; that of secondary hardwoods tripled and of pine quadrupled. In 1980 control prices for luxury woods were added. Since 1980, there have been no changes.

In general, export prices have, except for a few instances, risen over the period from 1980. Hence, control prices have not kept pace with actual changes in the international market (see Appendix 20). In the domestic market, the TFAP team observed

numerous instances where control prices were not being followed. Therefore, the attempt to exercise control over domestic prices at present does not seem to be effective.

Trade in forest products is, of course, affected to some extent by the export and import taxes. The export tax on logs and sawnwood is 5% ad valorem. It is understood that manufactures of wood are not subject to the export tax. These taxes do not generally appear to be a major disincentive to production or export and do provide a surer method of determining trade flows. Import taxes are considerably higher, generally 25% ad valorem. These are large enough to have a major discouraging impact but have not precluded substantial imports of plywood or even of sawnwood and logs. Recently, limitations on import permits appear to have practically stopped flows of the latter two products; which were primarily pine from Honduras.

Table 3.17: Lumber Imports.

		1980	1981	1982	1983	1984
Coniferous	Thousand bd.ft.	467	691	226	27	103
	(m ³)	(1,102)	(1,631)	(533)	(63)	(243)
Non Coniferous	Thousand bd.ft.	305	1,803	1,090	4	1
	(m ³)	(719)	(4,255)	(2,572)	(9)	(2)

3.4.4: Prospects for Wood Industry Expansion

Availability of raw material

In recent years, thinking about the potential for forest industries in Belize has been heavily influenced by estimates arrived at in 1978, in the course of a FAO/UNDP supported project, that there appeared to be a country wide allowable cut of 49 million cubic feet (1.4 million m³). As this compares with an annual cut at present of around 2 million cubic feet (56,000 m³), it implies a huge potential for expansion.

It has not proved possible to find out how this estimate was arrived at. Evidently it must refer to all species, including the large number of secondary hardwoods which have no commercial use, as well as those which are presently not used but which might be in the future. It therefore clearly overstates, probably by several orders of magnitude, the actual aggregate potential flow of wood raw material which might be used for industrial purposes.

To arrive at a relevant estimate of allowable cut the total must be disaggregated in order to separate out the commercial, and potentially commercial, component. As was pointed out in

Section 3.3 on Forest Management, the available narrative evidence indicates that in actuality the presently commercial species are being depleted. Though this cannot be documented quantitatively yet, there is good reason to believe that even present levels of supply of mahogany, pine and certain other species may not be maintainable indefinitely; at least under present management and harvesting systems. The bulk of what is available to support possible higher levels of output is in the utility category of "other hardwoods".

As was noted earlier (Table 3.10), 60% of log production in 1987 came from outside the Forest Reserves. Table 3.18 shows that almost half the volume of logs produced in that year came from private lands. This has been true for a number of years. Currently, the largest sawmill company, Belize Timber, is entirely dependent on private land for its wood supply, as is the largest bandmill operating, New River Enterprises.

Table 3.18. Forest Industry Log Sources by Legal Conveyance (1987)

	Number	Log Production (% of vol)	Area (%)
Private Forest Permit	31	47.7	20.3
Forest Permit	48	10.8	14.5
Forest Licence	24	11.5	32.2
Long Term Forest Licence	6	24.5	33.0
Petty Permits		2.9	---
Forest Department		2.6	---
Total		100	100

The limited amount of information about the forest areas in private hands strongly indicates that these are essentially being mined for their remaining stock of commercial species. As has been noted earlier, even on the BEC lands, the only private forest area that was systematically managed for a considerable period of time, output of mahogany was maintained only by steadily reducing the size of trees harvested. It is not possible to say how much longer output can be maintained from private lands, but it is clear that eventually production will have to be based progressively on the resource contained in the Forest Reserves - and any additional areas of forested Crown Land as may be added to the Reserved Forest estate.

At the time of the TFAP exercise, almost all the large good areas of hardwood and pine within the Reserved Forests had been given out under licence (but were not necessarily being worked), except the Sibun, Sittee, Columbia River Forest Reserves, and most of the Chiquibul Forest Reserves. The first two of these reserves, the Sibun and Sittee, are in very steep country and it

is questionable whether these areas should be logged at all. Probably the steeper terrain in all the Forests Reserves mentioned above should be considered as Protection Forests. As has been noted earlier, the Chiquibul was badly damaged by the 1961 hurricane and has not totally recovered; and it is doubtful whether much of the Reserve should be licensed again as it was logged without rest from the 1920s until 1985.

While there appears to be some room for expansion of the area being logged for forest industries using hardwoods, it will be in the forests further from the main roads and ports of export. The main potential for expansion in output evidently lies in improving the productivity of the areas which are already licensed. Several of the licences are inactive, and most others, in particular annual licences, are being worked at a very low intensity. As was noted earlier (section 3.3.3), the quantity of other hardwoods being produced from the Forest Reserves is very low. A very considerable potential therefore exists for expanding output as the licences become available for reallocation, - through the changes in forest management discussed in Section 4.3; and, where necessary, by attracting better qualified and equipped enterprises to operate the licences (Section 4.4).

Export market prospects

As the country's economy grows and diversifies, the domestic market for wood products will expand. This is discussed in Section 4.1, in the course of the review of future development prospects. However, if there is to be a substantial increase in production it will have to be sold primarily into export markets. Some of the main factors affecting export prospects are discussed below.

As was noted earlier, wood product exports are very narrowly concentrated on mahogany and small quantities of a few precious hardwoods. Past market studies have confirmed the difficulties of finding export outlets for the utility woods among the secondary hardwoods. Even as well proven a wood as Santa Maria has not found continuing markets. Though an U.S. importers' journal describes Santa Maria as "equal to northern hard maple except slightly less hard", no evidence could be found of regular import of the species into the US market. Most of the complaints about the wood - that it cups, warps and bends - were very evident in watching logs being broken down on the circular headrigs of saw mills. Band sawing and an experienced hardwood sawyer could probably do a better job of the opening face of the log and prevent some of this.

Other problems with attempts to promote these hardwoods have been failure to meet firm orders, or inability to supply the quantity requested. This has hurt the image of the secondary hardwoods, and the willingness of importers to spend time developing markets for them. As has been pointed out in earlier studies, there are possibilities; predominantly as further

manufactured products rather than as sawnwood. But these are likely to be on a small individual scale. Working with the North American importing hardwood associations would be a big help - to get to know the small importers who will go out of their way to find special niches for lesser known species.

In recent years there has been a modest growth in export of semi manufactures, but again predominantly in mahogany. This dependence on the latter emphasizes again the importance of channelling supplies of the wood into high value outlets such as exports.

Development of exports also faces a number of infrastructural difficulties. Being a small country, Belize is not on the main sea lanes. Infrequent shipping schedules and low volumes have made shipments costly. Links with traditional nearby customers such as Jamaica have only recently improved, with new shipping services provided by small Caribbean shipping lines.

Belize City is the only container port, with only an 18 foot (5.5 m) draft, and all containerized lumber flows through it. This is especially hard on sawmills in the south, which are furthest away from the port and have to haul to it over a poor road. Big Creek has plans to improve facilities by dredging to a depth of 23 feet (7m), but will not be able to handle containers.

Containers have certainly improved the shipping situation, but have not solved the problem of getting Belize's timber exports to market cheaper. As it takes 12,000 - 16,000 bd.ft. (28-38 m³) to fill a container, small mills have to ship through a timber broker who buys from several mills and makes up a container shipment. There are several timber brokers who handle the exportation of lumber and who have established channels in Mexico and the U.S.

Drying of lumber is another key issue for export. The start up of the new kiln at Belmopan should stimulate renewed interest in building kiln drying facilities. But, more research is needed to develop kiln schedules for the secondary species.

Prospects for import substitution

The wood products that have been imported recently are: lumber, plywood and other panels, and paper and paper products. As was noted earlier, a substantial import of mainly pine sawnwood at the beginning of the decade has been restricted in recent years through government action.

There are two broad classes of panels being imported. One is US southern pine plywood, usually 3/8 to 1/2 inch (9.5-12.7 mm) thickness in 4 by 8 foot (1.2-2.4 m) sheets. As was noted earlier, this plywood is used in large quantities in construction, replacing traditional pine tongue and groove for siding, roof and floor underlayment; even though the plywood

costs twice as much as lumber. The reason for this is that plywood is easier and cheaper to install. The other type of panel imported is hardboard with a wood veneer or paper or plastic imitation wood grain laminate. These panels are used for interiors to cover walls, partitions and the like.

The largest potential for import substitution lies in a plywood plant making both sheathing grades from pine and interior grades from hardwoods. The volume of these commodities over the past 10 years is shown in Table 3.19. A minimum investment plywood mill using low cost second hand equipment might have to produce 100-200,000 ft³ (3,000-6,000 m³) of plywood to be profitable. Belize International Forest Products Ltd. is considering the possibility of manufacturing plywood when their veneer plant is operating, but this could be a several years off. The additional investment in glue spreaders, presses, sanders and trim saws would have to be made. Their mill could probably concentrate on the interior hardwood plywood, which in some instances could be substituted for imported pine plywood, provided it was competitive in price.

Table 3.19: Plywood and panel imports 1976-86.

Year	Ft ³	m ³	Year	Ft ³	m ³
1976	74,523	2,111	1983	503,389	14,256
1977	121,146	3,431	1984	49,558	1,403
1978	102,453	2,902	1985	122,444	3,468
1979	140,100	3,968	1986	75,990	2,153
1980	394,447	11,171	1987	1,173,780	33,252
1981	458,790	13,000			
1982	166,958	4,728	Average	281,964	7,988

The Belize market for hardboard and particle board could not justify the investment in a facility to manufacture these products locally. *What about the regional market?*

The aggregate import of paper and paper products is quite large in value, but is too small to justify a pulp or a paper mill. But the paper converting industry has possibilities. Already there is a tissue cut up plant in operation, and there is a potential for a corrugated box plant to be set up at some time in the future to produce boxes from imported paperboard for export of bananas. The Banana Control Board have estimated that it would take 5 million export boxes to justify a box plant using 15,000 tons of paper board. The trend in banana box exports is shown in Table 3.20.

Table 3.20: Tons of filled banana boxes re-exported.

Year	Tons
1981	1,647
1982	1,572
1983	1,593
1984	1,665
1985	1,626
1986	2,013
1987	3,360
1988 (Estimated)	4,683
1993 (Projected)	12,000

Operational capacity and productivity

The present section covers four aspects of the logging and processing industries which affect its productivity. These are its seasonal nature, lack of skilled labour, the equipment employed, and wastage. Proposals for implementing the measure's suggested for improving productivity are elaborated on later, in Sections 4.3 and 4.4.

Logging is carried on for only 4 to 5 months, during the dry season from January to May. While logging in many places in the world is seasonal, the logger is always looking for a way of extending his season to reduce his costs and keep his work force employed. In Belize, there are sandy areas along the coast where loggers are able to skid off and on during the rainy season. Elsewhere in the country, loggers complain that the black gumbo clay soils prevent skidders from operating and logging trucks from hauling on the logging roads in the rainy season. The problem of the haul roads can be solved by putting rock on the road and making it an all weather road, but skidding in black gumbo clay could stop most of the rubber tired skidders and track tractors. An FMC especially built for swamp logging, with low pressure on the tracks, might be a better machine for black gumbo soils; provided maintenance facilities could be provided in the country.

The seasonal fluctuations in log supply of course severely restrict the operation of the mills. The forest industry has about 5 or 6 mills that offer full time employment during most of the year; although even they all seem to shut down for several months during the rainy season for lack of logs. Employment for most forest and mill workers is therefore only seasonal.

This in turn aggravates the problem faced by almost every mill owner of lack of skilled workers. A sawmill cannot operate effectively without a competent sawyer. In many circular saw mills, where inserted teeth are used, the sawyer usually takes care of the saw himself - touching up teeth and making replacements. In band mills, a saw filler is needed as well as a

sawyer. The third most needed person is the millwright, whose responsibility is to keep the mill running. People acquiring this skill usually train on the job, learning from older millwrights (though some of the equipment suppliers have given more formal maintenance courses). Many mills do not have an experienced millwright, so there is no one for the apprentice to learn from.

All the personnel in the woods and in the mills need upgrading on maintenance and care of equipment. Poor maintenance aggravates the generally poor state of equipment employed. The scope for introducing more appropriate equipment is dealt with in section 4.4. Here, it needs to be noted that sawmillers report that they have difficulty in obtaining financing from commercial banks or government agencies; with the small sawmiller, who is in the most need of loans, considered the highest risk. Equipment dealers are reportedly reluctant to extend credit.

Wastage is heavy throughout the production and use system. In logging operations, little of the forest residues or logging waste are utilized on an organized basis. Slabs and edgings from sawmills are sometimes used by local people for use as lumber for their personal needs - housing, fences, etc. Planer shavings are either given away or sold to chicken or livestock farmers, as is sawdust. With the exception of the use of planer shavings in the dry kilns of the Woodworking Shop in Belmopan, there was little utilization of wood waste for energy observed.

Much lumber is sold at the mill, with buyers having the right to select the best boards, leaving the mill owner with all the poor quality boards. As has been noted earlier, there is also gross wastage in usage through use of lumber which has not been dried or treated. Most consumers in Belize do not expect quality sawn lumber, and are not prepared to pay for it. However, a few lumber wholesalers and retailers said they would pay higher prices (10-15%) to get "4-square" lumber. They realize that it would cost them less to produce siding and moldings from such material, and that they could turn out a better quality product.

3.4.5. The Role of Government in Forest Industry Operations

The government, through the Forest Department, is heavily involved in forest industry activities. The Department has logging and sawmilling operations in both its Western and Southern Divisions at Augustine in the Mountain Pine Ridge Forest and at Melinda near Stann Creek. The latter began in 1973 with substantial exploitation but operations are now limited to a small portable mill. The former recommenced operations in 1984 and has production in the order of 300,000 board feet (708 m³) annually. In addition to supplying their own sawmills, the Department logging operations conducted in public forests also provide logs for sale to private millers and to the pole treatment plant (Department leased to private industry). The Department sawmills sell some lumber at mill site, but the

greater part of output from the Mountain Pine Ridge mill goes to the Department Workshop at Belmopan.

The Department Workshop was initially established in 1971 in a modest way to use considerable volumes of small-sized Gmelina thinnings from the Melinda plantations, to replace a variety of imported wood manufactures, and to demonstrate the utilization of little known secondary hardwoods. The workshop encountered a variety of operational problems. Recently, with the assistance of the United Kingdom, the plant has been substantially enlarged and equipped and its staff is supported by an expatriate specialist. It has capacity for an annual output of 220,000 board feet (519 m³) of special lumber products, as well as doors and furniture. The workshop has been producing mill work and furniture for the Forest Department, for other government organizations and also against orders from the private sector.

Government operation of forest industries appears to be a contradiction of its general policy on economic development in which industrial and commercial activity is the concern of the private endeavour. There are, however, also government operations in other sectors of the economy.

Government activity related to the industrial and commercial sector could be justified for a number of purposes:

- 1) Developmental Research:
 - a) Practical tests on the use characteristics of lesser known species,
 - b) Development of logging and processing techniques suitable to conditions within the country,
 - c) Development of products for both local and export markets.
- 2) Demonstration and Training:
 - a) Centres for practical demonstration of equipment, techniques and products,
 - b) Training of managers and workers.
- 3) Development of Management Data Base for Forest Department:
 - a) Obtaining realistic information on costs and prices for sound assessment of royalties,
 - b) Obtaining first hand information on industry problems.
- 4) Filling Gaps in the Industrial Sector:

Provision of goods not being locally produced and not available or appropriate as imports.
- 5) Deliberate Competition with Private Sector as a Method of Regulating the Private Sector.
- 6) As Part of a General Economic System.

The last item above does not appear pertinent in the case of Belize. With respect to the penultimate item, there is some

evidence that control of log volumes removed, in relation to an appropriate allowable cut, has been one reason for Department involvement in logging operations. All of the other items have been indicated as justifications for the industrial and commercial activities of the Forest Department in logging, sawmilling and wood working operations. The lack of a clear statement of policy and of specific objectives has lead to ill defined and conducted programmes as well as to criticism from the private sector.

3.5 FORESTRY AND ENVIRONMENTAL CONSERVATION

3.5.1 Environmental issues

Belize is fortunate to have an environment in good condition, together with the institutional commitment to protect that environment. Much of the country is still in a natural state and little exploited; containing the range of ecological systems that were outlined in section 2.2. It is a frequently celebrated fact that wildlife species endangered or extinct elsewhere in Central America are fairly common in Belize. Belize has two natural features that are highly unusual: the barrier reef, largest in this hemisphere and second largest in the world, and the limestone caves of the Chiquibul drainage area, including the largest cave room in this hemisphere and the second largest in the world. But what is truly unusual, and of more importance than particular natural features or the status of certain species, is the fact that the overall environment is so little damaged.

There are compelling reasons to be concerned with saving ecosystems from damage and species from extinction, so maintaining biological diversity. Belizean citizens depend on the food, medicines, and industrial materials that are derived from biological organisms - now and in the future. Plants and animals that are not currently used will prove valuable in the future, if they are still extant. Wild relatives of species already in use will be needed for genetic improvements.

Also, Belize depends vitally on intact ecosystems for soil development and retention, and nutrient and hydrological cycles, for its continuing economic and social development. With a distinct dry period of three months, a long rainy period, as well as a constant threat of hurricanes, the protection supplied against drought, floods, soil erosion, siltation and excessive damage by wind and water during hurricanes is of great importance and value. The essential urban and agricultural water supplies provided by the Belize River, New River, Sibun River, Manatee River, Stann Creek, Monkey River and Rio Grande, as well as many smaller rivers and streams, owe their assured and usually clear flow to their origins in the major forest areas of the country - the Maya Mountains, the Cockscomb Basin, Mountain Pine Ridge, the Chiquibul Forest Reserve and the large block of private land held earlier by the Belize Estates and Produce Company. Soil protection provided by the forest cover has prevented erosion on steeper slopes and river banks. Mangroves on the cayes and mainland have retained shore lines and curbed the effect of tidal waves. The impact of flooding has been greatly diminished by the absorptive capacity of the soil as improved by forest trees and their litter. The sponge-like effect reduces peak runoff and retains water for a continuous flow over longer periods.

Also, there is a direct connection between the country's important tourist industry and the current healthy state of Belize's environment. In 1987, 55,000 tourists visited Belize. This is a large number relative to Belize's population of about

176,000. The majority of these tourists came to stay on the cayes, one of the outstanding natural features of Belize, but increasingly tourists are attracted to the interior. About 70 tours of birdwatchers (6-18 people each) came to Belize in 1987. Other tours come for orchids and archaeology. There were also numerous small groups interested in natural history but not connected with tour organizations, and whose numbers are not recorded as natural history tourists.

The number of natural history tour groups in Belize is increasing, and tourism experts feel that, given the environmental assets of Belize, the nature tour business can expand greatly. Scouts for tour companies are looking for additional sites to visit in Belize. There is also an incipient industry of adventure tourism, including rafting, caving and backpacking, that depends on the natural setting. The established reserves are attracting many visitors, especially Crooked Tree, Cockscomb, and the Community Baboon Sanctuary. Expanded facilities are needed at some reserves. The influx of visitors can benefit the reserves financially, but could also damage them, if not managed correctly.

The fact that serious erosion of the land and water base, or of the ecosystems, has not occurred has been due to the early declaration of Reserved Forests, and later of parks and sanctuaries; to a population even smaller than it is now; the fact that land development has largely been confined to the lowlands; and to the historical preference of much of the population for activities other than agriculture. However, the situation is now changing as a result of the growth in population size and the Government's promotion of development, particularly of the agricultural sector.

Not for much longer will erodible soils in the Maya Mountains adjoining Karst areas necessarily remain secure because they are too inaccessible to log or clear for farming. Steep areas of any reasonably accessible forest tracts are likely to come increasingly under pressure for timber harvesting. At the same time, water catchment protection will become increasingly more important to interests in the lowlands. The Stann Creek District may be cited as an example: it is dependent on the mountains for its water supplies; large scale agricultural development is in progress within it; tourism is also increasing; at least two hydro-electric developments are being considered for sites in the adjacent uplands; marine resources off-shore are increasing in importance. In view of these trends, any unfavourable changes in the quantity or quality of water supplies should not be tolerated.

A number of environmental impact issues affecting water quality and siltation are of growing concern. These include:

- agricultural chemicals (mainly pesticides and fertilizers) of which the public is fully aware and for which monitoring and control measures are being developed by the Central Experimental Farm;

-waste oil from sugar factories; cyanide from a zinc roofing and nail factory on the Belize River near the city; citrus factory wastes in the Stann Creek area; fish processing plant wastes; and waste disposal, which seems seldom to be done on an environmentally sound basis.

These have important implications for supplies of potable water and the well being of the mangrove and related marine ecosystems.

The other main environmental threat is the potential ecosystem losses or degradation arising from weaknesses in the protective system, which form the main subject addressed in the present Section.

Opportunities to protect and manage the environment are enhanced by the fact that more than 50 % of Belize is owned by the Government. Some 30 % of the country is in Forest Reserves, and the marine continental shelf and the majority of the cayes are also public land. Management plans can be based on results from research in the large area of comparatively undisturbed habitat in Belize. Belize has excellent natural laboratories for studies of wildlife, ecosystem processes, and alternative agricultural and forestry practices. Belize's Mayan archaeological heritage is also substantial.

3.5.2 Institutional Provisions for Conservation

Laws, Regulations and Conventions

In order to perpetuate its present positive environmental situation, Belize has enacted laws for the establishment of reserves and for protection of wildlife and other aspects of the environmental resource. The country has a modest system of completely protected areas, and it also has a large area set aside as Forest Reserves; some parts of which are referred to as protection forests. Even in those parts in which trees are harvested the forests remain as largely intact ecosystems. The country benefits from a number of non-government organizations that manage reserves or otherwise play a constructive role in conservation. And Belize receives financial support from numerous foreign donor agencies as well as attention from many individual conservationists and biological researchers eager to provide expertise and information to form conservation policy. Finally, there is native pride in Belize's natural heritage, and awareness among government and the public of the connection between the quality of the environment and economic and social welfare.

The National Parks System Act was enacted in 1981. It is administered by the Ministry of Agriculture, Forestry and Fisheries and provides for the preservation and protection of important natural and cultural features and regulates the scientific, educational, and recreational use of such features.

It defines and provides for the establishment and regulation of National Parks, Nature Reserves, Natural Monuments and Wildlife Sanctuaries. The Act provides for civil enforcement of its regulations.

A flaw in the Act is that parks, reserves, monuments, and sanctuaries can be dereserved by a simple decree, putting them on a precarious foundation. The de-reservation of Forest Reserves that has been occurring suggests the possibility of such reverses. Another flaw is that there are no provisions for reserve management in the Act.

The Wildlife Protection Act was also passed in 1981. It is also administered by the Ministry of Agriculture, Forestry and Fisheries and provides for the conservation, restoration, and development of wildlife. The Act protects all wild animals from unregulated taking. Some 30 mammal and reptile species and all but six bird species are protected from all hunting. The Act provides for the establishment of hunting seasons, licensing, royalties, restricted areas, bag limits, and civil enforcement of its regulations. In addition, a moratorium on harvesting of wildlife for commercial purposes for seven years (which expires in 1988) was declared, to provide time to study the potential and problems of commercial uses of wildlife. More recently a Tentative Wildlife Policy Plan for Belize was adopted which reiterated the cultural and economic importance of conserving wildlife and identified several goals of research on wildlife that will form the basis of rational wildlife policy.

Belize is a party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). All species listed as endangered by CITES are protected in Belize. Belize is not a party to other major international habitat or wildlife conservation conventions: the Convention Concerning the Protection of the World Cultural and Natural Heritage, the Convention on Wetlands of International Importance Especially as Water-Fowl Habitat (Ramsar Convention), the Convention on the Conservation of Migratory Species of Wild Animals and the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere; or UNESCO's Man and the Biosphere Programme.

The Fisheries Ordinance was revised in 1958. It applies to all rivers and territorial waters, prohibits fishing with poisons or explosives, and establishes authority to regulate size of net meshes. This ordinance has been used to set seasons for various species, minimum sizes, and to prohibit fishing with traps or other devices constructed with net or wire within 1800 ft (550 m) of the barrier reef.

Flaws in wildlife laws include lack of protection for some species that need it and lack of regulation of internal trade in wildlife. There seems to be no legal authority for protection of reptiles and amphibians, freshwater fish, and plants.

The Forest Ordinance was revised in 1958. It provides for the establishment of Forest Reserves and for licensing and

regulating forestry in the Reserves. A stated policy is that the forest estate be managed to ensure protection of ecosystems and wildlife. About one fifth of the Reserved Forest area is regarded informally as protection forest.

In June 1988 The Minister of Agriculture stated that the Ministry was soon to issue regulations concerning use and protection of mangroves. Although the mission did not examine the condition or use of the mangrove resource in any depth, it became aware of threats to it arising from building and related developments in the coastal region, as well as from uncontrolled or illegal cutting. Information as to the extent and condition of the mangrove resource is very limited: there is a need for an inventory to provide a basis for more adequate management and control than is exercised at present. Any excessive depletion of the mangroves through cutting or siltation would seriously affect a number of interests. It is anomalous that there is a lack of clarity as to responsibilities for management and protection of this resource.

The outcome of efforts initiated several years ago to develop environmental protection guidelines is not clear: the need for them as well as for effective control mechanisms is important. There is need also for a procedure to be developed for assessment of environmental impacts of proposed rural - and urban - developments, and for the definition and enforcement of practicable control regulations. The Forest Department has on no occasion been involved in any assessment of this kind.

Institutional responsibilities

Not all areas of conservation fall within the forest domain. At present, responsibility for conservation appears to be divided among the Ministries of Agriculture, Forestry and Fisheries; Natural Resources; Trade, Industry and Tourism; and Education. Other organizations engaged in conservation, environmental studies and management are the Belize Audubon Society, the Belize Heritage Society, the Belize Zoo and Environmental Research Centre, the Belize Institute for Agricultural Sciences and the Belize Centre for Environmental Studies. There seems to be no integrated effort among these and some conflicting activity has been reported. It is essential that this situation be resolved.

The Forest Department, in the Ministry of Agriculture, Forestry and Fisheries, is responsible for the administration of government-declared protected areas as well as the Forest Reserves. The Department has temporarily delegated the management of the protected areas to the Belize Audubon Society (BAS). Private protected areas are managed by a variety of organizations. Much technical and financial assistance for government and private protected areas comes from international conservation organizations and donor agencies of foreign governments.

The Forest Department is also responsible for wildlife

management and enforcement of wildlife laws, for which two positions of Conservation Officer have been designated. In reality, the Department is not allotted sufficient manpower or funds to have a significant impact on hunting and the wildlife trade. At present, there is only one Conservation Officer, whose work, in practice, also deals with wood products marketing.

The Fisheries Department in the Ministry of Agriculture, Forestry and Fisheries is responsible for fisheries policy, enforcement and research.

In order to manage the Government-declared reserves for which it has responsibility, the Belize Audubon Society (BAS) has secured funding from international conservation organizations. The arrangement between the Ministry of Agriculture and BAS is not entirely satisfactory. The terms of the agreement do not guarantee BAS enough authority to feel secure in making long term plans. Clear lines of authority are lacking. Most informed people, including BAS officials, feel that ultimately an Office of Conservation in the Ministry of Agriculture should assume responsibility for protected areas.

The BAS also supports in various ways the Community Baboon Sanctuary. It maintains visitor centres and develops brochures and plans for the reserves. BAS has an important role in identifying and promoting establishment of new reserves. It also educates the public about wildlife, habitats, hunting laws, and the benefits of conservation. Most financial support comes from several international conservation organizations.

Recently, there has been heightened awareness of the importance of conservation and protection of the environment both locally and internationally. This has resulted in many overseas funding sources for the programmes of the Belize Audubon Society and, to a lesser extent, of the Government. Such organizations as the World Wildlife Fund (US), New York Zoological Society and sister Audubon Societies in the United States have sponsored programmes in Belize.

Other non-governmental organizations also have taken on important responsibilities in the conservation area. The Belize Centre for Environmental Studies promotes the rational, sustainable use of Belize's natural and cultural resources. The Centre works to inform the public about conservation issues, compile and disseminate information about the state of the environment, create a forum for discussion of environmental issues, and assist others in research, education, and development. The Belize Heritage Society was formed to identify the most valuable natural habitats in Belize and to promote their establishment as reserves. The Belize Institute for Agricultural Sciences engages in research toward environmentally sound land use. The Belize Zoo and Tropical Education Centre maintains a collection of Belizean wildlife to educate the public about conservation, through visits to the zoo, travelling exhibits, radio, and television.

The Programme For Belize represents a consortium of conservation organizations. The goals of the Programme are to 1) assist in building a national system of conservation or multiple-use resource management areas, 2) gather the necessary information to set priorities for natural resources development, 3) expand environmental education, 4) enhance national capability for development planning, and 5) build technical capability in resource management through training. The Programme manages the 160,002 acre (64,752 ha) Rio Bravo Resource Management and Conservation Area, to conserve tropical forest and as a site for research on forest ecology and sustainable agriculture and forestry.

3.5.3 Management of Protected Areas

There are 11 formally protected areas in Belize and one scenic area, Thousand Foot Falls, which is protected by the Government but has no declared reserve status. The Rio Grande Nature Reserve, established in 1968, no longer exists. It was never demarcated on the ground, and so irrevocably damaged by farmers who later abandoned the area. Eight of the existing reserves are protected by Government, and the other three are private reserves.

Government reserves

Blue Hole National Park (established 1986), on the Hummingbird Highway near Belmopan, is 576 acres (233 ha) of tropical moist forest, rivers, and caves. The Park includes Blue Hole Natural Monument, where the roof of a cave collapsed, exposing part of an underground river. The Park is a popular place for recreation and may face problems of over use in the vicinity of the Natural Monument. It is managed by BAS.

Cockscomb Basin Wildlife Sanctuary (est. 1986), on the eastern slope of the Maya Mountains is 3640 acres (1473 ha) of second growth subtropical wet forest. It was established primarily as a reserve for wild cats, especially the jaguar, for which it is good habitat. It is too small by itself to maintain a viable jaguar population, but the reserve is embedded in the much larger Cockscomb Basin Forest Reserve, in which hunting is prohibited. Because the sanctuary is identified with the spectacular jaguar, it attracts many Belizean and foreign visitors and has publicized the environmental assets of Belize and the enlightened attitude of the country toward conservation. A detailed short term management plan was prepared for this sanctuary. A chief potential problem is over use. It is managed by BAS.

Crooked Tree Wildlife Sanctuary (est. 1984), near the Northern Highway 33 miles (53 km) from Belize City, contains 3632 acres (1470 ha) of freshwater lagoon, marsh, and swamp forest. It supports large numbers of resident and migratory birds. Being near Belize City, this sanctuary attracts many

Belizeans and educates them about conservation of wildlife. Visits have greatly increased in the past year, benefitting locals who rent boats. Lack of transport makes patrolling difficult. Consequently poaching is a problem. The area is managed by BAS.

Crown Reserve Bird Sanctuaries (est. 1977) are seven small cayes located mostly along the Caribbean shoreline and among the outer cayes, with one site in Northern Lagoon. They have supported colonies of nesting waterbirds. It has been very difficult to protect these sites; bird colonies have been wiped out on three of them; the condition of others is damaged or unknown, and only one has remained undisturbed. It is managed by BAS.

Guanacaste Park Crown Reserve (est. 1973) is 52 acres (21 ha) of riparian (riverside) forest between the Western Highway and the Belize River near Belmopan. This location makes Guanacaste a likely site for recreation and education about conservation and the purposes of reserves. It has been disturbed by farmers and woodcutters in the past but is now better patrolled. It has a well-developed system of trails. It is managed by BAS.

Half Moon Key Natural Monument (est. 1982) is a 45 acre (18.2 ha) sand cay on Lighthouse Reef, 50 miles (80 km) southeast of Belize City. The cay is half covered with a coconut palm grove and half covered with a denser, more species-rich vegetation that supports thousands of nesting seabirds. The BAS developed a five-year plan for the Monument in which several problems are described, among them: isolation and low visitation rates and consequent neglect, lack of enforcement of fishing regulations and lack of trained managers. It is managed by BAS.

Hol Chan Marine Reserve (est. 1987) is 3,200 acres (1,295 ha) of open water, reef, mangroves, and seagrass beds four miles (6.5 km) south of San Pedro, Ambergris Cay. Proximity to rapidly developing San Pedro will make Hol Chan well known and an educational tool. At the same time, development pressure around San Pedro may adversely affect Hol Chan. The Reserve has received a major grant from USAID, supporting a manager, a biologist, and two wardens. Hol Chan is privately managed, with assistance from the Fisheries Department.

Society Hall Nature Reserve (est. 1986) is 6,741 acres (2,728 ha) of tropical moist forest located 10 miles (16 km) southwest of Belmopan. This reserve is the largest government-declared, strict reserve, and thus the largest such reserve of the species-rich forests of Belize. Society Hall is difficult to reach and penetrate and has not been explored by biologists. It has suffered incursions of milperos on one edge. Privately managed.

Management of some reserves is inadequate, due to lack of funding, training, and technical information. Lack of training in reserve management, wildlife management, and concepts of

conservation biology extends through all levels of the Forest Department and BAS. Under the aegis of BAS, US Peace Corps volunteers with conservation training have managed some of the reserves. This programme is being phased out, at least temporarily. Thus the reserves are without technically trained managers. Also there is little information on the ecology of the reserve habitats on which to base management decisions.

Private protected areas

Each of the private reserves represents a different, novel, and enterprising approach to conservation.

The Community Baboon Sanctuary (est. 1985) is 1,920 acres (777 ha) of riparian forest, pasture, and farmland along the Belize River at Bermudian Landing. It consists of 75 land parcels whose owners have signed a non-binding agreement to manage their properties such that they remain suitable habitat for Howler Monkeys, locally called baboons. Nearby communities on the river are interested in joining the Sanctuary. This community agreement is unique among wildlife sanctuaries and is a model that may be extended to other situations. The Baboon Sanctuary is managed by one paid employee, with support from BAS. Tourist facilities are needed to accommodate visitors.

The Shipstern Wildlife Reserve (est. 1987) is 20,480 acres (8,288 ha) of subtropical moist forest, mangrove, and saltwater lagoon near Sarteneja, 20 miles (32 km) east of Corozal. The forest has regrown after a devastating hurricane in 1955. Shipstern is owned by British interests whose goals are to preserve this habitat by making the reserve self-supporting through tourism and butterfly farming. The attempt to make the reserve self-supporting is an important experiment in the field of natural resource conservation. Shipstern is managed by two biologists and employs several workers.

The Rio Bravo Resource Management and Conservation Area (est. 1988) is 160,002 acres (64,752 ha) of subtropical moist forest and savanna in the northwest corner of Belize, north of Gallon Jug, bounded by Guatemala on the west and on the east by a line paralleling, and about 2.5 miles (4 km) east of, Booth's River. The area includes tall forest, as well as low forest on poorly drained areas, rivers, and small lakes. It is also the site of a large complex of Mayan temples. The Rio Bravo Conservation and Management Area will be used for applied research in forestry and agriculture, basic research in tropical biology, and training in research and conservation. The results of this programme could have far-reaching, salutary effects on conservation and economic development in Belize. This reserve is managed by the Programme for Belize.

Forest Reserves

The sixteen Forest Reserves cover 2,545 miles² (6,592 km²), or 30 % of Belize. Nearly all this Reserved land is in the south

of the country, and most of it comprises the Mountain Pine Ridge, the Maya Mountains, and the Chiquibul Reserve, which lies between the main divide of the Mountains and Guatemala. A stated policy is that the Forest Reserves be managed to ensure protection of ecosystems and conservation of wildlife. To the extent that these areas are managed for selective logging, with careful control of logging practices such that the Reserves remain essentially as wild land with their ecosystem processes intact, the Forest Reserves will serve to protect much of Belize's biological diversity. However, adequate plans addressing the biological diversity questions do not exist for the Forest Reserves. Also, although one fifth of the Reserved Forest is regarded informally as protection forest, no areas are specifically designated for management for catchment protection.

Parts of the Forest Reserve system have been dereserved for agriculture. While this may be advisable in some cases, it should be done only after considering conservation objectives. The most recent addition to the system was the Cockscomb Basin Forest Reserve, established in 1984.

Aerial photography and reconnaissance indicate that unplanned deforestation of hilly Reserved Forest land through illegal shifting cultivation is not widespread and largely confined to parts of Sibun, Mountain Pine Ridge, Freshwater Creek and small areas in the Maya Mountains, Columbia River and Deep River Forest Reserves. Recourse to legal excisions of some of the areas affected indicates a lack of the means to preserve the integrity of these areas. That traditional or near-traditional forms of agriculture affect stream flow has been observed (though not scientifically measured) by agricultural specialists in the Jimmy Cut area in Toledo District, although the local people do not perceive it as a problem. In general, the logging that has taken place to date in Belize, being selective and therefore not usually intensive, and not usually on steep land, has caused little erosion or siltation.

The Reserved Forests are not currently managed through formally sanctioned, periodically up-dated management plans. Thus, the various parts of Forest Reserves are not specifically assigned under a detailed management plan to the most appropriate uses, e.g. production, protection, wildlands conservation or combinations of these. The lack of an effective management system on the ground denies the Government the opportunity to plan the use and management of the forest estate to optimum effect. For example, the opportunity is lost to assign areas to wildlands conservation in a broad, integrated manner that would ensure that each ecosystem type is represented adequately. There is no yardstick nor the means to do this. Nor, e.g. in the case of Wildlife Sanctuaries, are there criteria to indicate the optimum extent of areas that should be reserved for different species or of buffer zones. The same applies in relation to the "refuge areas" that the Department of Archaeology seeks round developed archaeological sites. These matters are basic to proper application of the concepts of multiple use management and buffer zones.

In addition to the lack of definition of areas to be managed for water catchment protection, there are no specific criteria for this, or guidelines or conditions for activities that might be permitted in them. Intermediate slope areas between production and water catchment zones tend to be "grey." The boundary between the two seems usually to depend on the need for timber and the extraction capabilities of the logger. A linked question is whether, and to what extent, streambank vegetation in the forest (or forests in particular kinds of country), should be protected from cutting. This, and forestry's duty to minimize siltation from the upland forest, raises the further issue of the lack of a legally enforced soil conservation programme of general application, i.e. to the agricultural as well as the forestry sectors. To have one without the other would be anomalous.

3.5.4 The Protection System in Practice

The strict nature reserves (no hunting, logging, etc.) in Belize have been established to protect particularly threatened or valuable areas, such as vulnerable natural features and bird nesting sites (e.g. Hol Chan, Crooked Tree, Half Moon Key), recreation areas and interesting geologic features (Blue Hole), or symbols of the conservation ethic (Guanacaste). Many forest types and other habitats, and thus many species and the ecosystem processes that support them, are not represented in the strict reserve system. These habitats and ecosystems are "gaps" in the system of strict reserves.

A useful technique for enumerating them is "gap analysis". First, the various elements of biological diversity are classified. Then the existing and proposed systems of protected areas and other land-management units that help conserve biological diversity are examined. Finally, the analysis determines which elements (e.g., major ecosystems, vegetation types, habitat types, species) are unrepresented or poorly represented in the existing system of conservation areas. Once this is known with reasonable precision, priorities for the next set of conservation actions can be established. The process can be continued indefinitely, so that the conservation system is refined as land use changes and as better information about distribution and status of species and ecosystems is obtained (Burley 1988).

The underlying rationale is that by ensuring that all habitat types are well represented in a system of conservation areas, it is assumed that much if not most of the biological diversity (species and ecosystems) will be protected. Thorough gap analyses have been conducted in Great Britain, Peru and Australia (Specht et al. 1974, Sattler 1986).

Gap analysis of terrestrial habitats

As part of the TFAP exercise, an elementary gap analysis of the terrestrial habitats of Belize has been carried out, to

illustrate the process of gap analysis, and to indicate the deficiencies and most glaring gaps in the terrestrial reserve system. (Marine habitats are equally important, but a ready classification of them or facts on their distribution are not available.)

Wright *et al* (1959) list 34 major vegetation types found in Belize. The following are represented by some acreage, however small, in the strict reserves:

Broadleaf forest rich in lime-loving species,
deciduous seasonal forest 50-70 feet (15-21 m) tall
Broadleaf forest rich in lime-loving species,
deciduous seasonal forest 70-100 feet (21-30 m) tall
Broadleaf forest moderately rich in lime-loving species,
evergreen and semi-evergreen seasonal forest
Broadleaf forest with occasional lime-loving species,
semi-evergreen seasonal forest
Broadleaf forest with few lime-loving species,
semi-evergreen seasonal forest
Transitional broadleaf forest poor in lime-loving species
semi-evergreen seasonal forest
Transitional low broadleaf forest and shrubland,
poor in lime-loving species (one of two types)
Pine forest and orchard savanna,
without lime-loving species (one of two types)
High marsh forest (two of three types)
Low marsh forest
Herbaceous marsh and swamp (two of two types)
Mangrove swamp (two of three types)
Littoral forest
Littoral swamp
Cohune palm forest

The major vegetation types not found in strict reserves include:

Broadleaf forest rich in lime-loving species,
deciduous semi-evergreen seasonal forest 80-100 feet
(24-30 m) tall
Broadleaf forest rich in lime-loving species,
deciduous semi-evergreen seasonal forest 100-120 feet
(30-36 m) tall
Broadleaf forest with occasional lime-loving species,
evergreen seasonal forest
Broadleaf forest with few lime-loving species,
evergreen seasonal forest
Transitional broadleaf forest rich in lime-loving species
Transitional broadleaf forest poor in lime-loving species
evergreen seasonal forest
Transitional low broadleaf forest and shrubland,
rich in lime-loving species
Transitional low broadleaf forest and shrubland,
poor in lime-loving species (one of two types)
Shrubland with pine
Pine forest and orchard savanna,
with lime-loving species

Pine forest and orchard savanna,
 without lime-loving species (one of two types)
 High marsh forest (one of three types)
 High swamp forest
 Palm swamp
 Mangrove swamp (one of three types)

A preliminary interpretation of this gap analysis, together with consideration of the acreage and importance of the vegetation types, yields several points:

--Eighteen of 34 major vegetation types are represented in the strict reserves, but actually only very small areas of many of these habitats are included.

