A Photographic Technique for Estimating Forage Productivity

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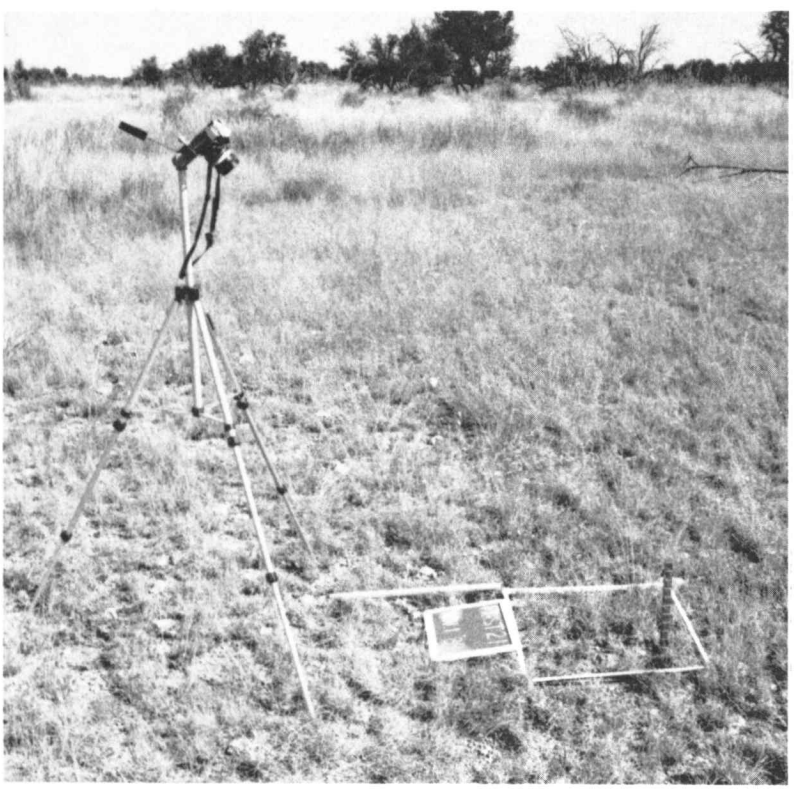
Realistic estimates of rangeland forages where amounts and composition vary greatly are very difficult to obtain. Most ranchers are conservative and rely on past experience to establish or adjust stocking rates. However, there are many ranchers who each year overstock and are then forced to sell under crisis conditions or buy expensive feed and hope for adequate amounts of precipitation to grow more forage.

To aid in proper forage estimation and facilitate stocking rate decisions a quick, practical range sampling procedure is needed. The sampling procedure should (1) be easy to use with a minimum of training; (2) provide estimates of forage supply with confidence intervals for risk consideration; (3) require a minimum amount of time at a specific location so that large pastures can be sampled, and (4) provide information specific enough so that grazing management decisions are improved.

