Name of the Project: **Rainfall Partitioning within Juniper Communities**
Geographic Area of the Project: **Edwards Aquifer Recharge Area**
Name of Principal Investigator: **M. Keith Owens**
Mailing Address: Uvalde Research and Extension Center
1619 Garner Field Road
Uvalde, TX 78801
Phone: 830-278-9151 ext 128 *FAX*: 830-278-1570
E-mail:m-owens @tamu.edu
Amount of Funding Requested: **$ 14,941**

Project Need, Description, and Expected Outcomes:

The Edwards Aquifer supplies water for large urban areas such as San Antonio (the 8th largest city in the United States), for irrigated agriculture, and for maintaining springflow for endangered species. Annual recharge to the aquifer averages about 450,000 acre-feet, but the Texas Water Development Board estimates that demands on the aquifer may exceed 750,000 acre-feet by the year 2040. This great discrepancy can only be reduced by managing both water use and water supply.

Water supply is largely from rangelands where Ashe juniper (*Juniperus ashei*) has become the dominant plant. Juniper trees exert both a physiological and physical impact on local water budgets. Physiological impact is through transpirational water loss and physical impact is from rainfall interception and partitioning. Current studies indicate that juniper canopies intercept about 45% of the ambient rainfall, which is then potentially lost through evaporation. Water is also transported via stemflow directly to the base of the tree. It has been suggested that this water is funneled to the root system of the juniper trees, allowing them to survive in a semiarid environment. Recent studies with other trees, such as mesquite, demonstrate that the stemflow actually infiltrates rapidly through root channels and quickly passes through the rooting zone of the tree. The fate of stemflow water is juniper communities is unknown. Data from previous studies on Ashe juniper (Figure 1) indicates that nearly 6 gallons of water is funneled to the base of the tree for every 1 inch of rainfall (measured on 20 ft tall trees). In a juniper community of 65% cover that received the rainfall measured in Figure 1, nearly 38,000 gallons of rainfall water per acre is funneled to the base of the tree and is not accounted for in the hydrologic budget. In a simplistic extrapolation to the Edwards Aquifer region (assuming 65% cover over the entire 5400 mile^2 area and uniform precipitation), this could represent as much as 200,000 acre-feet of water per year. Clearly this information would be valuable in a more realistic model of water use and production from the Edwards Aquifer region.

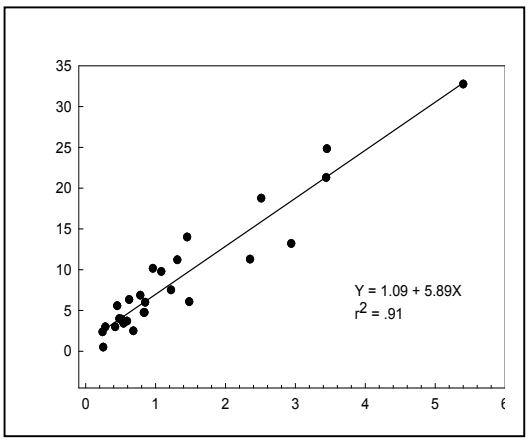

Figure 1

Another basic assumption regarding the interception of rainfall is that this water is lost via evaporation and does not contribute to the local water budget. The scale-like morphology of juniper needles is very efficient in capturing rainfall and holding moisture in the needles. This retained moisture may result in decreased transpiration losses compared to trees which do not

retain rainfall. The decreased transpiration may represent a water savings to the plant, leading to an exaggerated estimate of water use by juniper trees.

Our overall objective is to quantify water loss due to juniper trees, and specifically to: 1) determine the significance of stemflow water, and 2) of retained canopy water (intercepted rainfall) to the water budget of juniper communities. This information will be critical in refining estimates of water use by juniper trees for modeling water savings following brush control. These estimates are essential for regional water planning efforts.

Objective 1. Determine the significance of stemflow water to the water budget of juniper trees.

The usual technique of applying dyed water to the outside of the stem and excavating the tree to determine water flow paths will not work because of the limestone environment of the Hill country. Several alternative approaches will be developed to directly measure transpiration changes. The first set of experiments will be conducted by applying water as stemflow directly to test trees. Transpiration will be measured continuously using a heat pulse sapflow system on test trees and on paired control trees. The sap flow rates, combined with sapwood area, will be used to calculate total plant water use. If stemflow water is available to the tree, water use should increase in the test trees and not in the control trees. We will apply different levels of stemflow, derived from storms of different sizes, at sites in Uvalde, Bexar and Kerr counties. Applying just stemflow without additional soil moisture from general rainfall should provide the most stringent test by making stemflow the only available soil moisture. Litter moisture will be measured gravimetrically at the same time to determine if the stemflow is retained in the litter rather than the soil, and infiltration will be estimated by subtraction of litter moisture and increased transpiration from the stemflow applied.

The second set of experiments will be conducted using natural stemflow after rainfall. Collars will be placed on test trees to capture stemflow and divert it away from the tree. Transpiration will then be monitored on collared trees and on control trees which retain their stemflow. We will instrument the trees at all three sites prior to the rainy season and leave the sapflow system in place to take advantage of natural rainfall.

Objective 2. Determine the significance of retained canopy water (intercepted rainfall) to the water budget of mature juniper trees.

Retained canopy water can potentially decrease transpiration losses for the tree immediately after rainfall. The amount of water evaporated from the canopy and lost to the local water budget may be much less than currently assumed if transpirational water losses are decreased at the same time. To test this effect, we will instrument test trees at the Uvalde County site with sap flow gauges (Dynamax System) on individual branches. One-half of the branches will be watered with a rainfall simulator and one-half will remain dry. Transpirational water loss will be compared between these sets of branches to calculate the duration of altered transpiration and total amount of water use.

Specific Issues Addressed

We are currently conducting studies on rainfall partitioning in juniper communities and have expanded the effort to include oak and mesquite trees. This project will allow us to refine the impact of juniper trees on the community water budget. We will address the issues of brush control for soil, water, and wildlife management; water resources - quantity; and plant water use requirements as stated in the RFP.

Collaboration

Brad Wilcox - Department of Rangeland Ecology and Management, Texas A&M Univ., Rangeland Hydrologist, Collaborator on juniper interception and rainfall simulator study

Robert K. Lyons - Texas Cooperative Extension, Range Extension Specialist, Technology transfer

Billy Kniffen, Joe Taylor, Kenneth White - County Extension Agents - District 10, Technology transfer and local programs

Bill Armstrong - Texas Parks and Wildlife, Kerr Wildlife Management Area, Research site access and maintenance

Submitted by: _____

Approved for submission:___