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Monitoring Environmental Change with Color Slides

Arthur W. Magill

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Monitoring human impact on outdoor recreation sites and view landscapes is necessary to evaluate influences which may require corrective action and to determine if management is achieving desired goals. An inexpensive method to monitor environmental change is to establish camera points and use repeat color slides. Successful monitoring from slides requires the observer to determine if there are increases or decreases of trees, shrubs, or herbaceous plants; bare ground or duff; screening by trees; and soil erosion. Illustrated guidelines are given for land managers who must monitor human impact on recreation sites and view landscapes. Slides taken at various intervals demonstrate how to detect differences in views of timber harvesting, disturbed sites, and recreation sites, and suggests what to look for in scenes with subjects viewed from various distances. By using the process, visual sensitivity for detecting and evaluating environmental change, using repeat color photography, should be increased.

Retrieval Terms: color slides, environmental change, monitoring, outdoor recreation, repeat photography, visual sensitivity

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Cover: Change in tree cover over a period of 17 years as a consequence of invasion of a road overcast near the Trinity Information Center, Shasta-Trinity National Forest (top—1969, center—1977, bottom—1986).

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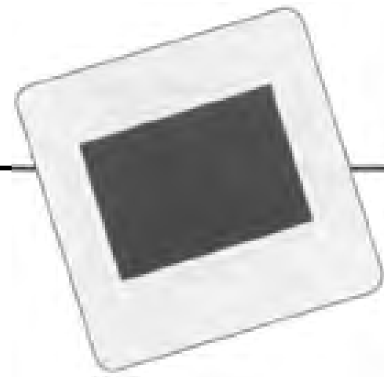

CONTENTS

IN BRIEF ...

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Monitoring human impact on outdoor recreation sites and view landscapes is necessary to evaluate influences that may require corrective action and to determine if management actions are achieving desired ecological and esthetic goals. Using ecological surveys to monitor environmental change is costly, and may not be necessary where there is little or no change. An alternative may be to establish permanent camera points and use repeat photography, employing 35 millimeter color slides. Photographic monitoring may be considered an "early warning system" that would activate an ecological survey only if adverse trends are detected.

The difficulty with photographic monitoring rests with the ability of the observer to analyze slides or photographs for chronological changes, which are often subtle and difficult to detect and interpret. Professional resource training and interest in the environment are an asset for recognizing changes, but without additional training, essential details may be missed. Successful monitoring of environmental change from slides requires the observer to determine if there are increases or decreases in the following: tree, shrub, or herbaceous plant cover; bare ground or duff; screening by trees or shrubs; and soil erosion.

An illustrated guide is provided for land managers who must monitor human impact on outdoor recreation sites and view landscapes. Slides taken from 1960 to 1970 were repeated in 1985 or 1986. These slide pairs or triplets are used to demonstrate how to detect differences in view landscapes, recovery after timber harvesting, disturbed sites, and developed recreation sites. The reader is told how to prepare slides for analysis, and what to look for in various scenes viewed at middle to background distances, as well as a variety of foreground situations. Following the guidelines should increase visual sensitivity for detecting and evaluating environmental change, using repeat color photography.

INTRODUCTION

Monitoring human impact on outdoor recreation sites and view landscapes is necessary to evaluate influences that may require corrective action and to determine if management actions are achieving desired ecological and esthetic goals. A sound monitoring program would ensure effective allocation of limited funds, and should be intensified whenever resources or social uses are threatened (Haas and others 1987). In addition, Federal regulations (36 Code of Federal Regulations 219.5 (k)) require that agencies, such as the Forest Service, U.S. Department of Agriculture, and the Bureau of Land Management, U.S. Department of the Interior, monitor and evaluate their land management practices.

Permanent camera points have been successfully used by scientists and managers to record environmental conditions and changes for many years. A published guide described the usefulness of permanent camera points for obtaining photographs to be used for monitoring esthetic and biologic changes of wildland resources (Magill and Twiss 1965). Also, it outlined procedures for establishing a camera point and recording data about the location and each photograph. A subsequent paper described a method for establishing a network of permanent camera points or landscape control points for monitoring and predicting the visual impacts of landscape alterations (Litton 1973). In other studies (Gibbens and Heady 1964, Gruell 1983, Gruell 1980), historical photographs have been replicated to assess the influence of timber harvesting, recreational use, fire and vegetative trends, and fire on wildlife habitat.

Despite the documented applications of repeat photography, it is unlikely that resource managers, responsible for monitoring the environment to detect potentially detrimental changes, possess the necessary visual sensitivity to make photographic assessments without additional training. This lack of sensitivity may exist even though a majority of resource professionals probably are experienced photographers—most as amateurs (family photos and such), some in relation to their work, and a few may be experts. However, being an experienced photographer does not automatically provide one with the visual sensitivity needed to analyze slides for chronological changes, which are often subtle and difficult to detect and interpret.

Successful monitoring of environmental change from slides requires the observer to determine if there are increases or decreases of trees, shrubs, or herbaceous plants; bare ground or duff (litter); screening by trees or shrubs; and soil erosion. Professional training and natural interest in the environment are assets for recognizing changes. Nevertheless, people tend to overlook details, so it is easy to miss seeing subtle changes—the scene in an original and a repeat slide looks so similar as to superficially look the same. For example, a companion, early in a trip to obtain photographic examples of various landscape impacts, would ask why I was stopping—what had I seen that was worthy of a picture? Upon pointing to a subject, she would admit not having seen it. However, near the end of the trip she began telling me of subjects I had not seen while driving—she had become sensitized. Actually, she liked her visual experiences better before she became sensitized! Nevertheless, developing sensitivity in the reader is the main purpose of this paper.

Slides taken from different locations throughout California were repeated during 1986. The majority spanned 17 to 26 years, but a few covered only 9 years. Some slides had been repeated at 2, 4, or 5 year intervals, which permitted an approximation of whether change may have been more rapid early or late in the sample period. This report uses these slides, developed as photographs used in the figures, to provide guides for improving people's ability to analyze slides in search of ecological changes, as well as to provide case histories of changes which may have occurred at specific locations.

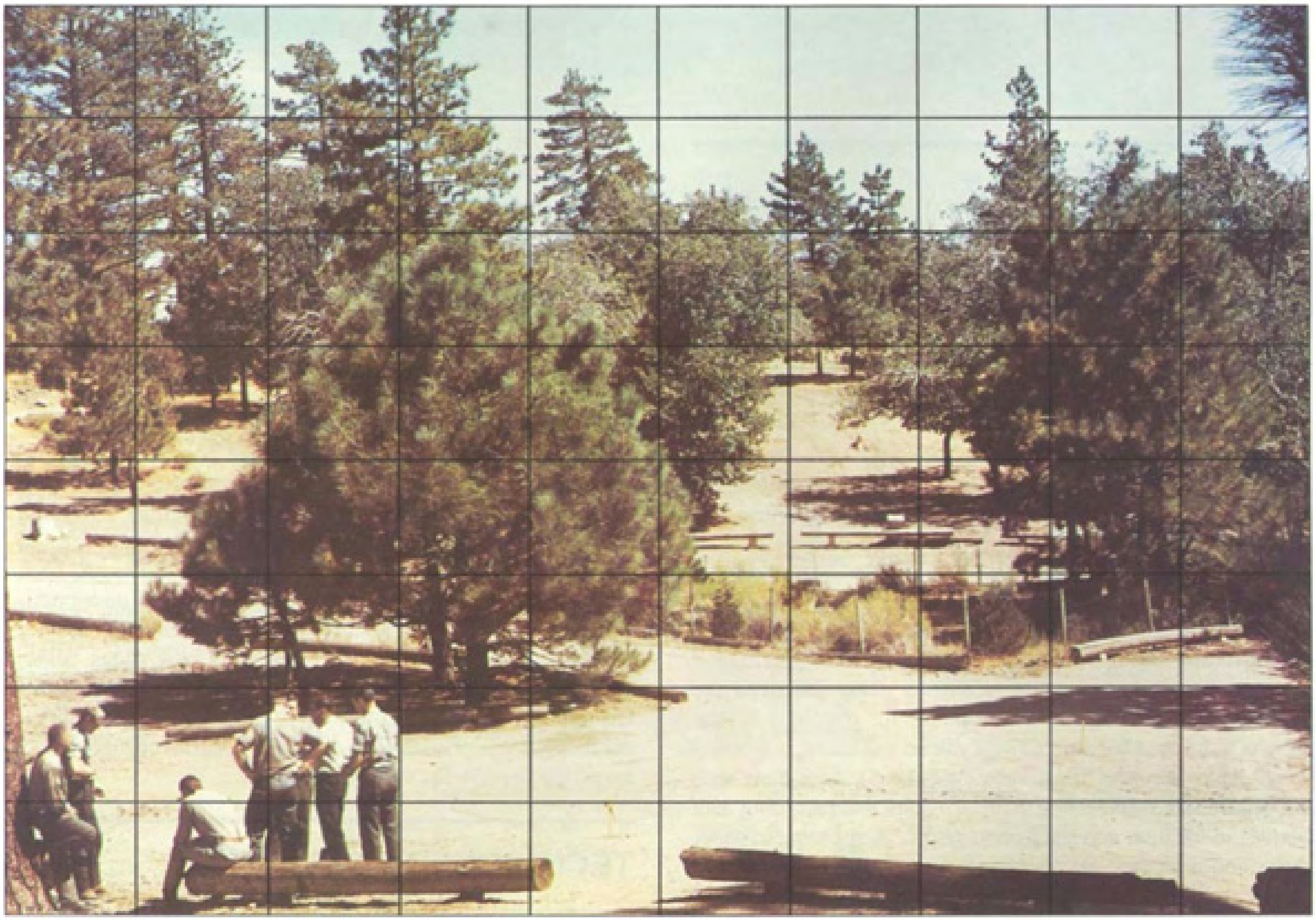
TECHNIQUES

Using 35-Millimeter Color Slides

Typically, historical photographs have not been in color, although Kodachrome[1] film has been available for about 50 years. Consequently, some detail, necessary for evaluating ecological and esthetic change, was not available. Experience in analyzing change using black-and-white photographs has shown that low or prostrate vegetation was difficult to differentiate from vegetative litter (Magill and Twiss 1965). In addition, unhealthy forest conditions—loss of normal leaf color or dead foliage that had not dropped—was not readily apparent. Color slides provide more complete and easily analyzed data.

Color photography has not been recommended for permanent camera points, because "color materials cannot be relied upon to be permanent under normal storage conditions" (Todd 1982). There is evidence to refute the recommendation against using color. For example, a majority of about 8,000 color slides had retained their original color after being stored at room temperature (65 to 85 degrees F [18 to 29 degrees C]) in the dark for up to 25 years. Furthermore, Kodachrome kept in dark storage at

[1]Mention of trade or firm names in this publication is for information only and does not imply endorsement by the U.S. Department of Agriculture.



A

Figure 1—Example of grid overlays used to determine vegetation, litter, and soil percentages in slide pairs and triplets. 1967 *(A)* and 1986 *(B)* views of Mountain Oak Campground, Angeles National Forest.

