2017

Master's Project: Guiding Recreation at Travertine Hot Springs: An Environmental Assessment and Photo Monitoring Protocol

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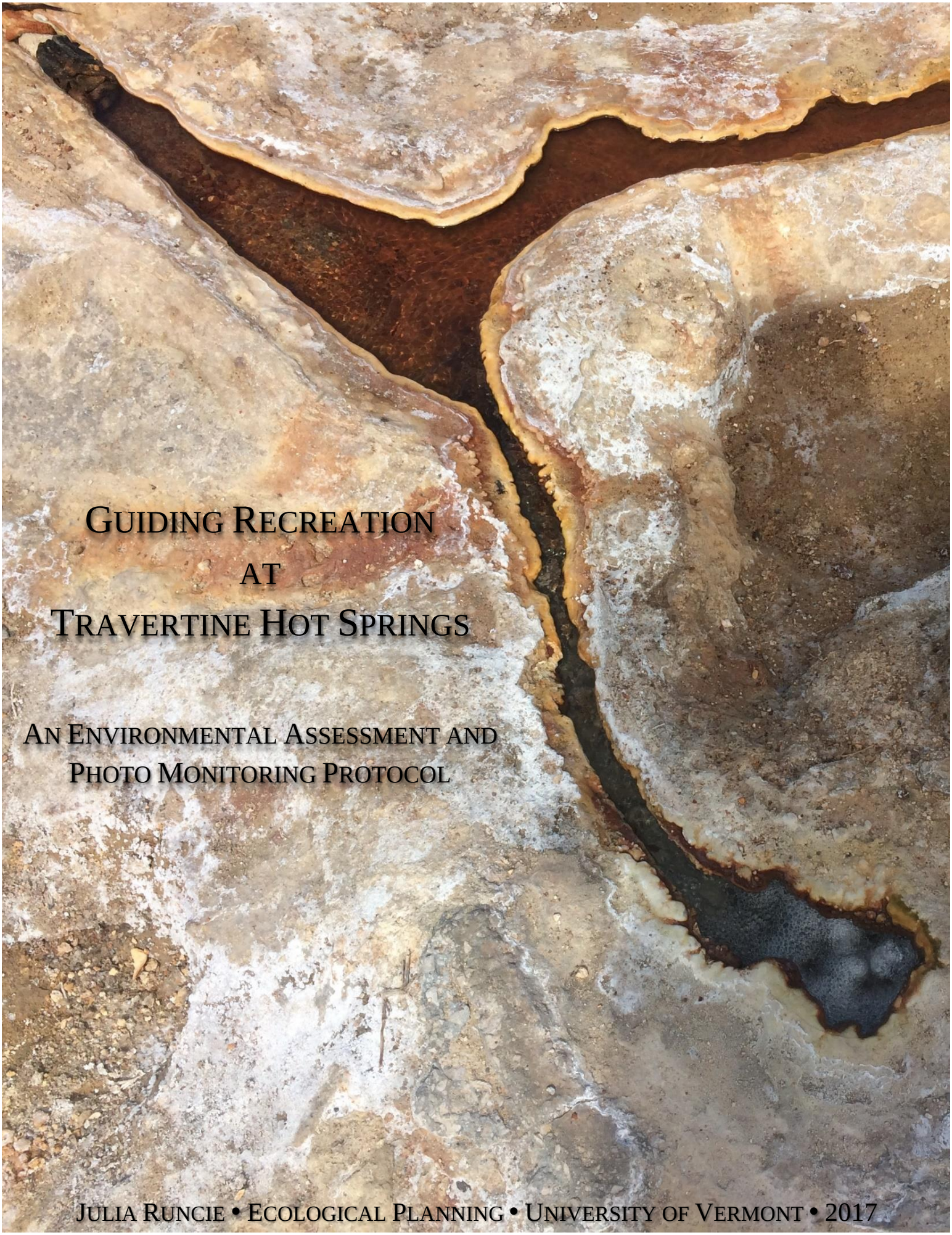

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An Environmental Assessment and Photo Monitoring Protocol

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Acknowledgements

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EXECUTIVE SUMMARY

FEBRUARY 2017

» CONTEXT

Travertine Hot Springs sits at the edge of Bridgeport Valley in eastern California. These 160 acres of alkali meadow, sagebrush steppe, and pinyon-juniper woodland are located on public land administered by the Bureau of Land Management (BLM). Natural hot springs flow along ridges of travertine stone, supporting wetland habitats that are uncommon in the arid Great Basin desert. The site's rich human history may stretch back 10,000 years. In October 1987 the BLM designated Travertine Hot Springs as an Area of Critical Environmental Concern (ACEC) in recognition of its extraordinary cultural, natural, and recreational value. This designation elevated the protection of the area and prioritized the preservation of its most fragile resources.

Over the last 3 decades, Travertine Hot Springs has hosted tens of thousands of visitors each year. This high tide of visitors has left trash, illegal campfire rings, and barren ground in its wake. Road closures in the mid-1990s mitigated some of these impacts, but in recent years the proliferation of nearly 2.5 miles of informal foot trails within a 16-acre area has caused erosion, soil compaction, destruction of vegetation, and damage to travertine formations. The meandering trail network also makes it difficult for visitors to locate the hot tubs. Although camping is prohibited within the ACEC, 2 prominent pullouts invite illegal camping and provide additional points of access to the informal trails.

