



The applicability of repeat photography in rock art conservation: a case study of mixed methods in the Arkansan Ozarks

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with 11 figures

Abstract. Detailed scientific analyses of rock decay and site stability can aid rock art conservation but cultural sensitivity often limits the use of traditional methods, which often require rock samples or other invasive procedures. The need for intuitive non-invasive rock art analysis led to the creation of the Rock Art Stability Index (RASI). While RASI is a validated rock art assessment tool, a primarily quantitative approach can sometimes overlook the aesthetic component of rock art – a characteristic critical to the presentation and perceived value of the resource. Therefore, this research examined the applicability of repeat photography, or rephotography, in addition to RASI providing a more comprehensive approach. This mixed method approach was employed at three different rock art sites in the Arkansan Ozarks of varying lithologies, geographic characteristics, rock art type, and management policies. Results suggest that RASI allows for more consistent and reliable assessments, as rephotography has more restrictions and limitations. Nevertheless, when available, rephotography proved to be an immensely useful addition to quantitative research techniques, such as RASI, to provide heritage management with a more holistic evaluation addressing both geologic stability and changes in visual quality over time.

Keywords: Cultural Resource Management, Geoarcheology, Heritage Science, Rock Art Stability Index (RASI), Cultural Stone Decay, Heritage Conservation

1 Introduction

Due to the protective nature of rock art and cultural resource management entities, the applicability of most traditional research methods is often contested, if not restricted, as many require forms of partial destruction (i.e. sample collection) and/or significant funding. However, detailed analyses of cultural stone decay and site stability can greatly benefit heritage management decisions and policy efficacy (ALLEN & GROOM 2013, CERVENY 2005). Therefore, the development and validation of reliable non-invasive technologies to study cultural sites is imperative to their survival. One such method is the Rock Art Stability Index (RASI), employed across the American Southwest and Caribbean by a number of academic and governmental agencies (ALLEN & GROOM 2013, ALLEN et al. 2011). Assessing over three-dozen specific rock decay processes RASI provides a quantitative evaluation of observational data. While this information is invaluable to conservationists, sometimes purely numerical assessments neglect a critical component of cultural and heritage resources: aesthetics. If a host stone is geologically stable but the rock art is obscured or difficult to see then some may argue its usefulness or appeal as a resource is diminished (HEYD 2003). In attempts to create a more holistic approach to rock art research, this study tested the applicability of an additional, more qualitative technique known as repeat photography, or rephotography. Essentially, rephotography involves repeating historic photo-

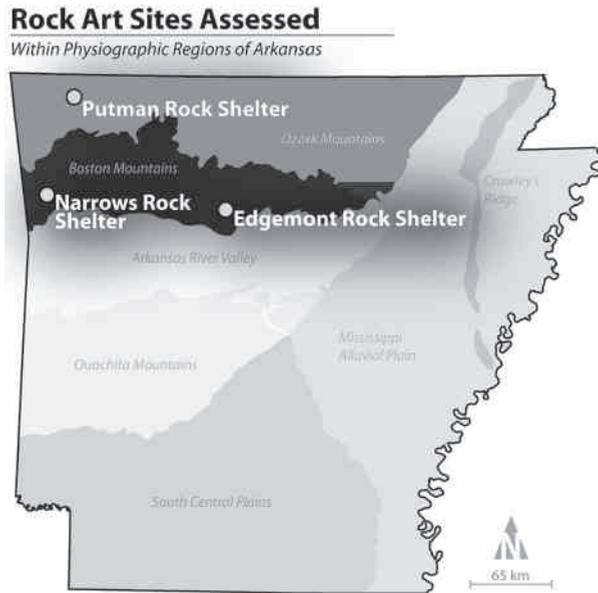


Fig. 1. Map of the three study sites in relation to Arkansas's physiographic regions. Locations are approximate. Map by author.

graphs from the exact same location, elevation, and angle – often called the ‘camera station’ or ‘vantage point’ – and then the old and new photographs are compared with analyze visual change (WEBB et al. 2010).

In order to examine the benefits of employing multiple techniques, a mixed method analysis combining RASI (quantitative) and rephotography (qualitative) was conducted at three different archeological sites in the Arkansan Ozarks: The Narrows, Putnam, and Edgemont Rock Shelters (Fig. 1). Because looting is often an unfortunate consequence of archeological discoveries, the exact locations of these sites will remain confidential and only general details will be provided. These sites not only represent variations of rock art types, host lithologies, geographic surroundings, and management policies common to the region but also show up in early photographic records held by the University of Arkansas Museum and the Arkansas Archeological Survey, making rephotography a viable option.

Before discussing the research, a basic outline of rock art definitions and terminology is necessary. Rock art itself is classified as four principal types, varying by technique and size: pictographs, petroglyphs, geoglyphs, and intaglios (WHITLEY 2001). Pictographs and geoglyphs are additive techniques – created via the application of foreign materials to the stone surface or landscape. Pictographs are considered motifs and patterns drawn on a rock surface using chalk, charcoal, paints, or other similar substances (WHITLEY 2005). Some of the oldest and most identifiable rock art are categorized as pictographs. Well-known examples include the *Aurignacian*-period cave paintings in *Chauvet-Pont-d'Arc*, southern France and the Fremont-associated Buckhorn Draw in San Rafael, central Utah. Similarly, geoglyphs designate the intentional ar-

rangement of stones, ranging from pebbles to boulders, into distinct, often geometric, designs (WHITLEY 2005). Some of the most famous examples of geoglyphs are the Aboriginal *Wurdi Youang* stone arrangements in Victoria, Australia (LANE & FULLAGAR 1980).