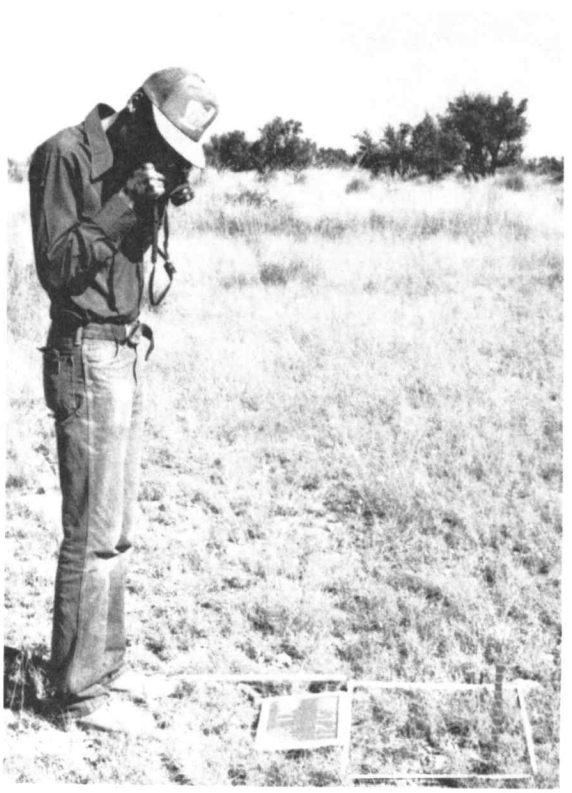
Most methods for measuring forage involve clipping and weighing samples and converting to oven dry material. While clipping is considered to be the most accurate, it is very labor intensive and often impractical for a ranch situation. "Weight estimation" is another sampling method where weight estimates are compared to clipped plots. Using this method, a person estimates the weight of a plant or plot and then clips and weighs it. After they are able to accurately estimate the weights, the person can then make visual estimates with only an occasional clipped plant or plot to check themselves. The clipped and estimated values are used to compute a linear regression or ratio correction. This method provides a basis for the photographic assessment technique discussed in this paper. Photographs of forage plots that have then been clipped, oven-dried, and weighed, are used as a basis for estimating the amount of forage in similar plots on the range.

Equipment

Any camera can be used to take the pictures, but it is best to use the same camera and lens for all pictures. Our



Photographs using tripod-mounted camera.



Hand held photo of plots.

photographs were taken with a camera that uses 4″ × 5″ sheet film. This is not the easiest camera to handle, but photograph quality is very good. Most 35mm cameras will produce excellent results. We have experimented with Polaroid instant cameras but have been unable to consistently produce suitable photographs.

Film type is also a variable. Black-and-white film works well and produce photographs which are easy to "read". Plus-X (125 ASA) and Tri-X (400 ASA) films both produce good quality pictures. Color films are a possibility although picture quality in our tests has been inconsistent.

Each photo is taken with the camera mounted on a tripod at a fixed height. The tripod is placed the same distance from the plot frame in each picture (Figure 1). The camera is kept the same distance and the same angle from the plot frame for each picture. A measuring stick (1′ × 3/4″ × 3/4″) with a spike in one end and marked in 1-inch increments, is placed within each plot for each photograph. This provides a reference for judging the height and density of the vegetation. A 1/4 square yard (18 inch × 18 inch) frame, made from 1/4″ angle iron, fits the format size of our camera at the distance we placed the camera from the plot frame. The plot frame was painted white to provide more contrast against vegetation, rock, and bare ground.

Each photograph included a card (later changed to a blackboard) with information about the photo listing the date, pasture, range site and other pertinent information. Information on pasture and site were kept in a notebook along with other information about film exposure, time of photo, date, and weather conditions.

In addition to the plot frame photos, it is helpful to include a picture of each range site (areas in the pasture which are different due to type soil, soil depth etc.). These should show the type of terrain, dominant vegetation, and other site specific characteristics. These site photos should also be numbered so that the information can be filed for future use.

These guidelines are only suggestions and should be modified if easier or more efficient methods are developed. It is very important that each person's set of pictures be prepared consistently. Height and distance from the plot are important. Hand held cameras will work well as long as the photographer remains the same height and stands a measured distance from the plot frame (Figure 2). Using a tripod allows for flexibility in the shutter speed and aperture settings to create clear, sharp pictures with maximum depth and area of focus.

Forage Estimation

After the photograph has been taken, the plot should be clipped by plant type (i.e., grasses, forbs) or species and put into paper bags (Figure 3). These bagged samples are oven dried for 48 hr at 140° F (60° C) for dry weight determination. The samples are weighed, and converted to forage/acre. For accuracy the scale used should weigh to the nearest gram.

