Sierra Watershed Ecosystem Enhancement Project

Welcome to **SWEEP**! In our newsletters, we will explain the SWEEP project and highlight recent progress. In this edition, we will focus on tree leaf area models used to predict photosynthesis, water use and tree growth. For more information and past newsletters, please visit the project website at: http://ucanr.edu/sweep/.

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SWEEP Goals

SWEEP is a 4 year project with the goal of quantifying the physical and financial relationships in Sierra mixed conifer forests in terms of fire resiliency, carbon storage in trees, and water in streams. Much of the Sierra Nevada is covered with forests that are dramatically denser in trees per acre than before fire suppression policies led to extinguishing most wildfires. Today's denser forests are more prone to experiencing high severity fire in which most trees are killed and forest litter is consumed. These dense forests also use large amounts of water to sustain vegetative growth, resulting in less water in streams, rivers, and downstream in canals and the delta.

SWEEP's goal is to design and implement field level projects to quantify the interaction of forest biomass growth, fire risk, and water yield. Field measurements of leaf area, biomass, soil moisture, snowpack and evapotranspiration will be combined with intensive water measurements to better understand how the forests function now and the tradeoffs between different outputs. In collaboration with beneficiaries and stakeholders, we will then estimate the values different beneficiaries place on increases or decreases in fire resiliency, carbon storage, and water yield.

View of Sierra Nevada forest from within the canopy

What is LAI?

The leaf area index is the ratio of leaf surface area where the stomata pull in CO2 and release O2 and water to the land area. A leaf area index of 3 means that there would be 3 acres of leaf surface on an acre of forest.

What vegetation data tells us

Sapwood cross-sectional area of the tree stem is used to develop individual tree leaf area prediction models for the major conifer species in the mixed conifer forests of California (ponderosa pine, Jeffrey pine, sugar pine, incense cedar, white fir, Douglas-fir and red fir). Researchers are focusing on conifers because they are the largest contributors to leaf area in the study sites.

Graduate student Dryw Jones collecting a core sample high in the canopy.

Tree leaf areas are totaled and divided by the ground area covered to estimate leaf area index (LAI). LAI is a more functional measure of foliage than canopy cover because it provides a three-dimensional measure of foliage. It is also used in modeling forest structures because it is a representation of foliage mass and therefore potential photosynthesis. For SWEEP, LAI also relates to hydrologic functions such as interception, transpiration and other processes. By accurately predicting LAI and changes to LAI due to management, researchers will be able to estimate the change in evapotranspiration and therefore water yield. LAI alone won't tell us how much water is flowing through the tree stems - to estimate that, sap flow rates will be measured and related to temperature, aspect, competition and total leaf area of individual trees. With that information researchers will be able to model water flow through trees and, more importantly, across various stand structures at larger scales.

Leaf sampling

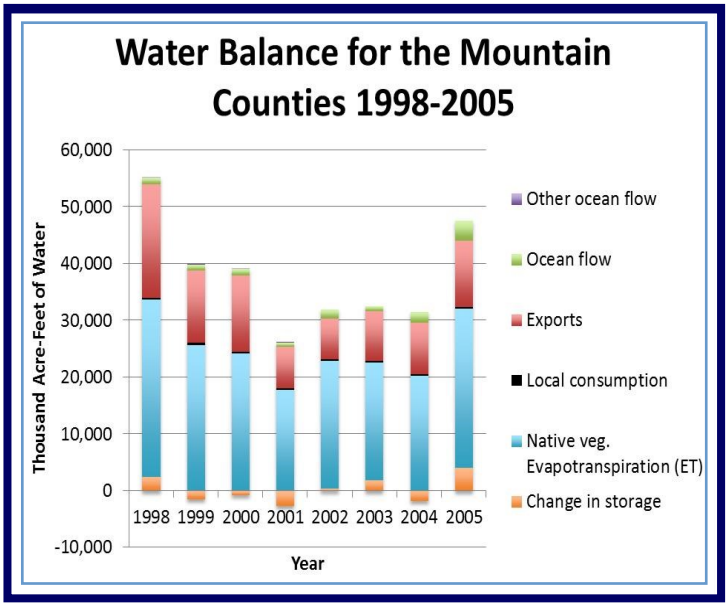
Leaf area data collection consists of sampling trees across the full range of diameters so that we can eventually correlate the biologically important leaf area to the easy to measure tree diamter. When sampling, the diameter and position along the bole of all live branches is recorded. Researchers randomly select two branches from each third of the crown and remove all of the foliage from those branches. The leaf area of a subsample is determined by scanning and then using software to determine the total surface area of the needles. The subsamples are oven dried and weighed to give the specific leaf area (leaf area / mass of subsample). The specific leaf area is used to determine the total leaf area for the branch by multiplying the oven dry mass of the remaining foliage by the specific leaf area of the subsample. Branch area to leaf area relationships are used to determine the total leaf area of the tree.

Stump height disc along with bags of needles from sampling. The clear ruler in the picture is used to determine the size of the disc, sapwood, bark and heartwood area. This method is faster than scanning the discs in directly and more accurate since these measurements are taken before the discs have a chance to dry out.

For more information: http://ucanr.edu/sweep/

How much water do plants use and where does the rest go?

The Department of Water Resources (DWR) is responsible for most big scale water planning in the state. The following chart is from the 2005 DWR five year water plan. For mountain counties, it was estimated that native plant evapotranspiration used 65% of precipitation that fell on the area, while locals and their apple orchards and alfalfa fields used only 1%. 34% of the total was exported to downstream users.



California's trees are designed to efficiently extract water from rain, fog, snow, and the soil. Some trees such as oaks will send roots down tens of meters searching for water while others such as Douglas-fir only exploit the available soil moisture near the soil surface. Still, many roots are sufficiently deep that Sierra Nevada mixed conifer forests transpire water throughout the summer.

Getting more runoff requires managing forests at less than full canopy cover (where LAI of the total canopy is the best proxy for water use). SWEEP's research into LAI and how different vegetation management techniques can increase water quantity and prolong snow melt, will help to identify different approaches to thinning as well as a wide range of desired goods and services. This will help to guide California natural resource managers in making decisions about the future of our forests and the water that runs through them.