On December 28, 2016, an earthquake of magnitude 5.6 occurred about 70 miles east of the ACEC near Hawthorne, Nevada. Following this event, the hydrology of the ACEC changed in ways that are not yet fully understood. The spring feeding 4 of the most popular tubs dried up entirely for several days, and then began flowing again at a much lower volume and temperature than before. Other springs increased in volume and temperature, and a new spring appeared in the parking lot. It is unclear how these changes in hydrology will affect recreational use patterns.

» PROPOSED ACTION

The BLM proposes a suite of recreation management and habitat restoration strategies to improve visitor access and to mitigate the adverse effects of unmanaged, intensive recreation at Travertine Hot Springs ACEC. This project would entail the following actions:

- **Designation** of a half-mile loop trail within the existing trail network to concentrate use and orient visitors.
- **Designation** of the closed road that runs along the ACEC's eastern and southern boundaries as a multi-use trail open to mountain biking, hiking, or horseback riding.
- **Improvement** of the designated trail by installing stairs or water bars in trail segments with slopes greater than 10 degrees.
- **Decommissioning** of superfluous trail segments, using hand tools to decompact, vertical mulch, or reseed and replant native vegetation as needed.
- **Reshaping** of 2 pullouts on the access road to discourage camping while leaving room for large recreational vehicles to yield the right-of-way or turn around.
- **Reshaping** of the parking lot to reduce congestion at the entrance and funnel visitors toward a trail access point near the bathroom and kiosk.

» ANALYSIS

Project activities may result in harm to individual plants, short-term infestations of non-native plant species, temporary disturbance to wildlife, or a slight increase in erosion or compaction within the tread of the designated trail. The scope of the project would be limited to previously disturbed areas, and we anticipate that native plant communities, soils, and wildlife would benefit from the concentration of human use and the rehabilitation of redundant trail segments. Any negative impacts associated with the project would likely be minor and of short duration.

» CONCLUSIONS

It is unlikely that this project would have any significant negative effects on the ecosystem or the human environment. Rather, we expect that the project would limit further damage to vegetation, wildlife habitat, travertine ridges, and Native American cultural resources within Travertine Hot Springs ACEC. The implementation of a monitoring protocol would keep land managers informed of new impacts and changes as they arise. By providing direction and infrastructure to concentrate use, enhance access, and enrich the visitor experience, the proposed action may serve to guide the development of a new recreational ethic at the ACEC.

ENVIRONMENTAL ASSESSMENT

GUIDING RECREATION AT TRAVERTINE HOT SPRINGS ACEC

United States Department of the Interior
Bureau of Land Management
Bishop Field Office
351 Pacu Lane, Suite 100
Bishop, CA 93514

INTRODUCTION

EA NUMBER: DOI-BLM-CA-C070-2017-0002-EA

LEASE/SERIAL/CASE FILE NUMBER: None

PROPOSED ACTION TITLE/TYPE: Guiding Recreation at Travertine Hot Springs ACEC

LOCATION OF PROPOSED ACTION: Travertine Hot Springs ACEC, Bishop Resource Management Plan, Bridgeport Valley Management Area, T4N, R25E, NW ¼ of Section 34, Mount Diablo Base & Meridian, Mono County, California (Figure 1).

APPLICANT (IF ANY): Bureau of Land Management (BLM) Bishop Field Office

BACKGROUND

Travertine Hot Springs Area of Critical Environmental Concern (ACEC) is located at the eastern edge of Bridgeport Valley in Mono County, California, within the Bridgeport Valley Management Area of the Bureau of Land Management (BLM) Bishop Field Office (Figure 1). Natural hot springs flow along ridges of travertine stone within a mosaic of alkali meadows, sagebrush steppe, and pinyon-juniper woodland. Infrastructure is sparse: a dirt access road, a small parking lot, a pit toilet, and 6 rustic tubs within 3 distinct areas, referred to in this report as the cement tub, the sheep dip tubs, and the last tub (Figure 2). The site receives tens of thousands of visitors annually, and in recent years the proliferation of 2.4 miles of informal foot trails within a 16-acre area has caused erosion, soil compaction, loss of vegetation, and damage to travertine formations. This meandering trail network also makes it difficult for recreational visitors to locate the hot tubs. Although camping is prohibited within the ACEC, 2 prominent pullouts invite illegal camping and provide additional points of access to the informal trail network.

On December 28, 2016, an earthquake of magnitude 5.6 occurred about 70 miles east of Travertine ACEC near Hawthorne, Nevada. Following this event, the hydrology of the ACEC changed in ways that are not yet fully understood. The spring feeding the sheep dip tubs dried up entirely for several days, and then began flowing again at a much lower volume and temperature than before. Meanwhile, the springs feeding the cement tub and the last tub increased in volume.

The temperature rose at a spring in the meadow west of the sheep dip tubs, and a new spring appeared in the parking lot.

It is unclear how these changes in hydrology will affect recreational use patterns. By providing direction and infrastructure while protecting natural and cultural resources, the proposed action may serve to guide the development of a new recreational ethic at the ACEC. Furthermore, the implementation of a monitoring protocol will keep land managers informed of new impacts and changes as they arise.

PURPOSE AND NEED FOR PROPOSED ACTION

The purpose of the proposed action is to implement a suite of recreation management and habitat restoration strategies to improve visitor access and to mitigate the adverse effects of unmanaged, intensive recreation at Travertine Hot Springs ACEC. The proposed action entails the implementation of 3 categories of management and restoration activities: 1) Designating trail access points and authorized trails to facilitate visitor use; 2) Eliminating and rehabilitating redundant and unauthorized user-created trails to mitigate adverse effects to natural and cultural resources; and 3) Reshaping and delineating pullouts and parking areas to discourage camping and encourage use of the authorized trail system.