--Sixteen major vegetation types are not included in any strict reserve.

--There are many additional, minor vegetation types not found in reserves.

--The tall evergreen forests of southern Belize, the most species-rich forests in the country, are poorly represented. Particularly rich are the wet forests of Toledo District, southeast of the main divide of the Maya Mountains.

--Pine ridge, a widespread, important vegetation type, is poorly represented in strict reserves.

--Mangrove swamp, another widespread, important vegetation type, is poorly represented.

--Wetlands in the high rainfall region of southern Belize are not represented.

Weaknesses in wildlife protection

As evidence of the current healthy state of Belize's wildlife, all but four of the 22 animal species listed by the Convention on International Trade in Endangered Species (CITES) for Central America are still common in Belize. Notable species that are extinct or endangered elsewhere but are common in Belize are the jaguar, tapir, curassow, Morelet's crocodile, and manatee. Some species have dangerously low populations. The Belize Country Environmental Profile (Hartshorn et al 1984) discusses the status of individual species.

But the conditions that allow wildlife to flourish in Belize are changing. As Belize's population increases and development pushes into formerly wild land, wildlife suffers. And hunting laws are commonly ignored. A study of hunting practices in the recently settled areas near the Hummingbird Highway showed that many Belizeans are ignorant of the hunting laws, or profess to be, and the laws are routinely broken (Bliss et al 1987). Populations of game species and other animals are reputedly much

reduced in the area. BAS is working to inform the public of the hunting regulations. But enforcement is nearly impossible given the lack of staff assigned to that task. Enforcement of fisheries regulations is difficult for the same reason, and some commercial fish stocks are reportedly significantly reduced.

Protected species at risk due to inadequate enforcement include the sea turtles, the Ocellated Turkey, and the Great Curassow and Crested Guan in some areas. Populations of important species that are not protected and are reportedly suffering, include the iguanas, whose eggs and gravid females are especially sought and the river turtle, or hickety.

The Wildlife Act declared a seven year moratorium (ending 1988) on commercial trade in wildlife. This has mostly succeeded in stopping export of animals and animal parts. The intent of the moratorium was to allow time for research into sustainability of wildlife trade, but that research has not been done. Some observers feel that there is still a damaging amount of internal trade in wildlife. Of particular concern is the internal and export trade, legal by licence in Belize, of black coral (Antipatheria sp.), which is nearly extinct elsewhere in its range, such as Mexico, adding to the pressure on Belizean populations.

Private investors have proposed developing commercial sport hunting of domestic and exotic species on game farms in Belize. Their plans were rejected by the Ministry of Agriculture on the advice of BAS. In theory, game farming can preserve habitat, benefit native wildlife, and contribute to the Belizean economy, but there are possible dangers from exotic animals and diseases. If the potential environmental impact of a game farming plan is explored and shown to be benign, and if proposals demonstrate careful foresight and guarantee effective management and adequate safeguards, game farming may be beneficial.

4.0 PROPOSALS FOR FUTURE ACTION

4.1 DEFINING A DEVELOPMENT STRATEGY FOR THE FORESTRY SECTOR

4.1.1 The Framework

The forests of Belize are clearly of immense importance to the country. Directly and indirectly they are critical to the nation's continuing economic and environmental prosperity.

A realistic strategy for further development of the forest sector must be based on the recognition of a number of salient facts:

1) Over a large part of the forest area timber production needs to be excluded or limited in favour of environmental outputs. A substantial portion, said to be a fifth, is on upland terrain where it serves a primarily watershed catchment protection function. Extensive other areas need to be managed to preserve biological conservation and touristic values.

2) The timber production potential of the forest reflects the long periods of continuous or repeated exploitation. If Belize is to continue to be able to draw down upon this important resource it will be necessary to invest in measures to maintain and rebuild its productive potential.

3) The current log production is made up of four elements:

- a) mahogany and some cedar - from 20 to 30% of output
- b) pine - 20 to 30% of output and increasing
- c) a few very high valued species - 1 or 2 % of output
- d) a number of other hardwoods - 40 to 50% of output

4) The export trade and earnings are based largely on mahogany and cedar sawnwood, which account for nearly 75% of the export value, and on pine (mostly stumps for naval stores) with one-fifth of export value. Most of the "precious" woods are exported but in aggregate comprise only 5% or so of exports by value.

5) The domestic market uses a substantial portion of the mahogany (on average about one-half); little of the "precious" group; nearly all of the pine (except stumps) and of the utility woods in the "other hardwood" group.

6) Continued production in the immediate future will be shaped by its present structure;

- Mahogany has been a declining resource, with smaller and smaller trees being harvested, but has continuing prospects from replacement.

- Pine stands, largely immature and of mediocre quality, are quite abundant, but are declining on the Southern Coastal Plain largely because of burning. An increased

harvest will be available from a maturing resource in the Mountain Pine Ridge Forest Reserve, if fire losses can continue to be contained.

- The few precious species are very limited in availability.

- Existing plantations are too limited to play any appreciable role.

- The large quantities of other hardwood species represent a major challenge for greater use.

7) The present Forest Department is too understaffed and underfinanced to successfully undertake the wide range of essential tasks needed for the planning and management of a large forest estate for conservation, protection and production purposes (as well as operating logging, sawmilling and woodworking enterprises).

4.1.2 Future Requirements for Forest Products

In order to assess how best to manage the forest estate, it is first necessary to try to establish the magnitude and nature of the demands for goods and services that are likely to emerge. Future requirements for wood products from the forest depend on many factors related to the growth and development pattern of the domestic economy, as well as the competitive position of the country in obtaining external markets for its forest products. This section will appraise the requirements which the forest may be expected to supply in 2000.

The current national macro-economic plan for Belize looks forward only as far as 1989. A recent report of the World Bank provides some estimates of prospective future development to 1997. The latter sees real GDP growth of 6.5% annually or higher in the next few years; dropping to 4.5% in the early 1990's and rising to 5% by 1995. Over the 10 year period 1987 to 1997, population is estimated to grow from 173,400 to 223,900; real per capita GDP from 1,216 to 1,592 in 1984 US\$; gross investment is estimated to increase from 69.6 million to 122.6 million in 1984 BZ\$, with similar growth in public and private sectors. Consumption expenditures are foreseen to grow from 405.2 million to 631 million 1984 BZ\$ with that of the private sector growing considerably faster. Forward estimates for trade do not show detail for forest products.

Historical data on total apparent consumption of sawnwood show no clear trend over the past decade or two - at most a mild upward trend. Nor does there appear to be any close correlation with GDP. This lack of evidence probably results from several factors, especially the small size of the domestic market and the consequent relatively large fluctuations from year to year. Hence, there is little upon which to base projections of consumption without an in-depth market study. A few points,

however, do stand out. There is some increase in both the level and share of pine in consumption offset by a combined loss in the relative share of mahogany and other hardwoods. Although there is a strong upward trend to the number of houses built over the past quarter century, the number of wooden houses shows, if anything, a downward trend. This is the result of the striking shift from wooden to concrete block housing. However, the latter do require considerable wood in their construction, nevertheless. Much furniture continues to be made of wood. There is some improvement in the efficiency of wood use.

Given the lack of clear evidence of strong trends in total wood use, it may not be unreasonable to place a lower alternative for consumption in 2000 at little above current levels - say 11 million board feet ($23,600\text{m}^3$). This represents an annual growth of 1.6% from the 1985/87 average. An optimistic outlook would suggest 12 million board feet ($28,320\text{m}^3$), corresponding to an annual growth of about 3% per annum.

The major forest product export, mahogany lumber, will be limited by the future physical supply - the growing stock - and by the economic efficiency of sawmilling units. The major market, the USA, continues to import substantial and increasing quantities of mahogany of the species produced in Belize. Indeed, the 1987 import by the USA was more than 100 million board feet ($236,000\text{m}^3$), some forty times the export of Belize. Market size and share should be no issue. Likewise there is no major effort required to market the limited quantities of the highly valued rosewood, logwood, and ziricote which become available. It is in the other group of hardwoods where the future market prospects are less certain. Physical supply is abundant in total but often limited for individual species. Demand for many of these species is weak. Success of the newly established veneer plants, and of a possible future plywood plant, could do much to determine the market future of these woods; as will the initiatives to penetrate markets for manufactured and semi-manufactured items.

It is recognized that the forest will be called upon to supply additional area for agricultural expansion - permanent agriculture for major cash crops and smaller farms as well as for milpa farming. Heaviest demands will likely be for land for planting citrus and bananas and for expanding populations depending on milpa farming as well as for subsistence plots for immigrants. Without some quantitative agricultural targets, the amount of land required can be but a guess.

The requirements for environmental benefits supplied by the forest will increase. A growing population and a larger agricultural sector will place greater demands on water regimes, and a growing tourism industry will become increasingly dependent on intact forest ecosystems. The values of maintaining biological diversity will also heighten pressures for the latter.

The production potential of the next few years will be based on the current and emerging logging and milling capacity. The

output in 1987 was heavily concentrated in relatively few units. Five establishments account for nearly three-quarters of existing sawmill capacity. One unit, operating on private land, accounted for nearly one-third of national production (including nearly one-quarter of mahogany output) from a forest holding representing less than 5% of the country's exploitable forest area. A considerable portion of the remaining national production also came from private land. The second largest unit draws logs from a Forest Reserve concession which is estimated by the operator to have supplies for two more years. The largest immediate increase in output will come from a recently established mill drawing on a new Forest Reserve concession with considerable potential for supplying core veneer stock, as well as sawwood. A good portion of this output may be expected to be in the softer and lighter coloured species. This mill also has a claimed longer term potential for plywood production.

Nearly all mills saw some mahogany, but much output is concentrated in a few medium sized mills, in the northern part of the country, which produce in considerable part from logs purchased from private operators. It is therefore difficult to foresee the levels of prospective production of this species from private land, much of which is not inventoried. Most mills saw some pine but the great bulk of production is concentrated in a few mills. The supply for these mills is presently being strained given the immature nature of almost all of the pine stands.

Although there is fairly good inventory coverage of much of the Forest Reserves, information necessary for assessing future potentials is not readily available without considerable additional analysis. In general, it may be assumed that, provided markets continue in an undepressed state, production over the next decade or so may be maintained at levels equal to, or modestly greater than, those of the present. Expansion will be largely in the "other hardwood" group. Very little of the extensive areas of "exploitable forest" can be seen to contribute to increased output until considerable further growth replacement takes place. Therefore, any alternative assumptions about production until the end of the century must be cautious.

4.1.3 Alternative Development Scenarios

In this section some indicative targets for the forestry sector to the year 2000 are suggested. These correspond to two assumptions of GDP growth from recent levels - 3% and 6%. Domestic consumption is somewhat arbitrarily assumed to be 10 and 12 million board feet (23,600 and 28,320m³) respectively for these two alternatives. These imply growth rates at roughly half that of GDP. For each of these general growth scenarios, two policy alternatives for the forest sector are considered. The first assumes a continuation of past forest policies and trends in supply, in domestic use patterns and in exports. The second or upper target level assumes a more aggressive forest policy and programme, as well as additional government supported incentives for industrial development.

Thus, under the trend assumption, domestic use of mahogany and cedar increases while exports decrease correspondingly, with production remaining at a level about two-thirds of 1987 production. Under the higher growth scenario, exports of these species decline to 500,000 board feet (1,180m³). Other hardwood consumption grows only modestly, while pine consumption increases considerably. The very valuable hardwoods continue to be exported at near present relatively small quantities. There will be some expansion of export of other hardwoods in the form of veneer. Manufactured wood products may expand slightly until domestic requirements limit available supply of lumber. Imports of manufactured wood and paper products will increase.

Under the aggressive forest policy alternative, other hardwood species are promoted for local use, while mahogany/cedar consumption declines modestly. The amount available for more highly processed exports of dressed lumber and wood manufactures increases; thus export value increases substantially. Up to half is manufactured into millwork or furniture. Domestic requirements are increasingly met by supplies of currently little used "other hardwoods" and smaller dimension pine processed by more appropriate equipment. This alternative foresees the replacement of much of the imported plywood with a domestic product. Some mahogany and luxury woods will be used in plywood but most production will be based on utility species. Some very high valued logs will continue to be exported.

Indicative estimates corresponding to the development alternatives are shown in Table 4.1.

4.1.4 Economic Policies to Support Development

In order to move activities within the forest sector in the directions outlined above, economic policies and policy tools need to be deployed which encourage the following:

- 1) Increasing the value added and export earnings through the further processing of a greater portion of an enlarged export of mahogany, cedar and other high-valued species. Given the resource limitations of most of those species, this objective implies reducing domestic consumption of these high valued species for utility uses and replacing them with suitable woods from the lower valued other hardwoods (or possibly smaller pine).
- 2) Replacement of imported manufactures of wood with domestic products. (The major items in this group are plywood and other wood laminates which have an import value approaching BZ\$ 1 million).
- 3) Maintenance of the many environmental benefits of the forest. This includes both the protection and aesthetic functions. In this context, it is important to determine estimates of the value of these forest services.

Table 4.1: Development Alternatives for the Forestry Sector.

	Units	1985-86 Ave.	2000		2000	
			Lower Growth		Higher Growth	
Population	Thousands	169	242		242	
Labour Force	Thousands	58	81		81	
GDP (1965/1986 Prices)	Million BZ\$	349	536		812	
GDP Growth to 2000	% per annum		3		6	
GDP per capita	BZ\$	2066	2215		3355	
<u>Logs, Lumber, Veneer & Plywood</u>						
	Million Bd. Ft.	1985-1987 Ave.	Trend	Agressive Policy	Trend	Agressive Policy
Production		9.5	11.4	13.1	13.0	14.1
Mahogany & Cedar	Million Bd. Ft.	2.3	2.5	2.5	2.5	2.5
Other Hardwoods	Million Bd. Ft.	4.2	4.8	6.0	5.3	7
Pine	Million Bd. Ft.	3.0	4.1	4.6	5.2	4.6
Domestic Consumption	Million Bd. Ft.	8.0	10.0	10.0	12.0	12.0
Mahogany & Cedar	Million Bd. Ft.	1.3	1.5	1.0	2.0	1.0
Other Hardwoods	Million Bd. Ft.	3.8	4.5	5.0	5.0	6.5
Pine	Million Bd. Ft.	2.9	4.0	4.0	5.0	4.5
Average Domestic Prices	BZ\$ per Thousand Bd. Ft.	913	905	910	908	929
Mahogany & Cedar	BZ\$ per Thousand Bd. Ft.	1200	1200	1600	1200	1650
Other Hardwoods	BZ\$ per Thousand Bd. Ft.	900	900	700	900	700
Pine	BZ\$ per Thousand Bd. Ft.	800	800	1000	800	1100
Value of Domestic Consumption	Million BZ\$	7.3	9.1	9.1	10.9	11.2
Mahogany & Cedar	Million BZ\$	1.6	1.8	1.6	2.4	1.7
Other Hardwoods	Million BZ\$	3.4	4.1	3.5	4.5	4.6
Pine	Million BZ\$	2.3	3.2	4.0	4.0	5.0
Exports	Million Bd. Ft.	1.3	1.4	2.1	1.0	2.1
Mahogany & Cedar	Million Bd. Ft.	1.2	1.0	1.5	.5	1.5
Other Hardwoods	Million Bd. Ft.	.11	.3	.5	.3	.5
Pine	Million Bd. Ft.	<0.1	.1	.1	.2	.1
Average Export Prices	BZ\$ per Thousand Bd. Ft.	1500	1521	1557	1460	1557
Mahogany & Cedar	BZ\$ per Thousand Bd. Ft.	1460	1500	1600	1500	1600
Other Hardwoods	BZ\$ per Thousand Bd. Ft.	3000	1700	1500	1700	1500
Pine	BZ\$ per Thousand Bd. Ft.	1400	1200	1200	1200	1200
Value of Exports	Million BZ\$	2.1	2.1	3.3	1.5	3.3
Mahogany & Cedar	Million BZ\$	1.7	1.5	2.4	.8	2.4
Other Hardwoods	Million BZ\$	.33	.5	.8	.5	.8
Pine	Million BZ\$	<0.1	.1	.1	.2	.1
Value Other Exports		.7	.7	1.1	.4	1.1
Pine Stumps	Million BZ\$	.5	.3	.3	.3	.3
Manufactured Wood & Furniture	Million BZ\$	.2	.4	.8	.1	.8
Value Total Sector Exports	Million BZ\$	2.8	2.8	4.4	1.9	4.4
Value of Imports (excl. Paper)	Million BZ\$	1.0	2.0	1.5	2.5	1.5
Estimated Employment in Sector	Man-Years	600	750	900	850	950
Share of Labour Force	Percent	1.07	.93	1.11	1.05	1.17

- 4) Increasing public revenues from the forest by broadening and deepening the base of charges for goods and services.
- 5) Increasing expenditures on the essential and important aspects of management of the forest estate.
- 6) In general, improving returns on investments.

Policy tools which are appropriate to implementing this strategy are:

- manipulation, i.e. differential pricing or rate setting of, structural changes in and, in some cases, abolition of:

- royalty and other public charges for forest use,
 - export and import taxes on forest products,
 - domestic control prices for lumber products;
- other incentives and disincentives to promote more efficient production in the desired direction;

In addition, a clearer definition of the role of the Government in the forest sector is needed; especially its role in logging, milling and woodworking operations. This needs to establish priorities for deploying public sector resources in the sector, and also to take into account the predominant private sector participation in forest products production.

These points are discussed in greater detail below. Subsequent sections examine what would be required in order to translate it into practice through improved land use planning and use; better forest management; more efficient forest industry operations; extension and strengthening of conservation measures; and strengthening of the Forest Department and other components of the institutional framework within which forest based activities occur.

Royalties and other public forest charges

The royalty structure, as described earlier (section 3.3.5), should be examined carefully for desirable revisions. Points of concern are (1) the lack of any differential reflecting the relative ease of logging and transport to mill; (2) the lack of adequate differential between species to reflect selling price differences; (3) the opportunity given, by the lack of area or concession charges, for the logger to maximize unit volume profits i.e. to high grade or "cream" the stands being operated; (4) the lack of a deliberate policy to use royalties as a management tool to discourage overcutting of scarce species and encourage cutting of abundant species.

The relatively short time available to the team to review the situation in depth precludes proposing precise solutions to the forest fee structure. It is recommended that such an appraisal be undertaken, with the following to be considered as tentative proposals:

1) Major licences offered for sale be allocated a minimum upset purchase price, reflecting the positive differential value over marginal logging operations. The licence should be offered at auction in line with current Forest Rules (Sections 5 & 6) except that a portion of price be a lump sum and a portion be an annual area rent rather than solely a higher royalty as in the Rules.

2) The royalty for cedar and mahogany be substantially increased, to reflect the considerably greater profit margins existing for these species because of their higher selling prices, despite similar processing costs to other species selling for roughly half the price (See Appendix 20). Indeed, the royalty should be high enough to necessitate a further increase in prices. A doubling or even tripling of the royalty would not seem excessive.

3) Special and frequent review should be done on the market for, and costs of, producing logs of rosewood, logwood and ziricote.

4) Royalty for some other species, e.g. Santa Maria, which have been and are in continuous demand at good export prices should be increased above that of the run of "other species".

5) Royalties on the great bulk of "other hardwoods" should not be increased under present conditions.

6) Royalties on private lands should be abolished as such and replaced by a special fee for scaling timber to be cut. This would provide a service to private owners and enable the Forest Department to keep a record of national harvest.

Control prices, trade barriers and other incentives

Control pricing is always a debatable issue. The objective of price control is normally to prevent retailers from taking unfair advantage of consumers in periods of tight supply. Currently, supplies of the primary hardwoods, and pine are not matching domestic demands. However, physical supply limitations do preclude the possibility of higher prices bringing, in the short run, substantially higher quantities to the market without the danger of further over-exploitation. Nevertheless, a continuation of unrealistically low control prices will, if not strongly enforced, lead to a major disruption of the control system. If these prices are enforced, both current and future production may be discouraged.

In the case of most secondary hardwoods, there is no immediate physical limitation on supply. Higher prices for these species, would, however, only intensify demand for the more desired species already in short supply, if the price of the latter were not also to be increased. Precluding imports from the domestic market appears only to worsen the situation by further distorting price anomalies and by limiting possible

supplies of conifers which might provide a short term solution until domestic pine production can be appropriately increased. Hence, it appears that neither price controls or export limitations will do other than worsen the situation with respect to the desired species that are in short supply.

Clearly, what is needed is a structure which will encourage higher use levels of the increasingly rare high valued primary and luxury hardwoods; allow a temporary supply relief for conifers until increased domestic supplies of pine can be produced without the damages of over-exploitation; and promote fuller use of secondary hardwoods, replacing in part current uses of primaries and pine.

It is therefore proposed that, either price controls on lumber be abolished or, if it is politically necessary to maintain them, control prices for all species be increased to encourage overall production; and that on mahogany and cedar be very substantially increased to discourage local demand. The current control price is nearly twice that of the ordinary hardwoods, but, nevertheless, mahogany is still widely used for utility purposes. Control prices on several luxury woods are already quite high but should be constantly kept under review. A few species such as Santa Maria which are popular and commonly known on export markets should be controlled in an intermediate price position.

It is thus proposed that royalties be used to differentially affect producer costs, and it may be expected that these differences will be reflected in the prices passed on to consumers. In the event that control prices are maintained they should also reflect these differences. Hence, royalty rates should have an impact on both supply and demand. Production of the species in short supply can be limited, at least on public lands, by appropriate controls on licensees. If judged of adequate importance, special measures might be taken to regulate trade in high valued species from private lands, but this is not recommended. High domestic prices will limit domestic demand and the higher royalties will also preclude the product being sold widely on the international market at low prices.

It is proposed that prohibiting or restricting either exports or imports be limited to very special and carefully examined cases e.g. possibly retaining all ziricote production for the use of domestic craftsmen. The trade tax structure already has provided, by the magnitude of import taxes, protection for potential industry. Special consideration should be given to additional, but temporary, tariff protection for potential establishment of plywood production for the domestic market, as well as for some manufacture of paper products based on imported paper stocks, e.g. paperboard boxes, sanitary papers, exercise books, etc.

It is proposed that other existing incentives for encouraging industrial establishment be maintained and that specific exclusions from import taxes of equipment and supplies, not available locally, be liberal.

4.2 LAND USE PLANNING AND ALLOCATION

4.2.1 Formulating a Land Use Policy and Plan

In view of changing economic conditions and technology it is inevitable and logical that thoughtful adjustments of moderate extent would be required periodically in the allocation of land to forestry. However, the review of current procedures used for this purpose (see 3.2.4) emphasizes the need for a more systematic, rigorously analytical approach to transfers of land out of forest use. The practice of de facto excision of illegally farmed land is also questionable as to its soundness.

The sound development of agriculture in Belize can only be accomplished if it is located where production of agricultural crops or livestock can be sustained and will be viable. As was indicated in the assessment in Section 3.2, some recent developments on soils of doubtful suitability must be a matter of concern; in particular given past failures. Though the investment involved has been largely from private sector sources outside the country, so that poor performance or failure is not at the expense of the government's investment resources, nevertheless there is a cost to Belize. The capital represented by the timber growing stock removed is lost, and some failed crops have impoverished the sites on which they were located to the extent that they cannot be put to other productive use.

Within the forest sector, the issue is not just whether land is more productively employed under crops, pasture or forests. There is also the question of the appropriate balance between the area of Reserved Forests and forests in other land ownership categories. As was noted earlier, much of the richer forest is on private or National Land. To the extent that it is on sites which land use surveys would show should stay under forest, the government could well wish to add suitable unreserved forest to the Reserved estate, in order to bring it more effectively under control and management.

There appear therefore to be good grounds for an objective review of the forest estate as it is now constituted, within the framework of an overall national land use plan, in order to make any adjustments either way that are justified, and to provide guidelines for dealing with proposals for excisions in the future. It is recommended that the Government should formulate an overall land use policy and plan, using existing land capability information, particularly the new information emerging from the ODNRI Land Use Surveys, extended as and when necessary by comparative agro/forestry/economic analysis taking into account the needs of environmental conservation management, and using aids such as a refined system of life zones, to define land use zones.

These instruments would then be used to review the current allocation of land to Reserved Forest as well as forested National Land not in this category, in order to identify (i) the areas within each that should be permanently classified as

Reserved Forest, (ii) areas now within Reserved Forest that should eventually be used for agriculture, (iii) areas of unallocated National land that are forested but that should eventually be converted to agriculture.

National land areas identified for allocation to Reserved Forest (numbered (i) in the paragraph above) would then be recommended to the Minister for declaration accordingly under the Forests Ordinance. Areas identified for eventual excision from the Reserved Forest category (numbered (ii) in the paragraph) and the areas described under (iii) in that paragraph would be listed for eventual agricultural use but be retained in their existing categories and managed and controlled as though they are part of the permanent forest estate until converted to agriculture. Before being released for that purpose, the timber on them would be harvested in accordance with current Forests Ordinance, Forest Rules and related procedures.

It is desirable that implementation of the foregoing recommendations should not necessarily await the extension of the land use studies into northern Belize: it should begin as soon as the necessary arrangements for the work to proceed can be made. The information base would be up-graded and the analysis based on it refined as new information comes to hand. An orderly, readily accessed land use potential/existing use/ownership information system bringing together all the available relevant information held by a number of government and other institutions (Forestry; Agriculture; Fisheries; Lands and Surveys; Commerce and Industry, including Tourism; Electricity, Transport and Communication (re water); Archaeology; Belize Audubon Society) should be developed as a priority.

4.2.2 Land Allocation

Formulating a land use policy and plan, implementing it initially, as suggested above, to review the existing situation with respect to forests, and keeping the system current through periodic review and analysis of issues, cases and proposals as they arise, would involve the interests of several departments. Forestry, Agriculture and Lands would be central in this respect. Others should be involved when their interests and responsibilities are affected, while others again (Commerce and Industry for example) would on occasions be asked to provide important information required for the analyses. The mechanism recommended to coordinate and supervise the recommendations made in this section of the TFAP report is an Inter-Departmental Forest Land Allocation Committee with specific terms of reference embracing the functions mentioned, appointed jointly by the Ministers responsible for Lands, Forestry, Agriculture, Fisheries and Water, and comprising the permanent heads of those Departments, who would rotate as Chairman.

The technical work of the Committee, including analyses, would be performed by a Task Force of three professional officers, one representing each of Agriculture, Forestry and Lands with officers temporarily assigned from other Departments

as required. Each would have training in land capability and use analysis. Except in the initial period of information assembly and analysis, when the whole of their time would be required, only as much of their time would normally be devoted to the work of the committee as is required for tasks that arise. The Committee would decide in which Department the secretariat would be and who would lead the Task Force. Based on the results of analysis and reviews by the Task Force, the Committee would recommend actions for approval by the Ministers of the Departments mentioned and any other departments concerned.

It is recommended that Government should require that proposals, e.g. from intending developers, for land to be transferred out of Reserved Forest for agricultural use should be justified by the protagonist as to scientific appropriateness, economic feasibility (even when the tax holiday is over) and sustainability of the intended development, and the cultural methods and procedures to be used. Such applications would be referred for consideration and recommendations of the Committee on the basis of analysis by its Task Force. The Government should require that plantation forestry using appropriate species and cultural methods be included as an alternative in the analyses of both protagonist and the Task Force. Before recommending any proposal for excision from Reserved Forest in these circumstances the Committee should satisfy itself that no alternative land suitable for the proposed development is available.

In view of the recommendation for a wide ranging review of allocations to Reserved Forest and of unallocated forested National Land it is recommended that, provided that no rights of occupation have been established, cases of illegal settlement of Reserved Forest by encroachment should not be settled by excising the land and granting lease or title to it. This would need to be accompanied by action on the part of the authorities concerned to expeditiously settle immigrants and others seeking land for settlement.

There is a need for more technical, land use-oriented analysis leading to: the formulation of land use/development conditions for sub-division of land under the Land Utilization Ordinance and the grants of leases and titles under the Crown Lands Ordinance.

4.2.3 Institutional Implications

It is recommended that a number of additions or modifications to the laws governing the allocation and use of land, be considered, viz:

- amend the Forests Ordinance and/or Rules to require that a licence be obtained to cut mangroves

- promulgate regulations or rules for the better formulation and implementation of policies under the Crown Lands Ordinance and Land Utilization Ordinance. Provide in each

set of rules for the application of appropriate agroforestry systems if they are deemed desirable to protect the soil of an area when it is developed for agriculture, or to contribute to meeting fuelwood shortages in the locality

-review the Land Tax Act and arrangements under it. Consider changes that would discourage people from holding indefinitely large parcels of land which, in the interests of Belize, should be developed for agriculture, tourism or as forests.

In order to implement the proposals on land use, priority would need to be given to strengthening the professional and technical support cadres and equipment of the Departments of Forestry (particularly to restore its capacity to plan and manage its programmes and to protect, manage and control the forests under its charge) and Lands and Surveys. This is discussed further in Section 4.6 on institutional strengthening.

The development of improved information on land productivity, which also will be necessary for more effective land allocation decisions, should be reflected in the research priorities of the Agriculture and Forest Departments. Some of the implications for the latter, including research in the area of agroforestry, are considered further in Section 4.3.3.

It is also recommended that a five-year moratorium should be declared on changes to the boundaries of the permanent forest estate, to permit the intensive gathering of data on land productivity and the development of a rational land use policy and necessary legislation.

4.3 FOREST MANAGEMENT

4.3.1 Developing Better Forest Management Systems

In the course of the Tropical Forestry Action Plan exercise, it became apparent that most attention needed to be given to assessing the productive potential of the forest resource; as this had to be understood before an assessment could be made of forest industry prospects - which the government had identified as its first priority. In order to do so, it proved necessary to re-evaluate available information about the forest in considerable depth. Therefore, this aspect of the forest sector has been analysed and reported on in considerably more detail than others. The salient parts of these reports on the forest resource, and on their management, are to be found in Appendix 19; with the present section providing a discussion of the main points raised there.

Defining management possibilities

Since there is substantial ecological diversity in the Belize forests it follows that no single management or utilization model will suit all circumstances. Equity requires that the forest law be the same for all but that does not imply that the terms of each concession (forest licence or permit) have to be equal. Similarly, the management systems and silvicultural regimes may differ substantially between forests. Also, as was pointed out earlier, some parts of the forest estate need to be rested in order to allow time for the growing stock to rebuild. (E.g. the Chiquibul Forest Reserve, exploited almost continuously from the 1920s until 1985 and damaged more or less severely by hurricane in 1961.)

The analysis in Appendix 19 considers in turn the management of four types of forest land: broadleaved Forest Reserve, Mountain Pine Ridge, pine Forest Reserve on the Southern Coastal Plain and forest on private and national (formerly Crown) land. In the present section the discussion focuses on the general approach to better management that is recommended. In most cases, changes in management will be gradual because substantial areas of the permanent forest estate have been given out under 5- and 10-year long-term forest licences in 1986 and 1987.

Having drawn up general terms and conditions for forest exploitation (see the section below, "Revise concession agreements"), the Forest Department needs to consider each area in turn, as to its present state and most appropriate management regime. This process involves the review of multivariate data and a wide spectrum of potential uses of the forest land. Much of the permanent forest estate is on broken topography with steep slopes. The foothills and flatter land are increasingly being converted to temporary and permanent agriculture and the primary purpose of much of the gazetted forest could be to regulate water flows and to prevent erosion damage to agricultural land.

The first step in management operations for a particular

Forest Reserve or portion of national land is thus to use the topographic maps and aerial photographs to delineate areas which should be permanently retained under forest for agricultural protection. The ODNRI land resource surveys of Toledo and Stann Creek Districts (King et al. 1986, 1988) offer reasoned suggestions as to which land systems should be protected.

The second step is to delineate areas which should remain unlogged because of their greater value as sources of genetic material, as tourist attractions or as recreation areas; a process discussed in more detail in section 4.5. The remaining area of a Forest Reserve is now assumed to be available for management for tangible forest products; sometimes in conjunction with other uses, such as wildlife habitat in buffer zones round conservation reserves.

Three of the large Forest Reserves with broadleaved forest have not been inventoried after the 1961 hurricane: Manatee, Sibun and Sittee. Sibun and Sittee have little land which could be managed for timber production because the topography is so severe. Manatee will obviously come under pressure for complete dereservation or partial excisions, as soon as the new Stann Creek-Belize City road is opened. Some of Manatee is on easy terrain but attempts to reduce the Forest Reserve should be resisted until after the area has been covered by the 1989 land resource study. It would then be appropriate to inventory the unthreatened and marginal areas of that reserve, to facilitate discussion about its future.

The assembly of inventory data constitutes the third stage of management operations. Belize has no yield plot data for broadleaved forest so only the static inventories are to be considered. The broadleaved Forest Reserves other than the three discussed immediately above have been inventoried in the 1970s or early 1980s. Although they have been logged subsequently the production levels have been both low and highly selective as to species, and no significant hurricane damage has been recorded since the inventories were carried out. There is thus no need for planning-level inventories to be executed again.

The fourth stage of management operations combines the results from the static inventory with log production data from the licensees, recorded by the Forest Department and checked against the licensee's obligatory annual statement. These figures, together with the Forest Department's knowledge of the logging techniques used by each licensee, will suggest the standing stock in each site type. The size class distribution of each species or species group on each site type can then be superimposed on forest type maps. Provisional compartments can be delineated, based on topography (natural boundaries such as ridges and streams are preferable) on the provisional stock map.

At this point, the fifth stage, the Forest Department needs to consider the priorities for bringing the compartments progressively under active management. Usually the compartments with the growing stock closest to commercial size would be

managed first (diagnostic sampling, silvicultural treatment if appropriate, installation of permanent yield plots). However the Forest Department would need to consider the purely silvicultural priorities in conjunction with its industrial strategy. Are there mills to be supplied by this forest with particular species, sizes and quantities of forest products?

Obviously the matching of forest production capability to industry, and other consumers of forest products, is an iterative process. It will need to take into account both the need to bring about shifts in the pattern of species use which have been discussed in section 4.1 and elsewhere in this report, and the potentials for changes in utilization practices which are reviewed in section 4.4 on forest industries.

The sixth step in forest management operations is to decide when the forest can be cut again. This should occur when the mean annual increment in volume of the commercial species has attained its maximum. It is worth emphasizing that the inventories showed that the broadleaved Forest Reserves are still recovering from the 1961 hurricane damage. They are not in a steady state, and the mean annual increment therefore cannot yet be harvested in full without violating the forest policy.

Adapting forest management to ecological characteristics

Section 3.3.4 has explained why the polycyclic selection system more or less applied in Belize should be replaced by a monocyclic uniform system wherever the conditions are suitable.

A change to a monocyclic uniform management system needs to be accompanied by more intensive logging. Inventories in the broadleaved forests show consistently that the bulk of the present growing stock is in species which have technically adequate timber properties but which have not been harvested so far except on a small scale. The traditional practice of highly selective and low intensity logging has conserved the ecological structure of the forest but militates against silvicultural improvement: the forest remains stocked with technically acceptable species and the reduction in basal area is too small to justify silvicultural measures in favour of the few primary species which have been logged.

The cutting girth limits should be modified to match the ecological characteristics of the tree species. The species of major importance are not shade bearers, nor is there any evidence that they will respond to liberations except in the juvenile stage of growth. Cutting limits should be geared to the control of damage to residual trees by logging and to the maintenance of an adequate population of mother trees for seed production. The mother trees should be of good phenotype from desirable species and the quantity of regeneration of these species, whether as seedlings or as adolescents, should be sufficient to provide for a fully-stocked following crop. The quantity of regeneration should be sufficient to compensate for logging damage.

Low intensity logging over extensive areas is expensive to administer as well as to operate. It is not surprising that the Forest Department control over licensees in the field is weak. Loggers should be required to work systematically through the forest, by demarcated logging blocks, and to take all technically acceptable trees. There should be enforceable penalties for leaving such trees and for avoidable damage to regeneration.

More intensive logging concentrated into smaller areas will obviously be cheaper to operate than extensive logging with long hauls and high transport costs. Supervision costs are also lower for the Forest Department. Pre-logging sampling is essential to confirm that there is sufficient regeneration of desirable species to grow into the next crop. If regeneration is scarce, the Forest Department can delay opening the compartment until subsequent surveys show the presence of enough regeneration, or the existing regeneration can be enriched after logging by line-planting. Alternatively, if there is a sufficient population of undergirth trees of desirable species, a polycyclic system can be used. There is no reason for a single silvicultural system to be employed throughout the Belize broadleaved forests; the system should be varied according to the results of compartment stock mapping and regeneration surveys.

The exploitation should be as heavy as possible, consistent with maintaining site productivity. In practice this means that sufficient regeneration or adolescent trees of commercial species (primary and secondary hardwoods) should be available to form the next crop, taking into account losses due to logging. Losses include the trees destroyed at the time of exploitation and the subsequent mortality of damaged trees and the net loss due to rot in the survivors. Stock mapping, yield plots and diagnostic sampling need to be introduced in order to supply the data from which the cutting limits can be determined for different areas within a licence area; it will be appreciated that this is quite different from the present system of nation-wide cutting limits varied only by species. The same data sources provide the list of obligatory species and sizes which must be cut by the licensee.

Post-logging management involves first a block-closing inspection, with the calculation of suitable fines for unnecessary waste, damage to residual commercial trees and regeneration and the drainage, and for failing to fell obligatory trees. A rapid sampling determines whether line enrichment planting is necessary to supplement natural regeneration. At about five years after logging, a thorough diagnostic sampling determines the need for and type of silvicultural treatment, and yield plots are re-established.

This brief summary of the management operations sequence does not include the specific procedures concerning the control of exploitation and post-logging silviculture. These are readily available in the literature (Surinam and Malaysia provide excellent examples).

4.3.2 Controlling Management and Use

Update and adopt working plans

Even the fastest-growing trees on a short rotation have a maturation period longer than most agricultural crops. Stability of policy and objectives, and continuity of execution, are fundamental for effective and efficient forestry. Forestry is too complex a subject for the management plans to be carried in the head of the DFO or responsible Forest Ranger. It is therefore essential that management be incorporated in formal working plans; a point made in most previous advisory reports on forestry in the country.

The working plan records the policy and biophysical justification for management activities; lays out what has been done and what should be done, where and when; and provides the criteria for measuring efficiency and success. In the absence of a forest management manual for Belize, the working plans should detail the procedures to be followed in the field and office.

Draft management plans were written for several areas after inventories in the 1950s. At least the 1956 plan for the Mountain Pine Ridge was revised in 1960 to accommodate the reduced budget following the cuts recommended by Downie in 1959. All existing working plans were nullified by hurricane Hattie in 1961. The inventories of the 1970s were followed by draft plans at least for the Columbia River and Maya Mountains Forest Reserves, Chiquibul Forest Reserve and the Mountain Pine Ridge. Indeed, the Mountain Pine Ridge has had several draft working plans prepared over the last decade. It is not clear why these plans have not been approved or executed. The TFAP Mission understands that field activities in the Divisions and Districts are carried out under annual work plans but current plans appear to be extremely sketchy.

The existing draft working plans provide a good or very good biophysical background for each of the four Forest Reserves. However they are weak on the justification of objectives, poor on the estimation of yield and provide almost no guidance on management routines. The weakness in yield calculation stems partly from the unsuitable processing of the inventory data and from the absence of growth data. However, yield plots and experiments do exist on the Mountain Pine Ridge and, in view of the Forest Department's great interest in this area, it would be appropriate to start the more suitable working plans with this Forest Reserve. It is, however, only 8% of the permanent forest estate, and has perhaps the lowest productivity. The simplicity of the ecology and management regime makes it a suitable teaching area for Forest Department staff before going on to the broadleaved forest.

Revise concession agreements

The forest law provides for the head of the Forest Department to recommend to the responsible Minister the areas and

terms for forest exploitation in the permanent forest estate. However, there is also provision for any person to solicit a licence or permit directly from the Minister. Information available to the TFAP Mission suggested that all current licences and permits have been issued as a result of petitions to the Minister and not through prior planning by the Forest Department. It would no doubt be helpful to the Minister if the Forest Department were to prepare more detailed standard conditions for the issue of licences and permits than are given in the Forest Rules which were last revised in 1980. Such new detailed conditions should give the Forest Department as custodian of the resource the necessary powers to direct its use in a sustainable manner. The present permits and licences are insufficiently explicit to inform a concession holder of his obligations and do not sufficiently relate to the conditions necessary to maintain long-term land productivity.

In 1960 the Forest Department prepared a tender document for one area which outlined the resource available and the terms under which a long-term forest licence would be granted. Unfortunately the forest was damaged by hurricane Hattie and the negotiations lapsed. This document could provide a basis for a new set of standard conditions. There are several FAO texts which detail the clauses to be considered: Schmithüsen's "Handbook of Forest Utilization Contracts on Public Land" (second edition 1977), Gray's "Forest Revenue Systems in Developing Countries" (FAO Forestry Paper no. 43, 1983), Bendz *et al.*'s "Logging and Log Transport in Tropical High Forest" (FAO Forestry Development Paper no. 18, 1974), together with field documents from individual FAO projects such as MAL/76/008. Additional clauses can be extracted from IUCN's series of ecological guidelines.

Standard conditions appropriate to sustained-yield land management should be drawn up for the different classes of forest concessions. These conditions should make full use of accumulated international experience of tropical forest logging and legislation.

Update and streamline legislation

At several points in this report there have been comments on the current forest law. The Forests Ordinance (cap. 176) and the Forest Rules were last revised in 1980. Compared with modern forest legislation in other parts of the tropics, that of Belize is still relatively unimproved. The following notes draw attention to a few of the aspects which should be re-written to facilitate the equitable administration of forest land.

When the legislation is revised, it would be desirable to confine those aspects which require Ministerial decisions to the Ordinance and those which can be decided by the Chief Forest Officer to the Forest Rules. The present allocation of powers to the National Assembly under the Ordinance should also be examined, as there seems to be no good reason for this provision.

Licence and permit fees and penalties are found in both the Ordinance and the Forest Rules. As inflation is endemic, it is desirable to group fees and penalties into the Forest Rules, or some other Order, so that they can be adjusted annually in line with inflation, without reference to the National Assembly. Increases or decreases for any other reason should require Ministerial approval. Present fees and penalties, including royalty rates, do not seem to bear any relation to the costs of collection, the nature of the offence or the value of the permitted activity. A differentiation into a forest land management fee and a royalty on natural products is long overdue. (See section 4.1.4 for a more detailed discussion of royalties and forest charges.)

