Site-Specific Repeat Photography

Site-specific means that a camera location and photo point or transect are permanently marked to document a specific topic on a limited tract of ground (not a landscape view) (Jensen and others 1999, Smith and Arno 1999). Directions and measured distances from witness site to camera locations and from camera to photo points or transects are required for precise relocation. For example, figure 20 is Pole Camp photo point "wet" (the wet meadow view). Topics were animal affects on willow shrubs (*Salix* spp.) and herbaceous stubble height remaining after grazing along the stream and adjacent meadow. A different kind of topic, planned disturbance and plant community development, is illustrated in figure 21.

Site-specific repeat photography may be divided into two kinds: topic and transect systems.

Topic Photographs

Topic photographs are shown in figures 20, 21, 22, and 23, where specific topics were monitored. This system uses a general photograph and may be supplemented by closeup photos of the meter board, a single plot frame (fig. 24), or overhead tree cover (fig. 25). Cole (1993) points out some limitations of topic photography when documenting damage to soils and vegetation from wilderness recreation. He indicates that measuring change from the photographs was difficult.

Transect identification using topic photography is used in the three-step method (Parker 1954, Parker and Harris 1959). In this method, Reppert and Francis (1973) could appraise species identification and their change in density and could verify correct replacement of the transect.

In British Columbia, Jensen and others (1999) applied topic photography to monitor recreational impacts, fuel loading, riparian vegetation and stream channels, disturbance recovery, and quantitative measurements of change in soil and vegetation. In an appraisal of observer variability, they found that a topic photopoint system could attain 80 to 100 percent overlap 95 times out of 100 (95-percent probability).

French and Mitchell (1983) used the single-topic approach to photograph change in shrubby vegetation in southern Idaho over 21 years. Pond (1971) evaluated an increase in chaparral (*Quercus* spp., *Ceanothus* spp., *Rhus* spp., *Arctostaphylos* spp.) for 47 years in an enclosure erected in 1920. Sharp and others (1990) show 40 years of change in a shadscale (*Atriplex confertifolia* (Torr. and Frem.) S. Wats.) stand in Idaho and correlate it with growing conditions to appraise effects of local weather on species dominance. In another study, Sharp and others (1992) document crested wheatgrass (*Agropyron desertorum* (Fisch. Ex Link) J. A. Schultes) production over 35 years and correlate it with growing conditions. Medina (1996) photo documented vegetation changes in the Santa Rita Experimental Range in southern Arizona at five locations: Burroweed (*Haplopappus tenuisectus*) increased and decreased with precipitation; jumping cholla (*Opuntia fulgida*) was absent in 1902, increased by the 1940s, then decreased; velvet mesquite (*Prosopis juliflora*) increased dramatically on mesic uplands but not on clayey, stony soils; and Lehman lovegrass (*Eragrostis lehmanniana*) increased and displaced many native species.

