THE UNIVERSITY OF ARIZONA
Cooperative Extension

az1946 September 2021

Using Repeat Photography as a Tool to Monitor Rangelands

Ashley Hall and Larry D. Howery

Introduction

In many situations land managers have recollections or anecdotes about an area such as, "This pasture used to produce more grass" but do not have data to backup these statements. Repeat photography is a simple and relatively quick way to monitor rangelands. Repeat photography can illustrate changes over space and time for rangeland attributes like plant growth, species composition, total plant cover, litter, spatial arrangement of plants, and soil erosion. These are all important attributes that can be related to grazing management practices, fire, drought, precipitation, and other environmental variables. When it comes to convincing others that management practices are improving the landscape, a series of photographs taken at the same location through the years can vividly demonstrate change on the range. It is especially important to document change when people may have the historical context of the landscape.

Public land grazing permits often have repeat photography sites already established at a permanent monitoring site, or key area, on the allotment. Ask your range management specialist for a map that shows the location of key areas and the types of monitoring activities conducted at these sites in the past. Keep in mind some key areas will have photo locations established, while others may not.

If permanent photo stations have not been established on your allotment you can set them up yourself but be sure to involve your rangeland management professional. Let resource managers know you are serious about learning how grazing management, invasive species infestation, drought, fire, and other factors (e.g., rodents, insects') may be influencing rangeland resources. Range management professionals can help you establish photo locations in key areas which are monitoring locations selected to represent larger areas. For long-term rangeland trend monitoring, key areas are chosen as a representative area to measure grazing impacts. To learn more about the key area concept see Extension Publication AZ1259 "Rangeland Monitoring: Selecting Key Areas".

As is true of all forms of rangeland monitoring, photography requires clear objectives and careful selection of places to monitor. In most rangeland monitoring programs, the objective is to detect changes in rangeland attributes due to grazing, fire, weather, and other environmental variables. An inventory of ecological sites, vegetation types, and utilization patterns helps determine where and how many key areas should be located. The more variable the rangeland, the more key areas are needed. One key area is probably adequate to monitor an irrigated pasture on flat terrain, but a typical Arizona ranch may need several key areas to adequately represent the different types of ecological sites and variation in grazing pressure.

Spurious conclusions may result if a change occurs in a key area because of a localized event, such as a fire or flood, but not the larger area the site was chosen to represent. For this reason, it's helpful to have more than one key area per pasture or ecological site so that you can be confident a change is general rather than due to local conditions. On the other hand, keep in mind that repeat photo monitoring takes time so it is pointless to establish too many key areas if you will not have time to monitor them. Begin by establishing a few key areas within the high priority areas of the ranch and add more as time allows. As you gain experience, you may want to add additional photo locations and even augment your photos with other more intensive rangeland monitoring methods such as frequency, dry-weight rank, and ground cover.

There are two types of photo monitoring methods, photo-plots and photo-points, that can be used to show how rangeland attributes may change due to management and/or environmental factors. Photo-plots are close-up photos taken of a relatively small, permanently marked plot on the ground within a key area. Photo-plots are useful if your objective is to intensively monitor changes for individual plant species populations or ground cover. Photo-points are established to photograph a general landscape view of a key area. Their objective is to detect broader changes in major vegetation types, such as the degree of shrub encroachment or the impacts of fire, across landscapes.

Photo-Plots

Photo-plots are a great way to intensively monitor changes in size and number of key plant species, and to monitor changes in soil attributes like cover, pedestalling, and rilling. At the long-term vegetation monitoring sites on the Arizona Strip some locations include photo-plots dating to 1968. In the

subsequent collection of photos from Black Knoll Allotment, blue grama (*Bouteloua gracilis*) and burrowed (*Isocoma tenuisecta*) composition and ground cover wax and wane from 1968-2009 mostly in response to variation of rainfall and time of year that the photos were taken (photos 1 to 8). In 2004 (Photo 7) a new species, threeawn (Aristida spp.), appears just out of the frame and in 2009 (photo 8) globemallow (*Sphaeralcea* spp.) is present for the first time.