The various permits and licences for the taking of forest produce are mostly too vague to guide either the Forest Department or a licensee as to their respective responsibilities. It would be almost impossible to secure a prosecution for forest offences with the present wording.

4.3.3 Research

The quality and quantity of research to support management needs to be improved. At present both the Forest Department and the forest industry are hampered by a lack of usable information. Forest management records are inadequate to describe what has been done where, when, why, how and how much. Such records are essential for the interpretation of survey data, planning and control. Research and management records are also essential bases for the consideration of future policy options.

The absence of yield plots or experiments in the broadleaved forest is the largest gap in the research programme. The preparation and implementation of working plans will be hampered by the lack of growth data. On the Mountain Pine Ridge the revision of the draft working plan will need the analysis of experimental and yield plot data to provide information on growth.

It is customary in most countries for the territorial foresters (DFOs and Forest Rangers) to install and manage the yield plots, since they would be the prime users of the data. The research division might need to train the field staff, given the absence of experience in Belize, but thereafter the division's responsibility should be limited to summarizing the data and updating the estimates of growth and yield for the District staff. The yield plots should be installed initially in forest which most closely approximates the conditions foreseeable under the recommended intensive felling in a monocyclic uniform system. The field staff's knowledge of the operations of each of the logging companies should enable them to identify suitable areas. A frequency of about one 2.5 acre (1 hectare) yield plot per 500 acres (200 ha) of exploited forest is normal.

It may be preferable for the research division also to demonstrate the conservative layout of logging roads and skid

trails, and through paired plots to demonstrate the economic and silvicultural advantages of planned logging in broadleaved forest.

A formally designed trial to show the effect of logging to various cutting girth limits should be installed at an early stage, to supplement the data from yield plots in the preparation of management models.

For the Mountain Pine Ridge, the combined analysis of yield plots and experiments should show rapidly the gaps in the data which need to be filled for the preparation of growth models. Formal trials should be established for spacing and thinning in dense regeneration following clear-felling and prescribed burning of logging areas. Spacing trials should use systematic designs and thinning trials should follow the Correlated Curve Trend (CCT) model.

It is unfortunate that there has been a lapse in the prescribed burning trials which were started in 1976 but these should be reactivated, since prescribed burning is one of the principal management tools for the Mountain Pine Ridge.

Although some members of the Forest Department are convinced that thinning of middle-aged stands of pine enhances the increment of the residual trees, the TFAP Mission does not believe that this subject merits research of high priority, because it is so contrary to findings elsewhere.

The data from experiments and yield plots of pine on the SCP should be analysed in a similar manner to those for the Mountain Pine Ridge. It may be possible to produce a generalized model of growth and yield for Pinus caribaea to cover both upland and lowland sites. A combined or separate model should help to decide if any research or management is worth re-starting on the SCP.

Data from past inventories, yield plots and those experiments which are relevant to current management should be recovered, cleaned and stored in data-bases on micro-computers. Belize data should be combined with information from other tropical countries to help fill gaps in growth and yield models.

In terms of number of studies, forestry research in Belize has concentrated on plantation silviculture. This TFAP report has argued that plantations are a low priority for the Forest Department, but that selected work on trials could be appropriate in order to provide an information base for possible future commercial plantations, and the incorporation of trees into agricultural systems. The most recent evaluation of research (Evans 1983) recommended the retention of the pine thinning trials and increment plots, local progeny trials of Pinus caribaea, international provenance trials of various species (Cordia alliodora, Eucalyptus urophylla, Gmelina arborea, Pinus caribaea and Tectona grandis) and trials of species which had grown well elsewhere in Central America. Also recommended was

more work on teak, as having better market prospects than Gmelina or mahogany, if any plantations of hardwoods for timber were to be undertaken. If interest in energy plantations revives, Belize should make use of the information in the MIRA data-base at CATIE in Costa Rica.

The introduction and adaptation of agroforestry systems is recommended in the interests of production of fuelwood, poles and shelter in areas, e.g. in Corozal District, which are being denuded of trees; for the diversification of cropping systems and stabilization of traditional forms of agriculture, e.g. in Toledo District and along the Hummingbird Highway; to maintain or enhance soil fertility and, by using fast growing trees, to make more productive use of fallows, and to produce fodder for improved nutrition of pigs in traditional farming areas in Toledo and cattle in northern districts. The programme would focus on the development of intercropping systems of production, would complement or be integrated, as desirable, with on-going development entailing the growing of cacao, Bixa (annato), pepper, Gliricidia and citrus, ginger, bananas, pigeon pea and other leguminous species as well as melliferous tree species. The designs tested would include windbreaks, contour strips and more intimate mixes of annuals and perennials such as alley cropping.

It is recommended that the agroforestry research initiative be promoted by the Forest Department working with Central Farm and the Extension Service of the Department of Agriculture. Collaboration would be sought with NGO's already active in this kind of development, e.g. Hershey's programme to promote the growing of cacao, and with Menonite farmers engaged in integrating fruit and other trees in their farming systems. Consideration would be given also to linking up with the IDRC-aided programme for pasture improvement. The effort would be focussed particularly on small farms. Sociological factors concerning e.g. the impacts of changing production systems on land tenure, would be taken into account.

4.4 FOREST INDUSTRIES

In earlier sections of this report it has been argued that expansion of forest industry is likely to have to take place within markets and with a raw material supply not much different from what exists at present. The potential for expansion must therefore rest primarily with making better use of the raw material base, and channelling it into those products and outlets which will generate the greatest value added and return on investment.

It should be recalled here that market surveys (EFG 1984) indicate that there are no real prospects for international marketing of secondary hardwoods as lumber; export markets must be viewed in terms of finished and semi-finished products. More effort is needed to introduce secondary hardwood timbers into local usage. Much of the information about the technical suitability of species occurring in Belize's forests has been available for over 40 years (Lamb 1946, Echenique Manrique & Plumptre 1988), but with the continued availability of primary hardwoods from forest being liquidated on private land there has been little incentive for the Belize forest industries to engage in market promotion of other timbers.

It has been suggested that the needed changes can be achieved partly through the use of the economic incentives and controls discussed in section 4.1.4, and partly through the changes in harvesting practices proposed under forest management. In the present section, attention turns to what can and should be done within the logging and processing industry to improve efficiency of operation. Areas singled out for attention are upgrading of skills, and improvements to mill equipment. Also, the functioning of an effective timber producers' association, and the role of government in supporting forest industry.

4.4.1 Improving Logging and Sawmilling Skills

Lumber grading of export mahogany lumber is the one area where a good training job has been done. This can be attributed to the fact the National Lumber Manufacturers Association (NLMA) in the United States has lumber grading rules, and companies wishing to export to its members must employ graders who have passed a test and been certified. In earlier years North American importers would send their own certified graders to Belize, not only to grade their purchased mahogany lumber but also to teach local people how to grade. Some of the local graders later went to the United States and were trained and certified there.

With this exception, at every point along the production line from the forest to the lumber yard there is need for improvement in the skills of the people involved. Logging and milling skills are mediocre, probably because there is not enough expertise in the country to learn from. Equipment operators and truck drivers need upgrading, as does equipment maintenance.

Only one forest products company in Belize has the depth in personnel sufficient to ensure that workers learn on the job from other more experienced personnel.

The lack of expertise in woods (logging) operations, at all levels, is of particular concern. As has been noted earlier, if logging costs are to be contained it is necessary to extend the logging season by selective construction of all-weather logging roads. These need to be carefully planned, in order to ensure that they are located where the volumes of commercial timber available justify such an investment. At present most operators are unable to say what volumes are removed per unit of area, or what is the minimum acceptable volume per acre to log, or what the breakeven point is, or the relation between skidding distance and road spacing. Information about the location of loggable trees is not collected on a systematic basis, and is not transmitted to the people laying out the roads and developing the operating plan and maps in such a way as to relate volume to area; information that is essential to the planning of the logging operation and the location of roads, direction of skid, etc.

It would appear that the most effective way of developing such skills would be through a logging extension service, to work with the operators on the ground. Observation of woods operations during the course of the TFAP exercise suggests that many should be able to learn how to record the field data on operational maps quite quickly.

It is also recommended that a case study of one of the larger operators be made, to see to what extent the operators are correct in their assessment that they can only log in the dry season. It may be that an all weather road can be constructed, but that it is not possible to skid in the rainy season. If that were the case, then at least logs could be cold decked in the dry season so that volume could still be brought out during the rainy season.

As regards training of sawmill staff, past reports show that a number of activities such as seminars and training courses have been conducted in an effort to upgrade the skills of sawdoctors, filers and sawyers. It would appear that the task might best be approached by providing a full time sawmill extension service; to concentrate on helping the 40 smaller mills. This service should be staffed with someone who has the experience to size up the problems of such mills, to help solve immediately the problems that do not require much investment, and to make recommendations to the mill operators as to how to achieve longer term improvements. The extension expert should visit every mill in the country and set up a reporting system so that on future visits by sawmill specialists there will be a record of what has already been done.

Training of millwrights presents a particular problem. A good millwright takes years of on the job learning. A young man could short cut this by multi-disciplinary vocational school

training - in mechanical, hydraulic, electric, steam, and diesel maintenance. Probably a millwright specialist should be attached to the sawmill extension service from time to time to provide short periods of training.

Training in use of drying kilns calls for a different approach. As there are so few kilns in the country, a seminar or course should be given at the new kiln in Belmopan, to alert mill operators to their advantages and to start the education of prospective and present kiln owners.

In summary, it is recommended that the task of improving skills in the country's forest industries be tackled by bringing to Belize people skilled in logging and sawmilling to work on the job with the local people. This is needed in every category of logging and saw milling operations, but should concentrate on sawyers and saw doctors or filers, dry kiln operators, millwrights, logging equipment operators and logging planners.

4.4.2 Improving Sawmill Equipment and Quality

There has been a dramatic change in sawmill technology in North America and Europe in the last 20 years. Mills are continually replacing their old equipment with the newer and more sophisticated machines. Some of this older equipment could be used to improve mills in Belize.

North American and European mills are no longer processing big logs for the most part, they are processing small logs from young trees - down to 5 inch, or 12.7 cm, top diameters. There is no reason why the same technology could not be used in Belize, especially on pine. Another possibility would be the purchase of a chip and saw type mill for sawing pine dimension lumber and studs. Hardwood dimension stock for furniture, using a short log bolter may present another opportunity.

However, most of the mills in Belize are in no position to think about buying a new mill. For many of these, small improvements could be the answer to upgrading the quality of their production. Actions that would improve sawing quality include the use of carbide tip inserted saw teeth and stellite application to saw teeth. One mill is presently equipped with a stellite band mill, and a couple of mills with carbide tips on inserted circular saws. Another modest improvement that could upgrade quality is using a rain bird sprinkler system to keep the logs wet before sawing.

Most previous reports on the sawmilling industry in Belize have recommended replacing circular breakdown saws with band saw headrigs. However, there are some very good reasons why a circular mill would not make such a change. Even though it would reduce waste by 2.5% for every 1/32 of saw kerf reduced, to purchase a band saw means: (1) finding or training a sawyer; and (2) finding and training a saw filer (an extra man) to file the band saw. Unless volume improves considerably, the lumber volume gain is offset by the increased investment and higher labour and

operating costs.

Nevertheless, a search for the most appropriate band saw for Belizean conditions should be undertaken. A similar study has been carried out in Ecuador, through the USAID-assisted INFORDE programme, the results of which might be of relevance to Belize.

4.4.3 Market Intelligence

There is little obvious information related to market intelligence. Government information seemed entirely restricted to that collected by the Forest Department and the Customs. Even the detail of Customs returns, summarized by the Statistics Department in broader categories, are retained for only 3 years or so. Information on log input/sawn output does not seem readily available. Most conversions are done with crude assumptions.

Although there was a detailed report on international timber markets provided through an aid project in 1984, any current appraisal of external markets appears to be limited to the efforts of individual processors. An expatriate expert recently produced a report based on a year's assignment, but this appears of limited value and no follow-up has taken place.

There is clearly some need for improved statistical control locally, and for a flow of information from external markets. The latter could be facilitated by the creation of an effective association of timber producers/exporters.

4.4.4 Timber Association

A Timber Association could establish contacts with importing associations in North America, such as IHPA (Imported Hardwood Products Association), and in other major markets. This could be done in cooperation with the government's Belize Export and Investment Promotion Unit (BEIPU), and in association with the existing association formed by Belize furniture companies. Industry has not taken full advantage of the services offered by BEIPU as a means of contacting importers and buyers of Belizean made lumber and wood products. Little effort has been made to send samples or brochures on products to the various trade fairs attended by BEIPU.

There are many other things an active association could do for its members. They include: presenting the views of producers as a group in negotiations with government, over such matters as tariffs on imports of key supplies to the industry, such as spare parts and fuel; issues relating to forest regulations such as cutting diameter limits; and the enforcement of measures to prevent illegal cutting in areas licensed to industry. Transportation is another area the association can help, in getting reduced freight rates or combining container loads. An active association would also facilitate the improvement of training and skills, and of quality control through adoption and enforcement of standards.

It is therefore strongly recommended that the wood products industries in Belize be encouraged and assisted to set up an active and effective Timber Association. This might best be assisted by enlisting the help of one of the North American associations. The latter could provide advice on how to establish and run the association, and assistance to it in pursuing activities such as export promotion.

4.4.5 Identifying Opportunities for New Forest Industries

In section 3.4 attention was drawn to the growing market for plywood in Belize, and the possibility that this might provide an opportunity for producing this product in the country. The feasibility of such a development should be explored further.

A forest industry board could be set up with a government representative, possibly from the Belize Export and Investment Promotion Unit (BEIPU), an industry member and an outside consultant. This would take responsibility both for commissioning a feasibility study, and for identifying measures that the government might take to facilitate successful start up.

Such a body should also monitor the prospects for additional new industries. As has been pointed out earlier, paper board converting to make boxes for bananas, and other commodities, could be feasible as volumes of boxes used continue to grow. The prospects for producing wood chips for export from commercial plantations might also be explored further, as one United States forest products company is reportedly establishing Gmelina plantations in Guatemala and Mexico in order to create low cost chip supplies.

4.5 ENVIRONMENTAL CONSERVATION

4.5.1 Conservation Planning

Decisions bearing on use of natural resources should be consistent with the goal of preserving the full range of Belize's biological diversity and environmental integrity. This need not conflict with development of natural resources for economic purposes. Indeed, its aim is to ensure that natural resources are exploited in ways that ensure their perpetual benefit to Belize.

Since conservation and protection entail regulation of the use of land, conservation planning needs to be integrated with land use planning. A comprehensive conservation and land-use plan would be based on an inventory of Belize's habitats, wildlife, and natural resources and on an understanding of how habitats, organisms, and environmental processes are affected by particular land uses. The plan would provide the rationale for legislation and a framework for a system of reserves and areas set aside for protection of watershed catchments. It would embrace the need for economic development and be a reference point for devising environmentally-sound development methods. The plan would be formed, and continually revised in light of new information and changing circumstances, with input from all informed and interested constituencies. Comprehensive planning would include both terrestrial and marine habitats.

The foregoing concept provides an effective basis for multiple resource use management to optimize the overall output from a multi-faceted resource on one piece of land, the different facets being the concern or responsibility of separate offices. It can be applied also to the designation of buffer zones. Again, the limits of such zones and modifications to normal working of forest within them, should be clearly defined so that the arrangements can be fully effective and devoid of confusion.

Conservation thus needs to figure prominently in the process of developing a national land use policy and plan which was discussed in section 4.2. The planned creation of an Office of Conservation, in the Forest Department, will provide a badly needed institutional focus and capability for pursuing this, and other, dimensions of conservation planning and management.

The mission recommends that the Government establish the Office of Conservation within the Forest Department in the Ministry of Agriculture, Forestry, and Fisheries. Incorporation within the Forest Department will permit close coordination of activities and exchange of views between agencies with major responsibility for use of land. The Office's responsibilities would include overseeing: management of reserves and wildlife, enforcement of parks and wildlife laws, research on the environment, and maintenance of a conservation data base (see below in summary of research needs). Establishing such an Office would legitimize and publicize the concept of conservation in Belize, as well as bring the energy of full-time, trained

personnel to bear on conservation issues.

The Office of Conservation would take over only a small part of the conservation work currently done by non-government organizations in Belize. Those organizations will continue to play a major role. Each of them has a particular role not filled by the government or by other non-government organizations. Relieved of managing the reserves, the Belize Audubon Society would still have a major, crucial responsibility in environmental education. The non-government organizations will be needed for technical expertise and advice, research, fund-raising and contacts with foreign conservation organizations, education, and aid to visiting researchers.

The management of natural resources thus concerns many constituencies in Belize, and many types of information and points of view must be considered in making resource decisions. It is therefore recommended that a Conservation Advisory Board be created. This would be a non-statutory board, acting as an advisory body only, to assist the Office of Conservation with information, discussion and recommendations. This board could be made up of people from the resource-based industries (forestry, agriculture, fisheries, tourism) and the various non-government organizations concerned with conservation. The board could include foreign experts. Such a pluralistic advisory committee would help avert the adoption of extreme policies on resource issues, and it could develop alternative proposals for consideration by the Office of Conservation. The first job of this board might be to consider the conservation component of the proposed comprehensive land-use and conservation plan for Belize.

4.5.2 Laws and Conventions

The National Parks System Act provides a firm legal basis for the establishment of parks and reserves. Yet their status as conservation areas is insecure, because declarations under the Act are rescindable by simple ministerial fiat. This situation undermines the confidence needed to make long term plans for reserves and to attract funding to support reserves. It is recommended that legislation be enacted that requires a fully justified rationale, in terms of optimal land use, for any dereservation.

The establishment of parks and reserves can require lengthy consideration. The TFAP mission recommends that a provisional protective status be created to apply to land under consideration for reserve status. This will protect land while plans are made and will forestall preemptive exploitation of resources, or the intentional destruction of natural features to reduce an area's value as a reserve (as has happened on occasion in the United States).

A body of regulations for particular habitats is needed. The mission supports the Minister of Agriculture's intention to regulate use of the mangroves. The marine habitats and offshore islands are all especially fragile, important economically

(fisheries and tourism), and require protection. To prevent their degradation, as well as to correct an anomalous jurisdictional situation, it is recommended that protection and management of the mangrove resource be identified as a specific responsibility of the Forest Department and be activated in coordination with other agencies, e.g. the Fisheries Department and Tourism, involved in the management or use of coastal ecosystems. A comprehensive survey of the extent and condition of the resource should be undertaken, to provide a basis for management and protection.

It is recommended that the moratorium on commercial trade in wildlife, declared in 1981 and expiring in 1988, be extended. The purpose of the moratorium was to allow time for study of wildlife populations and the pros and cons of a commercial trade. Some commercial trade in wildlife may benefit Belize, but the needed studies have not been carried out. Meanwhile, it is certain that Belize is benefitting economically from the status quo of wildlife, because the current healthy animal populations bring tourists. It is best not to interfere with this positive situation until there is a good understanding of the impact of commercial trade. The wise course is to extend the moratorium.

The moratorium has chiefly affected the export trade in wildlife. Control of internal trade, chiefly of parrots, is needed. The fairly active internal and external trade in black coral should be scrutinized and probably closely regulated. This species has been eliminated elsewhere in its range.

Concerning the hunting laws, the mission feels that, lacking sound information, the conservative approach, as with commercial trade, is the best approach. There are several species not currently protected in Belize whose survival is known, from experience in other countries, to be very precarious in the face of heavy hunting pressure. These species should receive at least partial protection (bag limits, seasons). They are Crested Guan, Great Curassow, iguana, gibbon, and hickaty.

Laws should be enacted concerning the protection of plants, amphibians, and freshwater fishes, and an institution to implement those laws should be designated.

Belize should investigate the advantages of joining the Convention Concerning the Protection of the World Cultural and Natural Heritage, the Convention on Wetlands of International Importance Especially as Water-Fowl Habitat (Ramsar Convention), the Convention on the Conservation of Migratory Species of Wild Animals, the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere, UNESCO's Man and the Biosphere Programme and FAO's Gene Conservation Programme. Joining these programmes would require commitments from Belize but would also qualify Belize for technical and financial assistance from them.

The southern Maya Mountains and Belize's barrier reef are large and valuable enough as natural resources on a global scale

to qualify as a Biosphere Reserve and a World Heritage Site, respectively. These designations are made by UNESCO and bring technical and financial assistance, as well as publicity and tourist income. Such reserves are managed for multiple uses, not strict habitat preservation alone, and specific reserves are carefully designed to incorporate and sustain local economies.

Also in the international sphere, 15 wetland sites in Belize have been identified by Scott and Carbonell (1986) as potentially eligible for designation as Wetlands of International Importance under the Convention on the Protection of Wetlands of International Importance. For this designation Belize would need to join the Convention.

A further possibility is that Belize join with Mexico and Guatemala in establishing an international boundary park centred on the area where Belize, Mexico, and Guatemala all bound each other, known to some as the Azul Triangle. This is a vast, mostly uninhabited region, with many Mayan ruins. On the Belize side the 160,000 acre (64,752 ha) Rio Bravo Conservation Area (managed by the Programme for Belize) has already been dedicated to conservation and environmentally sound, sustainable exploitation.

Regional wildlife treaties, that affect Belize and its neighbours, will be to Belize's advantage, since its populations of wildlife are generally in better shape than those of its neighbours.

4.5.3 Protected Areas

~~Reserves~~

Now that some areas of special importance have been designated strict reserves, the fundamental goal of conserving biological diversity in all its forms is best accomplished by a systematic, comprehensive analysis of gaps, i.e. habitats and organisms not included in the reserve system, as was discussed in section 3.5.3. Of course, the ideal of strictly reserving an area of every type of habitat in Belize will not be attained. Compromises and trade-offs with other land uses will have to be made. But habitat types can be ranked for conservation priority according to the extent that they contain species not found elsewhere.

Proposals for new reserves should be based on the sound reasoning of gap analysis based on a thorough inventory and mapping of habitats and a comprehensive plan. Table 4.2 presents a list of sites that have already been proposed, with notes on their status and valuable features. They are listed in order of decreasing priority for reservation, as determined at a meeting in Belmopan in October, 1987, of Government, private, and expatriate people concerned with conservation in Belize. They include natural and archaeological sites. Some of these sites are so clearly important, or threatened, that designation need not await a comprehensive plan.

Table 4.2: Sites Proposed as Conservation Reserves

Caracol; important archaeological site, forest, cave system; reserve might be modelled on the Tikal design.

Upper Bladen; little-disturbed, species-rich forest of southern Belize, much wildlife, remarkable scenery; preliminary biological survey and plan completed.

Glover's Reef; good cross-section of marine habitats, colony of threatened Brown Noddies (terns); detailed management plan being drawn up.

Blue Hole and Long Cay, Lighthouse Reef; unique areas to be added to Half Moon Key Natural Monument.

Thousand Foot Falls and Double Waterfall; tourist attraction.

Caves Branch - Pteroglyph - Mt. Cow Cave; cultural sites; should be included in Blue Hole National Park.

Cockscomb Basin; extend current Cockscomb Basin Wildlife Sanctuary to include more area of species-rich southern forest and jaguar habitat.

Crooked Tree; extend boundaries to include additional habitats in the current Crooked Tree Wildlife Sanctuary, provide buffer, and add an archaeological site.

Southern Lagoon; provide sanctuary for the manatee; might be established on Baboon Sanctuary model.

Raspaculo River Valley; a particularly wild, undisturbed area, with Scarlet Macaws, caves.

Mussel Creek; connects Crooked Tree and the Community Baboon Sanctuary; could be managed jointly; bird survey completed.

Northern Lagoon, Turneffe Islands and Northern Cayes, Lighthouse Reef; breeding areas of the endangered American Crocodile.

Shipstern Lagoon; adjacent to the current Shipstern Wildlife Sanctuary, manatees and vulnerable rookeries, archaeological sites.

Sibun River Karst Area; interesting landforms, unusual vegetation, archaeological sites, near Belize City and new road.

Temash River; fine stand of mangroves.

Lamanai; archaeological site.

other sites that have been proposed (Hartshorn et al. 1984 and personal communications) are:

Laughing Bird Cay; undisturbed natural vegetation (uncommon on the cays).
Marrie Bow Cay; scientific reserve, currently used by the Smithsonian Institution.
Forest south of Union Camp and west of Little Quartz Ridge; some of the "best forest in Belize", unusual plants, perhaps unique highland avifauna.
Upper Guacamayo River Valley; least disturbed pine forest in Belize, adjacent to Raspaculo Creek area.
Silver Creek Bank; fine stand of pines, near Cockscomb sanctuary.
Baldy Beacon; unique geological features, plants, and butterflies.

Conservation management on other areas

For conservation goals there is a tendency to think solely in terms of national parks and wildlife sanctuaries. In fact it would be impractical and undesirable to put enough land in strict reserves to contain all Belize's species. Fortunately, other land uses are compatible with the aim of preserving biological diversity. For example, successful, sustained-yield management for timber of the Forest Reserves will maintain suitable habitat for most forest species.

Some reserves will be too small by themselves for certain species. So wise management of surrounding areas not dedicated to strict preservation is critical. For instance, the Cockscomb Basin Wildlife Sanctuary (3,640 acres, or 1,473 ha), popularly known as the "Jaguar Reserve", is probably too small to contain continuously more than one or two jaguars. But the surrounding area, a large Forest Reserve, is currently managed as good jaguar habitat. Areas surrounding reserves and under conservation management that includes multiple uses are known as "buffer zones", or: "Areas peripheral to national parks or reserves which have restrictions placed on their use to give an added layer of protection to the nature reserve itself and to compensate villagers for the loss of access to strict reserve areas." (Mackinnon 1981)

Management systems for buffer zones should be developed in the context of:

- the plan for protected area as a whole;
- regional planning and development policies;
- traditional land use systems operating in the area; and
- appropriate and sustainable use of land and biological resources. (Oldfield 1988).

Case studies and guidelines for buffer zone management are presented in Oldfield (1988).

All land uses should be evaluated in terms of their impact on biological diversity. How will various timber harvesting

schemes affect forest species? What animals frequent plantations of tree crops, such as citrus and cacao? How much coastal wetland can be converted to shrimp farms before there is a serious decline in the richness and population viability of coastal organisms?

As it develops its wildlands conservation programme the Government should seek support, in the form of advice on programme planning and management and development of information systems, from FAO's Gene Conservation Programme which was developed in collaboration with IUCN.

Much can be done to enhance the mutualism between conservation and tourism. While improved roads, accommodation and services throughout the country will help, there is a particular need for tourist facilities and services at current reserves (e.g. Cockscomb and the Baboon Sanctuary). Training of guides and wardens will improve the experience of visitors to reserves.

Tourists can help pay for conservation. The mission endorses the recommendation of the Belize Audubon Society that reserves become partially self-supporting by charging admission fees. Fees could be levied according to the ability to pay, i.e. personal income: less for children and Belizeans, more for adults and foreigners.

Watershed management

The management of watershed protection areas should be placed on a more systematic, deliberate basis under which there would be guidelines indicating what harvesting or other activities are allowed, where they would be allowed and what conditions would apply. The programme should be linked with a system of zonation to be applied with more intensive logging of associated production forest when the light selection cutting practised hitherto is phased out.

The Forest Department would benefit from collaboration with the authority within the Ministry of Energy and Communications that is responsible for water, to monitor at selected points the quantity and quality of water issuing from Forest Reserves and the effects both of watershed protection as a whole and of different forms and intensities of logging.

It is recommended that the Forest Department take the lead in working with Central Farm and the Extension Service of the Department of Agriculture to develop and promote the use of agroforestry systems as components of settled agricultural patterns. The application of a few well tried strategies on farm lands, particularly on slopes, should go a long way towards ensuring that needless erosion, siltation and damage to coastal ecosystems are minimized.

5.4 Research Needs

Because of its formative stage, and great variety, there is need for studies related to many aspects of conservation in Belize. The more important of these are summarized below, distinguishing between what is needed in order to strengthen conservation management, and the more basic studies that would also be appropriate given the country's rich biological endowment. As research of this kind is being carried out by a variety of different types of institution, no attempt has been made to identify sources of most of the studies. Much of it, as in the past, is likely to attract external support.

Information for ^{multitude} ~~reserve~~, wildlife and watershed management

Gap analysis is central to decisions on land use. It is a process that is continually refined, but there is an immediate need for a "broad brush" analysis to identify potential areas for conservation management and imminently threatened habitats. Such an analysis was illustrated in section 3.5.4.

Management policies for reserves depend on knowing what species inhabit the reserves, on understanding the habitat and food requirements of important species, and determining what their natural population fluctuations are. Thus floral and faunal inventories, periodic censuses, and basic ecological studies on selected species are needed in the reserves.

Land uses adjacent to reserves should be monitored to anticipate potential effects on reserve habitats and wildlife that ranges outside reserves, to determine their impact on biological diversity and to develop management practices that are consistent with conservation goals. Information about the impact of forest harvesting, particularly when it is intensive, on the distribution and ranges of one or two key wildlife species, e.g. jaguars in Cockscomb Basin, would clarify uncertainties concerning the extent of buffer zones required for wildlife sanctuaries in the forest and developing guidelines accordingly. Ways to enhance the natural history tourist trade need study, while impact of tourist development and tourist activity on reserves and other natural areas should be investigated.

For wildlife management purposes information is needed on the basic biology of important species. For example, the data gathered by the New York Zoological Society has helped form management policy for the jaguar. Basic questions in wildlife biology concern habitat needs, habitat locations, and population size and dynamics. It is especially important to learn what factors regulate population size.

Studies of the effect of hunting and collecting on species of potential commercial value are needed before commercial trade of wildlife is permitted. The animals most sought for meat need study; these are hickaty, iguana, gibnut, curassow, guan and many marine species, including sea turtles. Other vulnerable species, such as jabiru, manatee, and raptorial birds, need study.

Water quantity and quality monitoring, as a basis for setting standards and taking corrective measures where necessary, should be undertaken in one or two key catchments to gauge the effects of intensive harvesting and of the use of fertilizers, pesticides and herbicides used in any form of agriculture within catchments. The monitoring would be done in collaboration with the Department of Energy and Central Farm.

Basic and applied studies

Protected area

Reserve management, wildlife management, and management for other land uses depend on, or benefit greatly from, understanding the structure and function of natural systems. For example, discovering the natural causes of fluctuations in commercial fish populations will help to evaluate the effect of fishing and devise fisheries policy. Studies should be undertaken on basic processes such as biogeochemical cycles, vegetation dynamics, animal population dynamics, and seasonal patterns of growth, reproduction, and resource abundance. Long-term studies (of 10 years or so, depending on the research question) are especially informative. Ideally, long-term studies would take place in the major habitat types: coral reef, mangrove, savanna, pine ridge, and several of the hardwood forest types. This kind of research must take place in areas secure from disturbance. The larger reserves are likely locations.

The most convincing and valuable results come from experimental studies, in which a manipulated habitat or population is compared with an unmanipulated control. The opportunity for such experiments in basic ecology, forestry, and agriculture in the large, secure Rio Bravo Conservation Area has much promise for conservation, resource management and economic development in Belize. As one example, mahogany and Santa Maria are fairly common in the Rio Bravo area; experimental, long-term studies on their regeneration could aid the forest industry.

Conservation data centre

The most important tool for conservation decisions is a system and institution for gathering, cataloguing, and supplying information on Belize's biological diversity. This is the "conservation data centre". In it are kept such things as maps of vegetation, land uses, and animal and plant distributions; aerial imagery; reports on flora and fauna organized by species and cross-referenced to locations; copies of laws pertaining to natural resources. A good deal of information on Belize is available, but it needs to be assembled and organized for use. The information is continuously updated and used for purposes like gap analysis. The accumulated information can help identify areas of particularly high species richness or areas that contain species of limited distribution. Such areas have priority as reserves. The centre can be a starting point for basic ecological studies. The centre would be clearing-house of data and interpretations for other organizations.

Both the Belize Centre for Environmental Studies and the Programme for Belize function as conservation data centres. Eventually this function could be taken over by the trained personnel of the proposed Office of Conservation. Two US organizations, The Nature Conservancy and Conservation International, operate conservation data centres in tropical America. They are sources for more details of managing and using conservation data centres.

4.6 INSTITUTIONAL STRENGTHENING

4.6.1 Forest Policy and Legislation

As was pointed out at the beginning of this report, in section 3.1.1, Belize's existing forest policy contains a sound well balanced statement of the main thrusts that need to be enshrined in a statement of policy. However, it dates from the 1950s and an earlier constitutional setting. It would therefore seem very appropriate for the Government at this stage to develop and issue a new statement of forest policy, setting the latter in the context of the country's present situation and long term goals.

It will also be important that the Government's next five-year development plan contain a section on forestry outlining the major thrust of the development proposals for this sector of the economy in the short term.

Issues concerning legislation affecting the forest sector have been discussed at some length at various points in the report. Over the past 30-40 years, a number of enactments have been made relating to forests, wildlife, protected areas, Crown Lands, private forests, land utilization, land tax, plant protection, ancient monuments and antiquities, and development incentives. There is a need to review and harmonize these for more effective management of the forest resource base and conservation of the environment for human well-being. Review or formulation of regulations to give effect to these laws is particularly urgent in the case of wildlife and the use and protection of mangroves.

The forest legislation itself should be thoroughly revised to make it clearer and more equitable. The legislation should indicate more exactly the responsibilities of forest land users and the Forest Department. Both FAO and IICA hold examples of modern forest legislation which could be adapted for use in Belize.

4.6.2 Strengthening the Forest Department

This report has already discussed the responsibilities of different governmental, and non-governmental, bodies with respect to the forest sector. Suggestions and recommendations have been made concerning each of these, and about the collaborative mechanisms which exist or would be useful. The discussion in this section focuses on the issue of strengthening the Forest Department - the principal body of public forest administration in the country.

The Forest Department has, for many years, been suffering from a shortage of staff and low level of funding. This has led to inadequate management and low staff morale. At present, the Department has five Belizean professionals, three Foresters, eleven Forest Rangers, one Conservation Officer and nineteen Forest Guards in post, out of an establishment of seven

professional posts, four Foresters, eleven Forest Rangers, two Conservation Officers and twenty Forest Guards.

It is quite clear that the Forest Department must be strengthened. As was noted earlier, its strength is well below what would normally be required in order to effectively administer a forest estate of the size and structure of that in Belize. Using standards prevailing elsewhere in the tropics, it can be estimated that Belize would require 12 professional officers to be able to cope with the proposed forestry developments to the year 2000. This would normally imply availability of 50-60 technical staff and some 250-300 Forest Guards for good forest administration. However, given the special conditions in Belize, such as low population density and limited forest accessibility, it can be assumed that the country would not need such large numbers of personnel for administration and control.

Optimum deployment of resources

Given the government's constraints on increasing staff and expenditure in the public sector, it is evident that very careful thought needs to be given to how best to match available resources to the task of administering the forest sector. This needs to include review of how best to allocate scarce skilled manpower resources within the forestry administration, and of the tasks that need to fall to the public sector within forestry and forest industries.

To this end, section 3.4.5 of this report considered the active role of the Forest Department in forest industry operations. The possible reasons and justifications for these activities were examined as were the objections and criticisms against this participation. Although a number of reasons were stated for these activities there are no clearly defined objectives or programme. The limited resources of the Department are spread over a wide range of activities and effort directed to operational forest industries weakens the input needed for the essential forest management role. The TFAP mission considers that this, together with the understandable criticisms by the private sector concerning unfair competition, indicate that the Forest Department should withdraw from a continuing operational role in logging and sawmilling by the public sector.

In the case of the woodworking shop, justifications for the research, development and training roles are much stronger as the woodworking sector is not, as yet, well developed. Furthermore, a substantial aid programme supporting the workshop has been initiated and is continuing. It is considered wise to continue activity in the workshop project until the programme has had reasonable and ample time to bring about results in creating a viable woodworking subsector. At that time, it might be appropriate to dispose of the workshop establishment.

However, it is appreciated that there may be other factors in favour of Forest Department involvement in forest industry

operations of which the TFAP mission is unaware. What is important is that the matter be resolved as soon as possible, and the objectives and nature of activities to be pursued be clarified and defined. Should the decision be to maintain substantial production operations beyond research, demonstration and training activities, the Forest Department should be strengthened adequately to provide a full time operations manager, leaving forestry staff appropriate time to devote to forest management activities. In the discussion of staff needs that follows these are not included.

As concerns the optimum deployment of staff with specialized training, the TFAP mission believes that forest management should be carried out by the field foresters, the DFOs and the Forest Rangers. The field staff are not most usefully employed on purely administrative matters; these should be left to administrators. Staff specialists are certainly needed to assist the field staff but not to undertake the field management for them.

Appropriate staffing levels

Even if Forest Department responsibilities are focussed more sharply in these ways, it is clear that more trained staff are needed at all levels in order to achieve adequate management. Some measure of what would be entailed can be arrived at by examining the Department's main areas of responsibility.

In order to bring Forest Reserves under active management, experience elsewhere in the tropics indicates that the following standards should be met:

- graduate forester DFOs are required to plan and execute management in those divisions which have large areas of permanent forest estate. Forest Rangers should administer the smaller divisions;
- each active long-term forest licence (LTFL) should be supervised by a Forest Ranger;
- there should be 1 Forest Guard to check the log intake into every 3 sawmills and 1 Forest Guard to check the log production for every 80 miles² (200 km²) of permit and ordinary licence area (and to supervise the silvicultural crews of the Forest Department).

Using these standards, it is suggested that a suitable staffing to cover the territorial responsibilities existing in 1987, as shown in Table 4.3, would be as follows:

<u>Division</u>	<u>DFO</u>	<u>Ranger</u>	<u>Sawmill Guard</u>	<u>Field Guard</u>	<u>Administration</u>
Northern	0	2	5	4	1 clerk-secretary
Belize	0	1	2	3	1 clerk-secretary
Western	1	2	4	2	1 clerk-secretary
Southern	1	2	2	3	1 clerk-secretary
Toledo	1	2	3	4	1 clerk-secretary
Research	1	1	0	2	1 data-processing assistant

This gives Toledo Division the same status and level of staffing as the Western and Southern Divisions. The Northern Division would be concerned largely with protection. An increase in the staffing suggested above would be required if national land unsuitable for agriculture is incorporated into the permanent forest estate.

The size of the staff dealing with utilization and marketing will depend on the decision about the extent of the Department's continuing involvement operationally in these activities. However, at least one officer responsible for working with forest industry would be required. The Department will also need a forest economist/planner.

In order to create a capability to administer the conservation resources and activities, it is recommended that the proposed Office of Conservation be located in Belmopan and have two professional employees; specialists on reserves and wildlife respectively. Also needed would be district officers analogous to the District Forest Officers. It is estimated that 3 district officers would be required initially. Enforcement of the parks and wildlife laws will require a staff of game wardens; with 6 proposed to begin with.

The Department would continue to be headed by a Chief Forest Officer and Principal Forest Officer. The headquarters staff would include the forest economist, and, as departmental responsibilities expanded (e.g. into extension and public relations), possibly one other officer.

Thus, the Forest Department can be seen to require at present the following level of staffing in order to perform the functions already mandated to it:

Professional	
Headquarters	4-5
Forest management & research	4
Conservation management	2

	10-11
Technical	16-20
Forest guards/park wardens	40-45

These estimates include the present staff of 3 Foresters, and supporting staff in forest industry and public relations related activities.

On the basis of the above, and taking into account the growth in activities expected over the period, it is estimated that, over the next 10-12 years, Belize will require 12 professional officers to plan, organize and implement the development plans for forestry, wildlife, protected areas, environmental conservation as a whole and forest industries, as well as better control and management of forestry and related activities on Crown Lands and private lands. It has been estimated that expansion, and the need to allow for turnover among staff, could require the training of 45 technical personnel (Foresters, Forest Rangers and Conservation Officers) and at least 90 Forest Guards and Park Wardens.

Table 4.3: Territorial Responsibilities in 1987.
Areas in miles² (km²)

<u>Division</u>	<u>Forest Reserves</u>	<u>Sawmills</u>	<u>LTFL</u>	<u>Licences</u>	<u>Permits</u>
Northern	Freshwater Creek	14	4/87	6	9
total areas	114 (296)		114 (296)	167 (433)	157 (408)
Belize	(none)	6	none	2	18
total areas				73 (188)	173 (448)
Western	Chiquibul	12	2/87	4	3
	Mountain Pine Ridge		4/86		
			6/86		
total areas	913 (2364)		112 (291)	96 (249)	25 (66)
Southern	Cockscomb Basin	4	4/84	2	4
	Commerce Bight		5/87		
	Grant's Work				
	Manatee				
	Mango Creek				
	Sibun				
	Silk Grass				
	Sittee River				
	Swazey-Bladen				
total areas	704 (1825)		357 (925)	210 (544)	38 (99)
Toledo	Columbia River	10	1/85	5	1
	Deep River		1/86		
	Maçhaca Creek		1/87		
	Maya Mountains				
total areas	758 (1963)		317 (821)	332 (860)	0.4 (1)

Note: there are 7 small forest permits totalling 2.3 miles² (6 km²) not included on the Forest Department map which is the source of the areas in this table for licences and permits. There are also 6 forest permits for the salvage of sunken logs, presumably in Northern and Belize Divisions.

Decisions need to be taken in advance at the level of the Ministries of Agriculture, Economic Development, Finance and the Establishment Department to create the posts needed for the envisaged expansion of staff to meet the new targets set for forestry. Appropriate scheduling within the financial possibilities of the Government and commensurate with its commitment to the development of forestry is essential, if the planned targets are to be met.

4.6.3 Education and Training

This expansion calls for early and sustained action to develop staff. At least seven professionals in forestry and conservation should be trained on scholarships abroad as soon as possible. Facilities in tropical countries such as Liberia, Nigeria, Tanzania and the Philippines should be considered for such training along with those in Europe and North America, as well as Australia and New Zealand. Further training of serving staff should also be considered to the extent that they can be spared from their current duties.

