Documenting Landscape Change:
Photo Point Monitoring and Repeat Photography

By Wendy Anthony for Eric Higgs, UVic ES 490 Directed Studies, 13 Aug 2014

Photo point monitoring is used to document the "passage of time" in the landscape (Hoffman & Todd, 2010, p. 314), by replicating pre-existing photos of the same subject with a "paired equivalent" repeat photograph for assessing past change, or by creating a reference base photo for assessing future change (Gruell, 2010, p. xv). Repeat photography is useful as both a scientific tool, to test hypotheses about ecological changes, and as a "time capsule" (Webb, Boyer & Turner, 2010, p. xix), to document transformation of the landscape (Boyer, Webb & Turner, 2010; Crimmins & Crimmins, 2008; Hall, 2001B; Klett, 2010).

Repeat photography can document landscape-level changes in ecosystem structure, composition, and plant populations, and be used to communicate complicated issues of change. The purpose of the project, and the species being monitored, will determine what, and how often to document, and at what distances. With planning, one camera location can show many photo locations, linking together a larger area. Establishing a set of protocols including location, camera settings, and instructions will make it easier for someone other than the original photographer to take repeat photos (Boyer, Webb & Turner, 2010; Crimmins & Crimmins, 2008; Hall, 2001A; Webb, Turner & Boyer, 2010).

The two essential tasks to replicate a photograph are to accurately replicate the camera position, and to duplicate the lighting. Each photo has a unique "vantage point" from which the camera lens records the view (Klett, 2010, p. 32). To correctly interpret the data, repeat photos need to be as precise as possible by eliminating the observer's position variability - even a centimeter can make a difference. Lighting indicates a moment in time, defines an object's size, 3D shape and colour, and influences data interpretation. The original lighting conditions must be duplicated, and if monitoring vegetation, photos must be replicated during the same season, ideally on the same date, and time (Boyer, Webb & Turner, 2010; Hall, 2001A; Hall, 2001B; Hoffman & Todd, 2010; Klett, 2010).

To be useful as a scientific technique, the vantage point and other elements in the image must be suitable for replication, and will be most accurate if identifiable objects exist in the foreground, midground, and background. Using a field copy of the original photo, which may also include notes of plant species and landscape information, establish a rough location of the original camera position, draw a vertical line along the centre, or either side of the image, and move the camera back and forth along this line to align the features (Boyer, Webb & Turner, 2010; Klett, 2010). If the original camera location cannot be found because of disturbance or growth, establish a new location with an unobstructed view as close as possible to the original, describe the new location in field notes, and document the blocked view from the new camera location (Boyer, Webb & Turner, 2010; Hall, 2001B).

To create an original baseline photo, choose a prominent camera site for a "permanent benchmark", with the intent to replicate the view at some future time. All photos should include a scale, such as a "metre board" (Hall, 2001A, p. 28), which is useful both as a camera focal photo point, set at the same plane as the subject to be measured, and as a common size reference. Once chosen, the distance between the camera and the metre board must always remain the same for all subsequent repeat photos. Though this distance is more critical than the focal length, using a zoom lens creates an f-stop and focal length that will be difficult to reproduce, and will need computer software to digitally match points, to ensure that the metre board, which should be at least 25-50% of the photograph's height, is the same size in each photo. If there is no scale in the photo, each future photo must have the same focal length, though including something with a known size will make the scale more apparent. For close-up views of details not seen from the original camera location, walk closer to the metre board, placing it at one edge of the photo view, and align the top with the top of the photo (Boyer, Webb & Turner, 2010, p. 12; Hall, 2001A; Hall, 2001B; Hughes, Burley, King & Downey, 2009; Klett, 2010).

To put the photo point in context, take an overhead, perpendicular view of the canopy, while keeping the same focal length, before swiveling to the left, and then to the right, in 30° increments, to take 2 to 3 photos on each side, producing 5 to 8 overlapping images for a landscape or panoramic view, and draw a detailed map, or video the journey to the location, or the return after a disturbance (Boyer, Webb & Turner, 2010; Hall, 2001A; Hoffman & Todd, 2010; Klett, 2010).

