Southern Sierra Headwaters Tour

Introduction

The headwaters of the Sierra Nevada support the needs of California's diverse downstream communities, economies, and environments.

On this tour and in our research, we follow water as it flows from sky to meadow and forest to stream, and eventually to the Kings River. The tour will stop at a series of instrumented sites that are used to measure water moving through these forested headwaters.

You are here

The Kings River Experimental Watershed and Southern Sierra Critical Zone Observatory were established for watershed research and technology development. Strategically sited, instruments in this watershed were originally installed to understand the effects of forest cover, hillslopes, soils and other factors on snowpack, stream flow and cycling in these important upstream regions. Our wireless networks are installed throughout the Sierra Nevada watersheds, including the American and Feather Rivers.

These instruments help researchers understand the following information about our water.

What we know about our water

How much water is coming in and out and when it will be available.
- amount
- timing

How is water moving through the forest.
- water movement through the subsurface
- streamflow

How water is being used along the way.
- evaporation/sublimation
- vegetation water use (transpiration)

While our researchers also use remote sensing, on-the-ground sensor networks provide frequent measurements throughout the year. Researchers collect and clean the data for analysis, providing a clear picture of headwaters and water yield. This is useful for reservoir management, flood mitigation, forest and agricultural management, and groundwater recharge.

Stop 1. Snow and Rain at "Upper Met" Upper Meteorological Station

Snow and rain arrives at the Southern Sierra mostly in the winter, but storms are possible throughout the year.

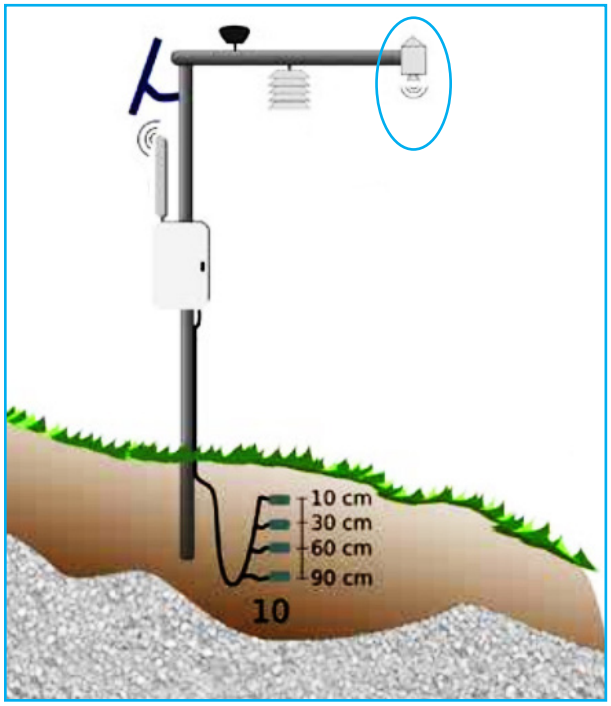
We collect precipitation and atmospheric measurements to account for all the water coming into the area. Many of these instruments are solar powered.

A. Meteorology includes wind speed and direction, solar radiation, relative humidity

B. Atmospheric deposition includes particulates settling from atmosphere to surface

C. Soil moisture and temperature sensors are at multiple depths under snow sensors

D. Precipitation gauge accurately measures rainfall and protects from wind.



Snow depth + pillow measurements are used to calculate snow density and the snow water equivalent.

Density =
snow pillow mass/volume

Volume =
snow pillow area x snow depth

Snow Water Equivalent (SWE) at any point = snow depth x density

How we know about snow

Snow depth sensors use sonar reflection to measure how deep the snow is every 15 minutes (pictured left). Think of it as "snownar."

The **snow pillow** is a giant scale measuring mass of known area to find density (below). Because we know the area of the pillow and the depth and weight of the snow we can calculate the volume, density and the **SWE (pronounced "swee"), or the snow water equivalent**.

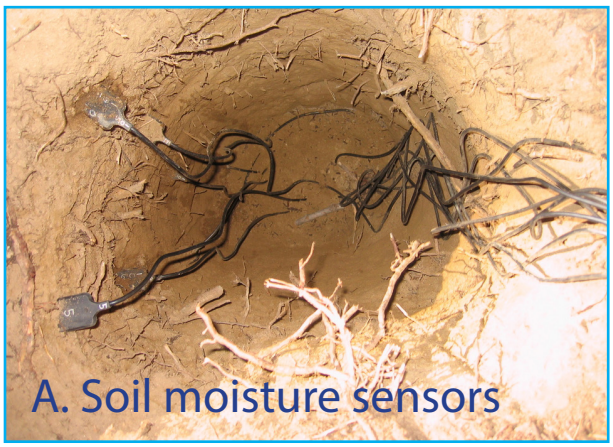
Stop 2. Flowing through the Meadow

Meadows are an important part of the water budget because some of them store water or slow it down before it enters streams.

A portion of the rain and snow melt infiltrates into the soil. Soil moisture and groundwater instruments are used to measure water in the subsurface of the meadow. Water in soil eventually will be used by vegetation, evaporate back into the atmosphere, or enter a stream. At our meadow sites we have:

A. Soil moisture sensors are placed at multiple depths

B. Meadow wells assess the water depth and piezometers measure water pressure to measure flow.



A. Soil moisture sensors

B. Meadow wells

Wireless Sensor Networks

Repeaters transmit data from sensors (snow depth, soil moisture, and temperature, etc.) to a central hub for downloading.

This field site was the testing ground for developing this wireless sensor network. We strategically chose where to place instruments and how frequently to collect measurements based on the questions we are trying to answer and the problems we are trying to solve.

