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Natural Areas News and Information Exchange

Windows into Change

Extracting Environmental Data from Old Photographs

Most people treasure old photographs for sentimental reasons. Others appreciate the historical value of early images. But to many students of the natural environment, historical photographs offer a treasure trove of scientific information that is useful for a variety of research and monitoring purposes. Among these are documentation of species composition changes; analysis of landscape changes such as the stability in woodland-grassland boundaries; quantification of demographics of major species; interpretation of geomorphic changes; and analyses in change in archaeological sites. At the Desert Laboratory of the University of Arizona, we have one of the largest repeat photography projects in the world with about 3,200 documented camera stations and between 15,000 and 20,000 cataloged negatives.

Repeat photography is particularly useful in providing historical data on environmental conditions. Most ecosystem studies suffer from a lack of baseline information on the environmental condition before disturbances or initiation of land-use practices. Anecdotal information, such as

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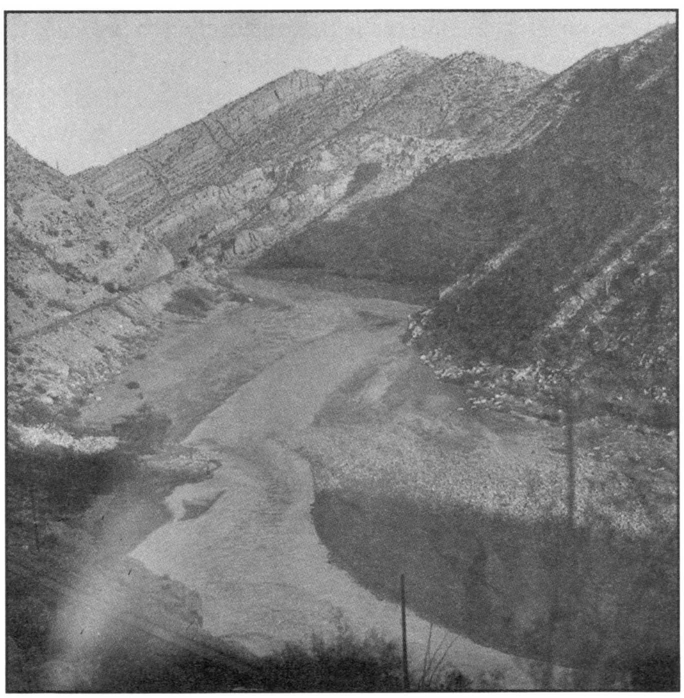

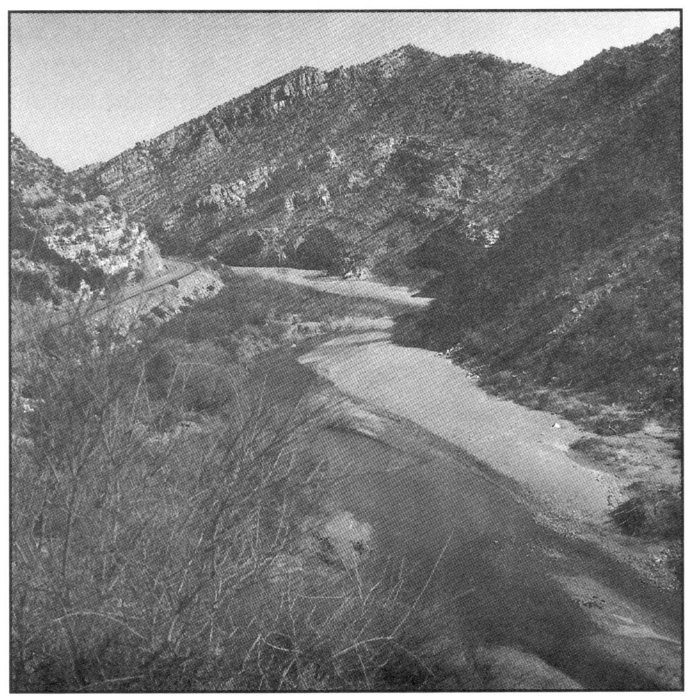

Upstream view of the Gila River near Winkleman, Arizona

February 1928. Photo shows Gila River in an open floodplain with a railroad line running on its west side. Floods possibly as high as 300,00 cfs once roared through this canyon, but by this time, the river had been regulated by Coolidge Dam for several years.
Photo by Charles Amsden, courtesy of the Southwest Museum