The geometric angles between photo elements are created by the distance between the camera and the metre board, and as this distance must be replicated for comparative analysis both camera stations and photo points should be permanently marked. Original photographers may have used rock cairns, or a chiseled an "x" into rock, while contemporary photographers might use rebar stakes, though marking with metal posts may not possible, or even appropriate, in forests, parks, areas of ecologically sensitivity, roads and streambeds, and could also cause a safety hazard for animals, humans and equipment. A stable camera platform, or a digital game-trail camera, could be attached to some permanent structure, such as a signpole, fencepost, large rock, easy to find tree, or stump (Boyer, Webb & Turner, 2010; Digital Earth Watch, 2012; Hall, 2001A; Hall, 2001B; Hughes, Burley, King & Downey, 2009; Mountain Legacy Project, 2011; Webb, Boyer & Turner, 2010).

Take detailed field notes of the date, time, camera location, model, and lens settings, and the ground-level distance between the camera and the subject. Include the GPS location, compass bearing of the view, camera vertical tilt, tripod height, and names of photographer and crew. Take a photo of the photographer posing with the camera setup to document the camera position and height – ideally the same camera should be used to replicate the photos. Describe the scene, and anything else that may help understand the change in view, including the weather, reproductive stages of dominant plant species, surface conditions, elevation, slope, land-use practices, and evidence of human use or disturbances. Include a dark blue photo ID card in the bottom of each view, with at least the photo ID#, location, and date, to ensure this critical information stays with the photo (Boyer, Webb & Turner, 2010; Hall, 2001A; Hoffman & Todd, 2010; Hughes, Burley, King & Downey, 2009; Klett, 2010).

To be of any help to answer future questions about change, photo collections need a protocol for cataloguing and archiving, using unique numbers to identify the camera station, year, and view, with embedded metadata and common terms documented in a database to enable searching. A standard protocol for secure storage, ventilation, relative humidity, temperature control, and regular migration to the latest available technology, will help guarantee the quality of the data (Boyer, Webb & Turner, 2010; Crimmins & Crimmins, 2008).

Traditional methods of paper-printed comparisons, typically viewed side-by-side, from oldest to newest, are being replaced by digital displays using web-viewers and GIS, with overlays, image dissolves, moveable mask-windows, and magnified views to assist detailed analysis (Boyer, Webb & Turner, 2010; Klett, 2010). Image analysis can estimate biomass by using grids to monitor the change in profile, and to document the green-up and senescence phases of deciduous shrubs and trees by using the photo colours. To facilitate comparison when estimating biomass, the individual species are typically shown in less detail, which limits the usefulness in documenting intermediate phenophases. The beginning and ending of the growing season can be determined by classifying the pixel values of the red, green, and blue [RGB] bands to record the timing of bud-burst, and mature stages of leaf colour and drop. Including a colour-control panel will help comparison as digital camera colour balance may change over time (Benton, 2009; Bullock & Turner, 2010; Crimmins & Crimmins, 2008; Hall, 2001A; Hoffman & Todd, 2010; Hughes, Burley, King & Downey, 2009; Jonsson, 2012; Webb, Boyer & Turner, 2010).

Photo point monitoring can be useful to evaluate change in plant communities, and assess plant assemblage populations (Webb, Boyer & Turner, 2010), but may have limited potential to document different phenophases of a specific species or plant, beyond the traditional green-up phase, without some form of close-up monitoring. Few studies actually focus on flowering phases, and as phenology stages are very responsive to temperature change, and the timing of flowering affects other cycles such as pollination and seed production, documenting these phases may help understand the influence of climate on ecosystem health. More detailed information could be gathered when paired with permanent research study plots, and frequent observations from an automated digital game-trail camera could detect the exact dates of phonological stages, though heavily vegetated areas may pose problems (Benton, 2009, p. 8; Duce, et al., no date; Hall, 2001A; Hughes, Burley, King & Downey, 2009).

Though erecting permanent markers may not be practical in ecologically sensitive areas, by establishing photo monitoring protocols and paying careful attention to the placement of the photo elements, views can still be replicated, and can become an accurate scientific tool to quantify change if a scale is included in the photo. Replicated photographs may show the passage of time, but as the external influences, or reasons for change may not be apparent, including field notes may help document the context for change, and help contribute as a conversation tool to illustrate change and transformation in the landscape over time.

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