***Quercus havardii* Rydb.** Havard shin oak
FAGACEAE

Synonyms: None

General Description.—Havard shin oak is also known as just Havard oak, shin oak or shinnery oak, but the names sand shinnery oak, sand scrub oak, panhandle oak, and midget oak have also been applied to it (McCoy 1981). Peterson and Boyd (1998) supply a fairly comprehensive review of this species. Havard shin oak grows to 1 m tall at maturity, but hybrids with other white oak species may attain greater height. It forms dense thickets because of an extensive underground system of horizontal rhizomes. The rhizomes are usually 3 to 10 cm in diameter but may be as thick as 15 cm. Most of the rhizomes and roots occur in the upper 60 cm of soil, but the plant is known to root to depths of 9 m. The bark is gray becoming papery scaly to rough with age. The twigs are brown to grayish, smooth to densely hairy with short yellowish or grayish hairs. The buds are dark red-brown, semi-globose, and lightly hairy. The leaves are simple, alternate, leathery, somewhat variable in shape, oblong, ovate, or lanceolate in outline, with rounded shallow lobes, although sometimes they may be more coarsely toothed than lobed (the teeth are not bristle-tipped), lustrous green and often smooth above, sometimes with hairy patches, densely yellowish to brownish green felty-hairy below, the veins prominent. The leaves range in length from 1.5 to 10 cm, and in width from 1.2 to 5.5 cm, with occasionally curled or wavy margins (Carter 1997, Correll and Johnston 1970, Flora of North America 1997, Great Plains Flora Association 1986, Martin and Hutchins 1980). Havard shin oak is a member of the white oak group, (i.e. it does not bear bristle tips on the leaves and the fruits mature in the first year). There are two varieties: *Q. havardii* var. *havardii* and *Q. havardii* var. *tuckeri* Welsh (Kartesz 1994).

Range.—This species occurs from western Oklahoma, and western Texas, into the southeastern portion of New Mexico, with outlying populations elsewhere in these states and as far west as Utah and Arizona (Great Plains Flora Association 1986, Peterson and Boyd 1998). Havard shin oak has recently been documented from Kansas for the first time (Freeman 2000). The elevational range of habitats in which shin oak may occur is from 500 m to 1,525 m. Variety *tuckeri* occurs in the Four Corners area (Utah and Arizona populations); these populations appear to be hybrids between shin oak and *Q. turbinella* Greene (scrub live oak) and *Q. gambelii* Nutt. (Gambel oak) (Flora of North America 1997).

Community Ecology.—Havard shin oak historically covered an estimated 5 to 7 million acres within the southern Great Plains (Peterson and Boyd 1998). Of this, 1 million acres occurred in Oklahoma, 1.5 million acres in New Mexico, and 3.5 million acres in Texas. About 30 percent of the acreage in Texas has been converted to cropland and grassland, and about 10 percent has been converted in Oklahoma and New Mexico. Shin oak occurs on deep sandy soils and plains, including sand dunes, and is the major shrub species comprising Plains-Mesa Sand Scrub vegetation in southeastern New Mexico and similar sandy soil habitats in western Texas including portions of the Llano Estacado ("staked" plains) (Dick-Peddie 1993). The shin oak or shinnery vegetation series variously places Havard shin oak in dominance with *Schizachyrium scoparium* (Michx.) Nash (little bluestem), *Artemisia filifolia* Torr. (threadleaf sagebrush), *Andropogon hallii* Hack. (sand bluestem), *Aristida purpurea* Nutt. (purple three-awn), *Bothriochloa saccharoides* (Sw.) Rydb. (silver beardgrass), *Yucca campestris* McKelvey (plains yucca), *Atriplex canescens* (Pursh) Nutt. (four-wing saltbush), *Sporobolus airoides* (Torr.) Torr. (alkali sacaton), and *Eriogonum annuum* Nutt. (annual

buckwheat). But there are a wide variety of other shrubs, forbs and grasses comprising numerous other vegetation series within the greater shinnery community. The tall grasses such as sand bluestem, big bluestem (*Andropogon gerardii* Vitmann), and Indiangrass [*Sorghastrum nutans* (L.) Nash] have been reduced in abundance through overgrazing of Havard shin oak communities. Havard shin oak itself may remain stable or also decrease with overgrazing, the cover of grass and Havard shin oak often being positively correlated. Stands of Havard shin oak on sites with shallow water tables, such as in Chavez County New Mexico, may contain cottonwoods. Hybrids with other oak species, such as *Q. stellata* Wang (post oak), occur and may be found within typical Havard shin oak stands, the hybrids often attaining greater height (2 to 3 m), and stand out as readily visible clumps from the surrounding shorter plants. These hybrids tend to have intermediate characteristics such as larger leaves and smaller acorns. These hybrids tend to be more common within the eastern portion of Havard shin oak's range (Correll and Johnston 1970, Flora of North America 1997, Peterson and Boyd 1998). Havard shin oak also hybridizes with *Q. mohriana* Buckley ex Rydb. (Mohr shin oak) that occurs within the rocky "breaks" area of the Texas panhandle. Hybrids are intermediate in characteristics and habitat location (Muller 1952).