January 1994. Despite about 70 years of flow regulation, and a large dam release during previous winter flooding, riparian vegetation has increased. Much of the vegetation close to the channel is non-native tamarisk, but native mesquites have increased significantly on the point bars which have aggraded by several meters.
Photo by R.H. Webb, stake 3108, Desert Laboratory collection

Repeat Photography and Monitoring: Using Old Photographs to Extract Environmental Data

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diaries or General Land Office survey notes, is useful but must be interpreted carefully to remove observer bias. The major bias in repeat photography is what the photographer chose to record, and that bias can be minimized by examining reasonably large numbers of photographs. A second bias is the resolution of the original photograph, particularly in comparison with the modern match, but this bias can also be at least partially overcome by obtaining high-quality images.

Replicating old photographs is generally not as difficult as finding the original views. Those of us who practice repeat photography on a regional scale are archive rats; some of our best friends work in places like the National Archives, state historical societies, or in the special collections branches of university libraries. Currently, there is no way to search archives through the Internet, so finding old photographs is still an exercise in detective work. The personal touch is best, because archives seldom know exactly what they have in their inventories, making visits to archives an important start to any repeat photography project. One of the most essential and usually difficult tasks is to determine the exact date or approximate year of the photograph. Many photographic collections, particularly ones from specific photographers, were donated with diaries or other documentation, and these commonly are kept in a separate location in the archives from the photographic materials.

Once appropriate images have been identified, some sort of hardcopy is necessary to match the photograph. The most critical step in repeat photography, and the most important factor in how much information can be obtained, is the acquisition of high quality images. Most archives offer 8x10 copy prints made from copy negatives, but these negatives may be several generations removed from the original negatives. The maximum resolution is obtained from a duplicate of the original negative, assuming that the original negative still exists. If the original cannot be found, the best alternative is to have a copy negative made of an original print. Here is where it doubly pays to have an excellent rapport with archivists, because special permission usually is required to obtain negatives of any sort.

The choice of camera system also strongly affects the information content of repeat photography. I firmly believe in using large-format cameras because of the high resolution, which is particularly useful for identifying plant species. The resolution of a good 4x5 system is far greater than that of the best 35 mm cameras. An added bonus of the large-format systems is the composure area on the ground glass corresponds to the exact image recorded on the negative. Most of our work involves 4x5 film in cut-film holders, although occasionally we use 6x9 cm film in rollback holders; in either case, we rely on Polaroids to make sure the match is done correctly in the field. We always mount our cameras on tripods and record camera height, the view azimuth, and the camera tilt, and we usually place a permanent marker under the lens.

Interpretation of replicate photographs is both art and hard science. Sometimes all the information in a replicate pair is extracted with a glance: the changes, or lack thereof, are obvious. One example is the downslope movement of trees into areas that formerly were grasslands. In most cases, repeat photography uses the best of observational science, requiring considerable expertise to identify subtle details or changes. Considerable knowledge and skill is required to reliably identify plant species from foliage or branching patterns, or to interpret subtle changes in fluvial systems. We now utilize image-processing software for a variety of automated photographic-interpretation tasks, including photo rectification and analyses of image tonal quality.

The Desert Laboratory collection consists of repeat photography of the southwestern United States — principally Arizona and adjacent states — as well as Mexico and Kenya. The largest single holding is of Grand Canyon, which comprises about 1,300 camera stations. Currently we are working on an update of *The Changing Mile*, a classic book by Hastings and Turner on environmental change in the Sonoran Desert; a repeat photography project in Baja California, in cooperation with the Mexican government; documentation of change in the Colorado River through Canyonlands National Park; and a regional-scale examination of the stability of riparian systems in the southwestern United States.

