# *Tahoe Science Research Update*: Understanding the Effects of Environmental Change and Landscape Heterogeneity on the White Pines of the Lake Tahoe Basin

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**Fig. 1:** Caging developing cones of a whitebark pine so that seeds can be collected later for seedbanking and trait analysis. Photo by Detlev Vogler.

## Management Implications

- Sites with low recruitment of white pines may warrant active intervention (e.g., site preparation and planting of suitable and locally adapted seedlings). Where recruitment is consistent, complex interactions among site factors may buffer some populations under a warming climate.

## Background and Purpose

**How forest tree species and populations respond to changing climatic conditions is difficult to predict.** Most bioclimatic models of forest trees predict major range expansions and contractions and, in some cases local extirpations. Complex and heterogeneous landscapes, particularly montane environments of the Sierra Nevada, provide a wide range of conditions that influence biotic interactions, genetic structure, and population dynamics. This environmental heterogeneity may be a key driver that can negatively affect forest tree species and populations, but may also buffer forest trees and populations, given a warming climate.

**We are taking an ecological and genetic approach to better understand interactions of *landscape characteristics* (stand conditions and history, soil properties, climatic gradients) and *evolutionary processes* (gene flow, selection) on the population dynamics and genetic structure of white pine species (sugar, western white, and whitebark pine) in the Lake Tahoe Basin.** We will evaluate the adaptive genetic diversity of these species, which should allow us to detect the sensitivity and potential vulnerability of white pine populations to environmental change (climatic warming, introduced organisms, and climate-driven outbreaks of native insects).

**The greatest effect of a changing climate on population dynamics will be on recruitment and mortality (birth and death).** One primary component of our work is to better understand how populations of white pines, across three elevation zones, are structured, and when, where, and why trees are regenerating and dying. We will relate regeneration and mortality trends to climate, soil properties, stand conditions, physiognomy, genetic structure, and pathogen and insect activity.

## Methods

Seeds collected from a Basin-wide cone collection effort (Fig. 1) will be grown in a common greenhouse environment for phenotypic evaluations of dates of bud flush and bud set, water-use efficiency, height, growth (shoot and root), disease resistance, and survival. DNA will be extracted from foliar samples, collected from the same families in which seed were collected for phenotypic evaluations, to identify candidate genes related to plant traits for disease resistance, water use efficiency, phenology, and growth. Phenotypic data will be associated with the genotyping data to determine patterns of adaptive genetic variation in ecologically important traits for withstanding predicted environmental changes.

## Summary of Findings to Date

Recruitment varies from location to location (Fig. 2), with the Glenbrook site experiencing much higher recruitment than the other sites (Fig. 3). Summaries of historical climate and soil moisture data and analyses are ongoing. Preliminary results indicate that soil type, microsite conditions, topography, stand composition, and management history (e.g., fire suppression and logging) are as influential on regeneration patterns as are high precipitation years.