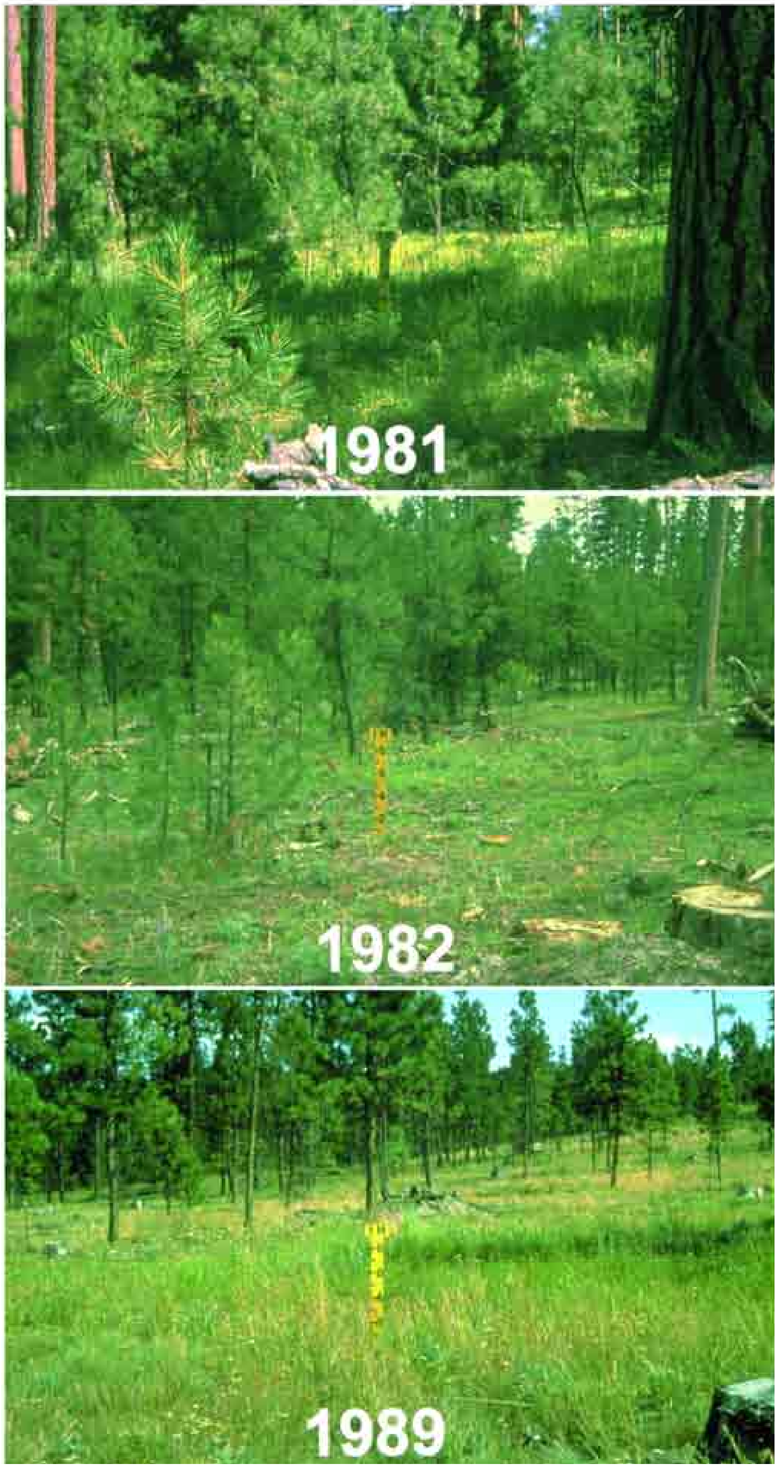

Figure 21—Aponderosa pine stand with pinegrass ground vegetation showing conditions after logging: undisturbed in 1981, after the first partial overstory removal in 1982, and in 1998 after the second overstory removal and precommercial thinning. These views, with their dramatic differences, emphasize the need for permanent marking of both camera locations and photo points. Exact reorientation of the picture uses the “1M” of the meter board as the photographic center (see fig. 29). All photographs were taken the first week of August.

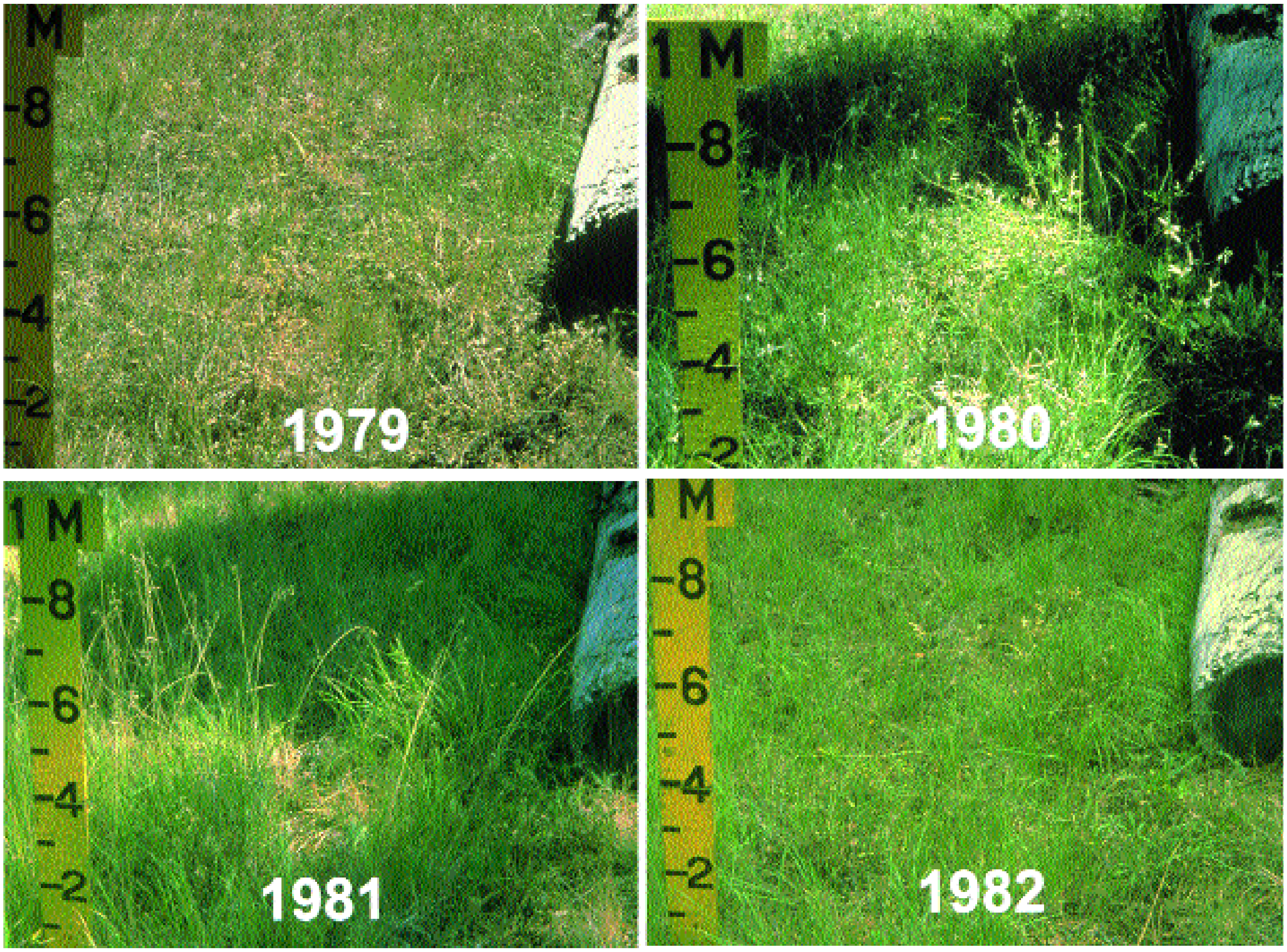

Figure 22—Photo monitoring each year at the same date (August 1) to document herbage production in a ponderosa pine stand with pinegrass. In 1979, drought occurred, which resulted in elk sedge (*Carex geyeri* Boott) dominance and only 400 lb of total herbage per acre. In 1980, lupine (*Lupinus caudatus* Kellog) was clearly important and pinegrass dominated over elk sedge with total herbage of 700 lb/acre. In 1981, Wheeler's bluegrass (*Poa nervosa* (Hook.) Vasey) was important, lupine was nearly absent, and pinegrass was common with total herbage of 750 lb, and in 1982, pinegrass was again clearly dominant without much bluegrass or lupine with total herbage about 600 lb/acre. Notice the lack of shadows under overcast skies in 1979 and 1982 compared to full sun in 1980 and 1981.