As discussed earlier, photo-plots should be placed within key areas. Each photo-plot is a small sample of the key area. It should include plant species of principal interest, such as at least one key forage species. If soil erosion is of concern photo-plots can be located in a rilled or gullied area. Because of the small area being monitored (the plot) it may be necessary to have several different photo-plots located within a key area to avoid making false conclusions based on too little information.

Photo 1. Black Knolls Allotment Site 17, August 1968.

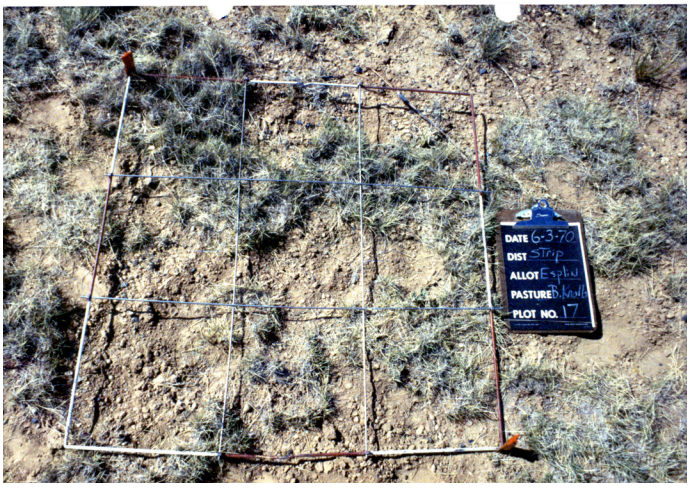

Photo 2. Black Knolls Allotment Site 17, June 1970.

Photo 3. Black Knolls Allotment Site 17, August 1974.


Photo 4. Black Knolls Allotment Site 17, November 1986.

Photo 5. Black Knolls Allotment Site 17, June 1989.

Photo 6. Black Knolls Allotment Site 17, March 1996.

Photo 7. Black Knolls Allotment Site 17, July 2004.

Photo 8. Black Knolls Allotment Site 17, May 2009

Small scale photos can show major changes, however, the overall vegetation at a landscape level may not have changed drastically. Plants often come and go at a small scale but at a large-scale vegetation change may not be apparent on the entire site. It would be beneficial to compare photo-plots and photo-points to document a more comprehensive view of changes across both small and large scales within each key area.

Photo-plots conventionally vary in size from 1 x 1-meter, 3 x 3-feet, or 5 x 5-feet (Figure 1). You will need a step ladder to ensure a high enough angle to photograph the 5 x 5-feet size.

To establish a photo-plot the following items will be needed:

- Frame made of PVC pipe, steel rods, or similar material to delineate the photo-plot. You can also use 2, 6-feet wooden carpenter rulers folded at 3-feet to mark 3 x 3-feet photo-plots.
- It is optional to use four rods to divide the 3 x 3-feet and 1 x 1-meter photo-plots into 9 square segments (Figure 1). The smaller segments can serve to further delineate changes in vegetation within a photo-plot.
- Three half-inch angle iron stakes (rebar or PVC pipe) at least 16-inches long. If you are concerned about metal stakes in the ground causing flat tires and/or injuring animal hooves, PVC pipe can be used. If you do not want any stakes in the ground rock cairns can also serve as plot markers.
- Dry ease board and marker or paper photo identification form (Appendix A). Pastel-colored paper (e.g., gray, or light green) works better than white paper because white paper can reflect light rendering form unreadable.
- Study location and documentation form to record site information and other important data (Appendix B). If you are using software for recording and managing vegetation data, like VGS, on a mobile device this information can be stored within the application.
- Bright colored spray paint, like yellow or orange, to be used to mark the angle iron so it will be easier to find when you return to the site.

