Title: Unraveling the Mechanisms of Below- and Aboveground Liana-Tree Competition in Tropical Forests

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BER Program: TES **Project**: University **Project Website**: n/a

Project Abstract: Liana presence can strongly suppress tree wood production and presumably also reduce the strength of the tropical forest carbon sink. In intact neotropical forests, liana presence has been increasing over the past few decades, though the mechanisms remain under debate. Better knowledge of liana morphology and allocation is required to unravel the mechanisms of below- and aboveground liana-tree competition in tropical forests and incorporate lianas into mechanistic forest dynamics models. To address these knowledge gaps, we have initiated a project that integrates empirical and modeling work.

Empirical measurements are being carried out in tropical dry forests in Guanacaste, Costa Rica, including excavations of ~80 entire trees and lianas. These excavations will enable measurements of belowground and aboveground biomass, coarse and fine root vertical distribution, and lateral root spread. Also being measured are liana soft and hydraulic traits, above- and belowground productivity, and species-level fine root productivity. The modeling work includes the incorporation of lianas into the TROLL model, which is a mechanistic, individual-based forest dynamics model. The model simulates the unique features of lianas, accounting for their structural parasitism and their different allocation strategies and morphology compared to trees. The simulated trees and lianas compete aboveground for light and belowground for water.

Thus far, 33 mature, canopy-exposed individuals (18 trees and 15 lianas) have been harvested and analyzed. For both trees and lianas, biomass partitioning to roots, stems, and leaves were consistent with the predictions of allometric biomass partitioning theory. Vertical root profiles varied across life forms: lianas had the shallowest roots, evergreen trees had the deepest roots, and deciduous trees had intermediate rooting depths. The liana root systems also had notably broader lateral extents than the tree root systems. Our empirical results have helped to motivate model development. Each of our modeled liana individuals is assigned a laterally-widespread root system that can potentially extend beneath many trees. The liana root system is then permitted to put up aboveground shoots that associate with trees within the footprint of the root system. Comparisons of simulated and observed above- and belowground productivity are currently being conducted.