Water Consumption By Phreatophytes

By Paul G. Sebenik and John L. Thames

Phreatophytes in the 17 western states occupy about 15 million acres of stream bank and river bottom sites and consume large quantities of water. These plants are made up of many species belonging to different plant families. They have only one characteristic in common, and that is they grow where they can send their roots down to the water table or capillary fringe overlying the water table to obtain an assured supply of water.

One of the more numerous and insidious species of phreatophytes is *Tamarix pentandra*. This species was introduced into the United States during the last century, and has become aggressively naturalized. It has no commercial value and no natural enemies, so has spread rapidly into flood plain areas and along river courses.

Results of this study in the San Pedro flood plain show that in an area where the ground water table is at considerable depths, water consumed by tamarisk equals or is greater than evaporation from a free water surface.

Use Tent Enclosure

Transpiration by tamarisk shrubs occupying a narrow flood plain between the San Pedro and Gila Rivers near Winkleman, Ariz. was measured during the summer in 1966. Measurements were made by the tent techniques as described by Decker, *et al.* (1962) and modified by Arnett C. Mace of the University of Arizona. Individual shrubs up to 10 feet tall were enclosed in a polyethylene tent inflated by a motorized blower. The rate of air flow from the tent was measured as well as the moisture content of the air stream at both the inlet and outlet. The difference between moisture content and the mean ventilation rate through the outlet gave the water loss from within the enclosure.

The tent method provides a reliable measurement of evapotranspiration as it occurs within the tent, and is the first order approximation of the nat-

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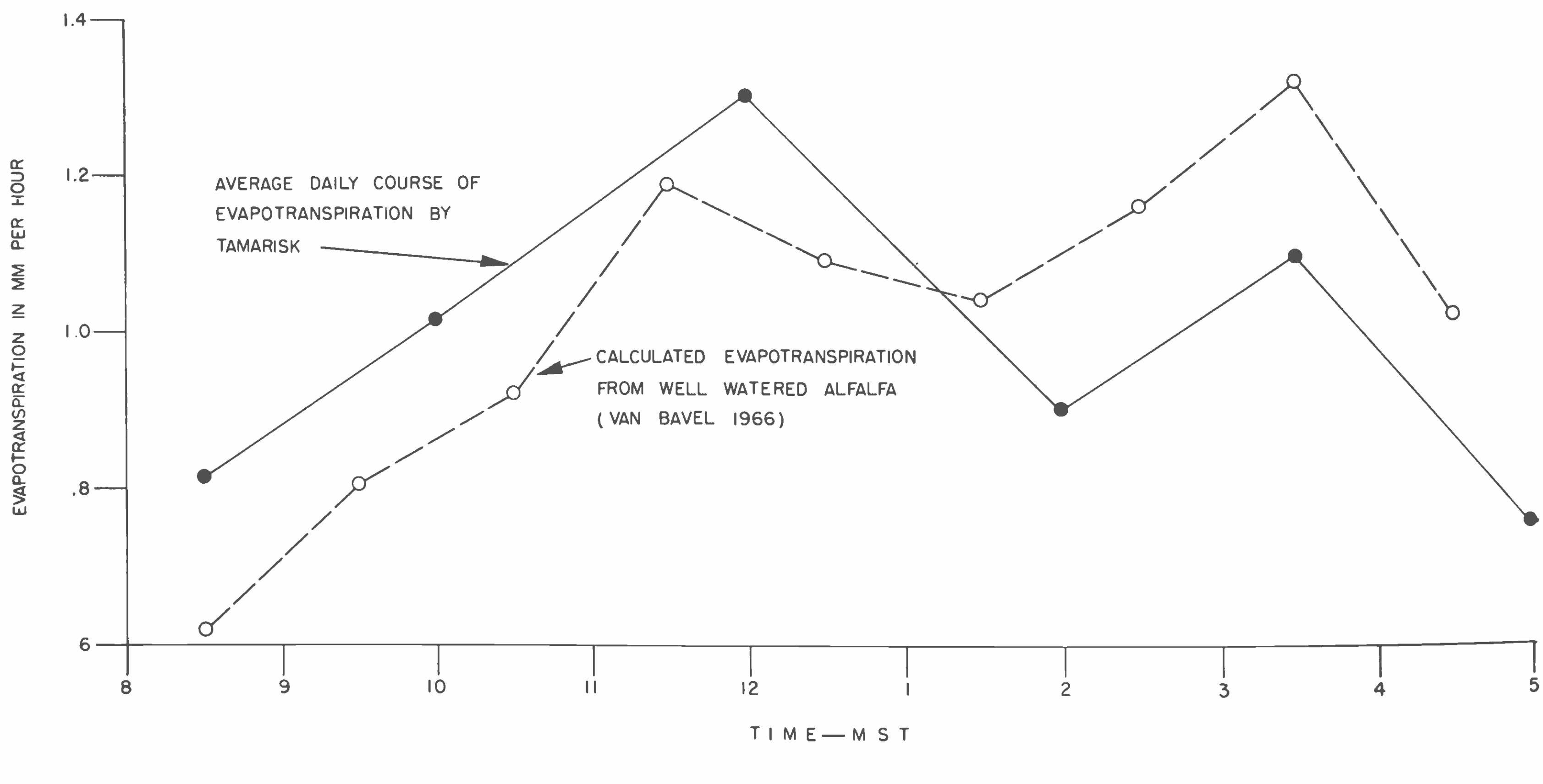
COMPARISON OF mean daily course of evapotranspiration from tamarisk during the summer with calculated evapotranspiration from irrigated alfalfa on June 21.
(Van Bavel — 1966)



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ural evapotranspiration. However, because of the unnatural greenhouse effect, it cannot be assumed that the tent measurements are exactly equal to the water loss from naturally exposed vegetation.

