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Photo Point Monitoring Handbook:

Part A—Field Procedures

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Abstract

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This handbook describes quick, effective methods for documenting change in vegetation and soil through repeat photography. It is published in two parts: field procedures in part A and concepts and office analysis in part B. Topics may be effects of logging, change in wildlife habitat, livestock grazing impacts, or stream channel reaction to land management. Land managers, foresters, ranchers, wildlife biologists, and land owners may find this monitoring system useful. Part A discusses three critical elements: (1) maps to find the sampling location and maps of the photo monitoring layout; (2) documentation of the monitoring system to include purpose, camera and film, weather, season, sampling system, and equipment; and (3) precise replication in the repeat photography.

Keywords: Monitoring, photography.

Preface

This handbook is a synopsis of repeat photography principles and photo point sampling from the publication *Ground Based Photographic Monitoring*, PNW-GTR-503, which is based on 45 years of experience in repeat photography by the author. During those years, many nuances were discovered that bear discussion and emphasis so that new users can avoid the pitfalls I ran into. The terms *should*, *must*, *do not*, and *will* are used to help users avoid problems and are not meant as rules.

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Introduction

Anyone interested in quick and effective documentation of change in vegetation or soil through repeat photography will find this handbook useful. Illustrations cover such topics as streamside changes, riparian willow response to beavers, logging, livestock use, and mountain pine beetle (*Dendroctonus ponderosa*) kill of lodgepole pine (*Pinus contorta* var. *latifolia* Englm.). People, such as foresters, ranchers, wildlife biologists, and nature enthusiasts, interested in natural resources can establish photo point monitoring (discussed here) to appraise changes (see part B) in natural resources. No special skill or training is required other than some knowledge of cameras.

There is one essential criteria if repeat photography is used to document change. Distance from camera to photo point **must** remain the same (part B). For this reason, both the camera location and photo point require permanent markers. The system recommended is use of cheap fenceposts or steel stakes, usually ½ inch (1.2 cm) diameter concrete reinforcing bar.

This field procedure handbook is divided into several parts: basic foundations for photo monitoring, with discussions on objectives, selecting an area, techniques for general photography, procedures for specific topic pictures, shrub profile monitoring, and tree cover sampling. Use of forms in part B are illustrated.

Basics

The primary consideration in photo monitoring is an objective. Ask yourself several questions: What is the topic of this photograph? Why do I want to take this picture? What am I trying to show? What appeals to me? What will the picture demonstrate? (Hedgecoe 1994, Johnson 1991).

Photo Monitoring Objectives

Consider the five basic questions for any inquiry: why, where, what, when, and how (Borman 1995, Nader and others 1995).

Why—“Why” to monitor reveals the question or questions needing to be answered. Implementation monitoring asks **if** we did what we said, effectiveness asks if it **did** what we wanted, and validation asks if it **is** meeting the objectives. The “why” question

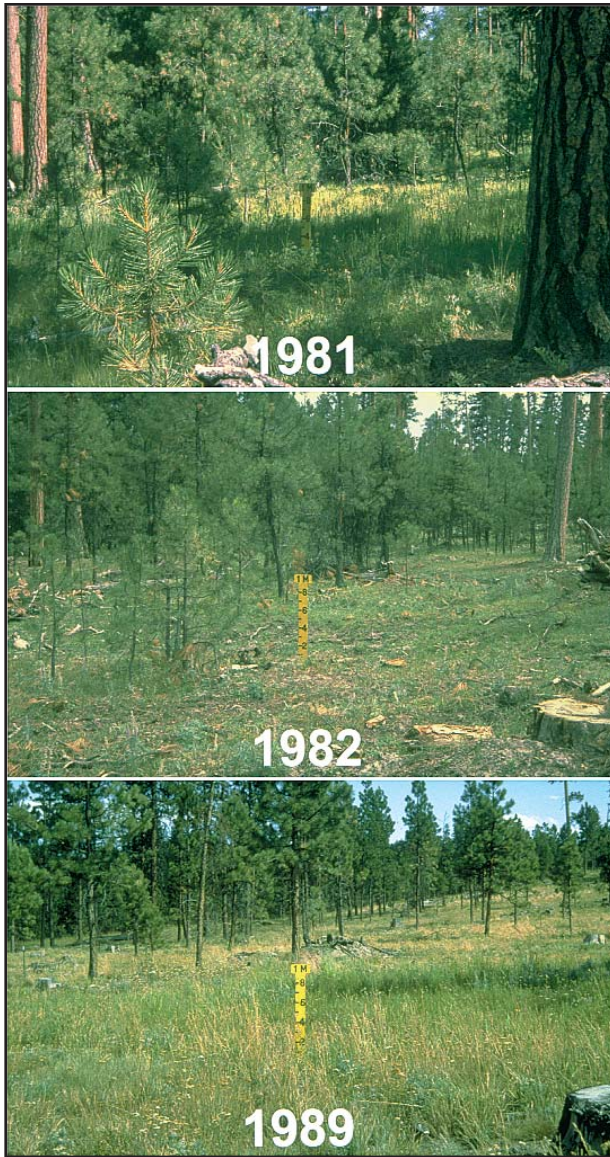


Figure 1—A ponderosa pine stand with pinegrass ground vegetation showing effects of logging: undisturbed in 1981, 1982 after the first selection cut, and in 1989 after the second selection cut and precommercial thinning. These views, with their dramatic differences, emphasize the need for permanent marking of both camera locations and photo points. Exact picture reorientation uses the “1M” of the meter board as the photographic center (also see fig. 18) and for focusing the camera for best depth of field at the meter board.

CAMERA LOCATION AND PHOTO POINTS			
Date	1997/6/17		
Area	Snow Mtn. Dist.	Camera Location	Witness Stump
Unit	Pole Camp	Number of Photo points:	2
Comments	From rd June, 43/4365, on rd 43 for 0.25 mi W. to turnout on S. side road; witness stump 22 nd LP 20 yds. S slope 1 Aspect W Slope position bottom		
Photo point A	_____		
Compass bearing:	237°M		
Distance:	_____		
Flood plain, left view of Pole Camp study site, Mt. pine beetle killed LP stand in background 1, 2, 3 are camera locations; S & W are photo points			
Photo point B:	_____		
Compass bearing:	270°M		
Distance:	_____		
Flood plain, right view of Pole Camp study site. 1 & 2 are camera locations, D is dry meadow photo point.			






Figure 2—Filing system form “Camera Location and Photo Points” showing general photographs of Pole Camp taken from the witness stump: (A) the left landscape, and (B) the right landscape diagramed in figure 6. Note repeat of fenceposts 1 and 2 in both pictures. Fenceposts identify camera locations 1, 2 and 3 and photo points “D” for the dry meadow, “W” for the wet meadow, and “S” for the streambank. Photo identification cards similar to figure 10, a form from part B, appendix A, are at the bottom of each picture. The purpose of these photographs is twofold: to illustrate the general sampling area and to show location of the photo monitoring layout. Used in conjunction with the map in figure 6, someone other than the original sampling crew could find and rephotograph this site.

sets the stage for all other discussion. Is a proposed treatment to be monitored (fig. 1)? Is animal distribution to be appraised? Are things changing as a result of management decisions (Borman 1995, Nader and others 1995)?

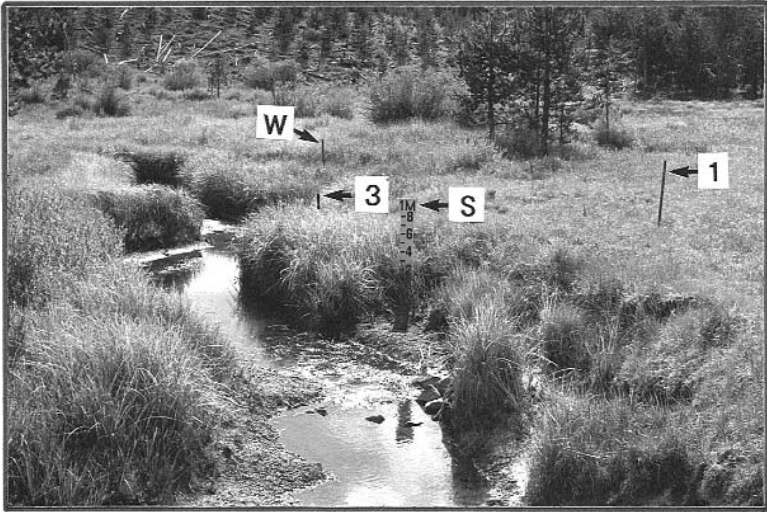


Figure 3—A general photograph taken in 1997 at Pole Camp; the topic is streambank stability. This streambank photo point is taken upstream from camera location 2 (shown in fig. 2 and on the map in fig. 6). Fencepost 1 is camera location 1, fencepost 3 is camera location 3 looking downstream at photo point “S,” “S” is the photo point for the streambank, and fencepost “W” is the photo point for the wet meadow.

Where—“Where” to monitor depends on the “why.” How does one select representative tracts, animal activity areas, treatment sites, or particular kinds of treatments? How are number, size, and location of activities, such as fire, logging, revegetation, livestock grazing or flood, selected? Ask yourself, “Where is the best location that will answer my questions (fig. 2; Borman 1995, Nader and others 1995)?” Critical documents are a map to locate the site and a site map to document all camera locations and photo points.

What—“What” to monitor means selecting specific items (topics) on the tract to support the “why” questions: vegetation, soil, streambanks (fig. 3), or animals. Ask yourself, “What are the critical few items that must be documented? What is expected to change? What will the picture demonstrate (Borman 1995, Johnson 1991, Nader and others 1995)?” The “what” dictates the sampling layout.

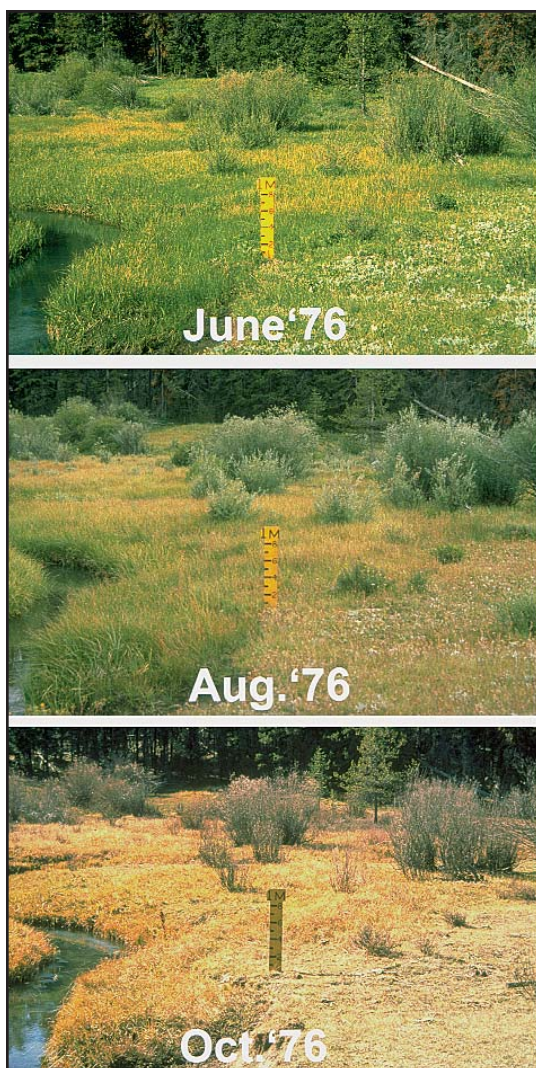


Figure 4—Pole Camp “W” (wet meadow) photo point showing three dates of the same year. June 15 is before scheduled grazing, August 1 is at change in rotation pastures, and October 1 is after grazing. This pasture was rested from June 15 to August 1. October 1 illustrates the degree of livestock use on Kentucky bluegrass at the meter board, on aquatic sedge behind the board, and on willows.

When—"When" to monitor supports the "why" and "what" questions. Does it encompass a year or years? one or more times a year (fig. 4)? specific dates? specific time(s) of day (Borman 1995, Nader and others 1995)? All are important with both animal and site monitoring. Scheduling when to photograph deals with before and after treatment and how often thereafter. Unplanned disturbances, such as fire or flood, pose special problems. A monitoring protocol may have to be developed on the spot during an event to establish photo points and define a followup schedule.

How—"How" to monitor is determined by "what" as influenced by "why" and "when." It may encompass detailed protocols for photographic procedures, which may be to obtain either qualitative data (estimates) or quantitative data (measured in the field or measured from photographs).

A simple question might deal with effects of livestock grazing on a riparian area: (1) Are streambanks being broken down? (2) Are riparian shrubs able to grow in both height and crown spread? (3) Is there enough herbage remaining after grazing to trap sediments from flooding? (4) Is herbaceous vegetation stable, improving, or deteriorating?

These questions require selection of a sampling location, placement of enough photo points to answer each of the four questions, and establishment of camera locations to adequately photograph each photo point. Try to select camera locations that will photograph more than one photo point. Next, time or times of year to do the photography must be specified, such as just prior to animal use of the area, just after they leave, or fall vegetation conditions. Will a riparian site be monitored for high spring runoff? late season low flows? or during floods? Monitoring of stream flows vs. animal use probably will require different scheduling.

Recommendation—Write down the specific objectives and protocols for each photo monitoring project. Write them so that someone other than the installer can understand the purpose, can follow the protocols, and can become enthusiastic about the project.

Selecting an Area

Selection of a monitoring area requires a great deal of professional expertise liberally mixed with artistic finesse. The **purpose** for photographic monitoring is the most critical factor in considering where to monitor (Borman 1995, Nader and others 1995): Where in the landscape is my topic of concern, and once at the area, what kind of change do I want to document? In some cases, "where" is straight forward; for example, documentation of logging impacts requires an area being logged (fig. 1), and effects of beavers on a stream requires beaver dams. On the other hand, documentation of impacts from livestock grazing requires understanding livestock distribution plus knowing the location of areas sensitive to grazing and the most critical season of use.

Once in an area, the real decisions must be made. Determine specifically what to monitor for change. Figure 2 shows two general views of Pole Camp in northeast Oregon where some examples of photo monitoring are located. The purpose was to document effects on a riparian area from livestock grazing. Pole Camp was selected because it was preferred by livestock. Specific objectives were to evaluate grazing effects on streambanks (fig. 3); willow (*Salix* spp.) shrub utilization (fig. 3); differences in use between Kentucky bluegrass (*Poa pratensis* L.) by the fencepost on the right (1) and aquatic sedge (*Carex aquatilis* Wahlenb.) at the fencepost in the left background (W). The topic in figure 3 is streambank stability.

Figure 1 is a different situation. The purpose for photo sampling was to document effects of a two-stage overstory removal and subsequent precommercial thinning on stand structure and ground vegetation. The sale area determined the site. Stand conditions of open ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) and clumped reproduction across an opening were chosen for the photo point. The opening was selected to avoid tree crown encroachment between the camera location and photo point and to appraise logging effects on livestock forage. It was photographed before and after each entry to log.

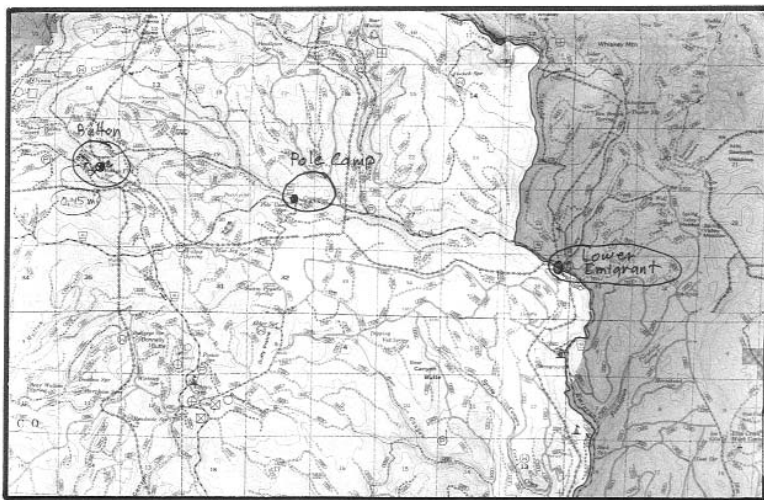


Figure 5—USDA Forest Service ranger district map showing location of the Button Meadow, Pole Camp, and Lower Emigrant riparian study sites. Road numbers, mileage from road junctions, and directions to the witness sites are given on the filing system form “Photographic Site Description and Location” (fig. 6).

After appraising the area, establish the photo monitoring system as discussed below in “General Photography” and “Topic Photography.” The sampling layout must be mapped as described next.

Locating the Monitoring System

Assume that the person installing the monitoring program will **not** be the one to find and rephotograph the area. Provide maps and instructions accordingly. A local map showing roads and the site locates Pole Camp, one of three locations for the Emigrant Creek riparian study (fig. 5).

After laying out the photography system, select a witness site to mark the area. Identify it with a permanent marker, such as an orange aluminum tag, and determine direction and measured distance to camera locations, photo points, or both. Inscribe these on the identification tag. Next map the camera locations and photo points with directions and measured distances on the filing system form “Photographic Site Description and Location” (fig. 6), found in part B, appendix A. Note whether the direction

PHOTOGRAPHIC SITE DESCRIPTION AND LOCATION

Date 1974/10/5 Area Snow Mtn. Dist
 Unit Pole Camp Observer: F. C. Hall
 No. of Camera locations: 5 No. of Photo points: 4
 Plant community Dry & wet meadow; willows
 Location: T.19S R.27E Sec. 29 SW of NE
 Location description: S of rd 43; 0.25 mi. W of junc. 43 & 4365 rds
off of turnout at E end of meadow
 Photo purpose: Document effects of change from season-long cattle
use to 3-pasture rest rotation
 Discussion: Three photo points established in Oct 1974 documented
dry meadow (D), wet meadow with willows (W) and a falling block of
rock at the stream edge (S) (1997) Flood at 2/96, washed out beaver
dams & created a new channel. Shrub sampling initiated 6/97.

MAP

Use back of sheet for additional details.

Figure 6—Filing system form “Photographic Site Description and Location” showing the monitoring layout for Pole Camp. In the lower left corner is a reference to the junction of roads 43 and 4365 at 0.25 mile (0.4 km). Immediately opposite the road turnout is a lodgepole pine witness stump 28 inches (71 cm) in diameter. An aluminum tag, orange for visibility, is attached to the stump with directions and distances to camera locations. An additional map, noted by the square labeled “See detail attached,” is shown in figure 17. It documents triangulation of the streambank photo point “S.” Another note, “Shrub transect - see attached,” refers to an installation in 1997, which is shown in figures 22, 23, and 25 dealing with shrub profile photo monitoring.

is taken in magnetic or true degrees by indicating either “M” or “T.” A 21-degree deviation in the Pacific Northwest must be accounted for. Measure distances between the witness site, camera locations, and photo points on the ground. Do not attempt conversion to horizontal distance.

Fenceposts or stakes—Monitoring, by definition, means repeated observation; therefore, all camera locations and photo points must be permanently marked. The recommended method is stamped metal fenceposts shown in figures 2 and 3. In 2000, these cost about \$2.75 each for a 5-foot (1.5-m) post. Stamped metal has several advantages over strong T-bar posts: they are flimsy and will bend if driven over by a vehicle or run into by an animal; they will bend flat and remain in the ground to mark the spot; they resist theft because they are just as difficult to pull out as a good fencepost but are not worth the trouble; and they are easy to carry and pound. The primary advantage of flimsy fenceposts is their visibility, as seen in figures 2 and 3. If visibility is not desired, steel rebar stakes are a choice but require a metal detector for relocation (White's Electronics, Inc. 1996).

Steel stakes, preferably concrete reinforcing bar (rebar) have been used and may be required for shallow soils, areas that will be disturbed, or locations where fenceposts may be obtrusive. If disturbance or shallow soils prevents the use of fenceposts, stakes should be driven flush with the ground. If left a few inches above the ground, stakes will damage tires, hooves, or feet. They are always difficult to find. When driven flush with the ground, they require a metal detector for relocation (White's Electronics, Inc. 1996), but even then, the stakes must be of some mass for detection with a simple, \$250 machine. Angle iron should be 1 inch (2.5 cm) on the angle and at least 12 inches (30 cm) long. Cement reinforcing bar should be at least $\frac{3}{8}$ inch (1 cm) in diameter and at least 12 inches (30 cm) long. Shorter lengths may be needed for shallow soils.

Distance from camera to photo point—One overriding consideration in photo monitoring is to use the same distance between the camera location and photo point for all subsequent photography of that sample. Any analysis of change depicted in the photographs can be made **only** when the distance remains the same (part B). Therefore, always **measure** the distance from camera location to photo point and mark with steel fenceposts or stakes.

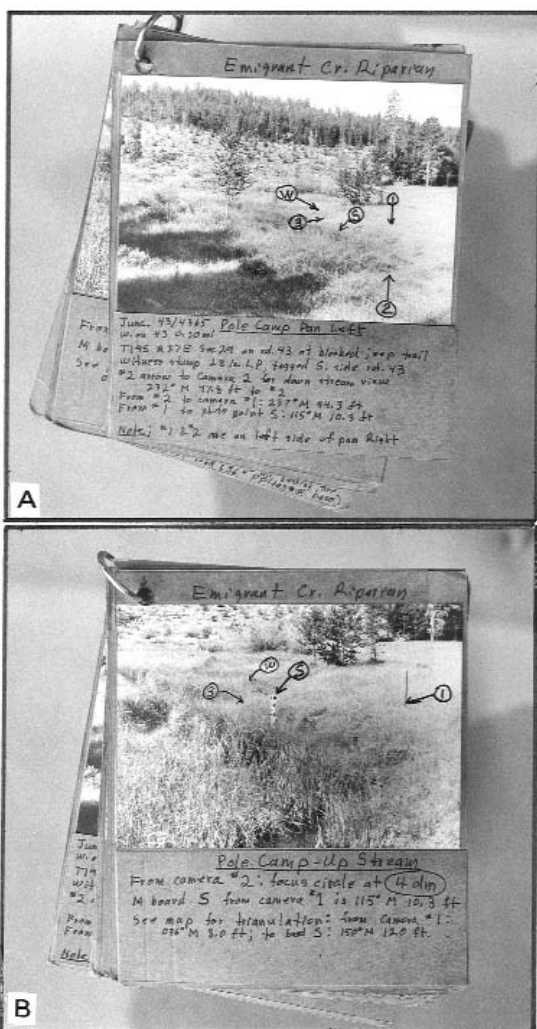


Figure 7—A site locator fieldbook is my system for finding camera locations and photo points. It is a pocket-sized set of photographs and directions mounted on cardboard (file separator thickness). (A) The left landscape view of the sampling area at Pole Camp shown in figure 2. (A) also locates camera locations 1, 2, and 3. Camera location 1 has two photo points: "D" is Pole Camp dry meadow and "W" is Pole Camp wet meadow (figs. 2 and 6). (B) The upstream photo point taken from camera location (2) to "S" (illustrated in fig. 3). A map of this area is shown in figure 6.

A fixed distance for all photo monitoring is not required. It may differ from one photo point to another. Camera format also may change, such as first pictures with a 50mm lens and next pictures with a 35mm lens, but distance must remain the same. It can remain the same in repeat photography only if permanently marked.

Site locator fieldbook—A photo monitoring fieldbook is recommended for carrying the original photos and some intervening photographs into the field (fig. 7). If previous photographs were done by different people, you may discover some disorientation of subsequent views. For that reason, a copy of the original photograph is very important. Rephotograph from the original and not from any misoriented intervening views.

My system for Pole Camp is depicted in figure 7. Figure 7A is a landscape view of the Pole Camp flood plain from the witness site that identifies camera locations and some photo points. It locates the left of two flood-plain scenes, both shown in figure 2 (and mapped in fig. 6). Figure 7B is a view from camera location 2 to photo point “S” on the streambank, the scene in figure 3.

The pocket-size booklet has a picture from each witness site to each camera location and photo point and includes directions from the witness site to camera location and orientation of the photo point.

Once at the area, review the photographs for changes in vegetation. Next, note the number of years since the last photograph, particularly if it was taken more than 3 years previous. The purpose is to evaluate change in the vegetation that might make previous photographs difficult to interpret (fig.1).

Relocating Photo Points

If camera locations and photo points were not marked, they may be approximated by the following triangulation procedure. Align items in the original photograph as shown in figure 8A. Start in the center of the photograph to orient the direction of the picture and draw line 1 on the photo, the photo point direction. Then, for

Text continues on page 15.

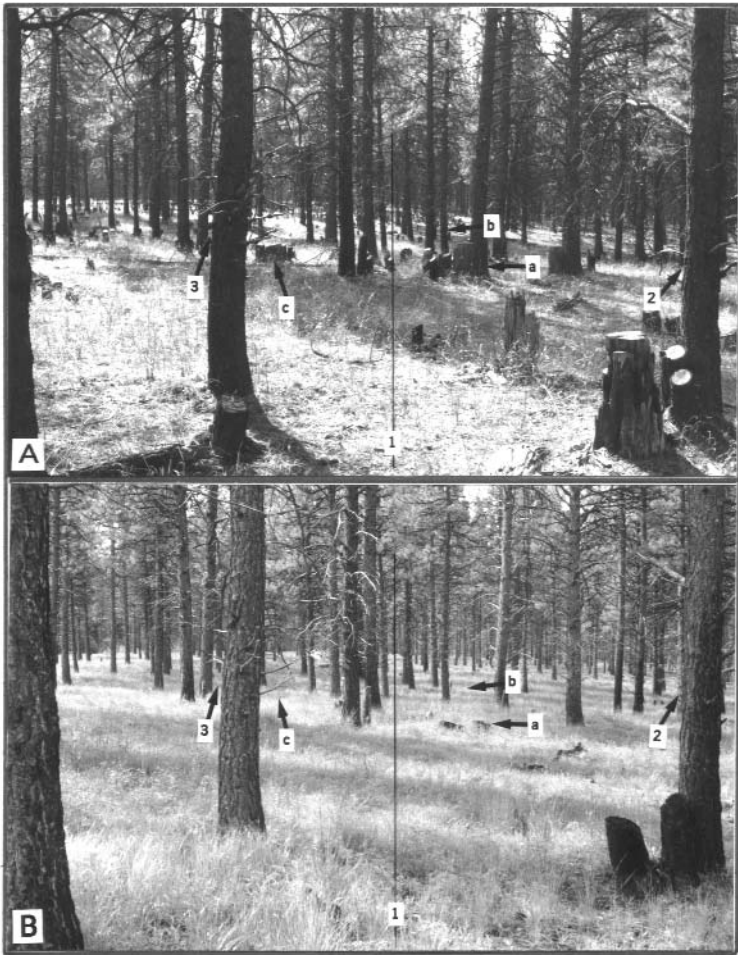


Figure 8—Photograph reorientation uses a black-and-white photo on which a triangulation system is diagrammed. A center line (1) is established on the original photograph (A) for direction. The center line is identified by position of trees in the background and framing the picture with trees in the foreground. Then positions of items 2 and 3 at the sides of the picture are used to triangulate the camera location. Looking to the right, note the position of trees at arrow 2 while also looking left for tree positions at arrow 3. For (B), the photographer moves forward and backward along the center line until items at arrow 2 and arrow 3 are aligned. Try to include some unusual object in the photograph, such as the pair of stumps in the lower right corner. Photograph (A) is preunderburn condition and (B) is postburn and salvage of killed trees. In (B), note the missing trees at arrows “a” and “b,” and a burned-out stump at arrow “c.”

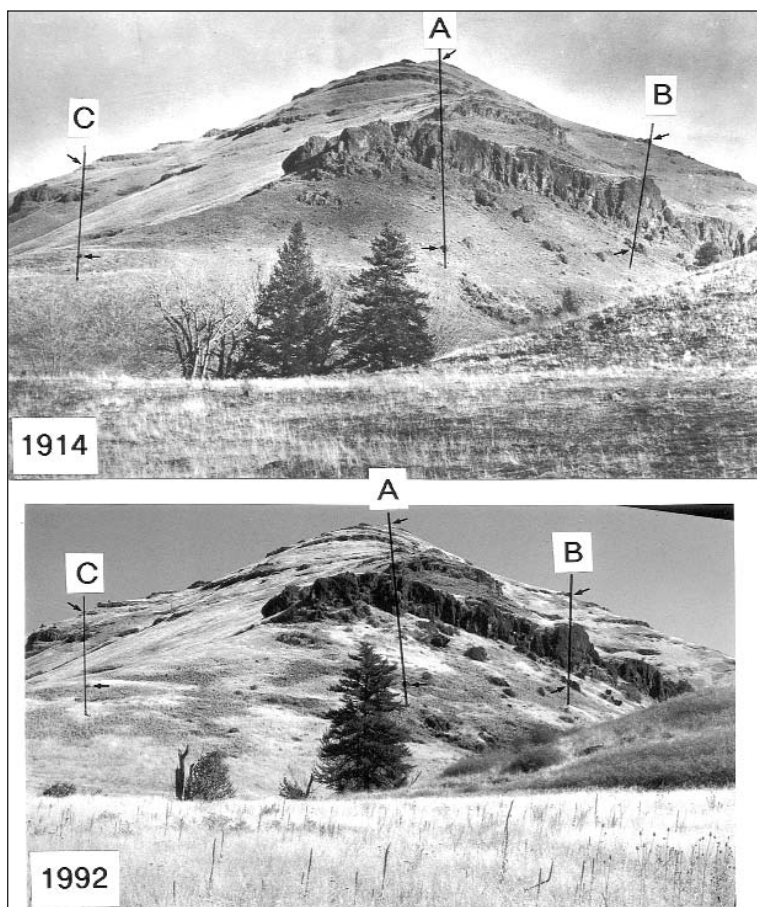


Figure 9—Relocation of a historical photograph taken in 1914 of Branson Creek, Wallowa County, Oregon. Skovlin and Thomas (1995, p. 22-23) took the bottom view in 1992. On a copy of the original (1914) photo, mark orientation lines. "A" identifies the centerline orientation. Then choose objects on the edges of the picture, such as "B" and "C," to triangulate location of the original camera. Once centered on the original photograph, move forward or backward until the angles of B and C are similar to the original photograph. Slight differences in orientation lines between 1914 and 1992 suggest that in 1992, the camera was a few yards left of the original location. The usefulness of black-and-white photographs is illustrated here by being able to draw triangulation lines directly on a copy of the 1914 picture.

the camera location, find items on the sides of the picture, shown by arrows 2 and 3, to triangulate the location. The items are distances between trees. Move forward or backward along line 1 (fig. 8B) to repeat the distances shown at 2 and 3. This is the camera location and photo point direction. Mark the camera location with a fencepost and add a meter board (photo point) location 25 to 35 feet (8 to 10 m) distant.

Figure 9 applies this triangulation concept to relocation of landscape photographs.

If major vegetation manipulation has occurred as shown in figure 1, relocation may be very difficult.

When to Photograph

When to photograph is usually determined by the activity being monitored. Pole Camp, for example, is part of a study evaluating effects of cattle grazing on a riparian area. Figure 3 illustrates one topic of concern, streambank stability. Photographs have been taken three times per year to correspond with livestock activity: June 15 just before grazing, August 1 as cattle change pastures, and October 1 after animals leave the allotment (fig. 4). This three-season monitoring is repeated every year.

Figure 1 illustrates a very different monitoring schedule. Photographs were planned for the first week in August as an index to appraise vegetation development. They were taken just before logging and in each of the two seasons after cutting to document rapid changes in ground vegetation. Then a 5-year rephotography cycle was established to follow slower changes in both stand structure and ground vegetation. The routine was repeated with the second logging and the precommercial thinning.

If vegetation is a primary topic, consider establishing a fixed date or dates for rephotography. Established dates have several advantages: (1) they set a consistent reference point to evaluate seasonal differences in plant phenological development, (2) they provide a consistent reference for comparing change over several years, and (3) they establish a consistent time interval over which change is documented.

Text continues on page 18.

DATE

AREA

UNIT

CAMERA: 1 2 3 4 5

PHOTO: A B C D

E F G H I J

Figure 10—An example of a photograph identification card to be placed in the camera view (fig. 2). This has been reduced to 60 percent of its original size. Part B, appendix A has blank forms that can be reproduced onto dark blue paper. The best paper colors are Hammermill Brite Hue Blue or Georgia Pacific Papers Hots Blue. Light colored paper, common in the office environment, bleaches out under direct sun and should not be used.




PHOTO POINTS AND CLOSE PHOTOS	
Date <u>7/7/66</u> Camera <u>Plot 226 (669)</u>	
Area <u>Snow Mtn. Dist.</u>	
Unit <u>Green Butte</u>	
Photo point: <u>A</u>	
Observer <u>E. C. Hall</u>	
Remarks <u>15 yr setback</u> <u>of ecology plot just</u> <u>prior to partial cut.</u> <u>Good range condition;</u> <u>benchmark for range</u> <u>condition guides. See</u> <u>plot 226 (669) for data.</u>	
Photo point A: Left of meter board	
Species/cover:	
<u>CAGE 60%</u> <u>PONE 15%</u> <u>CARO 5%</u>	
Comments: <u>Very good</u> <u>range condition; tight</u> <u>soil.</u>	
Photo point A: Right of meter board	
Species/cover:	
<u>CAGE 50%</u> <u>PONE 25%</u> <u>CARO 8%</u> <u>FRVI 2%</u>	
Comments: <u>Very good</u> <u>condition</u>	

Figure 11—Filing system form “Photo Points and Close Photos” documenting a ponderosa pine/elk sedge community. This area had not been previously logged and had only sporadic sheep use because water was 1.5 miles (2.4 km) distant. The general view is followed by pictures to the left and right of the meter board. The concept is to show both a general view and a pair of closeups to document change. Figure 18 illustrates what happened in this view after logging and 18 years later. Species noted are: CAGE (*Carex geyeri* Boot.), PONE (*Poa nervosa* (Hook.) Vasey), CARO (*Carex rossii* Boot.), and FRVI (*Fragaria virginiana* Duchesne).