Effects on vegetation, soil, and streambanks from adjustment in livestock management are shown by Anderson and others (1990), Chaney and others (1991), Elmore and Beschta (1987), and Skovlin (1991). In Elk Creek, Oregon, a pair of repeat topic photographs was used to show riparian improvement (USDA Forest Service 1993).

Gary and Curry (1977) document changes in soil condition and erosion with a 40-year photographic record of plant recovery on an abused ponderosa pine watershed in Colorado. Skovlin (1991) shows changes in soil and vegetation on a forest zone bunchgrass type with a series of 1939, 1949, and 1989 photos that follow a shift in cattle grazing from season-long to deferred rotation.

Fire effects were followed by Lyon (1984), who presents 21 years of postfire change at the Sleeping Child burn, and Stickney (1986), who presents a similar series of photographs on succession for the first decade after the Sundance fire, both in northern Idaho. In another case, Lyon (1971) documented vegetation development

Figure 23—Streambank monitoring at the Pole Camp study site. In 1981 the camera location was 3 dm from the bank at a bend in the stream. An ice flood during early spring 1982 eroded the bend of the stream, increased its meander, and destroyed the camera location. In 1982, the camera was relocated 1.3 m to the left and 1 m back from the original location. The result was (1) apparent movement of the right bank, (2) the hole indicated by an arrow shows that only a portion of the bank fell into the stream, and (3) the angle between a rock in the stream bed and the camera to meter board was changed from 44 degrees to 39 degrees demonstrating the camera relocation. This kind of change in camera location or photo point should be avoided.

Figure 24—A1-m^2 plot frame marked at 2-dm intervals. Plot frames are quite useful in sparse vegetation such as the Crooked River National Grassland. The decimeter marks may be used to grid the plot frame (similar to fig. 28, below) to appraise vegetation change. However, riparian areas or other dense vegetation make plot frames questionable for photography, as suggested by figure 34.

after prescribed burning of Douglas-fir in south-central Idaho for 7 years; preburn and postburn vegetation was sampled, and photo points were established and recorded annually for the 7 years. His publication shows prefire vegetation and conditions 1, 3, and 7 years after burning. Blaisdell (1953) documented effects of prescribed burning on big sagebrush-wheatgrass. He shows one general two-photo series and a closeup six-photo series of before, immediately after, and 1, 2, 6, and 12 years after the burn. Johnson (1998) shows 5 years of response to fire by grassland and forest in eastern Oregon. The National Park Service (1992) provides detailed guides for documenting fire effects on vegetation.

Fire suppression effects in ponderosa pine stands are documented by Biswell (1963), Gruell and others (1982), and Weaver (1957, 1959). Smith and Arno (1999) provide repeat photos at 13 locations for an 88-year period. Gruell and others (1982) show 10 sets of repeat photographs of changes in ponderosa pine stands after logging and fire suppression. Shinn (1980) illustrates effects of fire suppression on western juniper (*Juniperus occidentalis* Hook.) sites.

Documentation of logging effects is shown in figure 21. In 1978, conditions were an undisturbed ponderosa pine overstory with pinegrass ground vegetation (*Calamagrostic rubescens* Buckl.) in the southern Blue Mountains of Oregon. The site was entered twice for selection cutting. The 1982 photo shows stand conditions after the first selection cut, and the 1988 one shows conditions after the second selection cut and precommercial thinning. Edgerton (1983) illustrates effects of logging on bitterbrush (*Purshia tridentata* (Pursh.) DC.) under lodgepole pine (*Pinus contorta* Doug. ex Laud.).

