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## A Brief Evolutionary History of *Pinus* and Fire

The genus *Pinus* originated 150 million years ago in the Mesozoic Era, when high fire activity was a likely driver of the evolutionary divergence for this group of conifers. In the *Annals of Forest Science*, USGS ecologist Jon Keeley has reviewed the evolution of pine life history strategies as shaped by wildfires. Several different life history types are recognized:

**Fire-Avoider:** High-elevation pines — such as the western U.S. whitebark pine — and many desertic species of pinyon are examples of pines that persist in habitats where fires are rare. These pines uniformly have the thinnest bark in the genus, suggesting that thick bark in pines is indeed a fire adaptation, and not likely a result of natural selection by extreme cold or heat. Some of the fire-avoider species also tend to have closed seed cones that require birds to open and disperse seeds.

**Fire-Tolerator:** Ponderosa pine is an example of a *Pinus* species adapted to survive high-frequency repeat fires. Survival of these low-intensity surface fires is enhanced by traits such as self-pruning of dead branches; thick bark; and extreme height. Others, such as longleaf pine, have saplings that persist as needle tufts, allowing the apical meristem to remain buried to survive sporadic fires. Traditional fire suppression practices can highly disrupt the life history of fire-tolerator species.

**Fire-Embracer:** Lodgepole pine, jack pine and knobcone pine are *Pinus* species subject to high-intensity crown fires and have adaptations that actually enhance fire, such as the retention of dead branches which allow surface fires to promulgate into crown fires. Reproduction is dependent on fire-activated serotinus cones which are produced en masse to maximize chances from a single burst of seeding.

**Fire-Refugia:** California foothill pine and several other regional endemics fit neither fire-tolerator nor embracer strategies. These species often occupy environments subject to high-intensity crown fires yet they exhibit few of the traits that are typical of fire-embracers, such as serotiny. After fire, populations of these species often shrink back into refugia not subject to high intensity

### Management Implications

- Retaining historical fire regimes is critical to providing selective environments that favor different pine species.
- The majority of *Pinus* species are fire adapted, but it is useful to keep in mind that species are not adapted to fire per se, but rather to a particular fire regime.
- Contemporary *Pinus* species have diverged into a) species that favor stressful sites with random fires, and b) species that favor more productive sites subject to regular and predictable fires. Fire and forest management strategies should be catered to each species' ecology.

#### THIS BRIEF REFERS TO:

Keeley, J.E. 2012. Ecology and evolution of pine life histories. *Annals of Forest Science* 69(4): 445-453. doi: 10.1007/s13595-012-0201-8

<http://www.werc.usgs.gov/ProductDetails.aspx?ID=4757>  
<http://www.werc.usgs.gov/keeley>

fires, including grasslands, riparian zones, rock outcrops or other sites with sparse fuels. During fire-free periods, these pines recolonize sites with more hazardous fuels, and in the long run they are characterized by having dramatic population fluctuations.



*Pinus palustris* is an example of a species adapted to a "fire-tolerator" life history.