USING 35-MM PHOTOGRAPHS TO MONITOR HERBACEOUS AND WOODY PLANT ABUNDANCE IN RIPARIAN SYSTEMS

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Summary

Observer-based methodologies are used widely in vegetation monitoring programs. These methods often suffer accuracy problems within and between observer variations. We currently are exploring ground-based photography and computer image analysis as tools for monitoring herbaceous standing crop in riparian plant communities, and production and stand development of riparian willow communities. This technology has the potential to minimize observer bias and creates a permanent record of vegetation status. Preliminary data were collected in the growing season of 1999, and technique evaluation will take place during the growing seasons of 2000-2001. Our method for estimating herbaceous standing crop and woody plant production involves using computer image analysis to determine visual obstruction of a photoboard. The resulting numbers are regressed against the actual (harvested) weight of vegetation influencing the photoboard to determine the utility of computer generated visual obstruction values as predictors of herbaceous and woody plant abundance. Preliminary data between visual obstruction and plant abundance yielded an R^2 of 0.88 for herbaceous standing crop and 0.91 for current annual willow growth. We also are evaluating the use of community scale photographs and image analysis for tracking changes in the properties of willow communities over time. Photographs are taken from permanent photo-points and scanned, and willow clumps are hand-digitized. The processed image then can be used to generate diameter, height, and area measurements for willow clumps.

Introduction

Observer-based methods for quantifying vegetation abundance (e.g., canopy cover estimation) are used widely in monitoring protocols because they are time efficient, financially feasible, and, when sound protocols are followed, can provide a meaningful estimation of vegetation attributes. However, observer-based methods may suffer from several credible problems, namely observer bias and variability between observers. Additionally, observer-based monitoring programs lack a permanent record of vegetation status (e.g., photograph, classified image) that may be re-analyzed as new technologies become available. Variability between observers can be reduced by using quantitative monitoring techniques such as clipping and weighing plant material; however, quantitative methods are time intensive, often to the point of being prohibitive.

Analysis of remotely sensed imagery (e.g., aerial photos) as a monitoring tool provides a permanent record of vegetation status while minimizing observer bias. However, use of this technology may be limited by image availability, cost, and the scale of interest. Ground-based photography combined with image analysis may serve as a viable alternative for meeting small-scale monitoring objectives. To date, this technology has been used to measure a variety of plant autecological and community attributes, including canopy cover of individual (Birdsall et al., 1997; Ewing and Horton, 1999) and multiple (Dietz and Steinlein, 1996) plant species, and leaf area of woody species (Ansley et al., 1988). We currently are evaluating the use of ground-based photography and image analysis for the following applications: (1) quantifying standing crop of herbaceous vegetation in riparian plant communities, and (2) quantifying production of individuals and stand development of riparian willow communities. Preliminary fieldwork was conducted in the growing season of 1999 and experimental evaluation of techniques is scheduled for the growing seasons of 2000 and 2001.

Materials and Methods

Our study site is located in the Logan Valley, 80 km northeast of Burns, OR. This site is predominantly wet meadow vegetation dominated by *Poa* sp., *Carex* sp., and *Deschampsia caespitosa* and is bisected by several riparian drainages. Historically, the study site has been grazed in the early growing season and later hayed. Both livestock grazing and haying activities recently have been curtailed.

Our field methodology is based in part on the relationship between visual obstruction and plant production. The underlying theory is that changes in visual obstruction of an object will correspond to changes in the weight of plant material. For herbaceous vegetation, we relate visual obstruction to standing crop (current and preceding year's production), and for willow plants, to current annual growth. Visual obstruction has been shown to be a reliable predictor of herbaceous standing crop (Robel et al., 1970); however, the relationship between woody plant biomass and visual obstruction is less well defined.