Inversely, subtractive rock art techniques (petroglyphs and intaglios) remove surface matter to reveal differently coloured, often lighter, inner material. Petroglyphs are designs pecked, carved, or incised into rock faces so the more heavily weathered surface juxtaposes the freshly exposed interior (WHITLEY 2005). Renowned petroglyph sites include *Twyfelfontein* in north-western Namibia, Newspaper Rock in the Petrified Forest National Park outside of Holbrook, Arizona, and *Khaz'ali* Canyon in Wadi Rum, Jordan. Working at a different scale, intaglios are large figures created by stripping overlaying desert pavements, soils, or vegetation of a landscape uncovering paler subsurfaces. The curious *Nazca* Lines in coastal Peru and the Uffington White Horse in Oxfordshire, England are specimens of intaglios. Intaglios and geoglyphs are *not* synonymous, despite being regularly used interchangeably, as they signify two distinctive techniques: Intaglios, like petroglyphs, are subtractive while geoglyphs, like pictographs, are additive (WHITLEY 2005).

In terms of the Arkansan Ozarks, rock art techniques vary (SABO III 2005), as exemplified by the diversity among the three sites examined in this study. The Narrows Rock Shelter contains mostly petroglyphs, although some showed evidence of also being colored at one point. The rock art at the Putnam Rock Shelter are exclusively pictographs with red and black pigments. Edgemont Rock Shelter hosts mostly petroglyphs, many of which, unfortunately, have been partially or completely consumed by mosses and lichen. Knowing the basic rock art types and how they were created is vital to understanding how they decay and identifying which natural and/or anthropogenic processes pose the greatest threat to their continued survival.

2 Methods

2.1 Rock Art Stability Index

Composed of six overlying categories, RASI observationally quantifies over three-dozen individual rock decay processes to evaluate the current condition of rock art panels (groupings of rock art elements on a discrete rock face), as well as identify potential risk of decay in the future (DORN et al. 2008). The severity of each process is rated individually per category on a scale of 0 to 3; where: 0 = non-existent on the panel, 1 = decay is present but not significantly affecting the rock art, 2 = decay is obvious and causing problems, and 3 = decay is dominant on the panel and/or directly impacting the rock art. Once each value is determined, individual scores are summed to produce a total score with a maximum score of 100. While it is mathematically possible for a panel to score higher than 100, the severity of decay required to reach that point would have rendered the panel a lost cause. Lower final scores indicate more stable conditions where higher scores represent higher risk. For administrative accessibility, final score ranges are also given descriptive classifications:

- ≤ 20 : Excellent Condition
- 20–29: Good Status
- 30–39: Problem(s) that Could Cause Erosion

- 40–49: Urgent Possibility of Erosion
- 50–59: Great Danger of Erosion
- ≥ 60 : Severe Danger of Erosion

The six overarching categories assessed by RASI include: site setting, impending loss, large break-off events, incremental loss, rock coatings, ending with vandalism and other issues. ‘Site setting’ assesses the panel’s geologic context (e.g. stone hardness, fissures/cracks, and lithological factors). ‘Impending loss’ evaluates the potential of decay in the near future (e.g. undercutting or developing weathering rinds). ‘Large Break-off events’ focus on larger mesoscale decay events (e.g. rock fall or anthropogenic removal). ‘Incremental loss’ appraises microscale decay and superficial concerns (e.g. granular disintegration or deteriorating rock coatings). Rock decay processes at the centimetre- and millimetre-scale are abundant so RASI incorporates double the decay factors in *incremental loss* than any other category. ‘Rock coatings’ scores somewhat differently because, in many cases, rock coatings actually stabilize rock art panels. Therefore, half the elements in this section have negative values (i.e. 0, -1, -2, -3), lowering the final score. The breadth of processes addressed by RASI is its true strength as a research tool: not only does it provide the intensity of decay but it also identifies the major *drivers* of decay. RASI also incorporates a sixth, qualitative category (vandalism and other issues) that does not impact the final score but grants researchers the opportunity to record noteworthy observations. For a more comprehensive overview of RASI’s rock decay parameters, an online atlas is available (see: http://alliance.la.asu.edu/rockart/stabilityindex/RASI_Overview.html).

Although RASI is still moderately new – first published in 2008 – its effectiveness has been endorsed by the several universities and national government agencies as part of a 5-year National Science Foundation (NSF) funded project to examine the several thousand Native American petroglyphs found in the Petrified Forest National Park, near Holbrook, Arizona (DORN et al. 2008). In fact, RASI’s efficiency enabled 10 researchers to rate 24 separate sites and over a thousand individual panels in only two weeks (GROOM & THOMPSON 2011). Rapid, non-invasive assessment tools like RASI are critical to the cultural resource management of inherently fragile landmarks. While there may be significant scientific benefits of more traditional research tools (FITZNER 2002), RASI was designed as a management tool to provide prompt, detailed, and cost-effective evaluations of rock art sites and has been successfully employed across the US Southwest (ALLEN & LUKINBEAL 2011, GROOM & THOMPSON 2011), as well as internationally (ALLEN & GROOM 2013).

2.2 Repeat Photography

Nearly as old as photography itself, rephotography has proven to be a useful and versatile tool in the social and physical sciences (WEBB et al. 2010). One of the earliest pioneers of employing rephotography as a scientific tool was a Bavarian mathematician named Sebastian Finsterwalder, who, in 1888, used the technique to monitor glacial change over time (HATTERSLEY-SMITH 1966). His research was so successful rephotography grew in popularity and has been a long-standing tool in glaciology (BYERS 2007, FOX & COOPER 1998). Since then, the technique has spread to other physical disciplines such as ecology (CLEMETS 1905), geology (BRYAN & LA

RUE 1927), and geomorphology (LOBECK 1939). Not limited to the physical sciences either, rephotography has also been used to assess social concerns such as land-use change (KULL 2005) and the socio-economic influences of tourism (FINN et al. 2009). The method has also been adapted for use in anthropology as a means to assess place meaning and awareness (SMITH 2007). Rephotography has been casually employed to monitor rock art sites for decades but rarely in a scientific context (e.g. LOUBSER 2011).

