Carbon retention and recovery with reduced-impact logging in the Eastern Amazon: Why we should preserve the biggest trees

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OBJECTIVES

In this study, we addressed the question of how logging affects the dynamics of above-ground biomass in an Amazonian tropical production forest under RIL techniques management in eastern Pará (Brazil).

STUDY AREA

Figure 1: location of the study area and plots

The study site is located in eastern Pará, Paragominas, on the Fazenda Rio Capim owned by CIKEL-Brasil Verde group (**Fig.1**). Before logging in 2004, we set up 18 experimental RIL plots, 1ha each, in a 100 ha block distributed in 2 transects of 900 x 100 m (**Fig.1**). All trees with dbh ≥ 20 cm dbh were identified and measured. In each of these plots (except plot 5 that is henceforth disregarded), we also measured trees in the 10-20 cm dbh class in two randomly located 0.125 ha (25 m x 50 m) subplots. Successive measurements were carried out in May 2005, November 2006, and February 2008. We calculated the above-ground biomass (AGB) of all living trees ≥ 10 cm dbh before and after logging using the formula:

$AGB = \rho \times \exp(-1.499 + 2.148\ln(dbh) + 0.207(\ln(dbh))^2 - 0.0281(\ln(dbh))^3)$ where ρ is the wood density(g/cm^3).

RESULTS

Before logging, the mean above-ground biomass (AGB) recorded in primary forest was **410 Mg ha^{-1}** and falls within the range of published values for lowland tropical forest. RIL resulted in AGB immediate losses of **94.5 Mg ha^{-1}** including in felled trees (73%),and 25.2 Mg ha^{-1}(27%) in trees destroyed by logging **Fig.2**).

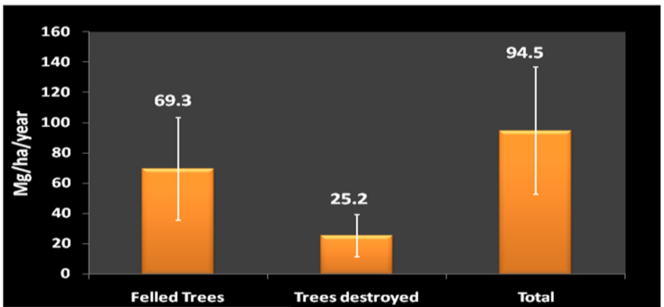


Fig2. Loss of AGB by RIL

During the first year after logging, the annual net balance of AGB was negative: **-31.1 Mg ha^{-1} year^{-1}** mainly because of the high mortality of damaged trees **-25.2 Mg ha^{-1} year^{-1}(Fig. 3)**. In contrast, during 2005-2008, the annual net AGB balance in the RIL plots was positive **2.6 Mg ha^{-1} year^{-1}**. For the period 2004-2008 the annual net balances of the AGB of the control plots were only **1.9 and 0.8 Mg ha^{-1} year^{-1}(Fig 4)**.

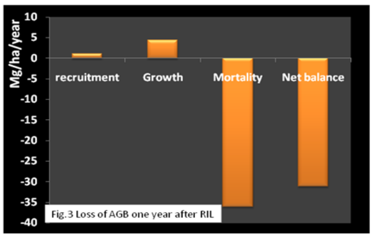


Fig. 3 Loss of AGB one year after RIL

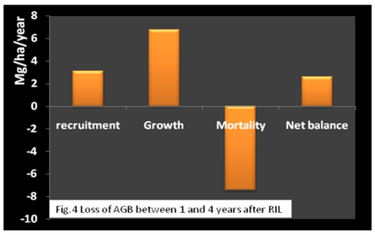
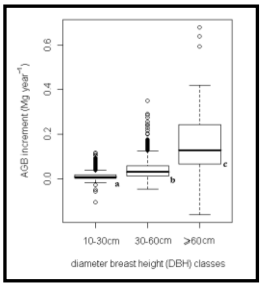
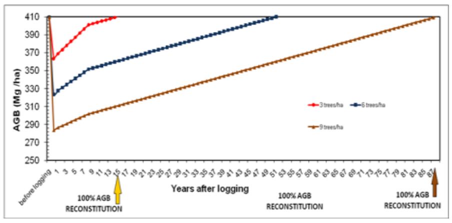


Fig. 4 Loss of AGB between 1 and 4 years after RIL

At the individual tree level, mean annual diameter increments of trees in the logged plots (0.33 ±0.37 cm year^{-1}) was more than double that recorded in the control plots (0.14±0.39 cm year^{-1}; ttest P < 0.01). Growth rates increased **significantly with dbh, large trees (dbh ≥ 60cm) contributing substantially more to AGB increases than small ones (Fig5).**



Assuming that the growth rates observed will be maintained for 8 years after logging and that the associated annual mortality rate will then drop to 1%, our simulation suggested the following (**Fig.6**):



- For a logging intensity of 3 trees ha^{-1}, **AGB will recover to its initial value in about 15 years.**
- For higher logging intensities 6 and 9 trees ha^{-1}, the AGB recovery time will be **51 and 88 years** respectively and therefore much longer than the 30 year minimum cutting cycle specified by Brazilian law.

CONCLUSIONS

1. Under low logging intensity (3 trees/ha) AGB will come back to its initial value 15 years after logging
2. Due to the high rates of increase in ABG in trees ≥70 cm dbh, plots with higher residual large tree densities showed higher overall AGB gains after logging
3. In addition to their contributions to AGB gains, large trees are also ecologically important create Excessively large canopy openings when felled, and have structural defects that reduce timber recovery percentages
4. Given that the largest trees frequently have structural defects that reduce timber recovery percentages retaining them is not as costly to loggers as their estimated standing volumes might suggest
5. For all of these reasons we suggest that felling trees >110 cm dbh should be prohibited.

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