Reduction of damage to tropical moist forest through planned harvesting

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SUMMARY

The damage occasioned by harvesting in a planned manner is assessed. The main features of the approach to damage reduction were: previous surveying and careful construction of roads and skidding trails, climber cutting and directional felling. Harvested volume was 20 m^3 ha^{-1}. The number of damaged trees over 10 cm in diameter was 5.3 per tree logged and the volume of damage was 0.27 m^3 per cubic metre extracted. Damage caused to the canopy by road and trail cutting, provision of landings and felling damage amounted to a maximum canopy opening of 15%.

Keywords: climber cutting, directional felling, harvesting damage, planned harvesting.

INTRODUCTION

In many parts of the tropics, forest management has paid little attention to the minimisation of damaged caused to the forest through exploitation. The main concern has been with the choice and performance of the logging technologies and equipment employed. With growing awareness of the fragility of humid tropical forest ecosystems it has become clear that forest operations have to be carefully planned and executed so not to unbalance the ecosystem (Braz 1992). When the subject of sustaining wood production over a number of cutting cycles is considered, it becomes obvious that planned exploitation is the key to ensuring that the growing stock is maintained at a desirable level. Quite apart from the sustention of timber production, maintaining the level of growing stock levels is, of course, important for the provision of other services such as biodiversity, local climate, etc. Regeneration also requires that attention be paid to size of clearing, a factor much influenced by the felling operation (Yared and de Souza 1993). There is a further factor in favour of careful planning of forest exploitation: planned production reflects positively on management costs. Hendrison (1989), based on research in Suriname, concluded that controlled exploitation was more efficient than conventional exploitation. He reported that average annual skidder production with planned harvesting was double that achieved in conventional exploitation.

The aim of the study reported here was to plan harvesting in an area of dense forest and to record the damage to the residual stand.

MATERIAL AND METHODS

Area characteristics

The CPAF-Acre forest area covers some 800 ha. The soil is predominantly dark red oxisol with a high clay percentage. The climate is type Am (Köppen classification); in other words a hot humid climate during the rainy season and a dry season from June to October. The Igarapé (river) Forquilha cuts the area diagonally producing a series of temporary creeks.

The planned felling operation was performed during the months of August and September 1992 on an area of 20 ha.

Pre-exploitation inventory

The study was mounted in an area already selected for harvesting and a 100% inventory of trees over 50 cm DBH carried out. DBHs were measured and tree species identified. Species of commercial value were also noted. A topographic survey was made and streams mapped to decide the locations of roads, skidding trails and landings. This work was carried out with survey points at 25 m intervals; contours were mapped at 10 m intervals.

Forest type

The CPAF/Acre experimental station forest is a predominantly open forest with bamboo (*Guadua* spp.) present but there is also dense forest and it was in this area that the study was sited.

Timber potential

Dense forest accounts for 36.8% of the area. It holds an average volume of 247.9 m^3 ha^{-1} in trees over 10 cm DBH with 133.9 m^3 ha^{-1} in trees over 50 cm. The understorey was not dense so allowing ready access for inspection, inventory and subsequently by machines. After subtracting the volume of species protected by law – rubber and brazil nut – the marketable species amounted to a total of 89.32 m^3 per ha of which 56.22 m^3 were over 50 cm DBH. The marketable species volume was contained in 109 trees per ha, of which 19 were of commercial size. The bulk of the extracted timber were sawlogs or veneer logs.

Harvesting methods

Cross-cutting

As a rule the felled tree was only cross-cut when it was impracticable to skid it in one piece.

Felling

Three basic rules were followed in order to guarantee 'safe' exploitation: cutting of climbers which connected the tree designated for felling to other trees, correct felling method, and directional felling (FAO 1980). In felling, the depth of the cut was 20 to 25% of the tree diameter (SUDAM 1978). The angle of the cut was such as to avoid tree slipping. Where the tree diameter was more than twice the length of the chainsaw blade, care was also taken to cut the central core. Since the felling of large tropical trees is particularly dangerous, the following precautions (based on FAO 1980) were taken:

a) area around the base of the tree and the escape route were cleared,
b) rubbish around the tree was removed,
c) all climbers were cut from the tree,
d) in felling the largest trees with a big supporting root, felling took place in the direction opposite this root,
e) special care was taken with leaning trees and trees leaning to the 'wrong' direction.

Normally in tropical forest the form and weight distribution of the canopy decides the direction of felling. However, with care it is possible to change the direction up to 45°. Felling direction should be between 30 and 60° relative to the skidding trail taking into account possible damage to nearby vegetation and efficient positioning for chokering.

Skidding

The skidding network was planned to reduce to a minimum the damage to neighbouring growing stock. Trails were made before felling and cross-cutting using the skidder's bulldozer blade to provide a 3 m width. The trail network was mapped to provide an overall view of the entire extraction network. The skidding operation was carried out in the manner described by Hendrison (1989).