While applications may vary, the fundamental idea behind rephotography is comparing old and new (repeat) photographs taken from the same perspective. There are several methods for finding these perspectives, also known as vantage points or camera stations, but no one method is superior to another, each is case specific (BOYER et al. 2010). Popular ways to find vantage points range from using the principles of parallax by identifying the cross lines between foreground and background elements in the photo (MALDE 1973) to utilizing geospatial technologies and advanced photogrammetry (HANKS et al. 2010). The most common method, however (and the one used in this study), is what is known as the Brute-Force Technique, where the researcher looks for major landforms in the photo and 'walks into the view' (HANKS et al. 2010). Once the vantage point is identified, the camera is then adjusted to match elevation, tilt, and azimuth to get the most accurate repeat. The degree of precision necessary often depends on the research topic and the preference of the researcher (BOYER et al. 2010).

Of course, rephotography also has to work within some fairly tight constraints and limitations. First of all, obviously, researchers wishing to employ rephotography are restricted to locations for which old photographs exist. Some places simply do not have photographic records necessary and are, therefore, excluded from rephotographic assessments. Secondly, not all photographs are eligible for reliable replication. In almost all cases, camera stations are located by somehow interpreting the relationship between identifiable objects in the foreground vs. those in the background (BOYER et al. 2010), so if a photograph lacks one of these two components then finding the exact camera location becomes significantly more complicated. Similarly, it would be exceedingly problematic to confidently find the vantage point of a photograph only showing indiscriminate or common landmarks, such as trees or hills.

Another limitation, or complication, with rephotography involves technology. Photographic technology has advanced rapidly throughout the years, slightly altering photographs along the way (BOYER et al. 2010). Everything from focal lenses, film material, film size, even the jump to digital cameras influences the quality and shape of a photograph. Much like cartography, photographs are 2D representations of a 3D landscape and, therefore, some form of image distortion is inevitable and each camera evolution alters the degree of this distortion (BOYER et al. 2010). For that reason, researchers must be aware of differences in camera equipment used by the original photographers when interpreting landscape change between photographs.

Despite these restraints, rephotography is still a valuable research tool. One of the most significant advantages of rephotography is that it allows a holistic analysis of overall change. This can include everything from surface recession and rock decay, vandalism, litter, land use, to any other ways in which human activity may have impacted the overall stability of the site. Even beneficial changes, such as the erection of a fence to deter looters or excavation for scientific discovery, can be included in the assessment. For culturally sensitive sites, such as archeological

ruins, a holistic analysis can be critical to creating better management policies and addressing issues often missed in traditional or overly focused assessments. Furthermore, once camera stations, or vantage points, are established and well documented, continual monitoring of sites or future repeats would be more easily obtained (BOYER et al. 2010).

For the case study in the Ozarks, historic photographs were chosen from a 1930s collection courtesy of the University of Arkansas Museum in junction with the Arkansas Archeological Survey. Despite hosting numerous sites throughout the state, Arkansas's rock art have attracted very little attention in the research community and remain under-researched (SABO III & HILLIARD 2005). One exception to this was a man named Samuel C. Dellinger (1892–1973), affectionately referred to as 'Raider of the Lost Arkansas' (MAINFORT 2008). Appointed curator of the University of Arkansas Museum in 1926, Dellinger was extremely protective of Arkansas's Native American heritage and detested how much excavated archeological material was being taken and displayed in out of state museums (LANKFORD 2009). In protest, Dellinger wrote several research grants to assemble local archeologist field crews that swept the state throughout the 1930s – resulting in one of the best archeological museum collections in the nation (MAINFORT 2008). Fortunately, Dellinger's teams also kept decent photographic records of many of the sites they excavated – including the Putnam and Edgemont Rock Shelters. While Dellinger did visit the Narrows Shelter his teams did not take any photographs, therefore, the photos repeated at this site were actually taken later in the 1950s.

At least 10 rephotographs were attempted at each site with the expectation that only a few would be viable as many photographs can be difficult to source or other situations might prohibit an accurate repeat. Arduous site conditions restricted the use of large equipment so no tripod was used and the modern camera was an Olympus® Tough Camera™ using the Brute-Force Method to locate vantage points. As a caveat, it is worth noting that the most obvious difference between Dellinger's photographs and their modern repeats (for all three sites) is what is known in the rock art community as chalking – outlining the art to make the motifs more distinct. While it was common practice throughout the early and mid-20th century, chalking is now considered damaging to the rock surface and use is now strongly discouraged (DORN et al. 2008). For that reason, all of the historic photographs have chalking while the repeats do not, thus, making some of the individual elements more difficult to identify in the modern photographs.