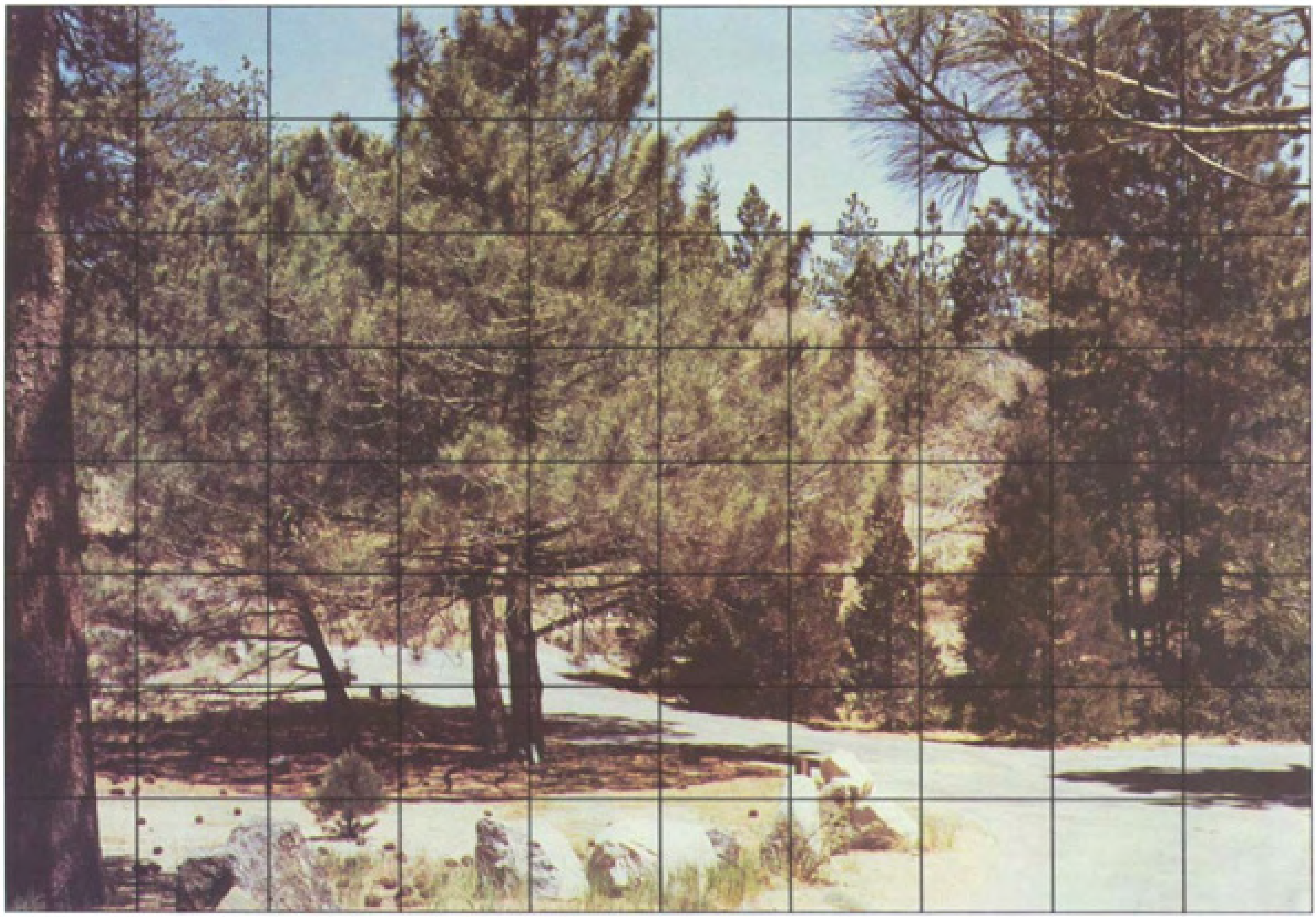
"reasonable" temperatures and humidities has been shown to be stable for periods up to 50 years, while Ektachrome was found somewhat less stable (Litton 1986). Following the more recent evidence, I recommend that color slides be used to monitor natural or human-caused ecological changes as well as scenic quality. However, if black-and-white photographs are preferred, they may be obtained simultaneously for only slightly greater cost.

Using 35-millimeter slides for permanent camera points has been criticized because of the small format (Todd 1982). Yet, regulations (U.S. Dep. Agric., Forest Serv. 1977) require "good 35-millimeter color slides for the Forest Service slide collection," and suggest that black-and-white photographs be made from them. Experience has shown that very acceptable black-and-white or color prints can be obtained from 35-millimeter color slides. Most may be enlarged to publication sizes without objectionable graininess, except when the film speed is ASA 400 or greater. In addition, slides can be projected, side by side, to a large size thereby simplifying comparative analysis.

Analyzing the Slides

Environmental change was estimated by projecting old and new slides, side-by-side, on two grids. The grids, plotted on white paper in 15-1/2 by 22-1/2 inch (39.4 by 57.2 cm) rectangles, were composed of 1-1/4 percent units which measured about 2 by 2-1/4 inches (5.1 by 5.7 cm) (*fig.1*). Since the purpose was to aid percentage *estimates*, the size of the grids may vary to suit the needs of each analyst. Rectangle size was determined, for this study, from a slide projected large enough to permit clear and easy observation of its content. The size of the projection was measured, and the grids were drafted. An alternative might be to obtain 8 x 10 inch color prints, overlay them with a 1/4-inch (0.6-cm) plastic grid, trace the areas containing the components to be assessed, and calculate their percentages (Shafer and others 1969).

Estimates of the percentages of shrubs, grasses and forbs, vegetative litter, and bare soil visible in each pair of slides were



B

obtained from dual projections on the grids. In addition, the number of trees lost or gained were counted, except where distance or density did not permit. In such cases, the percent of the scene obstructed by trees was estimated. Differences were used to describe site condition trends—deteriorating, improving, or static. Since there was no standard for assessing the seriousness of changes, differences were evaluated by the context of visual impacts, the time frame during which changes occurred, and the experience of the observer.

Analysis of ground-level photography provides only estimates of ecological change; it should not be used to make decisions about remedial actions where undesirable changes are detected. Ecological analysis is necessary for that type of decision-making. However, slide analysis permits a rapid and less expensive means to monitor areas for changes that may dictate the necessity for more intensive analysis. Relative differences in stem counts or percent of vegetative coverage along with the severity of visually detectable differences may guide professional judgment to undertake ecological surveys. Statistical methods are used in ecological analysis, but are not appropriate for the judgment associated with slide analysis.

The following examples, usually as slide (photograph) pairs or triplets, are provided to aid the development of observational skills and to develop awareness of specific problems encountered using slides to monitor the environment. Examples are divided according to a subject's distance from a camera point. Near views (within 1/4 mi. [0.4 km]) usually permit subject counts of trees and percentage determinations of shrub crowns, herbaceous vegetation, litter, and bare soil. On the other hand, distant views usually allow only descriptive analysis, such as identifying the outlines of tree stands of different ages, describing young stands of trees that resemble brushfields, or differentiating larger trees that grow on and define an abandoned road from smaller ones that surround and otherwise obscure the road. Individual examples may contain more than one detection subject or problem or both. The repetition emphasizes important conditions or variations or both of certain conditions.

Figure 2—1965 view of clearcuts (right ridge), Siskiyou Fork of the Smith River, Six Rivers National Forest.

Figure 3—Vegetation covered most of the exposed soil after 12 years (1977), Siskiyou Fork of the Smith River.

EVALUATING DISTANT SUBJECTS

Timber Harvesting

Smith River Drainage

Soil was exposed in about 20 percent of the visible or "seen" area of three clearcuts seen in *figure 2* in 1965. Twelve years later, new cuts, with newly exposed soil, considerably reduced the visual impact of the original three by drawing attention from them. Nevertheless, vegetation covered most of the previously exposed soil thereby reducing the visual impact of the older cuts (*fig. 3*).

Comparing *figures 4 and 5* provides a clue that delays may occur before cuttings are replanted and growth effectively conceals the ground from view. Can you find the clue? Examine the small clearcut in the upper right corner of the figures. In 1977 (*fig. 4*), piled brush could be seen on the cut area, but young conifers were growing on the site 9 years later. Given their size and the viewing distance, one might judge planting had taken place not more than 5 years before the slide was repeated. The time needed for vegetation to "green" a cut was documented by a study of more than 75 clearcuts (Bell 1983). Partial greening occurred in 4-5 years, total greening in 5-8 years, a brushfield look in 7-15 years, a hardwood appearance in 15-25 years, and a coniferous forest look in 20-40 years.

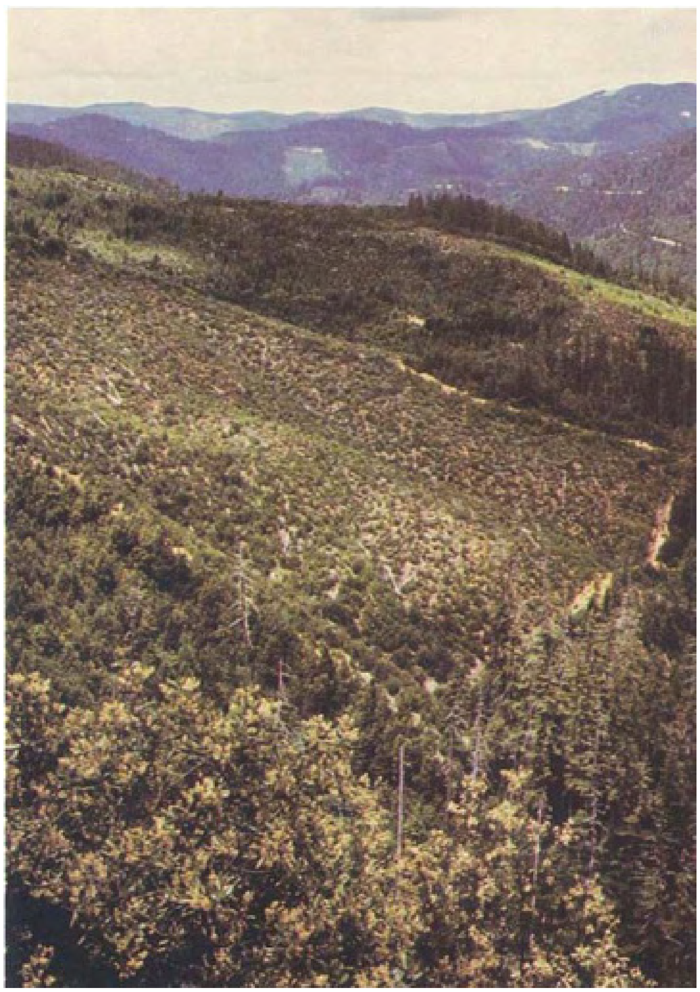


Figure 4—1977 view of clearcuts (left ridge), Siskiyou Fork of the Smith River. Notice the brush piled at the upper right and compare with *figure 5.*

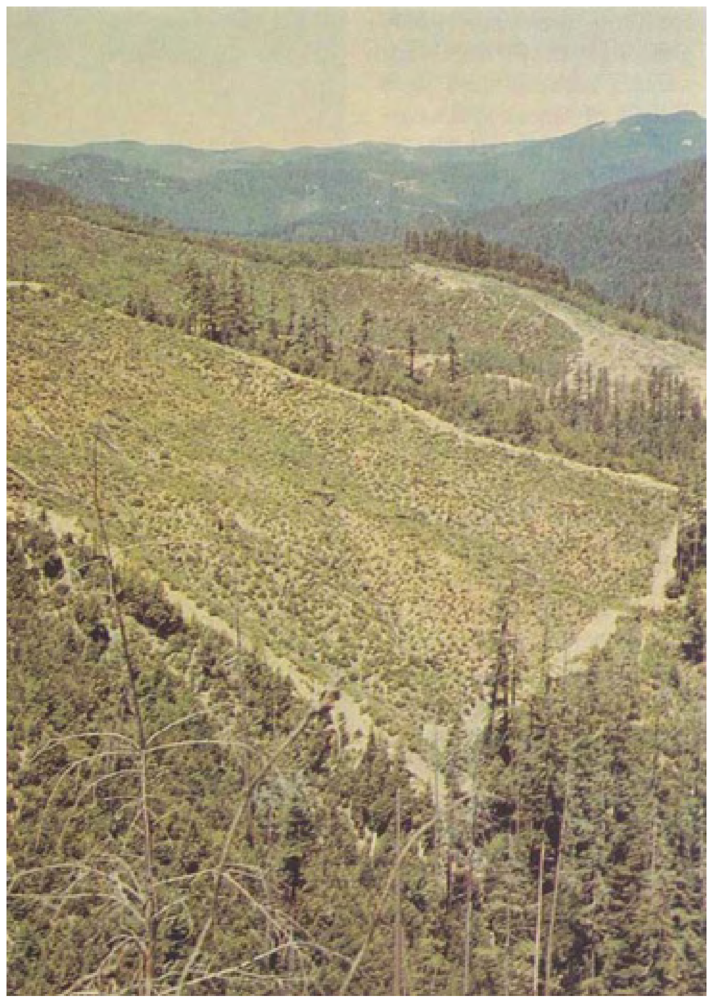


Figure 5—Nine years later (1986), little change has taken place. Young trees, where the brush was piled (*fig. 4*), suggest planting was delayed, Siskiyou Fork of the Smith River.

Distance from an observer to a cutting will determine whether or not plants growing on the cutting can be identified. It is difficult to determine if one is seeing 4- to 6-year-old conifers or a brushfield in the center of *figure 5.* And, it is equally difficult to separate the hardwoods from the conifers to the left in *figure 6,* whereas the dark trees to the right are clearly conifers. Color provides a clue to hardwood identification, since they have a yellowish cast not typical of conifers. In this case, planting did not produce a stand fully stocked with Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco), the desired species. Even though hardwoods—alone or mixed with conifers—are esthetically pleasing, they were not wanted, because areas were cleared of tanoak (*Lithocarpus densiflorus* [Hook. & Arn.] Rehd.) and Pacific madrone (*Arbutus menziesii* Pursh) (*fig. 7*).

