

## ECOLOGY AND ECOPHYSIOLOGY

### STATE AND TRANSITION SIMULATION MODEL (ST\_SIM) CURRENT / POTENTIAL LANDSCAPE DISTRIBUTION OF KOA AND ASSOCIATED CARBON DYNAMICS

**Paul Selmants, Ph.D.** (US Geological Survey), **Benjamin M. Sleeter, Ph.D.** (US Geological Survey), Nicholas Koch (Forest Solutions), and James B. Friday, Ph.D. (University of Hawai'i at Mānoa Department of Natural Resources and Environmental Management)

**Paper Title:** The potential carbon benefit of reforesting Hawai'i Island non-native grasslands with endemic *Acacia koa* trees

#### **Background/Question/Methods**

Large areas of forest in the tropics have been cleared and converted to pastureland. Hawai'i Island is no exception, with over 100,000 ha of historically forested land now dominated by non-native grasses. Passive forest restoration has been unsuccessful because these grasslands tend to persist even after grazers have been removed, yet active outplanting of native tree species can be cost-prohibitive at the landscape scale. It is therefore essential to seek co-benefits of forest restoration to defray costs, such as accredited carbon offsets from increased carbon sequestration. We developed a reforestation scenario for non-native grasslands on Hawai'i Island by outplanting endemic koa (*Acacia koa*) trees paid for with carbon offsets via the California Cap and Trade Program. This scenario entails reforesting 53,531 ha of non-native grassland at 2500 ha y<sup>-1</sup> over 22 years. We estimated planting costs at \$6,178 ha<sup>-1</sup>, a total cost of approximately \$331,000,000. We used the Land Use and Carbon Simulator (LUCAS) model to estimate island-wide ecosystem carbon sequestration with and without koa reforestation using 100 Monte Carlo simulations per year over a 60-year period. Income from carbon offsets was set at \$13.57 per ton of CO<sub>2</sub> equivalent, the current California Cap and Trade Program carbon market price.



**Figure 1: Koa reforestation on Mauna Kea, Hawai'i Island**

### **Results/Conclusions**

Koa reforestation on Hawai'i Island was projected to increase island-wide annual net ecosystem production (NEP) by two to four times, with a peak in annual NEP two years after the entire 53,531 ha planting area had been reforested (simulation year 24). During this peak year, terrestrial ecosystems of Hawai'i Island were projected to sequester 422 kilotons of carbon (>1.5 million tons CO<sub>2</sub>), approximately 60% more than projected with no reforestation. Also during that peak year, the koa reforested area alone was projected to offset 5% of statewide CO<sub>2</sub> emissions. Reforestation of non-native grasslands to koa forest on Hawai'i Island sequestered a total of 25 million tons of CO<sub>2</sub> over the entire 60-year simulation period, providing a projected total income of ~\$340,000,000 at the current California Cap and Trade Program market price. Although this income from carbon offsets would cover all original planting costs, incorporating projected costs of financing, verification audits, and ungulate fencing would render such a large-scale restoration effort far from profitable. Nevertheless, our results demonstrate that koa reforestation of non-native grasslands on Hawai'i Island would greatly increase ecosystem carbon sequestration, and that a substantial portion of landscape-scale reforestation costs could be defrayed through accredited carbon offsets.