3 Results & Analysis

3.1 The Narrows Rock Shelter

One of the more famous rock art sites in the Arkansan Ozarks is the Narrows Rock Shelter in Crawford County. Situated just off the road on property owned by the US Forest Service, the site contains petroglyphs and other archeological materials dating back to around 1425 AD (HILLIARD 2010) – although all significant artifacts are now under the protection of the University Museum and the Arkansas Archeological Survey. Due its notoriety, the Narrows is visited often and, unfortunately, not always for academic purposes – prevalent illegal activities such as vandalism, looting, and graffiti represent major concerns for heritage management (HILLIARD 2010). However, awareness of these issues has attracted conservational interest as well, making

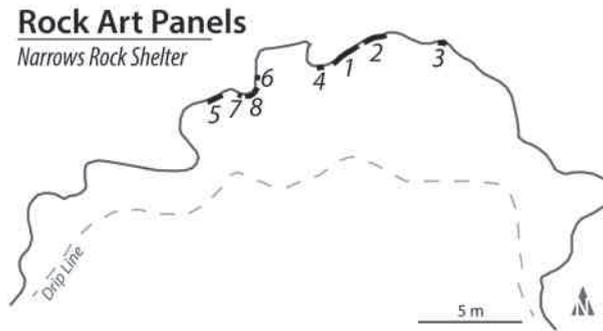


Fig. 2. Map showing the rock art panels in the Narrows Rock Shelter. Map by author with the permission from the Arkansas Archeological Survey.

the Narrows one of the few rock art sites in Arkansas to have actually undergone any kind of non-archeological scientific research (HILLIARD 2010). In early 2014, University of Arkansas honors student Ashley Kupillas attempted to determine environmental influences on the deterioration of rock art at the Narrows Rock Shelter, thus, incorporating rock decay assessments for the first time at this site (KUPILLAS 2014). The research presented here is a continuation of this endeavor. Nine rock art panels were assessed via RASI and two photographs were successfully repeated (Fig. 2).

Physical Setting: Geologically, the Narrows is part of the Boston Mountain system along the Arkansas River Valley (HILLIARD 2010). The rock art itself is constrained to the Atoka sandstone formation, a capstone to other shales and siltstones in the region (ADAMSKI et al. 1995). Situated on a hill slope, water runoff often flows through the rock shelter, as well as drips off the ceiling and overhang. In addition, the mouth of the rock shelter is surrounded by thick vegetation – mainly shrubs and deciduous trees. Access to the shelter is fairly simple, thanks to a stone staircase built by the Civilian Conservation Corps in the 1930s (HILLIARD 2010).

Rock Art Stability Index: With an average RASI score of 36.25, the petroglyphs at the Narrows Rock Shelter are categorized as having *Problem(s) the Could Cause Erosion*. The lowest score was panel 6 (31 = *Problem(s) the Could Cause Erosion*) and highest was panel 1 (42 = *Urgent Possibility of Erosion*). Some of the most prevalent forms of decay/risk include intense sedimentation within the entire shelter, lithobiont activity such as lichen and moss, and textural anomalies causing differential decay. The sedimentation is probably of the most concern – as the soil level has reached several panels (which were most likely created at eye level) and a number of petroglyphs are at risk of being buried completely. While burial may prevent further anthropogenic damage, the chemicals and moisture in the soils could cause significantly more discoloration and surface deterioration.

That said, for a site as heavily visited as the Narrows, these scores were actually significantly lower than expected. Despite the site's risks and sedimentation, many of the decay processes that plague sandstone rock art in places such as the American Southwest do not appear to be as prevalent here. Common sandstone issues such as splintering, salt efflorescence, or fissuresol development all scored very low (0–1) at this site. Fissures, both independent and dependent to

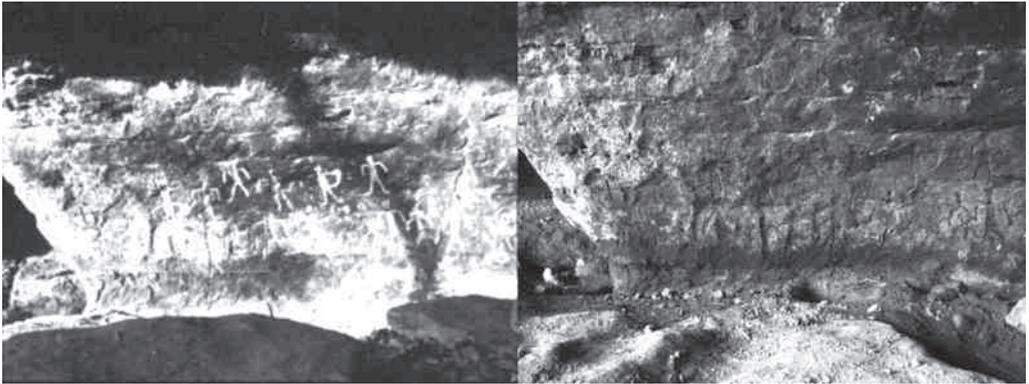


Fig. 3. Left: 1955 photograph of panel 1 at Narrows Rock Shelter with permission of the Arkansas Archeological Survey. Right: Repeated photograph by author.

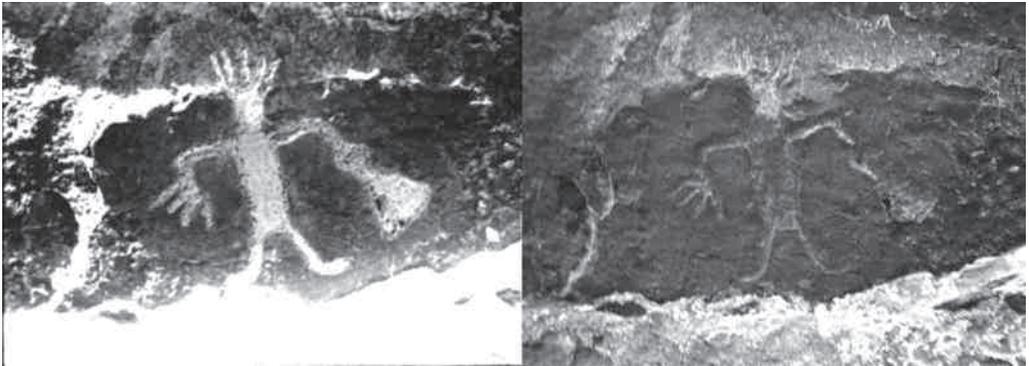


Fig. 4. Left: 1955 photograph of panel 7 at Narrows Rock Shelter with permission of the Arkansas Archeological Survey. Right: Repeated photograph by author.

the bedding plane, were also very few. This would indicate that many of the problems experienced at the Narrows involve topical decay and the sub-structure is actually relatively stable. There is also abundant anthropogenic carving, such as initials or dates, throughout the site but since many of the panels are at floor level due to sedimentation there is actually very little vandalism on the panels themselves – decreasing their impact in terms of RASI scores.