Action is needed to alleviate impacts to upland vegetation, wetland habitat, travertine ridges, and cultural resources within and adjacent to the ACEC, while improving the recreational experience. The current user-created trail system is ineffective at supporting visitor use in the ACEC and contributes to unacceptable adverse impacts to the natural and cultural values for which the ACEC was designated.

SCOPING AND PUBLIC INVOLVEMENT

On July 19, 2016, a group of interested parties including members of the BLM Bishop Field Office, Justin Nalder (Tribal Administrator of the Bridgeport Indian Colony), and April Sall (Director of the Bodie Hills Conservation Partnership), met at Travertine Hot Springs to discuss management options for the ACEC. All interested parties indicated support of the proposed action.

PLAN CONFORMANCE

The proposed action is subject to the Bishop Resource Management Plan (RMP), approved March 25, 1993 (BLM 1993). Although the proposed action is not specifically provided for in the RMP, it is clearly consistent with RMP policy and direction.

LUP Name: Bishop Resource Management Plan
Date Approved: March 1993

- "Public lands will be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and

archaeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition" (BLM 1993, RMP General Policies, 4, p. 8).

- "Vegetation will be a key element in the [Bishop Resource Management] plan and management will be directed toward the achievement of desired plant community goals" (BLM 1993, RMP Area Managers Guidelines, 4, p. 9).
- "Emphasize primitive, semi-primitive motorized, semi-primitive nonmotorized and roaded natural experiences… Manage visitor use to conform with semi-primitive and other physical settings" (BLM 1993, RMP Record of Decision, p. 17).
- "The goals of the ACEC are to enhance recreation opportunities and to protect candidate species habitats, unique geologic features and cultural resources" (BLM 1993, RMP Record of Decision, p. 29).

The proposed action is also provided for by the Travertine Hot Springs ACEC Plan, approved September 1, 1995:

- "A Roaded Natural (RN) area will allow…resource modifications and structures to be obvious but harmonize with the natural environment. Some obvious on-site controls might consist of pathways, information signs, and special guidance for the protection of sensitive resources…" (BLM 1995, Management Philosophy, p. 4).
- "To ensure continuation of the natural processes which give the area its unique association of plants and animals the ACEC will be managed to: 1) preserve the area's soil and hydrologic processes; 2) ensure stable and healthy populations of native plants and animals; 3) meet desired plant community goals for wetlands as described for the Bridgeport Valley Management Area; and 4) reduce or eliminate the occurrence of non-native species" (BLM 1995, Management Philosophy, p. 4).
- "Close road to [sheep dip] tubs. Develop a trail into the [sheep dip] hot tub area along northern-most ridge" (BLM 1995, Proposed Actions, p. 14).
- "Prohibit camping within the ACEC. Provide information on camping in dispersed and developed sites that are available within 15 miles of the ACEC" (BLM 1995, Proposed Actions, p. 14).
- "Implement restoration of damaged sites, e.g. turn-arounds and trenches in alkali meadows" (BLM 1995, Proposed Actions, p. 18).
- "Where habitat is degraded or limited due to human cause, take corrective actions to eliminate or substantially reduce the impact" (BLM 1995, Proposed Actions, p. 19).
- "Develop natural history displays for kiosks" (BLM 1995, Proposed Actions, p. 20).

The proposed action is consistent with Mono County planning, which establishes the following goals (Mono County 2009):

- **Objective 7.C.** Maintain, enhance and diversify the natural resource-based recreational opportunities in the Bridgeport Valley.

  Policy 7.C.2. Work with appropriate agencies and groups to develop and implement management plans for the local hot springs.

  Action 7.C.2.a. As appropriate, assist the BLM and the Bridgeport Indian Colony in their efforts to manage recreation at the Travertine Hot Springs.

TIERING TO EXISTING CATEGORICAL EXCLUSION

The Categorical Exclusion document DOI-BLM-CAC-070-2014-0025-CX (BLM 2014) provides for the construction of a 5-foot-high steel kiosk in the ACEC parking lot.

PROPOSED ACTION AND ALTERNATIVE

Alternative 1: Proposed Action

The BLM proposes implementing a suite of recreation management and habitat restoration strategies to improve visitor access and to mitigate the adverse effects of unmanaged, intensive recreation at Travertine Hot Springs ACEC. The proposed action entails the implementation of three categories of management and restoration activities: 1) **Designation** of access points and trails; 2) **Rehabilitation** of redundant and unauthorized trail segments; and 3) **Reshaping** of pullouts and parking lot to discourage camping and direct vehicular traffic appropriately.

1. Designation

a) Designate a half-mile trail system within the existing trail network. Delineate trail borders using local stones and install 6 to 10 small interpretive signs as wayfinding aids along trails.

- Visitors have created at least 10 access points and a 2.4-mile network of redundant foot trails throughout a 16-acre portion of the ACEC (Figure 2). By using existing travertine stones to delineate a simple half-mile loop trail that connects all 6 established tubs, the proposed action would guide visitors to their destinations without confining the minority that prefers to wander off-trail. The loop trail would avoid meadows and areas of maximum compaction and erosion (Figures 3 and 4). Strategically placed interpretive signs would act as wayfinding aids to direct visitors away from meadows, cultural resources, and travertine ridges (Figure 5).

b) Designate the closed road that runs along the ACEC's eastern and southern boundaries as a multi-use recreational trail open to mountain biking, hiking, or horseback riding. Improve placement of barrier boulders so mountain bikes and horses can enter the trail.