Photograph Identification

Each photograph should be identified by site name, photograph number, and date. Figure 10 is an example for use with general or topic photographs (fig. 2). A critical factor is identifying **negatives** for color or black-and-white pictures or digital images. The borders of slides can be written on, but there is no similar place to identify negatives or digital memory card images. Placing a photo identification card in each picture assures a permanent record on the negative or image. This—negative identification—has been one of my biggest problems. Part B, appendix A, contains blank photo identification forms (“Camera-Photo” and “Shrub Photo Sampling”), which can be copied onto medium blue colored paper.

Paper color is the next consideration. Plain white or light colors, common in the office environment, are not suitable because they are too light in color and will bleach out when photographed. The recommended paper color is either Hammermill Brite Hue Blue or Georgia Pacific Papers Hots Blue (part B, app. A). Tests have shown these darker blue hues to be superior to other intense colors such as green and yellow.

Describing the Topic

Describe what is in the photographed scene. Include plant species, ground conditions, disturbances, or any other pertinent item. Part B, appendix A, contains forms having provision for recording these notes. For example, the filing system form “Camera Location and Photo Points” is shown in figure 2 with two views of Pole Camp and brief comments about each photo. And figure 11 is the “Photo Points and Close Photos” form for a general view and two closeup photographs of a ponderosa pine/elk sedge (*Carex geyeri* Boot.) plant community in undisturbed condition. Canopy cover estimates of dominant species are recorded in each closeup photo. Other topic description forms are discussed below in “Shrub Profile Photo Monitoring” and “Tree Cover Sampling.” The forms are available in part B, appendix A.

General Photography

General photographs document a scene rather than a specific topic marked by a meter board. They are similar to landscape pictures in that they may not contain a size control board (meter

PHOTOGRAPHIC SITE DESCRIPTION AND LOCATION	
Date <u>Aug. 1976</u>	Area <u>Camas Cr. Meadows</u>
Unit <u>Ukiah District</u>	Observer: <u>F.C. Hall</u>
Number of photo points <u>5</u>	Plant community: <u>lodgepole pine</u>
Location: <u>T. 45 R. 33 E. Sec. 35 9W of 5W</u>	
Location description <u>on Ore. highway 244 between mile posts 15</u> <u>8.16 & 0.20 mi. east of junc. with Bowman Cr. Rd.</u>	
Photo purpose: <u>Document effects of Mt. pine beetle</u> <u>attack on bottomland climax lodgepole pine</u>	
Discussion <u>Some beetles noticed in 1975; this year major</u> <u>kill (70%) of dominant lodgepole-needles red. Follow</u> <u>for each year for 3 yrs, then about 5 yr. intervals.</u>	

MAP

Use back of sheet for additional details.

Figure 12—Filing system form "Photographic Site Description and Location" with a map to locate camera locations and photo points to document the affects of mountain pine beetle on lodgepole pine. Two camera locations are shown. Figures 13 to 15 are from camera location 1 and show photo points 1A and 1B.

board) on which to focus the camera and orient subsequent photographs. A photo usually covers an area of 2 to 20 acres (0.8 to 8 ha) and distances of 50 to 200 yards (40 to 180 m) (figs. 12 to 15).



CAMERA LOCATION AND PHOTO POINTS	
Date <u>7/7/82</u>	Camera Location <u>Orc 244, Series 1</u>
Area <u>Camas Cr. Meadow</u>	Number of Photo points: <u>5</u>
Unit <u>Ukr. Dist</u>	Observer <u>JEV</u>
Comments <u>LD 70% with white needles, many shed; 20% red needles. 5 stands 90% dead - all larger trees; mtn. pine beetle</u>	
Slope <u>10</u>	Aspect <u>E</u> Slope position <u>Top</u>
<p>Photo point A: Compass bearing: <u>260°M</u> Distance: <u>—</u> <u>Camera located on</u> <u>Orc 244 centerline</u> <u>massive lodgepole</u> <u>kill</u></p>	
	
<p>Photo point B: Compass bearing: <u>240°M</u> Distance: <u>—</u> <u>Camera on Orc 244</u> <u>centerline</u></p>	
	

Figure 13—Filing system form “Camera Location and Photo Points” documenting stand conditions in 1977, one year after mountain pine beetle attack on lodgepole pine. The needle color on trees killed in the first year changed from green to dark red (not visible here). Compare to figures 14 and 15. Photo orientation used the road center line.

Concept

In many cases, general photographs document a scene in which a meter board cannot be placed to orient and focus the camera. One use of general photographs is shown in figure 2. Filing system form “Camera Location and Photo Points” is used in two pictures of Pole Camp where fenceposts marking camera locations and photo points may be identified. Another use is illustrated in figures 13 to 15, which document effects of mountain pine beetle attacks on lodgepole pine.


CAMERA LOCATION AND PHOTO POINTS			
Area	Camas Cr. meadow	Date	7/8/87
Unit	Utah Div.	Camera Location	Ore 244, Series 1
Comments	Large dead needles gray & shed; few green trees are mostly less than 3" dbh.	Number of Photo points:	5
Slope	10	Aspect	E
		Slope position	Top
Photo point A:			
Compass bearing: 260°M			
Distance: —			
90% of dominant & codominant trees with gray or shed needles			
Photo point B:			
Compass bearing: 240°M			
Distance: —			
Galvanne logged winter of '77-78. Screen of dead trees retained			
			

Figure 14—Stand conditions in 1978, 2 years after beetle attack in 1976. Photo point "A" has 90 percent kill and massive standing dead fuel. Photo point "B" was salvaged the winter of 1977-78.

Equipment

The following equipment is needed:

1. Camera or cameras for different film, or digital camera.
2. Photograph identification form "Camera-Photo" from part B, appendix A (fig. 10).
3. Clipboard and its support for holding the photo identification sheets (part B, app. B).
4. Compass and 100-foot (30-m) measuring tape.
5. Previous photographs for orientation of the camera.



CAMERA LOCATION AND PHOTO POINTS			
Date	9/18/5	Camera Location	Ore 244 Series 1
Area	Camas Cr. meadow	Number of Photo points:	5
Unit	Ukiah Dist	Observer	et al
Comments	Lodgepole regeneration growing well.		
Slope	10	Aspect	5
Slope position	Top		
Photo point A:			
Compass bearing:	260°M		
Distance:	70% of lodgepole down by 5th year after beetle kill		
Photo point B:			
Compass bearing:	240°M		
Distance:	70% of trees in screen down after 5 yrs. salvaged area well stocked (not planted) and growing well		
A			
B			

Figure 15—Stand conditions in 1991, 14 years after beetle attack and 13 growing seasons since figure 13. Photo point "A" shows most dominant trees are down, which creates severe burn conditions at ground level. Photo point "B" illustrates natural regeneration height growth. Orientation of repeat general photography without a meter board requires skill and a set of orientation pictures similar to those in figure 7.

- Filing system forms "Photographic Site Description and Location" (figs. 6 and 12) and "Camera Location and Photo Points" (figs. 2 and 13-15) from part B, appendix A.
- Fenceposts and steel stakes sufficient for the number of camera locations desired. Include a pounder.
- A tripod to use for camera reorientation.

Technique

Select a scene that will meet your monitoring objectives. Describe it, including plant species, ground cover items, disturbance, or whatever the topic of the photograph is by using the filing system form “Camera Location and Photo Points.”

Photograph the scene.

Make maps of the location and layout of the scene on the filing system form “Photographic Site Description and Location” (figs. 6 and 12). In figure 6, the two photos from figure 2 are labeled “Pan Left” and “Pan Right.”

Reorientation—Reorientation of subsequent pictures is a major concern due to lack of a meter board. Identification of key items in each view will be needed. In figure 6, for example, the tall tree in the right background of picture (A) is the same tree as in the left background of picture (B). Panoramic views, such as figure 6, always should include about 10 percent overlap between photographs.

Systems used for landscape photo reorientation (discussion at fig. 8) are of major help. On a black-and-white copy of the scene, mark reorientation items as shown in figures 8 and 9. With the camera mounted on a tripod, compare the picture in hand with the scene through the camera. Orient the camera accordingly.

Figure 7 illustrates a site locator fieldbook for rephotographing general views. It has 3- by 5-inch (7.5- by 12.5-cm) photographs mounted on 5- by 5-inch (12.5- by 12.5-cm) cardboard. Instructions are given under each picture for its location and orientation. These fit into a vest pocket for use in the field. Figure 3 is a recent picture of figure 7B.

Example—Figures 13 to 15 illustrate general photography documenting effects of mountain pine beetle on lodgepole pine along highway 244 in the Blue Mountains of eastern Oregon. Figure 12 is filing system form “Photographic Site Description and Location” mapping two camera locations. Camera location 1 has two photo points (figs. 13 to 15) and camera location 2 has three photo points. Monitoring started in 1976 when beetles first attacked the stands.

Figures 13 to 15 show the use of filing system form “Camera Location and Photo Points” to document beetle effects over a 14-year period. Figure 13 depicts second-year effects of beetle attack where trees killed the first year have started to drop their needles. Figure 14 is the third year after attack and shows massive standing fuel (14A) and salvage (14B). Figure 15, 14 years after initial attack and 13 growing seasons after figure 13, illustrates tree fall (15A) and growth of natural regeneration (15B).

Topic Photography

Topic photography narrows the subject from a general view to a specific item of interest. It adds a meter board, or other size control object, to identify the photographic topic (figs. 1, 3, 4, and 11).

Concept

We will assume monitoring objectives have been established as discussed in “Basics.” A meter board, or other size control board, is placed at the selected topic for several reasons: to (1) identify the item being monitored for change; (2) establish a camera orientation reference point for subsequent photography; (3) set up a constant size-reference by which change can be documented, for example by grid analysis; and (4) provide a point on which to focus the camera for optimum depth of field.

Figure 3 illustrates identification of a very specific topic, stream-bank stability. Figure 1 deals with a general view limited to area around the meter board; the topic is effect of logging and pre-commercial thinning on stand structure and ground vegetation. Purpose of topic monitoring is the primary factor in selecting a monitoring layout.

The effect of distance from the camera to the meter board to emphasize a topic is shown in figure 16. The topic in 16A is a transect for nested frequency, in 16B it is density of grass and big sagebrush (*Artemisia tridentata* Nutt.), and in 16C it is species density and use (none in this case). Select a camera-to-photo-point distance that best depicts what you want to emphasize. Remember that once the distance is established, it **must** remain fixed.

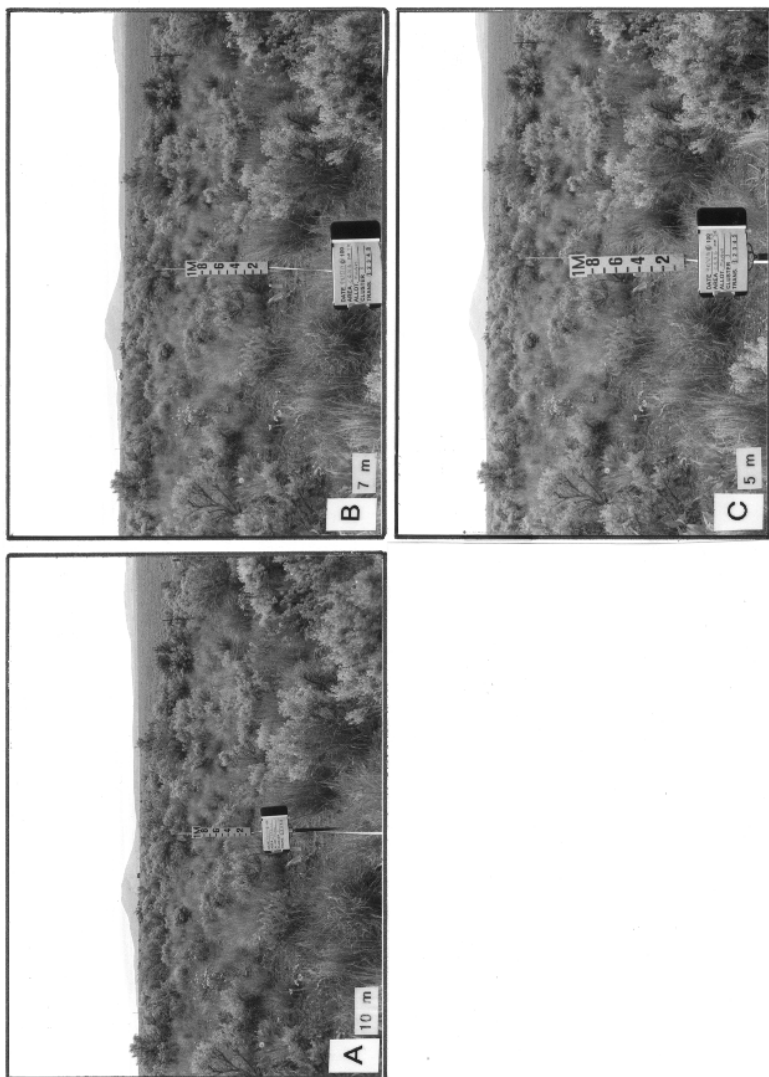


Figure 16—Evaluation of a 35mm lens on a 35mm camera for placement of a meter board to emphasize a topic. This is a transect on the Crooked River National Grassland in eastern Oregon. (A) Placement of the meter board 33 feet (10 m) from the camera. It is essentially the same as 46 feet (14 m) distance with a 50mm lens. (B) Distance of 23 feet (7 m), essentially similar to 33 feet using a 50mm lens (fig. 31, part B). (C) Sixteen feet (5 m) distant, equivalent to 23 feet with a 50mm lens. A consistent distance between camera location and photo point for all photographs is not required. Choose a distance that best documents what you want to show. But, after your choose it, it must remain the same.

Equipment

The following equipment is required for topic photography:

1. Camera or cameras with both color and black and white film or a digital camera.
2. Form "Camera-Photo" from part B, appendix A, printed on medium blue paper.
3. Forms for site identification and photo points from part B, appendix A: "Photographic Site Description and Location" and "Camera Location and Photo Points"
4. Meter board (part B, app. B).
5. Clipboard with its support to hold the photo identification forms (part B, appendix B).
6. Fenceposts and steel stakes sufficient for the number of camera locations and photo points desired. Include a pounder.
7. Compass and 100-foot (30 m) tape for measuring distance.
8. Metal detector for locating stakes.

Technique

Several steps are needed to establish topic photo monitoring. Pole Camp (fig. 2) is used as an example.

Define the topics of interest. At Pole Camp, primary topics were effects of livestock grazing on streambank stability, differential utilization on dry and wet meadows, and impacts on willow shrubs.

Next, define what coverage is desired in the monitoring area. How many streambank sites are desired? How many dry and wet meadows and where? How many shrubs should be monitored and where are they located (see "Shrub Profile Photo Monitoring")? Notice the distribution of willow shrubs in figure 2A and the pattern of dry to moist to wet meadow in 2B.

Photo points and camera locations—Based on the desired objectives, locate photo points (meter boards) to best document change. Then establish camera locations for optimum coverage of the photo point topic. Coverage might require multiple photo

points from the same camera location or multiple camera locations focusing on the same photo point. Figure 6 maps two photo points (“D” and “W”—dry and wet meadow) from camera location 1 and two camera locations (2 and 3) focusing on photo point “S” (streambank). Figure 2 shows these camera locations and photo points. Advantages are twofold: First, relocation tends to be easier when only one point must be located that will serve two or more views, and second, one point showing several views tends to tie the sampling area together.

Riparian considerations—Riverine riparian settings have two unique photo monitoring characteristics not found in dryland situations: floods and beavers. These characteristics require some special considerations in locating both camera locations and photo points.

Camera locations should not be placed at the stream edge because they cannot be relocated if the edge erodes. Place them 3 to 5 feet (1 to 1.5 m) away from the edge and, if deemed necessary, triangulate their location (fig. 17). They should not be placed in the stream unless exact relocation for both height above the original streambed and position in the stream is assured. At times, camera locations documenting photo points in or at a stream edge may be difficult to establish.

Photo points at the stream edge may be highly desirable (figs. 3 and 17). Consider the following: (1) Use a fencepost to mark the meter board and pound it down to exactly the meter board height. This will help document erosion or deposition (fig. 3) at the base of the fencepost. When the meter board is placed for a repeat photo, measure the distance from the top of the fencepost to the top of the meter board to document the amount of change. (2) Triangulate location of the streambank fencepost (fig. 17) to assure its exact relocation should a flood remove it. If it is removed, replace the fencepost to the current meter board height. Amount of change in the meter board can be documented from an unchanged camera location only by comparing the meter board with adjacent items, such as the streambank.

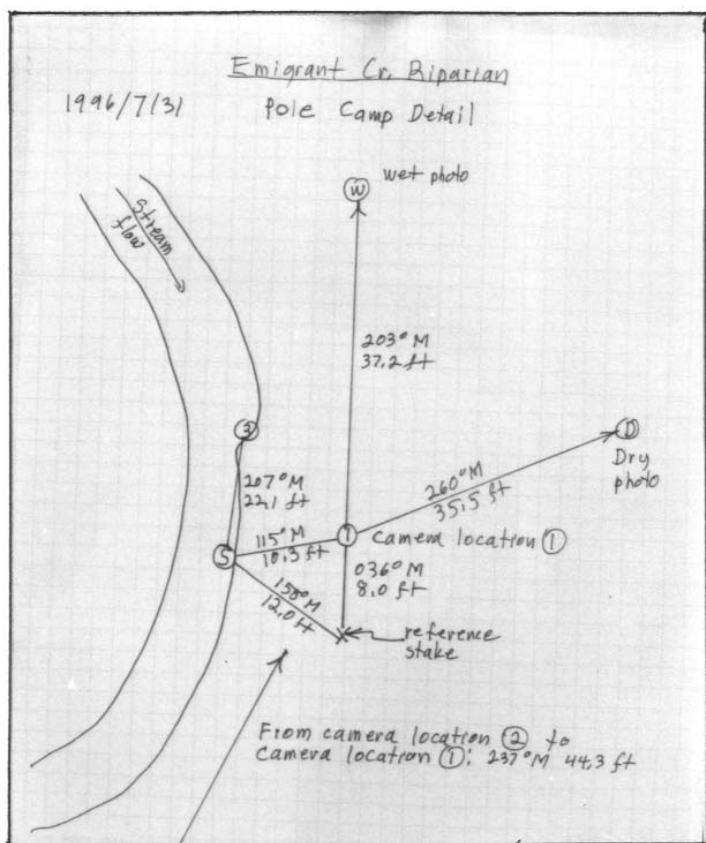


Figure 17—Triangulation location of the meter board in figure 3 to document streambank erosion at Pole Camp. This map is the boxed area shown in figure 6. Any photo point or camera location in a tenuous spot should be referenced by two or more locator stakes.

Camera orientation and focus—Consistent repeat photography requires a reference point to orient subsequent views. The objective is to have the view remain constant as items within the view change. A meter board serves this purpose. Figure 18 shows three repeat photographs of a ponderosa pine/elk sedge community that was selectively cut. Figure 18A illustrates how the camera focus ring is placed over the “1M,” which accomplishes two things: (1) it provides a common orientation point for the first and subsequent photographs, and (2) it provides a

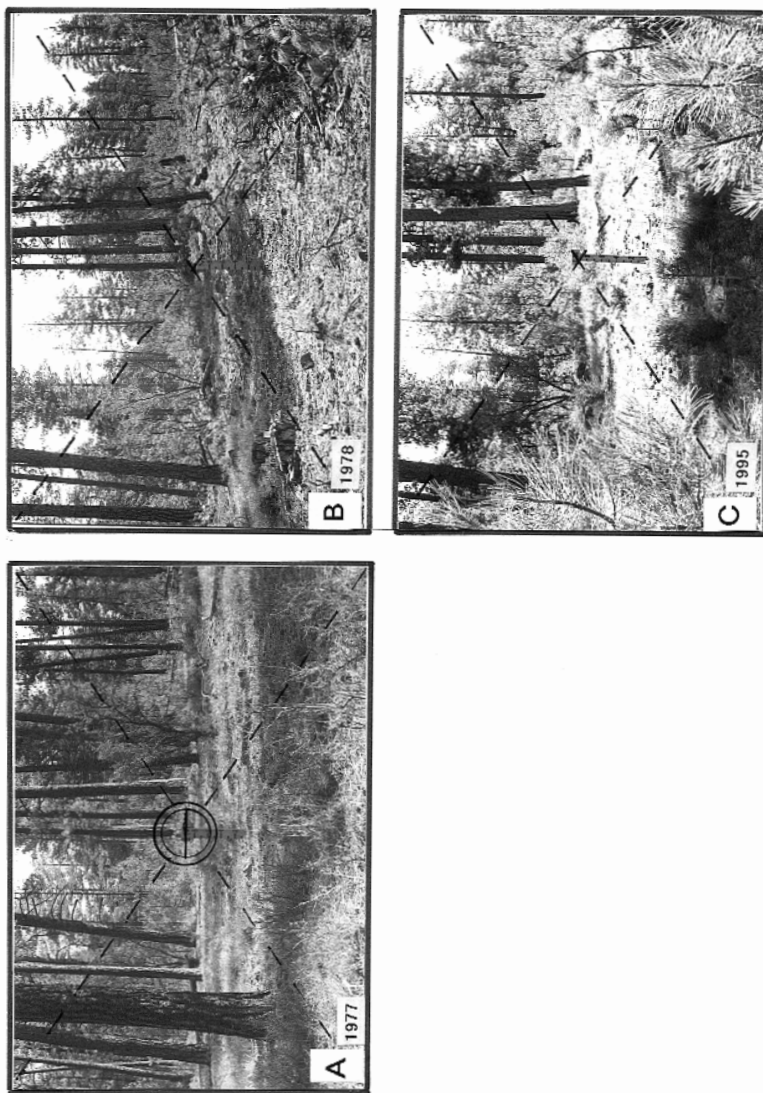


Figure 18—A meter board is used to aim the camera for consistent repeat photography. (A) Placement of the camera focus ring on the 1M," which puts the "1M" in the center of the picture (dashed lines). This orientation produces exact replication of repeat photographs as shown in (B) and (C). Focusing the camera on "1M" provides optimum sharpness and depth of field at the meter board. 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 (fig. 11). (A) 1977 just before a selection cut, (B) the summer after the cut (a two-turn skid trail crossed the meter board location), and (C) 1995, 18 years later.

locus for focusing the camera for maximum depth of field. With the meter board placed at the topic of interest, the topic should always be in sharp focus.

Other options may be considered with topic photography: close-up pictures of the meter board and overhead photos of tree canopy.

Closeup photos—In many cases, details might be desired that are not accommodated by a meter board 20 to 35 feet (7 to 10 m) distant. Closeup photos, one from each side of the meter board, are recommended (fig. 19). After the general photo is taken, walk up to the meter board and photograph it on each side. With a 50mm lens, stand 7 feet (2 m) away or with a 35mm lens, stand 5 feet (1.5 m) away. Figure 19 illustrates a 50mm lens.

A critical element is to always place the top of the meter board all the way up in a corner of the view (fig. 20). Details on the ground are shown in about a 5- by 5-foot (1.5- by 1.5-m) area on each side of the meter board (figs. 19 and 20). Always take a general photo and two closeup photos to document change (fig. 11).

Figure 11 illustrates use of filing system form “Photo Points and Close Photos” (part B, app. A) for mounting and filing topic photographs. It is the 1977 view of ponderosa pine shown in figure 18.

Overhead canopy—Pictures of the overhead tree canopy may be useful when documenting changes in tree canopy cover. The technique is discussed in “Tree Cover Sampling.” A word of **caution:** camera focal length **must be the same** for all subsequent pictures because there is no size control board by which to adjust different focal length photos to the same size.

An investigator may elect to do all three kinds of photography: topic view, closeups on each side of the meter board, and an overhead view for maximum documentation of treatment effects.

Text continues on page 33.

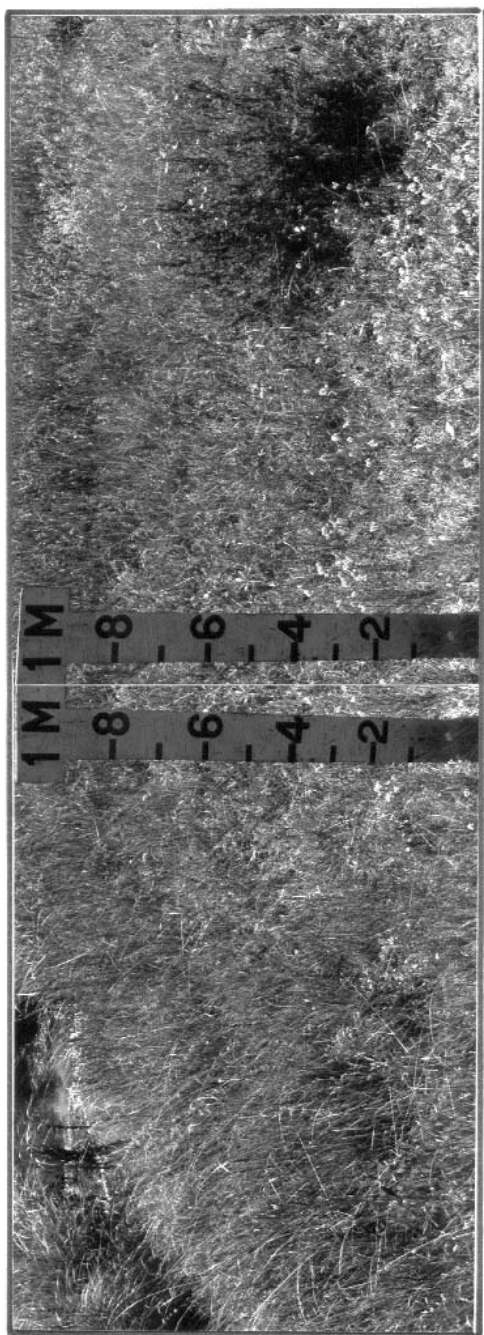
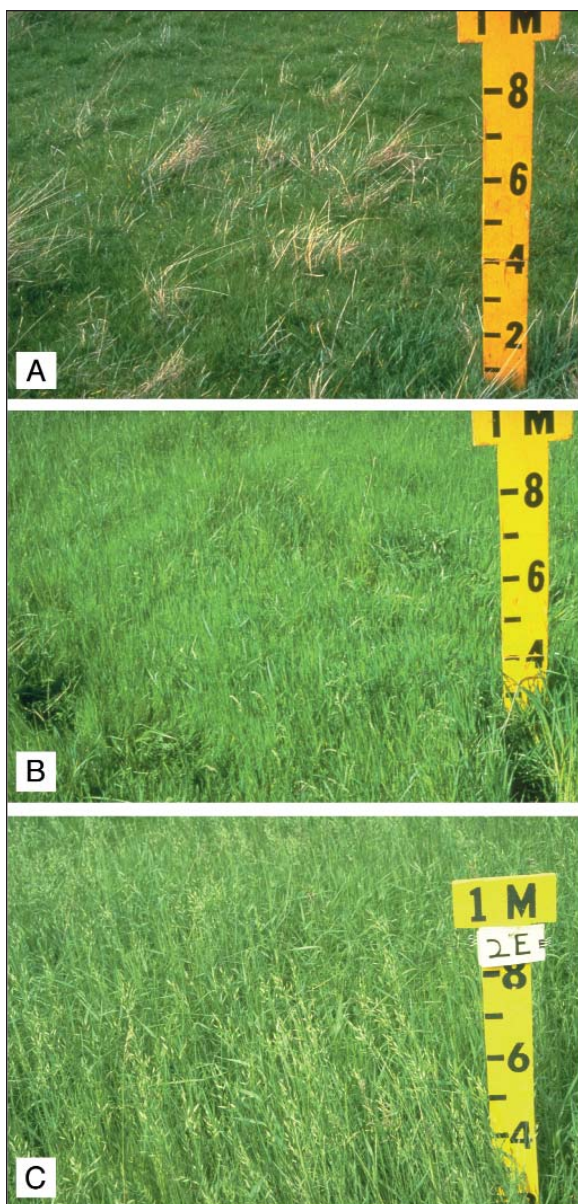


Figure 19.—Technique for documenting ground vegetation by using the meter board. Take one picture to the left and one to the right with the meter board at the corresponding edges of the photographs. Stand 7 feet (2 m) away from the board. Tilt the camera slightly off horizontal to make the meter board parallel with the side of the photograph. Place the “1M” of the board in the upper corner of the view. The 7-foot distance, along with a 50mm lens on a 35mm camera, will place the bottom of the board in the lower corner of the picture (fig. 20). Set the camera to 3 meters (9 ft), which allows the vegetation to be in focus from bottom of the meter board to at least 7 feet (2 m) beyond the board. These are closeup views of figure 4, June 15. If pictures are mounted in this fashion, I overlap the meter boards so that only one is showing.



Analysis of Change

The meter board also is used as a constant size reference point for analyzing changes. The recommended system is grid analysis (discussed in part B). In a nutshell, a clear plastic form with site identification information is taped to the photo and topics of interest outlined. Then an analysis grid is adjusted to exactly match the size of the meter board in the outline and is printed on white paper. The outline form is taped to the grid, and grid intersects within the outlines are counted and recorded. Amount of change between photos can then be determined.

Topic Description

Describe the setting and topic to be photographed each time photos are taken. Figures 13 to 15 show mountain pine beetle effects on lodgepole pine. New conditions are recorded for each repeat photograph. Figure 11 illustrates a general photo and two closeup pictures of ground conditions. Plant species and their estimated canopy cover are recorded for the closeup pictures each time they are taken. The "Photo Points and Close Photos" form provides space for these notes.

- ◀ Figure 20—Orientation for closeup photos of a meter board in dense vegetation. In photograph (A) with 4 inches (1 dm) of stubble height, the meter board bottom can be visually estimated. In (B) and (C) it cannot. Exact reorientation of the photograph is essential: (1) the "1M" must be in the top corner of the view, (2) the bottom of the board must be in the lower corner, (3) the photograph must be taken from 7 feet (2 m) away with a 50mm lens on a 35mm camera, and (4) the camera must be tilted slightly off horizontal to make the board parallel with the side of the view frame. In photograph (B), just 3 months later, grass is over 16 inches (4 dm) tall effectively hiding the bottom of the meter board. Problems with tall vegetation and exact photograph reorientation are shown in (C). The "1M" was not placed in the top corner of the view frame. Instead it is about 8 inches (2 dm) below the corner meaning the bottom of the board is about 8 inches (2 dm) below the bottom of the picture, an unacceptable repeat photograph. Photo (C) also demonstrates a problem photographing plot frames because a frame would not be visible.

Shrub Profile Photo Monitoring

Change in shrub profile area can mean either shrub use or shrub growth. It may be documented through repeat photography with grid analysis and horizontal camera orientation. Permanent camera locations and photo points, marked by steel fenceposts or stakes, are required. Season of photography is a key factor in documenting change and causes of change in shrub profiles.

Concept

The concept of documenting change in shrub profile area is to photograph a shrub on two sides with the camera location moved for a 90-degree difference between views (Reynolds 1999). This photographs all profiles of a shrub. Camera locations and photo points must be marked with steel fenceposts or stakes to assure the same distance from camera to meter board for all future photographs. The same distance need not be used, however, for all camera locations. Adjust distance to suit the topic being photographed. Tall shrubs, where double meter boards are used (fig. 21), require a much greater distance than short shrubs (fig. 25, below).

Once photographs have been taken, use the photo grid analysis procedure (in part B) to document changes in shrub profile area and shape.

Guidelines

All basic photo monitoring requirements for relocating the monitoring area and for maintaining the same distance from camera to meter board must be met. Some guidelines follow.

The primary objective in monitoring change in shrub profile area or shape is to document usage (reduction in area, Reynolds 1999) or growth (increase in area). Thus, season of photography is of critical concern. If effect of animal browsing is the topic of interest, photography both before and after this use may be necessary. This requires selection of two seasons to photograph, such as just before livestock grazing and immediately after. If livestock graze at different seasons in the same pasture over a period of years (such as rest-rotation systems), three dates may



Figure 21—Use of a folding 2-meter board to document height and growth of tall shrubs. This board is hinged in the middle and held upright by a barrel bolt. When folded together (fig. 54, part B), it is a 1-meter board and unfolded it is 2 meters.

be required to document grazing effects over several years. Other dates, established by local knowledge, probably will be required for wild animals.

If growth in shrub profile area is the topic of interest, then photography after termination of growth would be desirable. Dryland shrubs usually have a definite termination of growth and are called determinate shrubs. Some riparian shrubs, such as many willows, continue to grow until environmental conditions, such as frost, cause growth to stop. These are indeterminate shrubs. Season to photograph must thus be based on the physiological development of the shrub species under study.

Procedures

1. Establish a monitoring objective at the same time as the area and species of shrub to evaluate are selected. Determine photography date(s).

2. Make a map to find the monitoring area (fig. 5) and a map of the transect layout (figs. 22 and 23). The transect layout must include direction and distance from the witness mark to the first shrub photo point and then its two camera locations, and from there the direction and distance to the next shrub photo point and its camera locations (fig. 23). All shrub photo points must be tied together for ease in future location. The transect layout need not, probably will not, be a straight line (fig. 23).
3. Placement of the meter board is critical because it will be used to document changes in shrub profile. There are three concerns: (1) Placing the meter board far enough to the side of the shrub to allow the shrub to grow in crown diameter (figs. 24 and 25). Consider a distance that is half the current shrub crown diameter (fig. 24). (2) Placing the bottom of the meter board far enough toward the camera to assure the lowest line of the grid will be **below** the bottom of the shrub if it grows. Consider placing the 2-decimeter line opposite the current bottom of the shrub (fig. 25). (3) Placing the board in one location and moving the camera for a 90-degree change in view (figs. 24 and 25).
4. Select a camera-to-photo-point distance that will permit the shrub to grow in both height and diameter. Consider a distance where the current shrub is about 50 percent of the camera view height and 70 percent of the camera view width (fig. 25, A and B).
5. Try to select a single shrub or several shrubs separated from other shrubs in the camera view. If shrubs increase in area of profile, their outer crown periphery may become difficult to separate from adjacent shrubs (fig. 25). Color photographs greatly aid in shrub profile delineation.
6. Aim the camera so that the meter board is at the extreme left or right of the view (fig. 25). The "Shrub Analysis Grid" (part B, app. A) shows the meter board at the sides (fig. 25). Next,

SAMPLING SITE DESCRIPTION AND LOCATION

Circle: 1 Sq.Ft. Nested Freq. 1 sq.m. Robel Pole (Shrub Form)

Date 1997/6/17

Site Data: Elev. 5200 % slope 1

Area Shrub mtn.