Herbaceous vegetation. Approximately 150 sampling points will be subjectively chosen to represent a broad range of biomass values. Sampling will take place during the growing seasons of 2000 and 2001. At each point, a 1 m^2 white photoboard will be placed perpendicular to the ground, and a 35-mm photograph will be taken of the photoboard, using a 50-mm lens, at a distance of 2 m. The height of the camera will be equal to the center-point of the photoboard. A 40- x 100-cm quadrat then will be placed immediately in front of the photoboard, and all herbaceous vegetation will be clipped, dried, and weighed. Photographs will be scanned and cropped to encompass the dimensions of the photoboard. Visual obstruction will be estimated using Sigma Scan 5.0 computer software by determining the amount of the photoboard visible in the image and comparing that to its actual area. The relationship between percent visual obstruction and standing crop will be evaluated using regression analysis. Preliminary analysis of pilot data from the 1999 growing season indicates a strong relationship between herbaceous standing crop and percent visual obstruction of the photoboard (Figure 1).

Willow. The relationship between visual obstruction and the weight of current annual willow growth (CAWG) will be determined using a sequential removal technique and image analysis. Harvested willow branches will be placed in a holding device such that they are oriented perpendicular to the ground and located in front of a 1-m^2 photoboard. The CAWG obstructing view of the photoboard then will be incrementally removed, with each successive removal representing about a 25 percent decrease in visual obstruction of the photoboard. A photo will be taken before and after each removal, and harvested CAWG will be dried and weighed. Camera placement will be at 3.5 meters from the photoboard with a lens focal length of 80 mm. Slides will be scanned and cropped to encompass the dimensions of the photoboard. Visual obstruction will be estimated for all scanned images, using Sigma Scan 5.0 software, by determining the amount of the photoboard visible in the image and comparing that to its actual area. The relationship between percent visual obstruction and the weight of CAWG will be evaluated by regressing the weight of CAWG covering the photoboard against percent visual obstruction.

Preliminary results using this technique indicate a strong relationship between CAWG and percent visual obstruction of the photoboard (Figure 2).

We also will explore the use of permanent visual obstruction monitoring stations for ascertaining changes in willow abundance over time. Each monitoring station will consist of two 30-cm-wide visual obstruction boards placed behind a willow clump (Figure 3). The boards will be placed at approximately 1/2 and 2/3 the height of the willow clump. If the clump is immature, an average willow height of nearby mature willows will be used to determine height placement of boards. Annual photographs will be taken from a permanent photo point located perpendicular to the visual obstruction boards. Photos will be scanned and visual obstruction of each board will be determined as described above. This setup will facilitate determination of visual obstruction at two levels in the tree canopy. Changes in these readings from year to year can be used to imply changes in the amount of CAWG in the clump. The boards will be of known length and can be used as scale references for determining the height and width of the clump. We will put in place six visual obstruction monitoring stations at the Logan Valley site.

We will use a combination of community scale photographs and image analysis to evaluate changes in the size of the willow community surrounding the visual obstruction station. Permanent end posts will be put in place to mark the outer boundaries of the community photograph and will be located equal distance from the edge of the visual obstruction monitoring station (Figure 4). A 35-mm photograph of the community scene will be taken at a permanent photo-point at the end of each growing season. Images will be scanned and willow clumps in the image then will be hand digitized with a mouse and measured using Sigma Scan 5.0 software. Measurements will include maximum clump diameter, maximum height, and area. This approach to monitoring changes in willow community properties is similar to that presented by Hall (1999).

Literature Cited

Ansley, R.J., D.L. Price, B.K. Lawrence, and P.W. Jacoby. 1988. A truck-mounted mobile screen for photo digital estimation of whole plant leaf area. J. Range Manage. 41:355-358.

Birdsall, J.L., P.C. Quimby, Jr., N.E. Rees, T.J. Svejcar, and B.F. Sowell. 1997. Image analysis of leafy spurge (*Euphorbia esula*). Weed. Tech. 11:798-803.

Dietz, H. and T. Steinlein. 1996. Determination of plant species cover by means of image analysis. J. Veg. Sci. 7:131-136.

Ewing, R.P. and R. Horton. 1999. Quantitative color image analysis of agronomic images. Agron. J. 91:148-153.

Hall, F.C. 1999. Ground-based photographic monitoring. Draft manuscript. USDA, For. Serv.