An early start to training is particularly important in the conservation field, as no Belizeans have the training to fill the main or district office positions of the proposed Office of Conservation. The reserves specialist should be trained in the theory of reserve design and the practice of reserve management. He or she would be charged with guarding against infringements on reserve land, with monitoring incompatible land uses adjacent to reserves, and with resolving conflicts between permissible uses of multiple-use reserves. This position would also include investigating possible new reserves and making recommendations for their establishment, as well as continuing research on management of established reserves. The wildlife specialist would be trained in wildlife management. Responsibilities would include continuing research on ecology and population dynamics of wildlife, administration of management practices, and enforcement of wildlife laws concerning hunting and trade.

For the time being, qualified persons will have to be sent abroad to train for the administrative and research positions. Commitment by the Government to establishing an Office of Conservation will attract technical and financial assistance from foreign and international conservation organizations. It is also recognized that there is currently no office space, equipment, or vehicles for this proposed Office of Conservation. This is another financial problem.

With regard to the training of technicians, there are now good prospects of providing initial Forest Ranger training at the Belize Agricultural College (BCA). This College offers a 2-year diploma course in agriculture. Candidates must be secondary school graduates or older students who demonstrate above-average performance in the BCA Entrance Examination and satisfy the BCA Acceptance and Scholarship Committee, through an interview, that they possess the interest and desire to undertake a career in the agricultural industry. There have generally been more applicants

for admission than the 36 places available annually.

The College teaches 24 hours of Forestry in the second year (Jan.-Mar.) in addition to extensive coverage of the principles and practices of Watershed Management, Landscape, Horticulture and other subjects of relevance to Forestry such as Biology, Chemistry, Mathematics, Surveying, Experimental Design, Agro-meteorology, Communications and Extension, Civics and Development Studies, Apiculture, Pastures and Farm Mechanization.

With judicious rearrangement of subjects and introduction of specific Forestry subject matter, it would not be too difficult to establish a 2-year Diploma Course in Forestry at this College to meet the Forest Technician requirements of Belize. There would be sufficient students available to satisfy the small annual requirements of the Forest Department, by increasing annual intake of students by 7-8 during the period 1990-1995.

Following a common course in the first year, specialization in forestry can be provided in the second year. After a minimum of two years' field experience, promising Rangers can be sent to forest technician schools abroad for a diploma course that would qualify them for promotion to Forester. Good courses at this level are available in Cyprus, Ghana, Malawi, Nigeria and Tanzania. Tanzania also offers both certificate and diploma courses in wildlife management and good practical training in sawmilling and sawdoctoring. Forester training would continue to be provided abroad through bilateral scholarships.

Other ad hoc arrangements would need to be made for the training of Forest Guards and Game Wardens. Forest Guards should continue to be trained on the job, supplemented by short in-service training courses provided by competent instructors, who can also train skilled workers for a variety of field operations, ranging from seed collection and nursery practices through silvicultural techniques to logging and transportation including road maintenance.

4.6.4 Extension and Public Relations

Very little has been done in the way of extension since there has not been a great deal of private forestry practised in the country. However, the radio and press are used to inform the general public about major events. In recent years, an increasing number of citizens have expressed views on forestry matters which have been taken into account in decision-making at the Departmental level. The vigorous and growing interest and participation of local non-governmental organizations in the debate about the country's natural resource patrimony is one of the strengths of Belize; and one to build on in pursuing the suggestions and proposals set out below.

An extension programme needs to be established, aimed at farmers, and also to ensure better management and utilization of both Crown and private forests. Extension to farmers clearly should be in cooperation with, and through the extension service

of, the Department of Agriculture.

Sustained efforts need to be made to create public and political awareness of the role of forests and conservation in national development, and of their importance in human welfare. The present weak position of the Forest Department with regard to the boundaries of its estate seems to be due, in part, to the lack of public projection of the role of forests and forestry. The national forest policy provides for public education through schools and by radio. The shortage of suitable staff may explain the current reticence, but more liaison with NGOs and educational groups inside and outside Belize may help to repair the deficiency. Internationally, there is a wealth of educational material which could be distributed and used in Belize with little or no modification. The Forest Department should enlist all legal means of support to ensure that the Reserved Forest estate is indeed permanent. The value of forests and forestry should be conveyed vigorously to the Belizean people of all ages.

Strategies for heightening awareness may vary from the use of power, such as legislation and law enforcement, to non-directive counselling and education. Comprehensive programmes aimed at long-term, pervasive changes are required to achieve the changes in behaviour that are necessary for the conservation and appropriate use of forests. They will involve, for example, changes in forest legislation, the planning of actions to deal with forestry problems and of communication to inform, educate and persuade those concerned. The strategies employed should be based on the involvement and participation of rural populations in matters concerning forestry or the environment, and the fact that such populations should be guaranteed rights with respect to the forests.

Political awareness of the importance of forestry and conservation is a prerequisite for the introduction of appropriate institutional measures, such as the updating of forest policies and legislation, the re-ordering of priorities in government planning to favour forestry and conservation, and changes in administrative structures necessary for applying new forestry conservation concepts.

The need for certain actions makes involvement of the mass media crucial with respect to the mobilization of public and political support. For the long-term purposes of moral and financial support of efforts to conserve and use forests properly, the national education system must become fully committed and actively engaged. For this purpose, special courses and educational materials on forestry and conservation for school teachers must be provided, and visits by forestry staff to schools organized on a regular basis, not only to popularise forestry and conservation but also to encourage teenagers to opt for forestry as a career.

School curricula in environmental education can be expanded and improved considerably, at primary, secondary and technical school levels. Teachers likewise need training in environmental

principles. Less formally, the Government can participate in environmental education through the Government Information Service, which reaches many Belizeans. The programme of non-formal education which the Government has proposed through the Belize Institute for Community Enterprise, Training and Development could also provide a channel for informing and engaging community leaders in environmental issues. Both Government and NGOs can use assistance from international conservation organizations which develop and disseminate educational materials. Coordination and specialization of effort among groups may improve overall efficiency.

Associative and voluntary organizations, including women's organizations, can also be mobilized to serve forestry interests in ways similar to those of schools. The high literacy rate in the country, and the small size of the population, should facilitate such mobilization and mounting of forestry and conservation campaigns aimed, in particular, at rural communities and adults.

4.7 SUMMARY OF RECOMMENDATIONS

The different proposals and recommendations which have been developed and put forward in the preceding sections of the Tropical Forestry Action Plan report are brought together in summary form below; and are presented to show a suggested sequence in which they would need to be implemented during the Plan period.

Actions which it is recommended should be initiated as a matter of urgency are principally those needed in order to proceed with the substantive interventions. They include the policy decisions required (e.g. to set up the Office of Conservation); short course training in key areas such as land use planning and conservation; assembly or analysis of selected data, such as that needed in order to plan forest management and forest industry changes and to revise forest charges; and preparation for the recruitment and training programme to build up the Forest Department.

Most of the recommendations fall into the category of actions which should be initiated as soon as such preparatory measures are in place. Some are concerned with further strengthening the basis for change through studies, preparation of plans and legislation and setting up of additional institutional mechanisms - such as the proposed Land Allocation Committee. Others are designed to put in place the related changes; such as the rationalization of land use, improvements in forest management, and the monitoring and assembly of more accurate information about various aspects of forest sector activity.

The main focus of most of what is proposed is on first strengthening and improving the management and performance of the large part of the country's forest estate which is in the public sector. This is likely to be a necessary prerequisite to introducing better management of forests on private lands.

RECOMMENDATIONSURGENTLAND USE

- short courses on land use for staff of the Forestry, Agriculture and Lands Departments;
- complete LRS/ODNRI surveys in rest of Belize;
- temporary moratorium on changes in forest estate boundaries;

CONSERVATION/PROTECTION

- establish Office of Conservation and Advisory Board;
- short courses and start long term training in conservation;
- extend moratorium on commercial trade in wildlife;
- mangrove inventory;

FOREST MANAGEMENT

- rework forest resource inventory, growth and harvesting data for long and short term land use, forest and industry planning;
- short courses in forest management;

SOON

- establish Land Allocation Committee;
- formulate Land Use policy, guidelines and plan;
- rationalization of land use;
- review and revise Land Use legislation;
- develop and promote appropriate agroforestry systems;

- establish Conservation policy;
- inventory of ecosystems and wildlife (compile results in Conservation Data Centre);
- gap analysis to define critical areas;
- develop comprehensive plan for wildland and wildlife management;
- promote basic and applied research on wildlife and ecosystems;
- monitor water quality;
- monitor effects of logging;
- establish criteria for definition of protection;
- support and improve education in conservation;

- improve monitoring to provide better estimates of forest dynamics;
- improve estimates of values of forest products and services;
- rationalize intensity, scales and techniques of management;
- revise terms for concession agreements;
- update forest legislation and regulations and harmonise with other legislation;
- improve monitoring of production from national and private lands;

BEYOND

- continues;

- continues;

- continues;

- continues;

- continues;

- continues;

- application of forest management to national lands suitable for forestry;

- promote better practices on private land;

- continues;

FOREST INDUSTRY

- collect and improve mill input-output data;
- develop Timber Association;
- help producers and BEIPU promote products of secondary species;
- clarify role of Forest Department in industrial production;
- provide extension to help industry improve woods operations (logging plans, etc.);
- provide extension to help the milling industry (improve production and maintenance, etc.);
- explore opportunities for import substitution;

ECONOMIC POLICY MEASURES

- undertake in-depth appraisal of royalties, other forest charges, control prices on lumber, and import and export taxes;
- revise policies, strategies and pricing/charge structures to encourage greater return from high quality woods, fuller use of secondary species in domestic markets, increased public revenue, import substitution, and greater expenditures on forestry;

INSTITUTIONAL STRENGTHENING

- restate national forest policy and development of strategies for its fuller implementation;
- draft forestry section of the 1989-94 development plan;
- plan necessary infrastructure development;
- plan Forest Department staff development;
- identify candidates and funding for training of professionals;
- negotiate expanded future Forest Department establishment;
- execute programme of training at professional, technical and vocational levels;
- develop necessary infrastructure;
- strengthen forest research activities;
- develop public and political awareness;
- continues;
- continues;
- continues;

5.0 EXTERNAL ASSISTANCE

In the present section a series of proposals are assembled, which indicate possible inputs from the donor community which could facilitate the preparation and implementation of the measures which have been recommended in this report for Belize's Tropical Forestry Action Plan. These have been prepared by the TFAP mission, in an attempt to identify those forms of assistance which would most usefully complement, strengthen and add to the country's existing resources in the forest sector. Care has been taken, therefore, to try and tailor the proposals to what can be accommodated by the Forest Department and other government departments concerned with the forest sector. Each proposal therefore identifies what inputs by the government would be required in order to implement it.

Given the acute shortage of trained staff for forestry, forest industries and wildlife and protected area management, the highest priority for external assistance would appear to be to provide education and training to fill expanded professional and technical cadres in the Forest Department; both abroad, and by supporting existing facilities and developing new training programmes in Belize. Pending the arrival of graduates and diplomates from this phase of training, external assistance could also contribute to needed specialized training of selected existing staff.

A complementary area of high priority would be to provide short term expert assistance to help build up a stronger information base, to carry out analyses needed for policy and planning decisions, and to start the process of putting improved management systems in place, during this period when progress is unavoidably restricted by shortage of trained and experienced Belizean personnel. In some instances this can best be achieved by consultant assignments (e.g. to review forest legislation, or forest charges), in others by carrying out particular studies (e.g. the mangrove inventory), and in others by seconding expatriate staff to Belize for longer periods (e.g. as forestry instructors at the College of Agriculture).

A third area is that of funding infrastructure and equipment expansion and upgrading. An expanded Forest Department, and the new Office of Conservation, will require office space, housing, etc. Additional investment may be needed in roads in some of the reserved forest areas. However, for such aid to be effective, a different approach to maintaining it by making provision for its replacement as the need for this arises is clearly needed.

Substantial amounts of capital equipment such as tractors, trucks, land rovers, fire fighting equipment, sawmill and wood working equipment, as well as buildings, have been supplied by aid projects in the past, or have been purchased or built. In some cases there seems to be no systematic financial accounting for these items after their original procurement. In other cases, notably the sawmill operations in the Mountain Pine Ridge Forest Reserve, there is a sound approach of estimating periodic

depreciation of capital items and of charging this depreciation as a cost of operation. This is, in turn, reflected in the value of goods or services produced. However, in no case was there found to be any established capital replacement fund, even as a book account. Thus, for example, sawnwood, produced by and used for, the government of Belize is directly subsidized by the depletion of equipment. In very few cases has the capital equipment been replaced, although there are some instances where this has been done through public accounts or by new aid projects.

The project proposals are primarily directed towards bilateral and multilateral sources of assistance. However, much of the work in the conservation area in Belize has been funded from non-governmental sources; and has been implemented with the assistance of expertise provided by overseas non-governmental organizations. A significant part of the additional aid proposed could also be secured in this way.

The proposals are shown in summary immediately below; with an outline of each provided on the pages that follow:

POSSIBLE EXTERNAL ASSISTANCE

ACTIVITY	G.O. BELIZE INPUT	DONOR INPUT
Establish Land Use Committee	Part time of Lands, Agriculture and Forestry staff	US\$230,000; 15mm consultant services
Mangrove inventory	Forestry/Fishery officers, 6mm Inventory crew, 3 times 2m	US\$250,000; 12 mm C
Agroforestry	Forestry officer (research)	US\$50,000; 3mm SA
Water quality monitoring	Forestry officer (research)	US\$100,000; 3mm C
Conservation training	Reserves officer, 7mm Wildlife officer, 3mm 3 District officers, 12m each 6 game wardens, 3m each	US\$410,000 C
Establish Conservation Data Centre	Conservation officer, 12m	US\$400,000; 12mm C
Forest management	2 Forest officers, half time for 6m each; Field crew, 12m 2 study tours, 2m each	US\$185,000; 12mm SA
Mill data collection	Forester, 3m	US\$35,000; 3mm
Industry extension	Forest officer/Forester (utilization), part time 36m	US\$510,000; 42mm (3 consultants)
Develop Timber Association	Chief Forest Officer; Forest officer (utilization); BEIPU	US\$120,000; 6mm
Secondary species promotion	Forest officer (utilization), 1m	US\$60,000; 3mm SA
Revise fiscal policies	Chief Forest Officer; Forest Officer (planning); Ministry of Economic Development Ministry of Finance	US\$90,000; 6mm
Revise forest and related legislation	Chief Forest Officer; Attorney General's Office	US\$150,000; 12mm SA
Forest Department staff development, 1985-94	7 Forest officers, 4 years each; 10 Foresters, 12m each; 2 instructors, 6m each; 45 rangers (in country)	US\$2,500,000; (2 instructors each for 4 years)
Public education in forestry and conservation	Forest Department staff; Ministry of Education	US\$230,000; 18mm (2 consultants) C

Development of infrastructure

Public Works Dept.

US\$3,000,000

TFAP Adviser

Chief Forest Officer

US\$350,000; 36mm

PROJECT PROPOSAL: AGROFORESTRYObjective:

To introduce, adapt and develop agroforestry systems for application in Belize.

Justification

The benefits would be of three principal forms. Firstly, farm income from the land concerned would be enhanced by yields from the tree components of agroforestry cropping. Secondly, the beneficial influences of these components would maintain and enhance soil fertility and reduce erosion, and thus tend to stabilize milpa and slash and burn farming systems and the land needs of the farmers using them. Thirdly, a local source of poles and fuelwood would be created in areas such as some in northern Belize which have been denuded of trees.

Inputs by GOB

Counterpart staff: One Forest officer (research) and one Agricultural Research (Rates extension) Officer for three months each per annum from 1990 to 1994.

Office space.

Land on farms of the types concerned, for trials and demonstration.

Moderate labour inputs as and when required.

Inputs by Donor

Three months of the time of an agroforestry specialist: US\$50,000

Timing

Begin 5-year initial project phase in 1990.

PROJECT PROPOSAL: WATER QUALITY MONITORING.Objectives:

Firstly, to monitor the quality of water issuing from areas representing (a) totally protected catchments and (b) catchments subject to alternative intensities of forest harvesting ("normal", i.e. selective, and "intensive"). Secondly, to formulate standards and guidelines to ensure maintenance of the quality and of the patterns of flow of water from forest production areas.

Justification

The forested uplands of Belize are important sources of water for downstream communities as well as existing and future rural and industrial developments (including hydro-electric power generation) particularly, though not exclusively, in the eastern central and southern lowlands. It is necessary to ensure that management and harvesting practices in the upland forests do not threaten the physical and chemical quality, or the comparative regularity and uniformity of the patterns of flow to these waters. Of particular importance would be minimization of the effects of management and harvesting practices on flooding and siltation.

Inputs by GOB

) Counterpart staff: one Forest officer (research) for three months each year from 1990 to 1994.
Office space.

Inputs by Donor

) Three months of the time of a water resources\hydrology specialist, vehicle and structures. US\$ 100,000

Timing

Start project in 1990

PROJECT PROPOSAL: ESTABLISHMENT OF A LAND USE COMMITTEE AND
SUPPORTING TASK FORCE

Objectives:

To establish an inter-departmental Land Use Committee representing the Departments of Forestry, Agriculture and Lands, and a supporting Task Force comprising a professional officer from each of these agencies:

- (i) to formulate a national land use policy and plan for approval by the Government;
- (ii) to review the existing pattern of land use allocation as well as existing legislation particular thereto, and propose modifications that may be deemed to be desirable, for consideration by the Government;
- (iii) to conduct similar reviews on a regular basis (say annually);
- (iv) to analyse and make recommendations on proposals for changes to land use allocations that may be made from time to time;
- (v) to develop a computerized land use information system.

Justification

There is no consistent basis or procedure for analysis of alternative options for the allocation and use of land or of transfers of land between use categories that are proposed from time to time. This results in a tendency for proposals for transfers of land between categories to be dealt with in an arbitrary, ad hoc manner rather than on the basis of objective scientific economic analysis of alternative uses. Also, as a result of the dynamic nature of land use in some instances, periodic review of specific allocations is desirable to ensure that they are in the best long term interests of the country.

Inputs by GOB

Staff: Part of the time of one professional officer from each department concerned ; 2 months in 1990; 2 months annually for 4 years thereafter. These officers will have received training through short courses on land use analysis and planning. One secretary for the same period. Office space in Belmopan for the foregoing and for the expatriate specialist (see below). Field travel expenses for the above professional staff for, say, one month in each year.

Inputs by Donor

Technical Assistance: 2 months in 1989, 4 months in 1990, 2 months/year for 4 years thereafter, ie 14 man-months; vehicle and miscellaneous equipment and supplies. USS 230,000

Timing/duration

As indicated above

PROJECT PROPOSAL: MANGROVE INVENTORYObjective:

To assess the location, nature, extent, condition, degree of cutting and other depletion and disturbance, and to estimate the content, in terms of stems and volume per hectare, of the coastal and off-shore mangrove resource. The precise extent of the resource is not known.

Justification

The resource provides essential habitat for important elements of marine fisheries resources, affords protection to considerable length of coast-line on both the mainland and off-shore cayes. It is potentially a source of modest quantities of poles and fuelwood. It is being depleted in some areas by building developments. Some cutting takes place. It is at present virtually unmanaged and unprotected. The inventory would provide a basis for planning and implementing these much needed activities.

Inputs by GOB

Counterpart staff: One forester or fisheries officer for 50% of the time occupied by field work (say 6 months); one ranger and two boatmen full time; office space for six months.

Inputs by donor

12 man-months of expert assistance; locally employed assistants; rental of boats; equipment and supplies. US\$ 250,000

Timing

Begin in 1989; complete in 1990.

PROJECT PROPOSAL: TRAINING OF STAFF FOR THE OFFICE OF
CONSERVATION

Objective:

To provide trained staff for the newly created Office of Conservation.

Justification

The Office of Conservation would legitimize and publicize the concept of conservation in Belize, as well as bring the energy of full-time, trained personnel to bear on conservation issues. The Office's responsibilities would include: management of reserves and wildlife, enforcement of parks and wildlife laws, research on the environment, and maintenance of a conservation data centre. At present no Belizeans have the training to fill the main or district office positions of the proposed Office of Conservation, or to act as game wardens.

Activities

The reserves specialist would be trained in the theory of reserve design and the practice of reserve management. He or she would be charged with guarding against infringements on reserve land, with monitoring incompatible land uses adjacent to reserves, and with resolving conflicts between permissible uses of multiple-use reserves. This position would also include investigating possible new reserves and making recommendations for their establishment, as well as continuing research on management of established reserves.

The wildlife specialist would be trained in wildlife management. Responsibilities would include overseeing research on ecology and population dynamics of wildlife, administration of management practices, and enforcement of wildlife laws concerning hunting and trade. Because a major problem in wildlife management is lack of enforcement of wildlife laws, it will be important to maintain a trained corps of game wardens attached to the Office of Conservation.

Qualified persons will have to be sent abroad to train for the administrative and research positions. Game wardens could be trained by a visiting instructor.

Inputs by GOB

The Government of Belize would undertake to provide personnel to be trained.

Inputs by Donor

Fellowship funds for training 5 officers abroad; and provision of an instructor to train game wardens for 3 months in Belize.

US\$ 410,000

Duration

Three years for overseas training; three months for in-country training.

PROJECT PROPOSAL: CONSERVATION DATA CENTREObjective:

To assist in setting up an institutional base for collation of environmental data.

Justification

The most important tool for conservation decisions is a system and institution for gathering, cataloguing, and supplying information on Belize's biological diversity. This is the "conservation data centre". In it are kept such things as maps of vegetation, land uses, and animal and plant distributions; aerial imagery; reports on flora and fauna organized by species and cross-referenced to locations; copies of laws pertaining to natural resources. A good deal of information on Belize is available, but it needs to be assembled and organized for use. The information is continuously updated and used for purposes like gap analysis. The accumulated information can help identify areas of particularly high species richness or areas that contain species of limited distribution. Such areas have priority as reserves. The centre can be a starting point for basic ecological studies. The centre would be clearing-house of data and interpretations for other organizations. Methods of establishing and operating a conservation data centre could be based on practices devised by the Nature Conservancy in the US or by Conservation International (US).

Inputs by GOB

An officer from the Office of Conservation; office space.

Inputs by Donor

A consultant for 12 months, plus 3 following visits of one month each; 2 vehicles; remote sensing imagery; supplies. US\$ 400,000

PROJECT PROPOSAL: TECHNIQUES OF FOREST LAND MANAGEMENTObjective:

To assist the Forest Department to adapt techniques from other tropical areas for improved forest land management.

Justification

The analysis for the TFAP report shows that there have been major conceptual errors underlying some past and most present field management operations. They have persisted in part because Belize has not maintained contact with developments in other tropical areas, notably Suriname and Malaysia. Collection, handling and use of numerical data has been insufficient and records are inadequate to quantify or explain the present state of the forests after logging and damage by hurricane and fire. The staff lack confidence in changing the management systems without external support.

Activities

Three activities are proposed: the preparation of a manual of techniques for forest land management in Belize, the establishment of a demonstration area in natural pine forest in the uplands and the establishment of a demonstration area in the broadleaved lowland forest. Components will include:

- a review of current Forest Department plans for annual operations, draft working plans, standing orders and similar instructional material in order to help understand the bases for the present procedures and practices. This review would include a search for the arguments presented at the time of introduction of the current practices.
- expansion of the libraries of the Forest Department and the Belize College of Agriculture to cover tropical forest ecology, silviculture, management and protection. Obtain by purchase or exchange the major texts or journals on which modern forest management is based.
- selection of demonstration areas in upland pine and lowland broadleaved forest, about 10 logging blocks in each case.
- lay out of compartments and stock mapping, making use of any previous inventory and growth data, maps and aerial photography. Diagnostic sampling in broadleaved forest.
- lay out of logging blocks, roads and skid trails; building of access to FAO-recommended standards.
- marking of trees to be reserved for seed in stands ready for final felling; marking of final crop trees in juvenile stands to be thinned or released; pre-exploitation inventory of logging blocks.

- demonstration of various post-logging management and silvicultural techniques in broadleaved forest, such as block closing inspections, checks on reserved trees, regeneration sampling, freeing of seedlings and saplings, climber cutting, repair of drainage, poison-girdling.

- installation and measurement of yield plots in forest recovering from logging operations and hurricane damage.

- In all cases the demonstration would be supported by a draft chapter for a forest land management manual, with fully worked examples and illustrations. The teaching would include, where appropriate, training in the handling of the numerical data and its integration into a forest land management data bank, and selective retrieval and use of data from the same bank.

- two study tours, each of two months. One tour for a territorial District Forest Officer on the management of natural pine, uneven and even aged, in the southern United States. One tour for a territorial District Forest Officer on the management of lowland tropical moist forest in Surinam and East Malaysia.

Inputs by GOB

Two District Forest Officers, each half-time for 3 months; one full-time field crew for 1 year (1 Ranger, 2 Forest Guards and 8 labourers); salaries and subsistence in the field; office accommodation, clerical support, mapping and reproduction of maps.

Inputs by Donor

One specialist in the management of tropical forest lands for 12 months; 4-wheel-drive vehicle. US\$ 185,000

Duration

12 months.

PROJECT PROPOSAL: COLLECT AND IMPROVE MILL OUTPUT DATAObjective:

To organize existing data collection and develop a system of monitoring input (the log volume, species, quality, source location, dimensions, cost, harvesting method), and output of lumber or other products (by species, dimension, quality, cost, market destination and price).

Justification

The development of a better flow of statistics of the input and output of mills will enable the Forest Department to do a better job of monitoring the volumes, species, and source of logs going into the production stream and the product coming out of it. The waste factor, amount of secondary species used and actual volume of lumber produced will be available - this key data is not available from the present collection system. At present, sawnwood statistics are not based on actual sawnwood production records - they are derived from Forestry Department records of log input and converted at a recovery factor of 40%.

These statistics will help the Forestry Department manage the forest resource better and plan future policy. It will provide necessary information for the proposed sawmill extension expert to start his analysis and upgrading of Belize's 46 sawmills.

Input by GOB

One Forester for 3 months to assist expatriate expert; office space; and field travel expense for the Forest Department forester.

Input by Donor

Expert for 3 months; vehicle lease; equipment and supplies.
US\$ 35,000

Timing/duration

Three months as early as possible; the project should be completed before the rainy season starts in June.

PROJECT PROPOSAL: UPGRADE HARVESTING OPERATIONS.Objective:

To provide an extension forester, experienced in forest and woods (logging) operations, to upgrade the planning and harvesting operations of approximately 40 individuals and companies cutting on Government and private forest land. To study possibilities of extending the logging season through better roads and planning.

Justification

The country will benefit through better planning and orderly cutting patterns of the nation's forests. At the present time, on any concession, the area cut over and volume removed and size of residual stands are unknown. Upgrading the planning by taking into account the basics of topography, forest type, volume, soil and ground conditions, watersheds and stream courses will lead to better utilization of the resource and extension of the logging and sawmilling season. At present there is no information at the concession level about individual species occurrence.

Input by GOB

One Forest Officer for 18 months (2 logging seasons) to be trained in extension work; office space; field travel expenses for the Forest Officer for 18 months.

Input by Donor

Expert in woods operations for 18 months; vehicle; expenses and supplies. US\$ 210,000

Timing/duration

18 months, to begin after the proposed collection of mill input/output data has started to operate; preferably in late 1989 or early 1990, in order to be functioning by the beginning of the logging season.

PROJECT PROPOSAL: UPGRADE SAWMILL OPERATIONSObjectives:

To provide a sawmill extension expert to help 46 sawmills improve their operations. To work with the sawmillers on better operating procedures on log preparation, sawing, saw filing, care and maintenance of saws; headrig edger, trimmer operation, drying and general processing of the lumber; power plant operation; mill location planning in relation to resource and transportation system; land waste removal.

Justification

The country will benefit by better utilization of the resource (less waste) more and higher quality production for domestic and dollar earning export market; better use of invested capital and more jobs.

Inputs by GOB

One Forest Department officer (preferably the same one who worked with the extension forester on planning and harvesting) for 12 months; office space; field travel expenses for Forestry Officer for 12 months.

Inputs by Donor

Extension sawmill expert, 12 months; vehicle; expenses and supplies. US\$ 150,000

Timing

Should overlap with the project on upgrading harvesting operations.

PROJECT PROPOSAL: EQUIPMENT AND MAINTENANCE UPGRADEObjective:

To provide an extension millwright to upgrade the maintenance systems, and to train personnel in the maintenance of sawmill and harvesting equipment.

Justification

The country will benefit through better performance, less need for imported spare parts, better utilization of the resource through reduced waste and increased skills of maintenance personnel. Upgraded maintenance standards should improve production and quality of lumber and other products.

Inputs by GOB

One Forest Department master mechanic or equipment maintenance supervisor for 12 months; office space; field travel expenses for 12 months.

Inputs by Donor

Expatriate millwright for 12 months; vehicle; vehicle operation expenses and supplies. US\$ 150,000

Timing

There should be a two month overlap with the sawmill extension expert.

PROJECT PROPOSAL: FORMATION OF TIMBER ASSOCIATIONObjective:

To develop a functioning Timber Association, including secondary wood processing such as furniture.

Justification

The country would benefit from a strong association that would improve quality of production and increase export opportunities. Industry would have a common voice in the GOB policy and planning process. The Association would act on behalf of the industry in discussions and negotiations with the Forest Department and other GOB Departments, and conservation and environmental groups, concerning such issues as delineating cutting areas to accommodate conservation areas, lumber price ceiling, royalty rates, minimum cutting diameters, etc. It could lobby the shipping lines for better rates and service; work with BEIPU to develop export markets, and work with equipment suppliers and other organizations for personnel training. It would work with members to set domestic lumber grades.

Inputs by GOB

) The Chief Forest Officer, and a BEIPU Officer to accompany the expert in visits to loggers, sawmills and secondary industries.

Inputs by Donor

) A senior executive from a Timber Association which has faced problems similar to Belize, for six months; travel expenses; vehicle lease and operation. US\$ 120,000

PROJECT PROPOSAL: SECONDARY SPECIES PROMOTIONObjective:

To develop a programme for secondary species promotion with the Forest Department and BEIPU.

Justification

Development of export markets for secondary species and thus more foreign exchange income. Better utilization of the forests, increased employment and production (better utilization of existing mill capacity).

Inputs by GOB

One Forest Officer (utilization); BEIPU officer; field travel expenses for two months.

Inputs by Donor

The services of an importer of secondary hardwoods into the North American markets, for two one month assignments at a half-yearly interval; travel expenses; vehicle lease and operation.

US\$ 60,000

Timing

Should not overlap with the Timber Association project.

PROJECT PROPOSAL: APPRAISAL OF FISCAL POLICIES OF MAJOR
IMPORTANCE IN FOREST SECTOR

Objectives:

(1) Appraise in-depth the major fiscal policies affecting operation of the forest sector, in particular royalty rates for timber removed from both public and private lands, other charges made for use of the forest, other aspects of the fee system for concessions and sale of public timber, control prices for domestic sale of lumber, as well as export and import tariffs.

(2) Revise existing fiscal policies with the aim of improving public revenue, but even more, of promoting a healthy development of the forest industry sector.

Justification

Creation of a fiscal structure designed to (1) bring a more reasonable share of product value to public revenue; (2) make fuller use of the wood produced by the forest (3) promote greater export returns from the more valuable species; and (4) encourage substitution of lower valued species for mahogany and other high valued woods in domestic utility uses.

Activities

Study (1) the existing levels of royalties in relation to product prices (particularly domestic control prices of lumber) and costs of logging and milling, with a view to determining an appropriate portion of the ultimate product return to be allocated to value of standing timber being cut (stumpage price); (2) the impact of present pricing (both royalties and control prices) on relative demand for different species, especially mahogany versus the so-called secondary species; (3) the undesirable economic effects of the simple method of the state charging a flat unit volume fee for timber of a particular species, regardless of location of the area being operated or of the intensity of management being practised.

Examine the effects of control prices on levels of consumption and especially on the balance between various species being used.

Assess the impact of import and export tariffs on the forest sector.

Recommend and assist in the development of an improved system of forest charges and other fiscal devices.

Inputs by GOB

Three months of time of Chief Forest Officer; 3 months of time of forest economist/planner; 1 month each for officers of Departments of Finance and Economic Development.

Inputs by Donor

Six months of expatriate expert time, use of vehicle for 4 months, partial use of computer system for 6 months. US\$ 90,000

PROJECT PROPOSAL: STAFF DEVELOPMENTObjective:

To strengthen the Forest Department's capacity for forest land management.

Justification

Forestry development is hampered by a shortage of staff at all levels. At present there are only 5 professional officers and 2 trained Foresters in the country. There are no Forest Rangers or Forest Guards with formal training in the Department. It is therefore necessary to establish crash programmes of training for professional and other levels of staff.

Activities

- Training of 7 professional officers and 10 Foresters through scholarships abroad.
- Setting up of a crash course training at the Belize College of Agriculture to train 45 Forest Rangers.
- Conduct of short in-service training course within the Forest Department.
- Training of instructors.
- Setting-up of a forestry library at the Belize College of Agriculture.
- Supply of teaching and training material, equipment and vehicles.

Inputs by GOB

The government would make available the personnel to be trained; counterpart staff and facilities at the Belize College of Agriculture.

Inputs by Donor

Fellowship for training overseas as outlined above; 2 instructors for the College of Agriculture, each for 4 years; vehicles; library, teaching and training materials/equipment. US\$ 2,500,000

Duration

6 years

PROJECT PROPOSAL: REVIEW OF FORESTRY AND RELATED LEGISLATIONObjective:

To update forest legislation and concession agreements and harmonize them with related legislation.

Justification

Certain deficiencies have been observed in legislation relating to Forest Reserves, wildlife, national parks, national lands, private forests, land utilization and land tax. These are concerned with the responsibilities of the Minister and the Chief Forest Officer under the Forest Ordinance and Forest Rules; lack of regulations under the Wildlife Act; overlapping responsibilities for mangroves; lack of precision on mutual responsibilities of the licensee and the Forest Department in concession agreements.

Activities

- Critical review of current legislation and all types of forest concession agreements.
- Analysis of relevant legislation and public utilization contracts in tropical forests.
- Drafting of model agreements for each type of licence and permit.
- Provision of a framework for the reformulation of forest and associated legislation, with a view to their more harmonious application and more equitable distribution of responsibilities.

Inputs by GOB

Time of the Chief Forest Officer, Principal Forest Officer and staff of the Attorney General's Office.

Inputs by Donor

Expert in forest legislation for 12 months. US\$ 150,000

Duration

12 months

PROJECT PROPOSAL: PUBLIC EDUCATION IN FORESTRY AND CONSERVATIONObjectives:

To increase public awareness of and involvement in conservation and forestry matters.

Justification

Public understanding of and support for the role of forests and conservation is an essential prerequisite to many of the actions needed in pursuit of sound development of the forest sector. Political decisions - for example to enforce protection of the forest estate - need public support. Many persons are directly engaged in activities, such as agriculture, which would directly benefit from better knowledge of the role of trees.

Activities

Preparation of curricula, courses and teaching and reference materials; holding of workshops; and coordination of efforts among the several government and non-government organizations involved in environmental education.

Inputs by GOB

Part time services of staff in the Ministry of Education and the Forest Department; office space.

Inputs by donor

Two consultants, in public education and environmental education, for a total of 18 man months; vehicle leasing and operation; equipment and supplies US\$ 230,000

PROJECT PROPOSAL: DEVELOPMENT OF INFRASTRUCTUREObjectives:

To support necessary expansion of the infrastructure of buildings and roads needed for management of the forest estate.

Justification

The TFAP has identified the need to deploy larger numbers of Forest Department personnel through the forest areas, and to add a new unit to be responsible for conservation. This project will provide the funding for the additional buildings needed. It will also provide funding for additional road construction in the reserved forest areas.

The size of the project will depend on the magnitude of the expansion decided on by government. For illustrative purposes, the funding input identified below is based on the following assumed construction programme:

- headquarters building (US\$ 200,000)
- 2 DFO quarters (US\$ 35,000 each)
- 7 forester/conservation officer quarters (US\$ 27,000)
- 10 forest ranger quarters (US\$ 22,000)
- 20 forest guard/game warden quarters (US\$ 16,000)
- 100 miles of road (@ US\$ 20,000/mile)

Input by GOB

Land; services of the Public Works Department.

Input by donor

Capital funds US\$ 3,000,000

PROJECT PROPOSAL: TROPICAL FORESTRY ACTION PLAN ADVISERObjectives:

To assist the government in pursuing the Tropical Forestry Action Plan.

Justification

The increase in inputs into the forest sector proposed in the TFAP report will place additional heavy, and time consuming, burdens on the Chief Forest Officer and his immediate staff. An adviser experienced in the procedures associated with external assistance, and in coordinating aid projects, could relieve some of these burdens; and facilitate the preparation and processing of project proposals.

Inputs by GOB

Time of the Chief and Principal Forest Officers; office space.

Inputs by donor

A senior forester with substantial experience of forestry administration and external assistance programmes for 3 years; vehicle and operating costs. US\$ 350,000

Duration

Three years.

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APPENDICES 1 - 20.

Appendix 1: Terms of Reference

Belize possesses valuable forest resources, which over much of its history provided the mainstay of the country's economy. At present, following a period of reduced investment in the forest sector in favour of agriculture, production is at only a small fraction of the potential output that could be sustained from the forests, and accounts for only a minor part of the nation's economic product.

The government now wishes to achieve a substantially increased contribution from the forest sector, as part of a process of economic diversification and renewed growth. This is to be achieved through expansion of forest industries, in conjunction with expansion of tourism and development of indigenous wood-based energy.

The purpose of the Tropical Forestry Action Plan (TFAP) study is to assess the development potential of the forestry sector, to identify the constraints hindering its development and actions needed in order to relax or remove these constraints, and to define the possible inputs that could be provided through external assistance.

The study will be based on all available existing information, updated and supplemented where possible by field appraisal during the TFAP team's work in the country. Earlier review studies indicate that the main features of the forest sector are as follows:

- About 80% of the country's land area is classified as woodland or forest; divided roughly equally between reserved forests, Crown land under forest and private forest. Expansion of slash and burn farming and estate agriculture is steadily reducing the actual forest cover;
- Repeated logging for mahogany and other selected species has depleted stands of these timbers. The bulk of the remaining resource is in other lesser-known hardwoods, with an important pine resource as well.
- Much of the resource is still difficult of access or inaccessible. Log production is severely disrupted seasonally by rain.
- A forest industry comprised of small and medium sized sawmills processes - and has the capacity to process - only a small fraction of the estimated sustainable output of hardwoods; and only part of the pine available. Product quality is generally poor.
- The forests contain a rich variety of plants and animal species of biological, tourist and other value. The forest cover over much of the country also performs an essential protective function.

The study will include coverage of the following aspects and issues:

Forest management

- estimates of the magnitude of the potentially accessible commercial forest resource, in particular in permanent forests, and of the likely sustainable output;
- the management systems proposed for pine forests;
- development of management systems for mixed hardwoods;
- plantation forestry;
- silvicultural and management research;
- multiple use of forest lands for timber production, use by local people, protection, tourism and/or conservation.

Forest industries

- the adequacy and potential of existing industries;
- measures to better meet domestic demand for wood products; including products presently imported;
- strategies for expanding production for export; in particular production based on secondary hardwoods;
- the potential for the country's traditional non-wood products (naval stores, chicle, etc.) and new products.

Forests and land use

- the extent and location of land areas best suited to forest use;
- the appropriateness of ongoing and planned programmes to transfer land out of forest use;
- the potential and need for reforesting cleared areas which are unsuited for other uses;
- the scope for agroforestry systems to improve land use in interface areas;
- strategies for managing forested land destined for eventual transfer to other uses.

Conservation

- the protective functions of the forests, and their inclusion in forest management;

- management to enhance tourist values;
- conservation and management of wildland and wildlife resources;
- conservation of biological resources.

Energy

- the emergence of local shortages of wood fuels for existing users;
- the potential of wood-based energy to substitute imported fuels;

Institutions

- the adequacy of the institutions mandated to administer the forest sector (structures, programmes, manpower, resources, etc.);
- the appropriateness of legislation, regulations, incentives and other policy measures governing or influencing the use of forests and forest lands.

The study will be developed within a framework provided by the government's five year and current development programmes. Potential developments will be explored which respond to the priorities laid down by the government, and their likely impact on the government's objectives with respect to national product, government revenue and expenditure, foreign exchange earnings and employment will be assessed. Needs for external assistance will be identified, and will be formulated in outline as prospective assistance programmes and projects.

Appendix 2: PROGRAMME OF TFAP MISSION VISITS AND MEETINGS

2 May

Arrival in Belize of J.E.M. Arnold (team leader), F.B. Armitage (land use), J.R. Palmer (silviculture and management) and S.L. Pringle (forest economics).

3 May

- Ministry of Agriculture, Forestry and Fisheries:
 Mr R. Neal, Permanent Secretary
 Mr H. Flowers, Chief Forest Officer
 Mr O. Rosado, Principal Forest Officer.
 - Mrs Y.S. Hyde, Permanent Secretary, Ministry of Economic Development.

4 May

- Meeting with the Honorable Dean Lindo, Minister of Agriculture.
 - Dr M. Holder, Director, Central Farm (agricultural research).

5 May

- Mr J. Smith, Principal Agricultural Officer, Research.
 - Mr E. Aldana, Principal Agricultural Officer, Extension.
 - Dr S.A. Roberts, Chief Statistician, Central Statistics Office.
 - Mr V.V. Statistical Adviser, Central Statistics Office.
 - Mr D. Aguilar, Commissioner of Lands.

6 May

- Visit to sawmill of Belize Timber Co. at Iguana Creek; Mr J. Roberson

7 & 8 May

- Inspection of private forests in the area between Spanish Lookout and Blue Creek Village, with Mr O. Sabido, DFO (Management), Dr W. Burley and Mr M. Meadows. Overnight at Chan Chich Camp, Gallon Jug.

9 May

- Half-day workshop on forestry in Belize, and the role of the TFAP exercise, with senior representatives from:
 Ministry of Agriculture
 Ministry of Natural Resources
 Ministry of Commerce, Industry and Tourism
 Ministry of Electricity, Transport and Communication
 Ministry of Economic Development

Ministry of Education
 Development Finance Corporation
 Belize Audubon Society
 Belize Centre for Environmental Studies

10 May

- Travel to Melinda Forest Station with Mr Rosado; visits to Hummingbird Hershey Cocoa Co. and, with Mr R. Belisle (DFO South), to Forest Department Pine, Teak and Gmelina plantations.
- Overnight in Dangriga.