Slope aspect: N-NE E-SE S-SW W-NW

Allot. Pole Camp

Slope position: top up 1/3 mid low 1/3 (bottom)

Cluster No. 1

Micro topography: convex (flat) concave

Transacts: (1) 2 3 4 5

Macro topography: flat undulating (rolling)

Plant community SAGE

steep rough broken

CHAB

Geology:

Grazing system:

Deposition: wind (stream) lake colluvial

Type rest/rot Date 1977

residual

Type _____ Date _____

Material: limestone mudstone sandstone

Type _____ Date _____

granite serpentinite diorite

Kind of animal: (cattle) sheep

basalt (andesite) rhyolite

horses goats deer

tuffaceous cinders pumice ash

elk _____

Soil:

Location: T. 195 R. 27E

Restrictive layer: absent (clay pan) bedrock

Sec. 29 SW of NE

cemented

Description: Open meadow

Surface compaction: none (moderate) severe

between 43 rd and

Soil profile stone: (absent) gravel stony

Crowfoot Cr. 0.25 mi

Soil texture: sandy loamy (silty) clayey ashy

W. junc. 43/4365 rds

Other notes: 1998/8/1 fence almost old

access trail to meadow

MAP

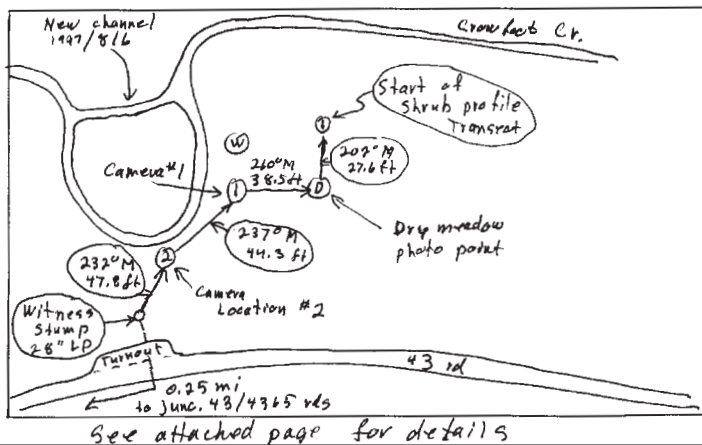


Figure 22—The filing system form "Sampling Site Description and Location" identifies the Pole Camp shrub profile monitoring system. On the first line of the form, circle the monitoring system used, in this case "Shrub Form." Information about the area is entered, and a map is drawn to locate the monitoring system. This shrub profile transect is one of several photo monitoring installations at Pole Camp; figure 6 diagrams five camera locations and four photo points. A note at the bottom of this map says that an attached page has details. This is shown in figure 23.

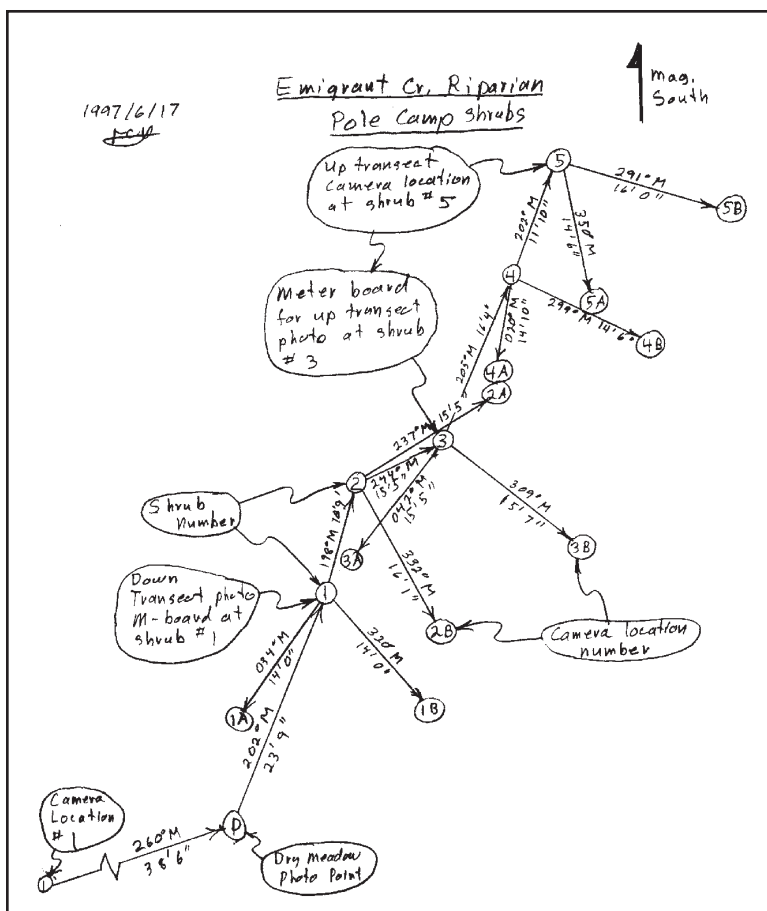


Figure 23—Details of the Pole Camp shrub profile transect (an attachment to the form shown in fig. 22). Instructions begin at camera location 1. The dry meadow photo point has been used as a camera location for a view down the transect (see fig. 25). Directions to five shrubs are shown in magnetic degrees and distance. Because a shrub is the point of reference, the two camera locations take direction and measured distance **from** the shrub to facilitate relocation.

orient the camera so that the bottom of the meter board is just **above** the bottom of the camera view (fig. 25). Thus, a maximum amount of photo is allocated to current and future crown area development of the shrub.

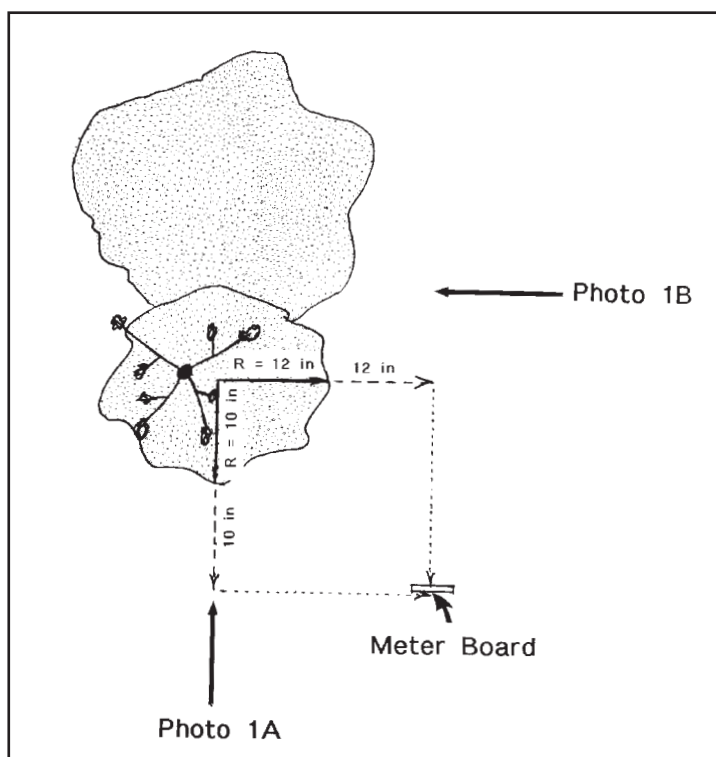


Figure 24—System for locating a meter board when photographing shrub profiles. Measure the shrub radius in two directions, at 90 degrees from each other to correspond to the direction of photographs (12 inches [30 cm] and 10 inches [25 cm]). Move out from the shrub the same distances (12 inches and 10 inches), and locate the meter board at the intersection of the distances. This will place the meter board far enough to the side and front of the shrub so that the shrub can grow and still be covered by a grid. These two views correspond to figure 25, 1A and 1B.

Note the relation between placement of the meter board bottom about 8 inches (2 dm) below the bottom of the shrub and orientation of the camera at the bottom of the meter board. The objective is to document change in shrub profile both upward and outward.

When tall shrubs require double meter boards, such as in figure 21, the boards may be placed in front and the “Analysis Grid-2-Meter” form (part B, app. A) used.

SHRUB PHOTO TRANSECT

Date 9/7/6/17 Cluster 1 Transect ① 2 3 4 5

Area Snow Mt. Dist
 Allot. Pole Camp
 Investigator: SW

Season of use late
 Grazing system: Rest -
Rotation - 3 pasture
 Animals Cow/Calf

Direction 202° M
 Distance 2319"

Shrub 1A
 Direction 214° M
 Distance 1410"
 Comments SALIX
GEYERIANA
Browsed 2 yrs ago
CAREX SIMULATA
POA PRATENSIS
POTENTILLA
FLABELLIFOLIA
 suggest a dryish moist meadow

Shrub 1B
 Direction 140° M
 Distance 1414"
 Comments SALIX
GEYERIANA
Browsed 2 yrs ago;
2 shrubs

Figure 25—The filing system form “Shrub Photo Transect” (part B, app. A) shows Pole Camp willow transect 1 and both views of shrub number 1. Notes about the vegetation and item photographed are made opposite each photograph. Direction shown is from the **camera** location to the shrub—a reciprocal of the map direction. The form provides for two views each of 10 shrubs with views down the transect from each end. The top photograph (T = transect) is down the transect under which are photo points 1A and 1B. Species are *Salix geyeriana* Anderss., *Carex simulata* Mackenzie, *Poa pratensis* L., and *Potentilla flabellifolia* Hook. ex Torr. & Gray.

Equipment

The following equipment is required for shrub profile sampling:

1. Camera or cameras with both color and black-and-white film, or a digital camera.
2. Forms from part B, appendix A: for transect and shrub identification, "Shrub Photo Sampling" printed on medium blue paper, and data/photo mounting form "Shrub Photo Transect" printed on medium yellow paper.
3. Meter board (part B, app. B).
4. Clipboard with its support for holding the photo identification forms (part B, app. B).
5. Fenceposts and iron stakes sufficient for the number of shrubs desired: 1 fencepost and 2 iron stakes per shrub. Include a pounder.
6. Compass and 100-foot (30-m) tape.
7. Metal detector for locating transect stakes.

Technique

The technique for shrub profile monitoring combines a transect system with principles discussed in "Topic Photography," above, and in part B, "Photo Grid Analysis." A primary objective is to monitor **change** in shrub profile area and not to measure canopy cover of shrubs or shrub profile area per acre (hectare). Shrubs, therefore, are objectively selected for photography. The following technique emphasizes this objectivity.

1. Locate the area of consideration. Walk the area to select shrubs to be monitored. In many cases, shrub distribution does not lend itself to straight line transects, particularly in riparian areas with winding streams. Ask, "Why am I concerned with change in shrub profile area? Is it to appraise usage, assess vigor, or document change in profile area? Is the location of shrubs important, such as creating shade along streams? Each shrub is a topic and becomes the key mapping and photo orientation object.

2. Mark each shrub to be photographed with steel fenceposts or a combination of posts and stakes: a fencepost to mark the meter board and two more posts or stakes to mark camera locations that view the shrub at 90 degrees (two different sides). Whenever possible, select a single meter board position that will accommodate the two camera locations (figs. 24 and 25).
3. After marking all the desired shrubs, diagram the transect layout (fig. 23). Take a direction and measured distance from the witness marker to the meter board position for the first shrub. Diagram the two camera locations with direction and distance **from** the shrub. This aids repeat photography. Find the shrub fencepost or stake, take direction, and measure distance to the camera locations. Fenceposts are easy to find. Stakes require a metal detector, which is greatly facilitated by this location system. The distance and direction should locate a 0.5-meter diameter area in which to find the stake.

Then take direction and measured distance from the meter board for the first shrub to the second shrub, again documenting direction and distance to the camera locations. Continue to the end of the transect (fig. 23). Remember to indicate magnetic or true direction.

4. When ready to photograph, fill out the filing system form "Shrub Photo Sampling" for photograph identification as seen in the three parts of figure 25.
5. Take a general picture of the transect by setting the meter board at shrub number one as shown in figure 25T. Stand 20 to 30 feet (7 to 10 m) from the board and put the "Shrub Photo Sampling" form in view (fig. 25T). Stake the camera location and add the location to the sampling layout diagram.
6. For each shrub, place the "Shrub Photo Sampling" photograph identification form next to the meter board (fig. 25, 1A and 1B). The form has a shrub number and letter for camera

locations for 10 shrubs. Match the shrub number and letter on the form with the transect diagram and circle the number, in figure 25-1A, 1A is circled for camera location "A." To photograph the shrub, focus the camera on the meter board to assure greatest depth of field for the shrub. Then swing the camera either left or right to place the meter board at the side of the frame.

Move to the second camera location (1B), turn the meter board and the photo identification form to face the camera, cross out the last shrub number on the form and circle the current one. In figure 25-1B, 1A is crossed out and 1B is circled representing shrub 1, camera location "B."

Make notes of what is in each photo on the "Shrub Photo Transect" form printed on yellow paper (fig. 25) from part B, appendix A. Identify the shrub, list herbaceous vegetation, and note anything of interest such as browsing and by what.

7. Move to the next shrub and repeat the process until completed.
8. Mount the photographs, as shown in figure 25. The filing system form "Shrub Photo Transect" is designed for 3- by 4½-inch (7.5- by 11.2-cm) photos.
9. Conduct grid analysis of the pictures as discussed in part B (fig. 26).

Tree Cover Sampling

Forest stand density, represented by canopy cover, has direct influences on ground vegetation species through root competition and by casting shade. Trend in density and composition of ground vegetation is often as much influenced by this competition as by grazing or light disturbance. Any photo point placed in a forested setting should consider tree cover photography.

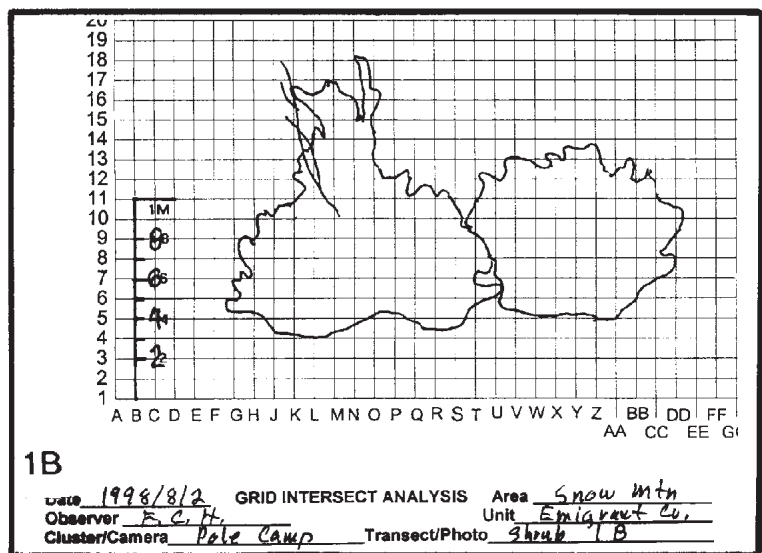
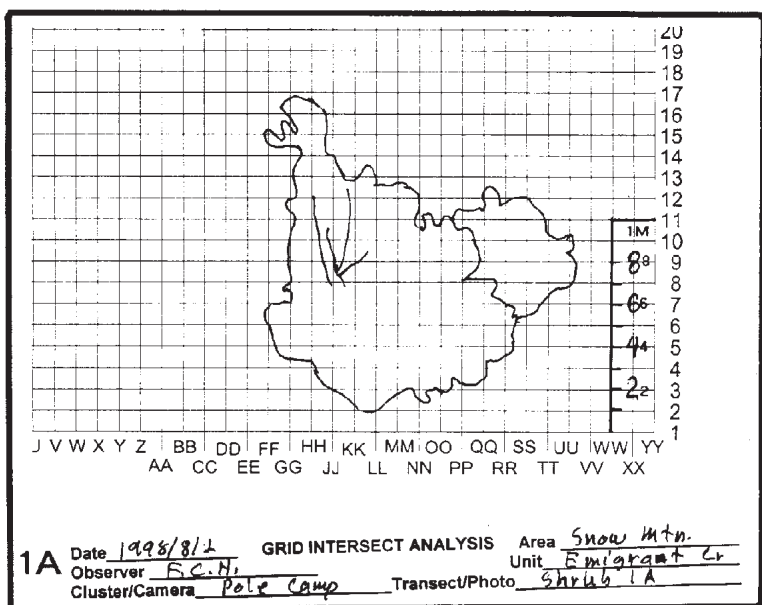


Figure 26—Grid outlines for shrub 1, views (1A) and (1B) on the Pole Camp shrub profile transect. Grids have been adjusted for size by the outlined meter board. Outlines are then taped to the grid. Count grid intersects and record on the filing system form "Photo Grid Summary" (fig. 49, part B).



Figure 27—System to photograph tree canopy cover. The photo point meter board will be crosswise of the view. Place the camera level board on top of the meter board and the camera on the level board. First, center the cross-view level by moving the meter board sideways. Then tilt the camera level board so that the down-the-view level is centered, move your head out of the camera view, and photograph.

Concept

Tree canopies are photographed perpendicular to the ground by using a camera leveling board to assure vertical orientation of the camera. Figure 27 illustrates a 35mm camera with 50mm lens in the correct position.

Whatever focal length is used to begin, the **same focal length** must be used for subsequent photos. There is no measured distance to a meter board or other size control used in the over-head view, therefore pictures **cannot** be adjusted to a common camera focal length to compare canopy cover.

Equipment

The following equipment is required for tree cover sampling:

1. Camera or cameras with both color and black-and-white film, or a digital camera.

2. A camera leveling board (part B, app. B).
3. Form from part B, appendix A, for data and photo mounting, "Photo Points with Overhead Views" (fig. 28)
4. Meter board (part B, app. B) on which to set the leveling board and camera and thus maintain a constant camera height.
5. A compass and 100-foot (30-m) tape.
6. Fenceposts or steel stakes with pounder.
7. Metal detector for locating stakes.

Technique

Position the meter board at the topic of interest following guidelines in "Topic Photography" (above). Hold the camera leveling board on top of the meter board, set the camera on the leveling board with the long axis crosswise to the scene (landscape orientation) and the viewfinder toward the camera location (fig. 27). The easy way to remember this is to view the photo point with the camera in landscape orientation (fig. 28, top view), then move to the meter board and rotate the camera to look up at the canopy (fig. 28, bottom view).

Move the meter board sideways to level the camera board across the view. Then level the camera board down the view, bend down to take your head out of the picture, and photograph (fig. 28, bottom view).

Important criteria—There is neither a size control (meter board) nor photo identification sheet in these pictures. Therefore three procedures **must** be followed:

1. The same focal length lens must be used for all subsequent photographs so that images can be compared.
2. The camera must be the same height aboveground. Use the meter board for consistent heights. Figures 31 and 32 in part B illustrate the effect of change in distance on size and location of objects.

PHOTO POINTS WITH OVERHEAD VIEWS

Date 9/6/85 Camera Wide Thin #3
 Area Prairie City Dist Number of Photo points: 2
 Unit Cold Cr. Observer F.C. Hall
 Comments 25 yrs since pct; clearcut about 1950

Slope 5 Aspect W Slope position mid Topography undulating

Photo Point A
 Compass bearing: 178° M
 Distance 32.0 ft
 Photo comments:
No cow use, trees
new growing at 2-2"
per dec.

Overhead of Photo Point A
 Photo comments:
Ponderosa pine is
fairly good vigor.
100 ft line transect
showed 47% cover




Figure 28—Filing system form “Photo Points with Overhead Views” documenting current tree canopy cover. The form is in part B, appendix A. Remember to make notes on what is in each photo.

- Make sure that the camera is oriented crosswise to the view with the viewfinder toward the camera location (fig. 27). Remember this by viewing the photo point through the camera, then rotating it 90 degrees upward to view the canopy.

Canopy cover also may be determined by using the photo grid analysis technique discussed in part B.

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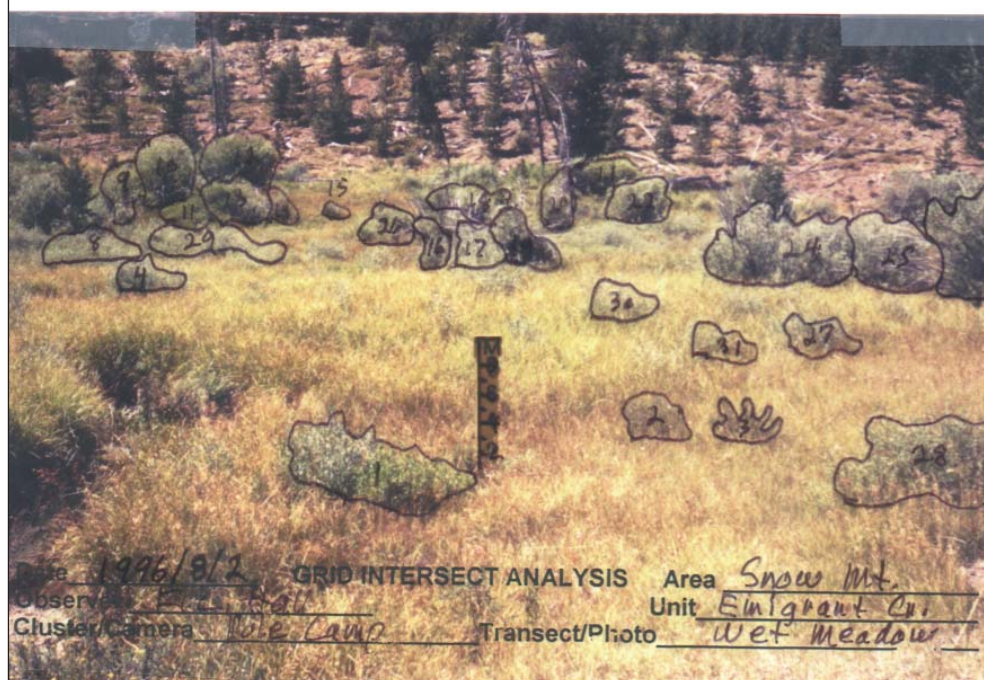
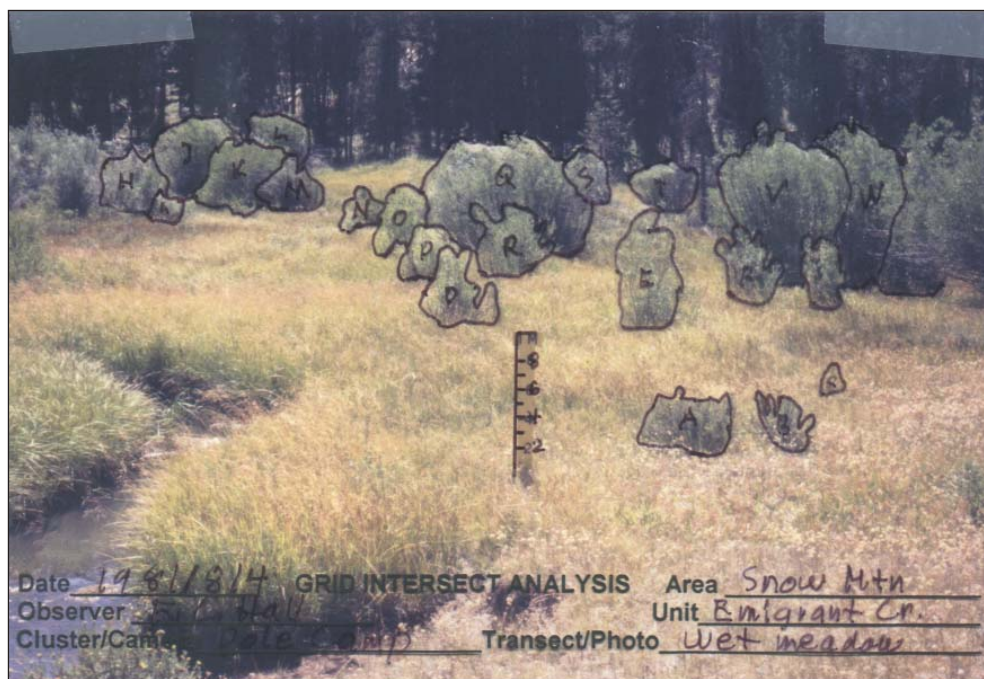
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Photo Point Monitoring Handbook: Part B—Concepts and Analysis

Frederick C. Hall



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Photo Point Monitoring Handbook:

Part B—Concepts and Analysis

Frederick C. Hall

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Abstract

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This handbook describes quick, effective methods for documenting change in vegetation and soil through repeat photography. It is published in two parts: concepts and office analysis in part B, and field procedures in part A. Topics monitored may be effects of logging, change in wildlife habitat, livestock grazing impacts, or stream channel reaction to land management. Land managers, foresters, ranchers, wildlife biologists, and land owners may find this monitoring system useful. In part B, (1) concepts and procedures required to use photographs for analyzing change in photographs are presented, (2) monitoring equipment specifications are given, and (3) forms for recording information and mounting photographs are provided.

Keywords: Monitoring, photography.

Preface

This handbook is an synopsis of repeat photography principles and photo point sampling from the publication *Ground Based Photographic Monitoring*, PNW-GTR-503, which is based on 45 years experience in repeat photography by the author. During those years, many nuances were discovered that bear discussion and emphasis so that new users can avoid the pitfalls I ran into. The terms *should*, *must*, *will*, and *do not* are used to help users avoid problems and are not meant as rules.

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Introduction

Photographic documentation of soil and vegetation topics of interest is an essential first step in photo monitoring. But monitoring implies the need to determine change. This determination has two components: (1) the basics of photographic technique; and (2) a method to assess change—in this case, grid analysis, which may be done by hand or with a computer. Appendices provide forms for photo monitoring and analysis as well as equipment specifications.

Basics

Use of photographic equipment is fundamental to photographic monitoring. The equipment may be either film or digital cameras. The purpose of photo monitoring is to document change in a landscape or topic over time. Measuring change requires photographs of good to excellent resolution and color, both of which are influenced by camera and film.

Cameras

Consumer cameras currently are classed into two broad categories: point-and-shoot automatic and single lens reflex (SLR) for either film or digital use. Point-and-shoot cameras usually provide safe exposure in average light conditions to produce nice snapshots. The SLR cameras use a view-through-the-lens system enhancing photographic composition and have various adjustments for fine tuning exposure. They can take superior pictures. Digital cameras are similar, but their quality tends to center on the number of pixels. Pixels are dots of different colors that form an image. Point-and-shoot digital cameras range from 1.1 to 2.4 megapixels and better quality ones usually have 3.4 or more. If measurements on photographs are contemplated, one must use a camera of 2.4 megapixels or higher.

Film and digital camera characteristics—Both camera formats come in two configurations: (1) viewfinder and (2) view-through-the-lens, or SLR. Many digital cameras use SLR principles with a liquid crystal display (LCD). An LCD is a miniature (2.5- by 3.3-centimeter [about 1- by 1.3-in]) computer monitoring screen that displays the image as seen through the lens (Kodak 1999a). With through-the-lens systems, the image is viewed exactly as it will appear. There is no parallax correction and the image will look fuzzy when out of focus. The SLR cameras are more expensive. Viewfinders are parallel with the lens, and there is an outlined box in the viewer (parallax correction) to show what the image will cover when pictures are taken at close range. The image always will appear sharp.

Both film and digital cameras provide for a strobe flash system. Less expensive cameras often have built-in flash that fires straight ahead and is effective up to 9 feet (3 m) for low-light conditions and as fill-in light for up to 16 feet (5 m). More expensive cameras provide a hot shoe to which a more powerful and adjustable flash system can be attached. Additional flash systems add cost to the camera. Some cameras have both an internal flash and a hot shoe.

Zoom lenses have become popular, particularly with the “point-and-shoot” automatic cameras. They are common on many digital cameras. These lenses add flexibility to the camera, but they tend to be less sharp than a fixed lens. Zoom lenses may pose problems in photo monitoring because lenses need to be carefully set to reproduce the original image. This is difficult, if not impossible, with zoom lenses that might range, for example, from 35mm to 100mm focal length for a 35mm film camera and 9.2mm to 28mm for a digital camera. This allows for a threefold difference in photo coverage. See the section on camera format (below) for details.

The lens speed on film cameras is given in f-stops. The “f” indicates how large a hole is open to admit light into the camera. Small f-stops admit much light and large f-stops admit little. For example, under a given light condition, f-8 might require 1/60 second exposure, but f-5.6 would require 1/120 second because it admits twice the light, and f-3.5 would require 1/250 second because it admits four times the light. The f-stop also influences depth of field. The length of in-focus distance increases with increasing f-stops. When a 35mm camera is focused at 30 feet (9 m), f-8 is sharp from 15 feet (4.5 m) to infinity, f-5.6 from 20 to 60 feet (6 to 18 m), and f-3.5 from 25 to 40 feet (7.6 to 12 m). Digital camera speed usually is provided by the processing unit in the camera computer, and faster speed costs more.

Resolution, the sharpness of the image, in film cameras is a function of (1) lens quality, providing that the camera was properly focused; and (2) graininess of the film as determined by an ISO rating. Cost of film between ISO 100 and 400 is not much, but good lenses (low f-stop such as 1.8) are expensive. Film speed, the light required for an exposure, is characterized by an ISO rating. The graininess of an image also is a product of film speed—larger grain with faster film. Common ISO ratings are 100 for medium speed and relatively fine-grained film, ISO 200, which can be shot at twice the shutter speed and has medium graininess, and ISO 400, which can be shot at four times the shutter speed of ISO 100 but is rather coarse grained.

With digital cameras, resolution is determined by maximum dots per inch (dpi) of the camera. Each image is characterized by dpi across the width and a vertical dpi, such as 1200 by 900 dpi for a total of 1,080,000 dpi, which is referred to as 1.1 megapixels (a pixel is one dot). Digital camera equivalents for film ISO ratings are about 1640 by 1460 dpi for ISO 400 (2.4-megapixel camera), 1960 by 1640 dpi for ISO 200 (3.2-megapixel camera), and 2280 by 1800 dpi for ISO 100 (4.1-megapixel camera). To determine the camera rating, multiply the two pixel numbers: $1200 \times 900 = 1.1$ megapixels.

As of January 2001, most digital cameras started at about 1.1 megapixels, suitable for 4- by 6-inch (10- by 15-cm) snapshots, and went up to 4.4 megapixels appropriate for 14- by 17-inch (35- by 42-cm) pictures. A 2.4-megapixel camera or higher is required for grid analysis (film speed of ISO 400 or less). Resolution also is enhanced by good quality optical lenses. Most digital cameras offer a choice of three to five resolution levels. For example, a 1.1-megapixel camera might offer its best at 1200 X 900 dpi, midresolution at 900 X 700, and lowest at 600 X 400 dpi. Finer resolution results in fewer images on a digital memory card and slower processing. Quality also is influenced by the kind of compression, if any, used to store the image. Compression permits more images to be placed on a memory card.

Film and digital concepts—The digital camera could be considered a special purpose computer designed to take photographs (Kodak 1999b). This dramatically separates it from a film camera, which physically captures images on a role of film. The images cannot be altered on the film, but they may be altered in the printing process. Digital images are captured on an electronic storage or memory card, which must be processed to produce an image. A digital image can be altered by

the camera through different settings. Images are made up of dots called pixels, each composed of three colors: red, green, and blue; intensity of each color can be adjusted. Film and digital storage cards are discussed in the next section.

A camera using slide film exposes an image on film—**period**. Once the exposure is made, there is no recourse through correction. With black-and-white and color negative films there is some recourse through changing print exposure time, selection of paper, and dodging or burning items to be enhanced.

With digital cameras, the image is only one link in the chain to a photograph (Kodak 1999a). This chain is (1) the camera with its dpi, or pixel resolution, lens quality that captures the image, and the camera's ability to modify pixel characteristics; (2) the CPU (the computer) that processes the image with its ability to make major changes in the pixels and thus the image; (3) the monitor with its color projection of the image on the screen, which is used as a basis for changing the image characteristics; and (4) the output device, which either prints the image (printer) or projects it (projector). Resolution (dpi), color quality, and contrast are affected at the camera, CPU, and output device. Best image quality is attained by matching the camera resolution with that of the output device. They may **not** be the same.

Output (a picture) differs between film and digital cameras. Prints are similar because they are an image printed on paper. Prints from color film, black-and-white film, and digital images all share the same end result—a picture one can hold in their hand or mount on a monitoring form.

In contrast, slides made from film and digital images share few common traits. A film image is determined at exposure and can be projected with a slide projector in presentations. A digital image cannot. Generally, the digital image must first be downloaded from the camera and placed into the memory of a laptop computer. Then the laptop must be connected to a digital slide projector for presentation. Recently, cameras have been programmed for download directly to a projector; however, this projects only images in the camera. It does not provide for a presentation using title, data, and instructional images.

Camera focal length—Photo monitoring is greatly facilitated by using the **same** focal length lens for all repeat photos. Use of the same focal length is highly desirable but not essential (Rogers and others 1983). If the same focal length is used, subsequent pictures can be compared side by side. If different focal lengths are used, pictures must be adjusted in size to be compared, which will be discussed in “Camera Format and Distance to Photo Point,” below. Conversion from film to digital cameras usually will result in a change of focal length, because the digital camera must be adjusted to match the film camera lens. Digital camera adjustment often is not precise enough to exactly equal the film camera; for example, setting it at 13mm to copy a 50mm lens. Nothing can be done with slides taken at different focal lengths.