Robel, R.J., J.N. Briggs, A.D. Dayton, and L.C. Hulbert. 1970. Relationships between visual obstruction measurements and weight of grassland vegetation. J. Range Manage. 23:295-297.

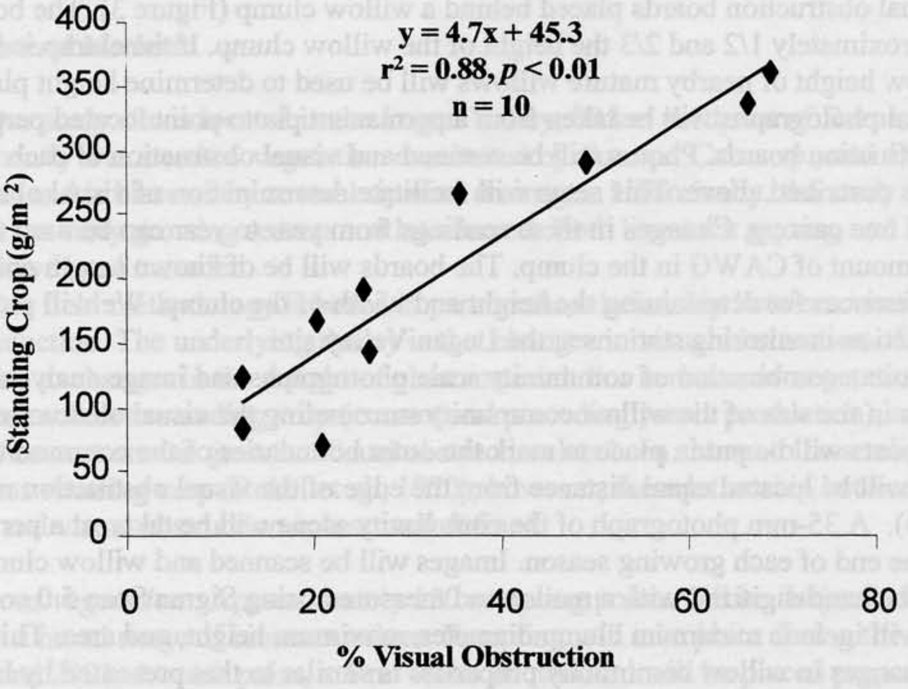

Figure 1. The relationship of herbaceous standing crop and percent visual obstruction for a wet meadow plant community.

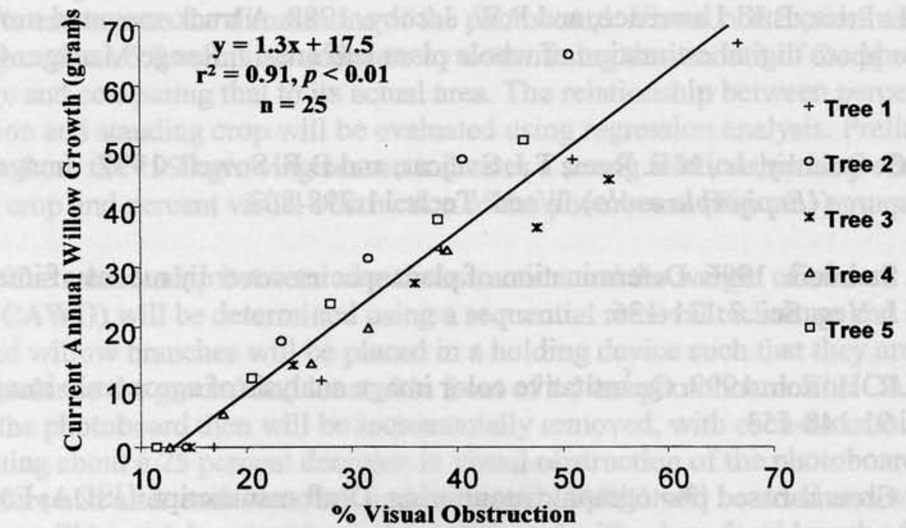

Figure 2. The relationship of the weight of current annual growth and percent visual obstruction for simulated willow trees.

