Riparian Mesquite: How Much Water Does It Use?

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Photo courtesy Dick Henderson, Saguaro-Juniper Corp.

Mesquite has a widespread reputation for using water, which has generated concern in the Southwest where water supplies are limited. Mesquite is known for its ability to access and exploit groundwater in arid riparian areas and to outcompete grass for water on uplands. This has led some to consider all mesquite to be detrimental to water availability in a watershed, most importantly where it is replacing existing vegetation or reclaiming agricultural land. Some have claimed that mesquite uses almost twice the water that alfalfa does, meaning that it consumes more water than even our most water-intensive crop. Concerns over mesquite's water use led Arizona legislators in 2014 to prohibit the use of Arizona Water Protection Fund money to restore riparian mesquite while allowing use of this money to remove mesquite in all environments.

How much water does mesquite actually use? First, it is important to distinguish between *riparian mesquite* and *upland mesquite*. Riparian mesquite depends upon groundwater and can form dense forests along river terraces. This contrasts with upland mesquite, which depends solely on precipitation and remains smaller and more dispersed. Yearly evapotranspiration by riparian mesquite is 2–3 times greater than that of shrubby upland mesquite, which covers far more ground area. This information sheet focuses on riparian mesquite.

Mesquite water use had not been well quantified before work in the late 1990s by Russell Scott of the Agricultural Research Service of the U.S. Department of Agriculture and others. These studies were undertaken to quantify water use in the San Pedro National Riparian Conservation Area in southeast Arizona, established in 1988. Scott *et al.* (2008a) focused on two different stands of riparian mesquite: (1) mature woodland with a canopy covering 74% of the ground surface, and (2) immature woodland with a canopy covering 55% of the ground surface. The average height of mature woodland trees was 23 ft and that of immature woodland trees was 10 to 13 ft.

The water-use values that Scott and coworkers found for mesquite are shown in Table 1. Evapotranspiration (ET) is a combination of water transpired by the leaves of the tree and water evaporated from the soil's surface surrounding the tree. Mesquite water use depends on stand density and can be more or less than these values. Groundwater use by riparian mesquite along the Mojave River in southern California is about 14"/year (Neale *et al*., 2011).

Table 1. Riparian mesquite and sacaton water use.

	ET	GW Use
Mature woodland	28.6"	19.3"
Immature woodland	26.0"	15.0"
Sacaton grassland	25.3"	14.5"

ET = yearly evapotranspiration; GW use = groundwater use.

For comparison, average annual Arizona alfalfa evapotranspiration is about 74", although total applied (irrigation) water can be up to 40% higher. If average annual Arizona precipitation of ~11" is removed from alfalfa ET, then alfalfa would require 3–4 times as much groundwater for growth as San Pedro mesquite.

Table 2 compares evapotranspiration of riparian vegetation with several other Arizona crops. Most irrigated crops use significantly more water than mesquite, especially forage crops such as alfalfa and pasture grasses. Again, crop values are for evapotranspiration only and do not reflect total applied water.

Table 2. Ranking of crop and riparian water use.

Crop/Vegetation	Yearly ET
Alfalfa	74.3"
Bermuda/rye pasture	54"-66"
Double-cropped sorghum	54.2"
Pecans	39"-57.5"
Citrus	38"-48"
Safflower	45.5"
Sugar beets	42.8"
Cotton	38"-42"
Cottonwood–willow	38.0"
Flax	31.3"
Mature mesquite woodland	28.6"
Immature mesquite woodland	26.0"
Wheat	23.3"–25.6"
Sacaton grassland	25.3"
Barley	25.0"

Most crop values are from Erie *et al.* (1982).

Figure 1 illustrates approximate alfalfa water use (ETo, red line) vs. riparian water use for the three San Pedro River communities (Table 1) as calculated by Nagler *et al*. (2013). Total annual evapotranspiration for mature mesquite woodland is about 40% that of alfalfa.