Recommendation—Specify the make and focal length of camera(s) to use in the monitoring.



Figure 29—A system for combining color and black-and-white photography. Both cameras are connected by strap aluminum 1/8 inch thick and 1 inch wide bent into a “U” with holes drilled for mounting screws to connect the cameras (see app. B for details). The cameras operate independently. Identical cameras simplify the photography because all control settings are adjusted in the same way, which helps in avoiding mistakes. Shown here are cameras with black-and-white film at 400 ISO and color film at 200 ISO.

Double camera system—My photography over the last 45 years used a pair of good quality 35mm SLR cameras and 50mm lenses (about \$500.00 each at 2001 prices), one for color and the other for black-and-white film. When both color and black-and-white photographs are to be taken, consider the camera system shown in figure 29. Both cameras are the same make and model to simplify adjustment for lighting and distance. Appendix B has details for constructing the apparatus.

Film and Digital Memory Cards

There are four ways to record images: (1) color slides, (2) color prints, (3) black-and-white prints, and (4) digital. Digital cameras are color and do not use film but, rather, memory cards.

Film—If film is used, both color and black and white are recommended because color film, slide or print, will fade with time and black and white will not. Once an exposure has been made on slide film, nothing can be done to enhance the image. Negative films, for either color or black-and-white prints, offer an opportunity to modify images in the print-making process. Different printing papers may be used, time of exposure can be adjusted, and overexposed or underexposed parts may be “dodged” or “burned” to enhance the image. Similar treatment, by computer manipulation, is available for digital images. But a word of caution, digital images can be so dramatically altered that they may not be admitted in a court of law.

Film comes in various degrees of graininess. This is roughly identified by film speed: the higher the speed, the grainier the film. For example, ISO 100 is relatively fine-grain film whereas ISO 400 is quite grainy. Digital camera equivalents are 4.1 megapixels compared to 2.4 megapixels. Determination of change between photos depends on the precision of measurement that can be made on a photo. Graininess limits precision.

Color rendition of vegetation is influenced by film chemistry. Tones can differ between brands from a single manufacturer, such as Kodak’s Kodachrome compared to Ektachrome, and between manufacturers, such as Fuji and Kodak. Film developing may produce different tones from the same kind of film. Color prints from the same negative can differ depending on how the prints were made. Time of exposure and kind of paper are critical. Subtle changes in green as the season progresses might not be captured from one year to another or from one kind of film to another.

Processing of film will influence how well photos can be compared. Most film is sent to a commercial processor where either slides are produced or pictures at a standard size are printed, such as 3 by 5 or 4 by 6-inch (7.5 by 12.5 or 10 by 15 cm). Quality of processing differs. Do not cheapen your product by cutting costs and quality at the final step (Johnson 1991).

Digital memory cards—Digital cameras do not use film but, rather, electronic memory cards (Kodak 1999a). Unlike film, memory cards do not have to be developed; they are processed by computer. Any or all images can be erased and the card reused. The color quality, contrast, and depth can be manipulated. Selected images or all of them can be copied from a memory card to another media, which greatly facilitates their storage and retrieval.

Different makes of cameras use different memory cards. Memory cards come in several configurations: Compact Flash and Smart Media are about half the size of a credit card and about as thick. Some cameras use a 1.44-megabyte floppy (3.5-inch diameter) and others use a 140-megabyte Super Disc floppy.

Memory cards differ in their megabyte capacity. Smart Media offers 2 to 64 megabytes and Compact Flash 2 to 160 megabytes. Many digital cameras are sold with an 8-megabyte card, but larger capacities are usable. Megabyte capacity directly limits the number of images that can be stored. A general conversion from number of pixels in an image to number of images per storage card is a 1:1.2 ratio: a 1-megapixel photo requires about 1.2 megabytes of storage card capacity. For example, an image at 1200 X 900 pixels (1.1 megapixels) would require an entire 2-megabyte card, or 29 photos could be placed on a 32-megabyte card. The same 32-megabyte card would hold 51 photos at 900 X 700 pixels (0.63 megapixels) from a camera's lower pixel setting.

Digital memory cards can be reused. The deleted images, of course, are lost.

Processing memory cards is quite different from film. There are two alternatives: commercial or home processing. Commercial means the memory card is sent to a digital processing laboratory for prints similar to film. Home processing requires use of a CPU with a download system from the camera and a printer. For best image quality, the dpi of the camera and printer should be compatible. Image quality is sacrificed if the printer cannot process the dpi of the camera. And image quality may be sacrificed by color rendition of the printer.

Digital images may be stored in any of three ways: (1) in the memory card used with the camera, (2) by being transferred to a compact disk (CD) or zip disc and the memory card reused, or (3) by being transferred to a computer hard drive with essential information in its file and the memory card reused. If images are stored in a computer, assure that instructions for locating the folder or file are placed in the photo monitoring filing system. Disks should be placed in the monitoring file (see "Filing System" below).

Color prints from film and digital systems are similar in cost; however, slides made from digital memory cards tend to cost more. A negative must be made at about \$5.50 and from it the slide for another \$2.25, for a total of about \$7.75 each. And the need for two steps, from card to negative and from negative to slide, tends to reduce quality of the image.

Recommendation—Specify the brand, type of film, and ISO rating that will be used; for example Kodak Elite Chrome ISO 200 color slide film and TMAX ISO 400 black-and-white film.

Camera Format and Distance to Photo Point

Camera format is the combination of camera body image size and focal length of a lens. Format concepts apply to both film and digital cameras. Exact duplication of camera format is not of critical concern (Rogers and others 1983) when evaluating change in the subject photographed. Images may be enlarged or reduced to a constant area of coverage, printed, and compared.

Concept—With slide film, images taken with different camera formats will project differently on the screen. This is a major concern discussed by Magill (1989) in his analysis of change in campgrounds. He projected slides onto a screen with a grid and adjusted size of the image according to specified criteria prior to analysis.

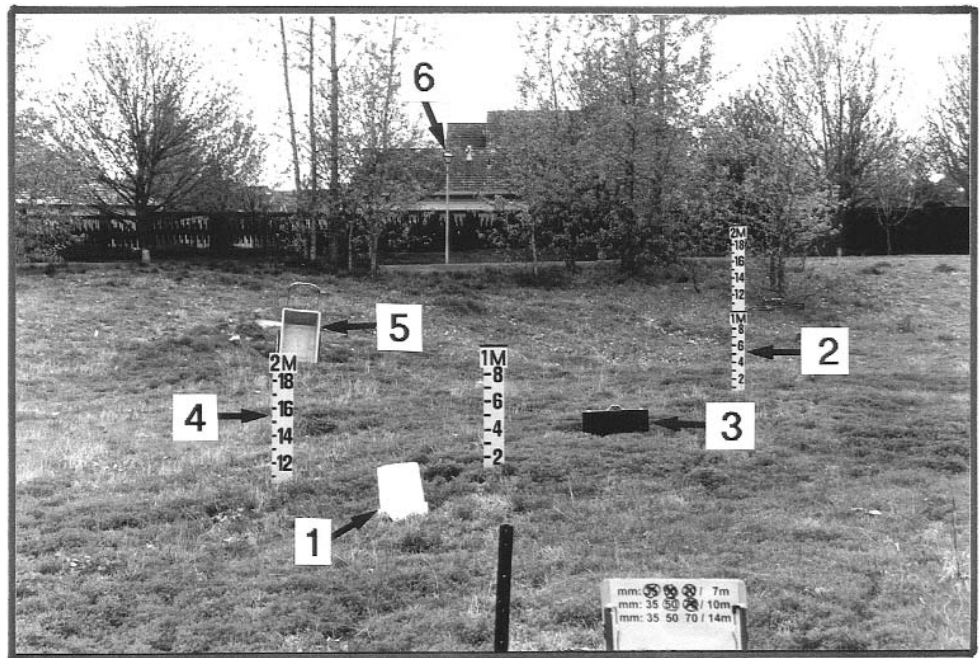


Figure 30—This landscape was used to test effects of camera format (focal length) and distance from camera to photo point (meter board) on determining size and location of objects. Camera format is 35mm image with two focal lengths: 35mm wide angle and 50mm standard. Distances are 23 and 33 feet (7 and 10 m) to the “1M” meter board. Numbered items are outlined and compared: (1) bucket between camera and the “1M” meter board; (2) double meter boards 23 feet (7 m) behind other “1M” meter board; (3) tool box; (4) top of 2-meter board parallel with the “1M” meter board, (5) cart 49 feet (15 m) from the “1M” meter board, (6) lamp pole 164 feet (50 m) from the “1M” meter board. Two situations are evaluated: (A) change both distance and focal length such that the meter board is the same size in both pictures (figs. 31 and 32), and (B) vary the camera focal length at a given distance (figs. 33 and 34). The fencepost at center front marks the 7-meter distance, and the photo identification sheet lists the focal length and distance to identify the negative.

Some examples of common film camera formats that cover about the same area of a landscape are (1) 25- by 35-millimeter (1- by 1.5-in) image size (35mm camera) using a 50mm focal length lens, (2) 2- by 2-inch (50- by 50-mm) image size using a 70mm lens, or (3) a 4- by 5-inch (100- by 125-mm) image using a 128mm lens. All are equivalent to a digital camera at 13mm focal length.

The advent of good quality zoom lenses permits a great variety of camera formats, but zoom lenses have both desirable and undesirable features. A desirable feature is increased flexibility in choosing photographic formats without the need to change lenses. Undesirable features include higher f-stops and no constant focal length when rephotographing monitoring sequences.

Testing in a landscape—The effects of camera format and distance from camera to photo point are shown and discussed in figures 30 through 34. Change in emphasis on a topic through distance is depicted in figure 16 in part A.

Figure 30 is a testing landscape where six objects were positioned, photographed, and outlined to compare their size and location with change in distance and focal length. I used two camera formats with a 35mm camera body; a 35mm wide angle

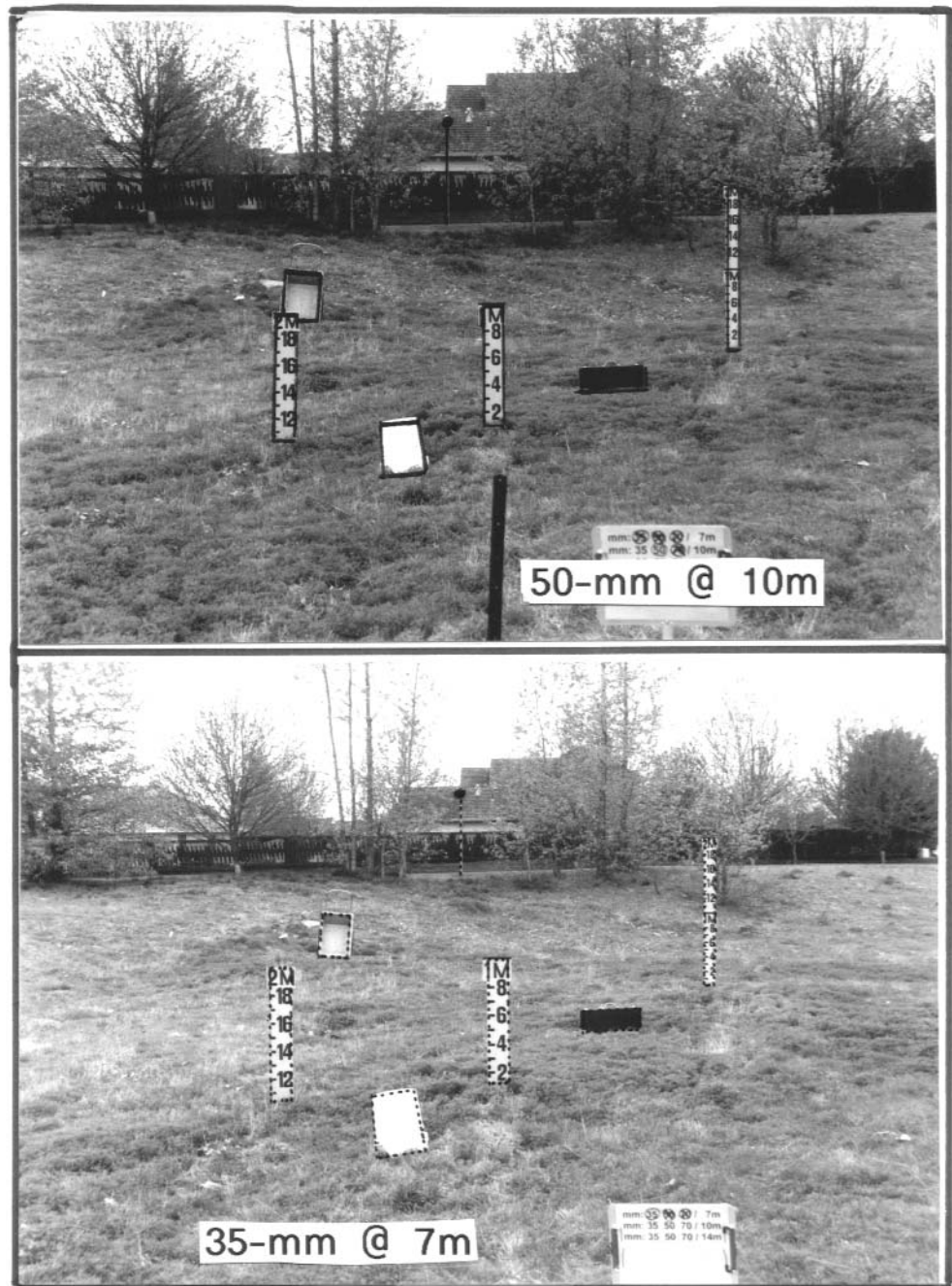


Figure 31—Both focal length and distance to meter board are adjusted to make the meter board the same size in each photograph: 50mm at 33 feet (10 m) and 35mm at 23 feet (7 m). Each of the six items have been outlined on clear plastic overlays as follows: 50mm at 10 meters in a solid line and 35mm at 7 meters in a dotted line. Note differences in backgrounds even though meter boards are the same size. Figure 32 compares the object outlines.

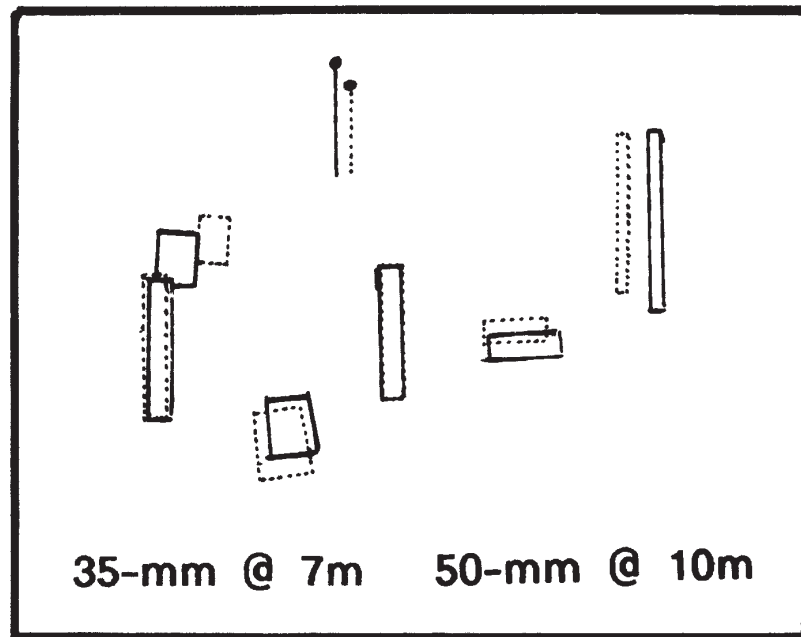


Figure 32—Object outlines from figure 31 overlaid to evaluate the effects of camera focal length and distance from camera to meter board on size and location of objects. The overlays for 35mm at 7 meters and 50mm at 10 meters show both different sizes and locations of objects even though the meter boards are the same size. This is because geometric angles from camera to objects change as distance changes. If objects in photographs are to be measured for change, distance from camera to meter board must remain the same. This is further demonstrated in figures 33 and 34.

lens was compared to a 50mm normal lens as a standard for evaluation. They are equivalent to digital cameras of 9mm and 13mm. The focal lengths were used in conjunction with two distances from camera to meter board: 23 feet (7 m) compared to 33 feet (10 m). Figure 30 illustrates the 50mm lens on a 35mm camera.

Camera format and distance—Both camera format and distance to meter board were adjusted in figure 31 to photograph the meter board at a constant size. The 35mm lens at 23 feet (7 m), dotted outline, gave the same size meter board as 50mm at 33 feet (10 m), solid outline. But note the different backgrounds. Comparison of object outlines in figure 32 shows that all objects are different in both size and location except the meter board. They are different because geometric angles between the camera and objects changed as distance varied from 10 to 7 meters.

Next, focal lengths of 35mm and 50mm were used at a distance of 33 feet (10 m), illustrated in figures 33 and 34. Figure 33 appears to show very different scenes. They are different in what is included within each photo. But when the 35mm image (dotted outline) was enlarged to size the meter board to be equivalent to that taken

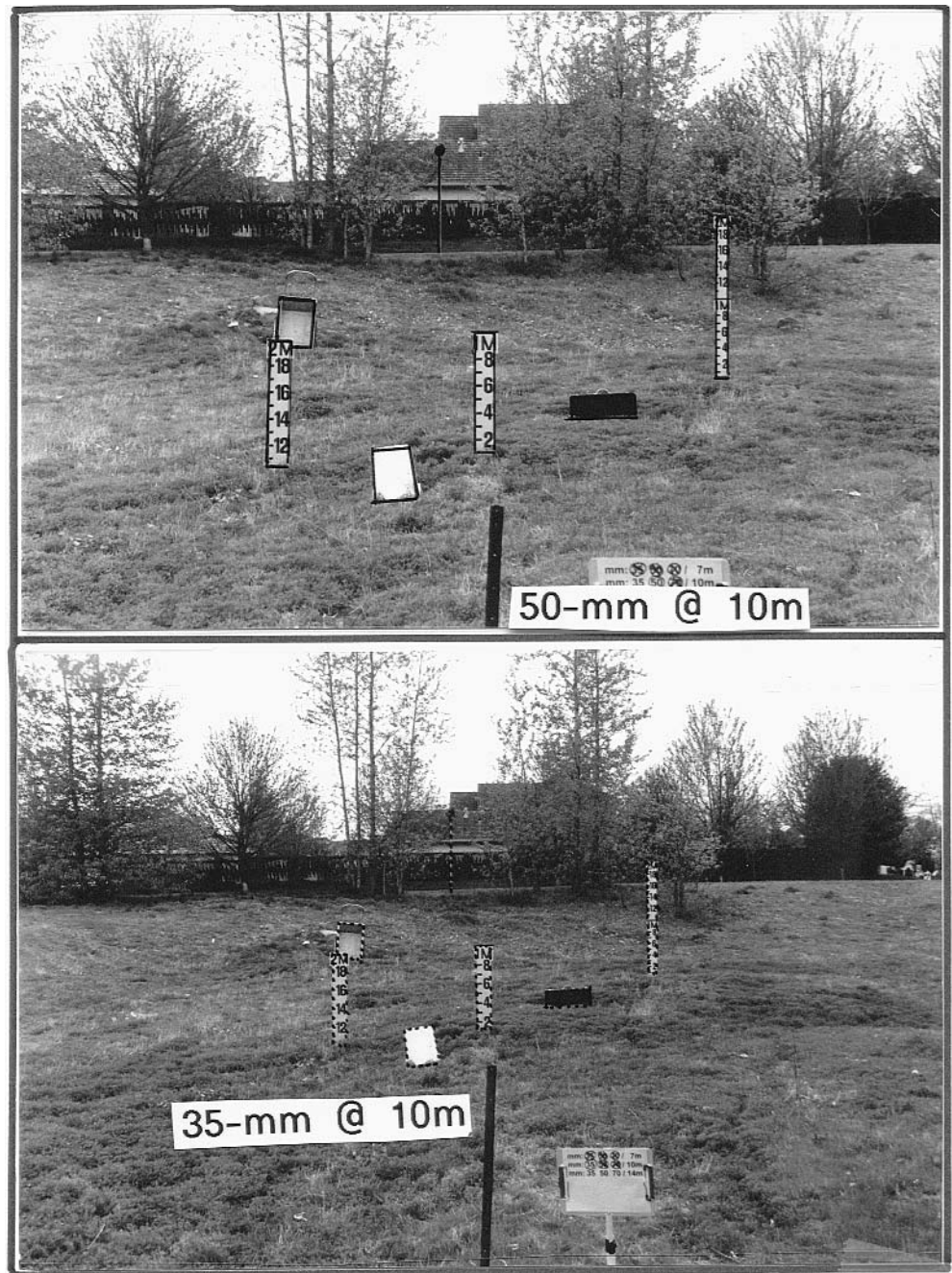


Figure 33—Effects of change in camera focal length of 50mm and 35mm at 10-meter distance from camera to the “1M” meter board. Objects in each photograph were outlined on clear plastic overlays and adjusted in size to the 50mm at 10 meter board as follows: the 50mm at 10 meter “1M” board was measured at 20 millimeters and the 35mm at 10 meter “1M” board at 14 millimeters; the percentage of enlargement was calculated as $20 \div 14 = 143$ percent. The 35mm at 10-meter outline was enlarged 143 percent. They are compared in figure 34.

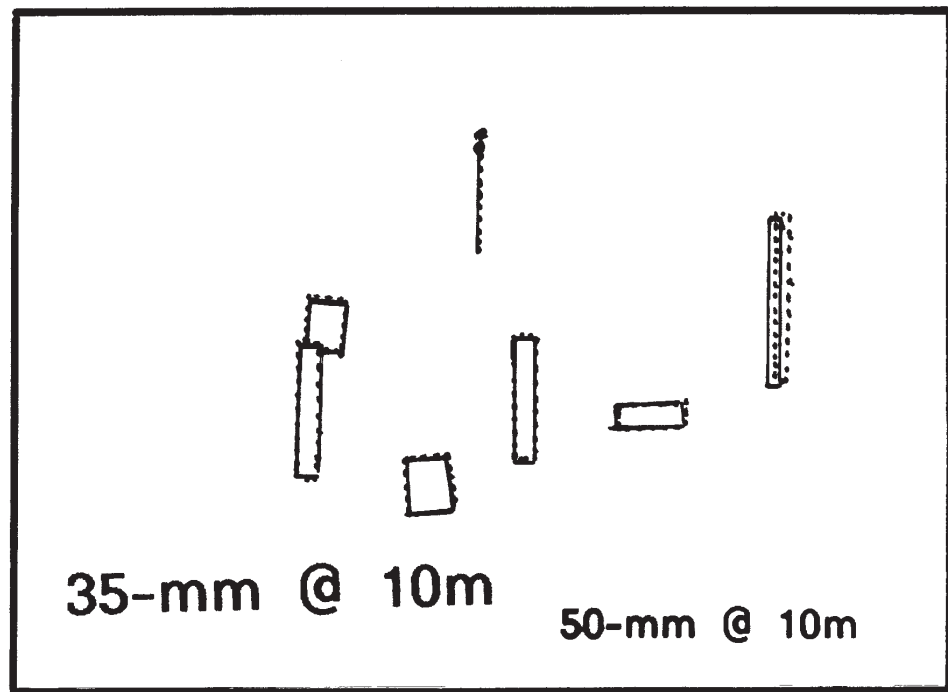


Figure 34—Object outlines for 35mm and 50mm camera focal lengths taken at 10 meters from the “1M” meter board (from fig. 33). Overlaying the enlarged 35mm on the 50mm shows little difference in object size or location. Camera focal length may differ without affecting analysis of photographic items when images are adjusted to a common size meter board. Comparison with figures 31 and 32 clearly demonstrates that distance from camera to meter board must remain the same.

at 50mm (shown in figure 34; solid outline), each object is almost exactly the same size and location. This effect is what Rogers and others (1983) discuss. Figures 31 through 34 clearly indicate that distance from camera to meter board is critical, whereas focal length is not.

Weather

How does current weather compare to conditions of previous photographs (Magill 1989, Maxwell and Ward 1980)? A dense, heavy cloud layer will produce different colors and tones compared to a high, thin overcast, which in turn will be different from full sunlight with attendant deep shadows. Maxwell and Ward (1980) suggest overcast skies to reduce shadows and taking at least three different exposures to achieve comparable color between photos.

Photo Grid Analysis

To quantify changes in vegetation, soil, fuel loading, streambanks, or other photographic topics, outline the selected topic on a clear plastic sheet. Then place a grid under the sheet. Count grid intersects falling on and within the outline, and record. Compare these to counts from previous photographs of the same topic to estimate change. Each plastic sheet with its outlines and associated counts is a set of data and must be identified clearly and then archived.



Figure 35—A 1981 view of the Pole Camp wet meadow photo point, which will be used to illustrate grid analysis. This photograph will be compared to one from 1996. The first step is to attach a clear plastic outline form (shown in fig. 36). Fill in the required site information and outline the shrubs (fig. 37).

An alternative method is digital analysis by computer. The computer cannot differentiate between pixels on the topic and those behind the topic that are of similar color (fig. 35). A plain colored backdrop is needed behind the topic (Reynolds 1999).

Concept

Grid analysis is based on standardized geometric relations between photograph, camera, and meter board. Having the same focal length lens, distance from lens to meter board, height of camera above the ground, and photograph size simplify the analysis. A set distance between camera and meter board for the initial and all subsequent photographs of a specific topic is a **must**. Different distances may be used for different topics (fig. 16 in part A). A standard camera height is desirable, but it is not essential unless the grid is used to track change in position of items over time, a tenuous procedure. Use of the same camera format, such as 50mm lens on a 35mm camera body is recommended but not required. Grids are designed to encompass a view limited to 13 to 15 degrees both horizontally and vertically. This limit is emphasized by heavy lines surrounding the grid see (fig. 39, below).

Obtain a color 8- by 12-inch (20- by 30-cm) photograph of the topic (see fig. 35), for easy viewing. Attach to the photograph a clear plastic sheet with the form “Grid Intersect Analysis” printed on it, for information on date, site location, and topic (fig. 36). This is used to outline objects. Then measure the meter board to calibrate the grid (distance between grid points and area of grid cells). Use a copy machine to precisely adjust grid cells to match the dimensions of the meter board: each grid cell

		GRID INTERSECT ANALYSIS		Area
Date				Unit
Observer				
Cluster/Camera			Transect/Photo	

Figure 36—Form used to identify photographic outlines. Print the form on clear plastic overhead projection sheets. This form has been reduced to 85 percent of the size in appendix A. The full sized form is suitable for 8- by 12-inch color photographs. Use of the clear plastic overlay is illustrated in figure 37.

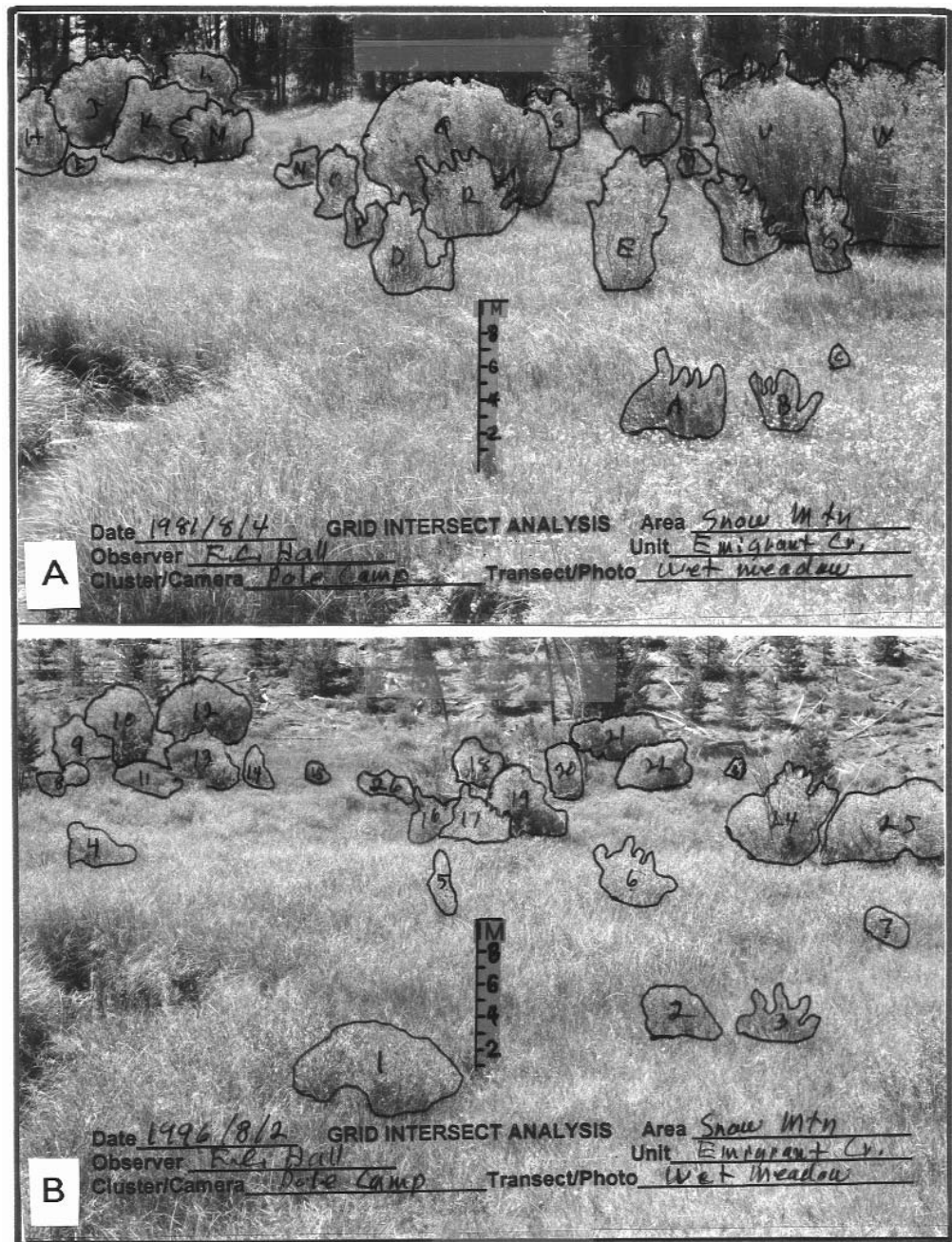


Figure 37—Photographs to be evaluated by grid analysis: (A) 1981 (from fig. 35), and (B) 15 years later in 1996. Clear plastic overlays (fig. 36) have been taped to each photo. Each overlay is a data sheet and therefore must have all information entered to identify the outlines. Date is the **photograph** date, not when the outline was drawn. First the meter board is outlined on its left side and top. Then each visible decimeter line on the meter board is marked and the decimeter number written on the overlay. Finally, each shrub is carefully outlined and given either a letter or number identification. The next step is size adjustment of the analysis grid (figs. 38 and 39).

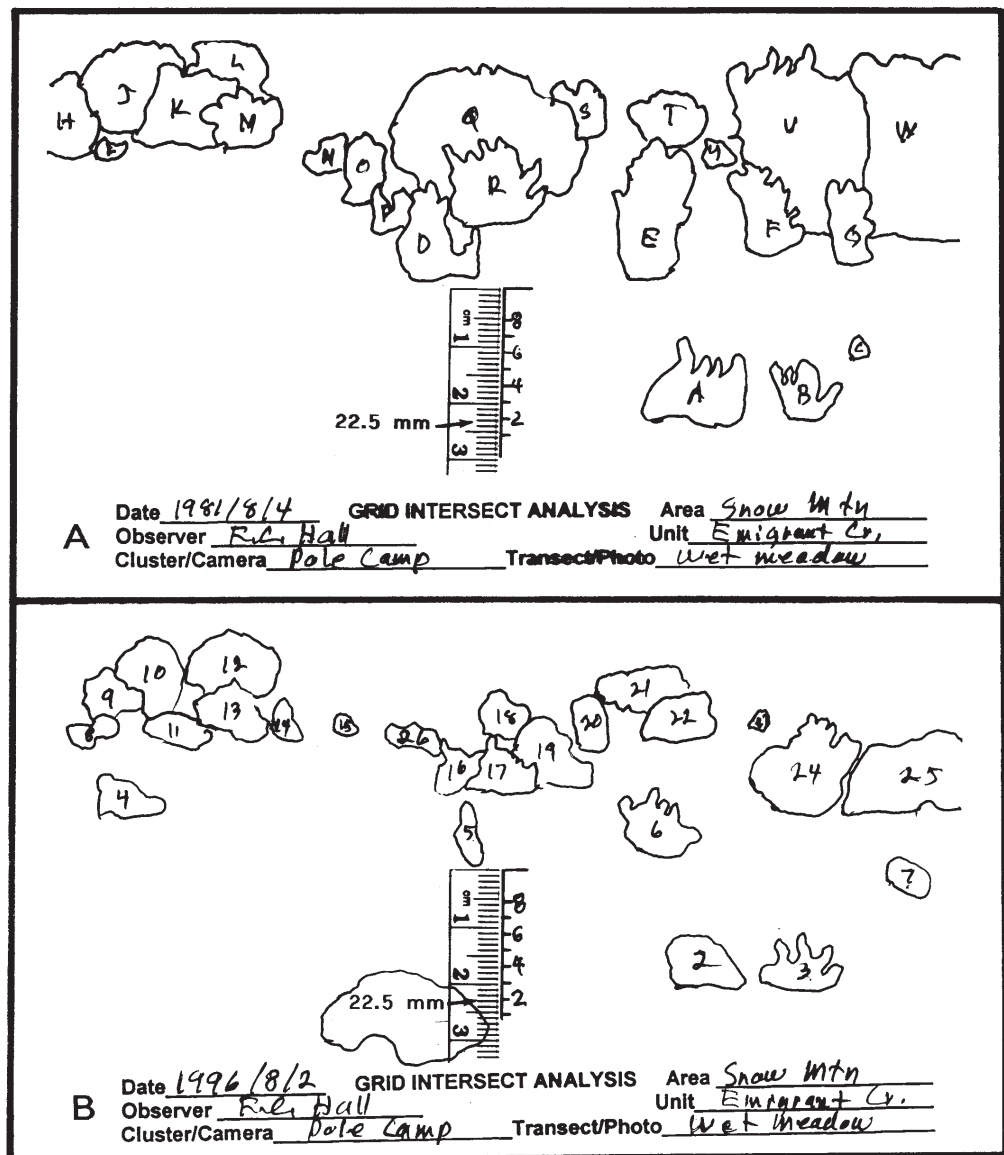


Figure 38—Measure meter boards for size adjustment of analysis grids: (A) 1981 and (B) 1996. Measure from the top down to the lowest visible decimeter mark to the nearest 0.5 millimeter, in these photos the 2-decimeter mark. Both measurements are 22.5 millimeters, which indicates that both are the same distance from camera to board and there was consistent enlargement of the photos. The analysis grid (fig. 39) will have to be reduced in size to exactly match the size of the meter boards in these outlines. An exact match is required for consistency in measurement between photographs.

should span 4 inch (1 dm) on the meter board. Print the adjusted grid on white paper. Outline the meter board and topics of interest in the photo on the clear plastic (fig. 37). For precise grid calibration, the meter board height should be at least 25 percent of the photograph height, preferably 35 to 50 percent. Each individual picture must be measured for grid adjustment. Tape the outline form onto the grid, carefully match the outline meter board with that on the grid, and count grid intersects that fall on and within each outlined topic.

