Map sources for the ranges of one and two-needled pinyons

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Pinyon Types Covered

The purpose of these maps is to delimit the geographic distribution of one and two-needled pinyon pines in order to determine their climatic tolerances. The two-needled variety, *Pinus edulis*, is usually accepted as a valid species. *P. monophylla* has traditionally been easily distinguished from *P. edulis* by having a single needle in each fascicle rather than a pair. This easy dichotomy breaks down in most regions between populations, where individual trees usually have a variable number of needles per fascicle, likely due to hybridization between the one and two-needled species (Lanner, 1974; Lanner and Phillips, 1992). Microhabitat has been suggested as an influence on needle number (Welsh et al., 1993) and needle number has been shown in at least one population in Nevada to reflect precipitation during the previous year with a greater number of single needles developing following a dry year (Tausch and West, 1986). Populations in central Arizona also seem to have variable ratios of one to two-needle fascicles from year to year (K. Cole, unpublished data).

The single-needle pinyons have been subdivided into three different entities by some taxonomists. They have been reported to have variable color, differences in needle morphology expressed as thickness, number of resin canals and stomatal rows, and differences in the fascicle sheath length and curl (Bailey, 1987) and variable biochemical content (Zavarin, 1987). Little (1968) proposed the name *P. edulis* var. *fallax* to represent the single-needled trees in central Arizona and southwestern Utah. Bailey (1987) further subdivided the group with the designation of *P. californiarum* to represent the western variety occurring primarily in the coastal ranges of California and renaming the Arizona populations as *P. californiarum* subsp. *fallax*. Zavarin (1987) and Zavarin et al. (1990) proposed that all the single needle pinyon remain as *P. monophylla* but with the separation of three sub-species: *P. monophylla* subsp. *monophylla*, subsp. *fallax* (Little) Zavarin, and subsp. *californiarum* (D. K. Bailey) Zavarin.

The purpose of this effort is not to support or negate any particular taxonomic arrangement, but instead to determine the geographic distribution of individual needle anatomical types for comparison with fossil needles. While needle anatomy may or may not be taxonomically meaningful, it is clearly related to climate. In all accounts, single needle fascicles are dominant on trees from the more arid habitats and times. Trees in Mediterranean climatic zones have thick schlerophyllous needles similar to the schlerophyllous leaves on other chaparral shrubs. Whether these trends are a result of ontogeny or phylogeny (or both) is less important as long as a particular needle anatomical type reflects a particular climate.

The four maps produced are:

Colorado pinyon (*Pinus edulis*) - Almost all fascicles contain two needles resulting in needles that are crescent shaped in cross section. Needles are thin, 0.80 to 1.25 mm in diameter when dried, contain 1-4 resin ducts, and 8-16 stomatal lines.

Arizona Singleleaf Pinyon - *"fallax"*- type. Almost all fascicles contain one needle, needles are thin, 0.80 to 1.25 mm in diameter when dried, contain 1-5 resin ducts, and 8-16 stomatal lines.

Single-Needle Pinyon (*Pinus monophylla*) - Almost all fascicles contain one needle, needles are stout, 1.15 to 1.80 mm in diameter when dried, contain 2-8 resin ducts, and 17-32 stomatal lines.

California Singleleaf Pinyon - *"californiarum"* - type. Almost all fascicles contain one needle, needles are stout, 1.20 to 1.60 mm in diameter when dried, contain 7-17 resin ducts, and 13-20 stomatal lines.

Target Density and Accuracy

This map is primarily intended to provide a digitized coverage suitable for use in GIS while combining all of the available data to create the most complete coverage possible. The target density for these maps is to cover those parts of a range that have a density of at least 1 tree per hectare. Densities below this threshold are unlikely to be mapped in some of the data sources used for the project. Outliers of less than 20 trees are unlikely to be mapped. The maps may err on side of exclusion rather than inclusion. If only one of the less reliable sources reported an occurrence it was often discounted. Little's (1971) maps were never intended for projection at this more detailed scale and were found to contain geo-referencing errors of up to 15 km for well documented stands. Boundaries for some of these data were shifted several kilometers to more closely conform with the expected elevational limits of the range using a 1 km Digital Elevational Model. GAP data from different states was variable in quality and rarely singled out pinyon species from a more general category of "pinyon-juniper woodland". Although these data were accurately geo-referenced, plant species distribution data was often inaccurate, and in some cases, highly unlikely. As a result, the GAP maps were often used as a more general guide, filling in the gaps between well documented plant occurrences.

These maps probably have an accuracy of 2 to 4 km. But, because plant ranges are not only poorly known, but also discontinuous and of variable density, there will always be errors and disagreements as to which areas should be included or excluded. Some regions are better covered than others. Data from California and Nevada may be the most accurate due to the detailed maps contained in Griffin and Critchfield (1976), Minnich and Everitt (2001), and Charlet (1996). Arizona and southern Utah may be more reliable as a result of extensive field experience of the contributors in those regions.

Few data are available on the distributional limits of the two less-well recognized types of single-needle pinyon; the *fallax* and *californiarum* - types. The limits defined by these maps were taken from the digitized locations of collections described by Bailey (1987), a generalized map of Malusa (1992), collections and observations of the authors (Cole et al., in prep.), and field observations contributed by G. Ferguson. No effort has been made to delineate the limits of the mixed populations, which comprise the majority of trees in the areas where pure populations overlap.

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