11 May

- Travel to Savannah and Machaca Forest Stations with Mr Rosado and Mr Belisle. Visits en route to:
 - Plantation and Estates Ltd. (citrus and pine);
 - Belize Internacional Forest Products Ltd. (sawmill and veneer plant under construction), Mr J. Kelly;
 - Tropical Produce Company Ltd (mango, citrus, bananas);
 - Savannah pine plantations and pine forest areas previously managed by the Forest Department to control fire;
 - Hercules depot at Big Creek for shipping pine stumps;
 - Sawmill of Mr C. Sellars at Los Lomitas.
- Overnight at Machaca Forest Station.

12 May

- Visit to Toledo Research and Extension Centre (TREC) project area with Mr Rosado and Mr S. Edwards (Forest Ranger Toledo Range) and, with Mr R. Quiros and Mr D. Hughes of TREC, inspection of milpa farming, and discussion with milpa farmers, in Jimmy Cut (upland) and Laguna (lowland) areas.
- Visit to Forest Department mahogany plantation, Colombia Forest Reserve.
- Visit to sawmill of Mr H. Whitney at Big Fall.
- Meeting with Mr A.C.S. Wright, soils specialist.
- Overnight at Machaca Forest Station.

13 May

- Travel to Belmopan with Mr Rosado; visits en route to:
 - Furniture plant and sawmill of Mr F. Durkits at San Antonio;
 - Sawmills of Mr. Milo Genus and Mr. Magnus Carcamd.
 - Mangrove forests in Placencia area (by boat);
 - Rosewood arboretum plot at Melinda Forest Station;
 - Blue Hole National Park.

14 May

- Analysis of documentation.
- Arrival in Belize of H. Hilmi (institutions).

15 May

- Mission discussions.

16 May

- Interim review meeting with Minister of Agriculture.
- Mr M. Jack, CDC regional agricultural adviser.
- Belize Electricity Board.
- Mr J. McGill, land use planner, Ministry of Natural Resources.

17 May

Main group:

- Visit to Central Farm agricultural research station.
- To Augustine Forest Station; visits en route to:
- Mennonite horse powered saw mills,
- Forest Reserve recreation area at Ric On falls.
- Dr M Kellman, pine systems ecologist.

Overnight at Augustine Forest Resthouse.

H. Hilmi:

- Mr E. Aldada, Head, Agricultural Extension Service,
- Arrival in Belize of N. Brokaw (conservation) and W.L. Bender (forest industries).

18 May

Main group (joined by N. Brokaw and W.L. Bender):

- Pine Ridge Forest Reserve; with Mr E. Green (DFO West) and Mr O. Sabido (DFO Management), visits to:
- pine stands on a variety of sites,
- thinning and increment research plots,
- thinning operations,
- logging operations,
- Forest Department sawmill at Augustine,
- sawmill of Pine Lumber Co. at Kinloch Camp.
- forest fire lookout at Cooma Cairn.
- Thousand Foot Falls recreation area.
- Overnight at Augustine Forest Resthouse.

H. Hilmi:

- Mr G. Henry, Permanent Secretary, Establishments Dept.
- Ms E. Chavarria, Chief Training Officer, Establishments Dept.

19 May

Main group:

- With Mr Green and Mr Sabido inspection of Chiquibul Forest Reserve.
- Coracol Maya archaeological site.
- Return to Belmopan.

H. Hilmi:

- Mr P. Barnard, Permanent Secretary, Ministry of Education.
- Mr J. Nemhard, Chief Education Officer.

- Mr R. Barrett, Belize Agricultural College.

20 May

- Mr V. Gillett, Fisheries Administrator, Belize City
- Mr O. Puga, Senior Economist, Ministry of Economic Development.

21 May

- Ms D. Weyer, Parrot's Wood Biological Station.
- Mission group discussions and work sessions, 21 to 23 May.

23 May

- Mr W. Craig, Director, Belize Audubon Society
- Ms L. Nicolait, Director, Belize Centre for Environmental Studies.

24 May

- Mr A. Moore, Archaeologist, Ministry of Education
- Mr S. Ordonez, Assistant Secretary, Ministry of Commerce, Industry and Tourism
- Toucan Match; Mr A. Bradley
- F. Magnum, Economic Development Adviser, Ministry of Economic Development.

25 May

- Mr K.A. Arnold, Financial Secretary.
- Mr S. Nolper, Tourism Adviser, Ministry of Commerce, Industry and Tourism
- Mr M. Miller, Belize Export and Investment Promotion Unit.
- Classic Furniture, Belize City.
- Caribbean Shipping Co., Mr S. Longsworth.

26 May

- Belize Timber Co.; Mr J. Roberson.

27 May

- Mr D. Aguilar, Commissioner of Lands.
- Mrs Y.S. Hyde, Permanent Secretary, Ministry of Economic Development.
- Mr L. Lindo, retired Chief Forest Officer.
- International Forest Products Co.; Mr S. Nail.
- Departure of H. Hilmi.

28/29 May

- Preparation of statement of preliminary findings.

0 May

- Meeting with Chief Forest Officer and Principal Forest Officer.
- Workshop to follow-up the meeting held with senior government and NGO representatives on 9 May, to discuss with them the mission's preliminary findings.

1 May

- Meeting with the Minister of Agriculture to report and discuss the mission's preliminary findings.
- Visit to Belize Timber Co. at Spanish Lookout.
- Departure of J.E.M. Arnold and F.B. Armitage.

1 June

- Community Baboon Sanctuary; Mr F. Young, Manager.
- New River Enterprises; Mr J. Loskot.
- Departure of S.L. Pringle.

2 June

- Society Hall Nature Reserve Ms S. Dietrich-Ward, Donor and Caretaker.
- Visits to sawmills and secondary processing plants in the Orange Walk, Shipyard and Blue Creek areas.
- Helicopter reconnaissance by J. Palmer of areas between Belmopan and Toledo.

3 June

- Shipstern Wildlife Sanctuary; P. and Z. Walker, managers.
- Visits to sawmills in Orange Walk, Sand Hill, Orlando and Isabella Bank.
- Return to Belmopan.
- Review of license policy and operation by J. Palmer; daily meetings over the period 3 to 8 June, with Mr Rosado.

4 June

- Ms J. Gibson, Member, Board of Directors, BAS
- Mr J. Nilsen, Forest Utilization Officer.

5 June

- Visit to logging operations of Belize Timber Co. at Spanish Lookout.
- Visit to Crooked Tree Wildlife Sanctuary; B. and C. Miller ornithologists
- Mr M. Cutlack, Editor, Tuesday Beacon

6 June

- Mr D. Taylor, former Manager, Cockscomb Basin Wildlife Sanctuary

Departure of N. Brokaw

W.L. Bender to Stann Creek District; visits to:

- Hummingbird Wicker Works; Mr R. Lopez;
- Melinda Forest Station sawmill;
- First National Trust sawmill;
- Banana Control Board; Mr C. Griffiths, Chairman;
- International Forest Products Sawmill; Mr J. Kelly.

7 June

- Visit to Machaka Forest Station, and sawmills in San Antonio and along Southern Highway.

8 June

- Return to Belmopan.

9 June

- Visit to lumber companies, exporters, boat builders and furniture plants in Belize City.
- Mr L.G. Hamilton, Housing and Planning Department.
- Meetings with Lands and Survey Department (up to 13 June) on land tenure and land use policy.

11 June

- Belize Exotic Wood and Veneer Co.; Mr H.A. Baisley.

14 June

- Mr E. Bradley, Toucan Enterprises.

15 June

Departure of W.L. Bender.

J. Palmer to Mountain Pine Ridge Forest Reserve, two days discussions on forest management, inventory and data processing with Mr Sabido.

16 June

- Return to Belmopan

17 June

- Mr D. Aguilar, Commissioner of Lands.
Departure of J. Palmer.

Appendix 3A: Belize - Agricultural Production 1978-87.

(Index: 1984 = 100)

	1978	1979	1980	Revised						
				1981	1982	1983	1984	1985	1986	1987
Sugarcane ('000 long ton)	1123	893	1014	970	1095	1132	1022	962	854	789
Volume index	100.0	87.4	99.1	94.9	107.1	110.7	100.0	94.1	83.5	77.2
Oranges ('000 boxes) a/	686	563	1109	1063	1058	750	1124	1043	1265	1672
Volume index	61.0	50.5	98.7	94.6	94.1	66.7	100.0	92.8	112.5	148.8
Grapefruit ('000 boxes) b	303	188	408	586	703	178	312	476	650	883
Volume index	97.1	60.3	130.8	187.8	225.3	57.1	100.0	152.6	208.3	283.0
Corn ('000 lbs.)	43000	34000	41500	46600	47000	33800	34500	43280	40747	53100
Volume index	124.6	98.6	120.3	135.1	136.2	112.5	100.0	125.4	118.1	153.9
Rice paddy ('000 lbs.)	14000	14700	19000	23890	17500	13500	12500	12100	9712	11109
Volume index	112.0	117.6	152.0	191.1	140.0	108.0	100.0	96.8	77.7	88.9
Cocoa ('000 lbs.)	-	-	12	9	39	108	123	142	177	255
Volume index	-	-	-	7.3	31.7	87.8	100.0	115.4	143.9	207.3
Red kidney beans ('000 lb	2160	2240	3073	3809	3900	4000	2834	2300	4007	5574
Volume index	76.2	79.0	108.4	134.4	137.6	141.1	100.0	81.2	141.4	196.7
Honey ('000 lbs.)	422	498	552	533	499	603	632	673	678	645
Volume index	66.8	78.8	87.3	84.3	79.0	95.4	100.0	106.5	107.3	102.1
Pork ('000 lbs.) c/	764	659	487	365	332	495	574	662	660	0
Volume index	133.1	114.8	84.8	63.6	57.8	86.2	100.0	115.3	115.0	0.0
Beef ('000 lbs.) c/	2577	2562	2310	2216	2913	2100	2238	2721	2441	0
Volume index	115.1	114.5	103.2	99.0	130.2	93.8	100.0	121.6	109.1	0.0
Poultry ('000 lbs.) c/	3800	4500	4300	5216	6060	6477	6672	6757	6888	0
Volume index	57.0	67.4	64.4	78.2	90.8	97.1	100.0	101.3	103.2	0.0
Timber ('000 bd. ft.)	-	8180	9316	8140	8993	7083	8698	9188	6953	9524
Volume index e/	-	94.0	107.1	93.6	103.4	81.5	100.0	105.6	79.9	109.5
Bananas ('000 boxes) d/	520	842	785	549	524	531	555	542	690	1120
Volume index	93.7	151.7	141.4	98.9	94.4	95.7	100.0	97.7	124.3	201.8
Milk ('000 lbs.)	...	...	...	650	700	975	1170	...	...	...
Volume index	...	...	...	55.6	59.3	83.3	100.0	...	...	...

a/ Estimated to be 90 pounds per box.

b/ Estimated to be 80 pounds per box.

c/ Fresh meat; in commercial slaughterhouses.

d/ Estimated to be 42 pounds per box.

e/ Jan-Sept. data only.

Sources: Ministry of Agriculture; Department of Agriculture, and Central Statistical Office,

Appendix 3B: Belize - Industrial Production 1978-87.

(Index 1984 = 100)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Sugar (long tons)	113,516	98,600	103,300	97,700	105,980	114,278	101,525	102,018	93,345	82,320
Volume index	111.8	97.1	101.7	96.2	104.4	112.6	100.0	100.5	91.9	81.1
Molasses (long tons)	39,877	32,300	32,278	31,980	35,100	36,600	32,600	28,099	28,099	24,296
Volume index	122.3	99.1	99.0	98.1	107.7	112.3	100.0	86.2	86.2	74.5
Flour ('000 lbs.)	15,154	15,821	14,554	9,100	10,900	10,992	2,528	0	6,000	18,000
Volume index	599.4	625.8	575.7	360.0	431.2	434.8	100.0	0.0	237.3	712.0
Fertilizer (short tons)	3,274	3,210	3,002	4,295	3,600	3,080	4,641	3,670	4,000	7,896
Volume index	70.5	69.2	64.7	92.5	77.6	66.4	100.0	79.1	86.2	170.1
Cigarettes (millions)	68.8	62.8	63.4	68.3	56.6	57.4	64.6	74.0	76.0	98.8
Volume index	106.5	97.2	98.1	105.7	87.6	88.9	100.0	114.6	117.6	152.9
Beer ('000 gallons)	642	731	689	689	818	850	630	600	544	568
Volume index	101.9	116.0	109.4	109.4	129.8	134.9	100.0	95.2	86.3	90.2
Batteries (number)	3,156	3,431	4,107	4,500	4,836	5,000	5,555	5,800	6,000	6,600
Volume index	56.8	61.8	73.8	81.0	87.1	90.0	100.0	104.4	108.0	118.8
Nails ('000 lbs.)	321	345	301	308	300	300	245	204	179	95.9
Volume index	131.0	140.8	122.9	125.7	122.4	122.4	100.0	83.3	73.1	39.1
Roofing ('000 lbs.)	752	758	579	592	595	600	284	212	200	211.5
Volume index	244.8	246.9	203.9	208.5	209.5	211.3	100.0	74.6	70.4	74.5
Sarments ('000 units)	1,238	1,400	1,400	1,200	577	781	1,966	2,734	2,800	2,556
Volume index	63.0	71.2	81.4	61.0	29.3	39.7	100.0	139.1	142.4	130.0
Fish Products ('000 lbs.)	1,324	1,189	1,075	1,468	1,468	1,859	1,782	1,608	1,370	1,590
Volume index	74.3	66.7	60.3	82.4	82.4	104.3	100.0	90.2	76.9	89.2
Citrus concentrate (('000 gals.)	646	634	987	1,580	1,379	871	1,066	1,251	1,588	1,919
Volume index	60.6	59.5	92.6	148.2	129.4	81.7	100.0	117.4	149.0	180.0

Sources: Central Statistical Office, Ministry of Economic Development.

Appendix 3C: Belize - Merchandise Exports by Major Commodities
1979-87.

	1979	1980	1981	1982	1983	1984	1985	1986	Prelim. 1987
(In millions of US dollars)									
Total Exports	91.0	110.8	119.0	91.0	77.6	93.1	90.0	71.9	102.0
Re-exports	30.2	28.8	44.3	31.2	12.6	20.3	25.6	18.2	15.9
Total domestic exports	60.8	82.0	74.7	59.8	65.0	72.8	64.4	74.5	86.1
Sugar	31.4	47.7	42.6	32.8	34.2	32.5	22.9	31.5	31.3
Citrus products	4.5	6.4	6.5	7.0	6.8	9.8	12.1	11.1	15.5
Fish products	4.4	4.1	7.2	6.3	7.0	6.7	7.5	7.4	8.0
Bananas	3.4	3.5	2.2	2.1	2.4	3.1	3.3	4.6	7.2
Molasses	2.0	2.2	1.2	0.9	0.9	1.1	0.9	0.5	0.6
Lumber	1.6	1.0	1.2	1.8	1.3	1.1	0.6	0.7	2.1
Other	13.5	17.1	13.8	8.9	12.4	18.5	17.1	18.7	21.4
of which: garments	(10.8)	(14.4)	(11.1)	(6.4)	(8.2)	(15.6)	(15.7)	(16.2)	(15.6)
(In percent of total)									
Total Exports	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Re-exports	33.2	26.0	37.2	34.3	16.2	21.8	28.4	19.6	15.6
Domestic Exports	66.8	74.0	62.8	65.7	83.8	78.2	71.6	80.4	84.4
Total domestic exports	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sugar	51.6	58.2	57.0	54.8	52.6	44.6	35.6	42.3	36.4
Citrus products	7.4	7.8	8.7	11.7	10.5	13.5	18.8	14.9	18.0
Fish products	7.2	5.0	9.6	10.5	10.8	9.2	11.6	9.9	9.3
Bananas	5.6	4.3	2.9	3.5	3.7	4.3	5.1	6.2	8.4
Molasses	3.3	2.7	1.6	1.5	1.4	1.5	1.4	0.7	0.7
Lumber	2.6	1.2	1.6	3.0	2.0	1.5	0.9	0.9	2.4
Other	22.2	20.9	18.5	14.9	19.1	25.4	26.6	25.1	24.8
of which: garments	(17.8)	(17.6)	(14.9)	(10.7)	(12.6)	(21.4)	(24.4)	(21.7)	(18.1)

Sources: Central Statistical office, Ministry of Economic Development.

Appendix 3D: Belize - Merchandise Imports by SITC Classification
1979-87.

	1979	1980	1981	1982	1983	1984	1985	1986	Prelim 1987
	(In millions of US dollars)								
Total Imports	131.8	149.2	161.8	137.2	117.6	131.8	131.1	126.5	147.5
Adjustment a/	-	-	-	9.2	5.8	1.5	3.0	4.5	4.5
Recorded imports	131.8	149.2	161.8	128.0	111.8	130.3	128.1	122.0	143.0
Food	32.3	32.8	39.9	29.4	23.4	28.0	30.5	29.1	31.6
Beverages & tobacco	3.3	3.2	3.6	2.9	2.5	3.2	3.5	3.8	4.1
Crude Materials	1.0	1.2	2.3	1.6	0.4	0.5	0.6	0.3	0.5
Fuels	16.6	27.2	25.7	22.8	26.3	21.7	21.9	17.0	18.8
Oils & fats	0.3	0.7	0.5	0.3	0.3	0.5	0.4	0.4	0.5
Chemicals	10.3	9.7	11.4	11.3	8.3	10.8	9.9	10.2	15.7
Manufactured goods	19.4	20.3	19.7	16.5	14.2	16.4	15.9	16.9	20.3
Machinery & transport	28.4	29.0	28.8	24.4	21.7	26.0	22.6	21.9	29.9
Misc. mfd. goods	19.6	24.0	29.1	17.7	14.0	22.4	22.3	21.4	20.7
Miscellaneous	0.6	1.1	0.8	1.1	0.7	0.8	0.5	1.0	0.9
	(Percent of total recorded imports)								
Food	24.5	22.0	24.7	23.0	20.9	21.5	23.8	23.9	22.1
Beverages & tobacco	2.5	2.1	2.2	2.3	2.2	2.5	2.7	3.1	2.9
Crude Materials	0.8	0.8	1.4	1.3	0.4	0.4	0.5	0.2	0.3
Fuels	12.6	18.2	15.9	17.8	23.5	16.7	17.1	13.9	13.2
Oils & fats	0.2	0.5	0.3	0.2	0.3	0.4	0.3	0.3	0.3
Chemicals	7.8	6.5	7.0	8.8	7.4	8.3	7.7	8.4	11.0
Manufactured goods	14.7	13.6	12.2	12.9	12.7	12.6	12.4	13.9	14.2
Machinery & transport	21.5	19.4	17.8	19.1	19.4	20.0	17.6	18.0	20.9
Misc. mfd. goods	14.9	16.1	18.0	13.8	12.5	17.2	17.4	17.5	14.5
Miscellaneous	0.5	0.7	0.5	0.9	0.6	0.6	0.4	0.8	0.6

a/ Adjustment for unrecorded trade from Mexico: IMF estimates.

Sources: Central Statistical Office, Ministry of Economic Development; and
 mission estimates.

Appendix 4: Forest Policy of Belize.

Colonial Secretary's Office,
Belize, 2nd September, 1954.

FOREST POLICY OF BRITISH HONDURAS

The following Forest Policy of the Government of British Honduras as approved by the Governor in Council is published for general information:-

The Forest Policy of the Government of British Honduras is:-

To establish, preserve for all time and develop a Crown Lands Forest Estate consisting of areas of Crown Land in any of the following categories:-

- (a) land unsuitable for permanent agriculture but supporting or capable of supporting forest.
- (b) land capable of producing a greater sustained financial return, if retained or developed as forest than if used for other purposes.
- (c) land which is best kept or put under forest for the better protection of watersheds, catchment areas, drainage basins, steep hill slopes and for the prevention of erosion, the control of run-off, the regulation of stream-flow and the stabilisation of the climate.
- (d) areas which are required for the production of fuelwood for use in the towns and villages or by local industries, or for the production of rough building and fencing materials for local use.
- (e) areas which from time to time may be set aside as nature reserves.

2. In order to establish the Forest Estate, to survey, demarcate, and constitute as Forest Reserves by proclamation, all Crown Land areas described in paragraph 1 above. Forest Reserves once constituted will only be dereserved wholly or in part by the Governor in Council as a result of some over-riding public necessity.

3. In order to preserve the Forest Estate, to maintain demarcated boundaries by clearing of traces and maintenance of boundary marks as may be necessary to afford protection to the forests from fire, animals, insect pests or diseases, trespass and illicit felling, removal of or damage to forest produce, by such measures including legislation as the Government may deem advisable and practicable; and to place all exploitable Forest Reserves under sustained yield management by enumeration surveys,

and calculation of increment or other practicable methods of yield control; by control of exploitation, and by natural or artificial regeneration and tending operations, so that their yield of timber and other forest produce will be maintained in perpetuity.

4. In order to develop the Forest Estate and thus ensure an adequate and increasing supply of timber and other forest produce at a reasonable price to the people, industries and timber trade of British Honduras, and for export; to establish intensive regeneration centres in selected forest reserves. At these regeneration centres, the aim will be to create fully stocked forests or plantations of mahogany, cedar, pine or other species including exotics by artificial or intensively-assisted natural regeneration over areas adequate to supply in perpetuity a sawmill or processing plant of economic size at or near each centre.
5. To increase production from Forest Reserves by ensuring full utilization of prime hardwoods and pine, and encouraging the use of secondary hardwoods and other forest produce; by developing local and export markets for small dimension stock of prime hardwoods and pine; for secondary hardwoods and other forest produce; by exploring the possibilities of other forms of Forest utilisation, for example for paper pulp.
6. To raise the quality of sawn lumber exported to world markets by the institution of Timber grading, the encouragement of seasoning and of accurate sawing and machining to specification, in order to achieve assured markets for British Honduras timber abroad.
7. To promote the practice of forestry on freehold lands, by the control of felling of mahogany, cedar and such other species as the Government may deem advisable, by the inspection and marking for felling of trees of these species to specified minimum girth limits; encouraging and assisting landowners to draw up and implement simple working plans for the sustained yield management on approved lines of their forest land in the categories described in 1(a), (b), (c) and (d) above; and by encouraging and assisting afforestation on private lands.
8. To control the exploitation of forests and forest produce growing outside Forest Reserves on Crown Land not yet taken up for agriculture by the issue of Forest produce licences framed in such a way that these forests, which are a wasting asset on land allocated to agriculture, will continue to augment the yield from Forest Reserves for as long a time as possible during the period when Forest Reserves are being brought up to full production.
9. To bring about an increased appreciation of the need for and aims of forest conservation amongst the general public by propaganda over the British Honduras Broadcasting Station, and to the schools.

10. To maintain a Forest Department of sufficient strength and supplied with sufficient funds to carry out the Forest Policy set forth in 1 to 9 above; supported by an adequate research programme; and to staff the Forest Department with personnel recruited locally so far as possible and trained at established University Schools of Forestry, or at Forester training schools, or locally, as may be appropriate to the different grades.

Dated this 28th day of October, 1958.

P.M. RENISON,
Governor.

By Command,
T.D. VICKERS
Colonial Secretary.

M.P. 759/53

NOTES ON LOG OUTPUT DATA

Methodology which was used for Calculation and Presentation of
Output in Annual Reports of Forest Department

- 1928-1961: Log Volume does not include logs domestically sawn;
Volume is expressed as bd. ft. Doyle Scribner volume/12, and is
thus not true volume, but rather an estimate of sawn outturn;
this is converted to an estimate of true volume by dividing by
0.45.
Sawn volume is bd. ft. /12 and is converted to log equivalent by
dividing by 0.55.
- 1962-1971: Total volume shown only as coniferous and non-coniferous;
exports show some detail;
Logs are (unlike earlier approach) removals for both export and
processing;
Sawnwood production is shown separately.
For 1962-1964 additional industrial wood was shown for pine
stumps harvested for pitch.
Conversion is made by multiplying by 1.82 (i.e. dividing by 0.55)
- 1972-1987: Data is shown as true volume; conversion factor is not stated.

However, there seems to have been considerable inconsistency between
various tables which appeared in published reports of the period 1962-1971.
This inconsistency appears to be related to whether production was reported in
volume of sawnwood output or in roundwood intake of sawmills. Indeed, at about
this time the method of measuring volumes for royalty purposes was changed from
sawnwood output to log intake. In some series, volumes are roughly two times
those in other series representing identical production. In the tables
presented in this note, some freedom has, therefore, been taken in interpreting
data for this period. In the interpretation, use has also been made of series
on royalties as well as FAO Yearbook production and trade series.

VALUE ADDED IN FORESTRY SECTOR

	Units	1980	1981	1982	1983	1984	1985	1986	1987
<u>Forestry Production</u>									
Total	'000 cu. ft.	1553	1357	1459	1161	1359	1436	1124	2173
Mahogany & Cedar	'000 cu. ft.	540	502	524	360	323	331	225	598
Other	'000 cu. ft.	1013	855	975	801	1036	1105	899	1575
Total	'000 bd. ft.	9318	8142	8554	7086	8658	9159	7252	13907
Mahogany & Cedar	'000 bd. ft.	3249	3012	3144	2280	2067	2118	1440	3827
Other	'000 bd. ft.	6078	5130	5859	4806	6630	7072	5812	10080
Total	bd. ft./cu. ft.	6	6	6	6	6.40	6.40	6.40	6.40
Mahogany & Cedar	bd. ft./cu. ft.	6	6	6	6	6.40	6.40	6.40	6.40
Other	bd. ft./cu. ft.	6	6	6	6	6.40	6.40	6.40	6.40
<u>Exports</u>									
Total	'000 bd. ft.	2241	1704	2837	1895	1205	893	1652	4244
Mahogany & Cedar	'000 bd. ft.	1542	1446	2064	1370	1044	345	277	2258
Other	'000 bd. ft.	699	258	772	525	161	548	1375	1986
<u>Local Consumption</u>									
Total	'000 bd. ft.	7077	6438	6157	5191	7493	6367	5600	9543
Mahogany & Cedar	'000 bd. ft.	1698	1564	1689	910	1023	1473	1163	1439
Other	'000 bd. ft.	5379	4872	5077	4281	6470	4894	4437	8104
<u>Local Price</u>									
Mahogany & Cedar	BZ\$ per bd. ft.	1.000	1.000	1.000	1.000	1.000	1.000	1.200	1.200
Other	BZ\$ per bd. ft.	.823	.823	.823	.823	.823	.823	.940	.940
<u>Value of Production</u>									
<u>Exports:</u>									
Total	'000 BZ\$	3703	2808	3773	2641	2131	1198	1469	4892
Mahogany & Cedar	'000 BZ\$	2096	2306	3267	2294	1828	795	254	3658
Other	'000 BZ\$	1605	502	506	547	303	403	1115	1234
<u>Local Consumption:</u>									
Total	'000 BZ\$	6125	5576	5258	4433	6347	7163	5566	9345
Mahogany & Cedar	'000 BZ\$	1698	1564	1689	910	1023	1473	1396	1727
Other	'000 BZ\$	4427	4010	4178	3523	5324	5690	4170	7618
<u>Export Price</u>									
Mahogany & Cedar	BZ\$ per bd. ft.	1.361	1.595	1.583	1.674	1.751	1.233	1.276	1.532
Other	BZ\$ per bd. ft.	2.296	1.946	.855	1.042	1.882	2.551	.807	.624
<u>Value of Forest Products</u>									
Wood & Timber Exports	'000 BZ\$	3703	2808	3773	2641	2131	1198	1469	4892
Locally Used Timber	'000 BZ\$	6125	5576	5258	4433	6347	7163	5566	9345
Chicle Exports	'000 BZ\$	456	0	262	741	847	169	0	0
Total Gross Output	'000 BZ\$	10284	8384	9293	8015	9325	8530	7035	14237
Gross Value Added (80% of G.O.)	'000 BZ\$	8227	6707	7435	6412	7460	6824	5628	11389
Net Value Added (98% of G.V.A.)	'000 BZ\$	8063	6573	7286	6284	7211	6682	5515	11122

VALUE ADDED IN FORESTRY SECTOR

	Units	1980	1981	1982	1983	1984	1985	1986	1987
<u>Value in Constant 1984 Prices</u>	'000 BZ\$								
Chicle Exports	'000 lbs.	129	0	69	195	246	41	0	
Unit Prices									
) Chicle Exports	BZ\$ per lb.	3.535		3.797	3.600	3.443	4.122		
M & C Exports	BZ\$ per bd. ft.	1.361	1.595	1.583	1.674	1.751	1.233	1.278	1.532
Other Exports	BZ\$ per bd. ft.	2.296	1.946	.655	1.042	1.862	2.551	.807	.624
) Local M & C	BZ\$ per bd. ft.	1.000	1.000	1.000	1.000	1.000	1.000	1.200	1.200
Local Other	BZ\$ per bd. ft.	.823	.823	.823	.823	.823	.823	.940	.940
) Constant G.D. = SUM (Po+Qt)	'000 BZ\$	10585	8593	10565	8492	9326	8732	7620	16724
Constant G.V.A. (60% of G.D.)	'000 BZ\$	8468	6274	8452	6794	7461	6986	6096	13379
) Constant N.V.A. (98% of G.V.A.)	'000 BZ\$	8299	6737	8283	6658	7312	6846	5974	13111
) GDP (current prices)(factor cost)	Million BZ\$	308.1	313.5	302.6	308.6	335.8	337.0	361.2	
Net Value Added (75% of G.V.A.)	'000 BZ\$	8063	6573	7266	6284	7311	6688	5515	11162
) % of GDP in Forestry		2.62	2.10	2.41	2.04	2.18	1.93	1.53	
) GDP (constant 1984 prices)									
(factor cost)	Million 1984 BZ\$	315.2	323.1	329.3	322.6	335.8	344.1	347.9	360
Constant N.V.A. (98% of G.V.A.)		8299	6737	8283	6658	7312	6846	5974	13111
) % of GDP in Forestry		2.63	2.09	2.52	2.06	2.18	1.99	1.72	3.45

Source: Department of Statistics, Belize; 1987 estimated by Mission.

FOREST BASED PRODUCTS EXPORTED FROM U.S.A. 1976-1987

SITC	Description	DATA	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
231.1	Chicle Gum	Quantity 000 lb. Value 0001B Unit Value \$B/lb. Major Markets	237 303 1.20 UK	400.70 562 1.40 UK	493.17 1567.70 3.10 USA	204.74 1063 5.19 USA	128.60 456 3.54 USA	0 0 0 USA	69.14 262 3.77 USA	195 741 3.80 USA	246.36 847 3.44 Japan	40.56 169 4.17 Japan		
231.12	Other natural Rubber	Quantity 000 lb. Value 0001B Unit Value \$B/lb. Major Markets										.02		22.55
														20
														.8%
														Mexico
231 TOTAL	CRUDE RUBBER	Quantity 000 lb. Value 0001B	237 303	400.70 562	493.17 1567.70	204.74 1063	128.60 456	0 0	69.14 262	195 741	246.36 847	40.56 169		
241.1	Fuelwood in logs or billets	Quantity cwt Value 0001B Unit Value \$B/cwt Major Markets		350 5 14.29 Panama		2500 57 22.80 USA		.04			95			
242.21	Sawlogs and Venner Logs C	Quantity 000 cu.ft. Value 0001B Unit Value \$B/cu.ft. Major Markets		.02 .16 7.62 USA				.24 5.60 23.33 USA			1.75 4 2.29 USA		1.69 10 10.65 Japan	2.76 35 12.70 Guatemala
242.31	Sawlogs and Venner Logs NC	Quantity 000 cu.ft. Value 0001B Unit Value \$B/cu.ft. Major Markets	40.51 97.17 2.40 USA	42 30.26 .72 USA	19.26 206.99 10.74 Japan	27.24 713 26.18 Japan	30.68 1061 27.43 Many	.24 179.28 734.77 Japan	29.14 5 17 USA	4.3 53 12.33 W.Ger	9.75 140 14.36 W.Ger,USA	6.33 178 28.13 USA,Korea		
242.9	Other Wood in the rough	Quantity 000 cu.ft. Value 0001B Unit Value \$B/cu.ft. Major Markets	9 73.60 8.18 W.Germany	10.85 46.90 4.32 USA	21.50 91.91 4.28 USA	69.92 867 12.40 USA,Japan	10.12 303 29.94 Japan	28.92 209.61 7.25 Japan	2.02 41 20.32 Japan	18.3 82 4.48 USA	.16 6 38.22 USA	2.03 23 11.31 USA	201.42 960 4.77 USA	260.70 588 2.26 USA
242 TOTAL	Wood in the Rough	Quantity 000 cu.ft. Value 0001B	49.51 170.77	53.01 84.78	40.76 298.90	97.16 1580	48.80 1364	29.41 394.49	31.16 46	22.60 135	9.91 146	12.36 203.29	219.42 970.65	265.84 665
243.1	Railway or Traway Sleepers	Quantity 000 bd.ft. Value 0001B Unit Value \$B/M bd.ft. Major Markets	5.50 1.30 235.63 USA			67.50 36 533 Jamaica		42.61 31.49 739 Mexico	48.40 30 620 Mexico					
243.21	Wood Sawn Lengthwise C > 5mm	Quantity 000 bd.ft. Value 0001B Unit Value \$B/M bd.ft. Major Markets	27.76 16.75 603 USA		.10 .01 110 USA				13.58 8 509 Mexico	20 24 1200 USA	11.22 10 891 Martinique			
243.22	Wood including blocks, strips, C	Quantity 000 bd.ft. Value 0001B							8.82		.03			

		Unit Value \$/M bd.ft.						USA		USA				
Major Markets														
243.311	Caribbean Cedar, NC>Saw	Quantity 000 bd.ft.	148.50	16.34	19.00	20.74	190.35	.60	.45		.92	5.14	1.09	75.24
		Value 000\$B	166.79	16.16	17.92	21	233	.90	1		2	6	2	111
	Rough Cedar	Unit Value \$/M bd.ft.	1123	909	943	1012	1224	1500	2222		2103	1160	1050	1475
	Major Markets		Canada	Jamaica	Mexico	Mexico	Mexico	Honduras		Japan,USA	Mexico	Mexico	USA	Jamaica
243.313	Mahogany, Sawn lngth, >Saw	Quantity 000 bd.ft.	036.10	300.66	640.40	307.14	453.41	137.66	277.69	120.1	74.76	452.01	246.22	1952.33
		Value 000\$B	808.38	367.59	510.30	322	508	170.19	317	181	88	504	312	2955
	Rough Mahogany	Unit Value \$/M bd.ft.	967	966	707	032	1120	1236	1142	1507	1177	1115	1267	1514
	Major Markets		Jamaica,UK	Jamaica,USA	Mexico	Mexico	Mexico	Mexico	Barb, USA	USA,Japan	Mexico,USA	Mexico,USA	USA	USA
243.319	Other Wood NC	Quantity 000 bd.ft.	71.60		15.35	419.20	359.75	35.54	514.53	369.6	46.75	05.48	79.74	254.33
		Value 000\$B	54.10		10.12	413	236	74.06	419	300	95	187	131	440
	Rough Other	Unit Value \$/M bd.ft.	756		659	985	656	2084	014	1050	2032	2188	1643	1717
	Major Markets		Jamaica,USA		Mexico	USA	USA	USA	USA	USA	USA,Japan		Mexico,USA	USA
243.321	Caribbean Cedar, NC planed, litg	Quantity 000 bd.ft.	143.84	133.56	6.07	91.44	16		195.03	4.1	111.98	62.08		1.05
		Value 000\$B	168.20	198.60	100.56	121	16		334	7	201	98		2
	Dressed Cedar	Unit Value \$/M bd.ft.	1169	1487	16561	1323	1000		1706	1691	1795	1579		1898
	Major Markets		Jamaica	Jamaica	Jamaica	Mexico	Guatemala		Jamaica	USA	Jamaica	Jamaica		USA
243.323	Mahogany, NC, planed, litg	Quantity 000 bd.ft.	1725.70	1018.29	998.44	1076.20	801.02	1306.65	1509.60	1246.32	055.89	125.43	29.30	360.15
		Value 000\$B	1853.39	1209	1138.22	2479	1341	2133.95	2615	2106	1537	187	40	590
	Dressed Mahogany	Unit Value \$/M bd.ft.	1074	1187	1140	1321	1521	1633	1745	1690	1796	1491	1362	1638
	Major Markets		Jamaica	Jamaica	Jamaica	Guatemala	Guatemala	Jamaica	Jamaica	Jamaica,USA	Jamaica,USA	Jamaica	Antigua, Cuba	USA
243.329	Other Woods, planed, litg	Quantity 000 bd.ft.	270.82	21.83	13.11	4.61	1.20	3.75	.70		40.23	7.61	1.57	42.38
		Value 000\$B	92.21	8.14	15.06	4	1	1.97	1		52	11	6	116
	Dressed Other	Unit Value \$/M bd.ft.	340	373	1148	867	833	525	1429		1293	1446	3022	2737
	Major Markets		Canada	USA	USA	El Salvador		Mexico		USA	USA	USA		USA
243 TOTAL SAWWOOD		Quantity 000 bd.ft.	3196.56	1570.69	1700.46	2866.91	1902.53	1526.01	2649.59	1760.20	1100.62	805.00	350.00	2700.00
		Value 000\$B	3143.07	1799.49	1792.18	3396	2335	2412.55	3727	2706	2011	1056	491	4227
		B247'000 bd. ft.	983	1146	1054	1185	1227	1580	1407	1537	1703	1312	1368	1566
292.11	Logwood used primarily in dying	Quantity 000 lb.						45.64	392.09	112.03				155.11
		Value 000\$B						6.21	69	19				42
		Unit Value \$/lb.						.14	.18	.17				.27
	Major Markets							USA	USA	Japan				
292.21	Gua Resins	Quantity 000 lb.	.10	630.20		620.93	39.39	240.03	190.26	86.86	41.36			
		Value 000\$B	.02	126.04		118	44	229.97	96	35	B			
		Unit Value \$/lb.	.15	.20		.19	1.12	.96	.50	.40	.19			
	Major Markets		Ship stores				USA	USA	USA	USA				
292 TOTAL MISCELLANEOUS		Quantity 000 lb.	.10	630.20	0	620.93	39.39	285.66	502.35	198.88	41.36			155.11
		Value 000\$B	.02	126.04	0	118	44	236.18	165	54	B			42
631.21	Plywood, Blockboard, etc	Quantity 000 cu.ft.						7.16	1.22					
		Value 000\$B						104.05	19					

SITC	Description	DATA	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
			Unit Value \$B/cu.ft.						14.53	15.64				
		Major Markets					Mexico Mexico							
631.81	Wood Paving Blocks	Quantity 000 lb. Value 000\$B Unit Value \$B/lb. Major Markets										USA	70 11 .16	
631.82	Riven Staves of Wood	Quantity 000 lb. Value 000\$B Unit Value \$B/lb. Major Markets								.15				06.63 14 .16
631.83	Hoopwood, etc.	Quantity 000 lb. Value 000\$B Unit Value \$B/lb. Major Markets			.05									
631.84	Wooden Slicks	Quantity 000 lb. Value 000\$B Unit Value \$B/lb. Major Markets			.15									
631.87	Wooden Beading & Moulding	Quantity 000 lb. Value 000\$B Unit Value \$B/lb. Major Markets								45				9 11.35 23 56 2.56 4.94
632.41	Prefabricated Buildings & parts	Quantity cwt Value 000\$B Unit Value \$B/cwt. Major Markets												250 75 300
632.49	Other Builder's Carpentry & Joinery	Quantity cwt Value 000\$B Unit Value \$B/cwt. Major Markets	3 1.22 408	281 10.19 36		153 2 13.07	3 1 333.33	3 .60 200	85 8 94.12				55 6 109.09	76 17 223.68
632.71	Wooden Picture & Photograph Frames	Quantity lb Value 000\$B Unit Value \$B/lb Major Markets												110 3 27.27
632.72	Household Utensils of Wood	Quantity lb Value 000\$B Unit Value \$B/lb Major Markets	100 .21 2.10			1180 1 .85								436 1 2.29
632.73	Standard Lamps, Table Lamps of Wood	Quantity lb Value 000\$B Unit Value \$B/lb Major Markets	500 3.54 7.07	200 2 10	1427 10.46 7.33	798 4 5.01	761 7 9.20		290 4 13.79	524 2 3.82	1400 19 13.57	1097 3 2.73	6587 40 8.07	3471 38 10.95
632.811	Tool, Tool Bodies & Handles of Wood	Quantity lb Value 000\$B Unit Value \$B/lb								98 2.85 1		5		200

Quantity	Value 000\$B	Unit Value \$B/lb	Major Markets												
632.099	Other Articles of Wood	Quantity lb Value 000\$B Unit Value \$B/lb Major Markets	1200 2.54 2.11	300 2 6.67	455 1.64 3.60	7759 3 .39	595 10 16.01	15473 24.15 1.56	405 2 4.94	33709 10 .53	5868 26 4.43	6407 15 2.34	182 1 5.49	3615 10 2.77	Jamaica
63	TOTAL Manufactures of Wood WOOD MANUFACTURE	Value 000\$B	7.51	14.19	12.25	10	18	24.75	30	21	45	25	194	197	
642.22	Envelopes	Quantity lb Value 000\$B Unit Value \$B/lb Major Markets									501 14 27.94	USA			
642.31	Exercise Books	Quantity lb Value 000\$B Unit Value \$B/lb Major Markets											2495 8 3.21	Jamaica	
642.39	Other registers, notebooks etc	Quantity lb Value 000\$B Unit Value \$B/lb Major Markets	20100 24.59 1.22		24261 28.52 1.18										
642.932	Toilet Paper	Quantity 000 lb. Value 000\$B Unit Value \$B/lb. Major Markets							224.33 418 1.86	240.47 471 1.96	235.38 550 2.34	60	2.50 8 3.21	Jamaica	
642.999	Other Articles of Paper Pulp	Quantity 000 lb. Value 000\$B Unit Value \$B/lb. Major Markets							40.28 111 2.76	35.72 87 2.44	.11 2 17.86	60	15 36 2.40	Jamaica	
642	TOTAL Manufactures of Paper PAPER MANUFACTURES	Quantity 000 lb. Value 000\$B	20100 24.59		24261 28.52	0 0	0 0	0 0	304.88 640	311.90 645	736.60 548	180	2527.50 00		
821.011	Chairs & Other Seats of Wood	Quantity cwt Value 000\$B Unit Value \$B/cwt Major Markets	12 .22 18.33	3 1.80 600	3 .49 162.67	5685 34	as read USA	as read USA	209 27 129.19	215 31 144.19	103 25 242.72	75 21 280	70 17 242.66	177 55 310.73	
821.091	Other Furniture & Parts of Wood	Quantity cwt Value 000\$B Unit Value \$B/cwt Major Markets	8 2.39 299	15 3.40 226.67	16 3.69 230.69	67 13 194.03	3096 6 1.94	5053 31.97 6.33	843 58 68.80	12 3 250	41 15 365.85	63 13 206.35	71 11 154.93	21 10 476.19	USA