Setting the Stage

Photography suitable for grid analysis includes the following:

1. Camera location and photo point (meter board) must be permanently marked so that exact relocation is possible. Stamped metal fenceposts driven 2 feet (0.6 m) into the ground work well.
2. Choose a distance from 16 to 65 feet (5 to 20 m), appropriate to the topic, for each site. Place a size control board (a 1-meter board or a double, 2-meter board; see figs. 21 and 35 in part A) such that the visible part of the board occupies at least 25 percent of the picture height. Then the meter board can be used to orient the photograph and adjust size of an analysis grid.

With a 50mm lens on a 35mm camera, a single meter board set 33 feet (10 m) from the photo point would span 25 percent of the photo height (figs. 31 and 33); at 23 feet (7 m), 36 percent. A double meter board, 7 feet (2 m) tall (app. B), spans 25 percent of photo height at 66 feet (20 m).

When grid analysis is planned, clip vegetation away from the front of the meter board to expose the bottom decimeter line. This will provide for maximum precision in grid adjustment.

3. When photographing, aim the camera view at the meter board. Place the ring in the viewfinder on the "1M" and focus (fig. 18 in part A). This provides for (1) reorientation of all subsequent photographs, (2) a sharp image at the topic marked by the meter board, and (3) an optimum depth of field.

Materials

Materials and equipment required for grid analysis are as follows:

1. Photographs of the setting. Print all photographs to be compared at the same size, preferably about 8 by 12 inches (20 x 30 cm), and in color for best differentiation of items to analyze. Figure 35, for example, is the wet meadow photo point at Pole Camp as taken in 1981. It will be compared to a photo taken in 1996 to appraise change in shrub profile area (fig. 37).
2. Clear plastic sheets used for overhead projection, such as 3M or Labelon Overhead Transparency Film. Film is designed specifically for various copy machines, such as inkjet, plain paper, or laser. Imprint these sheets with site information by using the form in figure 36 ("Grid Intersect Analysis") from appendix A.
3. A grid master form, which is shown in figure 39 (form is in app. A). Adjust the grid in size to precisely fit each picture and the outlined meter board as shown in figure 39. Instructions for grid size adjustment are given below.
4. Photo Grid Summary form (fig. 41 and app. A).
5. Permanent markers, such as Sanfords Sharpie Ultra Fine Point Permanent Marker, for drawing on clear plastic. Use different colors to aid in differentiating items when their outlines overlap, figures 38 and 40. Black, red, and blue work well together.

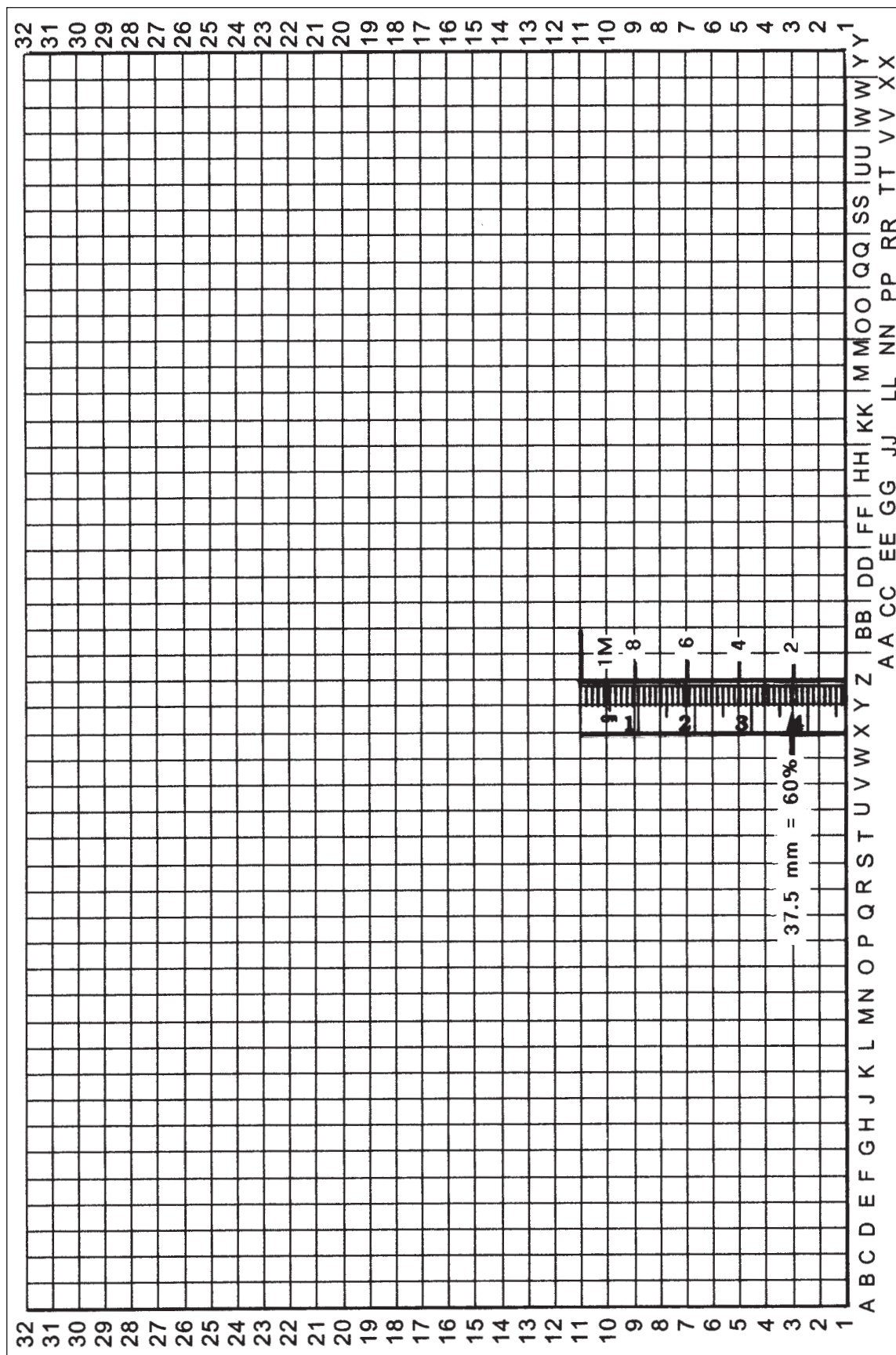


Figure 39—The master analysis grid is in appendix A. Measure from the top of the meter board to the 2-decimeter mark used in the outlines. This measurement is 37.5 millimeters. Divide 22.5 millimeters from the outlines in figure 38 by 37.5 for a reduction to 60 percent of the grid. Print the grid on white paper at 60 percent of its original size. The outline is laid over the reduced grid to check alignment of the meter board marks. Minor adjustments in grid size are made so that marks of the overlay and grid meter boards match exactly (fig. 40).

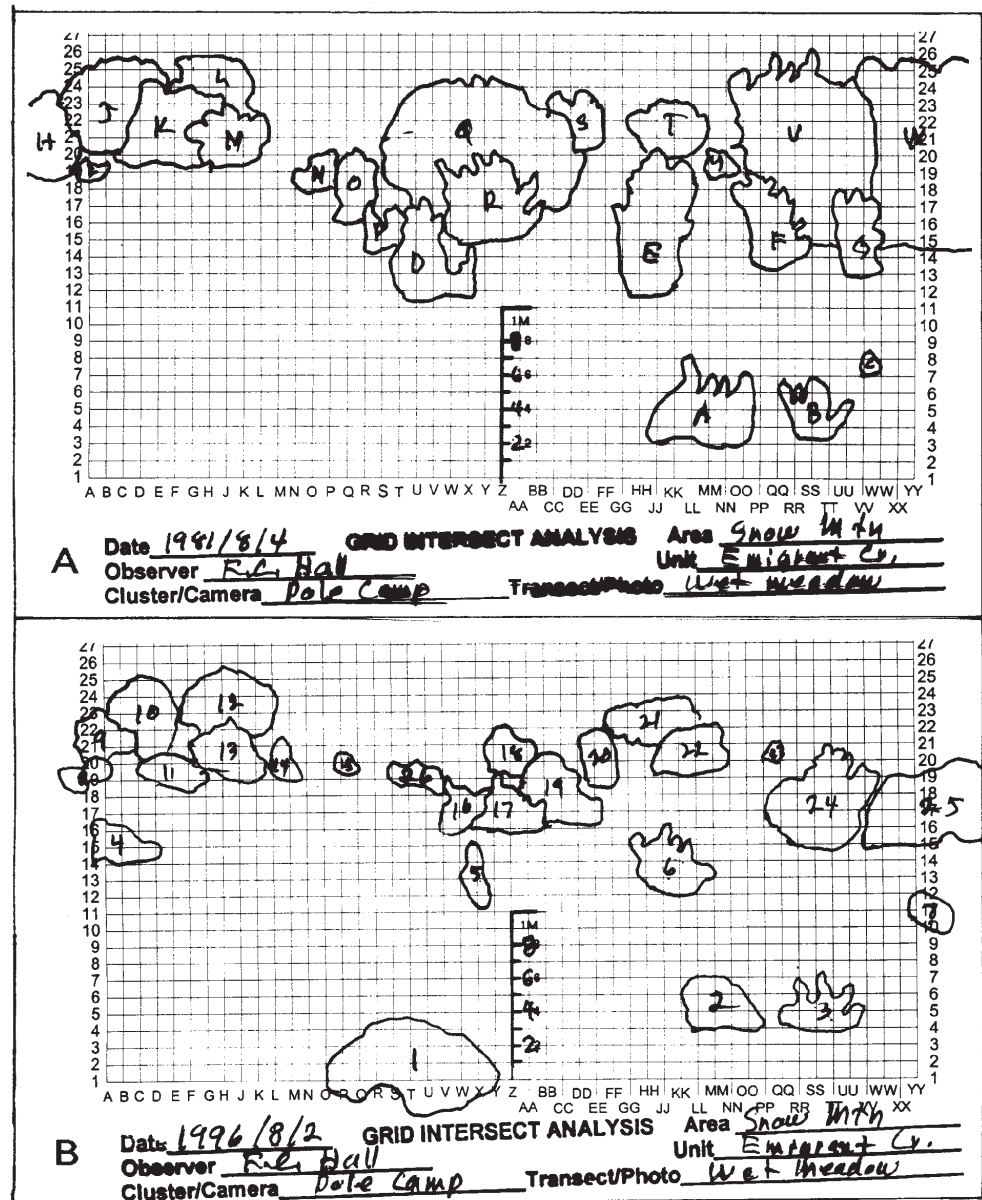


Figure 40—Outline overlays are placed on analysis grids for (A) 1981 and (B) 1996. The next step is to count grid intersects on and within each outline. When an outline crosses a grid intersect, such as between shrubs 17 and 19, AA-18 in photo (B), count the intersect for the shrub in front (number 17). Also count intersects along the grid edge, such as the five intersects in shrub 25 on line YY, photo (B).

6. Good quality hand lens to identify the periphery of items being outlined, in this case shrub profiles.
7. A copy machine that will produce clear plastic overhead projection copies and can adjust the size of the master grid to fit the photographs. Many copy machines can reduce to 50 or enlarge to 200 percent. Tape one grid, adjusted for size and printed on white paper, under each outline for analysis (fig. 40). Precisely align the outline meter board with the grid meter board.

PHOTO GRID SUMMARY

Date 1996/8/4 Observer F. C. Hall
Area Snow Mtn Unit Emigrant Cr.
Cluster/Camera Pole camp Transect/Photo Wet meadow

[illegible]

$$\frac{259}{401} = 0.648 = 65\%$$

67

Grid Adjustment

Outline interpretation requires use of a grid whereby each grid intersection on and inside an outline is counted and recorded. The grid must be adjusted in size based on the meter board outlined on each overlay.

1. Measure height of the meter board as it appears on the overlay to the nearest 0.5 millimeter. If the bottom line on the board is not visible, measure to the lowest visible decimeter mark. In figure 38 it is 2 decimeters, and measures 22.5 millimeters from top to 2 decimeters. Similar measurements between the 1981 and 1996 photographs indicate that distance from camera to meter board was the same and that both pictures were enlarged identically.
2. Next, measure height of the meter board on the grid. In figure 39 it is 37.5 millimeters from top to the 2-decimeter grid line (second from the bottom).
3. Determine the percentage of change required for the master grid: $22.5 \div 37.5 = 60$ percent. On a copy machine, reduce the grid to 60 percent and print on plain paper. Overlay the outline on the grid to determine any additional size adjustment (fig. 40). This usually requires two or three trials.
4. Place the clear plastic overlay with its outlines on the grid and ensure that grid divisions exactly match those on the overlay meter board. Orient the overlay on the grid by using the left side of the meter board outlines (fig. 40). When both overlay and grid meter board marks match exactly, tape the overlay to the grid.

Note the borders on the grid (fig. 39). These mark the maximum 12- to 15-percent angle useful for grid analysis.

Analysis of Photographs

Select a topic—For this example, change in willow profile area is the topic, thus, no other item—grasses, sedges, forests, or water—is outlined. Decide if individual shrubs will be evaluated or if all shrubs will be lumped together. In this case, individual shrubs will be evaluated. Proceed as follows.

1. Fill out all information on the clear plastic overlay ("Grid Intersect Analysis," app. A). It becomes the permanent data record and must be identified (fig. 36). Date is the **photograph** date, not the date of the outline.
2. Attach the plastic overlay to the photo at one edge, such as the top, so that it can be lifted for close inspection of the photograph and then replaced exactly (fig. 37).
3. With use of a straight edge, mark the left side of the meter board and its top on the overlay of each photo (fig. 37). Next, mark each decimeter division on the meter board and identify even-numbered decimeter marks by their number, such as 2, 4, 6, and 8 (figs. 38 and 40).
4. Select the topic; for example, shrub profile area. Start in front and work from left to right. Outline each element of the topic (shrub in this case) and label it with a letter or number (fig. 37). Labeling ensures that grid intersects on and inside an outline are not repeated or missed when recording data.

If identifying change in specific shrubs is desirable, each shrub identified in the initial photo will have to be identified in all subsequent photos, and the letter or number used initially will have to remain exclusive to the shrub or to the location where the shrub used to be. Any new shrubs will require their own exclusive new identification, such as shrub 1 in figure 37B.

5. When outlining, pay particular attention to the periphery of the shrub by following as carefully as possible the foliage outline. Do not make a general line around the outside of the shrub. Mark directly **on** the foliage, not outside of it. Check outlines by lifting the overlay to check the foliage and inspect with the hand lens.
6. Work back into the photograph. Overlapping shrubs are identified by the letter inside the front shrub outline (fig. 37). Overlapping outlines may be enhanced by using different colored marking pens. Intersects often will occur under an outline; count them for the shrub in **front** only (do not count the intersect twice).

Do not count intersects on outlines outside the grid.

7. On the filing system form "Photo Grid Summary" (fig. 41), fill in the required information and enter the year of the photograph in the "Date" column. This is the date on the plastic outline. List shrubs by letter or number in the "Item #" column. The form provides space for recording intersects for three photographs. Note that items, shrubs in this case, are not required to have the same identification. Here, shrubs from 1981 are letters and those from 1997 are numbers, because exact relocation of shrubs was not possible.
8. Starting in front and working from left to right, count the number of grid intersects on and within each outline. An intersect is where a horizontal and vertical grid line meet (intersect). Many times, the outline will separate two shrubs. When the outline covers an intersect, count it for the shrub in front. Do **not** count the intersect twice. See figure 40A: intersect BB-18 is on shrub "R" outline with shrub "Q" behind it. Record the intersect only for shrub "R." This is why outlining **on** rather than outside of shrub foliage is important. Do not try to count intersects of the shrub behind when they cannot be seen; for example, in figure 40A, intersects of shrub "Q" behind shrub "R." Count intersects on the edge of the grid but not beyond even though the shrub or outline might extend beyond the grid. The grid, not the photo coverage, defines the area of analysis.
9. Record the intersects for each shrub beside its letter or number (fig. 41). Recording by shrub letter or number is designed to simplify record keeping. One may stop or be disturbed at any time and still know what shrubs they have recorded and where to begin again. When finished, sum all the intersects.

Important note—Each picture is produced by enlargement of a negative. Seldom are two enlargements made at exactly the same scale even though the negatives might be precisely sized. Therefore, grids must be sized **independently** for each photograph (fig. 37).

Table 1—Effect of camera-to-meter-board distance on grid coverage at distances of 10, 20, 30, and 60 meters (33, 66, 98, and 198 ft) from the camera

Distance from camera to meter board	Ratio	Angle	Grid size at distance from camera of:			
			10 m	20 m	30 m	60 m
<i>Meters</i>		<i>Percent</i>	<i>Decimeters</i>			
5	1:50	2.0	2.0	4.0	6.0	12.0
7	1:70	1.4	1.4	2.8	4.2	8.4
10	1:100	1.0	1.0	2.0	3.0	6.0

height. Grids 2.2 percent larger in height are also 2.2 percent wider, which results in a 4.4-percent increase in outlined area. Thus the number of intersects on and within an outline can change by 4.4 percent.

A meter board occupying 33 percent of photo height would measure 1.2 inches (30 mm) in figure 38. A 0.02-inch (0.5-mm) difference here is only 1.7 percent change in grid size. The 1.7 and 2.2 percent represent measurement-precision errors.

Distance from camera to meter board also affects precision of measurement on items beyond the meter board. Table 1 illustrates the effects of three distances between camera and meter board and how they affect grid precision at various distances beyond the meter board. Because grids are adjusted to size at the meter board location, each grid is 4- by 4-inch (1 by 1 dm) in size at that location but changes as distances increase.

A grid adjusted to a meter board 16 feet (5 m) from the camera measures 8 inch (2 dm) between grid lines at 33 feet (10 m) from the camera. This is two times greater than a grid adjusted at 33 feet (10 m) from the camera. At 98 feet (30 m) from the camera, a grid adjusted to a board 16 feet (5 m) from the camera will cover an area 24 by 24 inches (6 by 6 dm). When adjusted to a meter board set 33 feet (10 m) from the camera, it will cover an area only 12 by 12 inches (3 by 3 dm)—one-half the dimensions and one-quarter of the area—a significant improvement in precision. Monitoring objectives help determine the optimum distance from camera to meter board when grid size adjustment and outline precision are being balanced.

Observer variability—“Perfect” outlines are influenced by three kinds of differences among observers.

1. Size adjustment of grids is influenced by observer skill. With a meter board at 25 percent of photo height, 0.02-inch (0.5-mm) measurement difference of the meter board can mean as much as 2.2 percent difference in grid dimensions and 4.4 percent difference in area. Meter boards closer to 33 percent of photo height and larger photographs help to reduce this error. I recommend 8- by 12-inch (20- by 30-cm) color photographs. A meter board at 33 percent of an 8- by 10-inch photo height would measure about 2.6 inches (66 mm). A 0.02-inch (0.5-mm) measurement difference would be only a 0.8-percent error.

Shrub	FCH	CE	DE	SE	MR	CQ	MN	Mean	Std.Dev.	5% CI	CI%Mean
A	10	9	12	8	13	8	7	9.571429	2.22539	0.8242813	8.611894322
B	4	3	5	2	4	3	2	3.285714	1.1126973	0.8242813	25.08682259
C	6	5	6	5	5	4	3	4.857143	1.069045	0.7919439	16.30472673
D	3	3	7	2	10	4	1	4.285714	3.1471832	2.3314196	54.39979127
E	22	13	26	22	23	17	15	19.71429	4.7509398	3.5194755	17.85241217
F	28	24	28	25	32	21	19	25.28571	4.4614753	3.3050415	13.07078572
G	17	12	18	14	19	15	11	15.14286	3.0237158	2.2399555	14.79215911
H	24	23	26	22	26	24	22	23.85714	1.6761634	1.2416946	5.204707832
J	30	23	26	24	30	25	21	25.57143	3.4086724	2.5251297	9.874808968
K	23	24	28	13	34	13	21	22.28571	7.6095178	5.6370978	25.29466952
L	86	81	79	91	82	81	77	82.42857	4.6853368	3.4708772	4.210769515
M	65	58	59	72	43	68	56	60.14286	9.5118973	7.0463722	11.71605833
N	6	6	5	6	6	6	5	5.714286	0.48795	0.3614713	6.325747193
O	7	4	5	4	6	5	5	5.142857	1.069045	0.7919439	15.39890858
P	14	14	14	12	16	13	13	13.71429	1.2535663	0.9286365	6.771307827
Q	9	12	11	11	7	14	9	10.42857	2.2990681	1.7031397	16.33147648
R	17	16	20	14	18	9	15	15.57143	3.5050983	2.5965616	16.67516637
S	24	23	22	16	22	24	21	21.71429	2.75162	2.0383881	9.387313837
TOTAL	395	353	397	363	396	354	323	368.7143	28.347335	20.999583	5.695353784
								MEAN	3.2249101	2.3432062	15.4060848

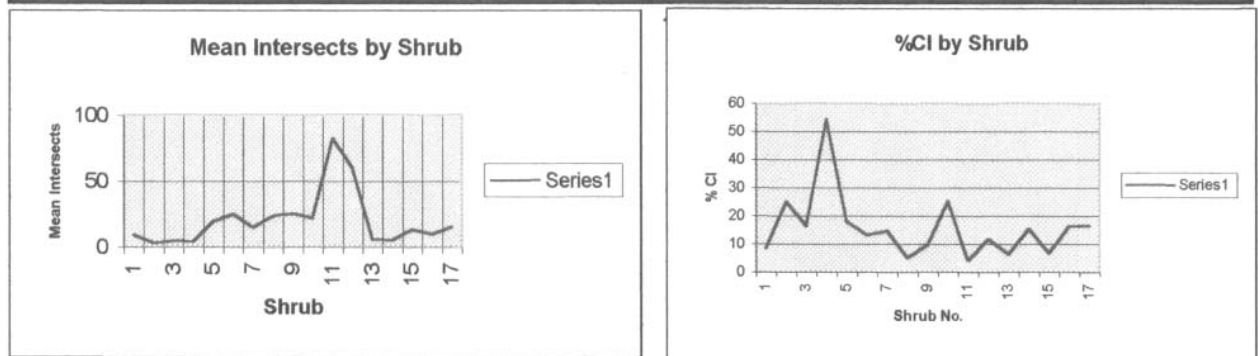


Figure 43—Summary of seven observers determining grid intersects on 18 shrubs in the same photograph. Variation among observers is characterized by the 5-percent confidence interval (5%CI) and expressed by dividing the 5%CI by the mean intersects by shrub and multiplying by 100 (CI%Mean). The mean and CI% Mean are graphed by shrub below the summary data.

2. The grid must be oriented exactly along the left side of the meter board as viewed (that is, the observer's left side) and precisely at the top and bottom or lowest clear decimeter mark. Orienting precision is subject to observer skill.
3. Interpretation of what constitutes the periphery of a shrub profile is subject to observer variability. One must make choices about where to place an outline and how precise it will be, particularly on overlapping shrubs. Note that an intersect is counted if the outline crosses it. The desirability, good or bad, of the topic being outlined tends to influence a person's willingness to include or exclude marginal parts. Outlining on clear plastic without grid lines tends to reduce observer bias.

A test was made in January 1998 of observer variability in outlining the shrub profile area shown in figures 35 and 37A. Results of the seven observers are given in figure 43. Color prints, 6 by 9 inches (15 by 22 cm) with properly sized grids, were provided. Observers placed the grids, outlined shrubs, and summarized intersects

Outline Analysis - 2 photos, 99/3

Photo	FH1	FH2	EC	DR	DF	MN	SE	CQ	Mean	Std.Dev.	Cof.Var.	Max.	Min.	Range	% Range	5%CI	CI%mean
1975	376	364	394	473	386	330	359	393	384.38	41.59305	10.82096	394	330	64	0.1665041	28.8219	7.49839184
1995	201	241	255	232	208	152	263	196	218.5	36.53961	16.72293	263	152	111	0.5080092	25.3202	11.5881706

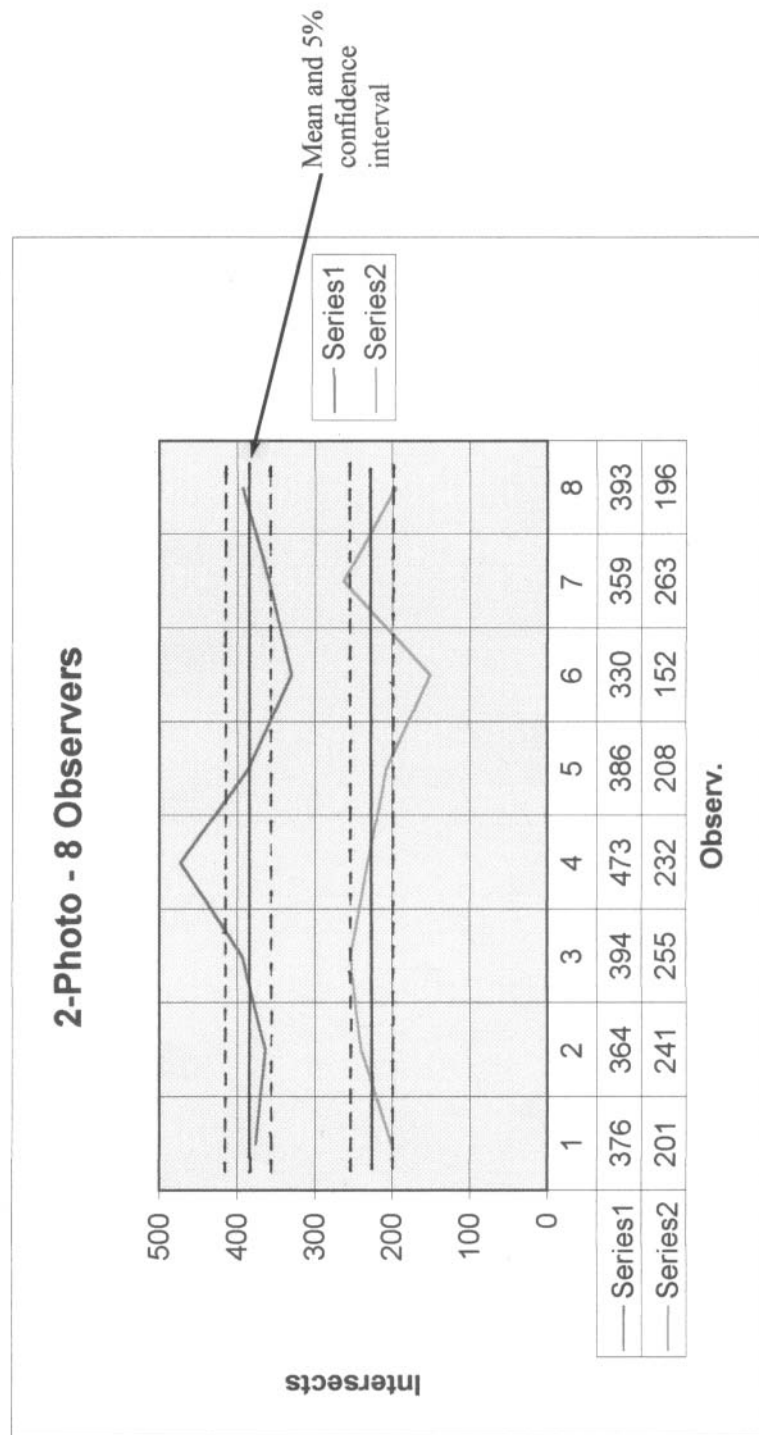


Figure 44—Outline analysis test for variation among eight observers in estimating shrub profile intersects. Photographs from 1975 (series 1) and 1995 (series 2) at the Pole Camp wet meadow photo point were compared. The 5%CI for 1995, 11.6 percent of the mean, is used to determine a significant change in shrub profile. FH1 and FH2 were observations by the same observer made 2 months apart to illustrate single-observer variability.

within each outline. Variation among observers was measured by the 5-percent confidence interval (CI). The CI also was calculated as a percentage of the mean: CI divided by the mean times 100 equals the CI% for each shrub, total of all shrub intersects, and an average CI. Low CI%, such as 5 percent (shrub H), is interpreted as low observer variability and that a change of more than 5 percent in intersects probably is a significant difference. High CI%, such as 25 percent (shrub B), means high observer variability and greater than 25 percent change is required.

The percentages for confidence intervals ranged from 4.2 percent (shrub L) to 54.4 percent (shrub D, fig. 43). The average CI% among the observers was 15.4 percent, which suggests that, to be significant, a change of more than 15 percent in intersects is required owing to observer variability. However, the CI% for total intersects of all shrubs combined was only 5.7 percent, indicating good concurrence between observers for the entire scene, a relation tested in 1999 and reported below.

The number of intersects in an outline seems to influence the CI%. Graphs at the bottom of figure 43 show higher CI% with lower intersects per shrub.

Differences in shrub profile area are rather clear in figures 41 and 42. Profile area in 1996 was 65 percent of that in 1981. Change in shrub profile is illustrated in figure 42. However, the reader may wish to test this for observer variability. Count the shrub profile intersects in figure 40 and compare to the data in figure 41.

Because CI% was rather high for individual shrubs, another observer variability test was conducted in winter 1999. Eight observers were provided with two photographs, one from 1975 and another from 1995, and asked to count total intersects of shrub profile. The CI% for 1975 was 7.5 percent and that for 1995 was 11.6 percent (fig. 44). The 1995 photo was more difficult to interpret.

The graphs in figure 44 illustrates the mean, 5-percent confidence interval, and observer variability by year. Using the largest CI%, 11.6 percent, the averages are significantly different at the 1-percent level of probability. Considering a maximum of 12-percent observer variability here and 15 percent for total individual shrubs, a value greater than 12 percent of the average intersects is proposed as being significant at the 5-percent level of confidence for observer variability. For example, a mean of 384 intersects must change by more than 46 to say that the change was real and not due to observer variability at the 5-percent level of confidence ($384 \times 0.12 = 46.1$). This may be expressed as 384 ± 46 and thus intersects greater than 430 or less than 338 may be considered a real change.

Studies, such as at Pole Camp where photographs are taken every year, are amenable to regression analysis of grid intersects. If the outlines are done by the same person, observer variability is reduced. Figure 45 illustrates regression on shrub profile intersects at Pole Camp from 1975 to 1997. Regression for the entire data set showed a decline at -0.63. However, when data were selected for the time when beavers were in the area, 1983 to 1994, the regression was at -0.90, highly significant. Trend lines such as these seem very useful.

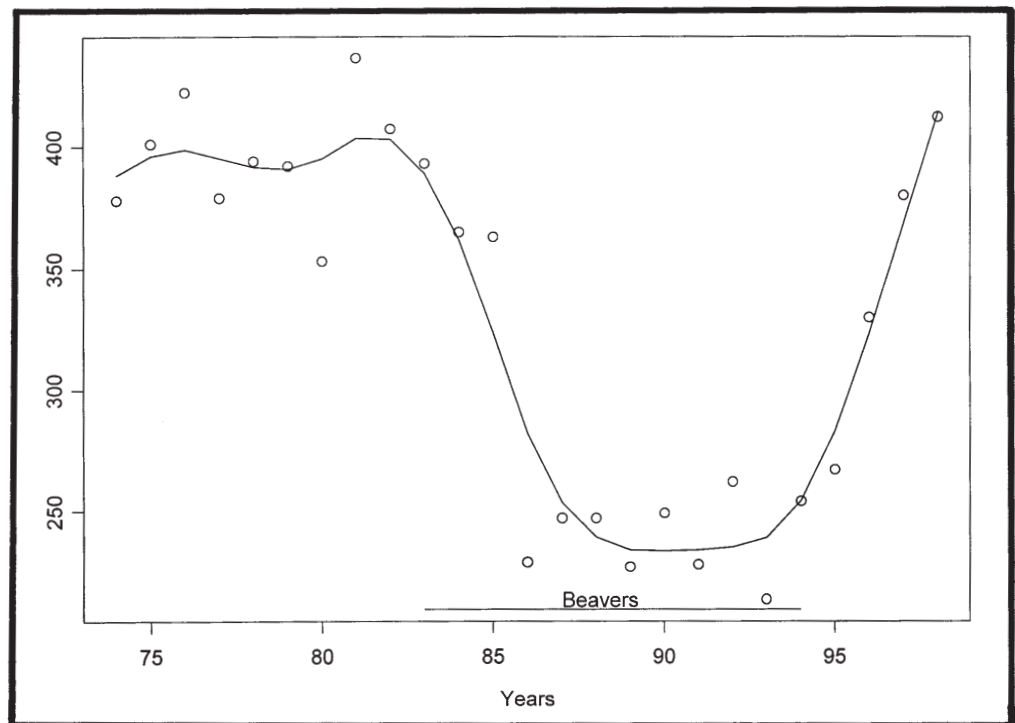


Figure 45—Regression of outline intersects from 1975 through 1997 for shrub profile changes at the Pole Camp wet meadow photo point. One observer made all 25 grid measurements. Intersects are totals from inside the grid area. Circles are the yearly total shrub intersects. The line is a smoothing spine regression. A note at the bottom of the graph indicates years when beavers were present.