Stop 3. The Critical Zone Tree

Why put all this effort into *one* tree? Understanding vegetation water use is a critical component of forest health and water accounting. Measurements around a single tree can reveal much more than one tree's life; it tells the story of the ecosystem, the species, the elevation, and the year. The forest is comprised of many trees, and understanding one helps us understand the whole forest's water use.

We study how much water the tree uses, where it sources its water, and how the rates of water use change through time. Today, we are visiting the Critical Zone Tree 1, a White fir that perished in the drought.

A. Sap flow meters show how the tree is moving water

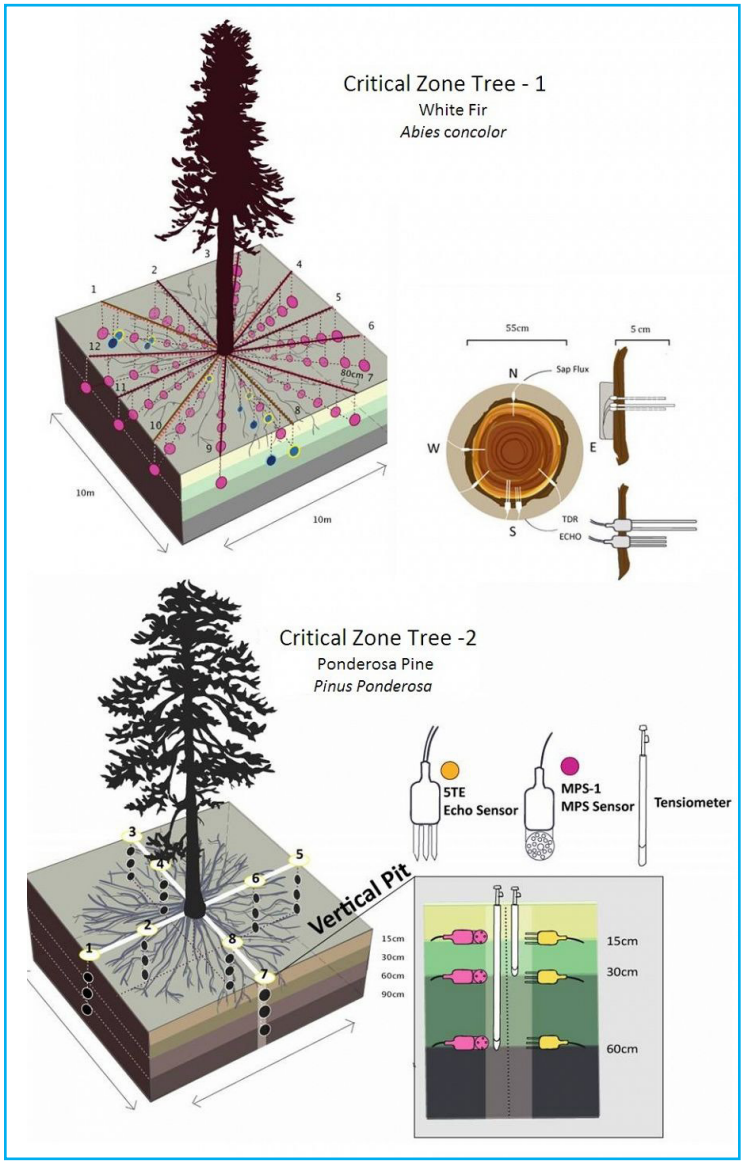
B. Soil moisture and temperature sensors

C. Snow sensors and a camera measure snow depth relative to the tree

D. Atmospheric measurements.

A. Sap flow meter

The "most instrumented tree in the Sierra"



Stop 4. Watching the Forest Breathe: Flux Tower

About half of the water that enters these headwaters returns to the sky before it ever enters a stream.

Evapotranspiration, water used by vegetation or evaporated back to the atmosphere, can be measured. An instrument at the top of the tower and above the tree canopy measures the **fluxes of water vapor and carbon dioxide in the atmosphere**. These measurements reveal forest-scale water use.

A. Eddy covariance gas analyzer measures two components that reveal forest function: carbon dioxide and water vapor

B. Precipitation gauge

C. Soil moisture and temperature sensors around tower.

Stop 5. Stream Gauge

Water that is not cycled back to the atmosphere or used by vegetation is compelled by gravity, down hillslopes to stream channels, tributaries of the Kings River. Using different types of stream gages and flumes, we can measure the amount of water flowing through the channel, that is, the discharge of the stream.

Stream Discharge = Precipitation – Evapotranspiration
Q = P - ET

Learn More

We hope this visit to the Southern Sierra gave you insights into California's water tower and the long shadow of the drought in Sierra Nevada forests and communities. Because these forests are a patchwork of public and private lands, we need to be active in addressing the large-scale needs of our ecosystems and communities, both upstream and downstream. Thank you for joining us today.

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Kings River Experimental Watershed

US Forest Service manages the Kings River Experimental Watersheds (KREW), a watershed-level, integrated ecosystem project for headwater streams in the Sierra Nevada.

Southern Sierra Critical Zone Observatory

criticalzone.org/sierra @ssczo

The SSCZO is an Earth-systems research program investigating the living part of Earth where rock, soil, water, air, and biota interact to form ecosystems.

UC Water

University of California Water Security and Sustainability Research Initiative

ucwater.org @ucwater info@ucwater.org

A multi-campus research initiative addressing water information and accounting, water management institutions, and green and gray infrastructure.

UCTV Sustainable California Channel

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This website has three videos on forests, water and our research: "Sierra Net," "Water in the Balance," and "Conifer Endophytes." Fresh content monthly.