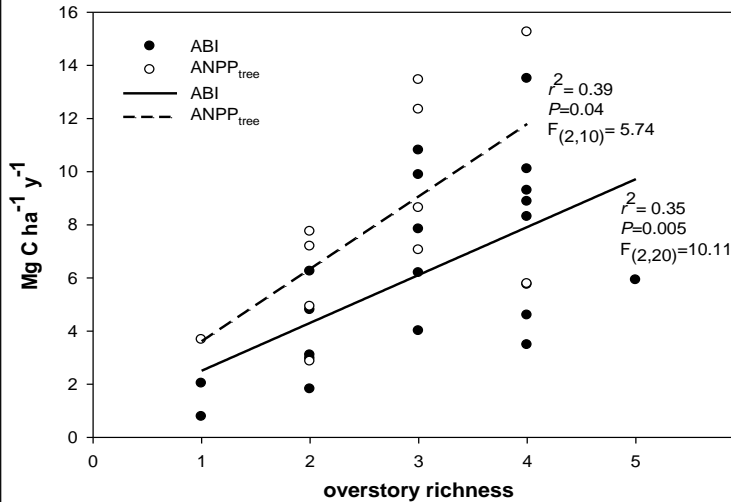


**Introduction**

Gradients in plant community composition and diversity may be important drivers of patterns in C cycling and productivity. Stand diversity (richness, evenness, and diversity of dominant species), especially tree species dominance within the stand could represent major biotic influences on ecosystem C dynamics (Fig.1). Species-specific differences in plant functional traits are well recognized as important controls on ecosystem processes and can be important drivers productivity. Experiments suggest a positive relationship between ecosystem productivity and species diversity (Naeem et al. 1994, Tilman et al. 1996, 2001, Hector et al.1999). Recent research in the Pacific Northwest also suggests a positive relationship between ecosystem carbon uptake and species diversity in natural forested systems (Liang et al. 2007, Kirsch et al. unpub.) (Fig.1) However there is a need for studies investigating biodiversity-ecosystem function patterns in natural systems (Duffy 2009).



**Figure 1.** Relationship between above-ground biomass increment carbon (ABI), aboveground Net Primary Productivity of trees (ANPP<sub>tree</sub>) and overstory richness of five most dominant tree species; *P. menziesii*, *A. macrophyllum*, *A. rubra*, *T. heterophylla*, and *T. plicata*. (from Kirsch et al. in prep.)

**Traditional Approach**

Traditionally tree species identification data is collected as part of field-based forest inventory or aerial image interpretation. These processes can be very labor- and time- intensive. Field-based inventory analysis is usually restricted to smaller and accessible areas. Although time-consuming, data collected in the field can be used as training and validation data for species discrimination processes based on remotely sensed data.

**Remote Sensing Approach**

Remote sensing provides the tools to monitor temporal changes in both species diversity and carbon flux over large areas. There are several biomass equations that have been derived from LiDAR metrics for PNW forest systems, however the need for accurate tree species discrimination with low omission errors is still needed for forests with high vertical complexity. High resolution images have been used for species classification based on crown shape, branch structure and species-specific spectral signature. Intensity and 3-D point cloud data from aerial LiDAR can be used for estimations of species-specific proportions. The fusion of LiDAR and high resolution multispectral datasets can provide better classification results than either dataset used individually.



**Figure 2.** LiDAR canopy height map of the study area and photos of 3 types of plots found in the EEON network. Mixed stands have a tendency to be more productive.

**Study Area:** This study area is adjacent to Puget Sound, Washington, USA in the Evergreen Ecological Observation Network (EEON), a long-term permanent plot network of 44 ecological monitoring plots located throughout a 380-ha forest reserve owned and managed by The Evergreen State College. The ecosystem is a structurally complex, second-growth temperate forest last clear-cut in 1937-39. The overstory is dominated by a mixed canopy of *P. menziesii* and four primary codominant species: *A. macrophyllum*, *A. rubra*, *T. heterophylla* and *T. plicata*, with an understory dominated primarily by *Polystichum munitum* and *Gaultheria shallon*.

**Objectives**

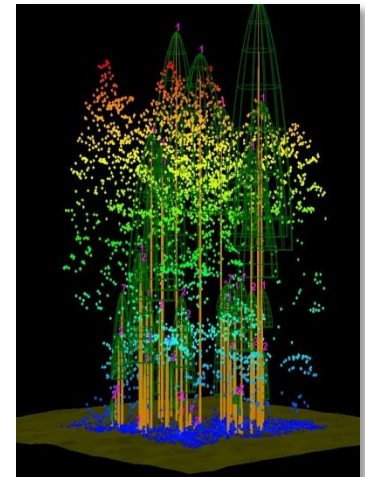
This study will utilize airborne LiDAR and multispectral imagery to:

*Investigate the feasibility of measuring tree species diversity using remote sensing in a structurally and compositionally complex, non-managed second growth PNW Forest.*

Future objectives might involve:

1. Development of species-specific biomass equations based on LiDAR-derived metrics for the study area.
2. Determining diversity and productivity relationships in a natural forest system using remote sensing data.

An obstacle in using remote sensing for estimating tree species diversity is the detection of shade tolerant species positioned in the subcanopy and obscured by the crowns of dominant species.



**Figure 3.** Stem map derived from field-based measurements from one of the study plots.

**THE ISSUE:** Tree species identification is important for understanding many ecosystem processes. There is a great need for a uniform, high-accuracy, low-omission model for tree species discrimination in high density, natural forest ecosystems. Through the combination of active (LiDAR) and passive (optical) remote sensing we provide fast and spatially explicit datasets that address this need.

**THE KEY QUESTIONS:**  
*Can LiDAR and multi-spectral imagery be used to estimate tree species diversity?*