Analyzing Location

Documenting change in position of items on a photograph requires precise photography. Three kinds of precision are required: (1) distance between camera location and meter board must be the same for all repeat photos, (2) height of camera above the ground and placement over the camera location stake must be the same for all repeat photos, and (3) sizing and orientation of the grid must be precise.

These variables do not consider observer interpretation. They do suggest that attempts to use photographs for monitoring change in position of objects is questionable if they are distant from the meter board. Table 1 illustrates effects of distance on grid precision. If documentation of position change is desired, place the meter board near the topic of interest, such as a streambank, and measure on the ground from the meter board to the object of interest.

Shrub Profile Grid Analysis

A review of photo grid analysis is required for this evaluation. Only highlights specific to shrub grid interpretation are presented here.

Photograph the shrubs from two directions as illustrated in part A, "Shrub Profile Photo Monitoring."

Print the photographs to be analyzed at 8- by 12-inches (20 by 30 cm) and in color for good resolution.

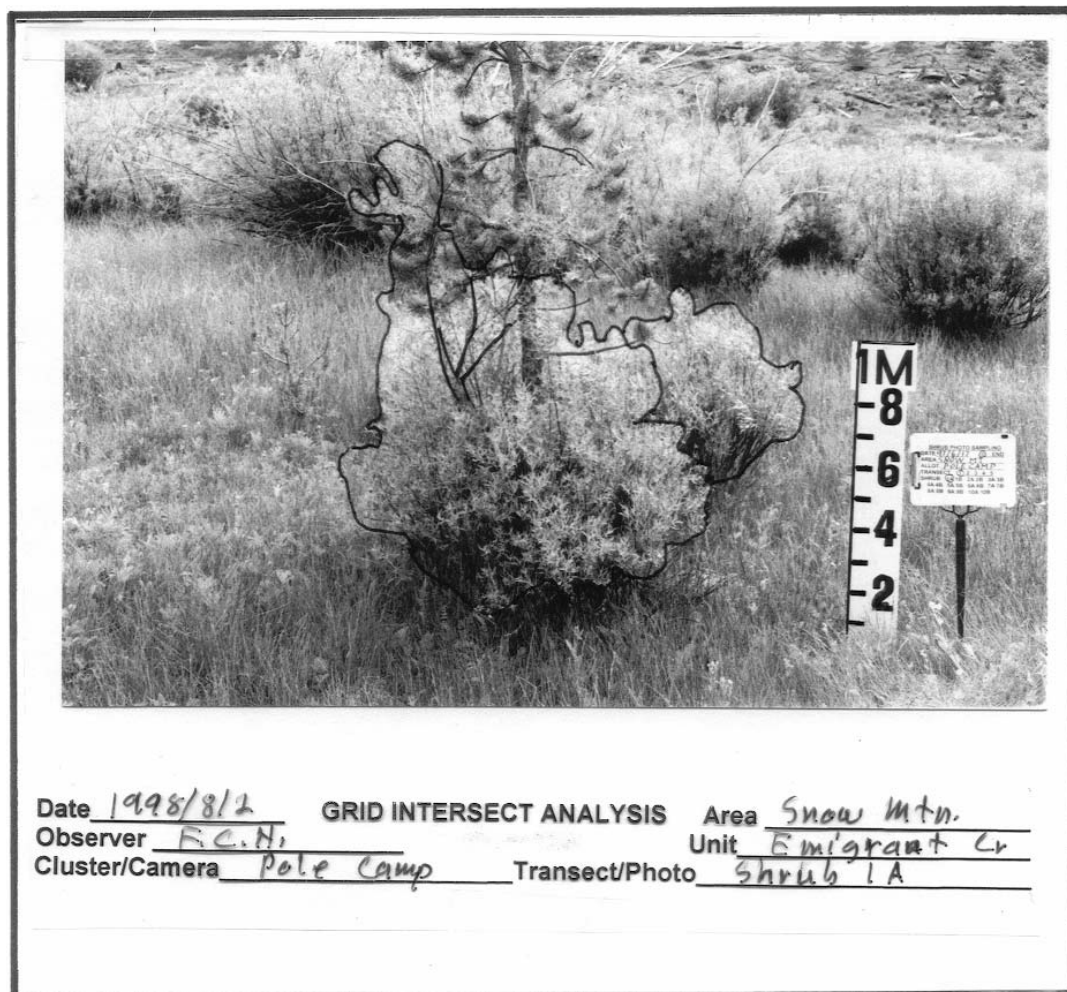


Figure 46—Grid analysis of shrub 1 on the Pole Camp shrub profile transect (see map, fig. 23, part A). This view is “1A” of the two photos of shrub 1 (1A and 1B, figs. 23 and 25). Both photos of shrub 1 are shown in figure 25, part A. The “Grid Intersect Analysis” outline form has been placed on the photo, information filled in, and the meter board marked. Outline as carefully as possible the shrub profiles. Do the same for the other photo of shrub number 1 (figs. 25, 1B, part A, and 47).

From appendix A, select the “Grid Intersect Analysis” form and duplicate on clear plastic. Fill out all information at the bottom of the form. “Date” is date of the **photograph**, not when the outline was made. The completed outline will become a basic data file and must be identified. Tape the outline form to the photograph along one edge such that the outline may be lifted for close inspection of the photo and then replaced exactly.

Outline the shrub or group of shrubs in the photo. Two shrubs are shown in figures 46 and 47. They have been separated for illustration purposes. Do not try to guess the outline of a shrub hidden behind another. Outline only what can be seen. Be as precise as possible. In figures 46 and 47, large willow branches have been marked on the overlay. The branches are clearly shown in figure 25 in part A.

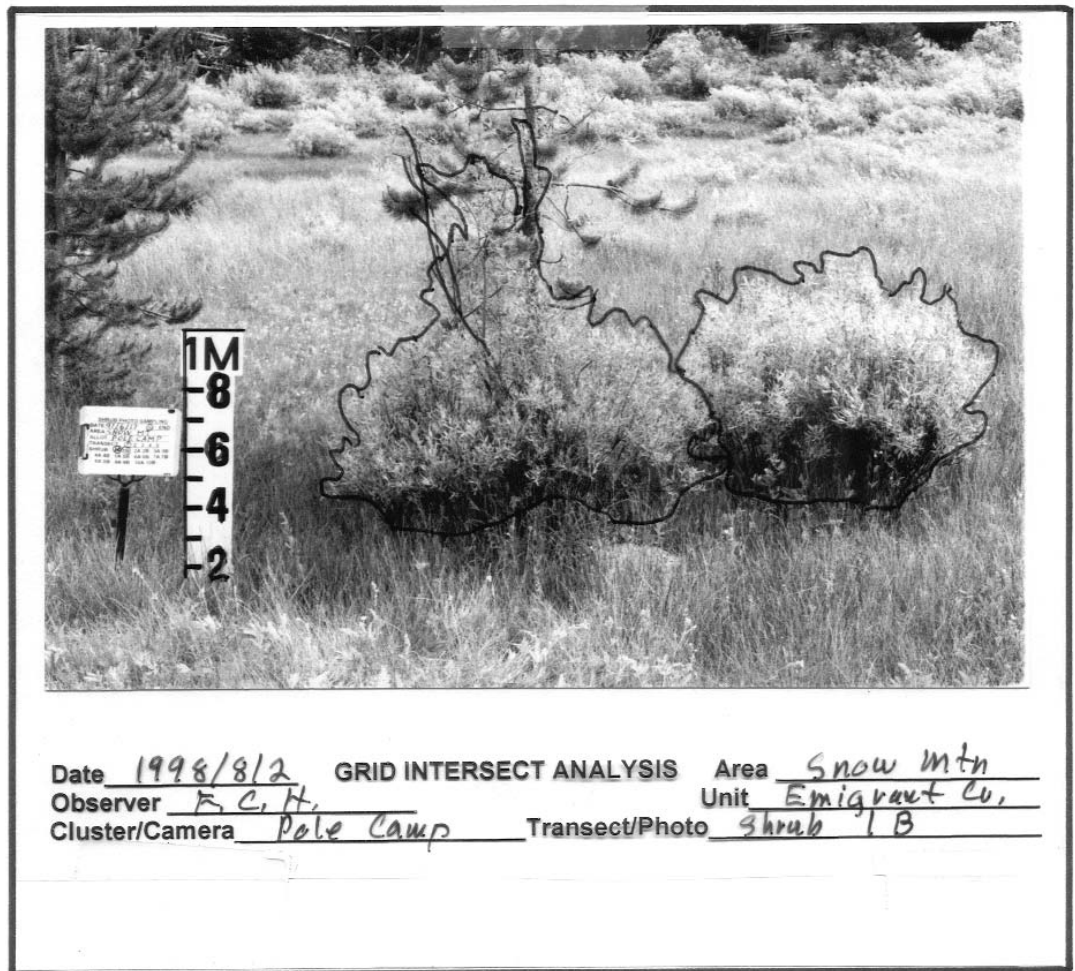


Figure 47—Outline of the second photo of shrub 1 (1B, fig. 25, part A), on the Pole Camp shrub profile transect. When two shrubs are present, separate their outlines as shown. Information at the bottom of the clear plastic overlay must be filled in for each photo. Remember to outline and mark the meter board. Outline **on** the foliage, not around it, to increase precision.

Next, adjust the shrub analysis grid, the one with meter boards at each side (app. A), to exactly match the outline meter boards as discussed in "Photo Grid Analysis," above. Tape the outline form to the adjusted grid (fig. 48).

Count intersects within each outline including those falling under an outline (fig. 48), and enter on the filing system form "Photo Grid Summary" (fig. 49). Refer to the section "Analysis of Change, Observer Variability," above, for a discussion of what constitutes a significant change in shrub profile area.

The reader may wish to test observer variability. Count grid intersects in figure 48 and compare to the results shown in figure 49. Expect a difference of three to six grid intersects.

Text continues on page 80.

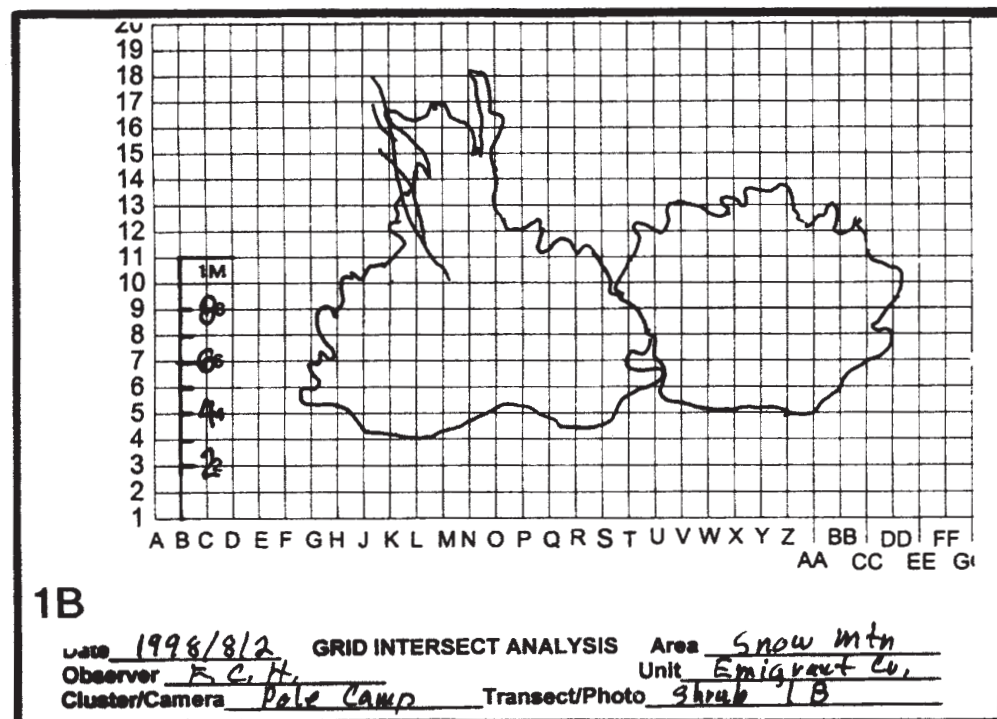
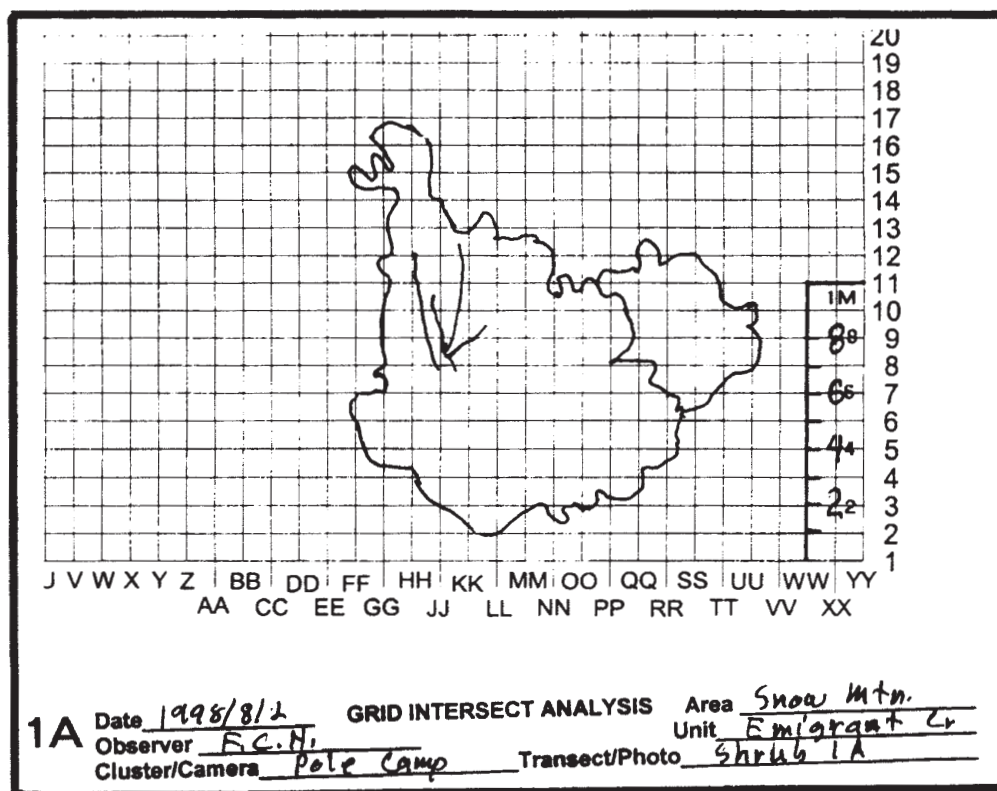


Figure 48—Grid outlines for shrub 1, photos (1A) and (1B) (figs. 46 and 47), on the Pole Camp shrub profile transect. Grids have been adjusted for size by the outlined meter board. Outlines are then taped to the grid. Count grid intersects and record on the filing system form "Photo Grid Summary (fig. 49).

PHOTO GRID SUMMARY

[illegible]

79

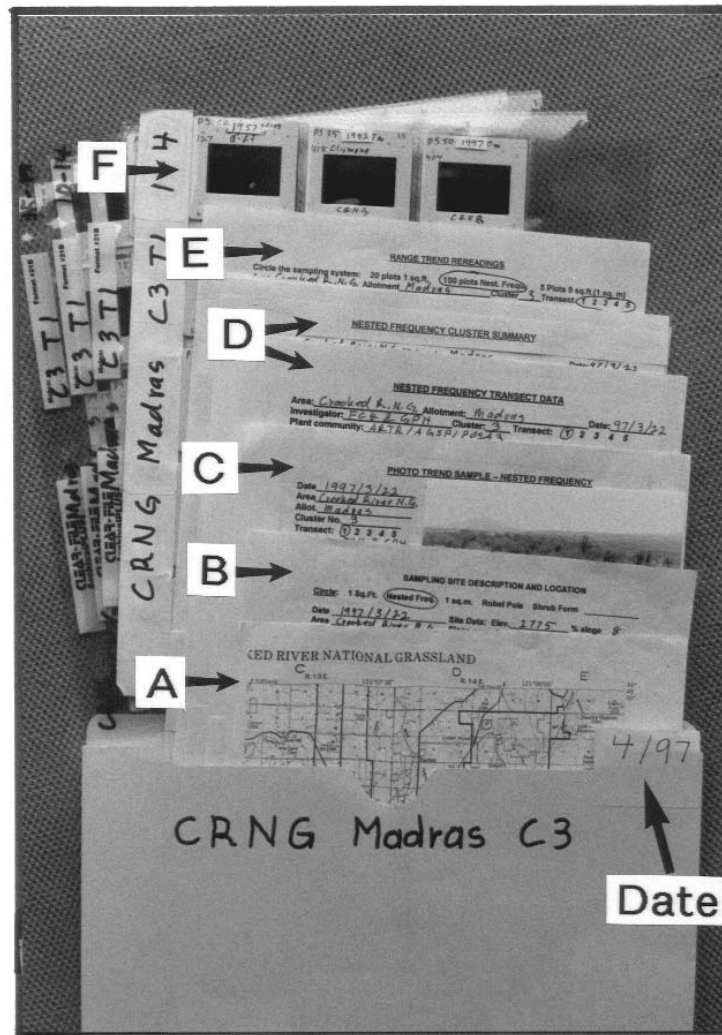


Figure 50—File folder contents for the Crooked River National Grassland trend cluster C3. Several sizes of expanding folders may be used: two-fold shown here, four-fold, or eight-fold to fit the file size. Each folder is labeled and the last date of sampling is attached to the upper right corner (arrow). All items pertaining to the sample location are included in the file: (A) general area map (fig. 5); (B) the form “Sampling Site Description and Location” for a plot layout map (fig. 6); (C) a form for attaching photographs and recording data shown here as the “Photo Trend Sample - Nested Frequency,” similar to figure 11; (D) data summary forms shown here as “Nested Frequency Transect Data” and “Nested Frequency Cluster Summary”; (E) trend interpretation using “Range Trend Rereadings”; and (F) clear plastic holders for slides. Not shown are black-and-white negatives in their envelopes identified by date, cluster, and transect.

Filing System

Photo monitoring requires a way to file maps, data, slides, prints, negatives, or digital memory cards. My system places each study in an expandable file containing everything (fig. 50): local map to find the study site (fig. 5, part A), the “Photographic Site Description and Location” with map of the photo monitoring layout (fig. 6, part A), photo mounting forms for color or black-and-white prints (figs. 2 and 11, part A), analysis grids if used, and clear plastic slide holders. Negatives are filed in their envelopes from processing. Two prints are made of each negative, one for mounting and one to be kept in the envelope for future use. Digital images may be filed as memory cards or as compact disks (CDs), which are recommended. The disk

should have an index card where identification of each image is stored. If images are stored on a computer (not recommended), identify the location and name of the computer, and the file where stored.

The expandable files are in a file cabinet dedicated to sampling and organized first by geographic location and then by date for next photography. Filing of studies by geography greatly facilitates travel planning. Noting the next photography date on each file helps in seasonal planning (fig. 50).

Literature Cited

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Magill, A.W. 1989. Monitoring environment change with color slides. Gen. Tech. Rep. PSW-117. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 55 p.

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Appendix A: Forms

This appendix contains forms for photo point monitoring. They may be copied onto three colors of paper or clear plastic for overhead projection, depending on their use.

Paper Color

Office forms are printed on standard white paper.

Field forms should be printed on either of two paper colors: blue for forms placed in photographs to identify each photo or yellow for field forms to ease eye strain. Outline forms for grid analysis are printed on clear plastic. Grids and summary forms are printed on white paper. Paper color suitable for each form is shown in **bold**.

Blue paper is Hammermill Brite Hue Blue or Georgia Pacific Papers Hots Blue to be used in photographs to identify the slide or negative. This shade of blue has proven to be least sensitive to changes in sunlight, from full sun to shade, and has the least tendency to “bleach out” in full sun.

Yellow paper is Champion Goldenrod or Hammermill Copy Plus GOLDENROD to be used for field forms. It has proven to be least annoying to eyes under direct sunlight when recording data, maps, diagrams, and other descriptions.

Clear plastic sheets for printing outline overlays are 3M or Labelon Overhead Transparency Film. These films are specifically designed for different printers such as laser, inkjet, or plain paper.

White paper is used for summary forms and for grids adjusted to the size of the outline overlays.

Forms and References

Forms are listed below by page number, and examples of their use are shown by figure number (figures are from both part A and part B). Several forms consist of two or three pages. The first page lists all pertinent items and the photo number. A second page leaves the photo number blank to be filled in as required. For example, "Camera Location and Photo Points" lists photo "A" and "B" on the first page and has a blank for photo points on the second page. Print enough of the second pages to mount pictures of the photo points established. Similar multipage forms are "Photo Points and Close Photos," "Photo Points with Overhead Views," and "Shrub Photo Transect."

Form	Page	Figure examples
Paper colors for field use	85, 87	None
Photograph identification forms; print on blue paper		
Camera-Photo	89	2, 10
Shrub Photo Sampling	90	25
Sampling location maps; print on yellow paper :		
Photographic Site Description and Location (map)	91	6, 12
Sampling Site Description and Location (map)	92	22, 23
Photo mounting and data forms; print on yellow paper :		
Camera Location and Photo Points	93	13 - 15
Photo Points and Close Photos	95	11
Photo Points with Overhead Views	97	28
Shrub Photo Transect	99	25
Grid Intersect Analysis Outline Form; print on clear plastic	102	36, 37, 38, 40, 42, 46 to 48
Analysis Grids: adjust size and print on white paper		
1 meter	103	39, 40
2 meter	104	none
Shrub Analysis	105	48
Photo Grid Summary Form; print on white paper	106	39, 49

Paper found best for photo identification is this color blue.

It is **Hammermill Bright Hue Blue[®]**

or **Georgia Pacific Papers Hots Blue[®]**

This page was intentionally left blank.

Paper color that is easy on the eyes and used for mapping the monitoring system and recording field notes for mounting photographs.

It is **Champion Goldenrod®**

or **Hammermill Copy Plus GOLDENROD®**

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DATE

AREA

UNIT

CAMERA: 1 2 3 4 5

PHOTO: A B C D

E F G H I J

SHRUB PHOTO SAMPLING

DATE _____ 0 _____ END _____

AREA _____

ALLOT. _____

TRANSECT 1 2 3 4 5 _____

SHRUB 1A 1B 2A 2B 3A 3B

4A 4B 5A 5B 6A 6B 7A 7B

8A 8B 9A 9B 10A 10B

PHOTOGRAPHIC SITE DESCRIPTION AND LOCATION

Date _____ Area _____

Unit _____ Observer: _____

No. of Camera locations: _____ No. of Photo points: _____

Plant community _____

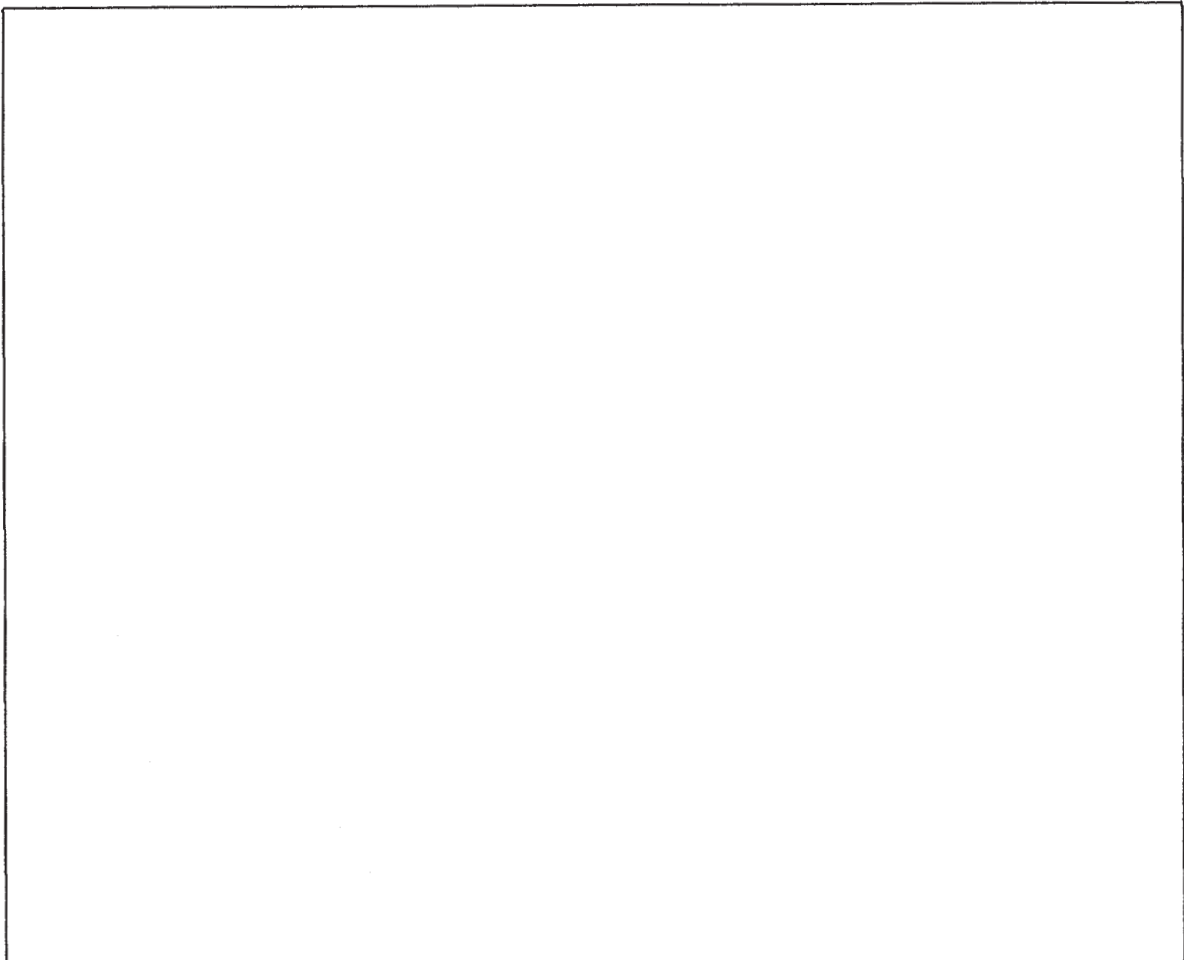
Location: T. _____ R. _____ Sec. _____

Location description _____

Photo purpose: _____

Discussion: _____

MAP



Use back of sheet for additional details.

SAMPLING SITE DESCRIPTION AND LOCATION

Circle: 1 Sq.Ft. Nested Freq. 1 sq.m. Robel Pole Shrub Form _____

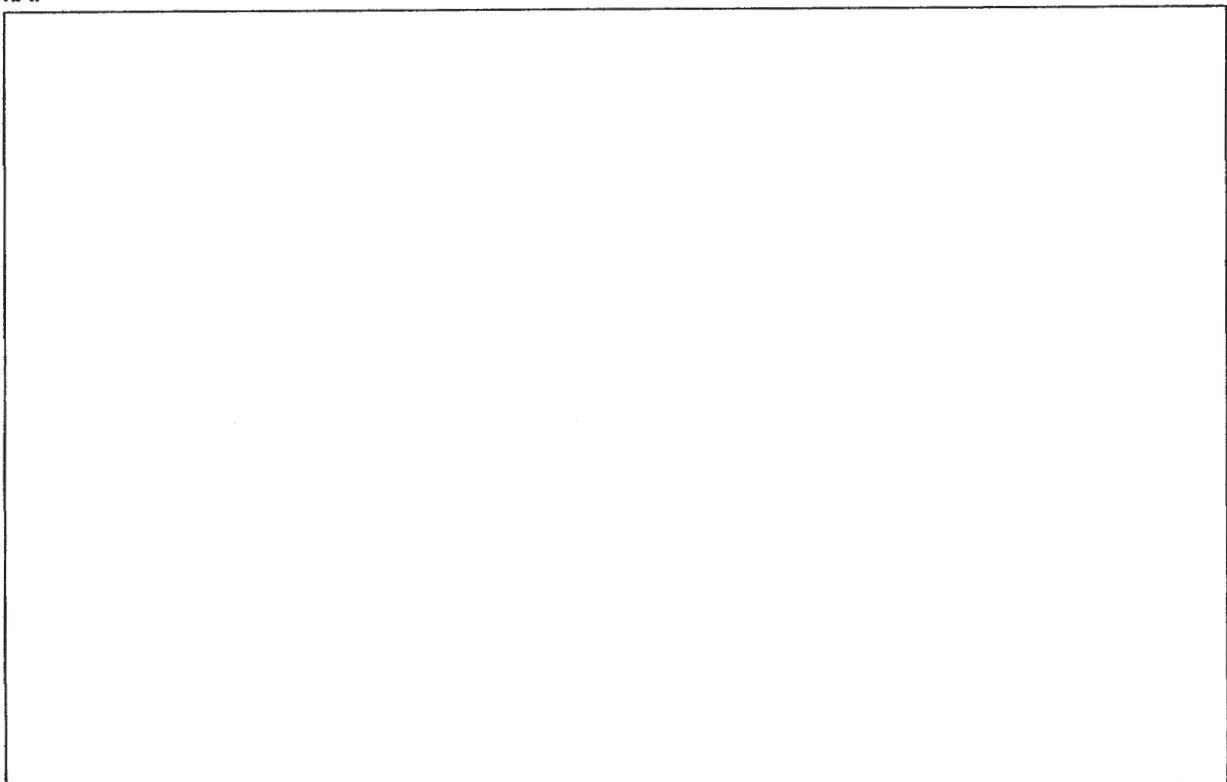
Date _____ Site Data: Elev. _____ % slope _____
 Area _____ Slope aspect: N NE E SE S SW W NW
 Allot. _____ Slope position: top up 1/3 mid low 1/3 bottom
 Cluster No. _____ Micro topography: convex flat concave
 Transects: 1 2 3 4 5 Macro topography: flat undulating rolling
 Plant community _____ steep rough broken

Geology: _____
 Grazing system: _____ Deposition: wind stream lake colluvial
 Type _____ Date _____ residual _____
 Type _____ Date _____ Material: limestone mudstone sandstone
 Type _____ Date _____ granite serpentine diorite
 basalt andesite rhyolite
 Kind of animal: cattle sheep
 horses goats deer
 elk _____ tuffaceous cinders pumice ash

Soil: _____
 Restrictive layer: absent clay pan bedrock
 cemented _____
 Location: T. _____ R. _____
 Sec. _____ Surface compaction: none moderate severe
 Description: _____ Soil profile stone: absent gravel stony
 Soil texture: sandy loamy silty clayey ashy

Other notes: _____

MAP



CAMERA LOCATION AND PHOTO POINTS

Date _____

Camera Location

Area _____ **Number of Photo points:** _____

Unit _____ Observer _____

Comments

Slope _____ Aspect _____ Slope position _____

Photo point A:

Compass bearing: _____

Distance: _____

1. *Journal of the American Medical Association*, 2000; 283: 2689-2695.