Robert H. Webb
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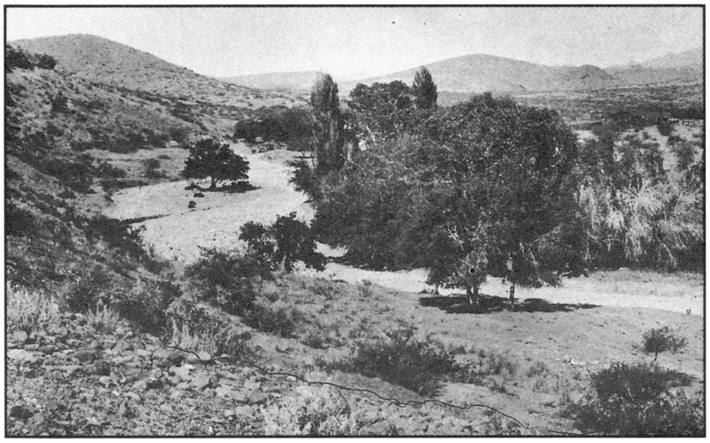
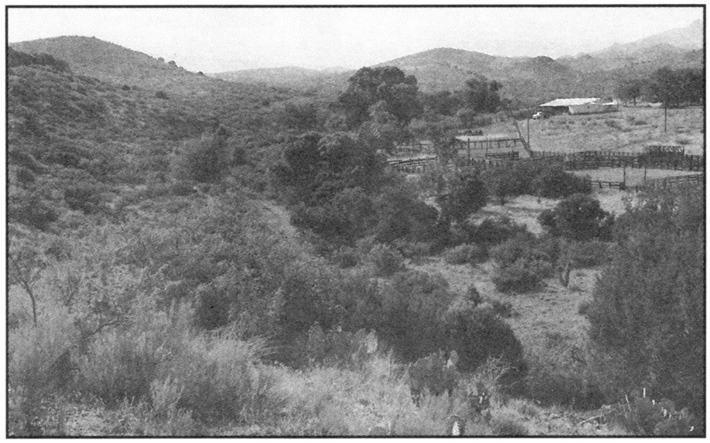
Tucson, Arizona





Ranch scene in Munk Draw, Dos Cabeza Mountains, southeastern Arizona

Unknown date between 1901 and 1919. The photograph shows an open ephemeral stream channel adjacent to the ranch headquarters, and relatively barren slopes with sparse shrubs and grasses.
Photo by J.A. Munk, courtesy of the Southwest Museum

June 1995. The ephemeral channel is hidden by dense riparian vegetation, all of which is native. Shrubs, including small mesquite trees, have encroached on the hillslopes. (Similar increases in both riparian vegetation and shrubs have occurred throughout southern Arizona during the last century).
Photo by D. Oldershaw, stake 3326, Desert Laboratory collection

Book Review

Restoring Diversity: Strategies for Reintroduction of Endangered Plants

Edited by Donald A. Falk, Constance I. Millar, and Margaret Orwell. Island Press, 1996, 505p.

Reintroducing endangered plants back into their native habitat remains an uncertain endeavor. As the editors of this volume point out, the basic biological understanding necessary for successfully reintroducing species and restoring natural communities is still poorly developed, and "links between restoration and the main body of ecological theory have barely been forged". This timely book, the result of a national conference, is the culmination of a project by the Center for Plant Conservation to gather the most current thoughts of natural resource professionals on the many aspects of endangered plant reintroduction.

The book opens with a discussion of the different forms of rarity in plants, and situations which might be most amenable to attempted reintroduction. However, as Lynn Kutner and Larry Morse point out in chapter 2, even the best planned efforts might have limited long-term success, if global climate change becomes a reality. Development, large-scale land conversion, and the introduction of exotic species are among many landscape-level environmental changes that have restricted many rare plants to small patches within a highly fragmented and altered landscape. The ability of these populations to persist without corridors of habitat linking them to regions with different climate is a concern.

