Repeat Photography Helps Tell the Story of Whitebark Pine

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ABSTRACT

Repeat photography—that is, photos taken from exactly the same location over time—is a powerful tool for describing landscape changes over time. However, this technique has not been used widely to document the decline of five-needle pines nor for showing progress in their restoration. We used repeat photography to show mortality of whitebark pine (Pinus albicaulis) at several locations in western Montana, USA; three of the resulting photo pairs are included in this paper. Because whitebark pine has declined so rapidly, we did not need the original, historical images to be very old. Even photos taken 16 years apart show dramatic changes in whitebark pine forests. Our photo pairs illustrate the heart-breaking story of whitebark pine mortality. More hopeful ways to use repeat photography would be to choose sites for restoration of whitebark pine that have a historical photographic record of healthy trees, and to establish new photo points on sites where whitebark pine restoration is underway.

INTRODUCTION

A pair or series of pictures taken from one location over time ("repeat photography") can be worth a thousand words for describing ecological change. We used this technique to illustrate the widespread loss of whitebark pine (*Pinus albicaulis*) during the past 50 years. While the whitebark pine's decline is not news (see, for example, Arno et al. 1993; Keane and Arno 1993), repeat photography has not been used widely to tell this heart-breaking story. The technique can be valuable in many ways: It can vividly illustrate the extent and rapidity of whitebark decline. It can provide context for sampling site data, since it can show change through time over a large area. Finally, if used in areas where whitebark pine is being restored, it can convey hope for the future of this beautiful species and the hundreds of species in its habitat - especially the iconic Clark's nutcracker (*Nucifraga columbiana*).

Repeat photography has been used to illustrate the effects of succession and disturbance in many ecosystems. Wright and Bunting (1994) used repeat photography to illustrate change in the abundance and health of limber pine (*Pinus flexilis*) at Craters of the Moon National Monument. White and Hart (2007) used hundreds of repeat photos to depict landscape change over time in the northwestern United States and southwestern Canada. Many of their photos are included in White's (no date) "Lens of Time Northwest" website, which uses computer animation—fading from a historical photo to a more recent one, then back again—to dramatize landscape change. The website is now used in a learning activity that challenges students to use photo pairs and dendrochronological data to envision how a given forest may change in the future (Smith et al. 2018). Similarly, Abrahamson et al. (2017) incorporated Gruell's (2001) repeat photographs from the Sierra Nevada into a learning activity for students in northern California.

An ecological restoration project in a managed ponderosa pine/Douglas-fir (*Pinus ponderosa*/*Pseudotsuga menziesii*) forest (Smith and Arno 1999) shows how repeat photography can complement historical reports and plot data. Treatments were conducted in the Lick Creek Demonstration and Re-

search Forest, Bitterroot National Forest, Montana, USA. They were based on Gruell and others' (1982) repeat photographs and synthesis of historical records from the area. The 1999 report's section on "Educational Value" notes that repeat photos provide visible evidence of the abstract concept of succession. Viewers can trace changes in a single location through time, following growth or loss of individual trees and noting the development of a dense understory. Thus, repeat photography makes the concepts of succession clear and the development of ladder fuels vivid. The Lick Creek project is continuing, with a website providing documentation and links to other products (Missoula Fire Sciences Laboratory (no date)).

METHODS

We used repeat photography to show changes in several whitebark pine stands in western Montana, USA. While most repeat photography projects show changes spanning many decades and sometimes more than a century, the decline of whitebark pine has been so rapid—and we are so old—that we could rephotograph some of our own photos from past years. This also made it relatively easy to find the places where the original photos were taken ("photo points"). The most useful images were those with a distinct foreground and background. By lining up foreground objects with background objects (or the horizon), we could orient the repeat photo correctly and pinpoint the original photographer's location with a few meters. The original photos needed to be clear, and it was helpful if they did not contain high contrast caused by patchy cloud cover, since this contrast could obscure any differences between cover types on the ground.

After selecting photos, we studied maps and satellite images to better identify the photo points, printed copies of the photos, then traveled to the sites and hoped for good weather. When we found the photo points, we recorded latitude and longitude and took multiple photos in an effort to capture the same field of view as that shown in the original. Since none of the repeat photos were taken with the same lens as the originals, they did not match perfectly, so we later cropped and adjusted them to minimize differences in the field of view.

In this paper, we use side-by-side pairs of photos to show the changes that have occurred in whitebark pine communities. In presentations and online, we have used computer animation instead. This provides an even more striking way to depict the decline of whitebark pines. We used PowerPoint to create the animations: The original photo fills the whole screen; then the repeat photo fades in on top of the first, usually from right to left, over a 10-second interval. As viewers go back and forth, they can watch the changes unfolding in different parts of the photos.