Rephotography: Where RASI quantified structural stability, the rephotographic assessment sought to evaluate the visual quality of the Narrows petroglyphs, how the aesthetics may have changed over time. Only two photographs were successfully repeated due to picture quality and lighting conditions: Panels 1 and 7 (two of the more recognizable panels at the site).

The first photograph repeated depicts the rock art panel most often associated with the Narrows Rock Shelter (Fig. 3). Besides the chalking, there are a few noticeable changes. First of all, the floor at the base of the panel has been greatly disturbed, most likely a result of illegal activities. In fact, there was a large looting pit with evidence of illicit drug use just beyond the frame of the photograph. Secondly, the degree of chipping and flaking on the panel has made

the petroglyphs more difficult to see and the lines are not as clear. That said, many of the petroglyphs on the right-hand side of the photograph show evidence of repatination – the accumulation of rock coating within a petroglyph.

The second photograph shows a close up shot of a single anthropomorphic petroglyph holding what appears to a mace on panel 7 (Fig. 4). The depth and clarity of the glyph made it an excellent candidate for rephotography and a number of features stand out, such as large chips in the bottom left corner of the mace and headdress. What stands out even more, however, is how remarkably little has changed. Once again, the rock surface shows evidence of repatination, within the petroglyph itself as well as the rest of the panel surface. The presence of repatination, a process suggesting stable conditions over a considerable period of time (DORN 2006), might actually help explain the unexpectedly low RASI scores from this site – as identified through the use of rephotography as a supplementary tool.

3.2 Putnam Rock Shelter

Once located high on the Springfield Plateau, the Putnam Rock Shelter now sits at the edge of Beaver Lake, a state reservoir built in 1966. Bordering private and US Corps of Engineers property on a steep talus slope, the site is extremely challenging to access. This difficulty has two major consequences for rock art conservation: there is hardly any evidence of vandalism or looting at this site but there is also very little modern scientific research. The Putnam Rock Shelter was first photographed in 1932 as part of Dellinger's archeological program, when the site was heavily excavated (CLELAND 1965). State archeologist Gayle Fritz later revisited the site in 1978 to determine if the rock art was still intact (HILLIARD 2004). The most recent archeological visit to the site was in 1986 as part of a project run through the Arkansas Archeological Survey called Dellinger Revisited (HILLIARD 2004). The rock art at this site consist of pictographs contextually dated to around 1550–1600 AD, although there is speculation that it could be even more recent (HILLIARD 2004). The research presented here is the first geologic analysis of the rock art at the Putnam Rock Shelter. RASI was employed on 13 panels in total with three repeated photographs (Fig. 5).

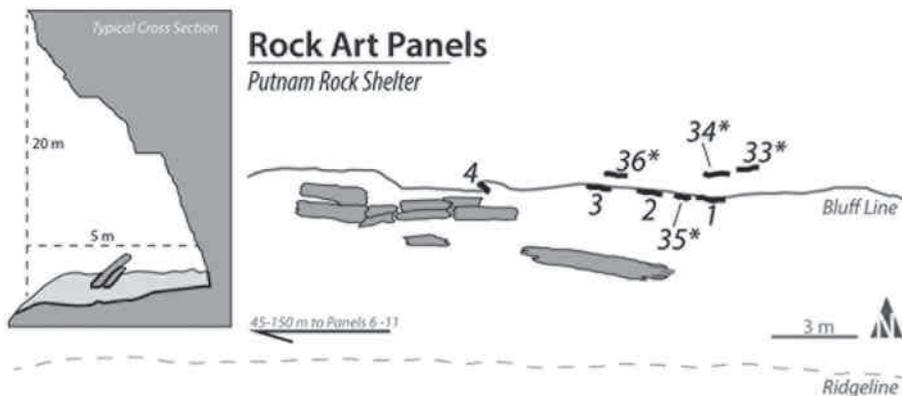


Fig. 5. Map showing the area of highest concentration of rock art panels at the Putnam Rock Shelter.



Fig. 6. Repeated photo sequence between 1978 (right) and 2014 (left) showing significant loss due to undercutting. Historic photo shown with permission of the Arkansas Archeological Survey and current photo taken by author.

Physical Setting: Part of the Springfield Plateau, the Putnam Rock Shelter is at an elevation of 340 m (1115 ft) in the Boone Limestone Formation – much more friable than the Atoka Sandstone of the Narrows. With the impoundment of Beaver Lake, water is a major feature of this site. Although the site is currently 5 m above the lake’s surface, US Corps of Engineers records indicate at least three high water events (2008, 2009, and 2011) capable of inundating the pictographs for over two weeks (EVANS 2013). Also, in the 1980s, as an attempt to discourage curious visitors, the Corps planted several trees to block the view of the bluff, making it difficult to see the site from the lake. The privacy and difficult access of Putnam has limited human activity but many natural processes are still profoundly impacting the site’s stability.