The importance of and the difficulties inherent in choosing or creating a viable environment in which to plant is underscored by the research findings described by Richard Primack (Chapter 9) on studies of experimental introductions. Primack and his associates introduced seed of several species into environments that appeared to match the site environments in which the plants naturally grew, and found that few introductions resulted in self-sustaining populations. This may be due to complex and subtle habitat characteristics that are difficult to predict at the time of planting.

A significant and valuable portion of this book is devoted to reintroduction within a mitigation context. Chapters by Ann Howald and Joy Zedler document failures (and a few successes) of past mitigation attempts, providing us with many ideas about how mitigation might be improved. These accounts make the case that consistently better results should be required before translocation is considered a viable conservation tool. Interestingly, as Howald points out, translocation is but one of several mitigation strategies, and is often viewed as the absolute

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Resurveying Vegetation on Fishtail Mesa, Grand Canyon National Park

Few areas exist in the southern Colorado Plateau that have not been heavily grazed. Those canyons and mesas with walls too steep for livestock are also nearly inaccessible to scientists wanting to analyze the condition of ungrazed land. This was the challenge faced by Don Jameson, Range Conservationist for the Rocky Mountain Forest and Range Experiment Station, in 1958, when he and two colleagues helicoptered onto Fishtail Mesa, an ungrazed 1,084-acre "island" plateau isolated from the "mainland" of northern Arizona and the nearby Kaibab Plateau.

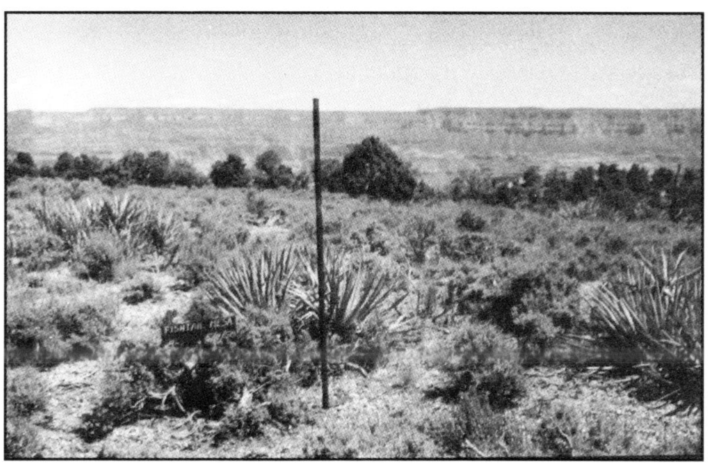
Jameson's intent was to compare the ungrazed condition of Fishtail Mesa, a waterless pinyon-juniper-sagebrush community, with nearby grazed lands, and to establish permanent transects that could be remeasured in the future. The team found notable differences in vegetation on Fishtail Mesa, particularly a greater abundance of big sagebrush and mutton grass, and less blue grama than had been recorded on grazed mainland sites. Jameson and colleagues published their findings in the journal *Ecology* in 1962, and although the study has been frequently cited in the literature of the region, the published version lacked much of the "metadata" necessary for resurveying the site.

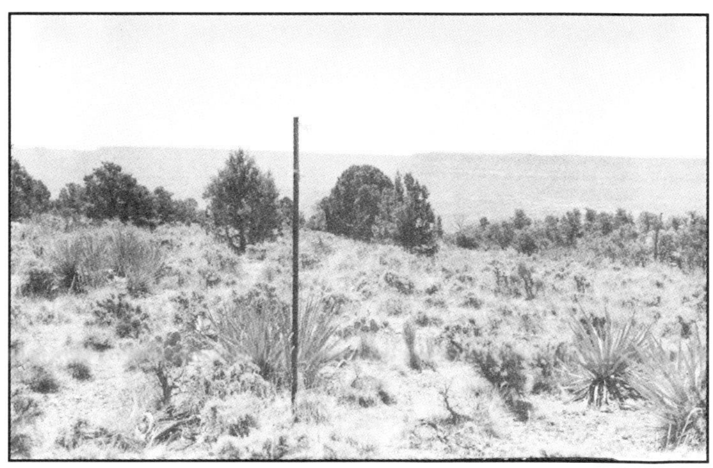
Many years later, Nancy Brian, botanist at the Grand Canyon National Park, and Peter Rowlands, research scientist for the Biological Resource Division, USGS, became interested in the Fishtail Mesa study as part of an environmental history they were preparing of the southern Colorado Plateau. Fishtail Mesa, now part of the National Park, would provide an opportunity to survey a relict site and to note nearly forty years of change.