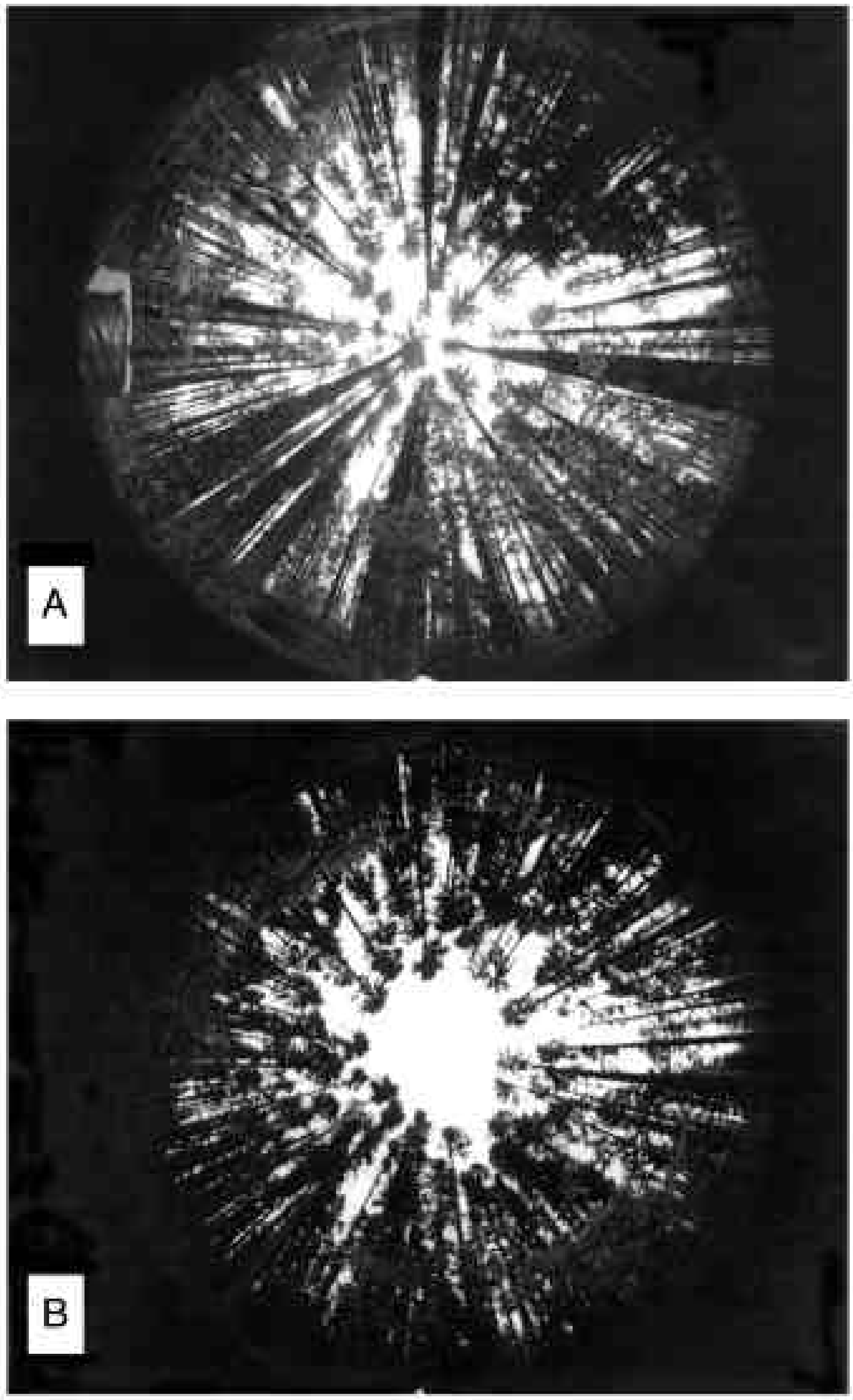

Figure 25—Photographs taken with a fisheye lens document change in forest canopy in a study of gap creation and effects on ground vegetation in 50-m-tall Douglas-fir (Easter and Spies 1993): (**A**) Canopy conditions before gap creation, and (**B**) canopy conditions after gap creation. Photographs cover a 180-degree vertical angle.

Another use of topic photo monitoring was documentation of harvester ant (*Pogonomyrmex owyheei* Cole) colonies over 9 years in southern Idaho (Porter and Jorgenson 1988).

In forested settings, tree cover often influences ground vegetation. Brown (1962) photographed tree canopy cover over a 180-degree arc using a special camera system. More recently, Chan and others (1986) applied electronic scanning and computer techniques to analysis of fisheye photographs under 50-m-tall Douglas-fir. Figure 25 illustrates use of fisheye photographs to monitor change in forest canopy following treatment to create small gaps (Easter and Spies 1993).

Topic photography does not have a fixed protocol similar to transect systems. Any topic that can be photographed is suitable; this is a very flexible concept.

Transect Photographs

Transect photo monitoring is a specialized activity dealt with in appendix A. Briefly, a general view of the transect is supplemented by closeup photographs taken of sample plots systematically along a line (fig. 25). Discussions are available in Bonham (1989), French and Mitchell (1983), Hall (1976), Lyon (1971), Nader and others (1995), National Park Service (1992), Owens and others (1985), Pierce and Eddleman (1970, 1973), Pond (1971), Ratliff and Westfall (1973), USDI Bureau of Land Management (1996), Wein and Rencz (1976), Wells (1971), and Wimbush and others (1967).

Winkworth and others (1962) supplemented their study of five measurement methods with systematic quadrant photographs taken from a stepladder. The photos gave an excellent representation of bunchgrass canopy coverage but were difficult to measure. Measurement required a simplification of the grass canopy outline, which introduced observer variability.

Transect photo monitoring may be summarized as follows:

1. Lay out the system and document it on a sitemap with directions and measured distances to camera locations and transect start and end (fig. 15).

2. Use the specified camera and focal length. Some recommend a 35-mm camera with a 28-mm lens. The 28-mm focal length will permit photographing a 1-m^2 plot with the camera held at eye level. Others recommend a 35-mm camera with 50-mm lens for small plots and oblique angles for larger plots (fig. 24).

3. Take two general photographs of the transect, one from each end, that include the photo identification form.

4. Use the required plot frame, such as 0.5 by 0.5 m or 1 by 1 m, placed at specified distances along the transect with a photo identification form (fig. 24).

5. To photograph and prevent shadows, stand on the north side of the plot frame, with toes touching the plot frame; make sure the photo identification form is visible.

6. Record data and information required by the system.

Figure 26—Landscape view of the Pole Camp riparian study flood plain. One problem with these landscape views is the lack of a fixed photo orientation spot, such as the meter board used in topic photographs (figs. 1, 20, 21, 23, and 28). Rephotographing the scene requires techniques similar to those shown in figure 17.

Pole Camp

Examples of site-specific repeat photography will use Pole Camp, a riparian meadow within a forested setting north of Burns, Oregon (fig. 26). In 1975 the cattle grazing system in Emigrant Creek watershed was changed from season-long use to a three-pasture, rest-rotation system wherein one pasture is spring grazed, a second is fall grazed, and a third is rested. This grazing is rotated over the following two years so that no pasture is used during the same time each year of a 3-year cycle. The purpose was to reduce livestock impacts on the riparian area and its stream. Monitoring was designed to appraise effectiveness of changed grazing. The five questions—why, where, what, when, and how—were addressed as follows.