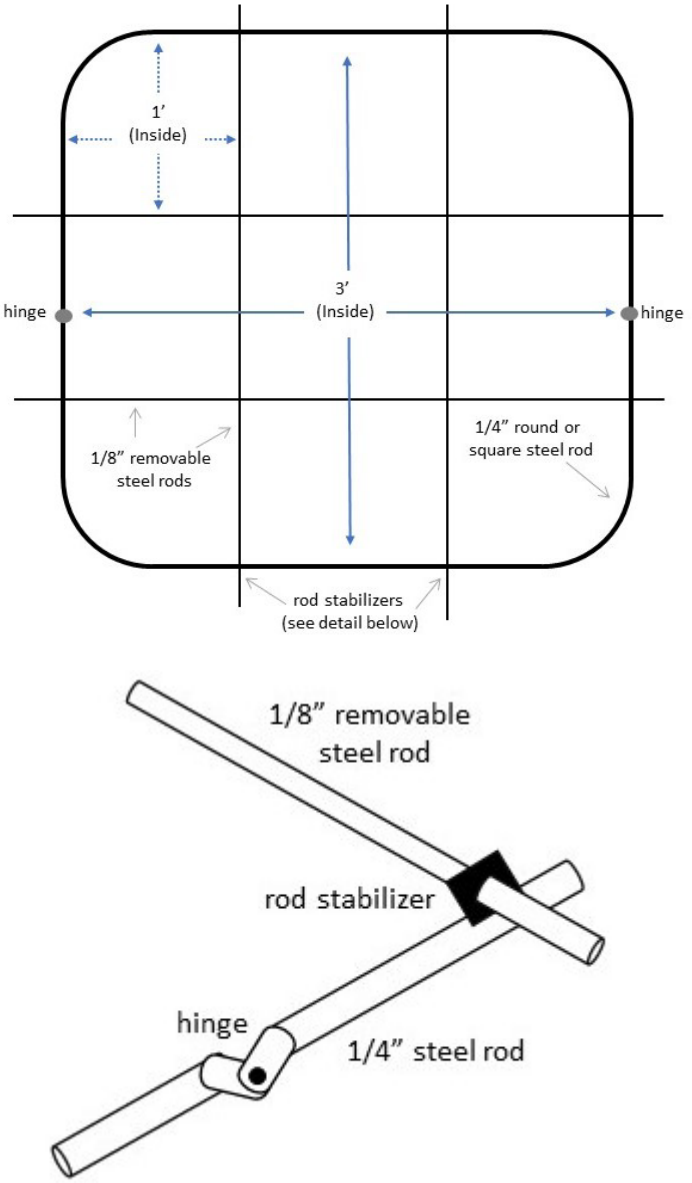

Figure 1. Photo-plot frame (3 x 3-feet).

- Steel t-post or some other device to serve as a roadside marker, commonly called a witness post.

Once you have determined the location within a pasture you want to establish a photo-plot, mark the area where the frame will be placed on the ground using stakes, including one stake just outside the midpoint of the north side of the frame (Figure 2). Next, follow these steps:

1. Place the frame on the ground aligning the plot frame so the sides are with the cardinal directions.
2. Label the dry erase board or photo identification form (Appendix A) and place it flat on the ground immediately outside of the photo-plot frame.
3. To reduce shadowing across the plot, take the photo from the stake at the north side of the photo-plot.
4. Take landscape photos of salient, permanent landmarks to help you relocate the photo-plot in the future, particularly if the witness post is removed.
5. Place the steel t-post, or witness post, near the rebar so the photo-plot location is easy to find during the next visit.
6. Mark the coordinates of the witness post using a GPS device. In case GPS device is lost it can also be helpful to make careful notes of the photo-plot location that will help you or others relocate the photo-plot in the future, including:
   - Prominent physical features of the key area (photographed in your landscape photos, step 4), such as roads, trees, fence lines, rock out- crops, streams. Be specific so that you or others could relocate the plot by following your directions. Remember, it may be a year or more before the plot is photographed again.
   - Other observations you deem appropriate to the general area (e.g., actual use, animal concentration, wildlife sign/use, rodent sign/use, insect infestation, flood, fire, rainfall, water availability, human impacts).