After much searching through unpublished reports and internal memos, Brian located Jameson's photographs of the study area, but his original field documentation was lost. So Brian searched out Jameson himself, and finally tracking him down, arranged for him to accompany her and a field crew of six to revisit his transect on Fishtail Mesa.

In May 1996, the crew helicoptered to the mesa to conduct the remeasurement, hauling in supplies for six days (including 600 pounds of water). Jameson helped to locate the steel fence posts he had used to mark the elbs, or transect lines, 38 years earlier. He explained details of his sampling methods as well as assumptions he had made that were not included in the published record. Jameson's consultation ensured that the remeasurements would conform to the 1958 survey.

The most striking thing Jameson noticed on his return to Fishtail Mesa was the apparent lack of change. The earlier survey had noted severe deer browsing in the area, there seemed to have been little recovery or regeneration of shrubs. This observation was easily quantified, because in the original survey Jameson had been careful to design a methodology to measure stable components of the site. The earlier survey had recorded basal intercepts of grasses and forbs, rather than the more ephemeral crown intercepts, along eight 800-foot transects. They recorded crown





April 1958 **Fishtail Mesa, looking east toward Powell Plateau, at Elb (Transect) 8** April 1996 measurements of shrubs and boll diameter of trees. Parker loop measurements, deer pellet counts, plot and scenic photography, wildlife observations, and a soil profile and map complemented the data set.

In considering the original study design, Jameson reflected on advice he would offer those who may be establishing a new long-term study.

It is important, says Jameson, to use statistical procedures that are appropriate to repeated measurement, and to define those procedures before data are collected. Obviously, the plots should be consistent with the statistical design, and well-defined with permanent, retrievable markers. (One of Brian's resurvey team members recorded the transect locations with a global positioning system and entered it into the park's GIS database.)

Finally, says Jameson, a thorough description of the methods and assumptions should be documented and archived in a retrievable format. Although a published record of the survey is important, no journals are able to accommodate the bulk of original data and supporting methodology important to designing a compatible resurvey. Yet, the availability of these records should be footnoted in the published report and archived where they can be accessed in the future.

"Long-term studies make us feel good, but few are useful," Jameson warns. Measurement fads change with the development of new gadgets, making data collected at different times nearly impossible to compare. Therefore, the statistical design of a long-term study must be adaptable to changing technology and flexible enough to be applied to new questions as they evolve.

Brian, Rowlands, and Jameson are now analyzing the results from their remeasurements. They are reconciling the inevitable changes in taxonomy and standards of measures in order to make the datasets comparable. Preliminary results include the recording of 90 plant species, with four new records for the park. Comparison with older records suggests an increase in species diversity, but overall very little change in total vegetation cover. Comparatively high reproduction of pinyon pine and low regeneration of juniper may indicate a "pinyon invasion." And scat tentatively identified as that of juvenile elk suggests movement of a recent invader in the Kaibab Plateau.

Brian has filed voucher specimens of species recorded and documented a laundry list of methodology to allow future researchers the opportunity to retrace their steps.

"In another 50 years," says Nancy Brian, "I will be a very old lady, and someone will call me up and say, 'Do you want to go to Fishtail Mesa?', and I will say, 'You bet!"