The obvious color difference of the forest in *figures 2* and *3* may be attributed to sunlight. The 1977 slide was taken in bright sunlight, whereas the earlier one was taken on a cloudy day. Most objects, including vegetation, tend to appear darker in color on overcast days, and some colors tend to vary with illumination (Magill and Litton 1986). Either condition may lead to misinterpretations concerning the health of vegetation being observed. Therefore, I recommend for monitoring purposes that slides be taken in full sunlight between the hours of 10 a.m. and 3 p.m. Repeat slides should duplicate

Figure 6—1977 regenerating clearcut has a mix of conifers and hardwoods (yellow cast), Siskiyou Fork of the Smith River.

Figure 7—The conifer-hardwood mix was esthetically pleasing, but the noncommercial hardwoods were being removed in 1986 (compare with *fig. 6*), Siskiyou Fork of the Smith River.

Figure 8—Clearcut before regeneration started, 1965, Siskiyou Fork of the Smith River. Can you locate the forked skid road (lower left) in *figure 6?* If not, then look at *figure* 7 where the taller dark-green conifers mark the road.

Figure 9—Trees in foreground prevented repeating the 1965 photograph from its original camera point in 1977 and 1986, Siskiyou Fork of the Smith River.

the conditions, even to being taken at the same time of day, if good quality matching prints are to be obtained.

Test your ability to observe. Examine the regenerating clearcut, the portion that looks like a brushfield (*fig. 6*). Can you detect some skid trails? It is well known that soil overcast from roads make a good place for plant establishment. Observe, in *figure 8*, the forked skid road in the lower left corner. Now look at the same location in *figure 6*, it is barely visible. However, it is clearly identified by the tall dark green coniferous growth in 1986 (*fig. 7*). More than 12 years was needed for the Douglas-fir to overtop the hardwoods, and permit the skid trails to be identified.

Tree growth on highly productive sites can obscure the view from camera points making it difficult to obtain repeat slides. Comparing *figures 6, 7,* and *8*, one should see that each was taken from a different location. Vigorously growing Douglas-fir are visible at the bottom of *figure 8*, and they obstructed the view in the 1977 photograph (*fig. 6*). More trees are visible in 1977 (at the bottom), so the camera point was relocated in 1986 (*fig. 7*). *Figure 9* shows the trees that obscured the view as well as demonstrates the 30 to 40 feet (9 to 12 m) of elevation needed to see over them. Using an alternate location makes analysis more difficult, but doing so is better than losing the photographic record.

Figure 10—Clearcuts, with bare soil and slash piles, surrounded by uncut areas and regenerating clearcuts at Redwood Creek, California, in 1977.

Redwood Creek

Several harvest cuts may be seen from the Berry Summit Overlook along California State Highway 299, west of Willow Creek in northwestern California. At least two cutting cycles were evident in 1977. Bare soil and rows of slash were clearly visible in the most recent cut, and regenerating clearcuts were partially to totally green (*fig. 10*). I estimated the older cuts at 5 to 6 years old, and they were starting to blend with the surrounding uncut areas. Nine years later, the older cuts looked like a brushfield, and regeneration concealed everything on the newer cuts except a few segments of the haulroads (*fig. 11*). Haulroads, usually being larger and permanent, require more time before they are obscured, and portions may always be visible.

In 1986, the cutover reminded me of regenerating timber lands in Oregon, where cuttings had been done in at least two stages (*fig. 12*). The Oregon cuttings were visible from a forest road, but not from a major highway as at Redwood Creek. A clearcut seen from a frequently used location might be expected to draw public criticism. However, if the view is not important to travelers, at the scale involved, they simply may not notice the cut. Results from a study in progress indicate that only 11 percent of those respondents, that viewed the Oregon regeneration at 1.2 miles (1.9 kilometers), actually recognized it as regeneration following a timber harvest—and they liked it! Eighty-nine percent of the respondents did not know what they were seeing, and 68 percent of them also liked what they saw. Though people may not like freshly logged areas, they simply may not notice them after regeneration has covered the bare soil. At Redwood Creek (*figs. 10* and *11*), the distance from the viewpoint to the cuttings was more than twice that for the Oregon study (*fig. 12*), which may make them even less likely to draw criticism once skid trails are hidden and the area turns green.

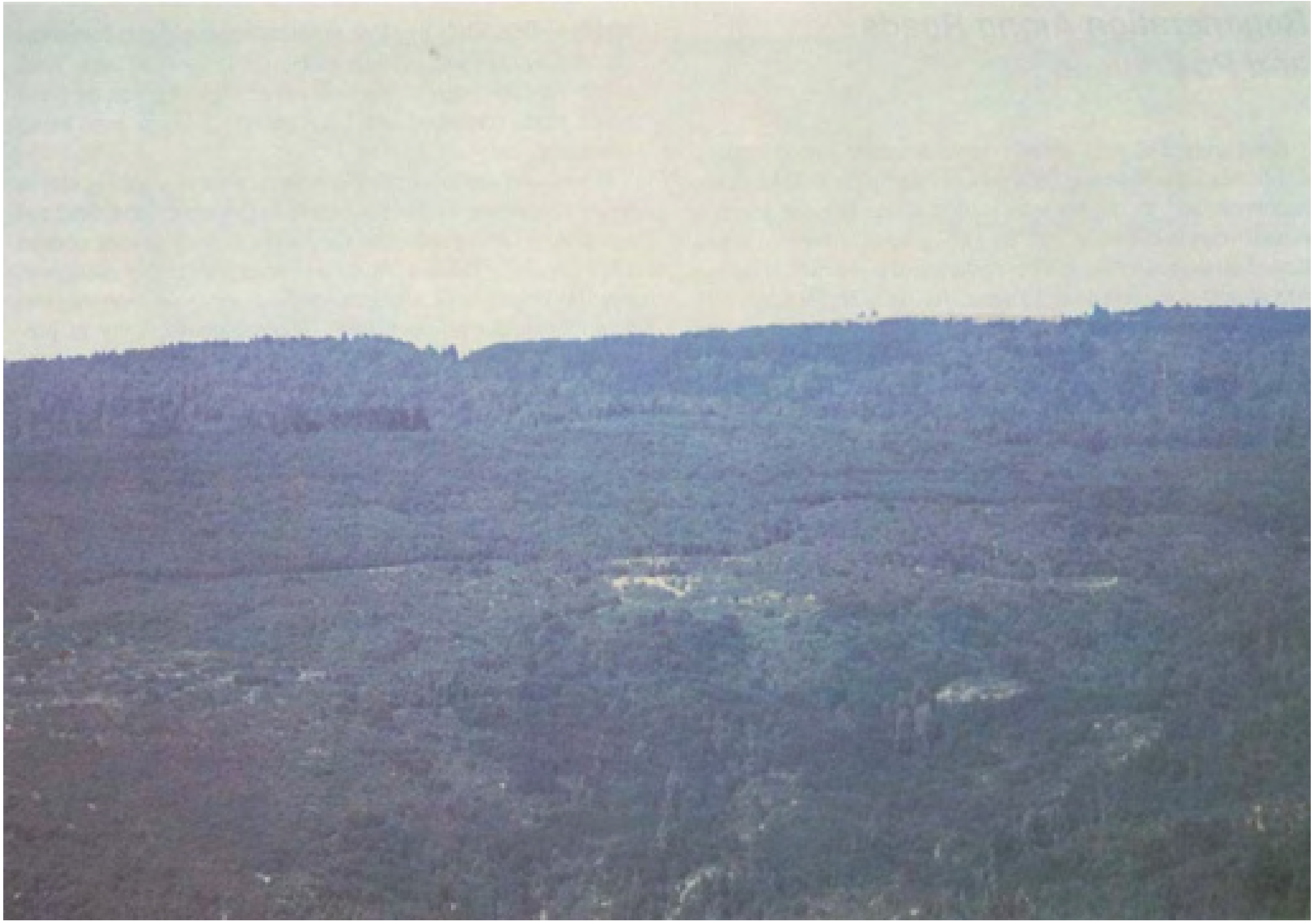


Figure 11—Nine years later (1986), the clearcut in *figure 10* is toned down and resembles a brushfield, Redwood Creek, California.

Figure 12—Regenerating clearcuts at Little Fall Creek in Oregon. The scene was liked by 68 percent of the respondents in a survey, and 89 percent were not aware the area had been clearcut. Compare this with *figure 11.*

Regeneration Along Roads and Powerlines

Road cuts and fills usually have a major visual impact. California State Highway 299, west of Redding at Whiskeytown Reservoir, and the powerline clearing above it made a strong visual image in 1964 (*fig. 13*). By 1977 growth of vegetation had started on the road fills, and revegetation of powerline clearings was almost complete after 13 years (*fig. 14*). In 1986, after 22 years (*fig. 15*), the road fills and powerline clearing had regrown to nearly match the surrounding vegetation, but the road cuts and a road through the powerline clearing remained unvegetated and highly visible. Only by close examination could one determine the feasibility of successfully revegetating the road cuts. And, unless roadside vegetation grows tall enough to screen the powerline road, continued use may prevent it from ever being concealed.

If you were the manager of this area, is there anything else in *figure 15* that would cause concern? In the foreground, dead and dying trees can be seen, and they were starting to look poor in 1977 (*fig. 14*). The site could have been intensively examined, possibly before 1977, to determine the cause of the mortality and recommend corrective action. Repeat photography at prescribed intervals (every 3 or 5 years) might have detected the problem earlier.

Figure 13—Road and powerline clearings along Whiskeytown Reservoir, west of Redding, California, in 1964.

Figure 14—After 13 years (1977) shrub and tree regeneration has commenced to cover the scars, Whiskeytown Reservoir.

Figure 15—Only the cut banks remain unvegetated after 22 years, Whiskeytown Reservoir in 1986. Numerous dead trees are evident in the foreground.

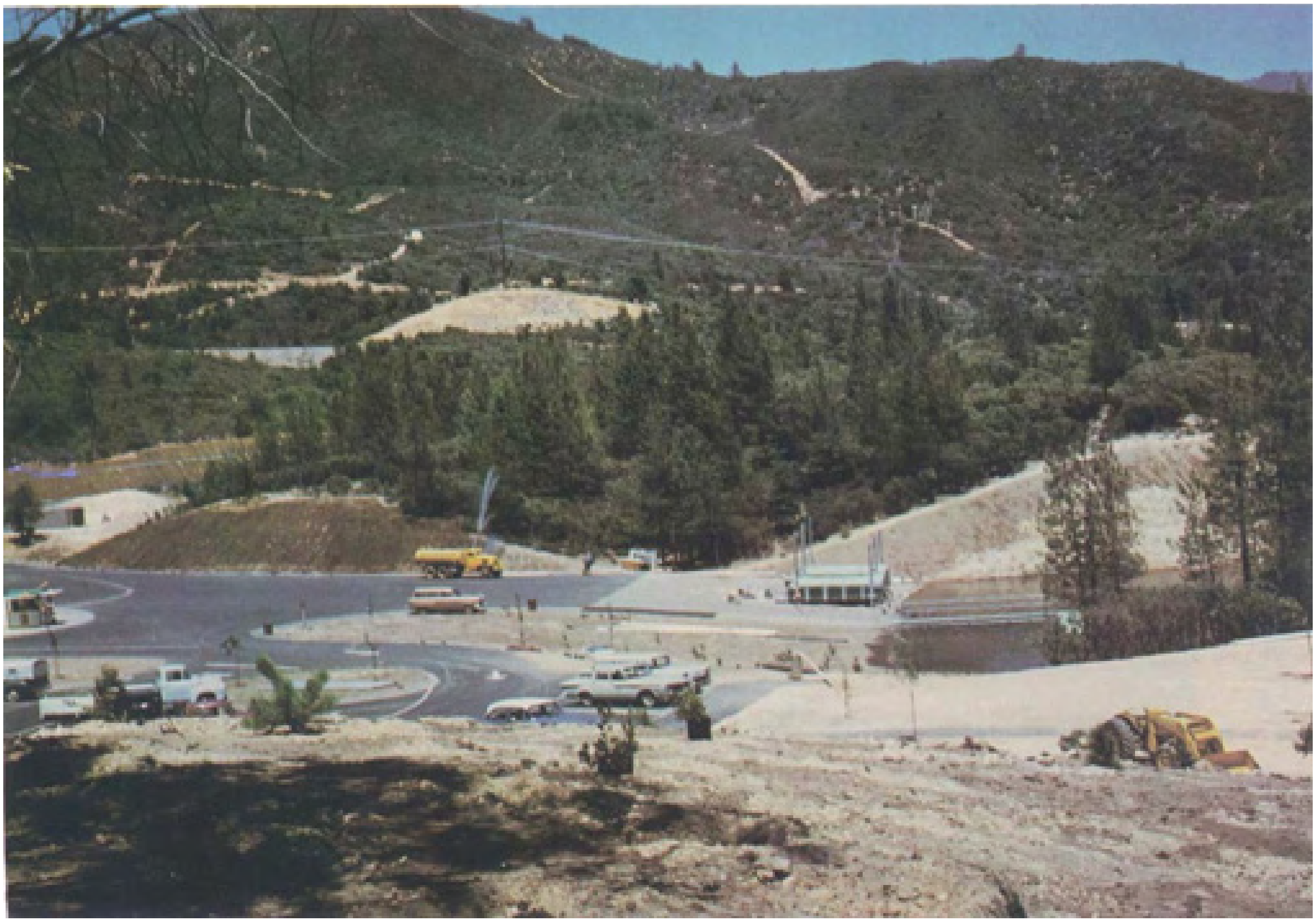


Figure 16—Oak Bottom Beach, Whiskeytown Reservoir, under construction in 1964. Notice the tractor trails on the background hill.