SITC Description	DATA	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
B21 TOTAL Furniture & Furniture Parts	Quantity cwt	20108	15	19	5752	3097	13157	1147.00	227	777.60	243	2598.50	21
WOODEN FURNITURE	Value 0001B	2.61	5.20	4.18	47	18	40.83	05	34	40	34	28	15
EXPORT VALUE FOREST BASED PRODUCTS	Value 0001B	3651.57	2591.70	3675.22	6214	4235	3100.00	4963	4201	3665	1487	1772	5154
GUINS	Value 0001B	303	562	1568	1063	456	0	267	741	847	169		
LOGS/ROUGH WOOD	Value 0001B	171	85	299	1580	1364	394	46	135	146	203	971	665
SAWNWOOD	Value 0001B	3143	1799	1792	3396	2335	2413	3727	2706	2011	1056	491	4227
MISCELLANEOUS	Value 0001B	0	126	0	118	44	236	165	54	8	0	0	42
WOOD MANUFACTURES	Value 0001B	8	14	12	10	18	25	30	21	45	25	194	197
PAPER MANUFACTURES	Value 0001D	25	0	29	0	0	0	640	645	568	0	88	0
WOODEN FURNITURE	Value 0001B	3	5	4	47	18	41	05	34	40	34	20	65
GUINS/LOGWOOD	Value 0001B	303	608	1568	1181	500	236	427	795	855	169	0	42
LOGS/ROUGH WOOD	Value 0001B	171	85	299	1580	1364	394	46	135	146	203	971	665
SAWNWOOD	Value 0001B	3143	1799	1792	3396	2335	2413	3727	2706	2011	1056	491	4227
MANUFACTURES & FURNITURE OF WOOD	Value 0001B	10	19	16	57	36	66	123	55	85	59	222	262
MANUFACTURES OF PAPER	Value 0001B	25	0	29	0	0	0	640	645	568	0	88	0
FORESTRY	Value 0001B	3617	2572	3659	6157	4199	3043	4260	3636	3012	1428	1462	4934
FOREST BASED MANUFACTURES	Value 0001B	35	19	45	57	36	66	763	700	653	59	310	262
TOTAL FOREST BASED	Value 0001B	3652	2592	3704	6214	4235	3109	4963	4336	3665	1487	1772	5196
ESTIMATED EXPORT TAX	0001B	181	129	183	300	210	152	210	182	131	71	73	247

FOREST BASED PRODUCT IMPORTS OF BELIZE 1981-1987

SITC	Description	DATA	1981	1982	1983	1984	1985	1986	1987
241.1	Fuelwood in logs or billets	Quantity cwt	2158	1	5	1	2	1	2
		Value 000\$B	5.01					3	
		Unit Value \$B/cwt	2.32					3000	
		Major Sources	France			USA	USA	USA	USA
241.2	Wood Charcoal	Quantity cwt	28.69	24.70	5426	68	112	645	73
		Value 000\$B	10.40	18	7	5	5	1	1
		Unit Value \$B/cwt	362.62				44.64	1.55	13.70
		Major Sources	USA	USA	USA	USA	USA	USA	USA
241 TOTAL	Fuelwood and Charcoal	Value 000\$B	15.41	18	7	5	5	4	1
242.21	Sawlogs and Veneer Logs Coniferous	Quantity 000 cu.ft.		32.42					
		Value 000\$B		26					
		Unit Value \$B/cu.ft.							
		Major Sources		USA					
242.31	Sawlogs and Veneer Logs Non-Coniferous	Quantity 000 cu.ft.			12.85		.05		
		Value 000\$B			31		3		
		Unit Value \$B/cu.ft.					60		
		Major Sources			Mexico				
242.9	Other Wood in the rough	Quantity 000 cu.ft.			.04	1.65			
		Value 000\$B			2	17			
		Unit Value \$B/cu.ft.							
		Major Sources			USA	Mexico			
242 TOTAL	Wood in the Rough	Quantity 000 cu.ft.	0	32.42	12.89	1.65	3	0	0
		Value 000\$B	0	26	33	17	6	0	0
243.21	Wood Sawn Lengthwise Coniferous > 5m	Quantity 000 bd.ft.		32.42			.06	12.19	18.79
		Value 000\$B		26				16	17
		Unit Value \$B/M bd.ft.						1313.09	904.83
		Major Sources		USA				USA	USA
243.22	Wood including blocks, strips, Coniferous	Quantity 000 bd.ft.	350.31	183.89	26.61	103.15	6.50	1.33	5.72
		Value 000\$B	255.73	151		32	7	5	5
		Unit Value \$B/M bd.ft.	730.03				1076.92	3770.74	874.13
		Major Sources	Honduras	USA	USA	Hond/USA	USA	USA	USA
243.311	Caribbean Cedar Sawn Lengthwise > 5m	Quantity 000 bd.ft.	340.89				75.87		
		Value 000\$B	680.63				25		
		Unit Value \$B/M bd.ft.	1996.61				329.50		
		Major Sources	Guatemala				Guatemala		
243.313	Mahogany Sawn Lengthwise > 5m	Quantity 000 bd.ft.	1366.40	552.93			343.29		
		Value 000\$B	2749.14	814			110		
		Unit Value \$B/M bd.ft.	2011.96				320.43		
		Major Sources	Guatemala	Guat			Guatemala		

SITC	Description	DATA	1981	1982	1983	1984	1985	1986	1987
243.319	Other Wood Non-Coniferous	Quantity 000 bd.ft. Value 000\$B Unit Value \$B/M bd.ft. Major Sources	70.80 82.08 876.74 USA	32.83 24 USA		1.23 4	2 3 1500	3.20 1 312.99	
243.321	Caribbean Cedar, planed tongued & grooved	Quantity 000 bd.ft. Value 000\$B Unit Value \$B/M bd.ft. Major Sources		10.01 3 Guat					
243.323	Mahogany, planed, tongued & grooved	Quantity 000 bd.ft. Value 000\$B Unit Value \$B/M bd.ft. Major Sources	4.35 .55 127.13 Guatemala	60.62 52 Guatemala				10 10 1000 Guatemala	
243.329	Other Woods, planed tongued & grooved	Quantity 000 bd.ft. Value 000\$B Unit Value \$B/M bd.ft. Major Sources	361.13 317.58 879.42 USA	443.70 559 Guat	4 7 USA	.15	34.27 31 904.53	.90 2 2222.22	3.38 3 887.57 USA
243	TOTAL Sawwood	Quantity 000 bd.ft. Value 000\$B	2493.88 4065.71	1316.39 1629	30.61 7	104.53 36	461.99 176	17.61 24	27.89 25
244.02	Natural Cork (blocks, plates, sheets)	Quantity lb Value 000 \$B Unit Value \$B/lb. Major Sources	25 .45 17.96	21 1	5	332 1 UK	3	75 1 13.33 USA	73 UK
631.21	Plywood, Blockboard, etc	Quantity 000 cu.ft. Value 000\$B Unit Value \$B/cu.ft. Major Sources	453.79 400.22 872.34 Spain	166.96 386 2311.96 USASpain	503.39 385 USA	49.56 475 USACHina	122.44 455 3.72 USA, Korea	34.12 377 11.05 USA	1.88 25 13.31 USA
631.219	Other Laminated Wood Products	Quantity 000 cu.ft. Value 000\$B Unit Value \$B/cu.ft. Major Sources					0 421 10.06 USA	41.87 902 .68 Brazil, U	1171.90
631.42	Reconstituted Wood	Quantity lb. Value 000\$B Unit Values Major Sources	9.16 4.26 465.39 USA	165.02 97 Sweden	90.30 36 GuaMexico	12.19 8 USAMexico	4.21 5 1.19 USA	2.88 2 .70 USA	9.72 8 .82 USA
631.81	Wood Paving Blocks	Quantity 000 lb. Value 000\$B Unit Value \$B/lb. Major Sources	4.85 6.27 1291.96 USA	172 USA			0	1.32 6 4.55 USA	
631.839	Hoopwood etc	Quantity 000 lb. Value 000\$B Unit Value \$B/lb. Major Sources					.03		1.32 7 5.30 USA
631.55	Match Splints etc	Quantity 000 lb. Value 000\$B Unit Value \$B/lb. Major Sources	4.85 6.27 1291.96 USA			1.54 1 UK	0		.65 3 4.64 UK

SITC	Description	DATA	1981	1982	1983	1984	1985	1986	1987
631.67	Wooden Beading & Moulding	Quantity 000 lb. Value 000\$B Unit Value \$B/lb. Major Sources	3.73 10.27 2755.97 USA	.68 3 USA		.66 1 Mexico	.39 1 Mexico	151 USA	220 2 USA
631 TOTAL	Processed Wood	Value 000\$B	427.28	486	424	485	461	806	847
632.1	Complete Wooden Packing Cases	Quantity 000 lb. Value 000\$B Unit Value \$B/lb. Major Sources	2.77 1.68 606.50 Guatemala	138 23 Mexico		2.47 3 USA	17.83 12 USA	19.92 35 USA	27.82 21 1.32 USA
632.2	Casks, Barrels, Vats, etc	Quantity 000 lb. Value 000\$B Unit Value \$B/lb. Major Sources			.01		8.25 8 .97		
632.41	Prefabricated Buildings & parts	Quantity cwt Value 000\$B Unit Value \$B/cwt. Major Sources	343 95.52 279.65 USA	159 22 USA	221 23 USA	317 36 USA	14 3 4.67 USA	21 7 3 USA	5 5 1 USA
632.49	Other Builder's Carpentry & Joinery	Quantity cwt Value 000\$B Unit Value \$B/cwt. Major Sources	1326 26.12 19.70 USA	3 1 USA	301 38 USA	59 11 USA	8 3 2.67 USA	1214 148 8.20 USA	9 9 1 USA
632.71	Wooden Picture & Photograph Frames	Quantity lb Value 000\$B Unit Value \$B/lb Major Sources	123 .68 5.52 USA	1 Mexico	35 1 Mexico	20	0		
632.72	Household Utensils of Wood	Quantity lb Value 000\$B Unit Value \$B/lb Major Sources	26763 55.51	11060 21	17257 35	29874 53	22666 42	12083 30	15186 34
				China	China	Czech	Czechslo	W.Germany	W.Germany, China
632.73	Standard Lamps, Table Lamps of Wood	Quantity lb Value 000\$B Unit Value \$B/lb Major Sources	66 .64 9.68 Taiwan	292 1 USA	124 2 USA	201 3 USA	645 2 3.10 Barbados	6	355 4 China
632.811	Tool, Tool Bodies & Handles of Wood	Quantity lb Value 000\$B Unit Value \$B/lb Major Sources	3369 2.06	7642 5	12835 3	12419 9	2325 2	179	135 3
				Mexico	Mex	Guat	Mexico		
632.899	Other Articles of Wood	Quantity 000lb Value 000\$B Unit Value \$B/lb Major Sources	21020 22.21	8579 32	10313 23	6644 22	20.29 30		26.17 46
			USA	USA	USA	Mex/WGer	USA		
63 TOTAL	Manufactures of which Cork & Wood	Value 000\$B	654	601	549	646	571	1054	977
631.21	Plywood, Blockboard, etc. & Other Laminated Wood Products	Quantity 000 cu.ft. Value 000\$B Major Sources	458.80 400.22 USA, Hondu	166.76 6.39E+8 USA	503.37 385 USA	49.56 475 USA	122.44 455 USA	75.99 776 USA	1173.76 827 USA
632.4	Builders Carpentry & Joinery	Value 000\$B	122 USA	153 USA	572 USA	376	14 USA	155 USA	14 USA

SITC	Description	DATA	1981	1982	1983	1984	1985	1986	1987
64 TOTAL	Paper, Paperboard & Articles of Paper		5516	n/a	n/a	5482	4947	6035	8111
	of which								
641.1	Newsprint	000 lb. Value 000\$B Major Sources	339.50 253.50	226.70 193	133.88 105	400.23 273	359.26 247	211.70 141	353.16 250
			Canada	Canada	USACanada	USACanadaUSA	USA, CanaUSA		
641.2	Printing & Writing Paper	000 lb. Value 000\$B Major Sources	466.80 506.90	375.25 514	184.36 206	251.34 251	160.30 175	202 261	775.71 412
			USA, Canad	USA, Canad	CanadaUSACanada	MexCanada	Canada	Canada, UCanada	
641.6	Fibre Building Boards	000 lb. Value 000\$B Major Sources	845 491.10	1080.60 652	860.44 445	1220.32 621	716.25 353	1119.40 607	1707.03 586
			Sweden, USS	Sweden, USS	Sweden, USS	SwedenUSAUSA	USA, Swed	Brazil, U	
641.22	Corrugated Paper & Paperboard	000 lb. Value 000\$B Major Sources	853.60 1027.50	447.47 471	911.17 899	1050.24 1018	510.10 452	754.20 646	544.11 620
			USA	USA	USAMexico	USAMexicoMexico	Mexico	Mexico	
642.112	Cardboard Boxes	000 lb. Value 000\$B Major Sources	1292.50 1338.69	2936.69 1864	1189.32 1011	1949.28 1444	2163.04 1533	3373.70 2054	4398.28 3426
			Hond, USA	Honduras	Honduras	Honduras	Honduras	Honduras	Honduras
241 TOTAL	Fuelwood and Charcoal	Value 000\$B	15	18	7	5	5	4	1
242 TOTAL	Wood in the Rough	Value 000\$B	0	26	33	17	6	0	0
243 TOTAL	Sawnwood	Value 000\$B	4066	1629	7	36	176	24	25
630 TOTAL	Manufactures of Cork & Wood	Value 000\$B	654	601	549	646	571	1054	997
640 TOTAL	Paper, Paperboard, Articles	Value 000\$B	5516	n/a	n/a	5482	4947	6035	8111
TOTAL	Wood-Based Imports	Value 000\$B	10251	n/a	n/a	6186	5705	7117	9134
	Estimated Import Taxes @ 25%	000\$B	2563	n/a	n/a	1547	1426	1779	2284

Appendix 6: Census Data on Housing Construction.

year constructed	houses	annual wood	% wood	Wood+Brick	% W+B	Wood+Concrete	% W+C	% part Wood	
1960	305	915	194	60.3	1	.3	5	1.6	1.97
1979	1326	1326	744	56.3	6	.5	26	2.0	2.41
1978	1341	1341	845	63.0	3	.2	31	2.3	2.54
1970-1977	8216	1027	4731	57.6	59	.7	253	3.1	3.60
1961-1969	8200	911	6216	75.8	43	.5	225	2.7	3.27
1960 & earlier	6716		5674	84.5	57	.8	212	3.2	4.01
not dated	1194		704	59.0	9	.8	15	1.3	2.01
total 1960 Census		27298	19100	70.0		.7		2.7	3.4
1970 Census				79.3		.7		2.8	2.8
Apparent Trend									
1960-				64.5					
1965				75.8					
1974				57.6					
1978				63.0					
1979				56.3					
1980				60.3					
Average 1970's				58.1					
1955				64.5					
1965				75.8					
1975				58.1					
1960 Census by Division									
Palize City	8197		6903	84.2					
Palize District	2140		1591	74.3					
Corona! District	3585		1831	47.1					
Orange Walk	3929		2135	54.3					
Stann Creek	2839		2517	88.7					
Toledo	2193		1750	80.2					
Cayo	3470		2370	68.3					
Benapan	655		3	.5					
	27298		19100	70.0					

Appendix 7: Estimated Employment in Forest Sector 1987.

Log Production	2173
Sawn Production	11580
Secondary Output	
Forestry Employment	120
Logging Employment	170
Sawmill Employment	200
Manufacturing Employment	250
Total	740
Days per 1000 Cu.ft /Logs	23
Days per 1000 Bd.Ft./Sawn	5
Labour Force	48100
Share	1.54

Appendix 8: Extracts from the report "An Economic Policy for British Honduras", by J Downie, 1959

(Extract from Chapter III - The Framework of Policy.)

FORESTRY

19. I am keenly aware that my views on the forestry programme conflict with those of others who have examined the economy of British Honduras and also with very deeply ingrained local sentiment. I am compelled to record nevertheless that I have the gravest doubts about the justification for a forestry programme of the present size. I appreciate the strong temptation to invest in something for which it is quite certain that the country is suitable, and how this is reinforced by the knowledge that present difficulties are so acute because of heavy disinvestment in natural forest capital in the past. I accept further that the ultimate return on forestry is very large. But there is a strong 'prima facie' presumption against a poor country investing a big proportion of its capital in a project which yields a return only after so long a period. When a peasant is hungry enough he eats even his seed corn. I do not suggest that British Honduras is in so desperate a position as that. Nevertheless, I do not believe that it can afford to wait anything from 40 to 100 years to get a return on its money. *

20. The Conservator of Forests was good enough to provide me with the information necessary to calculate a very rough rate of return on capital investment in forestry. The results I obtained were 8 percent on the relatively quickly yielding pine plantations and a rather higher rate on bringing pine under protection for natural regeneration. It may be suggested that, since money can be borrowed at 6 percent, the investment is justified. But this is an irrelevant comparison. For it is not possible for British Honduras to borrow unlimited amounts at 6 percent; not indeed at any rate of interest, however high. Since forestry is competing for capital with other urgent needs-many of which can offer a much quicker return-the 6 percent rate at which a limited amount can be borrowed is not relevant; the effective rate of interest which capital should earn is far higher; and by this standard forestry does not pay. This conclusion is all the more true for investment in hardwoods, where the period of the investment is much longer and the true financial return correspondingly lower.

21. I accept the need for a forestry service, to perform scientific and technical functions, manage the Crown estate, provide protection and supervise commercial operations. But I deprecate the investment of large sums of public money in the

* On the present programme, it will be after 1990 before the income earned from forest development begins to exceed the cost of development. Between now and then the programme, if unchecked, will have required about \$9,000,000 of new money.

creation of forest capital. I have seen the Conservator's proposals for the next five years, which involve further substantial increases in the expenditure. In my view, the need is rather to reduce them and I make proposals to this end in Chapter IV. I am not competent to advise on the detailed composition of the restricted programme I suggest. But the figures I have seen suggest that it should be heavily concentrated on bringing under protection for natural regeneration the quicker yielding woods, such as pine and balsa, expenditure on establishing plantations being authorised only if exceptional justification can be produced.

(Extract from Summary of Recommendations.)

6. The scale of the forestry development programme should be drastically reduced.

(Extract from Chapter IV - An Interim Outline Plan.)

12. Forestry: I have already explained why I think that investment in forests should be reduced. The level of spending I have proposed is intended to enable an effective forestry service to be maintained, provide for the preservation of the plantations already created, and permit some continued work on bringing areas under protection for natural regeneration.

Appendix 9: Specimen Job Descriptions.

Post: Chief Forest Officer

Classification: SMI Salary Scale (Senior Management)

Duties: Head of Forest Department and Chief Advisor to the Minister on forestry matters. Preparation of annual forestry budget and advising on its disbursement to forestry divisions. General administration of the Department's affairs which includes silviculture, protection, harvesting, utilization, national parks, wildlife management, technical personnel and timber marketing.

Responsible for:

Reports to: Permanent Secretary

Personnel supervised: All technical and professional forestry personnel.

Special considerations:

Qualifications possessed by present holder of post:

At least a Bachelor's degree in Forestry and ten years' experience in the forestry profession.

Post: Principal Forest Officer

Classification: ASI Salary Scale (Applied Science)

Duties: Deputy Head of Department who performs duties of HOD during his absence. He manages the Belmopan Wood Workshop and supervises forest rangers in charge of the Belize Toledo, Belmopan and Orange Walk Ranges. Assists HOD with answering of correspondence, the issuing of forest permits and short-term licences and collection of statistical data.

Responsible for:

Reports to: Chief Forest Officer

Personnel supervised: Wood workshop supervisors and technical staff in forest ranges.

Special considerations:

Qualifications possessed by present holder of post:

At least a Bachelor's degree in Forestry and five years' experience in the forestry profession.

Post: Forest Officer

Classification: AS 3 Salary Scale (Applied Science)

Duties: Responsible for the administration of Forestry Division, including the preparation of the Division's budget and an Annual Plan of Operations covering all forestry activities in the Division. This officer is responsible for the implementation and monitoring of the projects contained in the Plan after it has been approved by the Head of Department.

Responsible for:

Reports to: The Chief Forest Officer

Personnel supervised: Foresters, Forest Rangers, Forest Guards, Mechanics and Clerical Staff.

Special considerations:

Qualifications possessed by present holder of post:

At least a Bachelor's degree in Forestry with at least one year's practical experience prior to academic training in professional forestry.

Post: Forester

Classification: TSIA Salary Scale (Technical Support Services)

Duties: Senior Executive to a Forest Officer in charge of a Division. Responsible for the direct supervision of Forest Rangers such as reforestation, exploitation control, forest protection, silviculture and forest engineering.

Responsible for:

Reports to: Forest Officer

Personnel supervised: Forest Rangers, Forest Guards and other support staff.

Special considerations:

Qualifications possessed by present holder of post:

A two-year Diploma course completed at a recognized technical forestry school such as the Cyprus Forestry College.

Post: Forest Ranger

Classification: TS 3 Salary Scale

Duties: This officer is one who has acquired a great deal of practical experience over a period of years. He supervises Forest Guards and open vote workers in such tasks as the establishment of forest plantations, forest road construction and maintenance, forest protection and harvesting. On some occasions he is put in charge of forest sub-stations in ranges.

Responsible for:

Reports to: Forester or Forest Officer

Personnel supervised: Forest Guards and open vote workers.

Special considerations:

Qualifications possessed by present holder of post:

At least a primary school certificate and some years of experience as a Forest Guard.

Post: Conservation Officer

Classification: TS 5A Salary Scale

Duties: Enforcement of the Wildlife Protection Act and the National Parks System Act. Supervises all field operations of an environmental nature and assists in educating the general public on matters pertaining to conservation. On many occasions he also performs the duties of a forest ranger.

Responsible for:

Reports to: Forest Officer or Forester

Personnel supervised: Forest Guards and Forest workers.

Special considerations:

Qualifications possessed by present holder of post:
High School attendance.

Special Remarks: This post should be upgraded to the TS3 scale where it was.

Post: Forest Guard

Classification: TS6A Salary Scale

Duties: These are the most junior members of forestry technical field staff. After a short period of in-service training, they engage in such tasks as patrols for forest protection, releasing trees for harvesting, measuring logs for royalty assessment at sawmills and supervising work crews involved in silvicultural operations, forest engineering and fire suppression.

Responsible for:

Reports to: Forest Ranger

Personnel supervised: Forest workers

Special considerations:

Qualifications possessed by present holder of post:

At least a primary school certificate.

Appendix 10: Forest Resource and Area Information

The location and extent of the present forest resource

On a national scale, the 1:250,000 maps accompanying the report on land use (Wright *et al.* 1959) remain the primary source of information. The field traverses for the 1952-54 land use survey were used in conjunction with then-existing aerial photographs to prepare 1:40,000 soil and vegetation maps. The reduction to the final scale of 1:250,000 omitted the location of the field traverses so it was not possible for the TFAP Mission to determine which boundaries were drawn from field survey and which were extrapolated from the photographs. Wright *et al.* (1959, page 9) reported that field traverses were close together in farming areas such as Corozal but 30 to 40 miles (48-64 km) apart in the Maya Mountains.

The maps from the land resources surveys of Toledo District in 1986 (King *et al.* 1986) and Stann Creek District in 1988 (King *et al.* 1988) show the soil sampling points but no attempt was made to reclassify the vegetation. However the changes in vegetation cover between 1969/70 and 1985/87 are shown on the 1:100,000 maps for these two Districts. The base maps were the 1:50,000 topographic sheets.

The category "forest land" which appears in the annual reports of the Forest Department represents about 93% of the total area of the country. Forest land was reckoned at 8,230 miles² (21,322 km²) in 1981; cf. 8,490 miles² (22,000 km²) in 1978 (FAO 1978). This category includes all land except that in urban areas and that zoned by the Land & Survey Department as agribusiness land. The latter does not imply that the land is actually in such use, or even suitable for agriculture. The 93% is perhaps best viewed as an indication of the potential extent of the forest cover in the absence of human influence.

The large number of Classic Mayan sites, about 600, suggest that the ancient population may have been much larger than any in post-Columbian time. The small indigenous population, too small to be worth enslaving by the Spaniards, and the poverty of the soils, may have helped to maintain a very high proportion of forest cover in Belize for the nine hundred years until this century. The traditional lack of interest in agriculture has also helped to keep the land under forest.

The natural distribution of forest types is determined partly by climate but mainly by the soil. "Unquestionably, soil development is the key to the variation in the plant cover" (Wright *et al.* 1959, page 30). The role of fire in establishing or maintaining tropical pine forest seems to vary. Lightning-caused fires plus a heavily leached soil on a very ancient land surface appear to favour the conifers on the Mountain Pine Ridge and other isolated upland sites. On the coastal plains and in the north of Belize, the "pine ridge" seems to be confined to heavily leached sandy soil, and sustained by arson.

The broadleaved closed forest occupied in 1981 about 6103 miles² (15812 km²), mangrove and swamp a further 929 miles² (2408 km²), while open forest and pine covered only 381 miles² (986 km²) (Hartshorn et al. 1984). The sparsity of rain gauges makes extrapolation hazardous (Walker 1973) but the tropical pines seem not to be found where the average annual rain is more than 78 inches (2000 mm) (up to 117 inches, 3000 mm, on the southern coastal plain). However, this does not imply that the vegetation under lesser ~~rainfall~~ will be open and pine forest; fire and soil conditions then determine whether conifer or broadleaved forest will prevail.

The following table is taken from Lanly (1981):

Natural woody vegetation estimated at end 1980 in miles ² (km ²)						
Broadleaved	NHCfluc	NHCf2	NHCf	NHCa	NHc/NHO	nH
	3092	1760	4852	1583	355	178
	(8010)	(4560)	(12570)	(4100)	(920)	(460)
Coniferous	NSfluc	NSf2	NSf	NSa		
	347	27	374	444		
	(900)	(70)	(970)	(1150)		
Broadleaved & conifer	N.fluc	N.f2	N.f	N.a		
	3439	1787	5226	2027		
	(8910)	(4630)	(13540)	(5250)		

NH = predominantly broadleaved, NS = predominantly coniferous
 NHC = closed broadleaved
 NHCa = formerly closed broadleaved forest now in fallow after agriculture
 NHc/NHO = mixed forest trees and grassland
 nH = mixed shrubs and grassland
 fluc = logged forest not under intensive management but with capability for timber production
 f2 = forest lacking capability for timber production
 f = (fluc + f2)
 NSa = formerly conifer forest now in fallow after agriculture

The third column is the sum of the first two columns; the third pair of lines contains the sums of the first two pairs of lines.

In the Lanly compilation, the mangrove and swamp forests are included in the broadleaved classes. Clearly there are discrepancies between the Lanly compilation and the US-AID environmental profile. The 4852 miles² (12570 km²) of Lanly's NHCf should agree with the 7033 miles² (15812 + 2408 = 18220 km²) of Hartshorn et al. (1984). The difference is 2181 miles² (5650 km²), a massive 45% increase on the Lanly data. The Lanly compilation used the forest type estimates in Wright et al. (1959) and the terminal report of the FAO project BZE/75/008 Forestry Development, Belize. The latter cited unpublished sources in the Forest Department for its figures. The US-AID environmental profile prepared by Hartshorn et al. (1984) also relied on the 1978 terminal report of the FAO project. The figures should agree! It is no longer clear how the Forest Department, which is the proper source of such data, used to

compile the figures which have been cited by various consultants for more than a decade. The TFAP Mission was told that there have been no new compilations since 1978, yet the various consultants seem to have received different data sets.

The early work on forest typification was hampered by preconceptions about successional trends in the vegetation. Some soil surveyors and foresters considered that in time all forest would tend to culminate in a climatic climax of closed broadleaved high forest. Others considered that the rainfall was so great that erosion and leaching would impoverish the soil. Then broadleaved forest would degrade through broken ridge to pine and finally grassland with scrub.

Although several branches of the Forest Department's work were closed down during the depression years of the late 1920s and 1930s, the classification of forests was continued. A number of sample plots were established, using the methods recommended by Burt Davy. A preliminary vegetation type map was ready by 1933. Also during this period at least some of the forest was inventoried in strips at a frequency of 2%. The first three of what was clearly intended to be a longer series of papers on forest types were published in the Caribbean Forester in 1942 and 1945. The profile diagrams associated with the sample plots are still available in Belmopan. These early studies have been summarized and published in essentially qualitative terms but it is likely that the field work was quantitative. The original data could be helpful in management planning, especially as regards the regeneration.

The field books from the sample plots and from the sampling inventories, the strip maps and the vegetation type map from the 1920s-1940s should be recalled from the archives of the Forest Department and integrated with more recent data to prepare type and stock maps for each Forest Reserve.

The early work of the Forest Department on vegetation typing, plus that of the 1950s' land use survey team, was based on field traverses supplemented by aerial photographs. Wright et al. (1959) considered that the bioclimatic classification of an early version of the Holdridge system was more useful than the physiognomic system of Beard; the land use survey team did not have time to acquire sufficient knowledge of the structure of the plant communities. The boundaries of the broad categories of the ~~Holdridge~~ type system which are shown on the land use summary map (fig. VIII in Wright et al. 1959) thus depend on the extrapolations of rainfall patterns which were available at that time. Since these extrapolations are now considered to be incorrect (Walker 1973), there has been a tendency to disregard the finer classification of vegetation on the 1:250,000 map. The empirical vegetation associations and assemblages of Wright et al. (1959) were not defined. They were characterized by named pairs of species which the field surveyors considered were dominant in the type, supported by a short list of other common species. The classes of Wright et al. (1959) have also been criticized for lacking a theoretical framework (Hartshorn et al.

984) and, because they are not formally defined, for being hard to use consistently in the field (Johnson & Chaffey 1973). Nevertheless, the land use survey team was convinced that there was a close association between vegetation type and the underlying soil. Multiple discriminant analysis could be applied to the data of Wright et al. (1959) to test the strength of this association. The ODNRI land resource survey team in Toledo District (King et al. 1986) and Stann Creek District (King et al. 1988) did not find an evident correlation between soils and vegetation or landform. Partly for lack of time, the ODNRI team preferred to characterize the landforms and soils rather than map the boundaries between the soil types. The ODNRI reports stress the importance of more detailed surveys before decisions are taken about land use changes.

The Forest Department appears to have made little use of the land use survey, perhaps through misreading the 1959 book. The report of the 1969-71 inventory of Chiquibul Forest Reserve (Johnson & Chaffey 1973) states that the maps of Wright et al. (1959) "record the authors opinion of what is the natural climax vegetation for each locality. It does not follow that the vegetation types exist as mapped for each locality". The TFAP Mission was unable to find anything in Wright et al. (1959) to indicate that the maps show supposed climax types rather than those actually seen in the field or interpreted from the aerial photographs. Perhaps as a consequence the Forest Department's own inventories have made little attempt to relate the vegetation of the Forest Reserves to the 77 classes suggested by Wright et al. (1959). Unfortunately, no alternative classification for the forest associations has been proposed and hence the extrapolation of data from the inventory transects to the remainder of each Forest Reserve has been weak. However, this kind of forest typing is needed for the spatial application of field management; the managerial techniques are derived from experiments, inventories and diagnostic sampling, and the mapping of the forest types indicates where each technique should be applied.

The Forest Department should re-examine the field books of the inventories in the Forest Reserves and where possible delimit the forest associations of Wright et al. (1959) on the maps. Interpretation of the best available aerial photographs may assist, bearing in mind that some of Belize has been re-flown twice a year for several years.

Inventory data from the period 1969-1981 should be reprocessed with post-stratification and standard groupings of species and size classes to give information for management planning.

By the time that the Forest Department was created in 1922 a good deal of the northern half of Belize had been alienated. The Haematoxylon forests were privatised at an early stage of European settlement. Later, the easily accessible mahogany areas covering practically the whole of the north and part of the south left the Crown estate (Stevenson 1938). The Land & Survey Department's property map shows the great extent of the areas

assigned as "mahogany works", all through the lowland areas of the country. The establishment of the permanent forest estate, in accordance with the recommendations of the Hummel report in 1921 (Hummel 1925), was very largely restricted to the less accessible and higher lands of Belize, plus the southern coastal plain (pine and grass savanna) and swamps. The imposition of land tax caused relinquishment of some private holdings and consolidation of others. However, the proportion of privately-owned land in Belize in 1988 has altered less than 0.5% from the 45% in 1938. The Forest Department has not been able to obtain a permanent foothold in the rich mahogany forests north of the Belize River, except for Freshwater Creek Forest Reserve. The various estimates of areas for past and present Forest Reserves in Belize have been shown in Table 3.10.

There is little publicly available information on forest in private hands. The exception is the forest of the former Belize Estate and Produce Co. This company, holding at one time nearly one fifth of the land area of Belize and reputedly the richest mahogany forest, was one of the few to take advantage of the creation of the Forest Department. For some years, Forest Department staff were seconded to the company to assist in management. The size of the estate was reduced over time but was still 980 miles² (2538 km²) in 1984. The productive forest area of 754 miles² (1953 km²) was inventoried in 1975. The company estate is now split into several portions, some of which are under short-term forest licences and permits.

Forest land areas

Several estimates of the forest land area of Belize, according to different categories, are provided below. The TFAP Mission was unable to determine how the various figures were compiled but the origin of most data was given as the Forest Department. A particular problem concerns the categories "productive and unproductive" and "accessible and inaccessible" forest. These classes are not defined in the annual reports of the Forest Department. Inventories in the 1970s and early 1980s have used various classes. The Chiquibul inventory (Johnson & Chaffey 1973) used "inaccessible" to mean remote forest located on severely dissected terrain, but did not define remoteness or the degree of dissection. The same inventory used "unproductive" to mean unloggable forest located on rock, mainly steep limestone karst. The distinction between inaccessible and unproductive is unclear. The Maya Mountains and Columbia River inventory (Wilson ~~1978~~) used categories which are described confusedly in the ~~report~~. The Cockscomb Basin inventory (Woods 1977) confused definitions of slope classes.

It was not obvious to the TFAP Mission what use was served by these categories. Accessibility can be altered by road building and productivity by changes in utilization standards and by silvicultural measures. The classification of forest by "accessibility" and "productivity" should be dropped or replaced by unambiguous and consistent definitions.

The tables that follow have been taken from various sources. The origin of the data was usually ascribed to the Forest Department but the means by which the figures were compiled could not be ascertained by the TFAP Mission.

Forest land areas in km² in 1981
(table IV-7 on page 93 of Hartshorn et al. 1984, and DFS Deutsche Forstinventur Service GmbH 1983)

Forest land category	Forest reserves	National land	Private land	Total km ²	DFS (1983) total km ²
closed forest (broadleaved)	5286 83%	4367 67%	6519 73%	15812 74%	16335 74%
open forest (woodland & pine)	642 10%	210 3%	134 2%	986 5%	1505 7%
mangrove and swamp	26 -	974 15%	1408 17%	2408 11%	2393 11%
open and grassland	414 7%	1006 15%	696 8%	2116 10%	1782 8%
Total	6368	6557	8397	21322	22015

Forest land areas in km² in 1976, preliminary FD estimates
(appendix 4 in the terminal report of FO:DP/BZE/75/008 Forestry Development, Belize; FAO 1978. 1981 total from Hartshorn et al. 1984)

Forest land category	Forest Reserves protection	Forest Reserves production	1981 total	1981 total	non-permanent state reserves
closed forest (broadleaved)	1194	4103	5297	5286	611
open forest (woodland & pine)	130	513	642	642	202
mangrove and swamp	-	26	26	26	16
open and grassland	109	306	414	414	-
Total	1433	4949	6379	6368	829

Forest land areas in km² in 1976, preliminary FD estimates
(appendix 4 in the terminal report of FO:DP/BZE/75/008 Forestry
Development, Belize; FAO 1978)

Forest land category	National (Crown) lands			Private lands		
	protection	production	total	protect.	product.	total
closed forest (broadleaved)	2124	2918	5043	1070	(4915)	6159
open forest (woodland & pine)	4	206	210	28	(101)	134
mangrove and swamp	-	974	974	-	(1401)	1408
open and grassland	6	1110	1116	47	(642)	696
Total	2134	5208	7343	1145	(7059)	8396

Forest land areas in km, in 1976, preliminary FD estimates
(appendix 5 in the terminal report of FO:DP/BZE/75/008 Forestry
Development, Belize; FAO 1978)

Forest land category	productive forest areas			Forest Reserves unproductive forest areas		
	access.	inaccess.	total	access.	inaccess.	total
closed forest (broadleaved)	894	474	1368	976	1603	2579
open forest (woodland & pine)	427	13	440	-	-	-
mangrove and swamp	-	-	-	-	26	26
open and grassland	414	-	414	-	-	-
Total	1735	487	2222	976	1629	2605

Forest land areas in km² in-1976, preliminary FD estimates
(appendix 5 in the terminal report of FO:DP/BZE/75/008 Forestry
Development, Belize; FAO 1978)

Forest land category	National and private land			productive forest areas		
	access.	inaccess.	total	access.	inaccess.	total
closed forest (broadleaved)	9231	580	9811	1704	1036	2740
open forest (woodland & pine)	495	39	534	13	-	13
mangrove and swamp	-	-	-	-	2383	2383
open and grassland	1707	-	1707	-	-	-
Total	11433	619	12052	1717	3418	5136
All forest land	13168	1106	14274	2693	5047	7742

Exploitable area (km²) and volumes ('000 m³), productive forests of Belize. (table IV-9 on page 95 of Hartshorn *et al.* 1984)

Location	Area km ²	Primary hardwoods	Secondary hardwoods	Tropical pines	Total '000 m ³	2% AAC
Belize Estate	2430	444.0	4148.7	-	4592.7	91.9
Chiquibul FR	1850	80.8	3434.6	-	3515.4	70.3
Cockscomb FR	410	24.6	1410.4	-	1435.0	28.7
Columbia River & Maya Mountains	1340	80.7	8142.3	-	8223.0	164.5
Mountain Pine	515	-	10.6	205.8	216.4	4.3
other FRs	2614	?	3467.8	454.3	4102.1	82.0
other National						
Private Land	4850	?	4672.5	140.0	4812.5	96.3
Total	14009	630.1	25466.9	800.1	26897.1	537.9

(values from 1978:14270)

2% AAC = annual allowable cut, estimated as 2 per cent of the standing forest volume.

Plantations of Pinus caribaea on the southern coastal plain 18.73 km² (?)

Plantations of Gmelina arborea in Silk Grass Forest Reserve 7.49 km² (?)

Appendix 11: Details of Individual Forest Reserves of Belize**Bocotora**

No information obtained. The area is more or less coincident with Manatee Forest Reserve.

Chiquibul

Gazetted by SR&O 55 of 1956 with original area 1849.29 km². No excisions so far.

Cockscomb Basin

Gazetted by SI 93 of 24 November 1984 with original area 398.87 km². No excisions so far. The Cockscomb Basin is also covered by a "closed area for hunting" regulation (SI 94 of 1984) made under section 11 of the Wildlife Protection Act 1981.

Columbia River

Gazetted by SI 33 of 5 June 1954 with original area 448.07 km², but already a Crown Forest Reserve by 1930. The Forest Reserve was reduced to 416.69 km² by SI 40 dated 10 May 1977. The rectangle excised for milpa farming had contained the Forest Department (FD) taungya plantations of Swietenia which were established 1955-63. The rectangle was re-cleared for farming in 1975.

Commerce Bight

Gazetted by SI 46 of 10 May 1977 with original area 51.80 km² (however, FD records give the area as 44.15 km²). The Forest Reserve was divided by SI 59 of 30 July 1982 into two portions (986 and 2778 ha) and reduced to 37.64 km². However, Johnson (1988) mentions only the portion with 2778 ha.

Deep River

Gazetted by SR&O 49 of 1941 with original area 408.18 km². At some time before 1977 the Forest Reserve was enlarged to its present 590.53 km².

Freshwater Creek

Gazetted by SR&O 12 of 1960 with original area 296.20 km². However this area was certainly a Crown Forest Reserve by 1930 (Record 1930). FD records in 1977 give the area as 300.45 km², perhaps by inclusion of Honey Jib Camp Forest Reserve.

Golden Stream

~~No information~~ obtained. This hardwood reserve on the Southern Coastal Plain was dereserved during the 1950s.

Grant's Work

Gazetted by SR&O 47 of 26 July 1941 with original area 74.07 km². The boundary seems to have been altered several times. In 1977 the FD recorded an area of 75.11 km². It was reduced to 39.30 km² by SI 65 of 8 September 1980 and to 34.48 km² by SI 56 of 17 May 1985 or SI 67 of 6 June 1986. The current FD estimate is 32.40 km². However, Johnson (1988) gives 32.40 km² as the area of Grant's Work A and 13.60 km² for Grant's Work B.

Honey Jib Camp

No information obtained. A Forest Reserve by 1955. Perhaps absorbed by Freshwater Creek Forest Reserve.

Iguana Creek

No information obtained. The former forest reserve seems to have been taken over by the Mennonite settlement of Spanish Lookout, perhaps as a result of the recommendation for dereservation by Wright et al. (1959, page 189) on the grounds that some of the forest had little value and the area was needed to resettle the former inhabitants of Yalbac village.

Machaca Creek

Gazetted by SR&O 24 of 9 July 1963 with original area 41.26 km². The area was about halved by SI 41 of 10 May 1977 to 23.70 km² while the present FD estimate is 22.50 km².