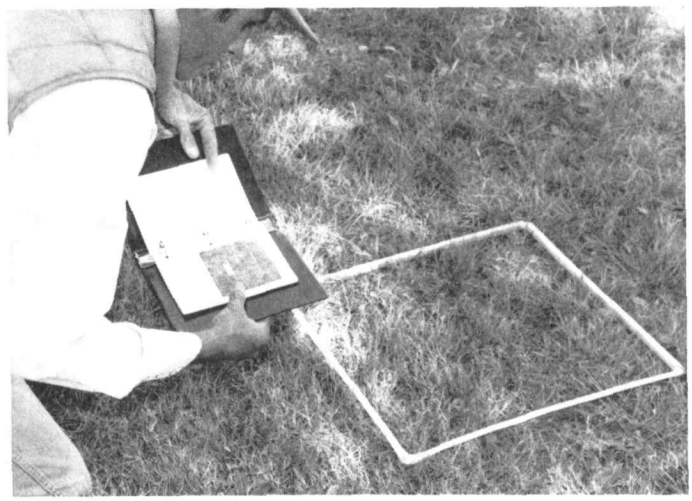
Clipping for biomass determination.

Frame size = 0.25 sq. yards — 1 acre = 4,840 sq. yards
4 plot frames = 1 sq. yard — grams per acre/454 = lbs/ac

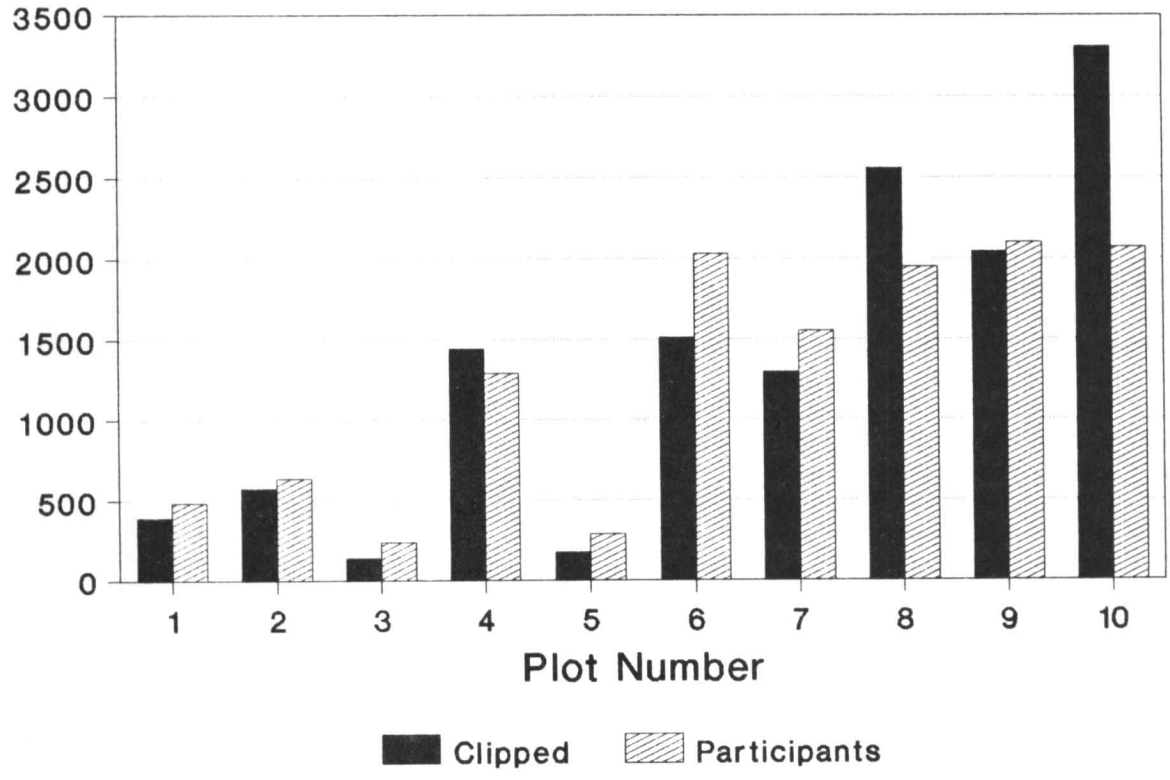
(Example)