RESULTS AND DISCUSSION

Sad to say, it does not take a century or more to see dramatic change in whitebark pine ecosystems. Our photo pair with the longest time interval, 49 years (figure 1), shows a cabin near the eastern edge of Martin Lake in the Deer Lodge National Forest, MT, west of Mount Powell. The cabin is built from whitebark pine logs. In 1971, it was surround-

Figure 1. Left (1971): Whitebark pines surrounding cabin at Martin Lake, Deerlodge National Forest, MT (46° 21' 12.3" N, 112° 59' 36.5" W, elevation 2637 m (8651 ft)). Right (2020): After 49 years, most of the whitebark pines had died and many had fallen. Subalpine fir and alpine larch were becoming established. (Left photo: Steve Arno. Right photo: Garon Smith.)

Figure 2. Left (1989): Scotch Bonnet Mountain, northeast of Lulu Pass, Gallatin National Forest, MT (45° 02' 52.5" N, 109° 55' 41.0" W, elevation 2878 m (9442 ft)). Right (2018): After 29 years, patches of dead trees—mostly whitebark pines—were visible on the slopes to the right of Scotch Bonnet Mountain and along the left edge of the photo. Tree regeneration in the foreground included only one whitebark pine. (Left photo: Steve Arno. Right photo: Garon Smith.)

Figure 3. Left (2005): Whitebark pines on ridge northwest of Glen Lake, Bitterroot National Forest, MT (46° 27' 35.7" N, 114° 17' 54.9" W, elevation 2607 m (8554 ft)). Whitebark pines were already declining. Right (2021): After 16 years, nearly all of the whitebarks were dead. (Both photos by Garon Smith.)

ed by large whitebark pines. In 2020, the cabin was still standing—albeit with a lean and no roof—but most of the whitebark pines were dead and many had fallen. Whitebark mortality was high throughout the area, but a few vigorous, cone-bearing trees were present. Subalpine fir (*Abies lasiocarpa*) and alpine larch (*Larix lyallii*) were abundant.

A second photo pair (figure 2) spans a 29-year interval. The photo point is on the northeastern slopes of Henderson Mountain in the Gallatin National Forest, MT, looking northwest at Scotch Bonnet Mountain. Lulu Pass is on the far horizon on the left, and part of Sheep Mountain is shown on the right. In 1989, forest cover was nearly continuous on the slopes below Scotch Bonnet and Sheep Mountains, although dead tree crowns were also visible. In 2018, large patches of dead trees were visible on these slopes, and patches of dead trees were also evident along the left edge of the photo. Substantial tree regeneration was visible in the foreground, but it included only one whitebark pine.

A third photo pair (figure 3) shows dramatic change over just 16 years. The photo point is at the top of the ridge northwest of Glen Lake in the Bitterroot National Forest, MT. Whitebark pines were already declining in 2005, but some of the tree crowns were still intact and many young, cone-bearing whitebark pines were present in the area. In 2021, all of the large whitebark pines were dead, and only a few young pines were present.

All of our photo pairs and our PowerPoint animations will be available for download from the Whitebark Pine Foundation's website (www.whitebarkfound.org). We hope other photographers will contribute photos as well, so future visitors to high-elevation forests can continue to tell the whitebark pine story.

LIMITATIONS AND RECOMMENDATIONS

The original photographs for our project were not necessarily taken for the purpose of repeat photography, so our project has inherent limitations, as does repeat photography in general. First, our photo pairs do not necessarily represent the condition of whitebark pine stands throughout western Montana, so they cannot be used as a basis for generalization. Second, the photo pairs are qualitative rather than quantitative; it is difficult to quantify trends from photos alone, and we did not attempt to do so. No quantitative information was available on the historical condition of the areas photographed, and we did not collect data ourselves. Third, photo points that show a landscape provide little information on conditions at a fine scale, such as understory cover and surface fuels.

Repeat photography could complement quantitative studies in whitebark pine. Photos can capture a much larger area than most sample plots, thus providing a visual context for plot data. Repeat photography is essential for documenting restoration projects and communicating their effectiveness. We can generally grasp a story told in photos more easily and quickly than we can interpret quantitative information that is summarized in graphs and tables. Photo points should be established at the beginning of the project and rephotographed as part of the monitoring protocol. To maximize the value of photo points, each one should be described by latitude, longitude, azimuth, a description of the physical setting, and possibly directions for accessing the site. It may be possible to select some restoration sites based on the availability of old photos that show healthy whitebark pines. In that case, photo pairs that currently show only decline could be turned into trios and quartets that show promise for the future of whitebark pine and the organisms that depend on it.

CONCLUSIONS

Whitebark pines are an essential component of healthy, resilient subalpine ecosystems in this region, but few people visit them, understand their fragility, or appreciate their beauty. Repeat photography can help viewers understand the extent and rapidity of whitebark pine's decline. It can also help those who love and care for whitebark pine to communicate the urgent need for protecting and restoring these landscapes. Repeat photography on sites where whitebark pine is regenerating can tell stories of hope, providing much-needed good news to managers and the public.

More than a century ago, poet Gerard Manley Hopkins expressed his grief at the loss of a row of beautiful trees lining a road in rural England, mourning that "After-comers cannot guess the beauty been" (Hopkins 1879). Repeat photography of whitebark pine stands can help "after-comers" appreciate what has been lost in high-elevation forests during the past century and envision the possible restoration of these unique, invaluable ecosystems.

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