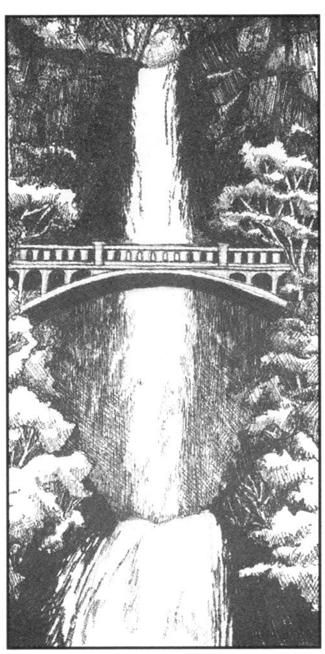
Margaret Herring
Editor, Natural Areas Report

Natural Areas Association 24th Annual Conference

August 27-30 Portland, Oregon

Mark these dates to attend the 24th Annual Natural Areas Association Conference in Portland, Oregon. The theme of the conference, "Bridging Natural and Social Landscapes" will challenge us to find areas of common ground, to form linkages between the natural and the cutural/socioeconomic values of landscapes. William Robbins, Distinguished Professor of History at Oregon State University, will open the conference. The plenary session follows with a reexamination of the role of natural areas in today's world.

A partial list of sessions and symposia includes:



- Native American perspectives on natural area management
- What is natural?: an interdisciplinary roundtable
- Urban and rural use and perceptions of natural areas
- Role of natural areas in ecosystem level management
- New and unplanned uses of native species
- Social and ecological implications of grazing: domestic & wild
- Invertebrates and natural area management
- Fire ecology - public perspectives and use

If you would like to receive a copy of the registration information and you are *not* a member of the Natural Areas Association, please write:

Natural Areas Association
1997 Conference Information
PO Box 23712
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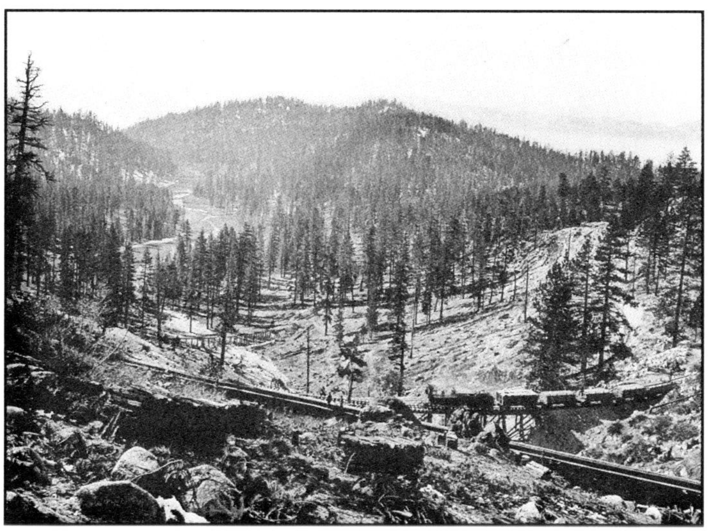
Using Repeat Photography to Measure Landscape Change

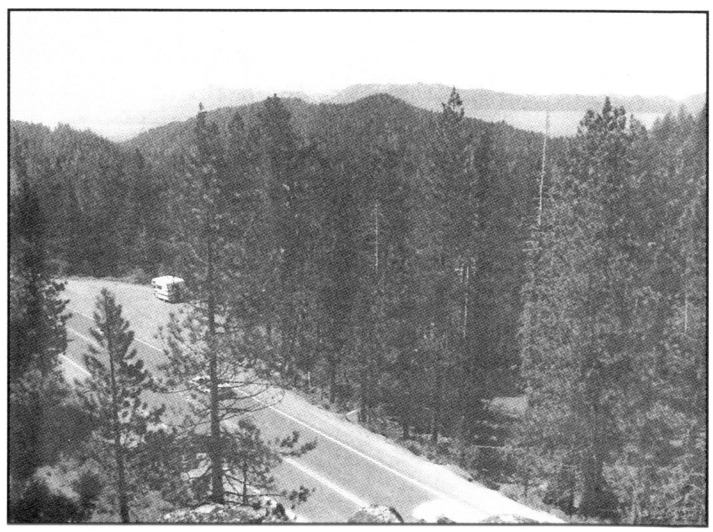
Repeat photography dates back to 1888 and 1889 when Professor Sebastian Finsterwalder initiated repeated photogrammetric surveys of glaciers in the eastern Alps. Since that time repeat photography has been widely utilized by geographers, geologists, botanists, biologists and others to document landscape changes. Over the past thirty years I have utilized this technique to interpret vegetative changes in the Great Basin, Northern Rockies and more recently in the Sierra Nevada.