Monitoring questions—*Why* to monitor dealt with the effectiveness of rest-rotation cattle grazing in improving riparian ecosystem function.

Where to monitor was determined by identifying critical or key livestock grazing areas. Pole Camp is one of three locations selected (figs. 14 and 26). Figure 14 is a road map locating the three areas, and figure 15 shows the Pole Camp monitoring layout.

What to monitor dealt with selecting specific sites at Pole Camp to record streambank stability (fig. 23), riparian shrub (*Salix* spp.) growth in height and crown width (fig. 20), herbaceous stubble height tall enough to trap sediments (fig. 20C), and herbaceous plant community stability, deterioration, or improvement (fig. 20).

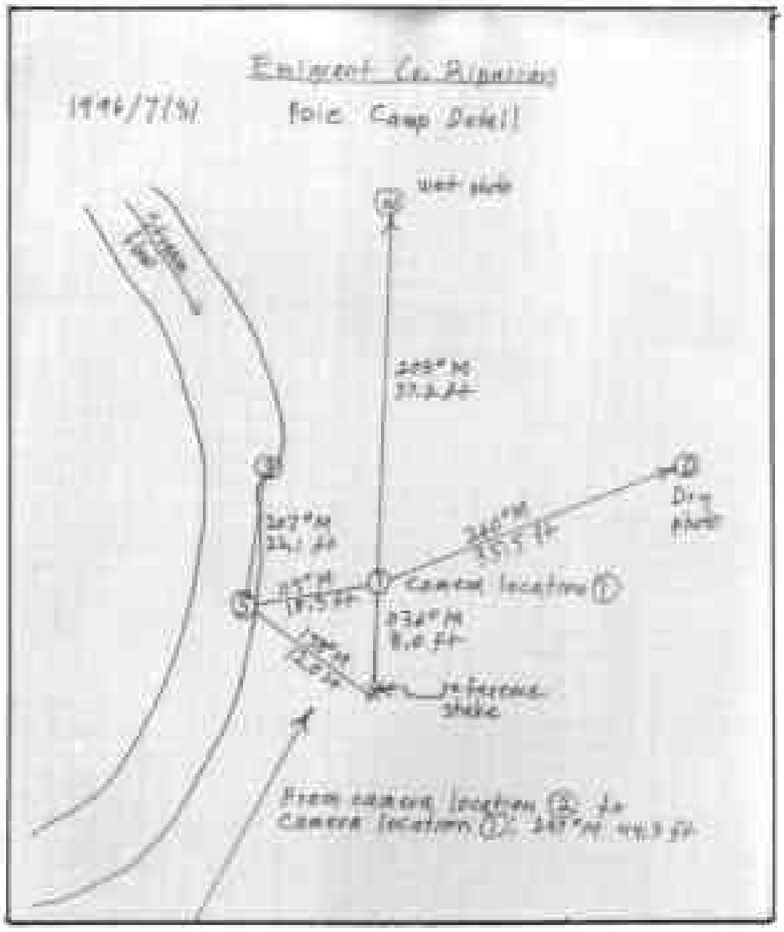

Figure 27—Triangulation location of the meter board (shown in figure 23) to document streambank erosion at Pole Camp. This map is the boxed area shown in figure 15. Any photo point or camera location in a tenuous spot should be referenced by two or more locator stakes.

When to monitor for livestock impacts was dictated by the grazing system, which required three monitoring times during the season: June 15 just before cattle grazing, August 1 as pastures were rotated, and October 1 after the grazing season ended (fig. 20). Pole Camp was used two years out of three: spring one year, fall another, and no use the third year.

How to monitor required developing a system of landscape, general, and closeup photos. A meter board in general photos is used for two closeup photos, one on each side of the board. A meter board generally was not used in the landscape pictures (fig. 26). An integral part of *how* was a map of the sampling layout (fig. 15) and any specific instructions, such as location of the instream meter board (fig. 23) shown in figure 27.

Exact Relocation

Exact relocation of photographs is one essential ingredient in site-specific photo monitoring (fig. 20). This is required if any comparison analysis of photographs is contemplated (Magill 1989, Rogers and others 1983; fig. 28 and app. A). Analysis entails comparing or overlaying photographs so change in the subject matter, usually vegetation, can be analyzed. Analysis may be through the use of grids as shown in figure 28 (Magill 1989 and app. A) or by use of digitizing (Cunningham and others 1996).

Exact realignment of general photographs is greatly facilitated by use of a target as shown in figures 20, 21, 28, 29, and 30. A meter board is recommended to mark the topic of interest, which usually is located in the center of the photograph. Place the meter board at a distance such that it will be 25 to 33 percent of the height of the photograph. Using a 35-mm camera with 50-mm lens, 10 m from the camera will produce 25-percent meter board height (fig. 2) and 7 m will produce 33 percent (fig. 2). This 7 m also will produce a 25-percent meter board height with a 35-mm camera lens (fig.4). Both the camera location and the meter board (photo point) are then permanently marked with fenceposts or steel stakes. The meter board is designed such that the numbers and letters can be read easily from a color slide or black-and-white photograph. Details of meter board construction are in appendix C.

A successfully used alternative employs a target board 0.5 m wide and 2.5 m tall set 10 m from the camera. The board is painted black and white alternately every 0.5 m (Van Horn and Van Horn 1996). It was designed to document riparian rehabilitation efforts in herb and shrub vegetation.