Two replicate runs of four hours each were made on five days between July 15 and Sept. 9. Shrubs were selected randomly from a half acre area. Average weight of transpiring foliage as measured on two shrubs was 2734 grams, 50 percent of which was water. No allowance was made for water loss from the soil or low cover. Gravimetric sampling indicated that at no time during the runs was the water content of the soil in the 0 to 4-foot depth above the wilting point. Low lying vegetation was essentially nonexistant on the site during summer.

Tent Total Exceeds Pan

Evapotranspiration as measured with the tent is compared with evaporation pan data from three locations in our table. The San Carlos Reservoir is located 22 miles northeast of the site, Tucson, 55 miles southwest, and Mesa 69 miles northwest. The tent data apply to the 10 hour period between 8 a.m. and 6 p.m. On all days of measurement, evapotranspiration from the areas enclosed by the tent exceeded pan evaporation.

Variation in the data is due to both measurement errors and variations in the weather. For example, on July 15 when high evapotranspiration was recorded, the air temperature at the site reached 114°F. Because of equipment failure on September 7, most of the measurements were made during midday. As a result the values were abnormally high.

Transpiration losses that are of the same magnitude as evaporation from a free water surface have been reported for wheat in England by Pennman (1963) and for irrigated alfalfa in Phoenix by Van Bavel (1966).

The daily course of transpiration by tamarisk on the study site averaged over all days of record are compared in our graph here, with the water loss calculated by Van Bavel for alfalfa. The double peaks of the curves are due to variation in weather in the case of alfalfa, and in the case of tamarisk to a build-up factor in the performance of the tent. However, the close agreement is striking.

Acre Foot Per Month

Total water use by tamarisk on an aerial basis may be computed from the number of shrubs in the area. At the study site there were 895 shrubs per

Evapotranspiration From Tamarisk Compared With Evaporation Pan Measurements.

Date of Measurement	*Evapotranspiration By Tent Method*		*Standard Evaporation Pan Measurements*	
	Winkleman, Arizona inches	San Carlos Reservoir inches	Mesa Exp. Station inches	Univ. of Arizona inches
July 15	0.51	0.40	0.38	0.42
July 19	0.43	0.39	0.45	0.43
July 23	0.39	0.46	0.30	0.34
Sept. 7	0.52	0.35	0.33	0.40
Sept. 9	0.27	0.35	0.14	0.32

acre. Multiplying this number by the area under the curves in the figure, and applying the proper conversion, gives an average monthly loss of 1.1 acre-feet from July to September. This is similar to the 0.72 acre-feet estimated by Turner and Halpenny (1941) for the period from May to December, but nevertheless remarkably high, considering that the soil was below the wilting point down to four feet, and only a few percentage points above wilting at deeper depths. The water used by the salt cedar necessarily came from the vicinity of the water table which was eight to nine feet below the surface when the measurements were made.

How can this water be salvaged for more valuable use? Often it has been suggested that, by eliminating the undesirable vegetation from the river channels, the value of annual benefits will accrue according to the value of the water lost by evapotranspiration. However, no studies to date have demonstrated how this saving can be obtained.

If phreatophytic areas were cleared, the water table would, in most cases rise. There would be little restriction to wind movement, and large quantities of heat would be advected into the area by warm dry air from the surrounding desert. The solar energy reaching the unshaded surface would also be greater. Direct evaporation from the ground-water body at the soil surface then would be increased.

Other Plants Would Invade

Furthermore, complete removal of the deep-rooted phreatophytes would be a continuous and costly operation. The area would most likely be reinvaded by low, shallow-rooted vegetation. This new vegetation would use nearly all of the precipitation that would fall on the area. In addition it probably would withdraw water from the elevated ground water reservoir. The indirect costs of increased erosion potential and destruction of game cover must also be considered.

Thus, it is not possible to predict the actual amount of water that could be saved each year by clearing the bottomlands, since the rate of water use from the area after clearing would depend on subsequent treatment of the area.

There are opportunities to rob the phreatophytes of water by one means or another. Lowry (1952) has shown that channel rectification, reservoir storage, drainage of bottomlands, and bypassing water around phreatophytic areas have reduced waste in the Rio Grande Valley of New Mexico. Perhaps the simplest and cheapest method is to substitute useful plants, such as pasture grasses or alfalfa, as has been done in the Escalante Valley near Milford, Utah, where sub-irrigated alfalfa now grows on ground water previously wasted by rabbit bush and greasewood.

A CORRECTION

We started a brand new year with an error, and wish to correct it.

An article referring to new sealing techniques for concrete-lined ditches, told of work being done by Robert J. Reginato and Lloyd E. Myers.

This article — taken verbatim from a publication of the Agricultural Research Service of the U. S. Department of Agriculture — said that in the 7,000 miles of concrete-lined canals in Arizona there was a water loss of "an estimated 20 million acre feet of water each year" (before new techniques were used).

That figure, corrected later by the ARS in a publication we did not catch, is of course clear out of line. The correct figure would be "one million acre feet or less," lost from leaky canals and ditches.