In 1964, the area surrounding Oak Bottom Beach, at Whiskeytown Reservoir, was planted with trees and shrubs and an irrigation system was installed (*fig. 16*). A repeat of the slide demonstrated how well the job succeeded. Tree cover increased by 32 percent and bare soil decreased by 42 percent over 22 years (*fig. 17*). One might have predicted the success of plantings which received good care. But, can you gleen more information from the figures? Tractor trails are visible in the brush on the background hill (*fig. 16*). However, brush had obscured nearly all of them by 1986 (*fig. 17*). Looking beyond the obvious may provide an observer with unexpected information. It is helpful to examine the whole slide for obscure details. Little things may provide a warning or, as in this case, knowledge of change.

The Whiskeytown slides provided more lessons. As previously mentioned, differences in slide color influence interpretations of repeat photography. First, notice the difference in the color of the vegetation between *figures 16 and 17.* Lighting was the cause. In 1964 (*fig. 16*), lighting was more nearly over-

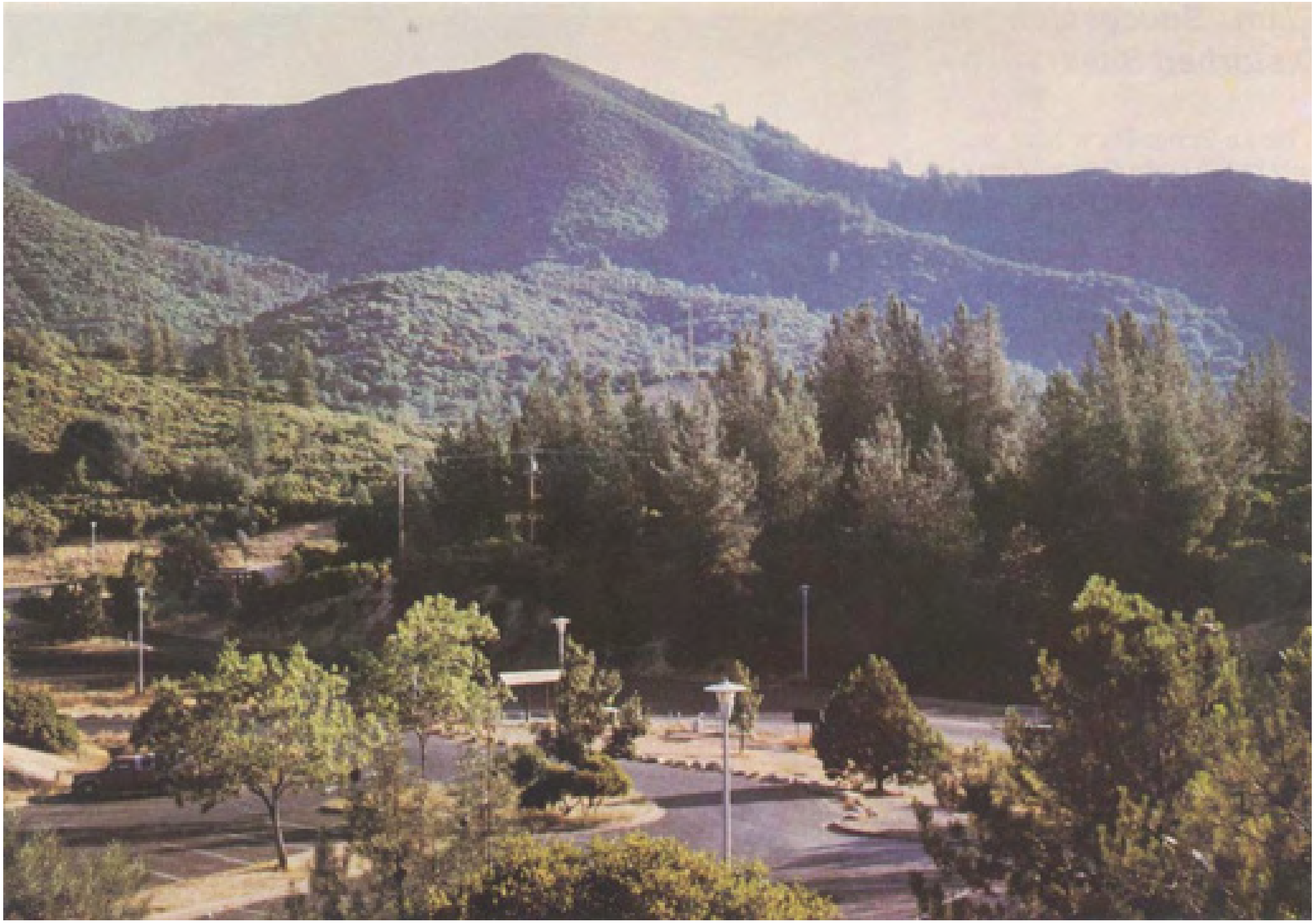


Figure 17—In 1986 the plantings were well established. The hillside trails seem to have been overgrown, however a trail is still visible in the shadow of the hill, Oak Bottom Beach.

head, whereas it came from the right at a low angle in 1986 (*fig. 17*). Obtaining the slides at the same time of day would have made them more comparable and prevented objects from being obscured, such as the tractor trail near the bottom of the shadow cast by the tallest hill (*fig. 17*).

Our second lesson is concerned with the type of film used. Notice that *figure 13* contains more blue than does either *figure 14 or 15.* Kodachrome film, which reflects more blue, was used for *figure 13*, whereas Ektachrome, which reflects more green, was used for *figures 14 and 15.* (For additional comparisons, see *figs. 16 and 17; 18 and 19; and 44, 45, and 46.*) In the case of Highway 299, the difference did not cause any difficulty with interpretation, but that may not always be the case. Therefore, I recommend that repeat photography be done with the same type of film, and possibly even the same brand. It is the photographer's choice as to which to use, the key is to be consistent.

Plant Succession on Disturbed Sites

The La Grange Placer Mine, originally known as the Oregon Mountain Group of Claims, was first operated in 1892. Water was carried 29 miles through ditches, tunnels, and flumes from the Stewart Fork of the Trinity River. Over 100 million yards of gravel were moved hydraulically, and $3.5 million in gold was produced. Few travellers along Highway 299 could identify what they were seeing without the interpretive sign. In 1964, the area did not resemble the surrounding forest, furthermore natural succession had changed the scene over the 46 years (*fig. 18*) since mining ceased in 1918. Visible plant invasion and growth increased only 2 percent over the 13 years from 1964 to 1977 (*fig. 19*), whereas it increased 18 percent in the 9 years between 1977 and 1986 (*fig. 20*). As might be expected, the northern exposure increased more rapidly—a 29 percent increase versus 7 percent on the southern exposure.

Now, hone your powers of observation. Looking near the center of *figure 18*, you should see a small wooden shack, which tree growth obscures in later slides (*figs. 19 and 20*). If you do not see it, look at *figure 21*. Now, do you see any power poles in the 1986 slide (*fig. 20*) or possibly in the 1964 picture (*fig. 18*)? I could find none in the 1977 slide (*fig. 19*), and only two, with a cross-bar, were barely visible in 1964. In *figure 20*, look on the ridge above the grassy area to the left, and you should see three white poles. In 1986 the poles were white, but the poles were brown in 1964 (*fig. 18*). Different materials, paint, or lighting may have made the difference. Unfortunately, converting the slides to photographs and enlarging them for publication increased the difficulty of detection. Viewing the slide with magnification or increasing the size by projection permits one to identify objects barely discernible to the unaided eye.

Figure 18—In 1964, young pines and some shrubs have invaded the La Grange Placer Mine (1892-1918) along Highway 299, west of Weaverville, California. Can you find a small wooden shack in the scene?

Figure 19—Thirteen years later (1977), trees and shrubs had grown and grass had increased about 2 percent at the La Grange Mine.

Figure 20—In the 9 years from 1977 to 1986 plan t coverage increased 18 percent at the LaGrange Mine.

Figure 21—If you did not find the shack in *figure 18,* it is indicated by the arrow, La Grange Placer Mine.

Figure 22—Gravel outwash from 1964 floods at Bluff Creek, a tributary of the Klamath River, Six Rivers National Forest.

A major storm devastated northwestern California in 1964. Bluff Creek, a tributary of the Klamath River in the Six Rivers National Forest, deposited large amounts of coarse rock on much of Bluff Creek campground. In addition, the creek broached a narrow neck which had prevented it from flowing directly into the Klamath River. After the course changed, the campground was a barren plain of coarse sand, gravel, and boulders (*fig. 22*).

Figure 23—Bluff Creek, after 22 years (1986), had only an 8 percent increase in vegetative cover.

Twenty-two years later (*fig. 23*), a few plants were growing, but the area still looked denuded. Tree invasion had produced only an 8 percent increase in coverage, and grasses, forbs, and a few shrubs were sparsely distributed throughout. Overall, most of the site had too little shade or screening to be an appealing campground, especially at a location where summer temperatures may exceed 100 degrees.

EVALUATING A VARIETY OF FOREGROUND SITUATIONS

Interference With Vistas

Slides taken from the Trinity Information Center, Shasta-Trinity National Forest (*fig. 24*), could not be repeated in 1986, because the center had burned. Since it was not safe to walk the charred beams, a slide (*fig. 25*) was taken at ground level to demonstrate how tree growth was obliterating the view. In 1969, four trees needed removal to preserve the view. Apparently, the trees were cut shortly after the picture was taken; however, by 1986 numerous trees were growing into the view, and would need to be removed in the next 2 or 3 years. This example suggests that trees should be cut every 15-17 years to maintain views, wherever the climate and growth potential are similar to the interior of California's northern Coast Range at 3,500 to 5,000 feet of elevation.

The information center, before burning, was surrounded by bare overcast soil in 1969 (*fig. 26*); however, Douglas-fir, sugar pine (*Pinus lambertiana* Dougl.), and knobcone pine (*Pinus attenuata* Lemm.) increased 53 percent by 1977 (*fig. 27*) and 81 percent by 1986 (*fig. 28*). Certainly, the trees were a favorable contribution to soil stabilization, but shrub cover would have preserved the view from the information center. Monitoring with slides has provided a satisfactory measure of successful change, in this case. However, a 5 year interval would have been better, especially if regeneration had not been successful. *Figure 28* shows how difficult it can be to relocate camera points when vegetation has grown significantly.

Figure 24—Trees were beginning to obstruct the view from the Trinity Information Center in 1969, Shasta- Trinity National Forest.

Figure 25 — Fire destroyed the Trinity Information Center, so an alternate camera point had to be used in 1986. The obstructing trees had been cut, but others were replacing them after 17 years.

Figure 26—Overcast soil provided a stark welcome to the Trinity Information Center in 1969.

Figure 27—By 1977, trees had increased by 53 percent at the Trinity Information Center.

Figure 28—The site of the Trinity Information Center was obscured from view by an 81 percent increase in trees over 17 years (1986).

Different growth conditions exist on the east side of the Sierra Nevada Mountain Range. Jeffrey pine (*Pinus jeffreyi* Grev. & Balf.), in the foreground of *figure 29*, needed to be removed in 1969 to restore the view at June Lake Vista on the Inyo National Forest. *Figure 30* shows they were removed, but it also shows that more trees need to be cut or the view will be screened once again. A different view from the vista (*fig. 31*) showed some young pines which were not considered a problem in 1969, but they caused an 18 percent increase in screening, after 17 years, and nearly eliminated the view (*fig. 32*).

Another test of observational skill is provided by comparing *figures 31 and 32.* The cliff (arrow in *fig. 33*) appeared as a rock face in 1969, but it was darker, giving the impression of being vegetated, in 1986. However, magnification did not show any vegetation. Shadows caused the illusion; the cliff is too steep and rocky to support vegetation.

Figure 29—Foreground Jeffrey pine needed removal in 1969 to preserve the view from the June Lake Vista, Inyo National Forest.

Figure 30—By 1986, the foreground trees had been removed, but additional pines were commencing to obscure June Lake.

Figure 31—The view from June Lake Vista across June Lake Campground was unobscured [sic] in 1969, though foreground trees indicate a growing problem.