Retake of historical photographs is a proven means of documenting vegetation change. However, whether original photographs are reliable indicators of conditions at the time of Euro-American settlement is being debated in the scientific community. Concern focuses on the emphasis of pre-settlement forests, grasslands and woodlands as a benchmark, or standard, of landscape health. Some critics maintain that many old photographs were made during a period of extreme disturbance and thus are not a reliable reflection of pre-settlement vegetation. This argument is often true, for instance in heavily impacted localities such as mining camps, but other areas had received little impact at the time historic photographs were taken. These latter photographs can be a valuable aid in providing insight on the appearance of pre-settlement vegetation. By retaking many pre-1900 photographs over a wide area one can gain insight on how the landscape appeared in the past and how it has changed.

Those interested in locating historical photographs that have potential for repeat photography can find them at universities, museums, historical societies, public libraries, government agencies and in private collections. Taken by professionals and amateurs, these scenes record scenic views, land surveys, geological features, railroad construction, mining, settlements, logging, and people. A key criteria in selection is the age of the photograph, depiction of a vegetation on the land, and the presence of landscape features that permit exact relocation of the scene.

Many scenes have little or no information and no distinctive features to aid location. Others contain prominent land features that allow identification of the general vicinity of the photograph. Sometimes people familiar with the scenes in question can provide critical knowledge for location. One can then locate the original camera point by lining up identifying features. This procedure can be frustrating when regrowth of trees and shrubs obscure the original view. In these instances, it is necessary to move the camera to an alternate camera point. This is often necessary in forested regions. Sometimes climbing a ladder or a tree or use of a helicopter allows a semblance of re-location.





Southwest view of Slaughterhouse Canyon, Lake Tahoe, Nevada

1873. Open slopes adjacent to railroad had been logged, while the patchy appearance of stands in canyon bottomand and in distance suggest that they had not been entered. Fuelwood stacked above flume in foreground awaits transport.
photo by C.E. Watkins; courtesy, Huntington Library and Art Center

1993 (120 years later). This photo was taken from a rock outcrop above the highway since the original camera point (below motor home) is densely forested by Jeffery pine. Many trees have died during the recent Tahoe Basin bark beetle outbreak.
photo by G.E. Gruell

Analytical techniques used in evaluating vegetation changes include field inspection of the photographed location to identify primary historical vegetation, including tree ages, stumps, and snags. It is also important to identify past disturbance including fire, livestock grazing, logging, and mining. Historical literature such as Government Land Office (GLD) maps and notes, journals of explorers and pioneers, and relevant scientific research aid interpretations of vegetation condition past and present.

Repeat photography is particularly effective in documenting vegetation change in mountainous regions where potential vegetation consists of trees and shrubs. For example, an expansive view from an elevated position showing landscape including riparian vegetation is a prime candidate for repeat photography. Within such settings, the more significant vegetation changes are often those caused by introduction or removal of livestock, fire, logging, or mining. Scenes in extensive semi-arid valleys with little variation in topography are not only difficult to re-locate, but usually show few obvious changes.