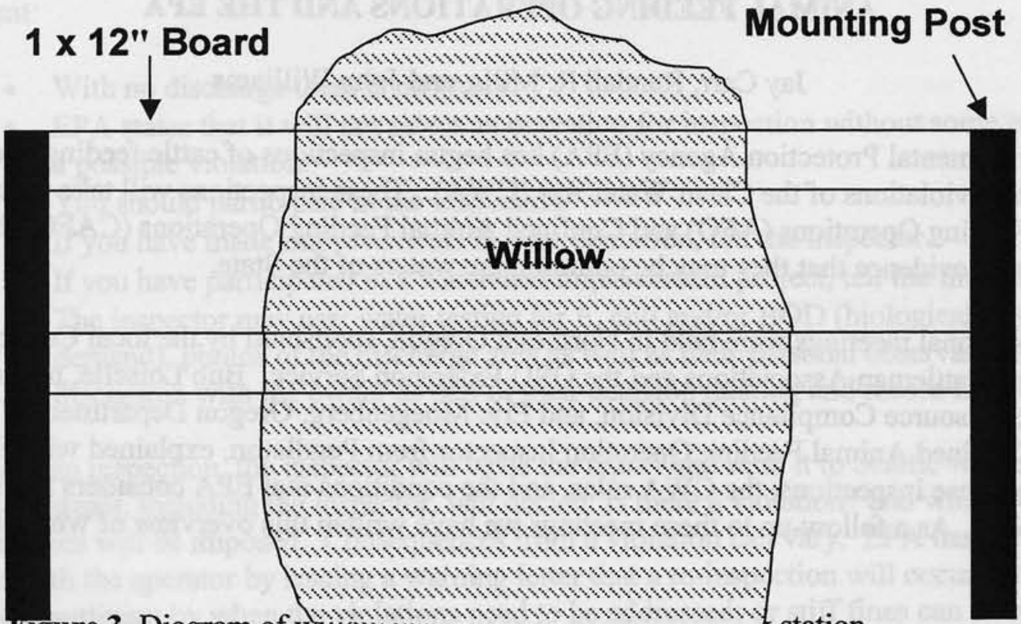

Figure 3. Diagram of willow visual obstruction monitoring station.

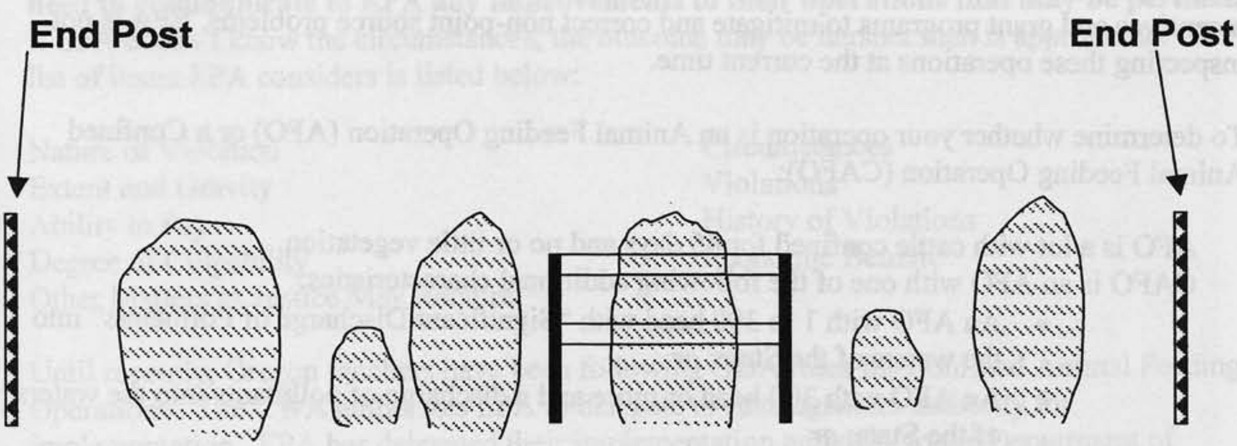

Figure 4. Diagram of willow visual obstruction and community monitoring stations.