Roads and landings

Roads were opened with a Caterpillar D-4 tracked tractor to provide 5 m width. Approximately 450 m were constructed, that is a density of 22.5 m ha^{-1} and 1200 m of trails were opened. A landing was established for 225 m^3 on an area 25 × 35 m with a front and side approach area 6 m wide.

DATA COLLECTION

All trees over 10 cm DBH within the sampled area which were damaged were measured. Damage was classified as: trees knocked down as a result of felling designated trees, trees broken in the course of felling designated trees, trees with canopy damaged as a result of felling designated trees divided into those with over three-quarters of the crown damaged and those with less than three-quarters.

To measure the damage done by the opening of roads and skidding trails, diameters of trees over 10 cm DBH were recorded every 50 m. Volumes of all sizes of trees were calculated using a local volume table relating volume to DBH ($V = 0.000308\ D^{2.1988}$).

RESULTS

Table 1 sets out the result of felling designated trees. In the table each line records by diameter class of trees harvested a. the number and volume of trees knocked down, b. the number and volume of trees broken and c. the volume of trees whose crowns were severely damaged.

The number of trees knocked down was between 3 and 4 for every commercial tree cut in the diameter range 50 to 99 cm (the number of trees over 100 cm DBH was too small to provide a basis for analysis). There appears to be no significant difference between tree sizes in this regard. This result may arise in part because of the effect of climber cutting. When trees have reached 50 cm in diameter they have already attained their maximum height so that the length of trunk falling differs little between diameters.

TABLE 1. *Volumes of trees damaged during felling relative to volume felled*

No = number, vol = volume in m³

Diameter class, cm	Felled trees no.	Felled trees vol.	Knocked down no.	Knocked down vol.	Broken trees no.	Broken trees vol.	Crown damaged no.	Crown damaged vol.	Total volume damaged	Damage as per cent
50-59.9	16	31.734	39	3.920	16	0.680	20	2.957	7.557	23.8
60-69.9	17	50.524	43	5.455	5	0.364	28	3.093	8.912	17.6
70.79.9	10	38.723	40	6.983	4	0.061	15	3.910	10.954	28.3
80-89.9	10	49.376	37	4.448	5	1.146	19	6.526	12.120	24.5
90-99.9	3	18.512	12	1.387	-	-	8	2.785	4.172	22.5
100 +	1	10.462	1	5.257	1	0.367	9	0.920	6.544	62.6
All sizes	57	199.331	172	27.450	31	2.618	99	20.191	50.259	25.2

Trees broken during felling show the same pattern across diameter classes. An average of 0.6 trees were broken for each felled tree.

By contrast the damage done to tree crowns increases with diameter of trees felled. This probably occurs because of the intricate climber network in trees' crowns, a network which is larger the bigger the canopy size of the larger trees. Overall 1.7 crowns were seriously damaged per tree felled and the average volume of the trees so affected was 0.2 m³.

Total damage due to felling amounted to 0.25 m³ per m³ felled.

Trees were also felled in the course of constructing roads and skidding trails. The area involved was calculated thus: a) 450 metres of roads of 5 m width, i.e. 112.5 m² per ha, b) 1200 m of skidding trails of 3 m width or 180 m² per ha, c) 2 landing sites accounting for 87.5 m² per ha. This clearance on 3.8% of the total area required the removal of 3.5 trees per ha averaging 0.4 m³ ha⁻¹ or an additional 2% of the felled trees' volume.

The overall damage caused therefore amounted to 27% of the volume removed. This result may be compared with figures compiled by Uhl and Vieira (1991) for 'traditional' exploitation. The present study showed approximately one-fifth the number of trees over 10 cm DBH knocked down or broken compared with the average in Uhl's study. In volume terms the relative proportions are more dramatic, the figures being 1.9 m³ per m³ of designated tree volume in Uhl's three areas compared with 0.25 m³ in our study using planned harvesting.

The canopy opening in our study averaged 1500 m² ha⁻¹ compared with 3800 m² on average in the 3 areas of Uhl's study. This degree of canopy opening (15%) may be compared with values obtained by Hendrison (1989) of 29.1% and Uhl and Vieira (1991) of 13.8% in careful exploitation.

CONCLUSION

Careful layout and construction of skidding trails, roads and landings is most desirable. Directional felling yields a major benefit. Climber cutting should also be regarded as a desirable practice especially as it can be readily performed at the time of marking. Further avoidance of damage to the crowns of neighbouring trees can be achieved by ringing of the designated trees. But this has to be done at least 2 years before felling and is only sensible in species which respond well to this treatment.

We consider that our results strongly support the views of various authors who have discussed the subject (Poore 1989, Costa Filho 1992, Ewel and Conde 1970, Hendrison 1990), namely that the control of felling and skidding significantly reduces the impact on the remaining stand of forest exploitation.

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