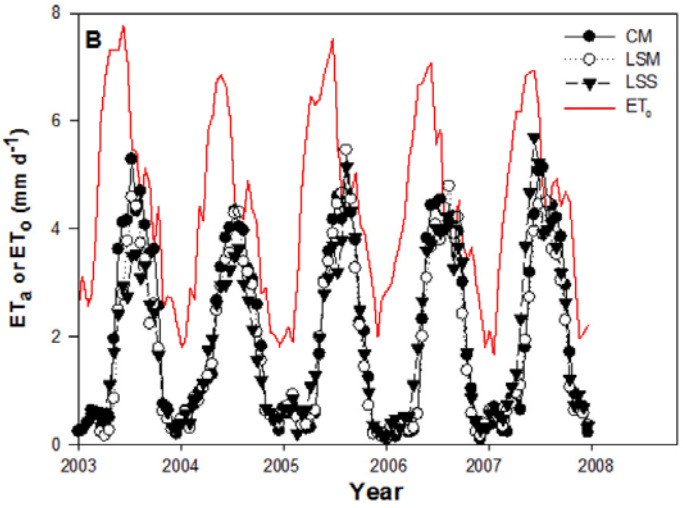

Figure 1. Measured ET for 2003–2007 for the three San Pedro River communities (ETa) vs. calculated reference ET for the sites (ETo, red line), which approximately equals that of alfalfa. CM = Charleston mature woodland, LSM = Lewis Springs immature woodland, and LSS = Lewis Springs sacaton grassland. From Nagler *et al.* (2013).

Although riparian mesquite does use significant amounts of groundwater, that use is less than that of most crops for four primary reasons:

- Mesquite is dormant for approximately half the year, whereas forage crops such as alfalfa are grown for nine months of the year or more.
- Mesquite harvests rainwater and stores it in deeper soil layers for use in drier times, reducing groundwater use (Figure 2).
- In contrast to most crops, the mesquite canopy usually covers significantly less than 100% of the ground surface.
- Native mesquite is physiologically adapted to an arid environment, whereas most cultivated crops are not.

Whether or not mesquite eventually accesses groundwater when it colonizes formerly cleared areas depends on the depth to groundwater. Mesquite does best when groundwater is between 7 and 40 ft deep. It does not tolerate excessively shallow groundwater, and its size and stature diminish as groundwater drops from 20 to 50 ft (Stromberg *et al*., 1992; Stromberg *et al*., 1993). Falling groundwater increasingly stresses already-established mesquite, and trees either die back severely or perish as water levels reach ~50 ft. At greater water depths only precipitation-dependent scrub mesquite can establish.

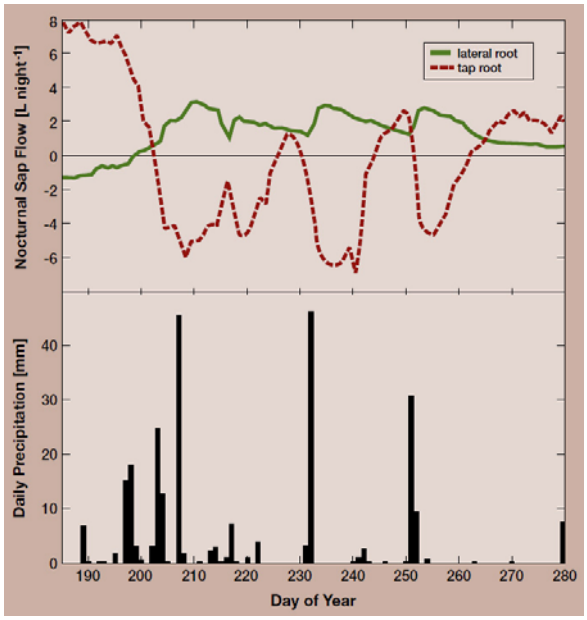

Figure 2. Downward pumping and storage of rainwater by mesquite during the 2003 summer monsoon. The negative red line reflects storage by the taproot following rain, shown at the bottom. The green line indicates gathering of rainwater by lateral roots and movement toward the taproot. From Scott *et al.* (2008b).

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For a more complete report on this subject, see http://www.lowersanpedro.org or http://www.cascabelconservation.org or contact the Lower San Pedro Watershed Alliance at P.O. Box 576, Mammoth, AZ 85618, lowersanpedro@gmail.com. September 2014.