(100 grams of dried forage) * (4) = 400 grams per sq. yard
(400 grams) * (4840) = 1,936,000 grams per acre
(1,936,000 grams per acre/454) = 4,264 pounds of forage per acre

With a set of photos representing the variation in forage supply for each range site, it is possible to go out and estimate how much forage is there at any time. Toss the plot frame randomly in a particular range site. At each plot flip through the book until you find a picture that best matches the vegetation amount and composition in the frame (Figure 4). Take as many plots as possible in each range site for better representation of the area. The



Using photo for estimating forage production.



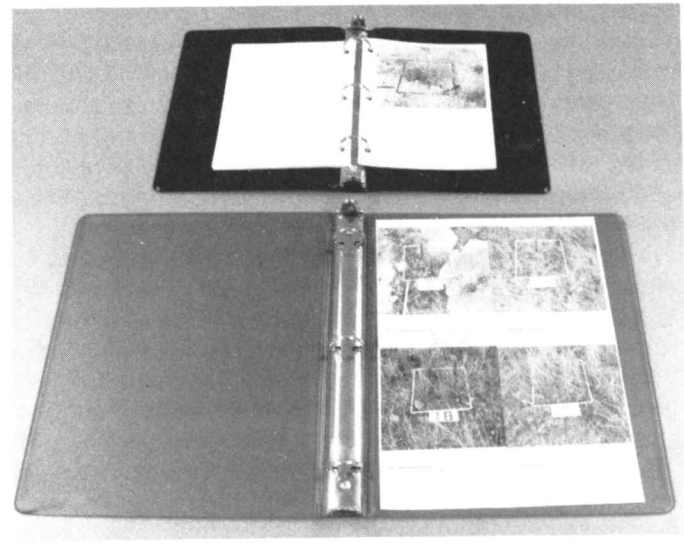
Comparison of photo estimates to clipped plots.

area sampled should be representative for the site and pasture. If more than one site is present in a pasture, sample each site and estimate how much of the pasture each site represents.

It is important to remember that each photo represents how much forage would be present if the density of the forage in the plot frame was expanded to one acre in size. To be more realistic in your estimation of forage for a site, it is better to throw your plot frame 10 or more times in each site and work up an average.

The method has been tested on two different groups of people. Thirty-nine participants of a grazing management field day used the method in October of 1986 and 8 researchers were tested in 1987. Although the photo estimated plots varied some from the clipped plots, the observers came very close to the clipped values (Figure 5). Generally, most observers estimated a smaller range of values than the corresponding clipped values. This may have been the result of too few pictures in the photo-assessment book to choose from. Also, only one picture per page is represented in the book. The authors feel greater accuracy and efficiency would be realized if multiple pictures per page (i.e., 2-4) were used and if each page represented a range of values such as 300-500 pounds per acre, etc. (Figure 6).

One of the advantages of the photographic method is that once the standard plots have been clipped, oven-dried, and weighed, comparisons of additional plot frames, estimated in the field using the photographs, are already



Notebook of photos.

figured on an oven dry basis. It is recommended that a set of photographs be developed for each season and different phenological conditions within seasons. This reduces the variablity associated with estimating actively growing vegetation from photos taken in the dormant or dry season.

This method allows the manager to estimate forage more consistently, and can also provide a visual record of

the ranch's progress or decline in overall range condition if photographed plots are permanently marked and estimated each 5 or 10 years.

This photographic method aids in the management of the range on a short-term basis (i.e., determine the proper stocking rate or the proper grazing cycle length), and can provide a reliable visual record of the manager's ability to improve it.