Figure 32—By 1986, the view from June Lake Vista was nearly obscured by Jeffrey pine.

Figure 33—Arrow indicates a rock cliff, seen from June Lake Vista, which appeared to be vegetated in 1986 (*fig. 32*). Shadows were responsible for the illusion.

Response to Treatment

Mountain Oak Campground on the Angeles National Forest was closed to public entry in 1967 to rehabilitate the site (*fig. 34*). About 1970, wood chips and straw were spread and disked into the soil. Perennial grasses and some native shrubs were planted, and fertilizer was applied, but the shrubs did not survive the first year. A sprinkler system was installed and used during the summer until 1974, and possibly until the campground was reopened in 1976.[2]

The campground was photographed in 1967,1969, and 1986. Analysis showed a small loss of trees over 19 years, but screening by tree growth accounted for most of the loss. During the first 2 years, bare ground decreased as grasses, forbs, and litter increased, all by relatively small percentages (*fig. 35*). Curiously, the increases occurred before the site was treated and the irrigation system installed. Overall, the condition of grasses, forbs, and bare ground remained relatively stable during the next 17 years. The ground cover in *figure 36* is mostly litter, not herbaceous vegetation.

The information and slides for Mountain Oak must be interpreted with care. Mulching, fertilization, and watering may have helped grasses and forbs, if not the trees, for a period during and shortly after treatment. However, the slides did not document any change resulting from the treatment or from reopening the campground. An ecological survey of the site could verify either conclusion. Again, one must analyze repeat slides and available records with care.

Figure 34—Mountain Oak Campground, Angeles National Forest, in 1967 when it was closed to use.

[2]1988. Unpublished information provided by the Valyermo Ranger District, Angeles National Forest, Pearblossom, CA.

Figure 35—Mountain Oak Campground in 1969. After 2 years of closure, there is little change except for a few weeds.

Figure 36—In 1986, except for growth of previously existing trees, not much has changed at Mountain Oak Campground.

Figure 37—Crest Park Campground, San Bernardino National Forest, was closed to public use in 1965.

Permanent Objects

Crest Park, located along the Rim of the World Drive on the San Bernardino National Forest, was a heavily used campground which was closed to entry in 1965 (*fig. 37*). By 1986 (*fig. 38*), trees that had been planted as an experiment could not be located, because native ponderosa pine, sugar pine, California incense-cedar (*Libocedrus decurrens* Torr.), and California black oak (*Quercus kelloggi* Newb.) had invaded and overgrown planted trees that had not succumbed to drought. Furthermore, screening by the young trees accounted for a decline in the number of trees counted in 1986 from 1965.

Young trees were so prevalent, they increased the difficulty of relocating camera points. *Figures 37 and 38* do not appear to be the same location. However, if you locate the leaning oak (to the left of the stove in the shadow at the right edge of *fig. 37*), it also can be verified in the 1986 slide by noticing the lean and comparing the limbs. Also, to the left and beyond the oak, compare the pair of pines which may be seen in the later slide. A smaller pine, next to the pair, as well as a cedar snag, above the stove, are missing in the 1986 photo. Searching for detail of this type will permit an analyst to relocate unmarked camera points as well as to identify plants that have succumbed—though not without some difficulty.

Figure 38—Ingrowth of trees was so good at Crest Park that it did not look like the same location in 1986.

The forest at Dogwood Campground on the San Bernardino National Forest was comprised of California black oak, incense-cedar, ponderosa pine, and white fir (*Abies concolor* [Gord. and Glend.] Lindl. ex Hildebr.) (*fig. 39*). Tree numbers suffered about a 7 percent loss from 1970 to 1986, but most losses were attributed to screening by new tree growth (*figs. 40 and 41*). If you had been assigned to rephotograph the site shown in *figure 41*, would you have had trouble relocating the camera point or even recognizing that it is the same site illustrated by *figure 39*? Ideally, you would have had good records to help reestablish the location. If you did not, then a tree, rock, or other distinctive feature must be located to provide orientation. Can you find such objects in *figure 39*? There are two deformed trees, one slightly to the right of center and the other halfway to the left edge, which may provide the necessary reference. Can you locate them in *figures 40 and 41* ? Only the tree to the right of center can be seen in all three slides. Without records or the deformed tree, it would have been very difficult, if not impossible, to have relocated the camera point in 1986.

Figure 39—Dogwood Campground, San Bernardino National Forest, prior to opening in 1965. The deformed tree (center background) provides a reference for *figures 40 and 41.*

Figure 41—After 16 years (1986), tree growth had screened from view about 7 percent of the trees that were present at Dogwood Campground in 1965.

Figure 40—Five years later (1970), dead wood and needle litter was reduced considerably at Dogwood Campground.

Figure 42—Grass was widespread at Silver Lake Campground, Inyo National Forest. Notice the staked plantings in this 1965 view.

Silver Lake Campground (*fig. 42*) on the Inyo National Forest appeared to have changed very little over 21 years (*fig. 43*), though the condition of the trees, shrubs, and grasses visually seemed to be improving by 1986. In the background, several quaking aspen (*Populus tremuloides* Michx.) and black cottonwood (*Populus trichocarpa* Torr. & Gray) had died, exposing the "U" of the valley (left side of the figures). Yet, the size of others had increased, and they covered more of the slope in the background and to the right. Grass coverage appeared to decrease by 7 percent, but the loss was not visually evident on location. Further examination showed the camera alignment for

Figure 43—Grass was still prevalent at Silver Lake Campground in 1986, but the plantings did not survive.

figure 43 to be too low, which put the estimate of grass percentage in error. If the distance is measured from the bottom of the figures to the road (right) and to the table (left), more grass is actually visible in the older slide. Repeat slides must be carefully aligned or spurious data will result.

Three planted and staked trees are clearly visible in the 1965 view (*fig. 42*). Can you locate any others? The tall brown stakes near the unit at the far right, are a clue to the location. Not all significant changes are easily seen, therefore searching for details is important. In this case, the plantings did not survive (*fig. 43*), not even to the fifth year (not illustrated).

Figure 44—Grout Bay Campground on the San Bernardino National Forest in 1964.

Figure 45—The yellow cast to the trees at Grout Bay Campground, in 1969, may have been caused by air pollution. Also, can you find a tree missing in this picture that was present in 1964? Look to the right of center.

Figure 46—Plant composition at Grout Bay Campground in 1986 has changed little over 22 years. The yellow cast was no longer present at this time. Even though the reason for improvement cannot be determined from the pictures, it was not caused by film differences.

Analyzing slides for environmental change challenges your ability to see, not only what is present, but what is not. The appearance of Grout Bay Campground, on the San Bernardino National Forest, changed very little over 22 years (*figs. 44-46*), just as with many of the rephotographed campgrounds. Shrubs and duff remained virtually the same; there was an increase in grasses and forbs, though the cover was sparse, and a few large pines had died and been removed. Can you locate a tree that was alive in 1964 (*fig. 44*), but is missing in 1969 (*fig. 45*)? Locate the tent in *figure 44* that appears to have a tree growing out of it. Compare the location in *figure 45*, and you will see that only the stump remained in 1969.

Color of Vegetation

I first attempted repeat photography at Grout Bay Campground, and it led to the use of color slides rather than black-and-white photos. *Figure 47* shows how the campground appeared in 1964, and *figure 48* shows it in 1969. Unfortunately, it was difficult to determine whether the material on the ground (right side, in front of the trees) was grass or duff. Differences between dead and living plant matter are much more evident in color slides. Notice the dead limb, left side in *figure 45*, which was alive in 1964 (*fig. 44*). While detectable in black and white, its condition is easily determined in color. Ground cover is depicted in shades of gray which doesn't indicate whether one is seeing different shades of green, or live and dead vegetation. Color permits such distinction. There also are two discernible species of shrubs, in the background in color, but they are nearly indistinct and easily overlooked in black and white. In part, the differences in the forest color may be attributed to the use of Kodachrome (*fig. 44*) versus Ektachrome, as discussed previously. However, *figures 45 and 46* were processed from Ektachrome slides. Therefore, the difference between colors is related to differences in stand conditions over the period documented by the three slides.

Figure 47—This 1964 black-and-white picture of Grout Bay Campground and *figure 48* are provided to demonstrate the advantages of color. Compare this picture with *figure 44.*

Figure 48—1969 black-and-white photograph of Grout Bay Campground. Compare with, *figure 45.*

Forest Conditions

Ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) and Jeffrey pine in the Angeles and San Bernardino National Forests have been particularly susceptible to damage from air pollution, a condition which intensifies the impact of drought, insects, and diseases. My 1969 slides (*figs. 45 and 35*) showed a yellowing of the pines, whereas those taken in 1986 (*figs. 46 and 36*), suggest their condition has improved. These observations have been supported recently by scientists studying the effects of air pollution on forests in Southern California (Polakovic 1988). On the other hand, many dead trees have been removed; an action that may have contributed to the improved appearance—only the healthy trees remained.

Pines in the Laguna Recreation Area, on the Cleveland National Forest, also had been declining, but recent observations suggest conditions have improved. Regardless of what caused improvement on the three forests, it is possible to detect such changes with color slides and recommend more comprehensive analysis to identify causes and suggest solutions.

Plant Phenology

The color differences between the slides of Rush Creek Campground, Inyo National Forest, were attributed to plant phenology. The 1969 slide (*fig. 49*) was taken in fall. As a consequence, most vegetation had dried and some was dead. Even the shrubs on the background slope had a yellow cast. By contrast, the 1986 slide (*fig. 50*) was taken in summer when vegetation was green and vigorous. Again, a resident photographer could have observed plant periodicity and provided a better photographic match.

Now, hone your powers of observation. Did you see any wet spots (other than the creek) in the 1969 slide of Rush Creek Campground? The pavement (lower left corner) is wet, and the dark spots on the campground roads are mud and water. Puddling is also evident in 1986, and sedges (*Carex* spp.) or rushes (*Juncus* spp.) (darker vegetation) may be seen above the puddle. Water from a spring was flowing across the highway and through the campground both years.

Effects of Traffic

Some conditions merit comment, though they do not involve evaluation of long-term changes. Contrast the distribution of the grass at Silver Lake Campground (*fig. 43*) with that at Rush Creek (*fig. 50*). What is significant about it? The grass at Silver Lake covered most of the ground, except a small area surrounding the stove and table (not visible in the slide). However, at Rush Creek there was a large bare area created by uncontrolled vehicle movement. The traffic control barriers at Silver Lake were quite effective at protecting campground vegetation. Foot traffic destroys some plants, but not nearly as many as the wheels of vehicles (Magill 1970).

An event involving short-term change was documented at Dogwood Campground, which was constructed in 1965 (*fig. 39*). Slides were taken to support an ecological survey done just before its opening. At that time, duff averaged 2.3 inches (5.8 cm) in depth, but when the campground was resurveyed 5 years later, it averaged 1.1 inches (2.8 cm). Since a third ecological survey was not done, it is not known whether the depth of the duff changed after 1970. On the other hand, the area covered by duff actually increased slightly during the first 5 years (*fig. 40*), but during the next 16 years, it decreased by 24 percent (*fig. 41*). Given the small amount of duff normally found in long-established campgrounds, it is not surprising that a significant loss occurred in the area covered by duff. Part of the duff was raked and removed (up to 30 feet around camp stoves) as a fire prevention measure. Another part was raked away as "housekeeping" by campers who failed to understand that duff protects the soil from being compacted and controls dust.

Figure 49—Rush Creek Campground, Inyo National Forest, as it appeared in fall 1969.

Figure 50—In summer 1986 phenological differences from 1969 may be due to season, Rush Creek Campground.

Figure 51—Horse Heaven Group Campground as it appeared in 1966. Shrubs had been cut, soil scraped by campers, and soil erosion was evident, Cleveland National Forest.

New or Missing Plants

Horse Heaven is a group campground located in the Laguna Recreation Area on the Cleveland National Forest. Nineteen years ago the site looked abused: shrubs had been cut, ground had been cleared and leveled by campers to set up tents, and soil erosion was evident (*fig. 51*). Despite a couple of shrubs missing in the middle of the slide, the site, as a whole, did not look any worse for the wear in 1985 (*fig. 52*). Some ground surfaces damaged by walking or digging in 1966 were healed in 1985, and other surfaces previously in good condition were damaged in 1985. On the average, a few trees had died and been removed throughout the camp, but that was true outside of the campground also.

Tree and shrub losses were greatest in the campground at the location illustrated. How many missing plants can you detect by comparing *figures 51* and *52*? Stumps are visible, above and between the tables (*fig. 52*), where trees grew in 1966 (*fig. 51*).

Figure 52—By 1985, Horse Heaven did not appear any worse; areas damaged in 1966 were healed and other areas were damaged.