Photo point B:

Compass bearing:_____

Distance: _____

Photo Point A

Photo Point B

CAMERA LOCATION AND PHOTO POINTS

Date _____ Camera Location _____

PhotoPoint _____
Compass bearing: _____
Distance: _____

Photo point _____

Photo Point _____
Compass bearing: _____
Distance: _____

Photo point _____

Photo Point _____
Compass bearing : _____
Distance: _____

Photo point _____

PHOTO POINTS AND CLOSE PHOTOS

Date _____ Camera _____

Area _____

Unit _____

Photo point: A

Observer _____

Remarks _____

Photo point A:

Left of meter board

Species/cover: _____

Comments: _____

Photo point A:

Right of meter board

Species/cover: _____

Comments: _____

General photograph of point A

Close photo to left of meter board

Close photo to right of meter board

PHOTO POINTS AND CLOSE PHOTOS

Date _____
Area _____
Unit _____
Camera _____
Photo point: _____
Observer _____
Remarks _____

General photograph of point _____

Photo point _____
Left of meter board
Species/cover: _____

Close photo to left of meter board

Comments: _____

Photo point _____
Right of meter board
Species/cover: _____

Close photo to right of meter board

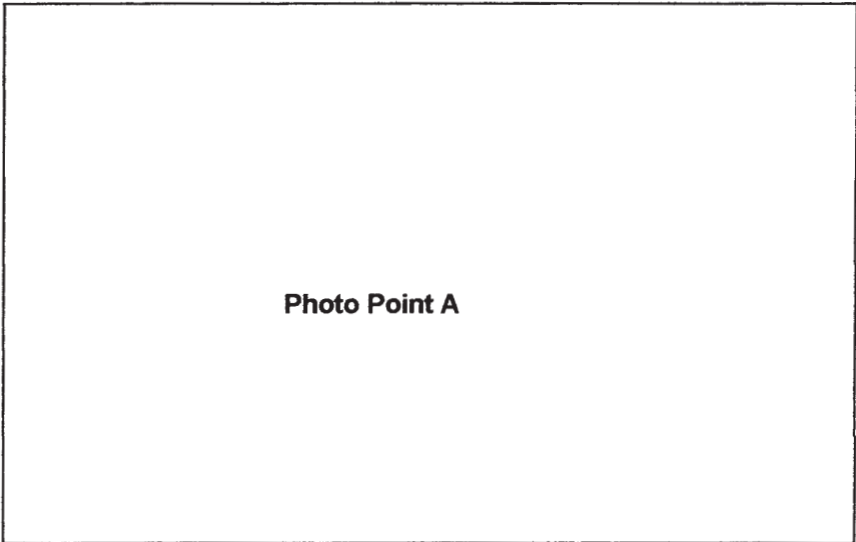
Comments: _____

PHOTO POINTS WITH OVERHEAD VIEWS

Date _____ Camera Location _____
Area _____ Number of photo points _____
Unit _____ Observer _____
Comments _____

Slope _____ Aspect _____ Slope position _____ Topography _____

Photo Point A
Compass bearing _____
Distance _____
Photo comments: _____



Overhead of Photo Point A
Comments: _____

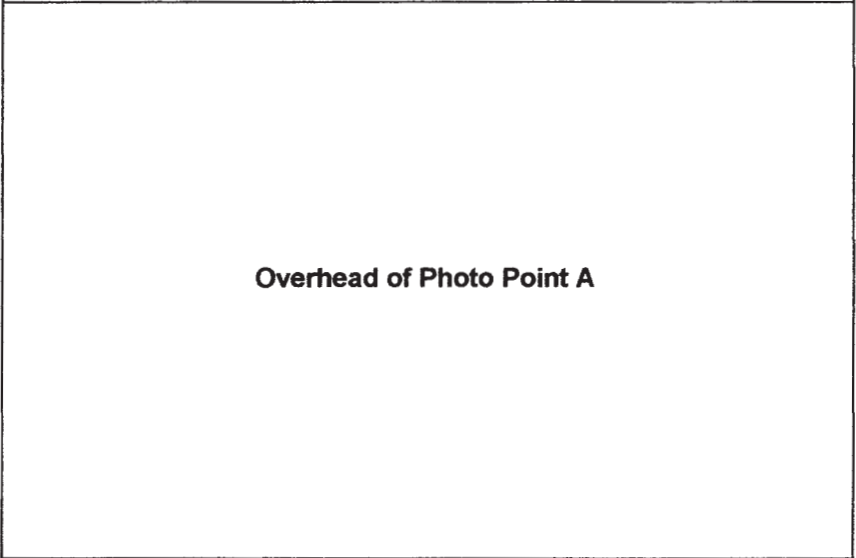


PHOTO POINTS WITH OVERHEAD VIEWS

Photo Point _____
Compass bearing: _____
Distance _____
Photo comments: _____

Photo Point _____

Overhead of Photo Point _____
Photo comments: _____

Overhead of Photo point _____

SHRUB PHOTO TRANSECT

Date _____ Cluster _____ Transect 1 2 3 4 5

Area _____

Allot. _____

Investigator: _____

Season of use _____

Grazing system: _____

Animals _____

Direction _____

Distance _____

General photograph down the transect

Shrub 1A

Direction _____

Distance _____

Comments _____

Shrub 1A

Shrub 1B

Direction _____

Distance _____

Comments _____

Shrub 1B

SHRUB PHOTO TRANSECT

Shrub ____A

Direction _____

Distance _____

Comments _____

Shrub ____A

Shrub ____B

Direction _____

Distance _____

Comments _____

Shrub ____B

SHRUB PHOTO TRANSECT

Shrub ____A

Direction _____

Distance _____

Comments _____

Shrub ____A

Shrub ____B

Direction _____

Distance _____

Comments _____

Shrub ____B

View up the transect:

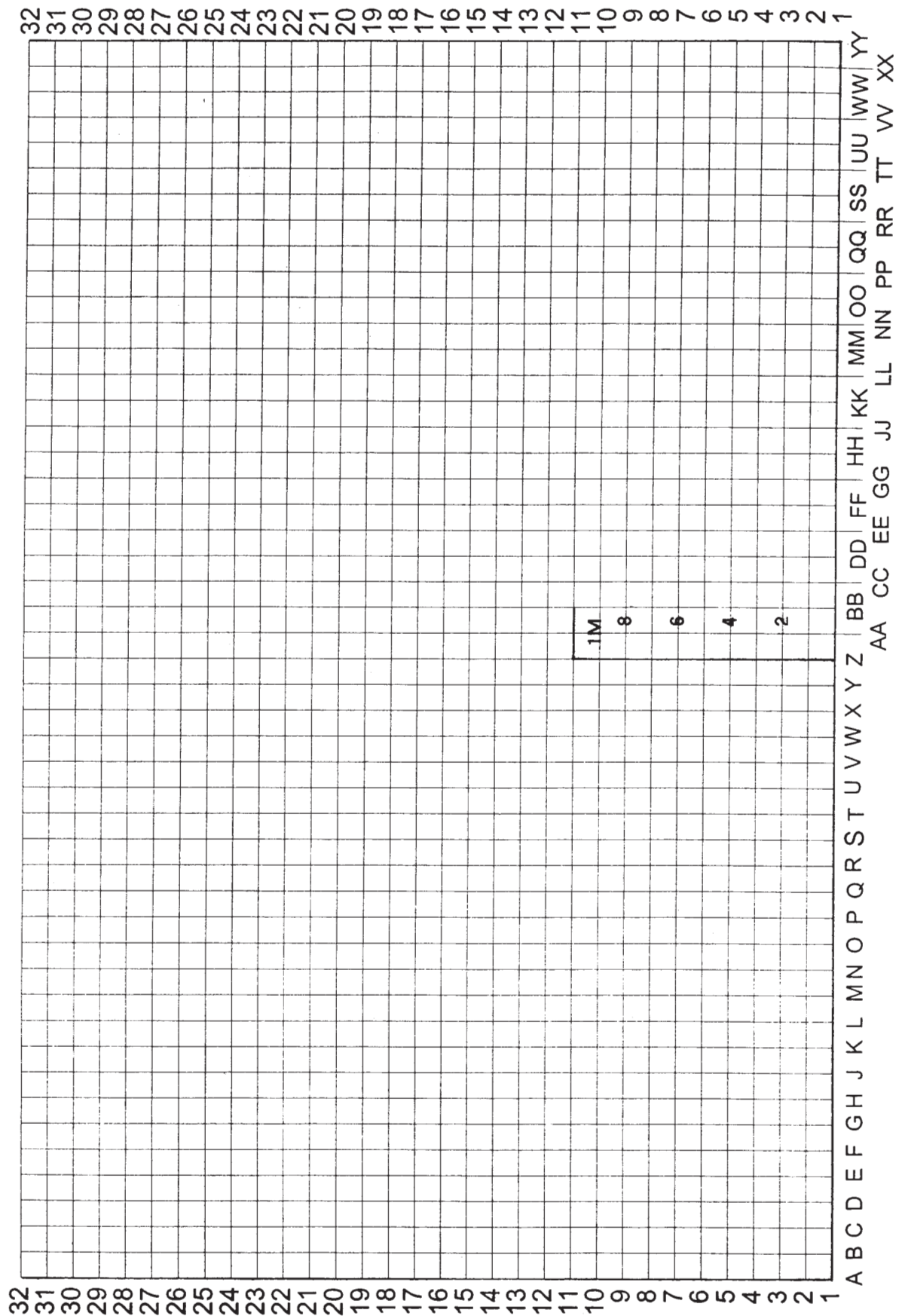
Direction _____

Distance _____

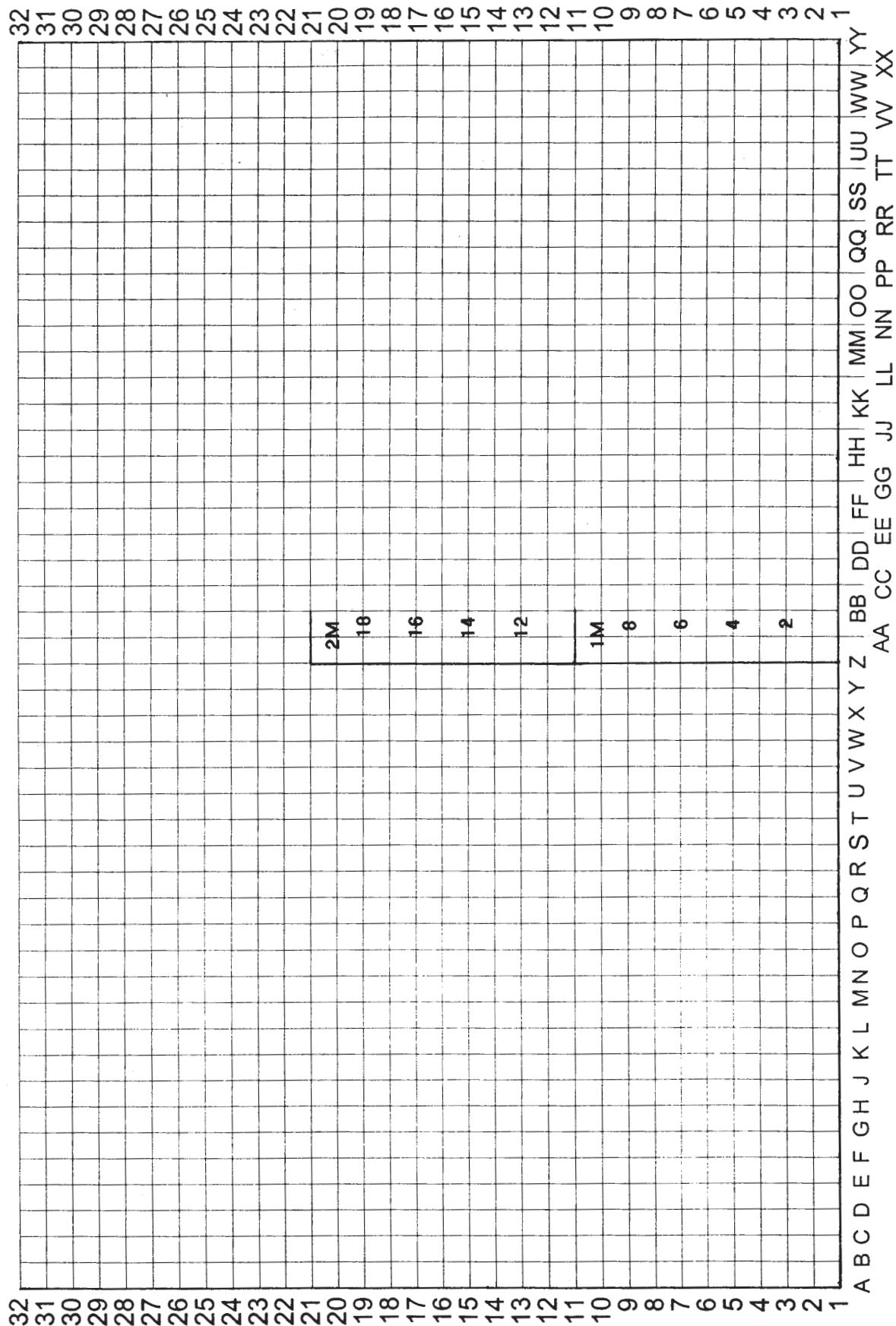
Comments _____

General view up the transect

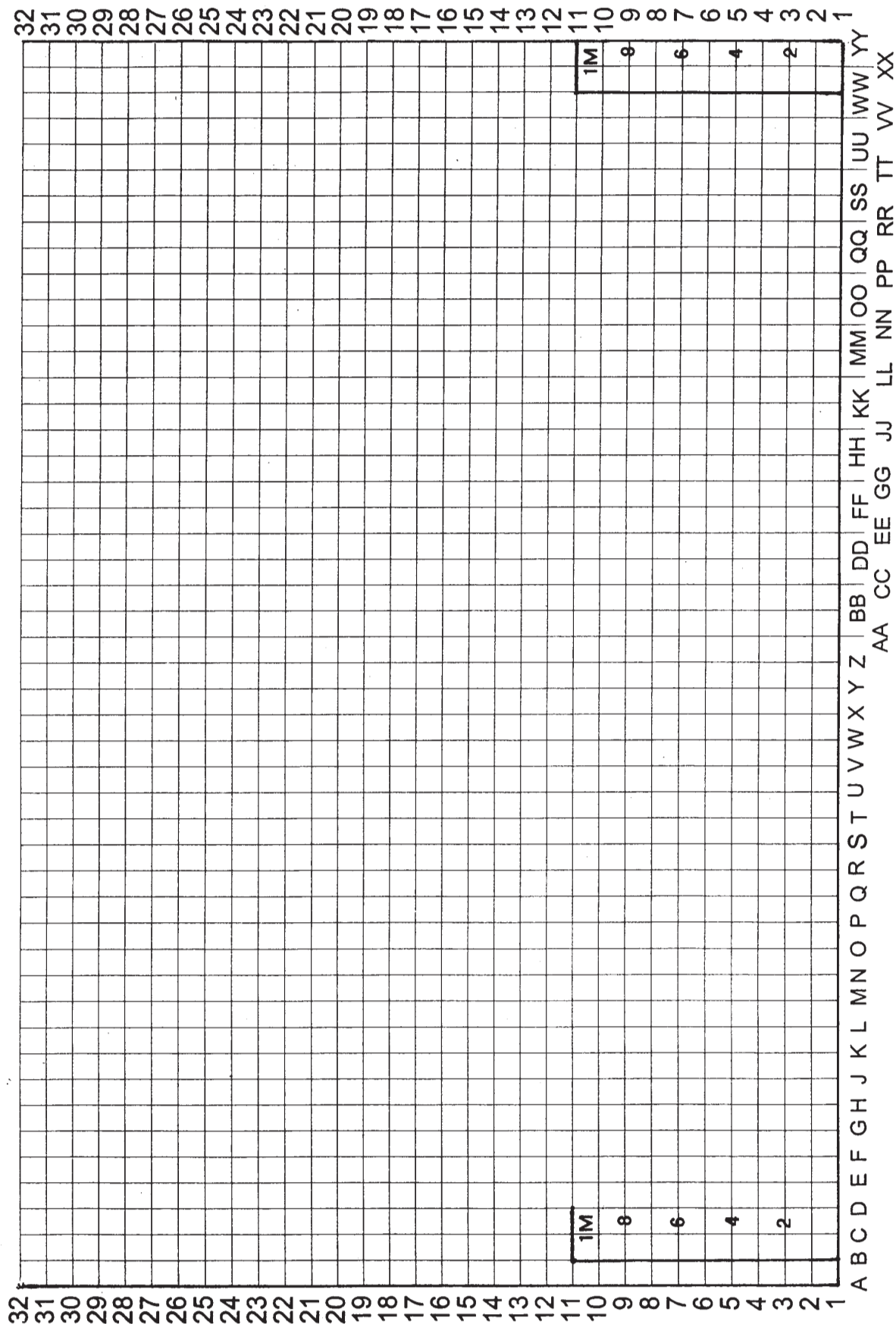
Date	_____	GRID INTERSECT ANALYSIS	Area	_____
Observer	_____	Unit	_____	_____
Cluster/Transect	_____	Transect/Photo	_____	_____



ANALYSIS GRID - 1 METER



ANALYSIS GRID - 2 METER



ANALYSIS GRID - SHRUB ANALYSIS

1999/2/19

PHOTO GRID SUMMARY

Date _____ Observer _____

Area _____ Unit _____

Cluster/Camera _____ Transect/Photo _____

[illegible]

Appendix B: Equipment

Introduction

This appendix illustrates equipment required for photo point monitoring. Six items are discussed: meter boards, photograph identification sheet holder, camera leveling system for overhead photography, bracket for using two cameras (one with color and the other with black-and-white film), orange tags for identifying monitoring sites, and flimsy fenceposts.

Meter Boards

Meter boards are used to mark photo points. They help in taking consistent repeat photographs by orienting the camera on the "1M" of the board. Sharp exposure at the meter board is assured by focusing the camera on the "1M." The meter boards also provide a size control in photographs that can be used to adjust analysis grids when measuring attributes in a photo. This section describes how to construct meter boards.

1-meter board—

Materials—Prices given are in dollars as of 2001.

	Cost
	<i>Dollars</i>
1 piece ½-inch, 4-ply plywood, finished on one side, exterior, 1 foot by 4 feet @ \$20 per sheet	3
3/16-inch-diameter steel rod, 36 inches long	1
Numbers:	
5¼ inches tall, on a reflector, adhesive, packet of 10 (need 2, 4, 6, 8)	4
(Alternative is 4-inch nail-on numbers [5 @ \$2 each])	(20)
Line or pocket level 4 to 5 inches long	4
16-ounce can of yellow spray paint, exterior	4
Screws:	1
2 line level screws #4 ⅝ inch	
9 spike plate screws #6 ¾ inch	
1 role black electricians tape	4
Total	21

Construction—Meter boards are constructed from ½-inch 4-ply plywood, at least exterior quality and preferably marine quality (waterproof glue). Waterproof glue is desirable when sampling in riparian areas is expected because the meter board often will be placed in water. Dimensions and layout are shown in figure 51. Cut out according to specifications (fig. 51).

Prime the front of the board before painting. Then apply two coats of dull textured yellow to reduce reflection from the sun. Yellow is used for visibility. If dull yellow is not available, do not sand or smooth the front of the board. Roughness tends to diffuse sun reflection because it adds roughness to the paint. Most of a 12-ounce pressure can will be required for two coats.

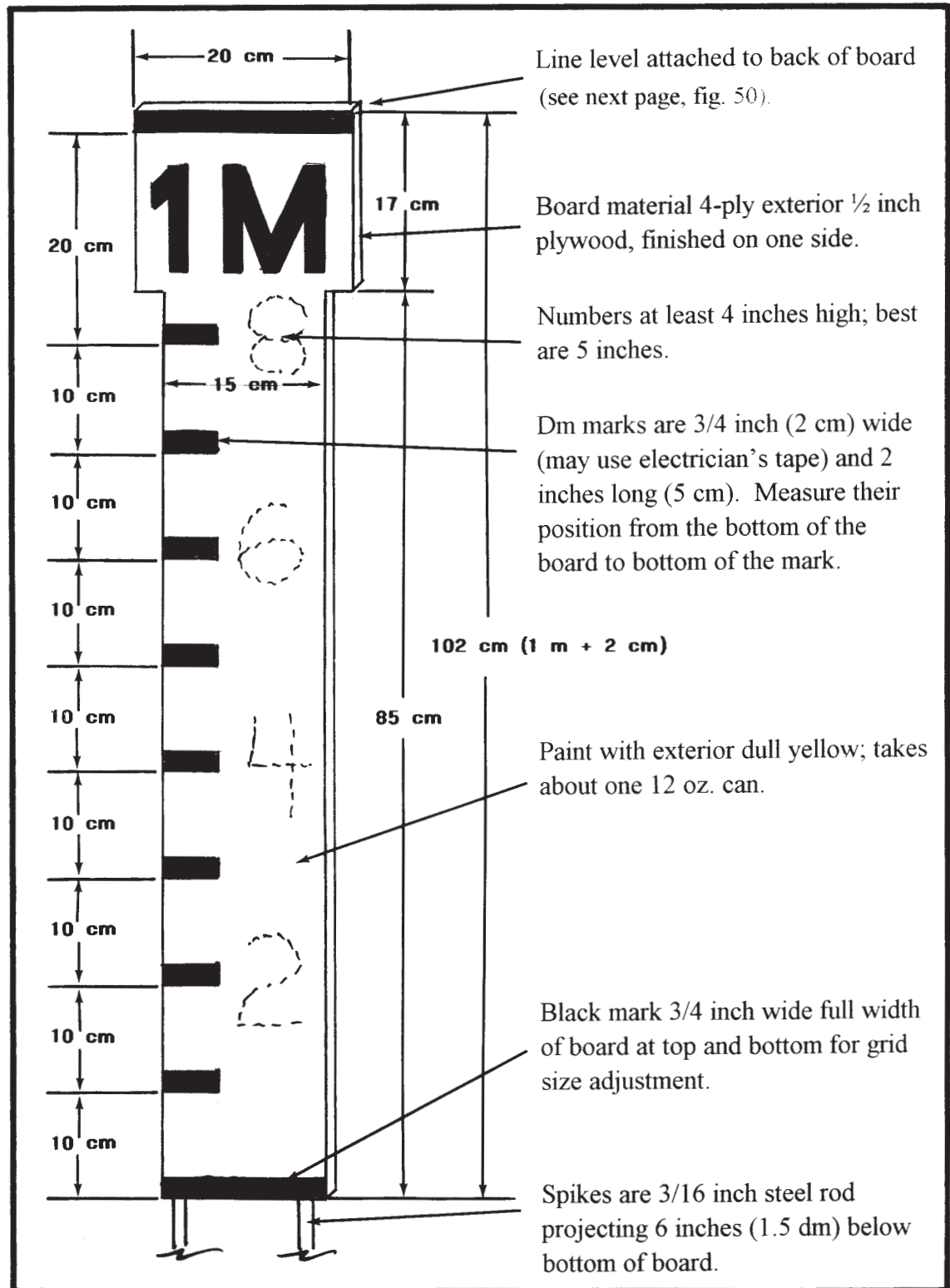


Figure 51—Construction details of a 1-meter-tall meter board. The same measurements are used for the 1-meter-tall folding board. A 2-meter folding board, hinged at 1 meter, has a 2-centimeter difference in board heights. See figure 54 and text for details.



Figure 52—A line level is used to orient the board vertically. Obtain a 4- to 5-inch-long (10- to 12-cm) line level and drill a hole in each end for a screw. Attach one end of the line level to the back of the meter board $\frac{1}{2}$ inch (1 cm) from the top. Then orient the board vertically by using a carpenter's level along one side. Hold the board in position, adjust the line level to horizontal, and carefully screw in the other end.

Numerals—The numerals 2, 4, 6, and 8 should be black and at least 4 inches tall. My preference is 5 inches tall for good readability when slides are projected. All illustrations in this publication show 5-inch numbers. There are many sources of these, including paste-on numbers, numbers on a card that must be cut out, and nail-on numbers. I use $5\frac{1}{4}$ -inch-tall numbers on a reflective card with adhesive on the back. Each number must be cut out and applied to the painted surface. The “M” for “1M” is made from electrician's tape or it may be painted on.

Black marks at each decimeter and bands at top and bottom may be applied in either of two ways: painted at 0.78 inch (2 cm) wide or by use of black electricians tape, which is $\frac{3}{4}$ of an inch wide (1.8 cm). The top, bottom, and decimeter marks are used to adjust grid size before grid analysis of items in the photographs. The marks on the meter board, therefore, must be positioned exactly (fig. 51).

Line level—A line level is attached to the back of the board at the top (fig. 52). This allows the board to be oriented vertically, which not only is essential for grid analysis but also makes pictures look good.

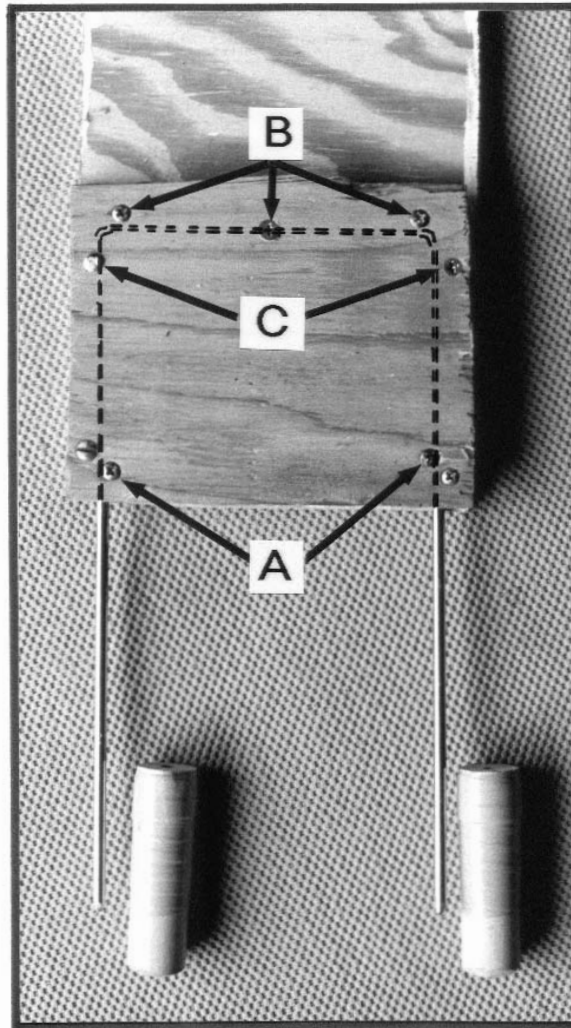


Figure 53—Spikes in the bottom of the board are pushed into the ground to hold the board upright. Use 3/16-inch-diameter steel rod about 30 inches (75 cm) long. Bend it into a “U” shape as shown by the dotted line. It is placed under a plywood plate and held in place by nine screws. Leave about 6 inches (1.5 dm) of rod below the board. (A) Insert screws on each side of the rod at the bottom; (B) insert three at the top to prevent upward and downward movement of the rod; and (C) place one at each side at top to prevent sideways movement. Drill out doweling to fit over the spikes for safety.

Steel spikes—Steel spikes are attached to the bottom of the board (fig. 53) to hold it in the ground. Steel rod 3/16-inch in diameter works well because it is strong enough to hold the board upright and small enough in diameter to be pushed down into rocky soil. Spikes should extend 6 inches (15 cm) below the bottom of the board (fig. 53). Rods come in 36-inch lengths. About 30 inches is required. Bend the rod into a “U” shape to match the dotted outline in figure 53. Doweling drilled out to fit the rod is placed over the spikes for safety.

For convenience, a carrying handle may be attached to the edge of the board around the 5-decimeter position.

2-meter folding board—Two 1-meter boards may be connected by a hinge.

Double meter boards 2 meters in height are used when shrubs or other vegetation exceeds the height of a 1-meter board (fig. 21, part A). They are simply two single meter boards attached by hinges and a barrel bolt so that either the 1- or 2-meter length may be used.

Materials—Prices given are in dollars as of 2001.

	Cost
	<i>Dollars</i>
2 pieces ½ inch, 4-ply plywood, finished on one side, exterior, 1 foot by 4 feet, each @ \$20 per sheet	6
3/16-inch-diameter steel rod, 36 inches long	1
Numbers: 5¼ inches tall, on a reflector, adhesive, 2 packets of 10 (need 2 each of 2, 4, 6, 8)	8
Line or pocket level 4 to 5 inches long	4
Two 16-ounce cans of yellow spray paint, exterior	8
2 strap hinges, heavy duty, 4-inch size	5
1 barrel bolt, heavy duty, 5-inch size	8
Screws:	2
2 line level wood screws #4 ⅝ inch	
9 spike plate wood screws #6 ¾ inch	
1 sheet metal screw #10 ½ inch, placed under barrel bolt (sheet metal for hardness)	
10 hinge wood screws #10 1 inch	
8 barrel bolt wood screws #10 ½ inch	2
1 role black electricians tape	4
Total	\$46

Construction—Construct two 1-meter boards as discussed previously with one important difference. The top board will **not** be 1 meter 2 centimeters tall. Instead it will be exactly 1 meter tall. The top board has its bottom decimeter mark supplied by the lower (1-meter) board (fig. 54).

Construct the bottom (1-meter) board, with spikes at the base and numerals as shown in figure 51. On the top board, use “2M” at the top instead of “1M”, and add numeral “1” to each of the decimeter numbers as shown in figure 54. The numeral “1” may be made from electricians tape. The top board will **not** have a decimeter bar at its base; this bar is supplied by the bottom board.

Hinge system—Figure 55 illustrates the hinge, barrel bolt, and position of the line level between the two halves of the meter board. The barrel bolt holds the boards open and prevents them from flopping in wind.

1. Refer to figure 55. First, measure thickness of the barrel bolt. Cut plywood from the same thickness as the barrel bolt and glue to both meter board halves. The 5-inch bolt shown in figure 55 required 3/8-inch plywood. These plywood blocks separate the meter board halves when folded so that the barrel bolt will clear both its connecting strap and the line level.
2. Attach the hinge straps to the top board first. Use a straight edge to align both meter board halves in a straight line, then attach the bottom straps to the bottom board while holding both halves firmly together.



Figure 54—The 2-meter board system. In the top photo, a standard 1-meter board is shown with the 2-meter half folded under it. In the bottom photo, the folded board has been turned over showing the 2-meter section. “No dm mark” designates the lack of a decimeter mark at the base of the top board; it is at the top of the 1-meter board shown directly above. Length of the 2-meter section must be 2 centimeters shorter (exactly 1 meter instead of 1 meter 2 centimeters) than the 1-meter board to account for this decimeter mark.

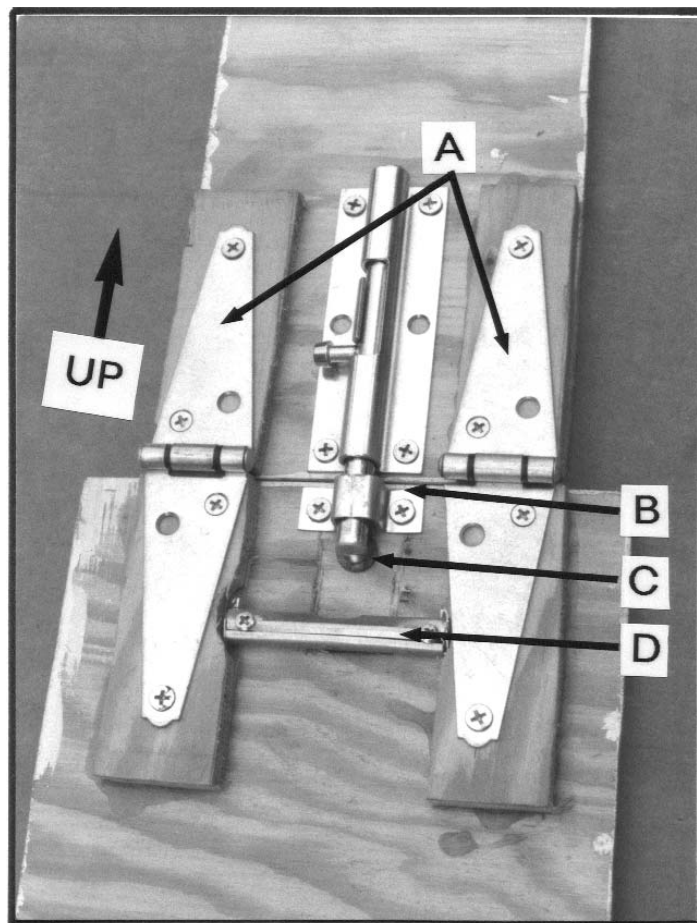


Figure 55—Hinges and a barrel bolt connect the two meter boards. (A) When installing hinges, attach to the top board first, carefully align the boards in a straight line, then attach the lower straps of the hinges. (B) The barrel bolt should be oriented to fall down when the board is unfolded. Position the bolt and its strap at the edges of the board halves so that the bolt protrudes about $\frac{3}{8}$ inch below the strap. (C) Install an adjusting screw (see fig. 56) to force the barrel bolt against its strap to stiffen the two boards when unfolded. (D) A line level is placed an inch (2.5 cm) below the barrel bolt on the lower board half so that it can be seen from above when the boards are folded and from behind when they are unfolded as shown.

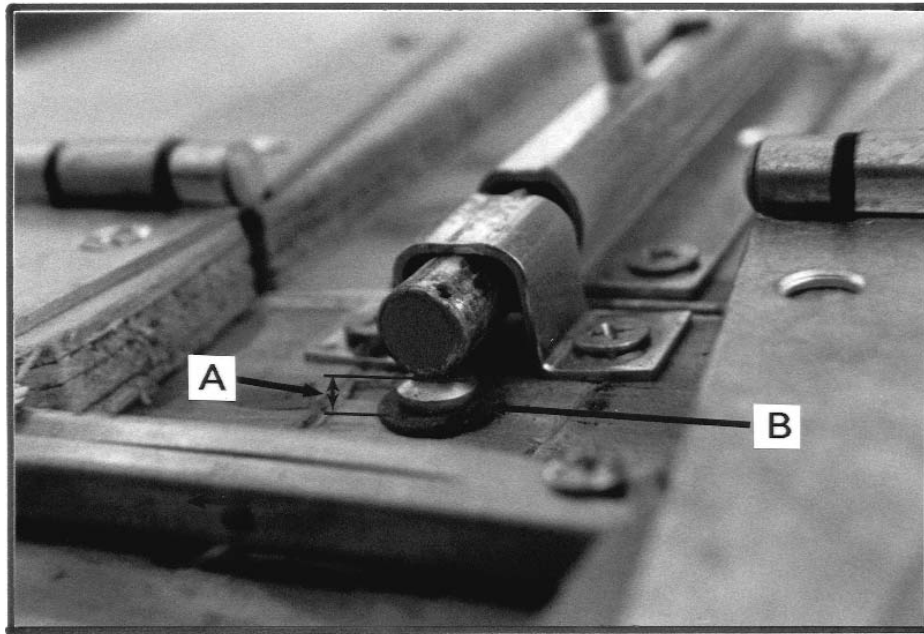


Figure 56—Adjusting screw and washer used to remove play between the barrel bolt and its strap to stiffen the two halves of a 2-meter board when unfolded. (A) Measure distance between the bolt and the board. (B) Insert a round headed sheet metal screw with enough washers to make the bolt fit firmly under the strap. Sheet metal screws are preferred because of their hardness. Pound the flange down if necessary.

3. Install the barrel bolt next (fig. 56). Position the barrel bolt at the very bottom of the top meter board so that the bolt drops down when the boards are erected. Place the barrel bolt strap as close to the top of the bottom board as possible without screws splitting the wood (fig. 55). The bolt should protrude about $\frac{3}{8}$ inch below the strap. Insert a sheet metal screw under the bolt end with sufficient washers to hold the bolt firmly against the strap. This will prevent flexing of the erected boards (fig. 56).
4. Position the line level on the bottom (1M) board where it can be seen from above when the boards are folded for 1-meter use, and from the back when unfolded for 2 meters (fig. 55). One can see the line level with boards folded by viewing down through the strap into which the barrel bolt drops.

