Document Title: Description, **AN, Use of the AccuPAR Ceptometer to Quantify Effects of Riparian Vegetation Removal on Stream Energy Balance**		Part # and Rev. 13949-01 Release Date: 7-14-09	
Rev.	Description	Revision By	Date
-01	Updated part number and assigned Desc. file	DDH	7/14/09

Production Filename: 13949 (In Product Library)

Path to Working Files: DecaDoc\Application Notes\Master\AG

Dimensions: 8.5 inch wide, 11 inch tall

Material: Paper, 92 Bright White or better, 75g/m² or heavier

Colors: Color Print on White

Printer: HP Color LaserJet 8550-PS

Adhesive: None

Special Notes: Illustrations are Ref Only ** Not to Scale ** (Page 1 of 2)

DECAGON DEVICES

Application Note

Use of the AccuPAR Ceptometer to Quantify Effects of Riparian Vegetation Removal on Stream Energy Balance

When the vegetation along a stream bank is removed, the solar load on the stream increases. This results in increased stream water temperature. Elevated stream temperatures degrade freshwater habitats, shifting species composition, and often endangering some of the species that live in the stream. An increasing awareness of this problem has led to the creation of riparian strips to shade streams when timber is harvested or prescribed burns are undertaken. The challenge is to know how much shade is needed, and how large to make the strips.

Both empirical and physically based models are available for designing the strips. The physically based models use an energy balance for a section of the stream. The energy balance considers all inputs and losses of heat for the stream. The change in temperature is the difference between inputs and losses divided by the heat capacity of the water. The inputs are solar and thermal radiation. Losses are thermal radiation and latent heat. Sensible heat can be either an input or a loss, depending on whether air temperature is above or below stream temperature. Inputs to the stream from ground water can also be inputs or losses, depending on their temperature relative to the stream temperature. Of these, the variable most susceptible to manipulation is the solar radiation, through changing the amount of shade. Manipulating solar radiation also changes the thermal radiation. Incoming thermal radiation from vegetation is greater than incoming radiation from the sky. Thus, increasing cover decreases solar input, but increases thermal input. Since the change in solar radiation is the larger of the two, decreasing solar input reduces stream heating, even though it also increases incoming thermal radiation. Our purpose here is not to present the model. A number of model sources, which give additional information, are cited below. We want to focus on the measurement of solar (and thermal) inputs of radiation to the stream. If the total solar radiation above the canopy is S_o, then the radiation at the stream surface is :

$$S = \tau S_o \qquad (1)$$

where t is the canopy transmission coefficient. The value of t depends on the leaf area index of the canopy above the stream, the angle of the radiation incident on the canopy, the angle distribution of leaves in the canopy, and spatial distribution of canopy elements. Harvesting or burning the canopy along a stream bank reduces the leaf area index and changes the spatial distribution of canopy elements. If we can measure the effect of management on t will have quantified the main effect of management on stream temperature.

The AccuPAR model LP80 makes a direct measurement of τ. It does this by taking a ratio of radiation measured under the canopy to radiation incident on the top of the canopy. The LP80 is particularly well suited to this type of measurement because it measures light at 80 locations with a single button-click. Light under plant canopies has high spatial variability, so many measurements are required for acceptable accuracy. Several button presses, with the probe in different locations, gives a good estimate of below canopy radiation.

Two questions now arise. First, the measurement of τ is at a particular location and time. How does this measurement relate to the energy balance over whole days and months? The second relates to PAR vs. total solar radiation. Since PAR is attenuated more strongly than total radiation by plant canopies, can one be determined from the other? Taking the second question first, Campbell and van Evert (1994) related values of intercepted solar and PAR radiation. Figure 1 shows a similar relationship to theirs, but in terms of transmitted solar and PAR. Note that at total transmission or total interception the two are equal. At 50% transmission of PAR, the transmitted solar is around 60%. At 10% transmission of PAR the transmission of solar is around 20%. The ratio of transmitted solar to transmitted PAR can be computed from

$$\frac{\tau_s}{\tau_p} = \exp\left[-\left(\sqrt{a_s} - \sqrt{a_p}\right)KL\right] \qquad (2)$$

where a is the absorptivity of leaves for either solar or PAR, K is the extinction coefficient of the canopy, and L is the canopy leaf area index. Typical values