Camera Techniques

General photographs—Consistent rephotography requires a reference point to orient subsequent views. The objective is to have the view remain constant while items within the view change. A meter board serves this purpose. Figure 29 illustrates three repeat photographs of a ponderosa pine-elk sedge community that was selectively cut; figure 29A illustrates how the camera focus ring is placed over the "1M." This accomplishes two things: (1) it provides a common orientation point for the first and subsequent photographs, and (2) it provides a locus for focusing the camera for maximum depth of field. When the meter board is placed at the topic of interest, the topic should be in sharp focus. Figure 30 illustrates effects of various camera orientations.

The meter board also provides a size control for indexing a grid. A grid can be overlaid on the photograph as suggested by Magill (1989), depicted in figure 28, and discussed in appendix A. Grid analysis entails outlining each topic of interest and counting the number of grid intersects within the outline. Figure 30D shows sloppy installation of the meter board because the board is not vertical. Vertical orientation is essential if grid analysis is contemplated. Appendix C has construction plans for a meter board that include attaching a line or pocket level to the top so that the board can be oriented vertically.

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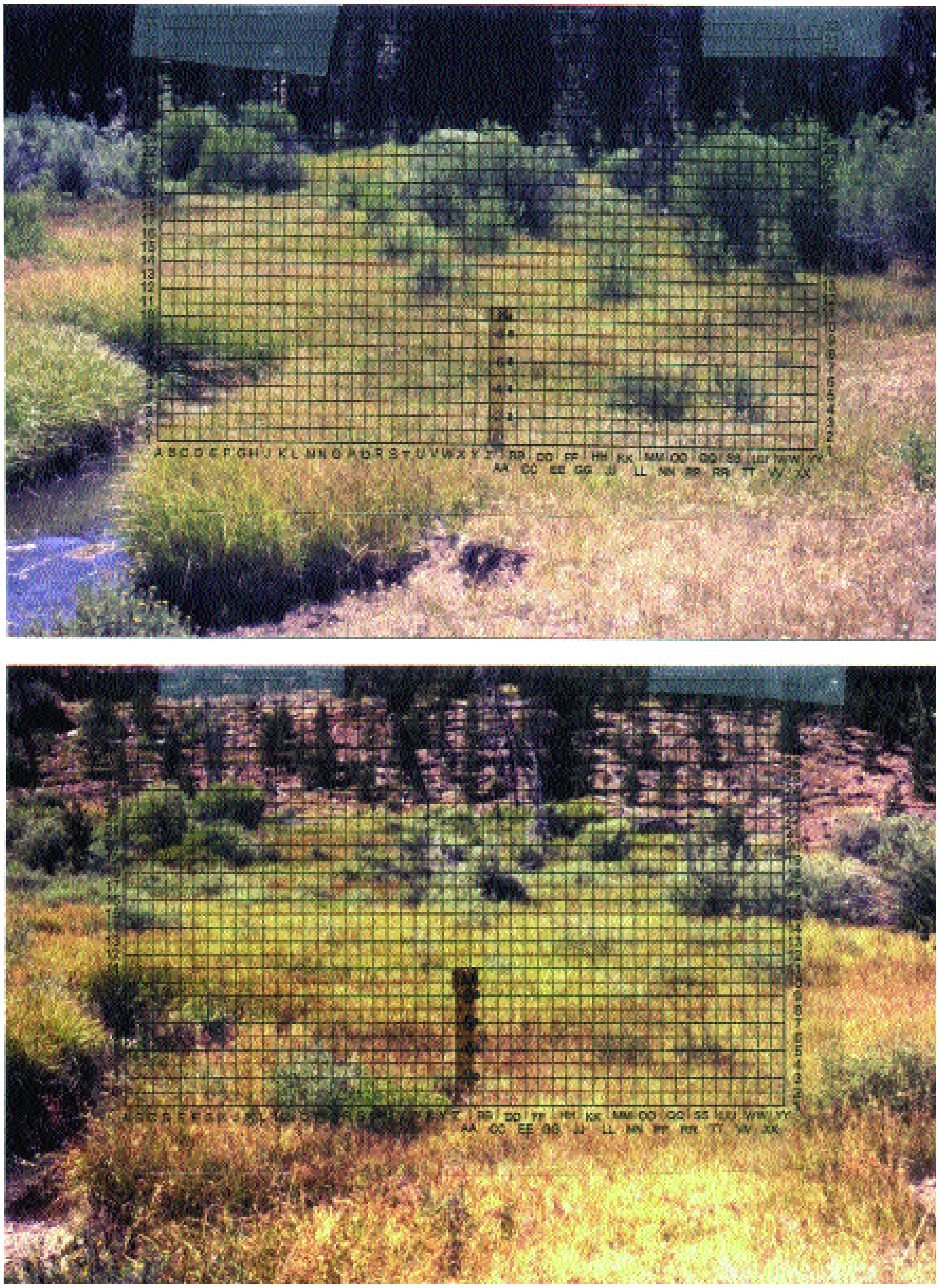

Figure 28—Grid intersect system used to outline and follow items with intersecting grid lines. This is Pole Camp wet (fig. 20) showing change in willow shrub profile area from 1981 to 1997 following 12 years of beaver (*Castor canadensis* Kuhl) utilization and high water tables caused by dams. In 1981, grid intersect U-13 identifies a young willow missing in 1997. Intersect RR-24 is at the top of a tall willow in 1981. The top is missing in 1997 owing to beaver cutting large stems for dam construction. Appendix Adiscusses grid analysis of photographs.