Rock Art Stability Index: The average RASI score for the Putnam pictographs was 41.15 (*Urgent Possibility of Erosion*). The lowest score was actually a panel from an adjoining site not included in Dellinger’s original study (33 = *Problem(s) that Could Cause Erosion*). The next lowest was a previously unrecorded element near panel 1 (34 = *Problem(s) that Could Cause Erosion*). With a highest score of 49 (panel 2 = *Urgent Possibility of Erosion*), some of Putnam’s panels can almost be categorized as *Great Danger of Erosion* – the second highest rating. Unlike the Narrows, much of the concern at the Putnam Rock Shelter is structural. Some of the primary decay mechanisms identified by RASI include fissures along the bedding plane, undercutting, splintering, flaking and scaling – all evidence of internal instability. In fact, at least one panel has been cut in half since the 1970s due to undercutting (Fig. 6). In addition, many panels have developed what is known as a weathering rind – a thin layer of minerals that have migrated to the surface leaving the underlying rock weak and susceptible to decay (OGUCHI 2004).

In addition, there is also considerable surface decay at this site. Many of the panels show evidence of intense fading, most likely the result of frequent flooding, making the pictographs more obscure and difficult to identify. Vegetation is also of concern. Many of the trees planted to protect the rock art have actually grown towards the panels, presenting a potential abrasion risk. Also, vines have covered much of the rock surface, possibly abrading or concealing pictographs. With all the issues influencing the stability of the Putnam Rock Shelter, the RASI scores



Fig. 7. Left: 1932 photograph of panel 4 at Putnam Rock Shelter with permission of the Arkansas Archeological Survey. Right: Repeated photograph by author.



Fig. 8. Left: 1932 photograph of panel 8 at Putnam Rock Shelter with permission of the Arkansas Archeological Survey. Right: Repeated photograph by author.

are actually rather modest. Many of the panels containing rock art, on their own, appeal stable prompting lower scores but when the site is assessed as a whole these panels exist on a relatively weak and vulnerable substrate. The severity of risk at this site is, perhaps, understated by the RASI analysis – which is where rephotography may be helpful.

Rephotography: The Putnam Rock Shelter was extensive but only two photographs from Dellinger's collection were successfully repeated. The rest of the photographs were simply too difficult to locate due to the intense fading and disappearance of the featured pictographs. In fact, both repeats had to be identified through unique geologic features and not the art itself, since the motifs were too faint to find on their own. Since this site has pictographs and not petroglyphs, any chalking seen in the old photos simply circles rock art elements instead of highlighting individual motif features.

The first photograph repeated exhibits one of the clearest pictograph as this site – panel 4 (Fig. 7). The repeat photo shows evidence of rock fall and undercutting occurring along the

outer cliff face as well as fading around the left side of the concentric circles motif. There is also considerable flaking and detachment of any beneficial rock coatings – leaving the surface lighter and less stable. The old photo also appears to show significant lichen growth on the interior of the panel, which has since then completely detached.

The second photograph depicts what is left of a faded red quadruped on panel 8 (Fig. 8). The motif is very worn, even in the 1930s photo. Despite the pictographs faintness, the minimal geomorphologic difference between the photos is surprising, since the panel had one of the highest RASI scores for the site (42 – *Urgent Possibility of Erosion*). This might suggest two things. One, that the panel has experienced significant decay just not within the time frame of the photos, which is geologically reasonable. The other possibility is that the RASI analysis may have inadvertently incorporated a certain degree of inherited decay – rock decay that took place prior to the application of the art (WARKE 1996, DORN 2006). Either way, rephotography illuminated a decay pattern otherwise indistinguishable with RASI alone.

3.3 Edgemont Rock Shelter

Situated near the Little Red River Valley in the Interior Ozark Mountains, the Edgemont Rock Shelter (also known as the Indian Rock House) differs from the other two sites. Representing an interesting case study for heritage management and popular use of cultural resources, the Edgemont shelter is privately owned by the Wyndom Indian Hills Resort at Fairfield Bay and highly advertised to promote the resort. Photographs of the shelter are shown on billboards, the site itself sits next to the golf course, and the interior of this fairly large shelter has been used for concerts, picnics, and other community events. There has even been a small stage built into the back wall of the shelter near a natural spring (Fig. 9). The University Museum has historic photographs dating back to 1931, but records indicate the Archeological Survey did not formally document the site until the 1950s (FRITZ & RAY 1981). Since the site is on private property it was

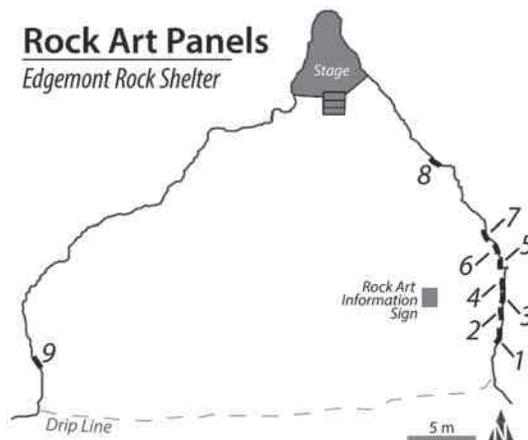


Fig. 9. Map showing the distribution of rock art panels at the Edgemont Rock Shelter. Map by author with permission from the Arkansas Archeological Survey.

never officially excavated and the petroglyphs are only contextually dated back to the late pre-historic. In addition, some time between the survey's visits in the 1950s and 1978, 2 m of infill was removed with a bulldozer – leveling the floor and elevating the rock art out of arms reach (FRITZ & RAY 1981).