Trees are missing, one to the right and one to the left, behind the large Palmer ceanothus (*Ceanothus palmeri* Trel.), which also was missing. The leaning tree on the left side is gone, as is the shrub in front of it. The tree above the camera has been cut, and its stump was illuminated by the sun in *figure 52*. Just to the right of the stump is a new shrub or regrowth of a cut shrub that existed in 1966. Did you locate all of them or find additional ones?

Litter increased about 7 percent at Horse Heaven, but only as a very thin layer. The increase may have occurred recently, because the slide *(fig. 52)* was taken after Labor Day. Use usually declines at that time, therefore litter could accumulate rather than be worn or "swept away." There was some decrease in bare soil, and, if you look closely, a couple of erosion control boards (or steps) have been removed behind and between the tables. Erosion is no longer evident at that spot, though the shadows may hide it.

Figure 53—Mountain whitethorn grew extensively beneath white fir at Almanor Campground, Lassen National Forest, in 1966.

Plant Succession

A notable change in plant composition occurred at Almanor Campground on the Lassen National Forest. In 1966 (*fig. 53*) mountain whitethorn (*Ceanothus cordulatus* Kell.) was growing extensively, but after 20 years, it has been succeeded by white fir (*fig. 54*). The change was evident throughout the area, not just in the campground. Therefore, it was probably unrelated to recreational use. As a consequence of the change of plant

Figure 54—By 1986, mountain whitethorn had been displaced by the white fir at Almanor Campground.

species, the slides appear to have been taken at different locations. However, the large boulders provide a convenient reference, and even some of the small rocks appear to have remained undisturbed. Also, two young trees growing out of the mountain whitethorn (center), and a third in the sunlight to the right (*fig. 53*), are the large trees in the foreground of the recent slide.

Figure 55—Antlers Campground as it appeared in 1969, Shasta-Trinity National Forest.

Obstruction of an Earlier Camera Point View

Various objects can obscure a subject when it is time to repeat a slide. When that happens, the observer must decide which course to follow: photograph the site later, if the obstruction is temporary; relocate the camera point to a more favorable position; take the slide at the camera point and interpret the situation; or not take a slide and record missing data. For example, the 1969 view of a unit at Antlers Campground (*fig. 55*) on the Shasta-Trinity National Forest was obstructed when I returned in 1986 (*fig. 56*). 1 could not wait for the boat and motorhome to move, so the slide was repeated by moving in front of the motorhome (*fig. 57*). Comparing the figures, one gets a "sense" that the site has changed very little in 17 years, but it is not possible to obtain counts or percentage estimates of change. Had I lived nearby, it would have been reasonable to take a slide after the vehicles were gone. It would be best to avoid photographing sites from across roads or parking spurs, but that is not always possible.

Figure 56—In 1986, it was not possible to use the original camera point to repeat the 1969 photograph of Antlers Campground.

Figure 57—Assessing change from in front of the obstruction at Antlers Campground was difficult. Obviously, it would be better to return when the site is clear.

More commonly, plant growth will obscure a view. A pine at Hume Lake Campground on the Sequoia National Forest obstructed the view from the camera point established in 1965 (*figs. 58 and 59*). In this case, it was possible to move only a couple of feet to obtain a useful picture (*fig. 60*), or one could have bent the plant out of view, as I did to photograph another scene from the same camera point.

EVALUATING LONG-TERM CONDITIONS

Despite the foregoing discussions of various impacts, recreational use on 21 campgrounds produced little visually detectable change over a period of 17 to 26 years, when one considers each campground as a whole. This means the observer should not only take slides of a site, but contrast the entire site with the original slides and record overall impressions. Doing so will permit more comprehensive interpretation of the slides after leaving the site. In my opinion, the campgrounds looked no worse and most looked better in 1985. Furthermore, the small amount of change was caused either by normal plant growth, mortality, or plant succession. And, where some plant losses were recorded, it was usually the consequence of younger plants, in the more recent slides, obscuring older plants from view. (Tables in the *Appendix* contain data on changes at the campgrounds, determined by analyzing slide pairs and triplets.)

Rush Creek Campground, for example, had been subject to long and heavy use when the slide was taken in 1969 (*fig. 49*). Use was stopped sometime between 1974 and 1976,[3] and sagebrush (*Artemisia tridentata* Nutt.) and bitterbrush (*Purshia tridentata* [Pursh] DC.) were commencing to recover, though grasses had decreased, by 1986 *(fig. 50).* Too little change had taken place to determine whether the vegetation was increasing (*Appendix, table 1*). Evidently it takes more than 10 years for the vegetation on heavily impacted recreation sites to recover naturally at high elevations where summer moisture is low, summer temperatures are high, and winters are severe. In this case, it may have been ecologically informative but not cost effective to install transects to monitor change after closure.

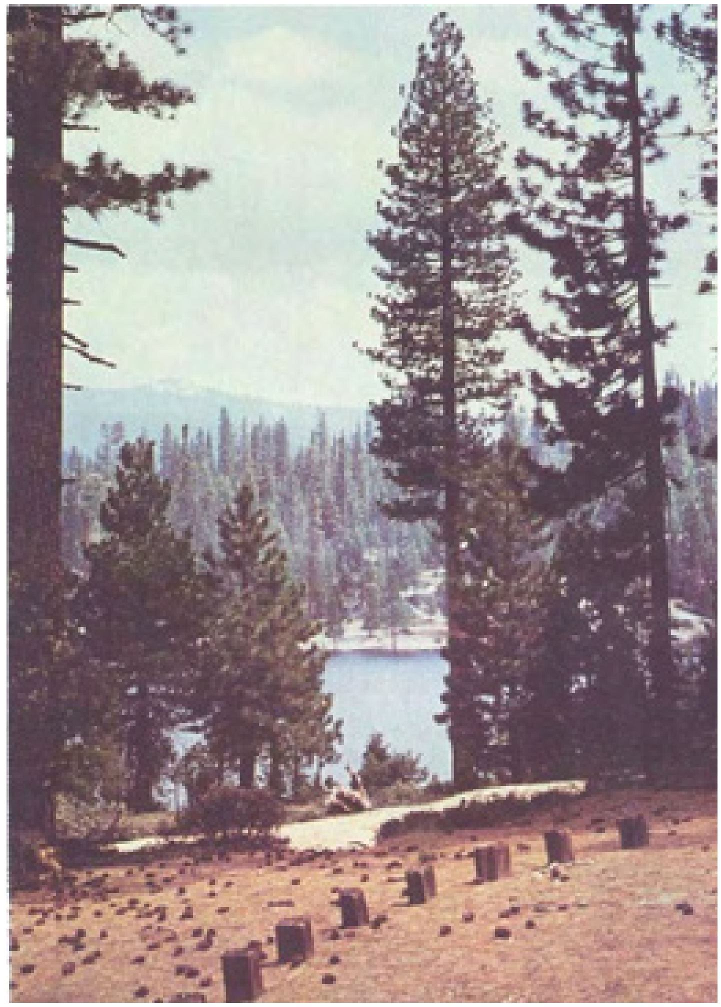


Figure 58—Hume Lake Campground, Sequoia National Forest, as it looked in 1965.

[3]1988. Unpublished information provided by the Mono Lake Ranger District, Inyo National Forest, Lee Vining, CA.

Figure 59—In 1986, a young pine obstructed the camera point at Hume Lake Campground (compare with *fig. 58*).

Figure 60—Moving the tree to the side permitted sufficient clearance to repeat the photograph at Hume Lake in 1986.

A second example, Pinecrest Campground, on the Stanislaus National Forest, had changed little over 20 years (*Appendix, table 2*). In the 1966 view (*fig. 61*), a pair of small trees, backdropped by the station wagon in the center, were about the size susceptible to loss. However, they were still alive in 1986 (*fig. 62*). One of a slightly larger pair, a few feet to the right, appeared to have been removed in the recent slide. However, closer examination shows the base of one is visible to the left of the foreground tree, and the top of the second may be seen to the right and higher. Since the top and the base do not align, one may conclude that two trees are present. Except for a slight misalignment, the slides are quite similar. Every tree present in 1966 was still there in 1986. After 20 years, even the diameter of the trees looked the same.

Figure 61—Pinecrest Campground as it appeared in 1966, Stanislaus National Forest.

Data collected during a 5 year ecological study, verified that change at Pinecrest had been small (Magill 1970). At other geographic locations, similar trends were identified in ecological studies of developed recreation areas, none of which spanned more than 5 years (Hartesveldt 1963, LaPage 1967, Echelberger 1971, Merriam and others 1973, Merriam and Smith 1974). Findings of the ecological studies tend to verify the findings of little change determined using repeat slides. Furthermore, the findings tend to support the contention that slides be taken at regular intervals and ecological analysis only be undertaken if photographic comparisons show a significant change.

Many more examples for detecting physical change over time at recreation sites and other managed areas could be presented. I trust I have provided enough to make the reader more sensitive to the subtle differences discernible in repeat slides. I hope that in the process, some readers may have been introduced to and others reminded of a relatively inexpensive and proven alternative for evaluating physical change in managed wildland environments, especially for situations where using more costly methods may not be warranted.

Figure 62—Pinecrest, like 20 other sites sampled over periods of 17 to 26 years, demonstrated very little visual change by 1986.

SUMMARY OF RECOMMENDATIONS

Color slides offer more complete and easily analyzed data than does black and white photography.

Taking Color Slides

- Record the location, date, time of day, photographic equipment, film type, and settings.
- Regarding time and lighting:
  - Take slides on sunny days; avoid overcast days as they may alter the color typical of different types of vegetation and soil.
  - If drifting cumulus clouds are common where you work, wait for the sun to illuminate subjects before taking a picture; avoid having the subject in dark shadow.
  - Take slides between 10 a.m. and 3 p.m. to avoid long shadows that may hide important components of scenes.
- Reference the camera point to permanent and readily identifiable objects such as trees, large rocks, or structures.

Taking Repeat Slides

- Take slides using the same camera, settings, and film.
- Take slides under the same lighting conditions—same time of year and day.
- Take slides during the same stage of phenological development—new growth on plants, trees with or without leaves, or similar foliage coloration.
- When obstructions prevent repeating a slide:
  - If obstruction is permanent, obtain the repeat slide from a slightly different angle or location if possible
  - If obstruction is temporary, repeat the slide a day or two later, after the obstruction is gone
  - Record the nature of all deviations of location or time

Preparing Color Slides for Analysis

Projecting Slides

- Project slides large enough to permit clear and easy content analysis, but not so large as to blur.
- Prepare two grids to accept the projection of slides:
  - Draft the two grids either side-by-side or one on top of the other
  - Draft grids to fit the desired projection size

Viewing Prints

Alternative approach: obtain 8 by 10 inch color prints and prepare a 1/4-inch (0.6 cm) transparent grid for analyzing them.

Measuring Plants, Duff, and Soil

- Count tree stems (count stumps as evidence of trees that died since the previous slide was taken).
- Estimate percent coverage by the following:
  - Trees, whenever stems cannot be counted
  - Shrubs
  - Herbaceous plants
  - Forest litter
  - Bare soil

Analyzing the Slides

- Develop a consistent pattern for scanning the slides, e.g., start on the left side of the grid, count background trees and move to the foreground, and repeat the backward/forward process as you move to the right. You may choose a different pattern, but be consistent. Percentage may be determined in a similar fashion.
- Search for details—look for the unobvious.
- In particular, be alert for increases or decreases in:
  - Numbers of trees
  - Percentages of trees, shrubs, herbaceous plants, litter, and bare soil
- To orient slide pairs, especially when they may look like different locations:
  - Look for unusual trees or rock formations
  - Notice limb patterns or leaning trees
  - Look for unique groups of vegetation distinct from vegetation commonly found in a given scene
  - Note snags or stumps of trees or shrubs
  - Observe evidence of soil erosion—such as gullies, soil washed away from table legs, and exposed roots
- Look for structures or roads in the background (especially in distant views) that may have been removed or added.
- Look for color differences that may signify:
  - Changes in plant health
  - Soil erosion
  - Change of plant species—plant succession
- Look for changes in the appearance of clearcuts as a clue to the age of coniferous regeneration in clearcuts:
  - Partial greening .... 4 to 5 years
  - Total greening .... 5 to 8 years
  - Brushfield look .... 7 to 15 years
  - Hardwood look .... 15 to 25 years
  - Coniferous look .... 20 to 40 years

(The above guide would be useful for the Douglas-fir/ponderosa pine types on the coast range in California, but similar criteria would need to be developed for forest types in other locations.)

A Reminder

Analysis of repeat slides permits only estimates of ecological change and suggests whether sufficient change is occurring to merit undertaking a comprehensive ecological survey. Furthermore, an ecological analysis is necessary to determine whether any remedial actions should be undertaken.

