Towards a new selective logging strategy?
The importance of diversifying commercial species

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The sustainability of selective logging
Selective logging in the tropics

- selective harvest of a few commercial species
  - intensity: 2-15 trees.ha\(^{-1}\) \(\equiv\) 5-60 m\(^3\)ha\(^{-1}\)
  - cutting cycle: 20-60 yr
- tropical timber production: 250 Mm\(^3\)yr\(^{-1}\)
- tropical Permanent Forest Estate:
  - dedicated to selective logging: 403 Mha
  - under protection: 358 Mha

Asner et al., 2009
Is selective logging sustainable?

• In most cases: no recovery of timber stocks at the end of the cutting cycle

What factors influence volume recovery, and how to sustainably provide timber?

Putz et al. 2012

Gardingen et al. 2006
Modeling timber recovery
Linking stocks and fluxes

• An original ecosystem model
  \( \Rightarrow \) robustness

• Linking total volume and volume changes in time:
  \( \Rightarrow \) predictive strength

\[
\frac{dV}{dt} = \frac{dV_G}{dt} - \frac{dV_M}{dt}
\]

\( \Rightarrow V(t_1) = \int_{t_0}^{t_1} \left( \frac{dV_G}{dt} - \frac{dV_M}{dt} \right) dt \)
Modeling volume changes

Growth: \[
\frac{dV_G}{dt} = \alpha_G \times (1 - e^{-\beta_G \times t}) - \theta \times V(t)
\]

Respiration

Mortality: \[
\frac{dV_M}{dt} = \alpha_M \times (1 - e^{-\beta_M \times t})
\]

Growth (m³ha⁻¹yr⁻¹)

Mortality (m³ha⁻¹yr⁻¹)
The effect of selective logging

- Selective logging → sudden decrease of the stand maturity
- The commercial volume is the proportion of commercial species in the total volume
Model inference

- data from Paracou station (French Guiana)
  - experimental logging
  - 48 plots, 75 ha
  - > 30 years of forest inventory

- model inference in a Bayesian framework
How much timber can we sustainably harvest?
Which parameters can influence volume recovery?

Easy to control

• logging intensity
• proportion of commercial species
• cutting cycle length

Difficult to assess

• stand maturity
• stand volume potential
The need to diversify commercial species
The need to diversify commercial species
Conclusions
• Current conditions are clearly not sustainable
• Need to harvest a wider variety of species:
  • at each cutting cycle
  • from one cutting cycle to another
• Composition changes: more pioneer species?
Thank you for your attention!
Additional graphs
Hump-shaped growth curve

(a) $\beta_G = 0.016$

(b) $\beta_G = 0.008$

(c) $\beta_G = 0.004$

Volume change (m$^3$ha$^{-1}$yr$^{-1}$)

Gross Productivity
Respiration
Net gain

Maturity

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Goodness of fit

Growth

Mortality

Volume

RMSE: 6.064

RMSE: 7.026

RMSE: 5.899