One speculated reason for this removal was as an attempt to protect the rock art from the prolific vandalism that has plagued the site. The entire shelter, as well as nearby cliffs and smaller caves, is littered with initials, dates and names going as far back as 1900 – making some of them historic in and of themselves. However, the temptation of continuing a legacy created by the extensive vandalism has created a dangerous feedback loop: the more names carved on the walls the less a future vandal might hesitate – almost creating the perception of socially acceptable vandalism. The resort has added a new sign discussing the rock art and their significance to instill respect for the art, per the suggestion of the Survey (FRITZ & RAY 1981), but many damaging engravings contain modern dates. Over half of the panels assessed in the Edgemont Shelter have been directly impacted by vandalism. Since there is little official documentation at this site, new panel designations were used for RASI – nine in total – and three photographs were repeated.

Physical Setting: Part of the Morrowan Witts Springs formation, the Edgemont Rock Shelter is composed of fine-grain sandstone (HUTTO & RAINS 2014). The natural spring near its rear keeps much of the shelter continually wet and damp, leading to considerable moss and plant growth throughout. Much of the other physical characteristics at the Edgemont Rock Shelter have been intentionally modified. Any trees or larger vegetation within the shelter were removed when the floor was lowered. Access to the site is not only easy, but also encouraged. Visitors of the resort are informed of the shelter's location and invited to drive their golf carts right up to its entrance. There is also a large sign with stairs leading visitors down from the main parking lot.

Rock Art Stability Index: With an average RASI score of 40.78 (*Urgent Possibility of Erosion*) many of the petroglyphs at Edgemont score between the *Urgent Possibility of Erosion* and *Problem(s) that Could Cause Erosion* categories. The scores are also relatively consistent – the lowest being 37 (panel 4) and a high of 44 (panel 3) – suggesting relatively unilateral decay. By far, the most dominant, and widespread, feature impacting the rock art is the rampant moss and lichen growth. RASI scores demonstrate both direct as well as indirect decay processes brought on by the lithobiont activity in this shelter. Directly, nearly all panels scored a three for decay features such as lithobiont pitting and lithobiont release – where the death and detachment of moss and lichen actually removes rock material (CERVENY et al. 2007). Indirectly, the digestion of minerals and coatings by lithobionts weakens the stone surface, enabling other topical decay such as flaking, granular disintegration, and rounding of the petroglyph edges to develop – all of which scored high in the RASI analysis at Edgemont.

Along with superficial decay, RASI also identified a few structural issues at this site, though not as many or as severe. High scores for independent fissures – fissures not constrained by the lithology or bedding plane – mark several panels and are present throughout the shelter, not just on panels containing rock art. In fact, there are a number of large and relatively cavernous fissures transecting the entire site, running from one side along the ceiling to the other end

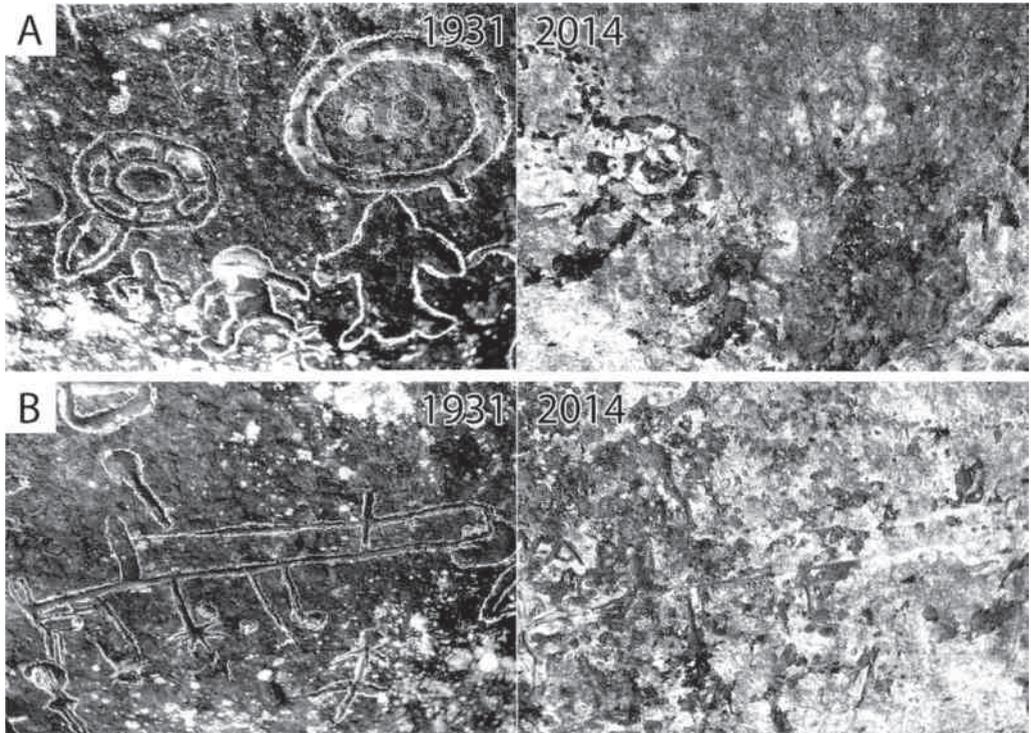


Fig. 10. Left side: 1931 photographs of panel 4 at Edgemont Rock Shelter with permission of the Arkansas Archeological Survey. Right side: Repeated photographs by author.

parallel to the shelter opening. These fissures are now home to bats and birds, as evident by their constant chirping and rustling throughout the research visit. Other geologic concerns at the site include decay features such as tafoni and anthropogenic cutting, both of which occurring within the shelter but mostly separate from panels containing actual petroglyphs.