Manatee

Gazetted by SR&O 21 of 1959 with original area 458.95 km². The FD recorded 458.44 km² in 1977 and the present estimate is 458.15 km². 112.71 km² lie in Stann Creek District and the remainder in Belize District.

Mango Creek

Gazetted by SR&O 6 of 1960 with original area 269.90 km². Mango Creek was dereserved in 1969 for large-scale commercial horticulture, especially hydroponically-cultivated tomatoes, by the US company National Bulk Carriers. This scheme failed and Mango Creek was then re-reserved. The boundary was slightly changed from the original line of 1960 by SI 43 of 10 May 1977 to 266.59 km² and there was another small reduction by SI 68 of 6 June 1986 to 265.32 km². The present FD estimate is 144.04 km², after an excision for which there seems to be no gazette notice. The company Plantation and Estates Ltd. (funded at least in part by Verband für Boise Kapital, Germany) intends to clear 1894 ha for oranges and 6000 ha for plantation-grown pine. It is not known how the balance of 4334 excised hectares will be used. Johnson (1988) considered that there were still 232.29 km² in the Forest Reserve at the beginning of 1988.

Maskalls

No information obtained about the original notification or extension. The reserve was extended by SR&O 11 of 1949. The forest reserve had been lost by the late 1950s.

Maya Mountains

Gazetted by SI 42 of 10 May 1977 with original area 937.69 km². There was an excision for a banana plantation of 395 ha at Medina Bank by SI 13 of 6 March 1979, leaving a present extent of 933.74 km².

Mountain Pine Ridge

Gazetted as a protection forest by SR&O ?? of 1944. It was reclassified as a production forest in 1952. The first gazette notice on file is SR&O 19 of 1959 (536.36 km²) but the area was

reduced by SI 49 of 10 May 1977 to 514.78 km², its present legal extent.

Sibun

Gazetted by SR&O 20 of 8 April 1959 with original area 515.27 km² but already a Crown Forest Reserve by 1930. This was reduced by SI 48 of 10 May 1977 to 429.75 km², its present area.

Silk Grass

Gazetted by Notice 624 of 28 October 1922 with original area 27.20 km². Silk Grass was the first forest reserve [?]. The FD recorded 28.49 km² in 1977 but the area was reduced by SI 60 of 30 July 1982 to 26.41 km².

Sittee River

Gazetted by SI 47 of 10 May 1977 with original area 380.09 km². Although there do not seem to have been any excisions the FD records a present area of 379.46 km².

Swazey-Bladen

Gazetted by SR&O 6 of 1960 with original area 62.16 km². There is no record of any excisions.

Vaca

No information obtained. A Crown Forest Reserve by 1930.

Xcanha

No information obtained. A Forest Reserve by 1955.

Yalbac Creek

Gazetted by SR&O 46 of 1956 with original area 183.89 km². The gazette notification is unusual because it states clearly the reason for the reservation: "to preserve from cultivation a valuable tract of mahogany forest". However, this forest reserve no longer exists.

Appendix 12: Hurricanes in Belize

page numbers from Wright et al. (1959)

1787 2 September. Settlement of Belize completely destroyed.

1813

1827

1864

1883

1915

1920

1931 10 September. Passed over Belize City, not felt 18 miles south at Gales Point (p.19). However, Cree (1956) stated that the forests were damaged within a belt of about 50 miles [width]. Practically all the pine forest in the vicinity of Belize Town was destroyed. Mahogany and other hardwood forests were also damaged, especially in the coastal areas. Further inland the damage to mahogany was not severe.

1941 28 September. Stann Creek District. Long anastomosing swathes of damage occurred to improved mahogany forest in Silk Grass Forest Reserve. The tops of the ridges in the most level portions of the reserve were the most badly hit and the forest on the south-east face of the hills lying to the north and west were very badly damaged. Mahogany appeared to be very wind resistant. Many large trees and tall poles survived undamaged in areas otherwise badly damaged. About 10 per cent of the larger pine trees in the Melinda area to the north of the Silk Grass Forest Reserve were blown down but the younger poles and regeneration were not badly damaged (Lindo 1967).

1942 Summer (date not given by Wright et al. (1959)). Toledo District. Destruction extended well into Guatemala and reached a point 85 miles inland from the coast. More than 75 per cent of the large trees growing on the clay soils of the lowlands were overturned (including almost all the remaining mahogany), but on the limestone soils most of the trees (including those in the main track of the storm) survived. After the gale, communications between villages were almost completely disrupted. Many of the tracks formerly used between villages have never been re-opened or have been re-aligned through the undisturbed forest of the limestone foothills (p.127)

1942 8 November. Northern half of Belize. The hurricane track passed over Freshwater Creek Forest Reserve. The southern boundary of new damage overlapped the northern boundary of the damage from the 1931 storm. A survey after the storm showed that more than 75 per cent of the canopy species [trees ?] in the hardwood high forest had been destroyed. The low bush was not badly damaged, but about 25 to 50 per cent of the pine were blown. On the deep black soils the larger trees were broken off, damaging and smashing the small vegetation. On the shallow red soils most of the trees were uprooted. The mahogany trees that were left standing were mostly of medium to small size with comparatively thin crowns. Survey data from two plots totalling 100 acres are given by Lindo (1967).

1943 a storm during the early 1940s, possibly 1943, affected the southern Maya Mountains (page 19 in the report by Woods (1978) on the 1975-76 inventory). This storm was said to have created the broken ridge forest adjacent to the Machaca Pine plantation. It could be the same as the 1942 summer storm ?

1945 crossed the coast between the mouths of the Temax and Sarstun rivers, devastated the forest on a 25-mile front, continued to cause forest damage until nearly 40 miles inside the Guatemalan border, in the basin of the Rio Machiquila. Almost every large tree was felled (p.19). Lindo (1967) says that the storm track was southwest and that damage extended north to Monkey River.

1955 [from FD annual report for 1955, p.6]

"50. Hurricane Janet swept over parts of the northern districts on the night of 27th September. It caused serious and widespread damage to mahogany and chicle forest covering about 500 square miles. The greater part of this forest had already been badly damaged by the [November] 1942 hurricane and most of it had already been heavily exploited in previous years both for mahogany and chicle. Most of the damaged forest is in private ownership, but three Forest Reserves, Freshwater Creek, Xcanha and Honey Jib Camp were badly blown. Maskalls Forest Reserve was also slightly damaged. In Freshwater Creek Forest Reserve, all mahogany seedbearers which had survived the 1942 hurricane were badly damaged, large branches being blown off, and some were blown down. The tops were blown off all palm trees and many small and medium sized trees of all kinds were blown down. The forest floor is therefore covered by a tangled mass of debris, which will constitute a severe fire hazard for some years to come. This debris will also make exploitation very difficult, and tending work on natural regeneration which was in progress virtually impossible. Except for the Forest Reserves in which no felling had been permitted since the 1942 hurricane and which were regenerating fairly well, the damaged forest could not be regarded as valuable, as it had been subject to over-exploitation and accidental fires for many years past.

"51. The valuable forests owned by the Belize Estate & Produce Company Limited in the north-west were undamaged."

...Lindo ~~(1967)~~ said that the main force of the wind appeared to have been in a northwesterly direction. Although a very large ~~number of mahogany~~ trees were blown down or had their crowns and large branches broken off, a surprising number of trees were not too severely damaged. This was especially true of the larger sized trees. The Achras zapota trees seemed to have suffered badly and all the cohune palms had their tops blown off or their leaves blown to ribbons.

1960 Abbie. mid-July. A small but intense hurricane crossed the coast between Stann Creek and Monkey River. Tops were broken off a few hardwood trees and some dead standing pine were blown over. Otherwise damage to the forest was minimal (Lindo 1967).

1961 Hattie. 31 October. The FD annual report for 1961, Langley (1963), Toleman (1963), Lindo (1967), Wolffsohn (1967) and Johnson & Chaffey (1973) give accounts of the damage to forest and the aftermath. Wind velocity may have reached over 300 kph. Light damage extended across a belt over 100 km wide, severe damage within 80 km. 90 per cent of the canopy trees were lost within a strip 50 km wide. strong gales affected the whole country.

1971 Laura. September in Stann Creek Valley, damaged the Melinda plantations (DFU's annual report)

1974 Carmen. 2 September. Track passed just north of Belize.
Fifi. 19 September. Damaged most forest plantations.

1978 Greta. 18 September. Damaged most forest plantations.

Appendix 13: Analysis of the Mountain Pine Ridge Forest Reserve
Growing Stock

Forest: Mountain Pine Ridge Forest Reserve

Vegetation type and area: mostly open pine forest, 514.78 km²
Inventoried area in 1970: 244.22 km², of which pine forest
189.56 km² (forest cover type 1.1, more than 70% canopy closure,
5134 ha; forest cover type 1.2, 40-70% canopy closure, 7342 ha;
forest cover type 1.3, less than 40% canopy closure, 6480 ha).
In the analysis given below, stockings are stems per hectare
weighted by the cover type area within each management block;
volumes per hectare are volume-table volumes for trees at the
mid-points of the 5-cm dbh classes multiplied by the stocking per
hectare; volume-table volumes are from the single-entry table
reported by Johnson & Chaffey (1973), total volumes under bark to
7.5 cm top diameter (tvub); cover volumes are volumes per hectare
multiplied by the cover type area.

cover type 5134 ha species	dbh class cm	stocking N/ha		volume/ha m ³ /ha		cover volumes m ³	
		1970	1980	1970	1980	1970	1980
Pinus caribaea	5-< 7.6	262	82	0.8	0.2	4035	1263
Pinus caribaea	7.6-<12.6	247	182	3.2	2.4	16485	12147
Pinus caribaea	12.6-<17.6	105	173	4.5	7.4	23180	38192
Pinus caribaea	17.6-<22.6	43	86	4.4	8.9	22738	45477
Pinus caribaea	22.6-<27.6	14	46	2.8	9.3	14591	47941
Pinus caribaea	27.6-<32.6	6	14	2.1	4.9	10874	25372
Pinus caribaea	32.6-<37.6	2	6	1.1	3.4	5781	17343
Pinus caribaea	>=37.6	1	1	0.8	0.8	4333	4333
totals for trees with dbh >=7.6 cm				19.1	37.2	97982	190805
net growth rate = 1.8 m ³ /ha/year							

values from Johnson & Chaffey (1973)

Pinus caribaea	>= 7.6	418	19.5	100113
Pinus caribaea	>=15.2	103	13.9	71363
Pinus caribaea	>=25.4	14	6.0	30804

cover type 7342 ha species	dbh class cm	stocking N/ha		volume/ha m ³ /ha		cover volumes m ³	
		1970	1980	1970	1980	1970	1980
Pinus caribaea	5-< 7.6	229	119	0.7	0.4	5044	2621
Pinus caribaea	7.6-<12.6	196	245	2.5	3.2	18707	23384
Pinus caribaea	12.6-<17.6	65	181	2.6	7.8	20521	57143
Pinus caribaea	17.6-<22.6	25	70	2.6	7.2	18906	52936
Pinus caribaea	22.6-<27.6	11	34	2.2	6.9	16395	50674
Pinus caribaea	27.6-<32.6	5	10	1.8	3.5	12959	25917
Pinus caribaea	32.6-<37.6	2	4	1.1	2.3	8267	16534
Pinus caribaea	>=37.6	1	2	0.8	1.7	6197	12393
totals for trees with dbh >=7.6 cm				13.9	32.5	101952	238981
net growth rate = 1.9 m ³ /ha/year							

values from Johnson & Chaffey (1973)

Pinus caribaea	>= 7.6	304	13.7	100585
Pinus caribaea	>=15.2	64	9.7	71217

Pinus caribaea cover type 1.3 6480 ha species	dbh class cm	stocking N/ha		volume/ha m ³ /ha		cover volumes m ³	
		1970	1980	1970	1980	1970	1980
	>=25.4	11	4.8	35242			
Pinus caribaea	5-< 7.6	166	168	0.5	0.5	3227	3266
Pinus caribaea	7.6-<12.6	103	357	1.3	4.6	8677	30074
Pinus caribaea	12.6-<17.6	25	189	1.1	8.1	6966	52663
Pinus caribaea	17.6-<22.6	10	45	1.0	4.6	6674	30035
Pinus caribaea	22.6-<27.6	4	12	0.8	2.4	5262	15785
Pinus caribaea	27.6-<32.6	2	5	0.7	1.8	4575	11437
Pinus caribaea	32.6-<37.6	1	2	0.6	1.1	3648	7296
Pinus caribaea	>=37.6	0	1	0.0	0.8	0	5469
totals for trees with dbh >=7.6 cm				5.5	23.6	35802	152759
net growth rate = 1.8 m ³ /ha/year							

values from Johnson & Chaffey (1973)

Pinus caribaea	>= 7.6	146	5.7	36936
Pinus caribaea	>=15.2	25	3.7	23976
Pinus caribaea	>=25.4	5	1.8	11664

Johnson & Grimbale (1987) assume an exploitable area of 28956 ha (18956 ha inventoried in 1970 north of the Brunton Trail and Angels Avenue and 10000 ha which have not yet been inventoried to the south of that line). This is just over half the area of the Forest Reserve (51478 ha).

figures calculated from the 1980 inventory

cover type 1.1, 5134 ha, tvub >= 7.6 cm dbh = 37.2 m³/ha
 cover type 1.1, 5134 ha, tvub >=32.6 cm dbh = 4.2 m³/ha
 cover type 1.2, 7342 ha, tvub >= 7.6 cm dbh = 32.5 m³/ha
 cover type 1.2, 7342 ha, tvub >=32.6 cm dbh = 4.0 m³/ha
 cover type 1.3, 6480 ha, tvub >= 7.6 cm dbh = 23.6 m³/ha
 cover type 1.3, 6480 ha, tvub >=32.6 cm dbh = 1.9 m³/ha
 weighted average tvub >= 7.6 cm dbh = 30.7 m³/ha
 average growth rate 1.8 m³/ha/year, net of mortality and logging

Both hurricane-induced mortality in 1978 and the log production during 1970-79 are implicitly accounted for in the net average growth rate shown by the difference between the 1970 and 1980 inventories. Log production summarised by Johnson & Grimbale (1987, table 2.1) was only 0.05 m³/ha/yr for 1970-79 and 0.16 m³/ha/yr for 1980-86 from the 18956 ha under management.

potential stock in 1988 = $30.7 + (8 \text{ years} \times 1.8) = 45.1 \text{ m}^3/\text{ha}$ at 28 years

potential stock on 28956 ha = $45.1 \times 28956 = 1,305,916 \text{ m}^3$

reduction for logging = $0.164 \text{ m}^3/\text{ha} \times 8 \text{ years} \times 18956 \text{ ha}$
 = 24,870 m³

net potential stock on 28956 ha = 1,281,046 m³

cut on a 50-year monocyclic rotation, the annual cut would be 25,621 m³

potential stock in 2010 = $30.7 + (30 \text{ years} \times 1.8) = 84.7 \text{ m}^3/\text{ha}$ at 50 yrs, that is, assuming that all the pine regenerated in 1960

potential stock on 28956 ha = $84.7 \times 28956 = 2,442,573 \text{ m}^3$

cut on a 50-year monocyclic rotation, the annual cut would be 49,051 m³

The FD intention, indicated without explanation by Johnson & Grimble, is a final stocking of 220 trees/ha at 35 cm dbh (0.563 m³) = 124 m³/ha. The yield and thinning plot data should be analysed in conjunction with the two inventories to see if this aim is achievable or to suggest an alternative target. There is no indication at present that another forest-wide inventory is necessary.

The calculations above result in figures which are quite similar to those suggested by Johnson & Grimble (page 14) in their extrapolation from the 1970 inventory, without reference to the 1980 inventory. However, these figures assume that the southern area will provide a similar yield to the Western Felling Series, and that the current growth rate will be maintained. Observations of the Mountain Pine Ridge stands, including the FD's yield and thinning plots, suggest the assumption of maintained growth rate is extremely unlikely.

The Southern Felling Series was excluded from the 1970 inventory, apparently because the topography was too steep for the exploitation which was then normal. An inventory may be desirable in this Felling Series, since the Johnson & Grimble calculation assumes that about one-third of the yield will be derived from the southern area. The annual report of the FD for 1961 records that the outlying slopes of the Mountain Pine Ridge suffered particularly badly from Hurricane Hattie, with windthrow up to 90 per cent. However DFO (West) told the TFAP Mission that the area south and east of the Brunton Trail did not show signs of storm damage except close to the ridge tops nor had the area been logged in the 1950s or 1960s.

What is clear from the successive revisions of working plans is the sometimes considerable discrepancy between the FD objectives, the state of the forest and the biological potential of the tropical pines.

Ecological basis of silviculture for the tropical pines

The tradition in Belize has been to permit the cutting of trees over a high girth limit, which varies between species. A cutting limit can be useful in limiting logging damage, since injury to residual trees in tropical high forest is more closely correlated with the number of trees felled than with the size of those cut. A cutting limit can also help to ensure that mother trees are left to ensure natural regeneration and are not cut before they produce viable seed.

For species which are shade-intolerant and unresponsive to thinning except when relatively juvenile, the selective felling of adult trees as they reach the cutting limit does not benefit the residual trees but does have a negative, dysgenic effect because the faster growing trees in a cohort are preferentially removed. The tropical pines are among this group of shade-intolerant species which are best managed under uniform and

monocyclic silvicultural systems, not polycyclic selection systems.

Regeneration of pine on Mountain Pine Ridge

An unpublished history of forest in Belize by the FD states that most of the older pine of the new generation dates from after the major fires which burned almost all the Mountain Pine Ridge in the drought year of 1949. Regeneration was further encouraged by the soil disturbance due to logging from 1955 onwards and the devastation of the mature (old growth) pine by Hurricane Hattie in 1961 and the subsequent fires and salvage logging. The old growth pine had been almost completely removed by 1971. Thus the great majority of the present pine dates from 1950-70. Unfortunately there are no maps or other observations to suggest which areas regenerated when, so the regeneration period has been assumed to start from halfway, 1960, for the Western Felling Series.

Mapping of soil types and estimation of site indices

It is clear from observation that some management blocks support better growth of pine and/or regenerated earlier than 1960; for example, in the Habet Road and Morris Road areas [could these be the survivors of the 1948 regeneration, of which half survived the 1949 fires?]. The area protected from wildfire was extended continuously during the 1950s and it is likely that some management blocks are thus appreciably younger than others; in spite of occasional disastrous years for fire such as 1955. Darcel in 1952 and Birchall in 1971-72 carried out reconnaissance soil surveys and their work should be retrieved and compiled into soil type maps. The soil typing and maps of fires should be used to interpret the site index estimations to be prepared from the thinning and yield plots, as suggested by Palmer in 1980 and 1982. If the observed dominant heights differ markedly from the heights predicted from the site indices then the assumption of even-aged crops must be abandoned. In such case, fresh calculations should be made for uneven-aged crops, aided by the methods developed at the USDA Forest Service North Central Forest Experiment Station; as suggested also in 1980 and 1982.

The stem frequency distributions indicated in the analysis above of the 1970 and 1980 inventories suggest that the forest of the Western Felling Series is behaving as if even-aged. The interpretation is complicated by the past and present pine thinnings and hardwood elimination by the FD. The cleanings and thinnings have not been carried out according to any consistent prescription, nor have the fellings been recorded as to location or quantity. The policy of felling trees infested with mistletoe and those tapped for oleoresin in 1974-82 also tends to eliminate preferentially the larger trees from a given area. DFO (West) believes that the tapped trees are no longer growing but there are no formal trials to confirm his opinion. Trees logged by the FD to its own sawmill are recorded as to the management block from which they were cut but this information needs to be supplemented by records of the thinnings and cleanings in order to interpret the present state of the blocks.

The 26 thousand hectares burned as a result of lightning strikes and human agency between 1963 and 1980 (more recent figures not seen) have also had an incalculable effect on growth and mortality, for lack of FD observations.

Past and present management of Mountain Pine Ridge
Mountain Pine Ridge was gazetted as a Forest Reserve in 1944 and classified as a protection forest. The regeneration resulting from the initial mainly manual fire protection was mostly wiped out in the great fires of 1949 but the ensuing abundant regeneration was so promising that the Forest Reserve was reclassified as a production forest in 1952. The granite basin area (about 18 thousand hectares) was inventoried by Williamson and Wolffsohn in 1953, a long-term felling licence issued in 1955 and the first working plan prepared by Wolffsohn in 1956. The plan gave emphasis to prescribed burning, with the intention of creating even-aged naturally-regenerated pine stands to be clear-felled at maturity (taken to be 42" girth measured at 18" agl, equivalent to 35 cm dbh).

The Mountain Pine Ridge working plan was revised in 1960 as part of the FD's response to the Downie report (1959). That report considered that Belize was too impoverished to support government investments which took a long time to mature. Implementation of the plan was nullified by the destruction caused by Hurricane Hattie in 1961. It is not clear what were the FD's plans for management after that event but by the third or fourth draft working plan, by Woods in 1978, a group selection scheme seemed to be preferred. What this means in practice is that the forest licensees can take any tree over the cutting limit from any part of their licence areas at any time. In view of the biology of the tropical pines, as indicated above, this practice is contrary to the national forest policy of sustained yield.

The FD considered that thinning of the dense young regeneration was necessary. A stick thinning was prescribed by Rosado in 1963 for stems in three height classes and revised by Lindo in 1965 for four height classes in young stands. A thinning guide for older stands was prepared by Woods in 1978. Thinning trials were laid down in 1963 and 1967 in stands of uncertain age with interventions prescribed at three crop mean girths. However the actual thinnings which have taken place in the management blocks have varied over time according to the inclinations of successive DFOs. There is a lack of records to show what interventions took place where, when and how; as mentioned earlier. The formal trials have not yet been analysed. Most of the management blocks in the Western Felling Series have been thinned one or more times by the FD (Locklear 1981).

All indications from the management of tropical pines elsewhere suggest that early thinning will concentrate the possible growth onto potential crop trees while thinnings in stands over ten years old are ineffective. Most of the FD thinnings in the last 15 years have thus served only to reduce the total standing volume.

Recommendations

1. Compile soil type overlays from the Darcel and Birchall surveys for the 1973 cover type maps.
2. Compile fire maps into overlays for the 1973 cover type maps.
3. Using the 1966 pole crop mapping (Dominguez) and 1977/78 work (Woods) as a basis, divide the management blocks into compartments according to soil type, fire history, crop age, stand structure, etc.
4. Analyse the thinning and yield plots, prepare site indices and compile site index maps into overlays for the 1973 cover type maps.
5. Develop a growth and yield model and revise predicted yields by compartments and management blocks, assuming no further thinning of the regenerated stands and clear felling when the stands reach maximum mai in volume.
6. Use the clauses in the current timber and transmission pole licences to require the licensees to work systematically by demarcated blocks (which would be indicated by the DFO). The lice.seees should be required to clear-cut the existing forest so as to convert the forest into even-aged stands, as was correctly intended in the first working plan in 1956. Seed trees of good phenotype should be left standing.
7. Clear-cut stands should be control-burned to eliminate the encroaching hardwoods and to stimulate abundant seeding and regeneration.
8. The dense natural regeneration should be thinned according to schedules developed initially from research outside Belize but later from more comprehensive trials which should be laid down on Mountain Pine Ridge.
9. The yield plot system should be modernised and greatly enlarged.
10. The recording systems for research and management should be thoroughly overhauled, updated and kept up to date.
11. The low natural fertility of the Mountain Pine Ridge soils ensures that there is no competition from agriculture but equally little chance of greatly enhancing forest growth above 2 m³/ha/year. Good mapping and adequate management records may indicate areas with sufficient potential to justify the application of slow-release phosphate fertilizer to stands thinned early to final stocking. However this treatment would depend on positive results from formal research trials.
12. For most of Mountain Pine Ridge, management intensity must be very low, because the low productivity does not justify more than minimal expense. The FD should withdraw from activities

which detract from its primary function, which is the sustained-yield management of forest for industrial use. In the Mountain Pine Ridge, management means mainly fire control, early thinning of dense natural regeneration, the monitoring of forest growth and the control of private sector licensed activities.

13. Besides the timber yield, the major product from the Mountain Pine Ridge should be tree seed. In particular, Belize is the world's greatest source of seed for the preferred provenances of *Pinus patula* ssp. *tecunumanii*. The FD should capitalise on this natural advantage and implement the recommendations of the Robbins report (1982), with appropriate changes to account for changes in global demand since then. An active policy of marketing top-quality seed, from stands of good phenotype managed for seed production, could result in income of well over half a million Belize dollars annually. The seed stands should be managed more intensively, with especial attention to fire control and the removal of the hardwoods which are the alternate hosts of the cone rust disease. The current licensed logging of this seed source is probably a less than optimum use of the resource, especially as FD control is minimal.

14. The FD needs to charge for the services which it provides to other bodies. For example, substantial damage is done to the roads by military vehicles driving at speed in wet weather but no compensation is charged or paid. Perhaps 12,000 tourists visit Mountain Pine Ridge but likewise pay nothing towards the maintenance of Forest Reserve facilities. Charges to forest licensees for the use of the roads are unrealistically low or non-existent.

Appendix 14: Royalty Rates for Logs, 1959 and 1980.

Area	Local Name	Scientific Name	1959 Rate	1959 Rate	1980 Rate	1980 Rate
			92 cents per cu.ft.	per tree	82 cents per cu.ft.	per tree
A - Northern & Coastal plain	Mahogany	<u>Swietenia macrophylla</u>	15	9.00	60	
	Cedar	<u>Cedrela mexicana</u>	15	9.00	60	
B - West Central	Mahogany	<u>Swietenia macrophylla</u>	15	15.00	60	
	Cedar	<u>Cedrela mexicana</u>	15	15.00	60	
C - South	Mahogany	<u>Swietenia macrophylla</u>	15	25.00	60	
	Cedar	<u>Cedrela mexicana</u>	15	15.00	60	
All Areas	Mayflower	<u>Tabebuia pentaphylla</u>	3	2.00	30	10.00
	Banik	<u>Virela koschnyi</u>	3	2.00	12	8.20
	Santa Maria	<u>Calophyllum brasiliense var. rekoii</u>	3	2.00	12	9.20
	Tubroos	<u>Enterolobium cyclocarpus</u>	3	2.00	12	9.20
	Yemari (San Juan)	<u>Vochysia hondurensis</u>	3	2.00	12	8.20
	Pine	<u>Ficus umbrosa</u>	8	2.00	20	9.00
	Food (cress?)	<u>Pithecellobium guatemalensis</u>	8	2.00	16	9.20
	Santa Helena	<u>Aspidosperma & Pithecolobium spp.</u>		1.00	12	8.20
	Cabbage Bark	<u>Lonocarpus castilloi</u>		1.00	12	8.20
	Carbon	<u>Tetracarpus stevensonii</u>		1.00	12	9.20
	Chicle Macho	<u>Achras chicle</u>		1.00	12	8.20
	Craamatee	<u>Guarea excelsa</u>		1.00	12	9.20
	Nargusta (bullywood)	<u>Terminalia amazonia</u>		1.00	12	9.20
	Salawood	<u>Cordia alliodora</u>		1.00	12	8.00
	Sapodilla	<u>Achras zapota</u>		1.00	12	9.00
	Tamarind	<u>Acacia, & Pithecolobium spp.</u>		1.00	12	8.20
	Timbersweet	<u>Nectandra, Ocotea & Phoebe spp.</u>		1.00	12	8.20
	Billy Webb	<u>Smeathia panamensis</u>		.75	12	8.00
	Bullet Tree	<u>Bucida buceras</u>		.75	12	8.00
	Caoba (cotton tree)	<u>Ceiba occidentalis</u>		.75	12	8.00
	Cortez	<u>Tabebuia chrysantha</u>		.75	12	8.00
	Ironwood	<u>Bialia guianense</u>		.75	12	9.00
	Frickly yellow	<u>Santroxylum spp.</u>		.75	12	9.00
	Waika Chewstick	<u>Syechonia globulifera</u>		.75	12	8.00
	Chechea (Black poison wood)	<u>Metopium brownei</u>		.50	12	9.00
	Mulady	<u>Aspidosperma spp.</u>		.50	12	8.00
	Siliqn (Sally young)	<u>Lycium & Sideroxylon spp.</u>		.50	12	9.00
	Granadilla	<u>Platycodon yucatanus</u>		.25	12	9.00
	Masola	<u>Serenoa filiformis, Swartz ellipticum</u>		.25	12	9.00
	Negrato	<u>Stauruba glauca</u>		.25	12	9.00
	Folal (Balsal)	<u>Ochroma lagopus</u>		.25	12	8.00
	Provision Tree	<u>Paonina aquatica</u>		.25	12	8.00
	Quawood	<u>Schreocloium parahyban</u>		.25	12	8.00
	Peowood (ridge)	<u>Museitoxylum jamaicense</u>		.25	12	8.20
	Madra Cacao	<u>Gliricidia sepium</u>		.20	12	4.20
	Mangrove	<u>Rhizophora, Laguncularia & Avicennia spp.</u>		.20		1.00
	Enter Pale	<u>Enter sp.</u>		.10		.40
Cabbage Pale	<u>Costanea cleraces</u>		.10		.40	
Morc	<u>Melocarpus & Solotia spp.</u>		.10		.40	
Mulady Pale	<u>Aspidosperma aegaloocarpum</u>		.10		.40	
				Per Ton	Per Ton	
		<u>Salicornia stevensonii</u>		4.00	20.20	
		<u>Chlorochora tinctoria</u>		2.00	20.20	
		<u>Homalium canariense</u>		2.00	20.20	
		<u>Cordia alliodora</u>		4.00	20.20	
		<u>Homalium canariense</u>		2.00	20	

Appendix 15: Households Using Wood or Charcoal as Fuel, 1980.

DIVISION	Number of Households	CENSUS of 1980		DIVISION	Household Consumption Survey, 1980				Average Household Expenditure on Wood	Annual Expenditure on Wood
		Households Reporting Wood/Charcoal as Cooking Fuel	Number Percent		Estimated Number of Households	Percent Using Wood	Annual Households Expenditure on Woodfuel	Using wood		
								'000 \$24	\$24	%
Belize City	8197	54	0.7	(Belize City)	(8440)	(6)	(23)	504	45	.40
Belize District	2140	754	37.1	Belize District/City	10360	19	102	1919	53	.59
Corozal District	3895	1715	44.1	Corozal District	4055	59	41	2392	17	.15
Orange Walk	3929	1723	44.1	Orange Walk	4000	53	1-3	2120	19	.77
Stann Creek	2539	1065	37.5	Stann Creek	2940	84	50	1952	27	.43
Toledo	2192	1469	67.8	Toledo	2290	61	3	1955	2	.09
Cayo	3470	1650	46.4	Cayo	4200	60	31	2520	12	.14
Belizean	655	35	5.3	Belizean				Not separately recorded		
Belize	27298	8554	31.3	Belize	29145	45	373	12774	29	.23
				Rural	12910	73	256	9424	27	.30
				Urban	15235	22	115	3352	34	.46

Appendix 16: Apparent Consumption of Sawnwood by Species 1981-87.

Mahogany Cedar

	UNITS	1981	1982	1983	1984	1985	1986	1987
LOG Prod	'000 Cu. Ft.	505	608	284	323	331	225	598
LOG Imp	'000 Cu. Ft.	0	0	0	0	0	0	0
LOG Exp	'000 Cu. Ft.	0	0	0	0	0	0	8
LOG Consp	'000 Cu. Ft.	505	608	284	323	331	225	590
SAWN Prod	,000 Bd. Ft.	3030	3648	1704	1938	1986	1350	3540
SAWN Imp	,000 Bd. Ft.	1711	623	0	0	419	10	0
SAWN Exp	,000 Bd. Ft.	1446	2064	1370	1044	721	310	2327
SAWN Consp	,000 Bd. Ft.	3295	2207	334	694	1684	1050	1213
% exported		46	57	80	54	36	23	66

Other Hardwoods

	UNITS	1981	1982	1983	1984	1985	1986	1987
LOG Prod	'000 Cu. Ft.	707	680	577	674	707	457	951
LOG Imp	'000 Cu. Ft.	0	32	0	0	0	0	0
LOG Exp	'000 Cu. Ft.	29	31	23	10	11	38	79
LOG Consp	'000 Cu. Ft.	600	681	556	664	696	421	872
SAWN Prod	,000 Bd. Ft.	4080	4086	3336	3984	4188	2526	5232
SAWN Imp	,000 Bd. Ft.	432	477	4	1	36	2	3
SAWN Exp	,000 Bd. Ft.	83	564	370	67	16	50	360
SAWN Consp	,000 Bd. Ft.	4429	3999	2970	3898	4208	2478	4875
% exported		2	14	11	2	0	2	7

Conifers

	UNITS	1981	1982	1983	1984	1985	1986	1987
LOG Prod	'000 Cu. Ft.	143	207	316	361	395	450	624
LOG Imp	'000 Cu. Ft.	0	32	0	0	0	0	0
LOG Exp	'000 Cu. Ft.	0	0	0	0	2	2	3
LOG Consp	'000 Cu. Ft.	143	239	316	361	393	448	621
SAWN Prod	,000 Bd. Ft.	858	1434	1896	2166	2358	2688	3726
SAWN Imp	,000 Bd. Ft.	350	216	27	103	7	1	6
SAWN Exp	,000 Bd. Ft.	0	22	20	11	0	0	13
SAWN Consp	,000 Bd. Ft.	1208	1628	1903	2256	2365	2689	3719
% exported		0	2	1	1	0	0	0

Appendix 17: Description Matrix of Sawmills Visited.

	LOG GRADE	PRODUCT	ANNUAL PRODUCTION FOR	SPECIES	MANAGEMENT	OPERATED	AGE OF MACHINERY	TYPE	SOURCE OF ENGINE	CONDITION	EMPLOYMENT	QUALITY OF LOGS	LOG PRICE 1971	VALUE OF LOGS 1971
ORANGE WALK DISTRICT														
LASCOT	PPP	L	1,000	M E H	US M D	Ltd	6	B56	M R	F	15	F	1.10-1.20 /cf	10c
Shipyards Camp 9 Krahn	B	C, D L, M	330	M H	M D	SP	10+	C60	US D	F	12	P	50-70c	15c
Orange Walk Loggia	B	L C, M	275	M H	C	SP	10+	C60	UK L	F	10	P-P		
Shipyards Camp 10 Wall	B	L C, D	600	M H	US M D	SP	6+	C60	US H	F	10	P-P		
Blue Creek Foreman	PPP C	L	25	M P HE	D	SP	1+	C54	US H	P	3-4	P		
Orange Walk Campos	FP FL	L	25	M H	D	SP	10+	C60	US H	P	3-4	P		
Shipyards Camp 8 Bannan	FP	C L	125	M H	M DJO	SP	10+	C60	US H	F	8	F-P	35c	
BELIZE DISTRICT														
Sand Hill Low	PL FP	L, D M	1,000	M P H	US H D	Ltd	15+	C54	Frick US	F	10-11	F	47-50c	25c
Burrell Boon Anselm Gillnet	B	L	240	M P	D	SP	15+	C54	US HY	P	6-7	P		
Isabella Bank Salas	FD	L	35	M P H	D	SP	5+	C60	US HY	P	3-4	P		
CAYO DISTRICT														
Mt. Pine Ridge Forestry Dept		L P	300	M P H	D	G	15+	C48	C	F	10-12	F		
Iguana Creek Robinson	PPP	L, D M	3,300	M H	US D	Ltd	2+	C60	US	G	30	F-C	20c w/o dep	22c
STANN CREEK DISTRICT														
Mango Creek First National Trust		L	300	P	O	Ltd	20+	C52	US Frick	G	6-8	F-C		
Melinda Forest Station Forestry Dept.		L	300	P	D	G	7+	C54	UK	G	12	F		
TOLEDO DISTRICT														
Mile 73 Southern Highway Genus	FL PPP	L	85	M P H	D	SP	15+	C60	US H	P	4-5	P		
Deep River Medina Bank Carcano	FL	L	50	M P H	D	SP	10+	C52	?	P	8	P		
San Antonio Road Derkitts	N.O.	L	500	M P H	D	SP	10+	B6	C	P	9	G	25-30c	12c
Southern Highway Harold Whitney	PPP FL	L, D M	2,000	M P H	D	Ltd	4+	C60	US FO	G	15	G	30-35c	25c
Sweasy Creek Belize Int. For Prod.	FL	L	1,000	P	D	Ltd	25+	C58	US C	G	10	F		
Machaca Tulery	FL	L	30	M P H	O	SP	10+	?	?	?	3-4	?	20c cost 30-35c sells	
Mile 73 Southern Highway Sellers	PL PPP	L C	60	M P H	US D	Ltd	10+	C54	US H	F		F		

KEY TO DESCRIPTION OF SAWMILLS VISITED

NO.	Refers to number of Forest Department list of sawmills.	
LOG SOURCE	PFP	Private Fores. Permit
	B	Buys on open market
	C	Custom saws
	FP	Forest Permit
	FL	Forest Licence
PRODUCT	L	Lumber
	C	Cants
	M	Machined (siding, tongue and groove)
	P	Poles
	D	Dressed
VOLUME	MBF	Thousand board feet lumber scale
	Note: If mill could not provide annual cut, then cubic feet of logs that royalty was paid (according to Forest Department statistics) was multiplied by factor of 6. This could under-estimate production because purchased logs from individual loggers already hammered would not be recorded.	
SPECIES	M	Mahogany
	P	Pine
	H	Hardwoods
	E	Precious hardwood, rosewood, ziricote, etc
MARKET	US	USA
	M	Mexico
	L	Local
	O	Own use
OWNERSHIP	Ltd	Limited Company
	SP	Single Proprietorship
AGE OF HEADRIG	Almost all mills were purchased second hand. If true age is unknown, age is given. If only number of years present owner has owned headrig, those years are given with a + afterwards indicating unknown years of former owner(s).	
TYPE	C	Circular with diameter
	B	Band mill with flywheel diameter
COUNTRY OF ORIGIN	C	Canada
	M	Mexico
	UK	United Kingdom
	G	Germany
	US	USA

MANUFACTURER	R	Rodriguez
	F	Frick
	L	Lyland
	D	Diston
	Hy	Hybrid - mainly of US origin
	FO	Forestal
	C	Corinth
EMPLOYMENT		People working mainly on mill floor and green chain, planer and moulder, but not in yard.
QUALITY OF SAWING	P	Poor
	F	Fair
	G	Good
LOG PRICE		Belize cents/Boardfoot Doyle log scale
MILLING COST		Belize/Boardfoot lumber scale

Appendix 18: Exports of Logs, Wood in Rough and Lumber 1985-87, by Species.

Product & Species	Units	1985	1986	1987	Total 3 Years	Average
<u>LOGS and WOOD in ROUGH:</u>						
Pine Sawlogs and Veneer Logs	'000 cu.ft.	1.75	1.69	2.76	6.20	2.07
Sawlogs and Veneer Logs, Hardwood						
Rosewood	'000 cu.ft.	6.39		3.09	9.48	3.16
Mahogany	'000 cu.ft.			8.00	8.00	2.67
Logwood	'000 cu.ft.	.57	1.72	2.59	5.29	1.76
Zericote	'000 cu.ft.	.29		1.76	2.05	.68
Sapodilla	'000 cu.ft.		.69		.69	.23
Pine Stumps	'000 cu.ft.		199.70	178.87	370.57	123.52
Unspecified Wood in Rough	'000 cu.ft.	2.94	15.63	71.36	89.93	29.98
<u>Total Logs and Wood in Rough</u>	<u>'000 cu.ft.</u>	<u>12.36</u>	<u>219.42</u>	<u>268.43</u>	<u>500.21</u>	<u>166.74</u>
<u>ROUGH LUMBER:</u>						
Pine	'000 bd.ft.			12.52	12.52	4.17
Mahogany	'000 bd.ft.	452.01	246.22	197.83	2666.05	888.68
Caribbean Cedar	'000 bd.ft.	5.14	34.77	196.23	236.14	78.71
Santa Maria	'000 bd.ft.	5.50	12.38	17.36	35.25	11.75
Rosewood	'000 bd.ft.	13.48	20.09		33.57	11.19
Zericote	'000 bd.ft.	5.60		22.74	28.34	9.45
Sapodillo	'000 bd.ft.		6.55		6.55	2.18
Bullett Tree	'000 bd.ft.			5	5.00	1.67
Cabbage Bark	'000 bd.ft.	3.00		1.75	4.75	1.58
Yeneri	'000 bd.ft.			1.65	1.65	.55
Margusta	'000 bd.ft.			1.40	1.40	.47
Cortez	'000 bd.ft.		1.30		1.30	.43
Granadillo	'000 bd.ft.		1.28		1.28	.43
Jobillo	'000 bd.ft.		1.00		1.00	.33
Unspecified	'000 bd.ft.	57.90	4.27	57.42	119.59	39.86
<u>Total Rough Lumber</u>	<u>'000 bd.ft.</u>	<u>542.63</u>	<u>327.85</u>	<u>2283.20</u>	<u>3154.38</u>	<u>1051.46</u>
<u>DRESSED LUMBER</u>						
Mahogany	'000 bd.ft.	125.43	29.38	360.15	514.95	171.65
Caribbean Cedar	'000 bd.ft.	138.16		1.05	139.21	46.40
Santa Maria	'000 bd.ft.			13.25	13.25	4.42
Granadillo	'000 bd.ft.	1.55			1.55	.52
Jokimo	'000 bd.ft.	.39			.39	.13
Zericote	'000 bd.ft.			.25	.25	.08
Unspecified	'000 bd.ft.		1.57	28.88	30.45	10.15
<u>Total Dressed Lumber</u>	<u>'000 bd.ft.</u>	<u>263.58</u>	<u>30.95</u>	<u>420.98</u>	<u>715.69</u>	<u>232.20</u>

VALUE OF LOG, ROUGH WOOD & LUMBER EXPORTS 1985-1987
 BY SPECIES
 (3 Year Totals)

Species	'000 BZs
Pine (including stumps)	1541.69
Mahogany	4629.83
Cedar	559.80
Rosewood	195.86
Santa Maria	90.15
Logwood	83.94
Zericote	51.37
Jobillo	13.64
Bullet Tree	7.50
Cabbage Bark	6.23
Sapodillo	5.36
Granadillo	3.96
Cortez	1.63
Nargusta	1.40
Yemeri	.99
Jokimo	.54

AVERAGE EXPORT VALUES OF LOGS AND LUMBER BY SPECIES AND CATEGORY
1985-1987

Species	Category	Units	1985	1986	1987
Logwood	Logs	BZ\$/Cu. Ft.		20.59	
Mahogany	Logs	BZ\$/Bd. Ft.			1.39
Rosewood	Logs	BZ\$/Cu. Ft.	29.11		11.01
Sapodillo	Logs	BZ\$/Cu. Ft.		2.47	
Ziricote	Logs	BZ\$/Cu. Ft.	20.69		12.05
Pine	Rough Lumber	BZ\$/'000 Bd. Ft.			1039
Bullet Tree	Rough Lumber	BZ\$/'000 Bd. Ft.			1500
Cabbage Bark	Rough Lumber	BZ\$/'000 Bd. Ft.	900		2010
Cedar	Rough Lumber	BZ\$/'000 Bd. Ft.	1168	1064	1536
Cortez	Rough Lumber	BZ\$/'000 Bd. Ft.		1250	
Granadillo	Rough Lumber	BZ\$/'000 Bd. Ft.		1400	
Mahogany	Rough Lumber	BZ\$/'000 Bd. Ft.			1983
Mahogany	Rough Lumber	BZ\$/'000 Bd. Ft.	1115	1267	1517
Rosewood	Rough Lumber	BZ\$/'000 Bd. Ft.	5246	3821	
Santa Maria	Rough Lumber	BZ\$/'000 Bd. Ft.	800	923	2402
Sapodillo	Rough Lumber	BZ\$/'000 Bd. Ft.		559	
Yameri	Rough Lumber	BZ\$/'000 Bd. Ft.			600
Ziricote	Rough Lumber	BZ\$/'000 Bd. Ft.	1429		920
Unspecified Hardwood	Rough Lumber	BZ\$/'000 Bd. Ft.	1897	902	1046
Cedar	Dressed Lumber	BZ\$/'000 Bd. ft.	1534		1898
Granadillo	Dressed Lumber	BZ\$/'000 Bd. Ft.	1400		
Jokiao	Dressed Lumber	BZ\$/'000 Bd. Ft.	1400		
Mahogany	Dressed Lumber	BZ\$/'000 Bd. ft.	1491	1362	1638
Santa Maria	Dressed Lumber	BZ\$/'000 Bd. Ft.			2765
Ziricote	Dressed Lumber	BZ\$/'000 Bd. Ft.			4800
Unspecified Hardwood	Dressed Lumber	BZ\$/'000 Bd. ft.		2737	2801

Appendix 19: Forest Management

Recommended scales of operation

The scales of operations should be those which maximize the financial returns from forest produce while maintaining the productivity of the forest site. That is, a balance has to be struck between what is desirable from the silviculturist's point of view and what is tolerable by the private sector users of the forest. Since there is substantial ecological diversity in the Belize forests it follows that no single management or utilization model will suit all circumstances. Equity requires that the forest law be the same for all but that does not imply that the terms of each concession (forest licence or permit) have to be equal. Similarly, the management systems and silvicultural regimes may differ substantially between forests.