- A closed road leads from the parking lot to a CalTrans maintenance yard just outside the southwestern corner of the ACEC. Barrier boulders near the ACEC parking lot and the maintenance yard prevent vehicles from accessing the road, but mountain bikers use the closed section as a connector to an extensive web of backcountry roads and trails reaching miles into the Bodie Hills. The road also connects to Highway 395 and to the Travertine ACEC access road, offering the possibility of a 3-mile loop (Figure 6). The proposed action would designate this section of rehabilitated road as a multi-use recreational trail open to hikers, mountain bikers, and horseback riders. A minor rearrangement (by approximately

3 feet) of the barrier boulders that block each end of the road would permit access by bikes and horses without reopening the road to vehicles.

2. Rehabilitation

a) Improve designated trail by installing stairs or water bars in trail segments with slopes greater than 10 degrees.

- To minimize erosion, the sustained slope of a foot trail should not exceed 10% (National Park Service 1998; Massachusetts Department of Conservation and Recreation 2014). In segments where the existing loop trail exceeds this slope or where water erosion is evident, routine trail maintenance may require the construction of stairs and/or water bars to mitigate further erosion.

b) Decommission superfluous trail segments, using hand tools to decompact, vertical mulch, or reseed and replant native vegetation as needed.

- If decommissioned trail segments outside the designated loop trail remained distinctly visible and barren of vegetation, the BLM would consider active rehabilitation of these trail segments. Rehabilitation would consist of using small stones to create visual barriers to off-trail travel, decompacting the trail tread, vertical mulching, or reseeding and replanting native vegetation.

3. Reshaping

a) Reshape 2 pullouts on the access road near the parking lot by installing or moving barrier boulders, leaving room for large recreational vehicles to yield the right-of-way or turn around.

- The upper pullout is approximately 90 feet long and 25 feet wide; the lower pullout is approximately 190 feet long and 25 feet wide. Both pullouts are currently used for illegal camping. The BLM would move the barrier boulders that form the end of the lower pullout to within approximately 20 feet of the access road, leaving room for vehicles to yield the right-of-way by pulling aside, or for large trailers to turn around. The BLM would install barrier boulders in a similar fashion to reshape the upper pullout for the same purposes (Figure 7).

  After the pullouts were reshaped, staff would monitor the area to determine if illegal camping was still occurring. If so, the BLM would consider posting the pullouts with No Parking signs or moving the barrier boulders flush with the road to further discourage vehicles from parking there overnight.

b) Reshape the parking lot by moving barrier boulders to narrow its entrance, funneling visitors toward a trail access point near the bathroom and kiosk.

- The current parking lot is approximately 0.38 acres in area and shaped like an elongated oval. The BLM proposes moving the barrier boulders to narrow the entrance to the parking lot (Figure 8), encouraging visitors to drive all the way to the bathroom and kiosk before stopping, and enhancing the privacy of those using the cement tub.

Design Features of the Proposed Action

- If cultural resources were discovered during implementation of this project, the BLM would cease project activity in the immediate vicinity of the discovery and technicians would notify the Bishop Field Office Manager and Archaeologist. The Bishop Field Office Archaeologist would evaluate the discovery per the National Historic Preservation Act.

- If the project activities were scheduled during migratory bird season (May 15 through July 30), the BLM would conduct a nesting bird survey within 25 feet of the project area at least 1 week before project activities commenced. If the survey found nesting birds, project activities would be suspended within 100 feet of active nests until surveyors determined that the young had left the nests.

- The BLM would delineate trails and access points using local materials gathered from multiple sources within the ACEC. Stones used for project work would be sourced from areas that are outside the zone of heavy visitor use and that are disguised from view by tall vegetation.

- Project activities would take place primarily in upland habitat. If the BLM determined that it was necessary to decommission trail segments in meadow or wetland environments, technicians would use less intensive rehabilitation methods such as placing stones to create visual barriers. If less intensive methods did not result in substantial vegetation recovery after 5 years, the BLM would consider decompacting, vertical mulching, or reseeding and replanting trail segments. Whenever possible, work would occur within the existing trail tread in order to minimize damage to wetland plants or soils.

- All project activities would be completed using hand tools, except the movement and installation of barrier boulders, which would require heavy equipment. Heavy equipment would operate only on established roadways and previously disturbed parking areas and pullouts. Barrier boulders blocking the proposed multi-use trail near the parking lot would be moved using hand tools to avoid excessive damage to vegetation.

- Equipment would be inspected for the presence of invasive weeds and seeds. If necessary, equipment would be cleaned before use at the project site.

- Private land and wilderness study areas adjacent to the ACEC would not be affected by the project (Figure 9).

Alternative 2: No Action

Under this alternative, the BLM would not designate access points or trails within the ACEC, install interpretive signs along designated trails, or reshape and delineate pullouts and parking lot. The BLM would not construct stairs or water bars in steep or eroding trail segments and would not decommission redundant trail segments.

ENVIRONMENTAL ANALYSIS

Alternative 1: Proposed Action

The proposed action would not impact prime farmlands, floodplains, essential fish habitat, or groundwater.

Air Quality

The project area falls within the Great Basin Unified Air Pollution Control District but is not within a federal nonattainment area and is not subject to conformance with a state implementation plan. The proposed action would not generate an increase in PM10 pollution and would have no measurable impact on air quality.

Areas of Critical Environmental Concern

The proposed action would take place within an Area of Critical Environmental Concern. The Federal Land Policy and Management Act of 1976 establishes the duty of the Bureau of Land Management to pursue special management actions within Areas of Critical Environmental Concern (Section 103a in BLM 2001). This project would comply with those guidelines.