Rephotography: Despite the large size of the Edgemont Rock Shelter with the added complication of the floor removal, three photographs were successfully assessed. The visual difference at this site is significantly more extreme than the other two, mainly due to chalking and lithobiont growth. As petroglyphs, chalking of major features is prevalent in the old photos. Many of the motifs are also more complex, so any loss of detail clarity is much more noticeable than with simple figures. Some of the angles are slightly skewed between historic and modern photographs due to floor elevation changes. A self-standing ladder was necessary to get as close as possible to original camera height but limited maneuverability affected repeat accuracy.

The first two repeated photographs are actually different sections of the same panel (panel 4) – the right side showing two circular motifs and some anthropomorphs (Fig. 10A) and the left end with a long-bodied quadruped (Fig. 10B). Since they both represent the same panel, and share many of the same aesthetical concerns, the two photographs were assessed jointly. The most significant difference between these photos is the rapid lithobiont activity that has

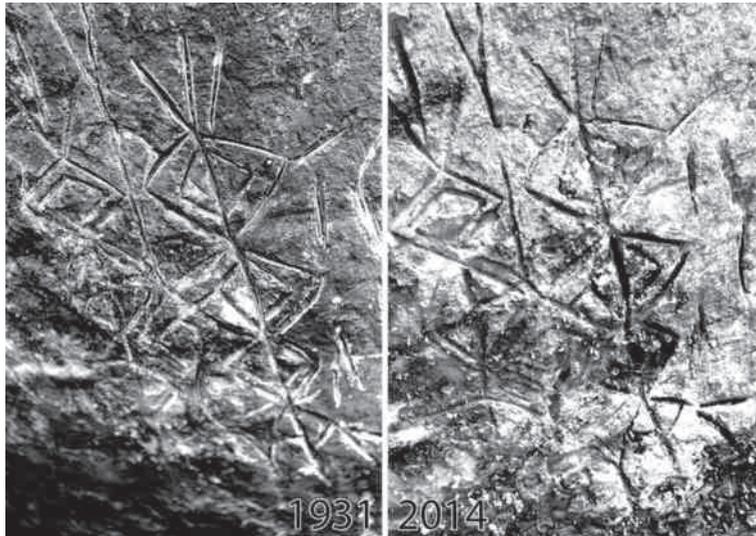


Fig. 11. Left: 1931 photograph of panel 7 with permission of the Arkansas Archeological Survey. Right: Repeated photograph by author.

obscured much of the art. While the motifs in the older photos might not be as distinct without the chalking, their surfaces are markedly clearer of mosses and lichen than the modern repeats. Many of the features in the recent photographs can only be identified through cross comparison with the old chalked photographs.

The third image analysed depicts a pair of fairly large prayer staffs, roughly one meter long each (Fig. 11). These petroglyphs were incised much deeper than others at the site – which could explain their apparent stability and midrange RASI score (40 = *Urgent Possibility of Erosion*). Most of the more noticeable differences in appearance occur in the middle components of the motifs where significant detail has been lost. The clear lines and engravings seen in the original photographs have since chipped and flaked with detaching lithobionts. There is also more lichen growth within the actually rock art – representing an immediate risk of further decay. The RASI scores for both panels signified lithobionts as a structural menace but for a site as heavily advertised as Edgemont, the visual impact of lichen growth poses an even more practical threat to the site's value as a marketable cultural attraction.

4 Discussion & Conclusion

Although all three sites scored fairly similar RASI scores (upper thirties to lower forties), each site faces unique decay processes and potential concerns for the near future – as seen in both RASI scores and rephotography. The Narrows, as the most commonly looted rock shelter of the three, rated much lower in RASI than expected. The individual RASI subsections show surface decay as the biggest challenge. Closer inspection of the rephotography also suggests repatination and other stabilizing processes may be influencing decreased rates of decay. The picto-

graphs at the Putnam Rock Shelter have more structural concerns and are at the most risk of decay with consistently higher RASI scores. Many of which already have already decayed beyond recognition – even before the 1930s, as witness in the repeat analysis of Dellinger’s photographs at this site. With the most intentional advertisement and water issues, Edgemont’s petroglyphs are overrun with lithobionts and vandalism – as identified more by rephotography than RASI.

It is also imperative to bear in mind that the physical and temporal contexts differ at each site. Any kind of direct comparison would be misguided and erroneous. The purpose of this research was not to assess rock art decay in relation to other sites but to lay the groundwork for understanding the *variety* of threats affecting under-researched state heritage and test method applicability. In fact, the focus sites were intentionally selected *because* they vary so much in geology as well as time. The actual rock art ages’ range from the 1400s AD to sometime in the late pre-historic – a significant span of time that discourages site comparison but aptly illustrates the diversity of rock art in the Arkansan Ozarks.

RASI has already been established as an effective research/management tool (DORN et al. 2008, ALLEN & GROOM 2013) but the addition of rephotography proved to be advantageous. Some of the more glaring limitations, such as historic photograph availability, may discourage rephotography as an independent research tool for rock art assessment, but its applicability as a secondary method is quite promising. The supplementary information provided through rephotography helped explain unexpected variations in RASI scores and reveal time dependent decay processes otherwise overlooked by a purely numerical method. In addition, the ability to empirically assess changes in visual quality and aesthetics over time can hold significant implications for cultural resource and heritage management. While numerical analyses are incredibly beneficial, a visual display of advanced decay over time may be more convincing when promoting the vital importance of conserving national heritage – such as the Native American rock art of the Arkansan Ozarks.

Acknowledgements

This research would not have been possible without materials and assistance provided by the University of Arkansas Museum and the Arkansas Archeological Survey. Thanks are also due to the US Forest Service, the US Corps of Engineers, and the Wyndom Indian Hills Resort for allowing access to sites on their property.

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