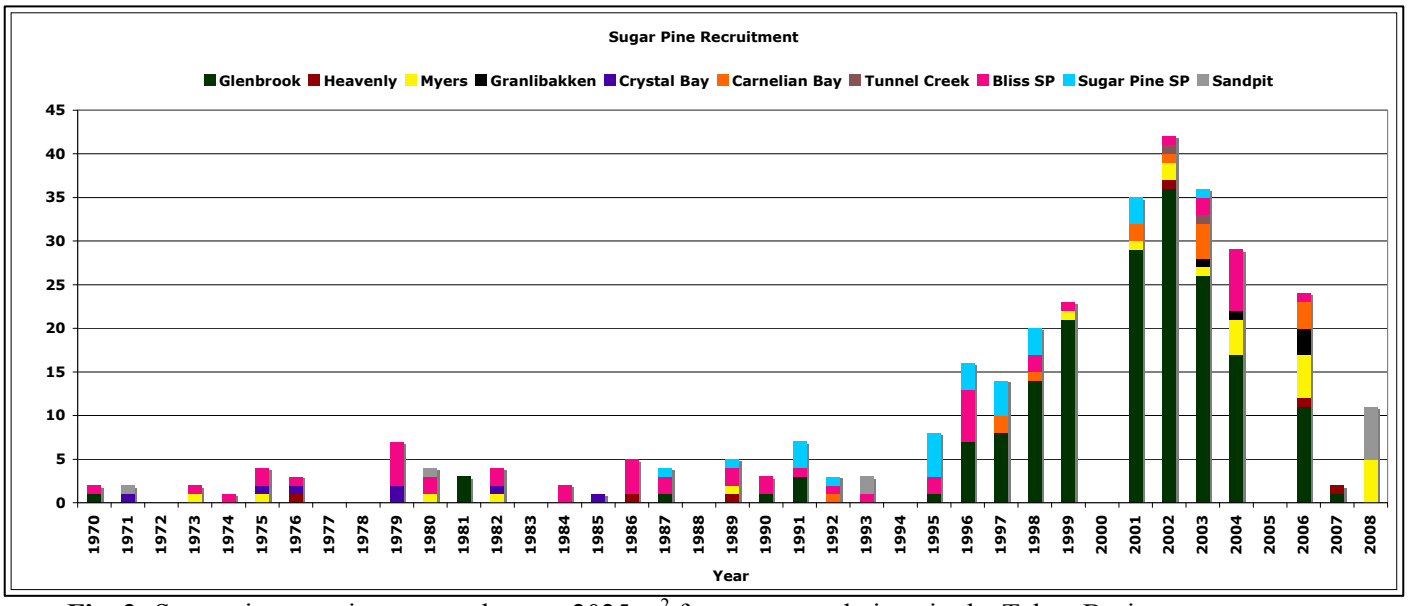


**Fig. 2:** Sugar pine recruitment number per 2025 $m^2$ from ten populations in the Tahoe Basin

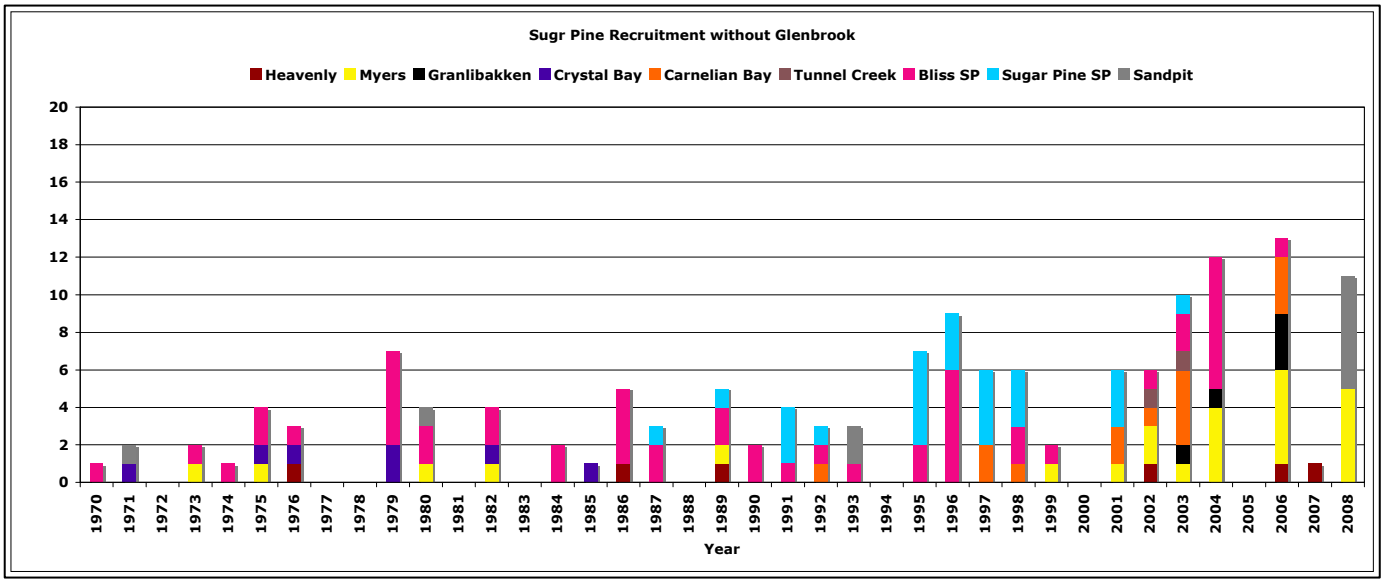


**Fig. 3**. Sugar pine recruitment from nine locations in the Tahoe Basin, excluding Glenbrook.

For more information about this project, please visit this webpage:
*http://www.fs.fed.us/psw/partnerships/tahoescience/r9_genetic_resources.shtml*