Senecio: A Dangerous Plant for Man and Beast

A.E. Johnson, R.J. Molyneux and M.H. Ralphs

The genus *Senecio* includes 1,000 to 3,000 species distributed throughout the world. *Senecio* and other species that contain pyrrolizidine alkaloids (PA) [i.e., hounds tongue *(Cynoglossum officinale),* fiddleneck *(Amsinckia intermedia),* and species of *Crotalaria, Borago, Heliotropium* and *Echium*] are perhaps the most important group of poisonous plants worldwide. They are toxic to livestock when grazed or ingested in hay or contaminated grains. They are also toxic to humans when ingested as contaminants in cereals, from PA contaminated milk products (PA's ingested by lactating animals are excreted in the milk), and when made into herbal teas. Tansy ragwort *(Senecio jacobaea)* is often confused with tansy *(Tanacetum vulgare),* which has been used in herbal medicines (Cheeke and Shull 1985). Comfrey *(Symphytum officinale),* which has been reputed as having medicinal properties, also contains PA.

In the western US, only 7 *Senecio* species are reported to be toxic (Kingsbury 1964), but many other species probably contain PA. The greatest economic loss is from cattle poisoning. Horses are also highly susceptible to PA, but sheep and goats are more resistant and may be an effective biological control for some *Senecio* species.

Three *Senecio* species cause the majority of cattle losses in the western US. Tansy ragwort was introduced from Europe and occurs in the coastal Pacific Northwest and in the Northeast. The plant is a weedy winter annual or biennial that germinates in the fall, over-winters as a rosette, and forms a tall flowering stalk in the spring and summer. It grows on moist well-drained soils in pastures, forests, and wastelands.

Threadleaf or woolly groundsel *(S. douglasii* var. *longilobus)* grows principally in the Southwest. It is a low-growing, perennial, evergreen shrub and is most abundant on loamy to clay soils. Its leaves and stems are covered with a white woolly pubescence. It is an increaser species that becomes abundant on abused and degraded rangeland.

Riddell's groundsel *(S. riddellii)* occurs in the Mid- and Southwest. It is a suffrutescent half-shrub that dies back to the crown each fall and thrives on sandy soil. It is similar in appearance to threadleaf groundsel except that its leaves and stems are bright green. It was implicated as causing "walking horse" disease early in this century and has systematically been eradicated in many areas of the Midwest (Barkley 1978).

Toxicology

Estimates of toxicity of *Senecio* species are commonly based on the amount of plant required to cause symptoms or death. These estimates are not reliable or realistic because toxicity depends on the PA concentration in the plant, the specific PA present, the form of PA, and the rate at which the plant is ingested.

There are many different PAs. The majority are toxic and primarily affect the liver. Tansy ragwort contains 8 PAs, threadleaf groundsel contains 4, and Riddell's groundsel contains only 1. Each PA exists in the plant as a nontoxic free-base or a N-oxide. They become toxic when the free-base is converted into highly reactive alkylating pyrroles by liver microsomal enzymes. The N-oxide must first be converted to the free-base, presumably in the gut, before conversion to the pyrrole. Initially the free-base form was considered potentially more toxic (Johnson et al. 1985b), but recent evidence suggests that the N-oxide can be equally toxic (Molyneux et al. 1989). Thus, the total PA content of a species is currently the best estimate of its toxicity.

The reactive pyrrole crosslinks with DNA and prevents liver cells from reproducing. As the cells senesce and die, they are not replaced. Increasing numbers of liver cells are damaged with each successive toxic dose of PA, resulting in a cirrhosis-like liver condition with blocked bile ducts and veins. These changes lead to eventual liver failure and death of the animal. The disease is progressive and symptoms may not become apparent for 3 weeks up to 18 months after ingestion of the plant. Thus, a large proportion of deaths and illnesss may go undiagnosed.

Editor's Note: 1 pound (lb) equals 454 grams (g)
1 kilogram (kg) equals 2.2 pounds

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