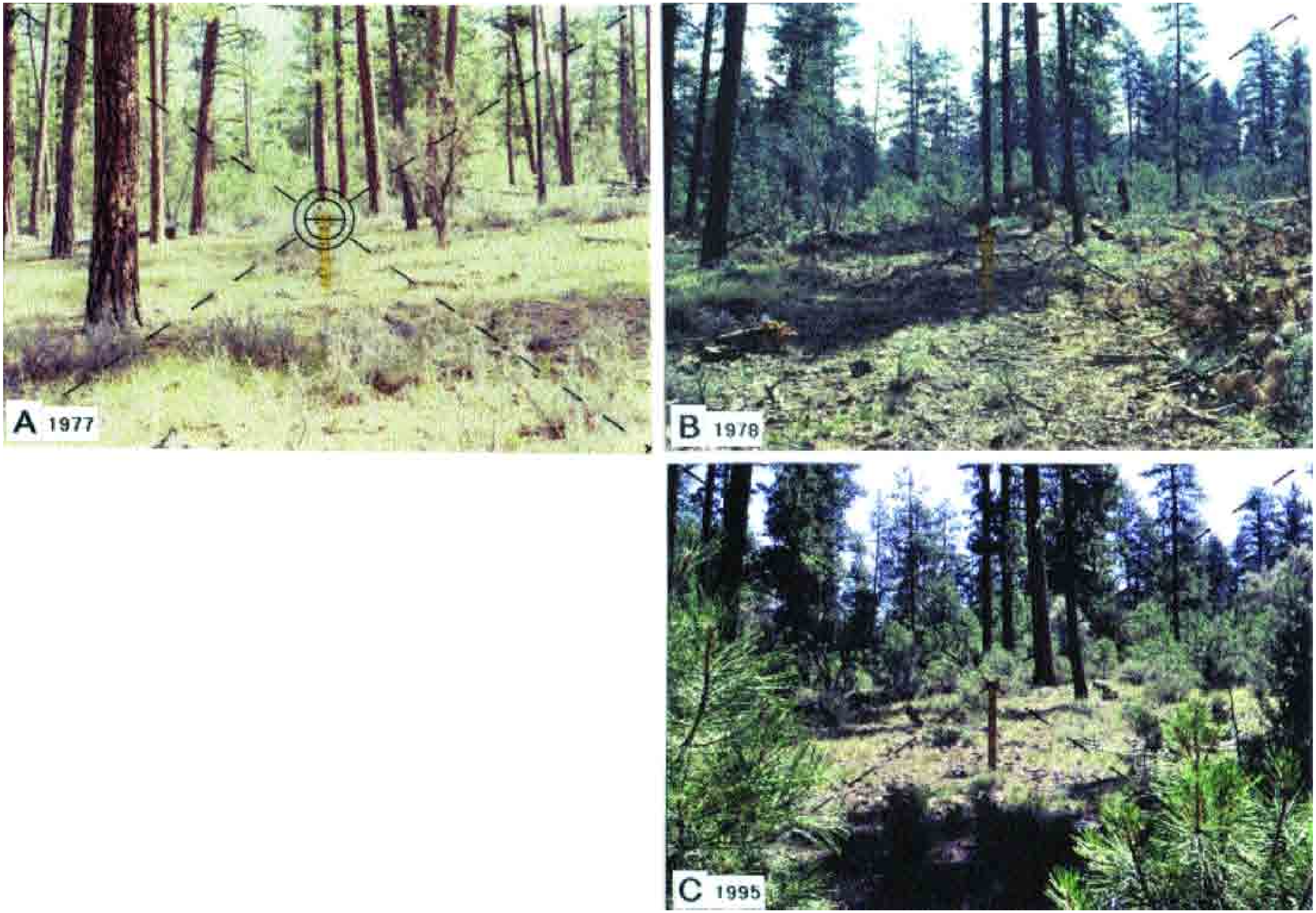

Figure 29—The meter board is used to aim the camera for consistent repeat photography. (**A**) Placement of the camera focus ring on the “1M”, which puts the “1M” in the center of the picture (dashed lines). This orientation produces exact replication of repeat photographs as shown in B and C. The camera is focused on the “1M” placing it at the optimum sharpness for depth of field. With an f-stop of 8, everything in the picture will be in focus. This series is part of a study following logging effects on ground vegetation and stand structure (figs. 50 and 51): (**A**) 1977 just prior to a selection cut; (**B**) the summer after the cut and showing a two-turn skid trail crossing the meter board location; and (**C**) is 1995, 18 years later. Notice the color difference in A. The slide film was Anscrochrome compared to Ektachrome in B and C.