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APPENDIX A—Results of Slide Analysis

Table 1—*Vegetative cover and change, Rush Creek Campground (abandoned), Inyo National Forest*

Trees		Shrubs		Grass/Forbs		Litter		Soil	
1969	1986	1969	1986	1969	1986	1969	1986	1969	1986
Percent									
10	12	18	26	14	9	0	0	2	1
Change for 17 year period 1969-1986:[1]									
+2		+8		-5				-1	
Estimated annual change:[1]									
+0.1		+0.5		-0.3				-0.1	

[1]Plus indicates an increasing change; minus a decreasing change.

Table 2—*Vegetative cover and change, Pinecrest Campground and Picnic Area, Stanislaus National Forest*

	Trees		Shrubs		Grass/Forbs		Litter		Soil	
Unit	1966	1986	1966	1986	1966	1986	1966	1986	1966	1986
	Count		*Percent*							
PC1	57	61	0	0	0	0	0	12	24	9
PC2	55	50	0	0	0	0	5	14	11	4
D40	40	42	0	9	0	1	3	9	21	10
D36	41	43	11	11	0	0	3	7	12	3
D22	22	23	0	0	0	0	11	13	4	7
D08	14	28	1	0	0	0	4	6	8	7
C09	45	46	0	0	1	1	4	12	1	8
C01	54	40	0	0	0	5	11	7	9	2
A53	45	46	0	0	4	33	9	0	5	0
C18	32	32	0	0	6	13	5	0	2	1
A33	25	25	21	24	0	0	0	0	1	1
Total	430	436	33	35	11	53	55	80	98	52
Avg.	39	40	3	3	1	5	5	7	9	5
Change for 20 year period 1966-1986:[1]										
	+1		0		+4		+2		-4	
Estimated annual change:[1]										
	0		0		+0.2		+0.1		-0.2	

[1]Plus indicates an increasing change; minus a decreasing change.

Table 3—*Vegetative cover and change, Clark Fork Campground, Stanislaus National Forest*

Unit	Trees		Shrubs		Grass/Forbs		Litter		Soil	
	1966	1986	1966	1986	1966	1986	1966	1986	1966	1986
	Count		*Percent*							
A17	42	49	0	1	1	4	2	11	11	2
A19	54	43	0	0	2	1	11	23	7	1
CF3	32	18	0	0	1	16	14	2	3	0
CF5	22	23	0	0	4	4	4	20	9	2
A28	31	21	0	0	12	12	7	10	3	0
Total	181	154	0	1	20	37	38	66	33	5
Avg.	36	31	0	0	4	7	8	13	7	1
Change for 20 year period 1966-1986:[1]										
	-5		0		+3		+5		-6	
Estimated annual change:[1]										
	-0.2		0		+0.2		+0.2		-0.3	

[1]Plus indicates an increasing change; minus a decreasing change.

Table 4—*Vegetative cover and change, Mountain Oak Campground, Angeles National Forest*

Unit	Trees			Shrubs			Grass/Forbs			Litter			Soil		
	1967	1969	1986	1967	1969	1986	1967	1969	1986	1967	1969	1986	1967	1969	1986
	Count			*Percent*											
MO1	24	25	21	3	3	2	0	19	3	8	5	4	5	0	3
MO2	25	20	13	7	8	3	3	4	0	2	11	6	7	1	0
MO3	10	13	11	8	7	9	6	5	3	2	3	3	2	1	1
MO4	14	13	13	0	0	0	0	6	13	7	18	6	15	3	0
MO5	24	23	19	0	0	0	0	3	4	2	9	20	18	7	1
Total	97	94	77	18	18	14	9	37	23	21	46	39	47	12	5
Avg.	19	19	15	4	4	3	2	7	5	4	9	8	9	2	1
Change for 2, 17, and 19 year periods 1967-1969, 1969-1986, and 1967-1986:[1]															
	0	-4	-4	0	-1	-1	+5	-2	+3	+5	-1	+4	-7	+1	-8
Estimated annual change:[1]															
	0	-0.2	-0.2	0	0	0	+2.5	-0.1	+0.2	+2.5	-0.1	+0.2	-3.5	+0.1	-0.4

[1]Plus indicates an increasing change; minus a decreasing change.

Table 5—*Vegetative cover and change, Laguna Campground, Cleveland National Forest*

	Trees		Shrubs		Grass/Forbs		Litter		Soil	
Unit	1966	1985	1966	1985	1966	1985	1966	1985	1966	1985
	Count		*Percent*							
L1	28	18	1	1	12	13	1	4	9	9
L2	19	17	1	0	8	7	6	9	10	5
L5	28	23	0	0	32	27	5	2	1	2
L6	24	27	4	5	6	6	2	2	13	18
L7	30	27	12	10	32	10	5	8	2	16
L8	19	18	6	8	8	12	4	5	4	1
Total	148	130	24	24	98	75	23	30	39	51
Avg.	25	22	4	4	16	12	4	5	6	8
Change for 19 year period 1966-1985:[1]										
	-3		0		-4		+1		+2	
Estimated annual change:[1]										
	-0.2		0		-0.2		+0.1		+0.1	

[1]Plus indicates an increasing change; minus a decreasing change.

Table 6—*Vegetative cover and change, Horse Heaven Group, Cleveland National Forest*

	Trees		Shrubs		Grass/Forbs		Litter		Soil	
Unit	1966	1985	1966	1985	1966	1985	1966	1985	1966	1985
	Count		*Percent*							
P1	37	40	0	0	3	3	0	2	31	37
P2	28	23	1	3	6	7	2	4	19	26
P3	25	20	9	8	5	9	0	7	28	23
P4	19	19	3	4	5	3	2	8	29	18
P5	25	19	4	4	3	3	2	12	9	5
P6	27	27	1	2	6	9	3	20	18	7
Total	161	148	18	21	28	34	9	53	134	116
Avg.	27	25	3	4	5	6	2	9	22	19
Change for 19 year period 1966-1985:[1]										
	-2		+1		+1		+7		-3	
Estimated annual change:[1]										
	-0.1		+0.1		+0.1		+0.4		-0.2	

[1]Plus indicates an increasing change; minus a decreasing change.

Table 7—*Vegetative cover and change, Almanor Campground, Lassen National Forest*

Unit	Trees		Shrubs		Grass/Forbs		Litter		Soil	
	1966	1986	1966	1986	1966	1986	1966	1986	1966	1986
	Count		*Percent*							
45	55	64	13	0	1	1	7	5	2	2
12	27	30	11	0	0	1	11	6	4	5
13	27	37	13	0	0	1	7	11	4	0
16	20	17	11	0	0	0	14	16	3	0
22	52	46	1	0	0	0	1	1	0	0
50	44	46	0	0	0	0	1	1	0	0
24, 25	48	40	20	3	0	1	2	1	12	0
05	49	25	7	1	0	3	2	12	7	2
09	22	36	16	1	1	9	2	3	16	14
18	35	36	1	2	2	2	4	10	3	3
19	40	37	2	0	0	0	16	8	10	2
23	33	38	2	0	0	0	8	25	6	0
26	35	35	16	0	0	1	3	31	11	1
30	41	64	2	2	3	1	7	20	5	1
31	54	47	0	0	1	2	16	26	2	0
Total	582	598	115	9	8	22	101	176	85	30
Avg.	39	40	8	1	1	1	7	12	6	2
Change for 20 year period 1966-1986:[1]										
	+1		-7		0		+5		-4	
Estimated annual change:[1]										
	0		-0.4		0		+0.2		-0.2	

[1]Plus indicates an increasing change; minus a decreasing change.

Table 8—*Vegetative cover and change, Silver Lake Campground, Inyo National Forest*

	Trees			Shrubs			Grass/Forbs			Litter			Soil		
Unit	1965	1969	1986	1965	1969	1986	1965	1969	1986	1965	1969	1986	1965	1969	1986
	Percent														
21	12	13	54	27	30	1	32	19	19	0	0	0	1	2	0
22	2	1	27	35	54	37	32	25	8	0	0	0	7	1	0
26	0	0	1	12	17	17	32	18	23	0	0	0	0	1	0
27	([1])—	([1])—	([1])—	31	27	27	20	11	14	0	0	0	2	1	1
39	([1])—	([1])—	([1])—	3	3	14	25	17	6	0	0	0	0	0	0
40	8	9	10	10	9	9	28	32	24	0	0	0	1	0	0
50	3	3	1	32	31	30	18	18	17	0	0	0	5	3	4
Total	125	26	93	150	171	135	187	140	111	0	0	0	16	8	5
Avg.	5	5	19	21	24	19	27	20	16	0	0	0	2	1	1
Change for 4, 17, and 21 year periods 1965-1969, 1969-1986, and 1965-1986:[2]															
	0	+14	+14	+3	-5	-2	-7	-4	-11	0	0	0	-1	0	-1
Estimated annual change:[2]															
	0	+0.8	+0.7	+0.8	-0.3	-0.1	-1.8	-0.2	-0.5	0	0	0	-0.2	0	0

	Trees		
Unit	1965	1969	1986
	Count		
27	2	0	0
39	21	28	37
Total	23	28	37
Avg.	11	14	18
Change for 4, 17, and 21 year periods 1965-1969, 1969-1986, and 1965-1986:[2]			
	+3	+4	+7
Estimated annual change:[2]			
	+0.8	+0.2	+0.3

[1]Percent not determined; stem count shown below.
[2]Plus indicates an increasing change; minus a decreasing change.

Table 9—*Vegetative cover and change, Shady Rest Campground, Inyo National Forest*

Unit	Trees			Shrubs			Grass/Forbs			Litter			Soil		
	1965	1969	1986	1965	1969	1986	1965	1969	1986	1965	1969	1986	1965	1969	1986
	Count			*Percent*											
R71	([1])—	([1])—	([1])—	6	8	6	0	0	0	3	2	4	4	1	1
78	([1])—	([1])—	([1])—	2	3	23	0	2	0	2	1	1	3	0	0
131	24	29	30	13	7	10	0	2	0	9	2	4	0	8	4
71	38	42	34	12	17	11	4	2	0	5	1	4	0	0	0
73	22	27	27	21	24	10	0	0	0	2	2	1	0	0	2
145	43	52	50	0	0	0	0	0	0	27	26	16	0	0	3
147	29	39	36	0	0	0	0	0	0	21	28	17	4	0	1
81	18	18	33	2	6	18	8	10	0	7	3	6	3	4	4
129	8	8	8	9	4	8	1	0	1	11	17	8	1	7	5
Total	182	215	218	65	69	86	13	16	1	88	82	61	15	20	20
Avg.	26	31	31	7	8	10	1	2	0	10	9	7	2	2	2
Change for 4, 17, and 21 year periods 1965-1969, 1969-1986, and 1965-1986:[2]															
	+5	0	+5	+1	+2	+3	+1	-2	-1	-1	-2	-3	0	0	0
Estimated annual change:[2]															
	+1.2	0	+0.2	+0.2	+0.1	+0.1	+0.2	-0.1	0	-0.2	-0.1	-0.1	0	0	0

Unit	Trees		
	1965	1969	1986
	Percent		
R71	35	35	47
78	41	44	51
Total	76	79	98
Avg.	38	38	49
Change for 4, 17, and 21 year periods 1965-1969, 1969-1986, and 1965-1986:[2]			
	0	+11	+11
Estimated annual change:[2]			
	0	+0.6	+0.5

[1]Trees not counted; percent shown below.
[2]Plus indicates an increasing change; minus a decreasing change.

Table 10—*Vegetative cover and change, Twin Lakes Campground, Inyo National Forest*

	Trees		Shrubs		Grass/Forbs		Litter		Soil	
Unit	1965	1986	1965	1986	1965	1986	1965	1986	1965	1986
	Count		*Percent*							
77	50	44	0	0	5	7	1	0	30	32
35	36	39	4	15	0	0	2	3	17	8
56	44	49	0	0	0	0	1	4	15	11
58	50	54	0	2	0	0	4	4	2	3
53[1]	32	24	4	41	17	1	4	0	9	0
08	34	33	0	3	0	1	23	23	2	1
07	45	47	0	2	0	0	15	3	3	19
Total	291	290	8	63	22	9	50	37	78	74
Avg.	42	41	1	9	3	1	7	5	11	11
Change for 21 year period 1965-1986:[2]										
	-1		+8		-2		-2		0	
Estimated annual change:[2]										
	0		+0.4		-0.1		-0.1		0	

	Trees			Shrubs			Grass/Forbs			Litter			Soil		
Unit	1965	1969	1986	1965	1969	1986	1965	1969	1986	1965	1969	1986	1965	1969	1986
	Count			*Percent*											
53[1]	32	30	24	4	13	41	17	11	1	4	1	0	9	6	0
Change for 4, 17, and 21 year periods 1965-1969, 1969-1986, and 1965-1986:[2]															
	-2	-6	-8	+9	+28	+37	-6	-10	-16	-3	-1	-4	-3	-6	-9
Estimated annual change:[2]															
	-0.5	-0.4	-0.4	+2.2	+1.6	+1.8	-1.5	-0.6	-0.8	-0.8	0	-0.2	-0.8	-0.4	-0.4

[1]Unit shown twice; it was the only unit with 3 years of data.
[2]Plus indicates an increasing change; minus a decreasing change.