Folding 1-meter board—If field transportation of a meter board is a concern, the 1-meter board can be made to fold at the 4-decimeter mark. The hinge system is described and shown in figures 55 and 56. Figure 57 illustrates dividing the board at 4 decimeters to provide protection for the spikes.

Photograph Identification Sheet Holder

Each photograph taken in photo monitoring should be identified. General and topic photos taken of the meter board are identified by a form attached to a clipboard and positioned between the camera and meter board. The clipboard and an adjustable post to hold it are described.

Clipboard—The clipboard is shown in figure 58. It is a standard 12-inch (30-cm) clipboard with the addition of a second clip removed from another clipboard and attached by rivets or screws as shown. The critical factor is to place the clips no closer than $10\frac{1}{2}$ inches (26 cm) apart to avoid covering any information on the identification paper. Two clips are required to prevent the identification sheet from blowing in the wind.

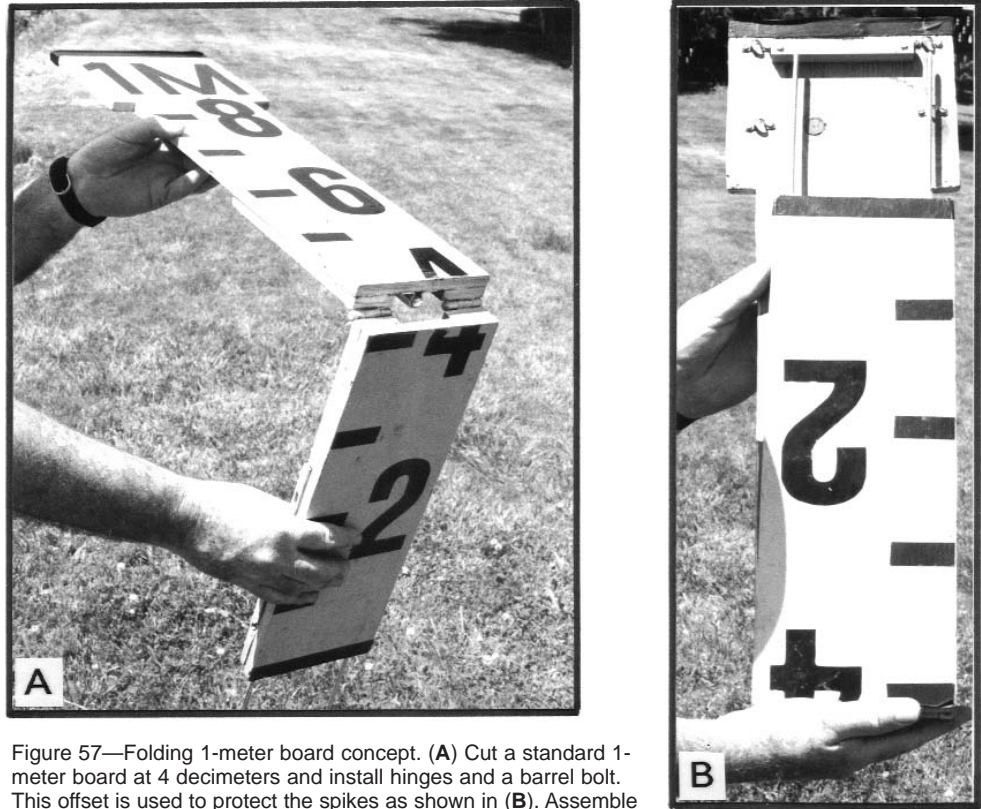


Figure 57—Folding 1-meter board concept. (A) Cut a standard 1-meter board at 4 decimeters and install hinges and a barrel bolt. This offset is used to protect the spikes as shown in (B). Assemble the board before painting and application of decimeter marks to assure correct measurements.

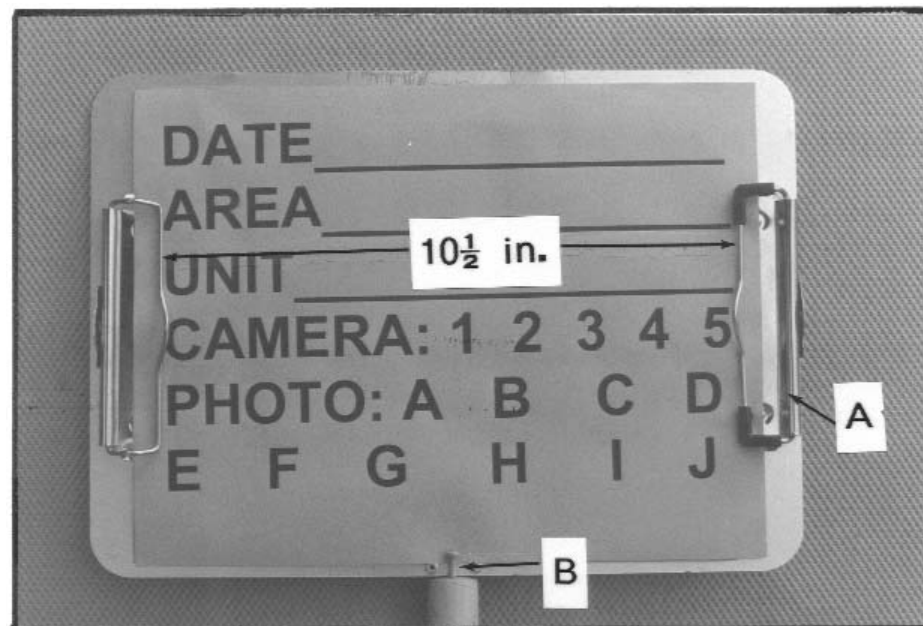


Figure 58—Clipboard for displaying photo identification forms. It includes a second clip (A) taken from another clipboard that is either screwed or riveted in place. Distance between the clipboard clips should be 10½ inches (26 cm) to (1) hold the sheet in windy conditions, and (2) not cover essential information. The clipboard is placed on the ground for plot photos or on top of a clipboard post (fig. 59) to be set in front of the camera. When placed on the post, a screw (B) inserted into the wooden block holding the ¼-inch rod behind the clipboard (figs. 58 and 61) prevents the clipboard from rotating in the wind. The form shown, "Camera-Photo" (app. A), is used for general photography.

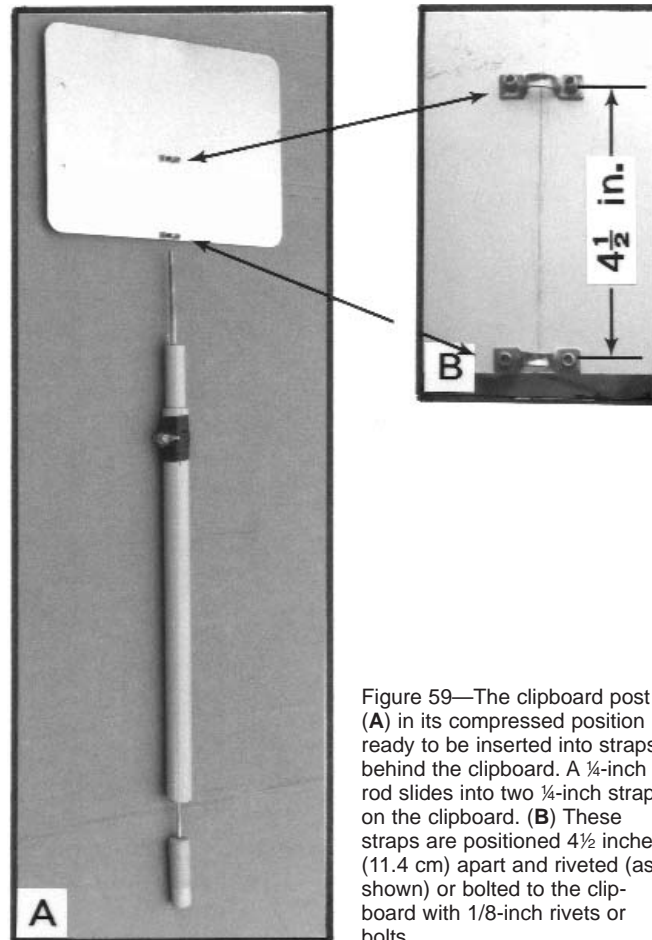


Figure 59—The clipboard post (A) in its compressed position ready to be inserted into straps behind the clipboard. A 1/4-inch rod slides into two 1/4-inch straps on the clipboard. (B) These straps are positioned 4 1/2 inches (11.4 cm) apart and riveted (as shown) or bolted to the clipboard with 1/8-inch rivets or bolts.

Materials—Prices given are in dollars as of 2001.

	Cost
	<i>Dollars</i>
2 clipboards 12 inches long @ \$4.50 each; second clipboard for its clip	9
6 each 1/8-inch diameter bolts or rivets to attach the clipboard clip and straps for the clipboard post	1
2 each 1/4-inch line guides or straps	1
Total	11

Construction—Remove the clip from the second clipboard and attach it to the first with either two bolts or two rivets (fig. 58).

Clipboard post—The clipboard post is an adjustable pole 1 inch in diameter with a spike on the end to be placed in the ground, a telescoping inside pole, and a rod at the other end on which the clipboard is placed (fig. 2 in part A; figs. 59 to 61). It is composed of telescoping plastic pipes each 18 inches (45 cm) long (fig. 60). It is 22 inches (56 cm) long when compressed and 32 inches (81 cm) long when extended. An adjustable hose clamp is attached to the upper end of the larger pipe, which compresses around the inside pipe to hold it in place (fig. 61).

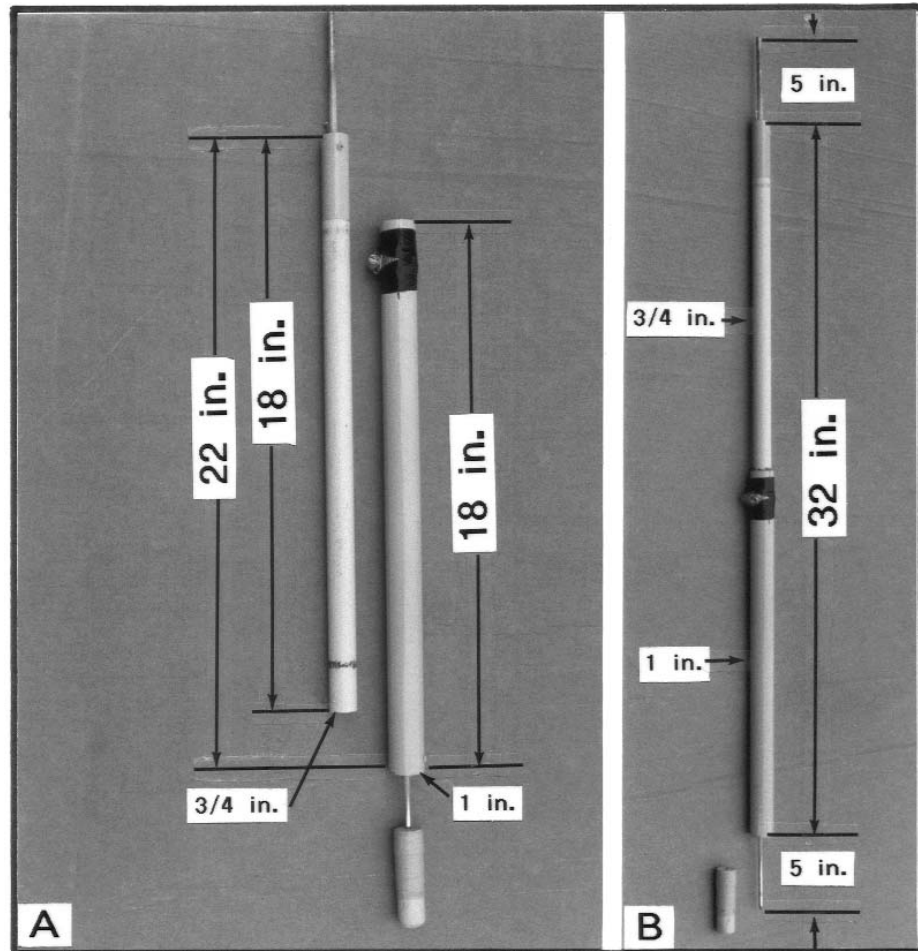


Figure 60—Construction details for the photo identification clipboard post. In (A), 1-inch PVC pipe CL 200 and 3/4-inch PVC pipe CL200, which fits inside the 1-inch pipe, are each 18 inches (46 cm) long. When the 3/4-inch pipe is inserted into the 1-inch pipe and compressed, they are 22 inches long (56 cm). In (B), the 18-inch inside pipe has been extended 14 of its 18 inches (36 of its 46 cm), increasing the length to 32 inches (81 cm). The 1/4-inch diameter spikes at the bottom and top both extend 5 inches (12.7 cm) beyond the pipe and are imbedded into doweling inserted in the pipe.

Materials—Prices given are in dollars as of 2001.

	Cost
	<i>Dollars</i>
PVC pipe 1 inch CL 200 at \$1 per 10 feet	1
PVC pipe 3/4-inch CL 200 at \$1 per 10 feet	1
Hose clamp 1-inch diameter	1
Steel rod 1/4-inch diameter, 36-inch piece, cut two 7 inch pieces	1
Electricians tape	1
Total	5

Construction—Figure 59 illustrates the clipboard post in its compressed position. Two straps capable of having a 1/4-inch-diameter rod inserted are attached to the back of the clipboard at the middle, as shown. They are centered 6 inches (15 cm) from each end and placed 4 1/2 inches (11 cm) apart so that the 5-inch (13-cm) rod will engage each.

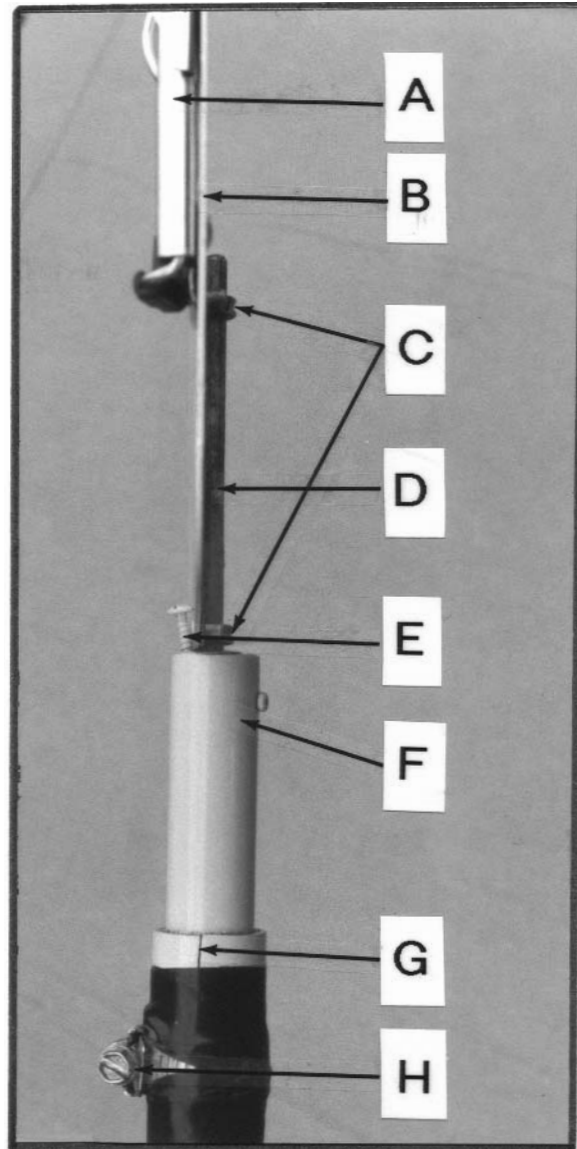


Figure 61—Details of how the clipboard is placed over the rod as viewed from the edge of the clipboard. (A) The clip of the clipboard. (B) The edge of the clipboard, in this case an aluminum board. (C) The $\frac{1}{4}$ -inch straps into which the $\frac{1}{4}$ -inch rod of the post is inserted. (D) The $\frac{1}{4}$ -inch rod of the post inserted into the clipboard straps. (E) A screw is inserted into the wood doweling that holds the $\frac{1}{4}$ -inch rod. The screw prevents the clipboard from rotating in the wind (fig. 58). (F) A piece of doweling fitted inside the $\frac{3}{4}$ -inch PVC pipe is drilled out for a $\frac{1}{4}$ -inch steel rod and is held in place by a screw. (G) With a saw, cut down 2 inches (5 cm) into the 1-inch PVC pipe so that the pipe can be compressed by the hose clamp (H) to hold the inside pipe at the desired height. At (H), secure the hose clamp with electricians tape.

The clipboard post is composed of two parts (fig. 60). One is 1-inch CL 200 PVC pipe and the other is $\frac{3}{4}$ -inch CL 200 PVC pipe, both 18 inches long. The $\frac{3}{4}$ -inch pipe fits inside the 1-inch pipe with some slack. If pipe specifications other than these are used, be sure that one pipe will fit inside the other. When compressed, the clipboard holder is 22 inches (0.5 m) tall. When extended with 4 inches of interior pipe inside, it is 32 inches (0.8 m) tall (fig. 60).

To make the clipboard post adjustable, saw down 2 inches (5 cm) into the upper end of the 1-inch pipe (fig. 61). Then attach a 1-inch hose clamp an inch below the top of the pipe and secure it with electricians tape. Tighten the hose clamp so that the inside $\frac{3}{4}$ -inch pipe can just be moved up and down to adjust height of the clipboard above vegetation or other obstructions.

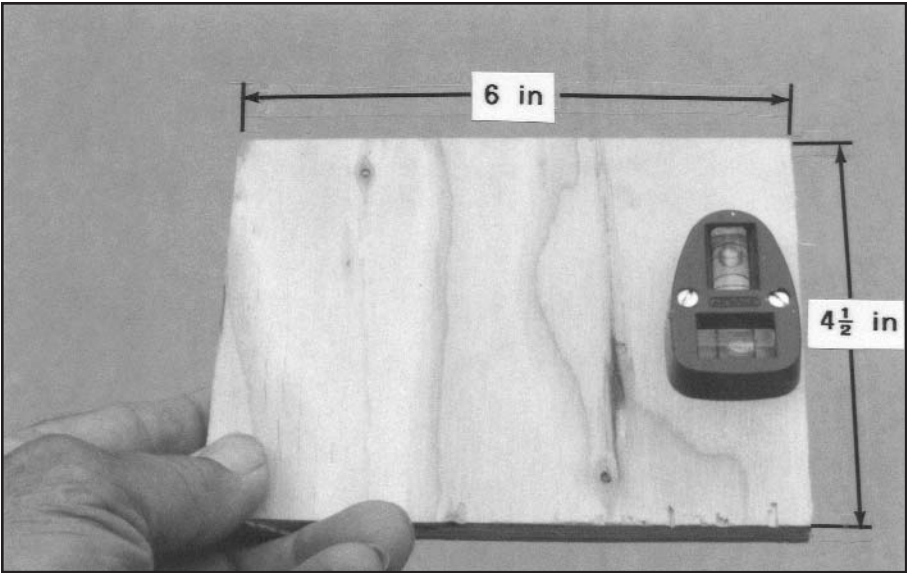


Figure 62—A leveling board for taking photos of tree canopy cover directly overhead measures 4½ by 6 inches (11.2 by 15.3 cm) and has a two-way level attached. It is made from scrap ½-inch plywood.



Figure 63—The camera leveling board is used to take repeat photographs of the tree canopy with some consistency. Place the leveling board on top of the meter board for consistent height above the ground. Place the meter board at right angles to the photo view. Move the meter board sideways to center the cross-view bubble, then tilt the level board to center the down-view bubble, move your head back, and photograph.

Camera Leveling System

Photographs taken by looking up at the tree canopy require a camera leveling system for consistent repeat photography. A leveling system described here uses the top of the meter board as one axis for consistently orienting the camera and a leveling board for the other axis (fig. 62). Figure 62 illustrates the camera leveling board and figure 63 illustrates use of the board.

Materials—Prices given are in dollars as of 2001.

	Cost
	<i>Dollars</i>
One two-way level or two line levels	4
Scrap piece of ½-inch plywood 4 by 6 inches (10 by 15 cm)	—
Total	4



Figure 64—Double camera bracket for use when photographing in both color and black and white. The bracket is made from 1-inch by $\frac{1}{8}$ -inch aluminum bar-stock with holes drilled to mount the cameras. Identical cameras are recommended to simplify camera adjustments. Figures 65 and 66 illustrate construction details.

Construction and use—Figure 62 illustrate the dimensions of the camera leveling board and placement of the two-way level. Figure 63 illustrates use of the leveling board. Place the board on top of the meter board, move the meter board left or right to center the cross-view level, then tilt the board to center the down-view level. Move your head out of the way and photograph.

Double Camera Bracket

Two cameras reduce complications when photographs are needed in both color and black and white. A bracket to hold both cameras together allows for simple and effective manipulation of the cameras (fig. 64), and identical cameras simplify adjustment. When ready to photograph, simply shoot with the top camera, then the bottom, and advance the films.

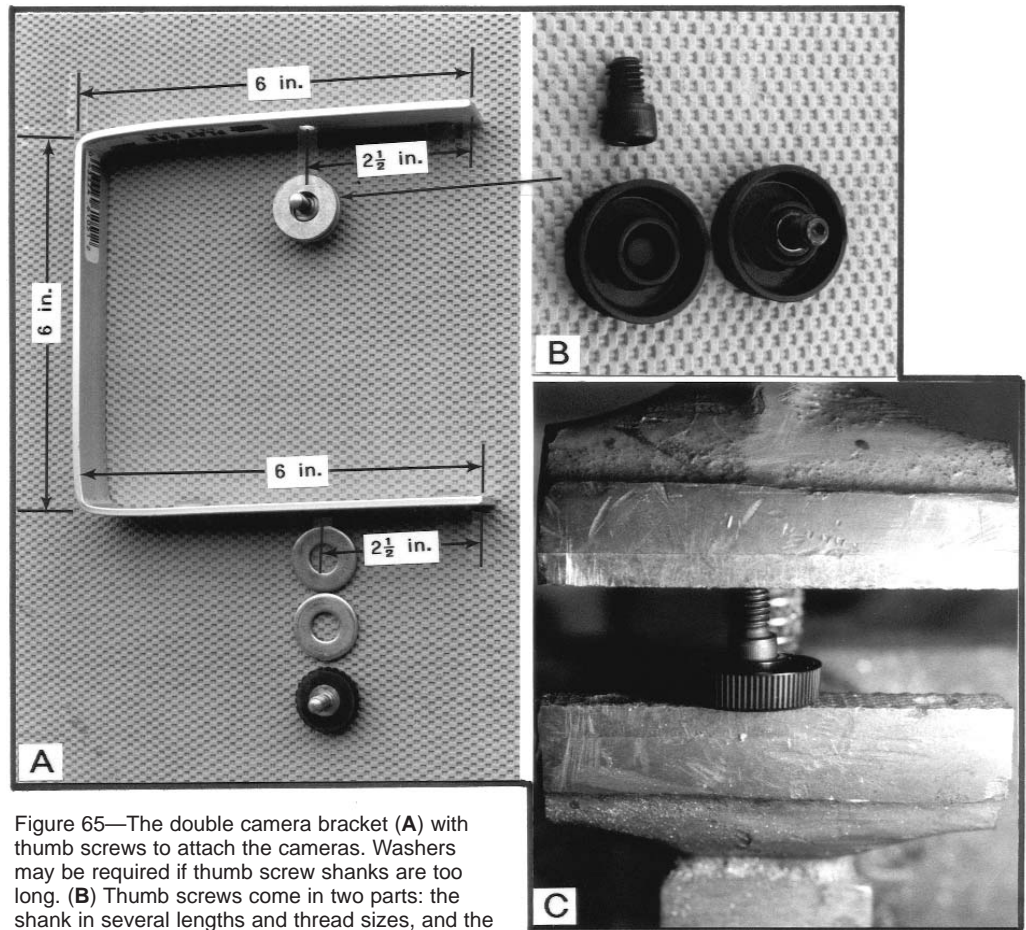


Figure 65—The double camera bracket (A) with thumb screws to attach the cameras. Washers may be required if thumb screw shanks are too long. (B) Thumb screws come in two parts: the shank in several lengths and thread sizes, and the head. The head must be forced onto the shank by using a vise (C). A shank diameter of 1/4 inch, length of 3/8 inch, and 20 threads per inch fits many cameras.

Materials—Prices given are in dollars as of 2001.

	Cost
	<i>Dollars</i>
Aluminum bar stock 1 inch (2.5 cm) wide by 1/8 inch (3 mm) thick, @ one 6-foot piece (will need 18 inches [45 cm])	8
Two instant thumb screws:	
Shank 1/4-inch diameter, standard 20 thread, 3/8 inch long (2)	1
Instant thumbs (2)	1
Total	10

Construction—The aluminum bar stock, cut into an 18-inch (45-cm) piece, is bent into equal 6-inch (15 cm) segments to form a “U” (fig. 65). Then 1/4-inch holes are drilled 2 1/2 inches (7.5 cm) in from the ends (fig. 66) to hold the cameras. Make sure the holes hold the camera in such a position as to make the rewind button available (fig. 66B).

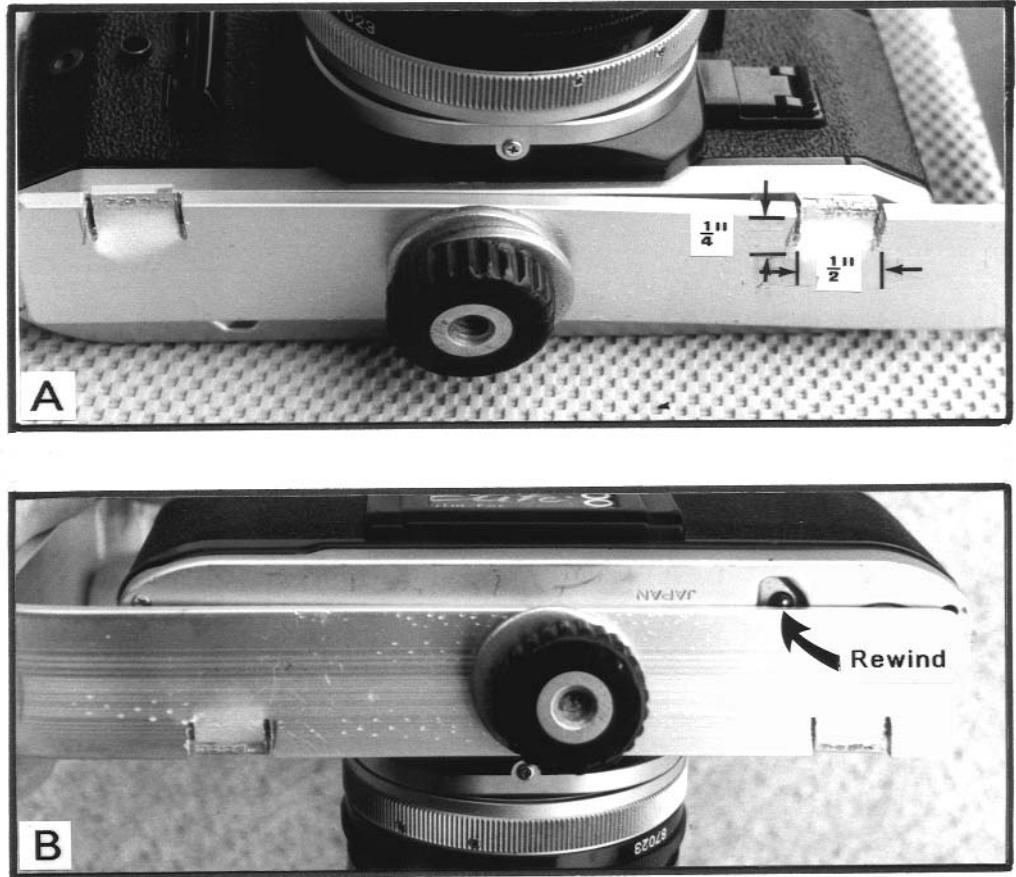


Figure 66—Two factors are important in attaching a camera to the bracket. (A), Make two cuts $\frac{1}{4}$ of an inch deep and $\frac{1}{2}$ inch apart into the front of the bracket. Bend up to about a 30-degree angle to prevent rotation movement of the camera. (B) Make sure the bracket clears the rewind button so that film may be changed while the camera is attached to the bracket.

Next make two $\frac{1}{4}$ -inch (6 mm) cuts $\frac{1}{2}$ inch (12 mm) apart into the aluminum toward the front of the camera and bend the $\frac{1}{2}$ -inch piece upwards to about a 30-degree angle (fig. 66A). Do not bend more than 30 degrees or the aluminum will break. These will prevent the cameras from rotating on the bracket.

Finally, assemble the thumb screws, which come in two parts: the shank and the thumb head. Make sure the shank will fit the camera mounting socket. Usually a $\frac{1}{4}$ -inch diameter, 20-thread shank $\frac{3}{8}$ inch long will work. Press the head onto the shank as shown in figure 65C by using a vise. Generally, heavy pliers do not apply sufficient force to seat the thumb head.

ECOLOGY PLOT REFERENCE SIGN
U.S. FOREST SERVICE - AREA 3

T. _____ R. _____ S. _____

ECO PLOT NO. _____

DISTANCE _____
BEARING _____

DATE _____ BY _____

16-1

Figure 67—Orange identification tag used to mark photographic monitoring sites. Inscribe, with a carbon point instrument, the monitoring identification name or number, date, person installing the system, and direction and measured distance to key items, such as camera locations or photo points. Mount the tag on a witness post or tree specified in the map on the "Photographic Site Description and Location" or "Sampling Site Description and Location" form.

Orange Identification Tags

Photo monitoring sites may be identified in the field by an orange tag attached to a witness post, tree, or other item identified on the sampling location maps. One kind of tag is shown in figure 67. It was custom printed for use with ecology plots. Other formats are available. The sign in figure 67 costs \$1.45 each in minimum lots of 50. New, custom printing costs \$20 for set up (prices in 2001). They may be obtained from:

Dixie Seal and Sign Co.
P.O. Box 54616
Atlanta, GA 30306
Phone: 404-875-8883
FAX: 404-872-3504

Flimsy Fenceposts

My preferred system for marking camera locations and photo points is flimsy, stamped metal fenceposts 5 feet (1.5 m) long (fig. 68). They are preferred over strong, T-bar posts for several reasons: (1) they are low in cost, about \$2.50 each; (2) they are lightweight such that four or five may be carried for the weight of one

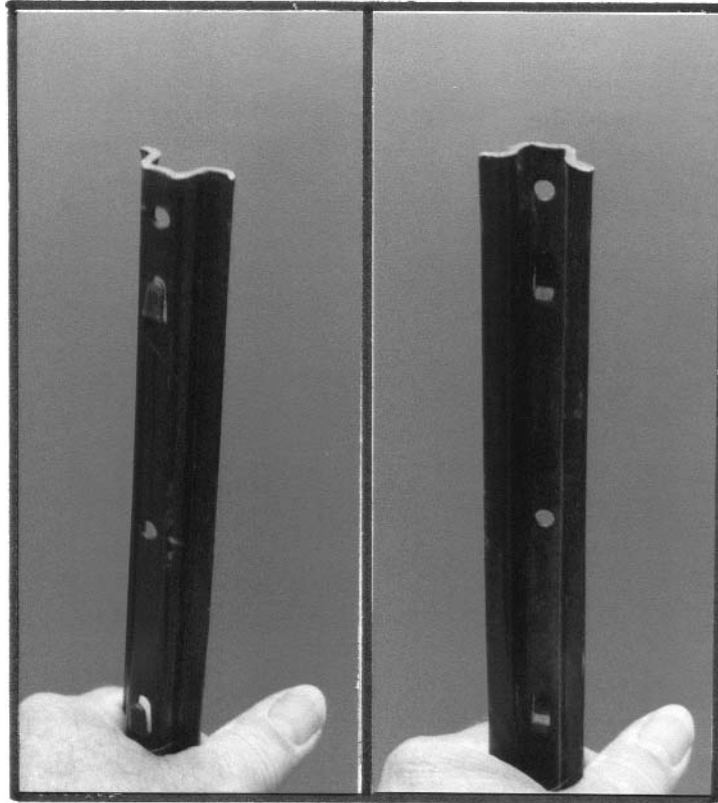


Figure 68—Flimsy stamped metal fencepost used to mark camera locations and photo points. Flimsy means the post can be twisted by hand. A 5-foot (1.5-m) length allows for pounding it 2 feet (0.6 m) into the ground, which tends to deter theft because the effort needed to remove it is not warranted by the post's value.

T-bar; (3) they are easy to pound, and the pounder weighs half of that used for T-bar; (4) of this 5-foot length, about 2 feet is in the soil when the top is even with a meter board, sufficient to require more effort to remove than the flimsy post is worthy of, thus deterring theft; (5) the flimsy strength means an animal can run into it and only be scratched, not impaled, or it can be driven over with minimum vehicular damage; and (6) the post will bend flat with the ground and remain in place when crushed by ice, logs, animals, or vehicles instead of being pulled out.

These posts are available at many large building material stores. My supply is through Home Depot. The manufacturer is Keystone Steel and Wire, 1-800-447-6444; select "Sales" from their menu, and ask for the representative in your area (such as Oregon) for a sales outlet. Ask for "5-foot, **light** duty, stamped metal fenceposts." They are also manufactured in medium duty, which are about an inch broader and stronger, an unnecessary attribute. The "light duty" posts probably will have to be ordered because they have limited usefulness.

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Bold = page where major discussion occurs

Italic = page with an illustration

Italic = page with an illustration and a major discussion

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