This section considers in turn the management of four types of forest land: broadleaved Forest Reserve, Mountain Pine Ridge, pine Forest Reserve on the Southern Coastal Plain and forest on private and national (formerly Crown) land. In most cases, changes in management will be gradual because substantial areas of the permanent forest estate have been given out under 5- and 10-year long-term forest licences in 1986 and 1987.

The management of the permanent forest estate does not imply that all parts should be under licence. The example was given of Chiquibul Forest Reserve, exploited almost continuously from the 1920s until 1985 and damaged more or less severely by hurricane in 1961. Evidently this area, which is remote from population centres and so not under pressure to supply small-wood for rural communities, needs to be rested in order to allow time for the growing stock to rebuild.

Having drawn up general terms and conditions for forest exploitation (see the section below, "Revise concession agreements"), the Forest Department needs to consider each area in turn, as to its present state and most appropriate management regime. This process involves the review of multivariate data and a wide spectrum of potential uses of the forest land. Much of the permanent forest estate is on broken topography with steep slopes. The foothills and flatter land are increasingly being converted to temporary and permanent agriculture and the primary purpose of the gazetted forest is to regulate water flows and to prevent erosion damage to agricultural land. This is the opinion of the TFAP Mission, since with one exception the gazette notices do not specify the specific objectives of individual Forest Reserves, there is no formal process of consultation before Forest Reserves are gazetted or dereserved, and the Forest Department does not maintain files for individual Forest Reserves.

The first step in management operations for a particular Forest Reserve or portion of national land is thus to use the topographic maps and aerial photographs to delineate areas which should be permanently retained under forest for agricultural

protection. The ODNRI land resource surveys of Toledo and Stann Creek Districts (King et al. 1986, 1988) offer reasoned suggestions as to which land systems should be protected. However, Central Farm has been unable to supply agroecological yield data to justify these recommendations, and has no current plans to do so. Documents seen by the TFAP Mission repeatedly mention an overall 20-22% of permanent forest estate as having a protective function but the origin of this value is unknown.

The second step is to delineate areas which should remain unlogged because of their greater value as sources of genetic material, as tourist attractions or as recreation areas. National and international conservation organizations and the Department of Tourism should be involved in the discussions. It is relatively easy to estimate a cash value of the commercial timber foregone by not logging an area and the Forest Department should be prepared to listen to arguments which appeal to intangible values. This does not mean that the Forest Department should automatically accept arguments for large scale bans on logging. The arguments for and against and the reasons for the final decisions should be recorded in (new) permanent archives for each Forest Reserve.

The remaining area of a Forest Reserve is now assumed to be available for management for tangible forest products. Three of the large Forest Reserves with broadleaved forest have not been inventoried after the 1961 hurricane: Manatee, Sibun and Sittee. Sibun and Sittee have little land which could be managed for timber production because the topography is so severe. Manatee will presumably come under pressure for complete dereservation or partial excisions, as soon as the new Stann Creek-Belize City road is opened. Some of Manatee is on easy terrain but attempts to reduce the Forest Reserve should be resisted until after the area has been covered by the 1989 land resource study. It would then be appropriate to inventory the unthreatened and marginal areas of that reserve, to facilitate discussion about its future.

The assembly of inventory data constitutes the third stage of management operations. Belize has no yield plot data for broadleaved forest so only the static inventories are to be considered. The other broadleaved Forest Reserves have been inventoried in the 1970s or early 1980s. Although they have been logged subsequently the production levels have been both low and highly selective as to species, and no significant hurricane damage has been recorded since the inventories were carried out. There is thus no reason for planning-level inventories to be executed again.

The inventories of the 1970s and early 1980s all used the same sampling design, two strips per block. The blocks were 3.1 x 3.1 miles (5 x 5 km) or 5.0 x 5.0 miles (8 x 8 km) squares, orientated north-south east-west, with 66 ft (20 m) wide transects (131 ft, or 40 m, for primary hardwoods) running the full length or width of a block. Square blocking is unsuitable for broken topography. Some attempts were made to stratify the terrain into more and less remote and more and less precipitous

zones, and notes were made on some site factors in every 66 x 164 ft (20 x 50 m) plot in a transect. It does not appear that these site characters were used to post-stratify the data. Data on secondary species were grouped by colour and hardness, and sometimes density, according to FAO-suggested classes. Unfortunately there seems to have been difficulties of communication between the field crews and the data processing institution, so that the results given in the inventory reports are not consistent between Reserves. None of the summaries are suitable for forest management planning, either for an individual Reserve or for national planning. It is not clear how FAO (1978) obtained estimates for the standing stock of timber, the annual increment and the annual allowable cut since the presently available summaries from the Forest Department's inventories do not permit such calculations.

The relative consistency of the inventory designs and field procedures will allow national estimates of the standing stock in the permanent forest estate after the data have been reprocessed in a consistent manner, including post-stratification according to site characteristics; the latter should include the Wright *et al.* (1959) forest type and the King *et al.* (1986, 1988) land system or soil type. The Forest Department has no yield plots in broadleaved forest so growth data are not available. Crude estimates of increment can be no better than the pantropical 14-29 ft³/acre (1-2 m³/ha) per year for unmanaged forest and 29-57 ft³/acre (2-4 m³/ha) per year for forest with extensive silvicultural treatment after logging.

The fourth stage of management operations combines the results from the static inventory with log production data from the licensees, recorded by the Forest Department and checked against the licensee's obligatory annual statement. These figures, together with the Forest Department's knowledge of the logging techniques used by each licensee, will suggest the standing stock in each site type. The size class distribution of each species or species group on each site type can then be superimposed on forest type maps. Provisional compartments can be delineated, based on topography (natural boundaries such as ridges and streams are preferable) on the provisional stock map.

At this point, the fifth stage, the Forest Department needs to consider the priorities for bringing the compartments progressively under active management. Usually the compartments with the growing stock closest to commercial size would be managed first (diagnostic sampling, silvicultural treatment if appropriate, installation of permanent yield plots). However the Forest Department would need to consider the purely silvicultural priorities in conjunction with its industrial strategy. Are there mills to be supplied by this forest with particular species, sizes and quantities of forest products? Obviously the matching of forest production capability to industry, and other consumers of forest products, is an iterative process.

The sixth step in forest management operations is to decide when the forest can be cut again. This should occur when the

mean annual increment in volume of the commercial species has attained its maximum. In uneven-aged forest it is conventional to substitute total basal area for age as the abscissa. Growth data cannot be substituted, hence the importance of installing yield plots as soon as possible. It is worth emphasizing that the inventories showed that the broadleaved Forest Reserves are still recovering from the 1961 hurricane damage. They are not in a steady state. The mean annual increment cannot be harvested yet without violating the forest policy.

The Belizean conditions favour exactly the opposite system to the polycyclic selective logging which has been used to date. Concentrated intensive logging under a monocyclic uniform system is obviously cheaper to operate than extensive logging with long hauls and high transport costs. Supervision costs are also lower for the Forest Department. Pre-logging sampling is essential to confirm that there is sufficient regeneration of desirable species to grow into the next crop. If regeneration is scarce, the Forest Department can delay opening the compartment until subsequent surveys show the presence of enough regeneration, or the existing regeneration can be enriched after logging by line-planting. Alternatively, if there is a sufficient population of undergirth trees of desirable species, a polycyclic system can be used. There is no reason for a single silvicultural system to be employed throughout the Belize broadleaved forests; the system should be varied according to the results of compartment stock mapping and regeneration surveys.

The exploitation should be as heavy as possible, consistent with maintaining site productivity. In practice this means that sufficient regeneration or adolescent trees of commercial species (primary and secondary hardwoods) should be available to form the next crop, taking into account losses due to logging. Losses include the trees destroyed at the time of exploitation and the subsequent mortality of damaged trees and the net loss due to rot in the survivors. The stock mapping, yield plots and diagnostic sampling supply the data from which the cutting limits can be determined for different areas within a licence area; it will be appreciated that this is quite different from the present system of nation-wide cutting limits varied only by species. The same data sources provide the list of obligatory species and sizes which must be cut by the licensee.

Post-logging management involves first a block-closing inspection, with the calculation of fines for unnecessary waste, damage to residual commercial trees and regeneration and the drainage, and for failing to fell obligatory trees. A rapid sampling determines whether line enrichment planting is necessary to supplement natural regeneration. At about five years after logging, a thorough diagnostic sampling determines the need for and type of silvicultural treatment, and yield plots are re-established.

This brief summary of the management operations sequence does not include the specific procedures concerning the control of exploitation and post-logging silviculture. These are readily

available in the literature (Surinam and Malaysia provide excellent examples).

The special case of the mangrove forests needs to be touched upon. The TFAP Mission had understood, during its visit to Belize, that the University of Edinburgh would be undertaking a wide-ranging study of the mangroves in Belize. As a result, less attention was paid to the mangroves than was really appropriate.

The demand for conventional mangrove products is low in Belize, unlike many tropical countries, but they are being reduced by clearance for sea-front housing and tourist facilities. Although no specific survey was made, the TFAP Mission was told informally that the 1961 hurricane destroyed a considerable area of mangrove and beach forest. There is some concern that the present clearing of mangroves may affect the stability of the cayes and the mainland shore. However the chief worry is the loss of spawning and feeding grounds and its effect on marine fisheries. The direct and indirect pollution of the mangroves near Belize City could perhaps be controlled by gazetting this national land as a Forest Reserve and managing it as protection forest for the fisheries and coast stability. Mangrove forests which are being exploited selectively for Conocarpus, preferred for fueling lime kilns beside the Hummingbird Highway, should be gazetted as production Forest Reserves. There is a large body of published information on the management of mangroves. Much of this has been consolidated into reviews and manuals and is available from FAO or UNESCO.

Although felling for timber should usually be a single-stage operation, once per rotation, in broadleaved forest in Belize the forest law correctly allows for the issue of different licences for different forest products over the same area. For example, it would be reasonable to license the harvesting of palm leaves for thatching simultaneously or immediately after commercial logging. The demand for minor forest products appears to be low in Belize, because of the small rural population and it is unlikely that fee collection for harvests of infrequent products would cover its cost. However the Forest Department should be able to prevent the collections which are detrimental to the major objects of management; for example, the taking of house poles from the sapling regeneration of commercial species should be prohibited.

It is most important that the Forest Department keeps good records of the costs of the different operations. The first charge paid by a licensee should be a per-acre/hectare management fee for the whole area of the licence. This charge should be quite distinct from any royalty on log production and the fines for violations of the licence agreement and the forest law.

Since the late 1940s the Forest Department has devoted a high proportion of its field operations to 47,000 acres (19,000 ha) of the 126,000 acres (51,000 ha) of the Mountain Pine Ridge. Progressively applied fire control has resulted in good regeneration and pole crops on most of the area. The poverty of

the soils is such that the average growth rate is very low, less than 29 ft³/acre (2 m³/ha) per year, so intensive management for timber is almost inevitably uneconomical. A total valuation of all the goods and services which are or could be produced by this forest should indicate the appropriate level of management. Appendix 10 contains an analysis of the growing stock, from preliminary analysis of the 1970 and 1980 inventories. Re-processing of the inventory data and combination with data from thinning experiments and yield plots will provide a much more solid base for pine management planning. It should be emphasized here that the existing thinning experiments cannot provide information leading to the development of thinning regimes: the design, execution, subsequent management of, and data collection from, these plots has been inconsistent with the original objectives (Palmer 1982). It should be further emphasized that trees with the ecological characteristics of tropical pines are unlikely to respond to thinning after the establishment phase and there is no quantitative evidence that those on the Mountain Pine Ridge have done so. Appendix 10 also contains 14 suggestions for the future management of the Mountain Pine Ridge.

Under present conditions, management of the natural pine in the Forest Reserves on the Southern Coastal Plain should be a low priority for the Forest Department. Even when the Department was at its peak in staffing and activity on the SCP, both plantations and natural pine suffered repeatedly from fires started by hunters and farmers. However, if fire can be controlled, the rate of growth on the SCP has been estimated to be about 86 ft³/acre (6 m³/ha) per year (Martin Johnson 1988, personal communication), that is, three times the rate on the Mountain Pine Ridge and twice that of the broadleaved forest. Fire control is most likely to be feasible in areas adjacent to citrus farms. Self-interest on the part of citrus managers should induce them to help in fire control (detection, suppression and prescribed burning). The Forest Department should explore the possibilities of joint management of natural pine stands adjacent to citrus schemes.

Johnson (in King et al. 1988) pointed out that the remaining pine plantations on the SCP are well into the middle of their rotation. It is now too late to thin them as a silvicultural measure to enhance the increment of the crop trees. Hurricanes and fires have reduced the stocking to levels not far from a saw-timber regime so growth rates may be near the potential of the unimproved sites. The cost of fire control in these small areas (Commerce Bight, Grant's Work A & B Forest Reserves and the Savannah plantations) should be analysed in relation to the value of the expected yield at rotation age; there are thinning experiments and yield plots on the SCP. There is the political point that the present failure of the Forest Department to protect its plantations from fire decreases the Department's status in the rural population.

How much effort is worth devoting to pine management on the SCP depends mainly on the projected demand for pine products. Multiple products and services on the Mountain Pine Ridge provide

a greater justification in the uplands but this is not true on the plain. Management of the broadleaved forest is also justified because of the multiple products and services; the growth and yield of timber alone would justify little more than a regulation of exploitation. It is important that the Forest Department conveys to the GOB the permanent value of these multiple outputs, as the basis for a much stronger Department.

The last part of this section concerns the management of forests on private and national land. In the early years of the Forest Department a substantial effort was made to extend Departmental control to forest outside the gazetted Forest Reserves. This was resisted by the logging companies but the responsible Minister may order the application of any of the provisions of the Forests Ordinance to private land; the Ordinance applies broadly to Forest Reserves and national land.

Since all the richest broadleaved forest, on the easiest terrain, is in private hands, it is easy to understand the desire of the Forest Department to improve the management through legal controls. At present the great bulk of the non-conifer log production is from private land and one can appreciate the desire of the GOB to obtain a royalty from the timber extracted. However, there is no GOB input into these private forests, and no fiscal or other incentive to a private owner to manage his area. The Forest Department can offer at present no demonstration area where the management of broadleaved forest is being practised in a Forest Reserve, nor a manual for management. Unless the private owner so operates his forest as to create a tort, and thus become liable to a private legal action, it is not clear that there is any principle in justice by which the owner can be compelled to use his land or forest in a particular manner; or be prevented from doing so. At least until the Forest Department has the gazetted Forest Reserves under active management there does not seem to be any point in seeking to intervene in the operation in private forests.

The application of the forest law to national lands is also debatable. If the land could be more profitably used for non-forest purposes the forest policy gives no ground for attempts at forest management. If the land should be under forest for protection of soil or water flows, it should be gazetted into the permanent forest estate. If the land can be most profitably used for forestry but is surplus to the satisfaction of domestic needs then the application of management depends on government policy towards exports. The TFAP Mission was able to find no quantitative guidelines from the GOB about the effort to be devoted to the support of exports. The simplest way of removing uncertainty would be to gazette as Forest Reserve all national land which the Land Use Committee declares to be best suited to forestry.

Update and adopt working plans

"Priority should be assigned to the preparation and implementation of management plans for the economic and rational utilization of the highest potential forest areas which are already reserved and partly inventoried, on the principles of sustained yield" (FAO 1978, page 9). This recommendation has been repeated in both earlier and later advisory reports to the GOB.

Draft management plans were written for several areas after inventories in the 1950s. At least the 1956 plan for the Mountain Pine Ridge was revised in 1960 to accommodate the reduced budget following the cuts recommended by Downie in 1959. All existing working plans were nullified by hurricane Hattie in 1961. The inventories of the 1970s were followed by draft plans at least for the Columbia River + Maya Mountains Forest Reserves, Chiquibul Forest Reserve and the Mountain Pine Ridge. Indeed, the Mountain Pine Ridge has had several draft working plans prepared over the last decade. It is not clear why these plans have not been approved or executed. The TFAP Mission understands that field activities in the Divisions and Districts are carried out under annual work plans but current plans appear to be extremely sketchy.

Even the fastest-growing trees on a short rotation have a maturation period longer than most agricultural crops. Stability of policy and objectives, and continuity of execution, are fundamental for effective and efficient forestry. Forestry is too complex a subject for the management plans to be carried in the head of the DFO or responsible Forest Ranger. The working plan records the policy and biophysical justification for management activities; lays out what has been done and what should be done, where and when; and provides the criteria for measuring efficiency and success. In the absence of a forest management manual for Belize, the working plans should detail the procedures to be followed in the field and office.

The existing draft working plans provide a good or very good biophysical background for each of the four Forest Reserves. However they are weak on the justification of objectives, poor on the estimation of yield and provide almost no guidance on management routines. The weakness in yield calculation stems partly from the unsuitable processing of the inventory data and from the absence of growth data. However, yield plots and experiments do exist on the Mountain Pine Ridge and, in view of the Forest Department's great interest in this area, it would be appropriate to start the more suitable working plans with this Forest Reserve. It is, however, only 8% of the permanent forest estate, and has perhaps the lowest productivity. The simplicity of the ecology and management regime makes it a suitable teaching area for Forest Department staff before going on to the broadleaved forest.

Data from static inventories, yield plots, experiments and log harvests should be organized and re-analysed to provide the

basis for a new generation of working plans, beginning with the Mountain Pine Ridge which is the simplest case.

All forest operations must be recorded, in selectively retrievable formats, to show why, what, how, how much, where and when. The many years of unrecorded operations on Mountain Pine Ridge lead to great difficulties in interpreting the stocking and growth of the residual trees.

The working plans must be based on the ecological characteristics of the forest. At present they either ignore this point or assume characteristics (shade-bearing species responsive to late release) which are the opposite of what is observable. Working plans which estimate future yields from present stand tables, assumed growth rates (0.4 inches, or 1cm, dbh/year) and times of passage must incorporate allowances for mortality. Cutting-limit, tree-by-tree selection felling should be replaced by crop felling systems with area control of yield.

Revise management to reflect the ecology of the species

Chapter 3.3 has explained why the polycyclic selection system more or less applied in Belize should be replaced by a monocyclic uniform system wherever the conditions are suitable. Mayan agriculture, hurricanes and, to a minor extent, past logging have combined to favour tree species which are relatively shade-intolerant after establishment, and fast-growing. They tend to have branching patterns and leaf layering which make them efficient at capturing sunlight. They often have open or light or bunched crowns at maturity although they may be narrow-crowned while in competition to reach full sunlight. Some of the commercial species are remarkably widespread across a range of soil types (for example, Calophyllum) or have a wide altitudinal range (for example, Vochysia) which simplifies management. Their propagules are produced relatively early in life, in abundance, and are wind-, bird- or bat-dispersed.

These factors are conducive to simple management systems. Once such trees are well-established and have plenty of room to grow, they need no intervention. Indeed they are not sufficiently plastic after early years to increase their rates of growth after thinning out "competition". They do require decisive management early in the rotation but otherwise can be left alone.

There are often relatively few trees of such species in the intermediate size classes because they grow rapidly and then cut off the light to succeeding cohorts of their own kind. The forests thus tend to contain a narrow spread of age classes. If the largest trees are repeatedly removed in a polycyclic selection system, those will be just those faster-growing specimens which should be the seed-bearers for improving the next generation and the less-desirable slower-growing trees will be left. Management for sustained or improved yield requires that one generation should be removed entirely to allow the next, seedling, generation to come through.

The pines are an extreme case of this pioneer-type ecological tendency. In Belize they occupy the sites which are extremely infertile for geological reasons and maintained in that state by fire. Where Man greatly increases the fire frequency the pine cannot survive long enough to get through the sensitive seedling stage and the trees are replaced by grass and scrub.

Pre-commercial thinning is unlikely to be economic except in the dense natural regeneration of the tropical pines. Thinning should be early and heavy, because the pines lose their plasticity to respond to thinning after their first decade.

The present practice in Belize of felling individual trees as they reach an arbitrary girth is exactly the way to remove the genetic traits for fast-growing trees from the population, and thus absolutely contrary to the principle of sustained yield.

The cutting girth limits should be modified to match the ecological characteristics of the tree species. The species of major importance are not shade bearers, nor is there any evidence that they will respond to liberations except in the juvenile stage of growth. Cutting limits should be geared to the control of damage to residual trees by logging and to the maintenance of an adequate population of mother trees for seed production. The mother trees should be of good phenotype from desirable species and the quantity of regeneration of these species, whether as seedlings or as adolescents, should be sufficient to provide for a fully-stocked following crop. The quantity of regeneration should be sufficient to compensate for logging damage.

The Forest Department map showing licence and permit areas for 1987 reveals that some parts of the permanent forest estate are under Standard Form I licences which are specifically marked as "Not for sustained yield working". This appears to be contrary to the forest policy. Observed cases are 4/87, 5/87 and 16/87 in the Maya Mountains Forest Reserve and 10/87 in Manatee Forest Reserve.

The management systems should depend on the present structure of the forests and the ecological tendencies of the commercial species. The systems employed in any particular management area should depend on the results of static and dynamic inventories of the forest as it develops, not on national-scale preconceived fixed rules.

More intensive logging

Inventories in the broadleaved forests show consistently that the bulk of the present growing stock is in species which have technically adequate timber properties but which have not been harvested so far except on a small scale. Some information on timber properties has been available for the principal 50 species for over 40 years. Forest industry development should be geared to the use of species in mixture rather than individual species. The historical concentration on a very limited number

of species was possible only because of the unusual richness of the Belize forests. However the 200 years of exploitation have greatly depleted the forests. The appearance of sustained production has been possible only by reducing the cutting limits. The impoverishment of the forests has been aggravated by hurricane damage. Large areas of forest are now almost lacking in trees of merchantable size and will need to be protected for several decades before they can be harvested again.

Harvesting costs in the broadleaved forests at present are, on the one hand, low because there is no investment in all-weather roads and, on the other hand, high because logging is not carried out all the year round. Per acre/hectare costs are raised by the low intensity of logging. The traditional practice of highly selective and low intensity logging has conserved the ecological structure of the forest but militates against silvicultural improvement: the forest remains stocked with technically acceptable species and the reduction in basal area is too small to justify silvicultural measures in favour of the few primary species which have been logged.

The gross characteristics of 46 secondary hardwoods were described by Lamb (1946). Improved information is about to be published by Echenique-Manrique & Plumptre (1988). For those species or their near relatives which occur in South America, the timber laboratory at INPA in Manaus and the furniture manufacturers' association AIMA in Quito could provide information on behaviour of the timbers in small dimensions and their finishing characteristics.

When the inventory and log production data have been re-analysed, there will be standardized information on the volumes and sizes of individual species in 5 of the broadleaved Forest Reserves (Chiquibul, Cockscomb, Columbia River, Deep River, Maya Mountains). This information should be extracted for different vegetation types (Wright et al. 1959) or land systems (King et al. 1986, 1988) or combinations of groupings, so that estimates can be made for the Forest Reserves which have not yet been inventoried. This information provides part of the base for long-term planning. Compartment stock-mapping and pre-exploitation logging block inventory provide the more detailed data for short-term planning.

The greatly improved information base should benefit both the Forest Department and the logging companies. Low intensity logging over extensive areas is expensive to administer as well as to operate. It is not surprising that the Forest Department control over licensees in the field is weak. Loggers should be required to work systematically through the forest, by demarcated logging blocks, and to take all technically acceptable trees. There should be enforceable penalties for leaving such trees and for avoidable damage to regeneration.

The change to a monocyclic uniform management system is most extreme for the pine forests. It is already known that clear felling with retained seed trees and a post-logging prescribed

burn gives abundant pine regeneration. Compared with the present system, the logging would be highly concentrated, thus reducing the costs of both the Forest Department and the exploiting company. Naturally there will tend to be a wider spread of tree sizes to be exploited, since whole stands would be felled (except the pre-marked superior seed trees) and this will probably require a change by the timber companies to sawmills more appropriate to the tree size than those they use at present.

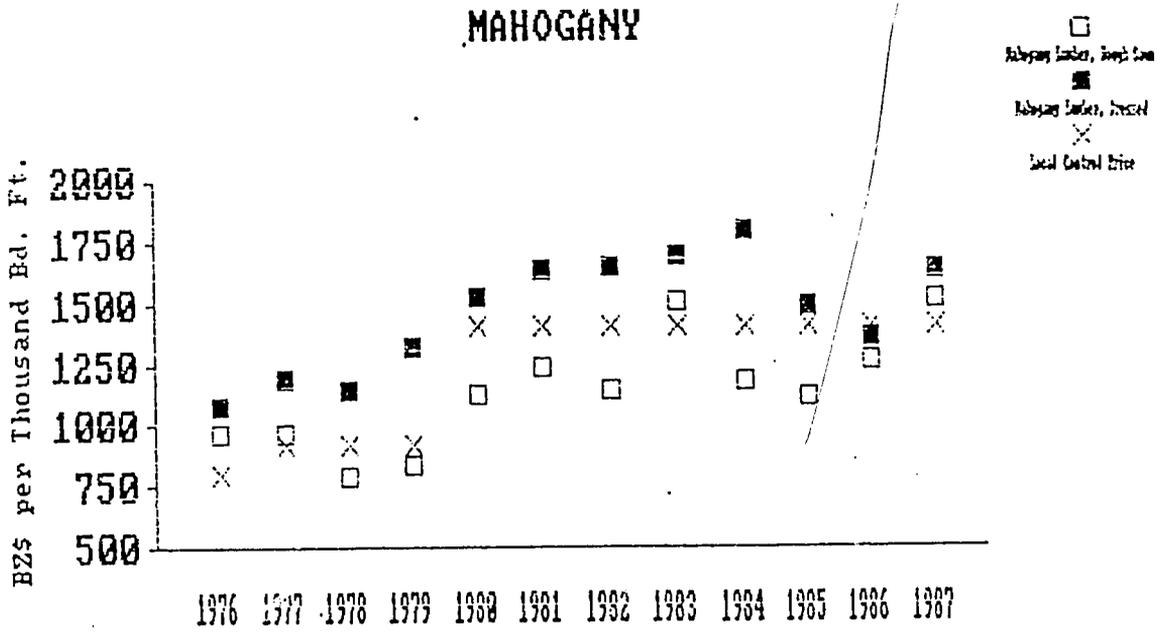
A change to monocyclic uniform working allows the Forest Department to offer a stick-and-carrot approach to adjusting the forest industries of Belize; those willing to invest in more suitable mills reap the benefits of lower logging costs through concentrated felling by stands rather than individual trees. Stand logging may also make two-stage exploitation more attractive, with larger companies taking out the prime logs for processing in big fixed mills and smaller companies or individuals following up to cut the smaller logs and logging waste with towed portable mills.

Lower logging costs also make it easier for the Forest Department to insist on higher standards of road-building, since this would be in the interests of the exploiter when taking out larger quantities over a fixed route. The forest law provides for Forest Department direction on roading standards.

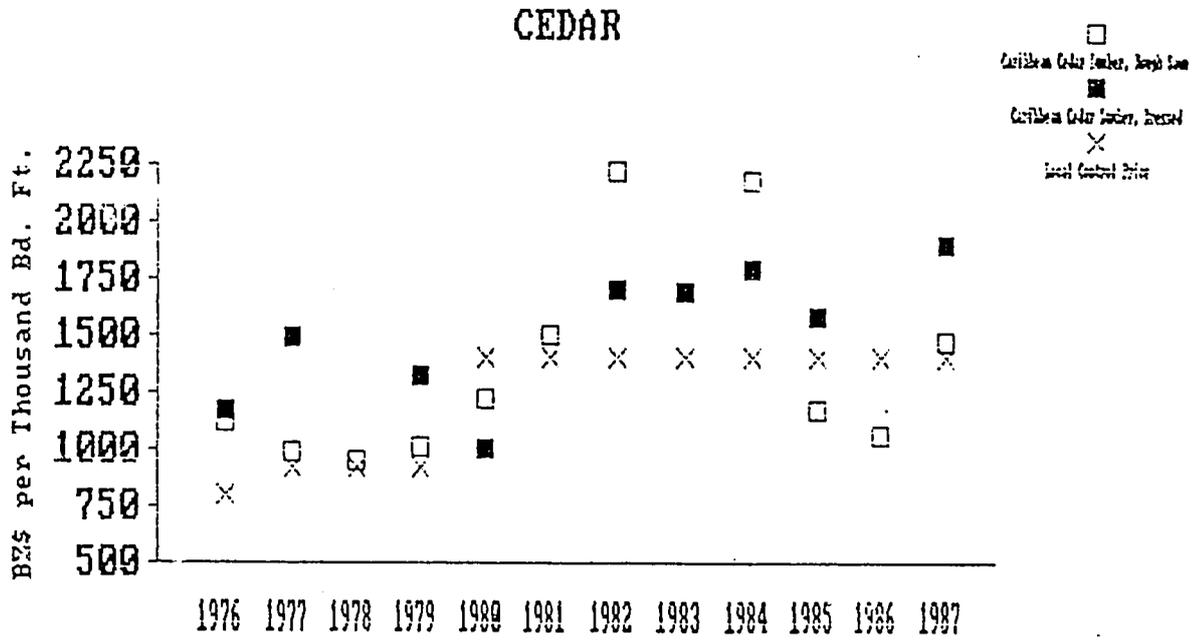
Appendix 20: Control Prices.

SCHEMATIC RELATIONSHIP OF
CONTROL PRICES, COSTS, ROYALTIES AND PROFIT MARGINS

	Mahogany	Pine	Other Hardwood
	BZ\$ per Board Foot		
Control Price	1.40	.70	.77
Logging & Milling Cost			
High	.90	.60	.90
Low	.55	.50	.55
Margin for Profit & Royalty			
High	.85	.20	.22
Low	.50	.10	-.13
Royalty @ 50% Yield	.10	.03	.02
Indicated Profit			
High	.75	.17	.20
Low	.40	.07	-.15

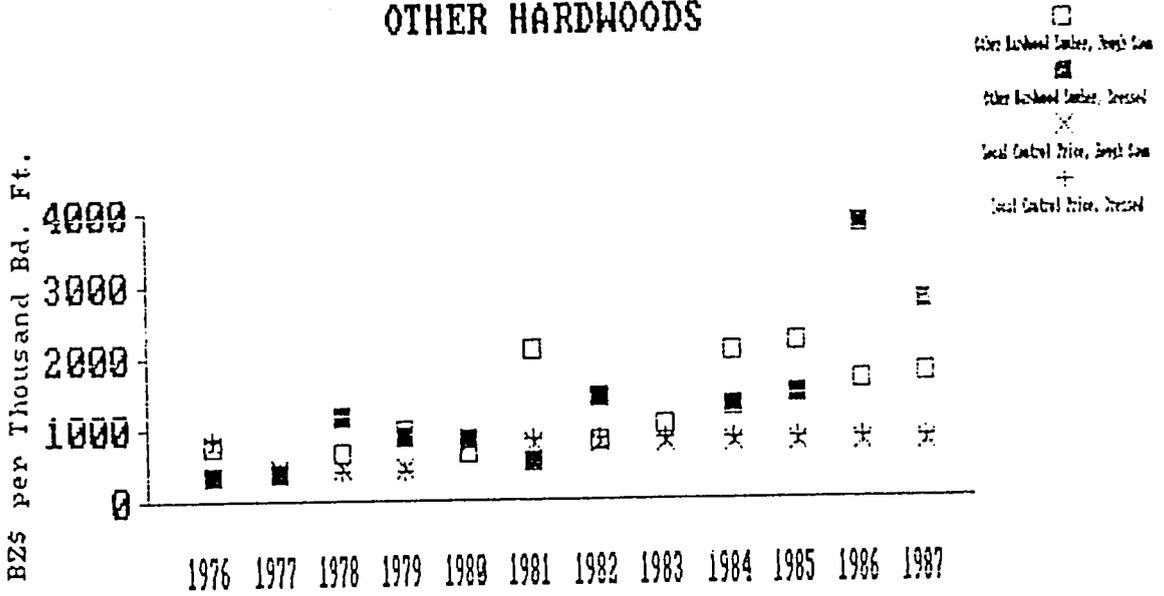


AVERAGE EXPORT VALUES AND LOCAL CONTROL PRICES



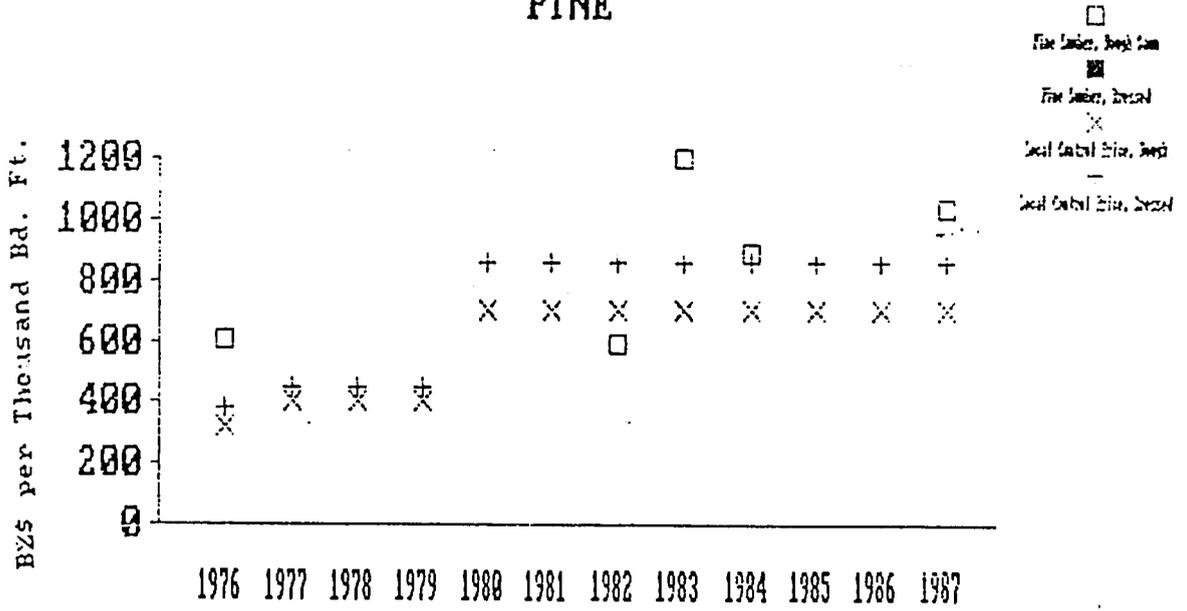
AVERAGE EXPORT VALUES AND LOCAL CONTROL PRICES

OTHER HARDWOODS

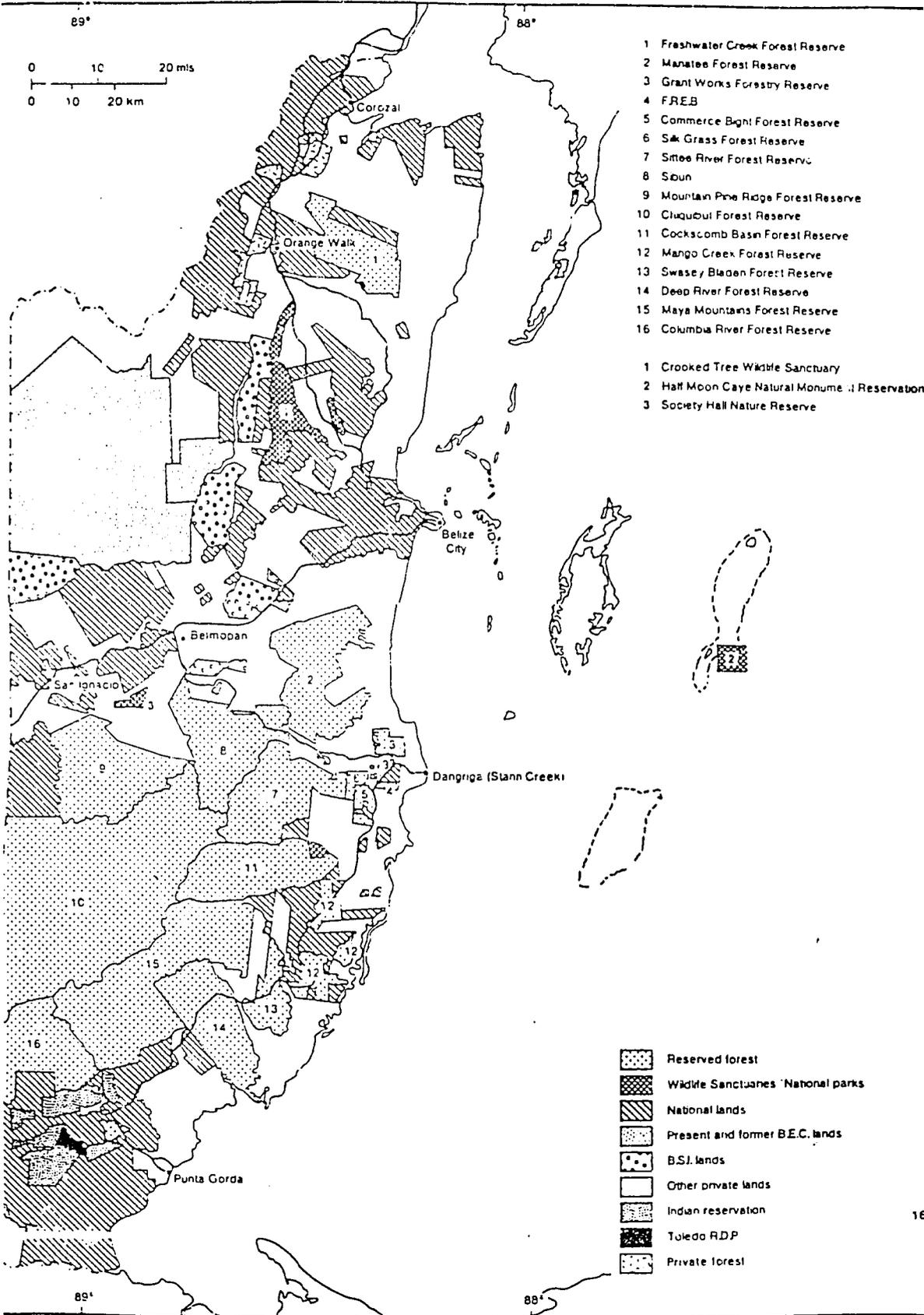


AVERAGE EXPORT VALUES AND LOCAL CONTROL PRICES

PINE



AVERAGE EXPORT VALUES AND LOCAL CONTROL PRICES



- 1 Freshwater Creek Forest Reserve
- 2 Manatee Forest Reserve
- 3 Grant Works Forestry Reserve
- 4 F.R.E.B.
- 5 Commerce Bight Forest Reserve
- 6 San Grass Forest Reserve
- 7 Sittou Forest Reserve
- 8 Soun
- 9 Mountain Pine Ridge Forest Reserve
- 10 Chiquibul Forest Reserve
- 11 Cockscomb Basin Forest Reserve
- 12 Mango Creek Forest Reserve
- 13 Swasey Bladen Forest Reserve
- 14 Deep River Forest Reserve
- 15 Maya Mountains Forest Reserve
- 16 Columbia River Forest Reserve

- 1 Crooked Tree Wildlife Sanctuary
- 2 Half Moon Caye Natural Monument Reservation
- 3 Society Hill Nature Reserve

- Reserved forest
- Wildlife Sanctuaries / National parks
- National lands
- Present and former B.E.C. lands
- B.S.I. lands
- Other private lands
- Indian reservation
- Toledo R.D.P.
- Private forest

272'