Autoecology.—The plant primarily spreads by its underground rhizomes to form large clonal clumps that may range in size from as small as 2 to 15 m in diameter to as large as 0.8 ha. Isozyme electrophoresis identified 37 clones/ha, larger clones being free of interclonal growth, and the sample population was outcrossing based on Hardy-Weinberg expected genotype ratios (Mayes and others 1998). There are no data on horizontal growth rates but they are believed to be slow. The plants are long-lived, estimated at hundreds to thousands of years (Peterson and Boyd 1998). The rootstocks are massive, comprising the bulk of the plant mass (73 percent); the above-ground shoots are merely small side shoots to the below ground parts. Above-ground biomass has been measured at 1,821 kg/ha (Sears and others 1986) and annual production has been estimated to be anywhere from 550 to 4,500 kg/ha depending on the site (reviewed in Peterson and Boyd 1998). The roots (which are mycorrhizal) and rhizomes absorb considerable amounts of water during wet weather with up to 50 percent of their mass being water. This gives the plant a great ability to survive drought. During spring drought it may not leaf out or may defoliate and leaf out later once water becomes available. It generates more negative leaf water potentials, -25 to -32 bars, than many other species in the surrounding community. Soils under shin oak, in addition to being sandy, are low in nitrogen (0.017 percent), low in organic matter (0.36 percent) neutral to slightly alkaline in pH, and low in clay and carbonates (a caliche layer is inhibitory). Havard shin oak has been reported to have allelopathic effects on other plant species.

Reproduction.—Shin oak flowers in April to May. As with other oaks, male flowers are born in pendulous catkins, the female flowers solitary or a few clustered within leaf axils. The male catkins are 2 to 3 cm long and densely flowered. The female catkins are 3 to 7 mm long with one to five flowers. For a small shrubby oak, the acorns are quite large, 12 to 25 mm long, up to about 20 mm wide, brown, ovoid to oblong in shape. They are born solitary or in pairs and the cup, 10 to 12 mm deep, covers about a third to a half of the fruit. The fruits mature from mid-July into September during the first year of development on the current season's branches (Carter 1997, Correll and Johnston 1970, Flora of North America 1997, Great Plains Flora Association 1986, Martin and Hutchins 1980). Acorns of the white oak group, show little or no dormancy, and will germinate immediately (Young and Young 1992). Acorn moisture content for this group cannot drop below 30 to 50 percent otherwise seed viability will be lost. Within a particular clone, acorn crops generally only occur every 3 to 10 years. Within a larger landscape scale area containing many different clones, at least one or a few clones will have acorns. Most acorns are attacked by weevils and will decompose quickly. There is little reproduction by seed because of the short lifespan of the acorn, the need for good environmental conditions for germination and establishment at the time of acorn drop, attack by weevils, and decomposers.

Growth and Management.—For purposes of agriculture and livestock, shin oak has generally been managed as an undesirable species. Havard shin oak has sometimes been classified as an increaser under livestock grazing, but reports do not substantiate this (reviewed in Peterson and Boyd 1998). Its poor reproduction by seed restricts its spread primarily to the slow growing rhizome system. An estimated 100,000 acres of land in New Mexico have been treated with the herbicide tebuthiuron for brush control. Tebuthiuron gradually kills the plant over a 3 to 4 year period.

Other chemicals that have historically been used on Havard shin oak are 2,4-D, benzoic acids, 2,4,5-T, and picloram. Tebuthiruron should not be used in drought years, and the treated land should not be summer grazed for 2 years. Various techniques of rotational and continuous grazing in shin oak communities have been tested with mixed results for livestock productivity. But rotational grazing is best for overall ecosystem management including maintenance of proper native grass covers, and management of the lesser prairie chicken and perhaps other wildlife. Goats have been used to control shin oak with reasonable success, although goats eating it continuously will lose weight. In addition to livestock use and direct agricultural conversion of shin oak habitat, another reason for shin oak management concerns the boll weevil (*Anthonomus grandis* Boheman). This cotton pest is known to overwinter in oak leaf litter and to reinfest cotton fields for up to a half mile away (reviewed in Peterson and Boyd 1998). Above-ground shoots may live 11 to 15 years. Shoot regeneration is rapid, 30 to 60 cm within the first year, when above ground tissues are removed mechanically or through fire. The response to fire is variable and dependent on timing of the fire. Burning reduced shin oak cover by at least 25 percent, with the greatest reduction, 50 percent, following spring burns (Boyd and Bidwell 2002). Winter and annual fires increased rhizomatous grass cover, and although oak cover was reduced, regrowth resulted in greater stem densities (e.g. increasing from 20 stems/ha to 40 stems/ha).

Benefits.—The sandy soils that Havard shin oak grows in are susceptible to wind erosion. The extensive underground rootstock system and dense above ground shoots make it an important soil stabilizer. Oak leaves can be good forage for sheep and goats, but are less utilized by cattle. Consumption of too much, especially young spring shoots, can be toxic and result in illness or even death for cattle and lambs (Gay and Dwyer 1998, Warnock 1974). As with many oak species, toxicity is due to phenolics and tannins. Later in the growing season cattle will utilize it in small and varying degrees. The crude protein content of foliage is about 9 percent. The plants are browsed by deer, pronghorn antelope, and southern plains woodrats. Phenolic content (15 to 20 percent) of catkins and buds were higher in livestock grazed plots than ungrazed plots. Crude protein and other nutritional qualities did not differ between treatments (Boyd and others 2001). The acorns are eaten by a variety of wildlife and are a staple food for lesser prairie chickens (*Tympanuchus pallidicinctus* Ridgeway) in the fall and winter seasons. Havard shin oak communities are important breeding and nesting habitats for the lesser prairie chicken. Prescribed fire in shin oak habitats can improve grass and forb cover and associated insect abundance for prairie chickens but at least a 2 to 3-year recovery period, no burning in spring, and burning in patches are necessary (Boyd and Bidwell 2001). The rare sand dune lizard (*Sceloporus arenicolus* Degenhardt and Jones), a threatened species in New Mexico, is restricted to Havard shin oak communities. Both Native Americans and early Spanish colonists would eat the acorns raw or baked. A flour can be made from the large acorns by first boiling them, then roasting, chopping into pieces, drying for 30 minutes, then passing them through a grinder a couple of times (Warnock 1974).

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