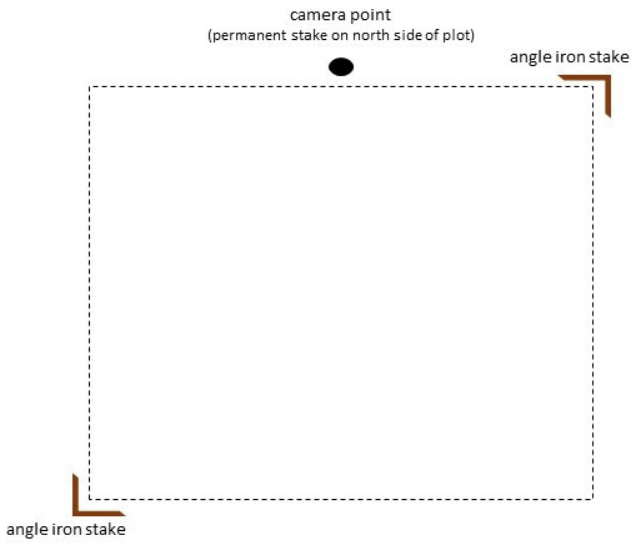

Figure 2. Permanent photo plot location (3 x 3-feet, 5 x 5-feet, or 1 x 1 meter).

7. Make note of the rationale for choosing this location as the site for the photo-plot.
8. It is optional to spray paint the stakes with bright- colored paint.
9. Organize your photos and forms in a 3-ring binder by date and photo- plot identification number. If you are using a tablet to collect information of vegetative attributes as part of a robust monitoring program, photos can also be organized and stored on the device.

Photo-Points

Photo-points are often used to monitor how rangeland vegetation may change temporally across a particular landscape. Landscape or oblique-view photos are especially useful for detecting shrub or invasive species encroachment into grasslands, and for monitoring the spatial arrangement of trees and shrubs (photos 9-16). At the Santa Rita Experimental Range (SRER), south of Tucson, Arizona, there are 124 photo-points that have been monitored using repeat photography since the 1940s. In the subsequent collection of photos from SRER Site 270-2 there are noticeable differences in the composition of grasses and shrubs over time. From 1948 to 2019, burrowed cycles in and out of the site which can be easily seen in this photo series, specifically between 2000 and 2007 (photos 13 and 14) as well as 2013 to 2019 (photos 15 and 16). Perennial grasses, such as Lehman lovegrass (*Eragrostis lehmanniana*) and Arizona cottontop (*Digitaria californica*) also change noticeably across the years.

Photo-points can be established in upland areas to document changes in dominant plant life forms (e.g., grasses to shrubs, or vice versa). In hilly or mountainous country, it helps to locate photo-points so that views can be shot across narrow valleys and hill slopes. These views spread out vertically and aid in plant identification. A photo-point location can also be positioned to allow for a 360-degree panorama of the key area.

Photo-points are also commonly used in riparian areas to document changes in streamside attributes (e.g., bank cover, erosion, stream width, changes in number and size of trees and shrubs). The number of photo-points established depends on your objectives and the length of the riparian area, but a minimum of three (i.e., upstream, downstream, and across-stream) are usually recommended at each photo location.

To establish a photo-point you will need items 4–16 listed in the photo-plot section. You will only need one, 1/2-inch angle iron stake (rebar or PVC pipe) if you choose to put stakes in the ground. In many situations the witness post can be used as the start of a vegetation monitoring transect and as the marker for the photo-point location. After the location has been chosen, follow steps 5 through 9 in the photo-plot instructions.

To make sure you are photographing the same location each time you return to the photo-point, bring your 3-ring binder or a mobile device that contains previous photos and site information with you. Use your previous photos and GPS to relocate the photo-point stake or witness post. Refer back and forth between the camera view finder and a previous photo until you are satisfied the photo includes the same landscape shown in the prior photo.