Table 11—*Vegetative cover and change, Convict Lake, Inyo National Forest*

	Trees			Shrubs			Grass/Forbs			Litter			Soil		
Unit	1965	1969	1986	1965	1969	1986	1965	1969	1986	1965	1969	1986	1965	1969	1986
	Percent														
07	40	40	40	0	0	0	30	19	19	0	0	0	0	0	0
09	47	47	39	0	0	0	29	19	16	0	0	0	0	0	0
Total	87	87	79				59	38	35						
Avg.	44	44	40				30	19	18						
Change for 4, 17, and 21 year periods 1965-1969, 1969-1986, and 1965-1986:[1]															
	0	-4	-4				-11	-1	-12						
Estimated annual change[1]															
	0	-0.2	-0.2				-2.8	-0.1	-0.6						

	Trees														
Unit	1965	1969	1986												
	Count			*Percent*											
40	27	26	32	14	4	14	14	10	1	0	0	0	4	6	4
Change for 4, 17, and 21 year periods 1965-1969, 1969-1986, and 1965-1986:[1]															
	-1	+6	+5	-10	+10	0	-4	-9	-13				+2	-2	0
Estimated annual change:[1]															
	-0.2	+0.4	+0.2	-2.5	+0.6	0	-1.0	-0.5	-0.6	0	0	0	+0.5	-0.1	0

[1]Plus indicates an increasing change; minus a decreasing change.

Table 12—*Vegetative cover and change, Dogwood Campground, San Bernardino National Forest*

Unit	Trees			Shrubs			Grass/Forbs			Litter			Soil		
	1965	1970	1986	1965	1970	1986	1965	1970	1986	1965	1970	1986	1965	1970	1986
	Count			*Percent*											
87	41	53	42	0	0	3	0	10	6	30	25	5	0	0	19
48	33	40	23	0	0	0	0	3	23	25	29	4	3	0	0
55	39	35	26	0	0	0	0	0	1	28	40	10	7	0	15
69	39	33	27	0	0	0	0	2	23	38	60	5	7	0	4
42	13	19	15	0	0	0	0	11	30	27	23	0	0	1	0
93	14	13	15	0	0	0	0	0	4	4	7	1	8	5	8
81	20	16	15	0	0	0	0	2	6	10	13	0	6	0	20
Total	199	209	163	0	0	3	0	28	93	162	197	25	31	6	66
Avg.	28	30	23	0	0	0	0	4	13	23	28	4	4	1	9
Change for 5, 16, and 21 year periods 1965-1970, 1970-1986, and 1965-1986:[1]															
	+2	-7	-5	0	0	0	+4	+9	+13	+5	-24	-19	-3	+8	+5
Estimated annual change:[1]															
	+0.4	-0.4	-0.2	0	0	0	+0.8	+0.6	+0.6	+1.0	-1.5	-0.9	-0.6	+0.5	+0.2

[1]Plus indicates an increasing change; minus a decreasing change.

Table 13—*Vegetative cover and change, Grout Bay Campground, San Bernardino National Forest*

Unit	Trees			Shrubs			Grass/Forbs			Litter			Soil		
	1964	1969	1986	1964	1969	1986	1964	1969	1986	1964	1969	1986	1964	1969	1986
	Count			*Percent*											
67	41	40	47	0	0	0	5	12	13	0	0	0	23	18	5
68a	11	11	11	5	6	5	1	3	8	3	2	3	4	2	2
68b	51	42	44	1	0	1	0	5	7	1	0	4	13	16	4
70	7	8	4	0	0	1	0	4	15	3	3	2	9	5	0
73	—	31	25	—	0	1	—	0	1	—	4	6	—	12	10
GBC	—	32	36	—	0	1	—	2	7	—	0	1	—	11	2
72	20	21	18	0	8	16	0	0	6	15	5	2	2	7	3
GB	16	16	14	0	0	0	0	0	3	0	2	4	13	10	7
Total	146	201	199	6	14	25	6	26	60	22	16	22	64	81	33
Avg.	24	25	25	1	2	3	1	3	8	4	2	3	11	10	4
Change for 5, 17, and 22 year periods 1964-1969, 1969-1986, and 1964-1986:[1]															
	+1	0	+1	+1	+1	+2	+2	+5	+7	-2	+1	-1	-1	-6	-7
Estimated annual change:[1]															
	+0.2	0	+0.2	+0.2	+0.1	+0.1	+0.4	+0.3	+0.3	-0.4	+0.1	-0.2	-0.2	-0.4	-0.3

[1]Plus indicates an increasing change; minus a decreasing change.

Table 14—*Vegetative cover and change, Hume Lake Campground, Sequoia National Forest*

Unit	Trees			Shrubs			Grass/Forbs			Litter			Soil		
	1960	1965	1986	1960	1965	1986	1960	1965	1986	1960	1965	1986	1960	1965	1986
	Count			*Percent*											
91b	—	36	34	—	0	0	—	17	14	—	2	2	—	1	1
96a	—	19	23	—	0	0	—	0	1	—	17	8	—	2	0
91a	—	32	24	—	0	2	—	1	4	—	31	20	—	0	0
96b	—	14	13	—	1	3	—	0	6	—	17	3	—	0	1
93	41	47	15	23	13	0	7	12	6	0	0	0	3	8	0
Total	41	148	109	23	14	5	7	30	31	0	67	33	3	11	2
Avg.	41	30	22	23	3	1	7	6	6	0	13	7	3	2	0
Change for 5, 21, and 26 year periods 1960-1965, 1965-1986, and 1960-1986:[1]															
	-11	-8	-19	-20	-2	-22	-1	0	-1	+13	-6	+7	-1	-2	-3
Estimated annual change:[1]															
	-2.2	-0.4	-0.7	-4.0	-0.1	-0.8	-0.2	0	0	+2.6	-0.3	+0.3	+0.2	-0.1	-0.1

[1]Plus indicates an increasing change; minus a decreasing change.

Table 15—*Vegetative cover and change, Wintoon Campground, Shasta-Trinity National Forest*

Unit	Trees			Shrubs			Grass/Forbs			Litter			Soil		
	1964	1969	1986	1964	1969	1986	1964	1969	1986	1964	1969	1986	1964	1969	1986
	Count			*Percent*											
22	27	23	2	2	1	0	0	1	21	7	25	5	13	1	3
Change for 5, 17, and 22 year periods 1964-1969, 1969-1986, and 1964-1986:[1]															
	+5	-4	+1	0	-1	-1	0	+1	+1	-14	+18	+4	+8	-10	-2
Estimated annual change:[1]															
	+1.0	-0.2	0	0	-0.1	0	0	+0.1	0	-2.8	+1.1	+0.2	+1.6	-0.6	-0.1

[1]Plus indicates an increasing change; minus a decreasing change.

Table 16—*Vegetative cover and change, Gregory Creek Campground, Shasta-Trinity National Forest*

Unit	Trees		Shrubs		Grass/Forbs		Litter		Soil	
	1969	1986	1969	1986	1969	1986	1969	1986	1969	1986
	Count		*Percent*							
1	3	1	12	27	0	0	0	0	0	0
2	16	15	7	8	0	0	5	12	31	12
3	25	19	8	8	0	0	4	6	5	0
4	28	26	2	4	0	0	11	23	22	4
Total	72	61	29	47			20	41	58	16
Ave.	18	15	7	12			5	10	14	4
Change for 17 year period 1969-1986:[1]										
	-3		+5		0		+5		-10	
Estimated annual change:[1]										
	-0.2		+0.3		0		+0.3		-0.6	

[1]Plus indicates an increasing change; minus a decreasing change.

Table 17—*Vegetative cover and change, Lakeshore Campground, Shasta-Trinity National Forest*

	Trees		Shrubs		Grass/Forbs		Litter		Soil	
Unit	1969	1986	1969	1986	1969	1986	1969	1986	1969	1986
	Count		*Percent*							
2	6	11	16	8	1	12	3	1	11	0
7, 9	35	39	0	0	0	3	22	14	4	3
Total	41	50	16	8	1	15	25	15	15	3
Ave.	20	25	8	4	0	8	12	8	8	2
Change for 17 year period 1969-1986:[1]										
	+5		-4		+8		-4		-6	
Estimated annual change:[1]										
	+0.3		-0.2		+0.5		-0.2		-0	

[1]Plus indicates an increasing change; minus a decreasing change.

Table 18—*Vegetative cover and change, Hirz Bay Campground, Shasta-Trinity National Forest*

	Trees		Shrubs		Grass/Forbs		Litter		Soil	
Unit	1969	1986	1969	1986	1969	1986	1969	1986	1969	1986
	Count		*Percent*							
13	53	26	0	0	6	8	0	0	0	0
40	45	50	11	10	3	6	5	7	19	5
3, 5	66	67	0	0	0	6	17	11	0	0
Total	164	143	11	10	9	20	22	18	19	5
Avg.	55	48	4	3	3	7	7	6	6	2
Change for 17 year period 1969-1986:[1]										
	-7		-1		+4		-1		-4	
Estimated annual change:[1]										
	-0.4		-0.1		+0.2		-0.1		-0.2	

	Seedling	
Unit	1969	1986
	Percent	
13	9	22
Change for 17 year period 1969-1986:[1]		
	+13	
Estimated annual change:[1]		
	+0.8	

[1]Plus indicates an increasing change; minus a decreasing change.

Table 19—*Vegetative cover and change, Antlers Campground, Shasta-Trinity National Forest*

	Trees			Shrubs			Grass/Forbs			Litter			Soil		
Unit	1964	1969	1986	1964	1969	1986	1964	1969	1986	1964	1969	1986	1964	1969	1986
	Count			*Percent*											
31	37	36	25	7	6	5	0	0	0	4	14	5	10	8	2
17	11	14	13	50	30	26	0	0	2	3	3	2	8	7	5
32	—	47	41	—	0	0	—	0	0	—	7	7	—	1	0
Total	48	97	79	57	36	31	0	0	2	7	24	14	18	16	7
Avg.	24	32	26	28	12	10	0	0	1	4	8	5	9	5	2
Change for 5, 17, and 22 year periods 1964-1969, 1969-1986, and 1964-1986:[1]															
	+8	-6	+2	-16	-2	-18	0	+1	+1	+4	-3	+1	-4	-3	-7
Estimated annual change:[1]															
	+1.6	-0.4	+0.1	-3.2	-0.1	-0.8	0	+0.1	0	+0.8	-0.2	0	-0.8	-0.2	-0.3

[1]Plus indicates an increasing change; minus a decreasing change.

Table 20—*Vegetative cover and change, Tannery Gulch Campground, Shasta-Trinity*

	Trees		Shrubs		Grass/Forbs		Litter		Soil	
Unit	1969	1986	1969	1986	1969	1986	1969	1986	1969	1986
	Count		*Percent*							
25	71	52	3	0	0	0	25	18	0	0
22	74	70	3	0	0	0	25	30	0	0
Total	145	122	6	0			50	48		
Ave.	72	61	3	0			25	24		
Change for 17 year period 1969-1986:[1]										
	-11		-3		0		-1		0	
Estimated annual change:[1]										
	-0.6		-0.2		0		-0.1		0	

[1]Plus indicates an increasing change; minus a decreasing change.

Table 21—*Vegetative cover and change, Fawn Campground, Shasta-Trinity National Forest*

	Trees			Shrubs			Grass/Forbs			Litter			Soil		
Unit	1964	1969	1986	1964	1969	1986	1964	1969	1986	1964	1969	1986	1964	1969	1986
	Count			*Percent*											
55	31	37	44	0	0	0	0	2	0	4	3	5	8	7	4
28	—	42	46	—	0	0	—	0	0	—	17	21	—	4	2
Total	31	79	90				0	2	0	4	20	26	8	11	6
Avg.	31	40	45				0	1	0	4	10	13	8	6	3
Change for 5, 17, and 22 year periods 1964-1969, 1969-1986, and 1964-1986:[1]															
	+9	+5	+14	0	0	0	+1	-1	0	+6	+3	+9	-2	-3	-5
Estimated annual change:[1]															
	+1.8	+0.3	+0.6	0	0	0	+0.2	-0.1	0	+1.2	+0.2	+0.4	-0.4	-0.2	-0.2

[1]Plus indicates an increasing change; minus a decreasing change.