

# Stand Level Impacts of *Ips* and *Dendroctonus* Bark Beetles in Pine Forest Types of Northern Arizona

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**Abstract**—Extensive tree mortality occurred in ponderosa pine forests and piñon-juniper woodlands of Arizona from 2001–2004. This mortality has been attributed to a combination of an extensive drought, overstocked stands of pine, and increased bark beetle populations. A complex of *Ips* and *Dendroctonus* species worked in concert to kill ponderosa pine. Piñon pine was attacked primarily by pinyon ips and to a lesser extent twig beetles. Initial tree mortality was associated with poor site quality (i.e., shallow soils, cinder hills, south-facing aspects, and lower elevations) and high tree densities.

Forest health monitoring, evaluation monitoring, funds were used to: 1) quantify the impact, extent and severity of bark beetles on ponderosa and piñon pine at the stand level through an extensive plot network on a portion of Arizona's northern National Forests, 2) describe the forest conditions in areas that have experienced moderate to high levels of mortality induced by recent drought and bark beetles and 3) look for correlations between stand and site conditions and pine mortality.

A GIS approach was used to populate sample points for each National Forest and forest type. The number of sample points was determined by the amount of area per forest type per Forest. A total of 941 fixed-radius plots were established in 2003 and 2004 across five National Forests in Arizona: Apache-Sitgreaves, Coconino, Kaibab, Prescott, and Tonto. Of these 633 were in ponderosa pine forests and 308 in piñon-juniper woodlands. On the Forest level, ponderosa pine basal area killed ranged from 5 to 23 percent. Ponderosa pine mortality caused by bark beetles was positively correlated with tree density and negatively correlated with elevation (most Forests) and tree diameter (Prescott). Piñon mortality ranged from zero to 48 percent on the Forest level. Piñon mortality was positively correlated with tree density and negatively correlated with elevation on most Forests. In ponderosa pine forests most of the observed mortality was in 10-30 cm diameter classes. In the piñon-juniper woodlands, piñon mortality occurred across all diameter classes with a higher percent of trees killed in the larger diameter classes. Piñon-juniper woodlands have been converted to essentially juniper only in many stands throughout north-central Arizona.

In addition, to this “on the ground” work, we collaborated with Forest Health Technology Enterprise Team, Remote Sensing Application Center and Kodak to analyze different remote sensing applications for the extent and severity of pinyon pine mortality across the Southwest. Satellite and multispectral imagery were collected from the same areas where we installed ground plots.

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