Cultural Resources

Several informal trails pass through areas that were used by Native Americans as seasonal camping grounds (Justin Nalder personal communication). The proposed action would select a designated trail that avoided those areas, directing the majority of visitors away from places where cultural resources might be disturbed by foot traffic.

The entire area of potential effect for the proposed project was subjected to a BLM Class III archaeological survey. The results of that survey are detailed in Cultural Resource Inventory Report CA-170-16-40. The evaluation found that no Historic Properties would be affected by this undertaking. One prehistoric resource was identified during the survey. This site, MNO-3113, is just outside of the proposed project area and was previously recorded (Halford 1998). The survey also located 1 multi-component site, MNO-3112. This resource is bisected both by a closed dirt road and by a portion of the trail system designated in the proposed action. Since no resources were identified within the roadway, the proposed project follows the existing road, and path delineation would be constrained to that footprint, the proposed action would not result in any impacts to this resource.

Unidentified cultural resources may exist within the ACEC. If any were discovered during project work, the project would be modified to avoid those resources.

Economic Impacts

The proposed action would have no measurable economic impacts. It is unlikely that recreational use of the ACEC would decrease as a result of project activities. As the project would enhance the accessibility of the hot springs, it is possible that recreational use would increase slightly.

Environmental Justice

Per Executive Order 12898, the project would not disproportionately affect low income or minority groups.

Global Climate Change

Secretarial Order 3226 directs the BLM to consider and analyze potential climate change impacts of activities on public land. Greenhouse gas emissions associated with the proposed action would be minimal, consisting of transporting a work crew to the project area and a brief (~1 day) use of heavy equipment to move barrier boulders.

Some models of climate change predict more extreme periods of drought or heavy precipitation. Extended droughts may affect the ability of native vegetation to recolonize decommissioned trail segments, while increased precipitation could cause more severe trail erosion than anticipated. The BLM would conduct photo monitoring to detect unintended consequences of the proposed action and respond appropriately.

Hazardous Materials

The project area does not contain any known hazardous materials and the proposed action would not require the use of any hazardous materials.

Invasive, Non-Native Plants

The areas around the parking lot and between the parking lot and the sheep dip tubs are infested with tansy-mustard (*Descuraina sophia*) and cheatgrass (*Bromus tectorum*). Tansy-mustard and cheatgrass also occur sporadically along trails elsewhere in the ACEC.

Ground disturbance associated with decommissioning redundant trails may result in short-term infestations of tansy-mustard, cheatgrass, or other non-native species. However, it is expected that native vegetation would eventually grow back in these disturbed areas. In addition, narrowing the parking lot and reducing the extent of trails and pullouts would concentrate visitor activities, decreasing the overall disturbance at the site and reducing the potential for the spread of non-native seeds. Therefore it is not expected that the proposed action would result in long-term persistence of non-native plants.

Recreation

Trails
Of the 6 established hot tubs, only 1 is visible from the parking lot. Without a kiosk to direct them to the other tubs, visitors have created at least 10 access points and a 2.4-mile network of redundant foot trails throughout a 16-acre portion of the ACEC. The proposed action would provide visitors with a well-defined half-mile loop trail that would serve to concentrate use, limit trail braiding, and improve the experience of those seeking the hot tubs.

Signs
In addition to the kiosk in the parking lot provided for by the Categorical Exclusion document DOI-BLM-CAC-070-2014-0025-CX (BLM 2014), the proposed project would install 6 to 10 small interpretive signs as wayfinding aids to direct visitors away from meadows, cultural resources, and travertine ridges. These signs would promote visitor enjoyment and stewardship by indicating the designated trail, communicating the natural and cultural history of the ACEC, and explaining the restoration efforts undertaken here.

Camping
Two pullouts near the ACEC parking lot encourage illegal camping, as evidenced by fire rings, trash, food debris, and vehicles parked in the pullouts overnight. The pullouts are not needed as campsites: at least 8 legal undeveloped campsites are accessible within 1 mile of the ACEC boundary (Figure 10), and 12 developed campgrounds within the Bridgeport Valley provide more than 100 additional sites. The pullouts also serve as additional access points to the informal trail network, promoting erosion, destruction of vegetation, and disorientation of visitors. Reshaping the pullouts to serve as turnarounds rather than campsites would deter visitors from camping there illegally, without inhibiting large vehicles from turning around. A map on the parking lot kiosk of developed campsites within the Bridgeport Valley may preempt illegal camping by providing visitors with information about nearby areas where camping is allowed.

Parking Lot
Vehicles pulling into the parking lot cannot immediately see the entire area and often park near the cement tub and picnic table, creating a choke point at the entrance to the parking lot and promoting additional access points to trails. Also, visitors who park here may not find the informational kiosk that will be installed near the bathroom, and would not have the benefit of a map of tub and campsite locations or any information about the historical and ecological value of the site. Reshaping the parking lot as proposed would reduce congestion and concentrate use, while ensuring that all visitors receive the same wayfinding and educational information.

Soils

Eighty-nine percent of the ACEC is underlain by soils of the Halfash-Domehill-Ocashe association. These soils are colluvial loams derived from volcanic andesite or tuff breccia parent material and composed of varying proportions of gravel, ash, sand, and clay. The northeast, southeast, and southwest corners of the ACEC contain soils of the Hardnut-Rock outcrop complex. These soils have similar characteristics but are generally found on steeper slopes that are slightly shallower to bedrock (Soil Survey Staff 2016; Figure 11).

