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Initial impact of supervised logging and pre-logging climber cutting compared with conventional logging in a dipterocarp rainforest in Sabah, Malaysia

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Abstract

Pre-marked skid trails, directional felling and climber cutting when logging in tropical rainforests may be important ways of reducing damage to the forest, thus creating a healthier stand and improving future yields.

This study, carried out in a virgin dipterocarp rainforest in the south of Sabah, Malaysia, compared two types of logging (both with and without pre-cutting climbers): conventional selective logging (CL) and supervised logging (SL). The latter is a selective logging system in which both pre-marked skid trails and directional felling were implemented. The pre-marked skid trails were aligned parallel to each other, spaced 62 m apart. A randomised complete block 2×2 factorial design was used in the experiment, consisting of 16 gross treatment plots, each of 5.76 ha with a 1 ha net plot in the centre.

Fewer trees tended ($0.050 < P \leq 0.100$) to be logged in SL plots than in CL plots (on average 9.4 and 13.0 trees $\geq$60 cm diameter breast height ha^{-1}). Pre-felling of climbers resulted in four more dipterocarp trees being logged ha^{-1}, compared with no climber cutting: a statistically significant difference ($P \leq 0.050$). The basal areas lost of both large trees ($\geq$ 60 cm dbh) and small dipterocarp trees (10–29 cm dbh) tended to differ between the logging systems, with CL leading to greater losses.

There were significant differences in the residual stands left by the logging systems, with respect to the number of dipterocarps and their basal area in the diameter class 10–29 cm; ca 30% more stems being found after SL. No significant differences (or tendencies) in these variables were found in the residual stands in other diameter classes, or when trees of all species were considered.

Keywords: Climber cutting; Directional felling; Logging; Logging damage; Pre-marked skid trail; RIL

1. Introduction

The conventional silvicultural management system that has been used in dipterocarp forests in Sabah in recent decades is the Modified Malayan Uniform System (Wyatt-Smith, 1995). In this system only trees larger than 60 cm diameter at breast height (dbh; 1.3 m above ground level) can be legally harvested.

Intermediate-size trees left after logging, seedlings and saplings are relied upon as structural components of the new stand and constitute the next crop (Poore et al., 1989). Extraction rates exceeding 100 m^3 ha^{-1} are common (Nicholson, 1979; Anon, 1991). Conventionally, this logging has been carried out by felling the crop trees and extracting them by unplanned tractor skidding, which often leads to severe damage to the residual stand (Fox, 1968; Nicholson, 1979; Marsch et al., 1996).

Chai and Udarbe (1977) and Lee (1982) stressed that applying post-harvest rehabilitation measures to the residual stand is pointless if logging damage is not addressed, and thus recommended that alternative logging systems should be developed to find ways and means of reducing logging damage. Several recommendations, such as pre-cutting climbers, directional felling and use of planned skid trails, have been suggested to reduce damage (e.g. Appanah and Weinland, 1990; Vanclay, 1993; Bruenig, 1996). Several detailed logging systems have been developed from these suggestions, one example being RIL (Reduced Impact Logging), as described by Pinard et al. (1995), Marsch et al. (1996) and Sist (2000).

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Pre-logging climber cutting involves killing woody climbers and needs to be carried out about a year before logging to be effective (Fox, 1968; Anon, 1972). Climbers are known to 'tie the forest together' (Richards, 1996), so it is possible that damage could be reduced by killing them and thus 'untying' the tree crowns or trees. Climber cutting alone can reduce damage (e.g. Fox, 1968; Appanah and Putz, 1984; Cedergren, 1996). However, the cost of the operation can be substantial (Liew, 1973; Pinard et al., 1995) and the effects on logging damage are sometimes judged to be modest (Liew, 1973).

Directional felling means felling a tree in a predetermined lay to reduce damage to intermediate-size trees, or so-called potential crop trees (PCTs). The procedure also facilitates skidding by avoiding the need to reorient logs and by shortening the extraction distance (Pinard et al., 1995; Cedergren et al., 1996). A felling accuracy study in Sabah found that some 90% of the harvestable trees could be felled within a reasonable lay (Cedergren et al., 2002), however, directional felling did not alone reduce felling damage.