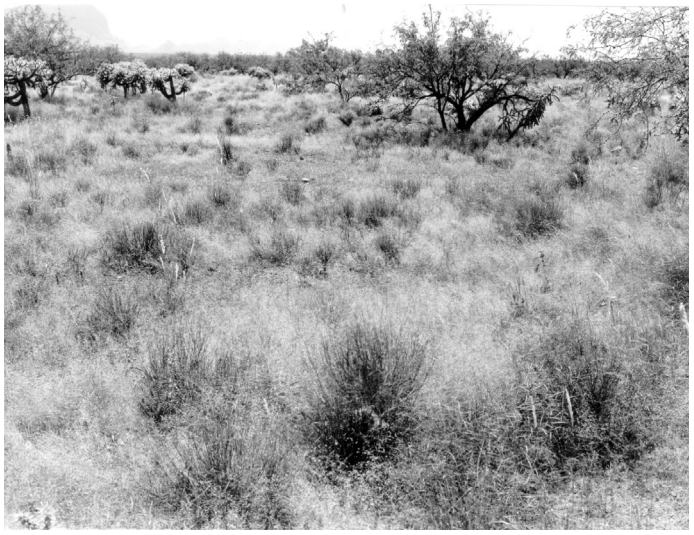

Photo 9. Santa Rita Experimental Range Site 270-2, September 1948.

Photo 10. Santa Rita Experimental Range Site 270-2, April 1960.

Photo 11. Santa Rita Experimental Range Site 270-2, October 1984

Photo 12. Santa Rita Experimental Range Site 270-2, January 1988.

Photo 13. Santa Rita Experimental Range Site 270-2, April 2000.

Photo 14. Santa Rita Experimental Range Site 270-2, March 2007.

Photo 15. Santa Rita Experimental Range Site 270-2, March 2013.

Photo 16. Santa Rita Experimental Range Site 270-2, March 2019.

General Reccomendations

Changes in rangeland attributes occur relatively slowly in the arid southwest, particularly in upland areas. Riparian areas have more potential to change rapidly in response to both management and precipitation. Repeat photography will help document subtle rangeland changes but are unlikely to provide sufficient information to evaluate complete progress towards your goals and objectives. Collecting quantitative data such as precipitation, forage production and utilization, species frequency, ground cover, and actual use (i.e., stocking rates,) etc. are critical to interpreting progress towards desired conditions.

Repeat photography should be an important part of any rangeland monitoring program. It is fast, inexpensive, repeatable, and can help you to document causal agents in vegetation changes when implemented over several years. If you are not currently participating in a formal rangeland monitoring program, repeat photography is an excellent way to start. It may be the only type of monitoring you have time for initially. The next time someone says "show me" how things have improved, you will have documentation. Remember, a picture can be worth a thousand words.

Update of *Arizona Ranchers' Management Guide* publication "Using Repeat Color Photography as a Tool to Monitor Rangelands" written by Larry D. Howery and Peter Sundt. Arizona Cooperative Extension. Originally published 1993 Edited 2001.

References

Interagency technical reference. *Sampling Vegetation Attributes.* Cooperative Extension Service, USFS, BLM, NRCS, 1996.

University of California, Cooperative Extension. *"How To" Monitor Rangeland Resources.* Division of Agriculture and Natural Resources. Intermountain Working Group Publication 2, 1994.

Photos provided by the Santa Rita Experimental Range Digital Database. Funding for the digitization of these data was provided by USDA Forest Service Rocky Mountain Research Station and the University of Arizona. https://cals.arizona.edu/srer/
and by the Bureau of Land Management.

THE UNIVERSITY OF ARIZONA
Cooperative Extension

AUTHORS

Ashley Hall
Area Assistant Agent, Agriculture and Natural Resources

Larry D. Howery
Noxious Weeds/Range Management Specialist & Professor

CONTACT

Ashley Hall
ashleys3@email.arizona.edu

This information has been reviewed by University faculty.
extension.arizona.edu/pubs/az1946-2021.pdf

Other titles from Arizona Cooperative Extension can be found at:
extension.arizona.edu/pubs

Date:_____

Site No.:_____

Allot.:_____

Past.:_____

Appendix B. Study location and documentation data form.

Repeat Photography Site Documentation			
Allotment:		**Pasture:**	**Site Number:**
Ecological Site:		**Date Established:**	
Elevation:	**Slope:**	**Aspect:**	
Coordinates:			
Transect Bearing:		**Photo-point Frame Size:**	
Rationale for Site Selection:			
Notes (prominent physical features of the key area, actual use, animal concentration, wildlife sign/use, rodent sign/use, insect infestation, flood, fire, rainfall, water availability, human impacts):			