Existing informal trails have eroded and compacted soils throughout a 16-acre portion of the ACEC. While the proposed action could result in a slight increase in erosion and/or compaction within the tread of the designated loop trail, soils outside this half-mile pathway would benefit from a considerable reduction in foot traffic. The cumulative ground disturbance caused by the installation of 6 to 10 small wayfinding signs would be identical to or less than that described for the larger kiosk provided for by the Categorical Exclusion document DOI-BLM-CAC-070-2014-0025-CX (BLM 2014). Stairs and water bars would minimize erosion on steep sections of the designated trail.

Special Status Plants

The BLM uses the term "special status plants" to include federally endangered or threatened plants, plants that are proposed for federal listing as endangered or threatened, and BLM-designated sensitive plants. The latter are plants that are not federally listed, but have been accorded special management consideration by the BLM State Director. State endangered, threatened, or rare plants of California, including plants designated 1B by the California Native Plant Society (CNPS), qualify as BLM sensitive plants in California (California Native Plant Society 2016). Plant surveys, historical Bishop Field Office records, and California Natural Diversity Database records document the presence of BLM sensitive plants in the ACEC.

Inyo County star-tulip (*Calochortus excavatus*) was documented in the ACEC in 1949. Since that time there have been no other reports of the species in the area. The nearest recent account of the species is approximately 40 miles to the southeast in Adobe Valley, and most known occurrences are in the Owens Valley in southern Mono and Inyo Counties. Surveys conducted for this project did not find any *C. excavatus*, and it is possible that the 1949 record is a misidentification. Bodie Hills draba (*Cusickiella quadricostata*) is also recorded within the ACEC. Surveys of the project area did not locate *C. quadricostata*; this species is typically restricted to low sagebrush sites and therefore would not be impacted by the proposed action.

There are no other records of BLM sensitive plants within the project area and none were found during surveys of the project area. Therefore the proposed action is not expected to impact BLM sensitive plants or their habitat.

There are records of several CNPS rare plants (not BLM sensitive) within the ACEC. Of these, only Torrey's blazing star (*Mentzelia torreyi* – CNPS list 2B.2) was located during surveys of the project area. It is possible that the proposed action could disturb individual plants, but overall the project would improve plant habitat by reducing the footprint of trails and pullouts.

Surface Water Quality

The proposed action would not increase sediment loads in drainages within the ACEC.

Vegetation

A system of ephemerally wet meadows and springs occupies nearly half the land area of the ACEC (Figure 12). The meadows are characterized by grasses (*Distichlis stricta*, *Puccinellia lemmonii*, *P. nuttalliana*), rushes (*Juncus balticus*, *J. mexicanus*), sedges (*Schoenoplectus americanus*, *Amphiscirpus nevadensis*), arrowgrass (*Triglochin concinna*), and goldenweed (*Pyrrocoma racemosa*).

Where the meadows transition to uplands overlying volcanic bedrock, greasewood (*Sarcobatus vermicularis*), rabbitbrush (*Chrysothamnus spp.* and *Ericameria spp.*), sagebrush (*Artemisia spp.*), saltbush (*Atriplex spp.*), and Great Basin wild rye (*Elymus cinereus*) are common.

Where upland communities grow on travertine deposits, common herbs include blazing star (*Mentzelia laevicaulis* and *M. torreyi*), wallflower (*Erysimum spp.*), Nuttall's sandwort (*Minuartia nuttallii*), apricot mallow (*Sphaeralcea ambigua*), ball-headed gilia (*Ipomopsis congesta*), thelypodium (*Thelypodium crispum*), and nama (*Nama densa*).

Knolls of volcanic andesite support communities of pinyon pine (*Pinus monophylla*), Utah juniper (*Juniperus osteosperma*), Mormon tea (*Ephedra viridis*), prickly phlox (*Linanthus pungens*), beavertail cactus (*Opuntia sp.*), and buckwheat (*Eriogonum spp.*).

Twenty years after roads within the ACEC were closed, photo monitoring provides evidence that native vegetation has recovered substantially within the old road beds (Figures 13, 14, and 15). It is likely that efforts to reduce foot traffic on redundant trail segments would allow vegetation to recover and result in the eventual disappearance of superfluous trails.

Because project activities would take place almost entirely within the tread of established trails and roads, very few individual plants would be harmed. Plant communities are expected to benefit from the proposed action, as concentrating use along a half-mile trail would likely reduce trampling of vegetation, erosion, compaction, and hydrologic alteration in off-trail areas.

Visual Resources

The Visual Resource Management (VRM) category specified for the public land encompassing the ACEC is Class III. The objective of VRM Class III is "to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape" (BLM 1993).

Project activities would conform to this standard. The proposed action would restore the natural character of the ACEC landscape by concentrating impacts to vegetation and soils within a single pathway. Wayfinding signs along the designated trail would be approximately 3 feet high and would not dominate the viewshed.

Wetland and Riparian Areas

Approximately 0.47 miles of the current informal trail system cross portions of alkali meadow habitat, an ecosystem that is rare in California (Pritchett and Manning 2009) and that supports groundwater-dependent vegetation, aquatic invertebrates, and nesting killdeer that may be disturbed by foot traffic. In many areas, the proposed loop trail would draw visitors away from these meadows. Where the proposed trail travels near springs or meadows, the BLM would conduct photo monitoring to assess for damage to meadow habitat and, if necessary, reroute trails to avoid meadows.