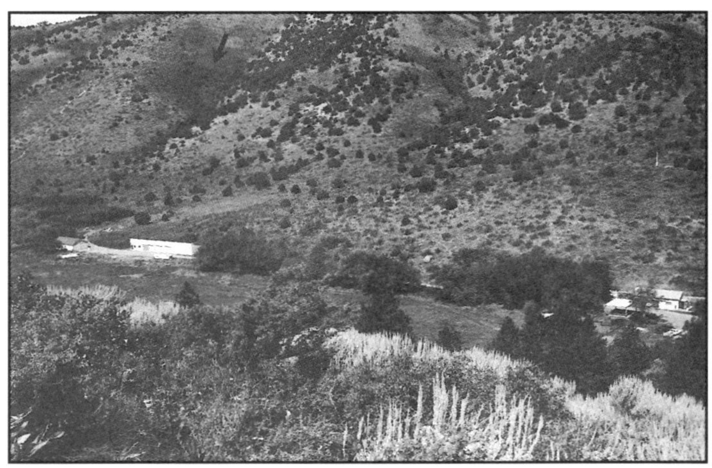
A new repeat photography study, titled *Sierra Nevada Forests Past and Present: 145 Years of Photographic Record*, by G. E. Gruell, will soon be published by Cooperative Extention University of California. It includes eighty-four paired photographs situated in four broad vegetation zones: Oak Woodlands and Pine Forest, Mixed Conifer Forests, Eastside Pine Forests, and Red Fir and Lodgepole Pine Forests. The study addresses three major questions: (1) What did the forests and woodlands of the Sierra Nevada look like during the early stages of Euro-American settlement? (2) what changes in vegetation occurred between 1850 and the 1990s? (3) and how have human activities and natural events acted as agents of change?

Interpretation of the paired photos demonstrate that profound changes have occurred in the spatial and temporal distribution of Sierra Nevada vegetation over the past 150 years irrespective of any logging. Before 1850, fire played a major role in determining vegetation characteristics. A shift from open forests dominated by large trees to dense stands and thickets of smaller trees has resulted in: (1) heavy infestations of insects and disease, (2) loss of productive understory plants, (3) accumulation of dead material on the forest floor, (4) conversion of shrubfields to conifers, (5) reduction in the availability of nutrients, (6) displacement of riparian hardwood vegetation by conifers, (7) decline and loss of mountain meadows.

Interpretation of the paired photographs suggests that changes in vegetation composition and structure have had profound implications for wildland ecosystems by reducing our ability to prevent catastrophic wildfire, and to sustainably manage wildlife habitat, livestock forage, wood products, scenic values, recreation opportunities, and water yield.

Repeat photography is a proven means of documenting vegetation change in the Sierra Nevada and elsewhere. A vast number of historical photographs with potential for repeat photography are deposited in various collections across the nation and provide a valuable source of long-term data.

George E. Gruell
Research Wildlife Biologist
US Forest Service, retired



Looking west across Mink Creek in southeastern Idaho

July 1907. Juniper on distant slopes is restricted to rock scree on south exposures where they are protected from frequent presettlement fires. Dark shrubs are bitterbrush that are closely grazed. Note dominance of herbs in foreground.
Photo by Professor Tourney, courtesy Douglas Turner

September 1982 (75 years later). In the absence of fire, juniper has markedly increased by spreading to deeper soils. Bitterbrush has also increased in density and size. Arrow points to expansion of aspen, chokecherry, and other shrubs. Foreground shows the general increase in woody vegetation. *Photo by G. E. Gruell*

(continued from page 3)

last resort by resource professionals. Many local government agencies who have the last say in development decisions often operate by different criteria. The need to document past experience, and to use this documentation to educate scientists and policy makers alike is apparent.

Defining success is not an easy prospect given the limited time scale over which many past projects have been evaluated and the current lack of information on what to expect. As Bruce Pavlik mentions, "our current inability to construct a robust definition of success is due largely to our past unwillingness to document failure". Pavlik presents a thoughtful framework for defining and measuring success based on abundance, extent, resilience, and persistence of reintroduced populations.

While practitioners of reintroduction and restoration may find some chapters of this book to be a bit theoretical, academics and practitioners alike will discover much useful information within these pages. Reintroducing plants for the purpose of biodiversity conservation is a relatively new endeavor, particularly considering the long time scales often necessary to gauge success and develop ideas and lessons from what went wrong. Such information is just now becoming available, and it is a bonus to have much of it compiled here in one book.

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Natural Areas Report

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