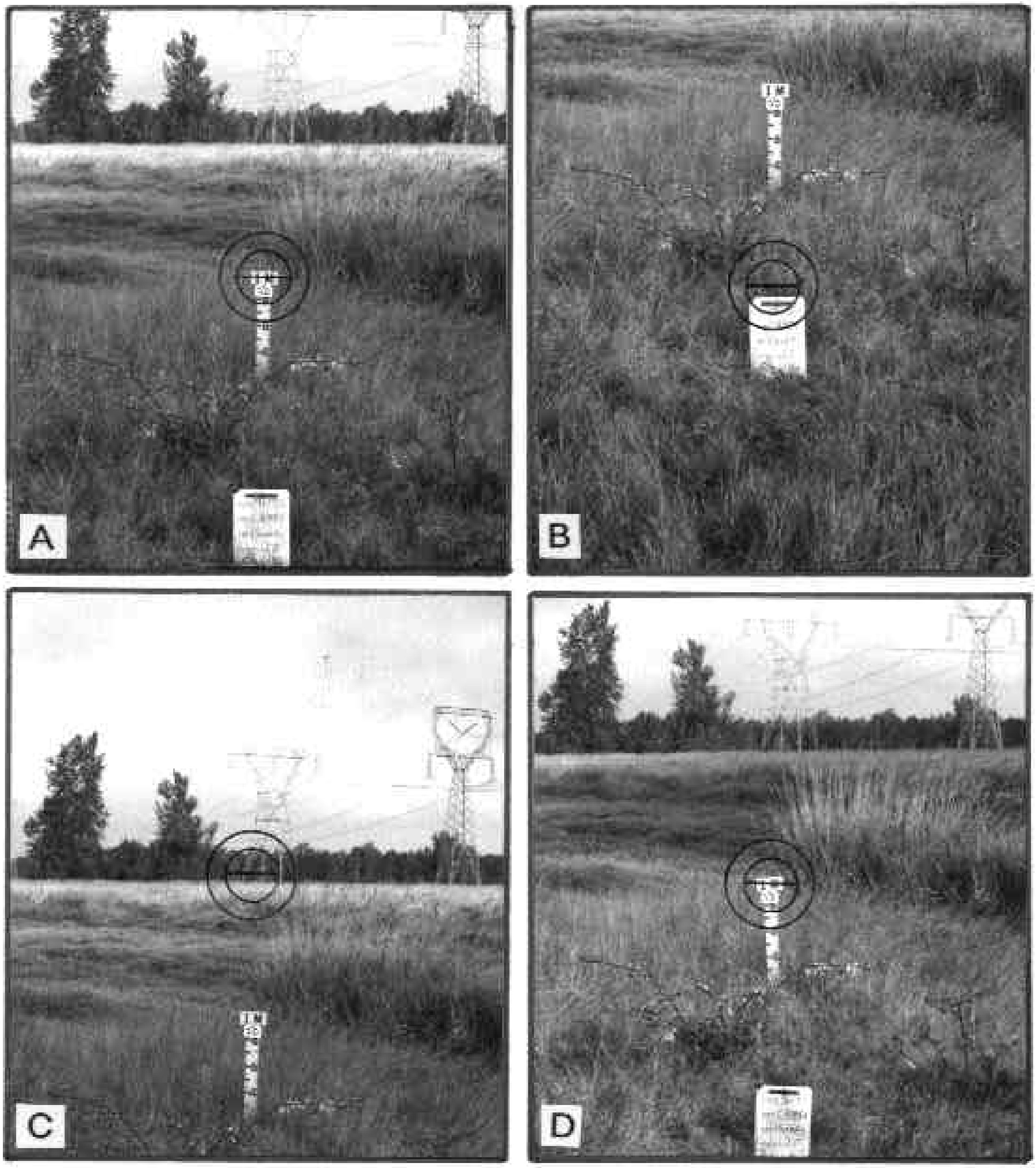

Figure 30—Photograph orientation using the camera focus system shown in **A** and placing it exactly on the “1M” of the meter board. (**B**) The focus is on the photograph identification sheet showing a maximum of ground vegetation. (**C**) The focus is on the distant horizon. (**D**) The meter board has not been set vertically, simply sloppy work. The tag on the meter board showing “2D” means this is photo point D at camera location 2. Five photo points are taken at this camera location. Notice the fadeout of the photo identification paper in B due to the light color. This will not happen with the medium blue shown in appendix C.

Use of double meter boards for identifying a topic of interest is illustrated in figure 31. The area is Lower Emigrant, one of three study areas on Emigrant Creek (fig. 14). When shrubs or other items exceed about 2 m in height, the double boards aid in following changes. Appendix C has plans for this double meter board, which folds in the center to provide a choice of either a 1-m or 2-m board.

Topic emphasis—Figure 32 illustrates four degrees of topic emphasis. A general topic, such as figure 21, may be represented by a 50-mm lens with meter board set at 14 m, a more limited topic is identified by the board set at 10 m, a closer view with the board set at 7 m, and a confined topic set at 5 m. The 5-m distance is recommended for shrub transect sampling discussed below.

Use of a 35-mm lens is illustrated in figure 33, a sagebrush-bunchgrass community. The meter board was placed 5, 7, and 10 m from the camera. The size of the meter board at these distances closely approximates a 50-mm lens at 7, 10, and 14 m, respectively.

Closeup photographs—Closeup photography is strongly recommended for topic monitoring locations. It is an integral part of transect systems. A view of ground conditions is taken with the meter board as a photo point locator and size control system. Figure 34 is a pair of closeup views from figure 20, Aug. ’76, showing characteristics of the wet meadow at Pole Camp. Accompany each photograph with notes on the vegetation.

Some people might prefer a square target on the ground (fig. 24). In sparse vegetation this is satisfactory, but it may not be a suitable system in riparian areas such as that in figure 35. Figure 35A was taken 1 month after cows were removed, and figure 35B shows the same area 3 months later. The 4-dm-tall vegetation would completely obscure any kind of plot frame laid on the ground.

Figure 35 also illustrates the importance of standing 2 m away from the meter board and placing the “1M” of the meter board in the upper corners of photographs. In figure 35A, the bottom of the meter board can be determined whereas in figure 35B it cannot be seen. The entire meter board must fit in the frame if analysis of the images is to be possible. In figure 35C, the “1M” of the meter board is down almost 2 dm from the top of the frame; the bottom of the meter board, therefore is 2 dm below the bottom of the photograph, which makes accurate comparison between figures 35A and 35C difficult.

This concept of precise relocation of photo images can best be illustrated by use of lap dissolve 35-mm projection equipment. The objective is to hold the meter board absolutely still on the screen and show the vegetation change as each photograph is dissolved onto another.

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