For dipterocarp forests, with a high concentration of commercial timber and a specific forest structure (Whitmore, 1998), several different methods of skid trail alignment have been developed (see, for instance, Jonkers and Mattsson-Mårn, 1981; Cedergren et al., 1996; Lohuji and Taumas, 1998). The method described in Cedergren et al. (1996) involves planning the layout of skid trails following natural borders such as streams, ravines and ridge lines and systematically aligning them at an almost fixed distance parallel to each other.

This study evaluated the initial impact of two different logging methods, and the impact of cutting climbers, on the forest structure and logging damage. The experiment compared "supervised logging", i.e. directional felling and pre-alignment of parallel skid trails, with conventional logging (see Section 2 for detailed descriptions of these logging systems), both systems employing logging at full intensity according to the forestry rules and laws in Sabah. In addition, both logging systems were compared with and without prior climber-cutting.

The major questions addressed were as follows. Are there differences between the residual stands created by the two logging procedures? Is less damage caused by selective logging with directional felling and pre-aligned parallel skid trails, than by conventional selective logging? Is less damage to the stand caused by the logging procedure if pre-logging climber cutting is used?

2. Materials and methods

The study was carried out at the Gunung Rara Forest Reserve in Sabah, Malaysia, (approximately 4°33′N, 117°02′E). The forest was a primary tropical rainforest, dominated by members of the *Dipterocarpaceae* family. Elevation ranged from 300 to 610 m a.s.l. The soils were Orthic Acrisols (Cedergren, 1996), and a major characteristic of the climate in the region is that the monthly rainfall exceeds 100 mm; the long-term mean annual rainfall ranging from 2000 to 4000 mm (Whitmore, 1998).

The experimental design was a randomised 2×2 factorial complete block design, where the initial impact of two modes of selective harvesting, and pre-logging climber cutting, was evaluated. The study area comprised four blocks and 16 treatment plots defined here as gross plots each of 5.76 ha (240 m × 240 m) (except for one plot measuring 200 m × 240 m). In the centre of each gross plot a net plot of 1 ha (100 m × 100 m) was established. In addition four non-treated plots, one per block, were also established, but the untreated plots were excluded from the analysis. The blocking factor was based on average ground inclination within the net plots, with a variation in mean slope from 22° (block 1) to 6° (block 4). Logging methods were randomly assigned to the plots within the blocks.

Plot establishment, including climber cutting, was conducted from March 1992 to June 1992. The first measurement of the plots was carried out at the same time. Harvesting commenced in June 1993 and was completed in August 1993. Re-measurement of the plots after harvesting was done from November 1993 to January 1994.

The net plots were divided into 100 sub-plots (10 m × 10 m), which were marked out on the ground for easy reference. During the first measurement, before logging, all trees within each subplot with a dbh of at least 10 cm were recorded and marked with an individual 5 cm aluminium number tag that was buried by the base of the tree. Recorded data for each tree were: tree number; distance (in dm) and bearing (using a 360° compass) to each tree from the centre of the sub-plot; species; diameter (measured with a diameter tape in cm) at dbh, if possible, otherwise 0.3 m above the highest buttress; and tree class (1, alive and standing; 2, alive but fallen; 3, dead but standing; and 4, dead and fallen). For each sub-plot the slope in degrees was recorded.

Trees were identified, to species level if possible, in the field by professional inventory rangers. The trees that could not be identified were classified as other timbers (OT). Trees were grouped into dipterocarps (all trees belonging to the *dipterocarpaceae* family) and non-dipterocarps (all other tree species).

The measurement procedure after logging was similar to that before logging, except that a subjective assessment of skid-trail cover in percent of each sub-plot was introduced. A damage variable was introduced to the tree recording, consisting of three classes: 1, undamaged, no visual damage; 2, minor injury, minor visual damage deemed unlikely to harm the tree in the long term; 3, major injury, major visual damage deemed likely to affect the tree's future growth or kill it. The diameter (dbh) was measured with a diameter tape in mm. A metal detector was used to find the trees' number tags.

In the experiment, two logging methods were used.

2.1. Conventional logging

In CL no assistance or guidelines whatsoever was given to fellers and tractor operators on how to conduct the harvesting operation. The trees were felled before the tractor was called in for skidding. In conventional logging the fellers were the contractor's personnel and they did not have any formal education in directional felling techniques.