Most project activities would be conducted in upland areas within the ACEC. Rehabilitation of existing trail segments in meadow habitat might entail minimal disturbance to vegetation or soils. This disturbance would be limited to the area of the trail segment, and would be undertaken with the objective of aiding long-term recovery of meadow habitat.

Wildlife, Including Sensitive, Threatened, and Endangered Species and Habitat

According to record searches, historical Bishop Field Office records, and pedestrian surveys in the ACEC, there are no known federally listed, federally proposed, or BLM-designated sensitive wildlife species or habitats within the project area (BLM 1995). Therefore, the proposed action would not impact any sensitive species or habitats.

The ACEC supports a diversity of wildlife species, including mammals like mule deer (*Odocoileus hemionus*), coyotes (*Canis latrans*) golden-mantled ground squirrels (*Callospermophilus lateralis*), and black-tailed jackrabbits (*Lepus californicus*). The mix of sagebrush steppe, pinyon-juniper woodland, and wetlands provides habitat for birds like house finches (*Haemorhous mexicanus*), rock wrens (*Salpinctes obsoletus*), Brewer's blackbirds (*Euphagus cyanocephalus*), pinyon jays (*Gymnorhinus cyanocephalus*), killdeer (*Charadrius vociferus*), and common nighthawks (*Chordeiles minor).* Reptiles like western fence lizards (*Sceloporus occidentalis*) and gopher snakes (*Pituophis catenifer*) are common. Invertebrates like Travertine band-thigh diving beetles (*Hygrotus fontinalis*, BLM 1995), water boatmen (*Corixidae*), and the nymphs or larvae of crane flies (*Tipulidae*), damselflies (*Zygoptera*) and dragonflies (*Anisoptera*) live in pools with muddy soft bottoms throughout the ACEC.

Project activities could cause temporary disturbance to wildlife. This disturbance would be minor and short-term, as most project activities would be completed with hand tools and would require minimal time. Sufficient similar habitat exists within the vicinity of the project area to accommodate any wildlife displaced by project activities. The project would take place primarily in previously disturbed areas and therefore would not result in any permanent loss of habitat. The design feature limiting project activities during migratory bird nesting season ensures that the proposed action would not negatively impact migratory birds.

In the long term, the project is likely to result in improved wildlife habitat and reduced disturbance through concentration of human use and rehabilitation of redundant trail segments.

Alternative 2: No Action

Under this alternative, the BLM would not undertake any designation of official routes, rehabilitation of steep or unnecessary trail segments, or reshaping of the pullouts and parking lot in the ACEC. It is likely that unofficial trails would continue to proliferate, leading to further soil erosion and compaction, loss of native vegetation, and deterioration of the visitor experience. Native American cultural resources and travertine ridges would be further endangered. Overnight camping within the ACEC would probably persist, resulting in accumulation of trash and food debris, illegal harvesting of firewood, and continued use of informal trails.

CUMULATIVE IMPACTS

We have identified no incremental or long-term impacts associated with the proposed action that would contribute to cumulative negative effects within or beyond the project area. Considering the proposed action in the context of planned future local and regional activities, it is unlikely that the cumulative impacts of these activities would result in significant negative effects on the ecosystem or the human environment.

CONSULTATION AND COORDINATION

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Figure 1.

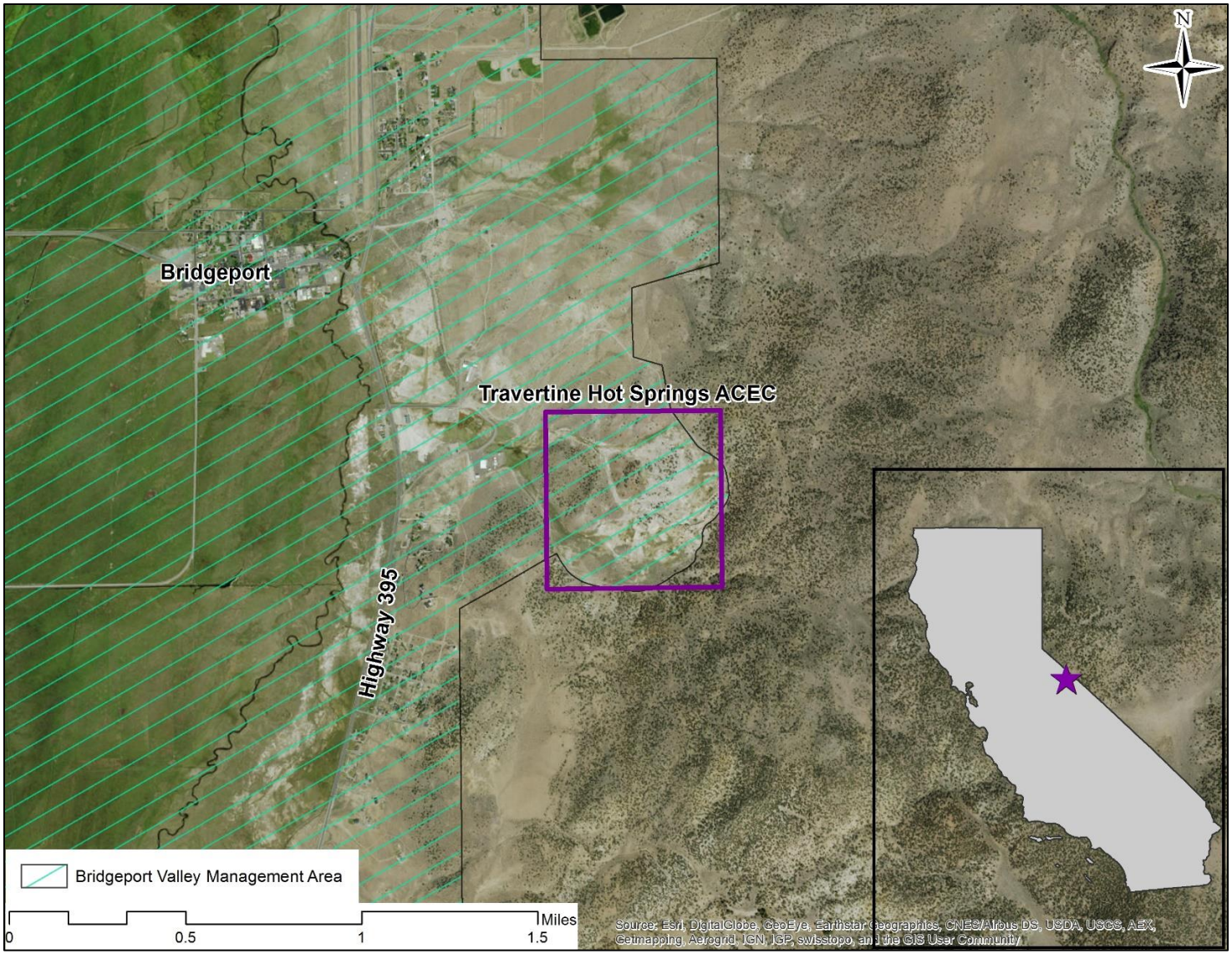

Figure 1. Location of the ACEC within the Bridgeport Valley Management Area in eastern California.

Figure 2.

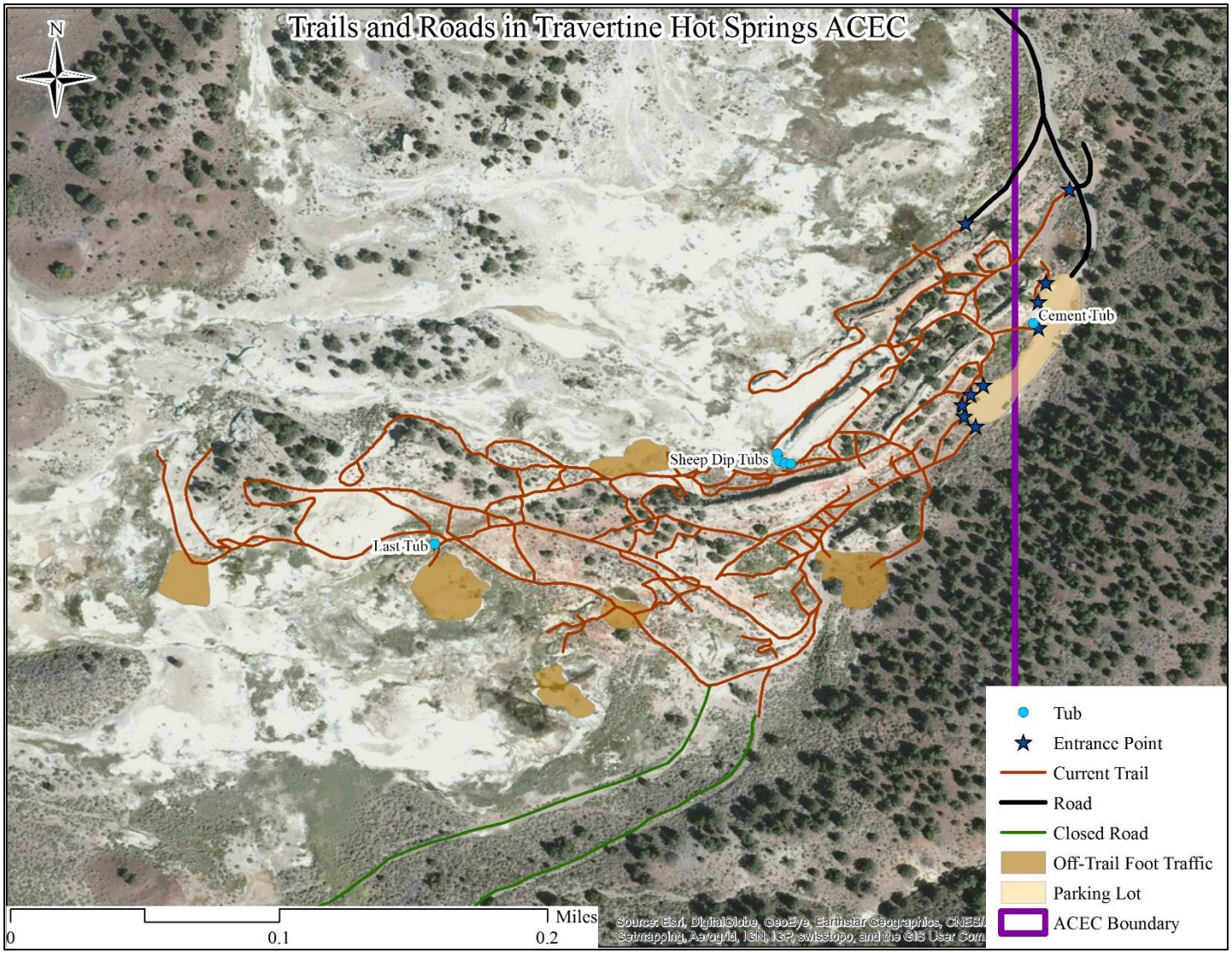

Figure 2. Current trail system, entrance points, and areas with extensive off-trail foot traffic in the ACEC.

Figure 3.

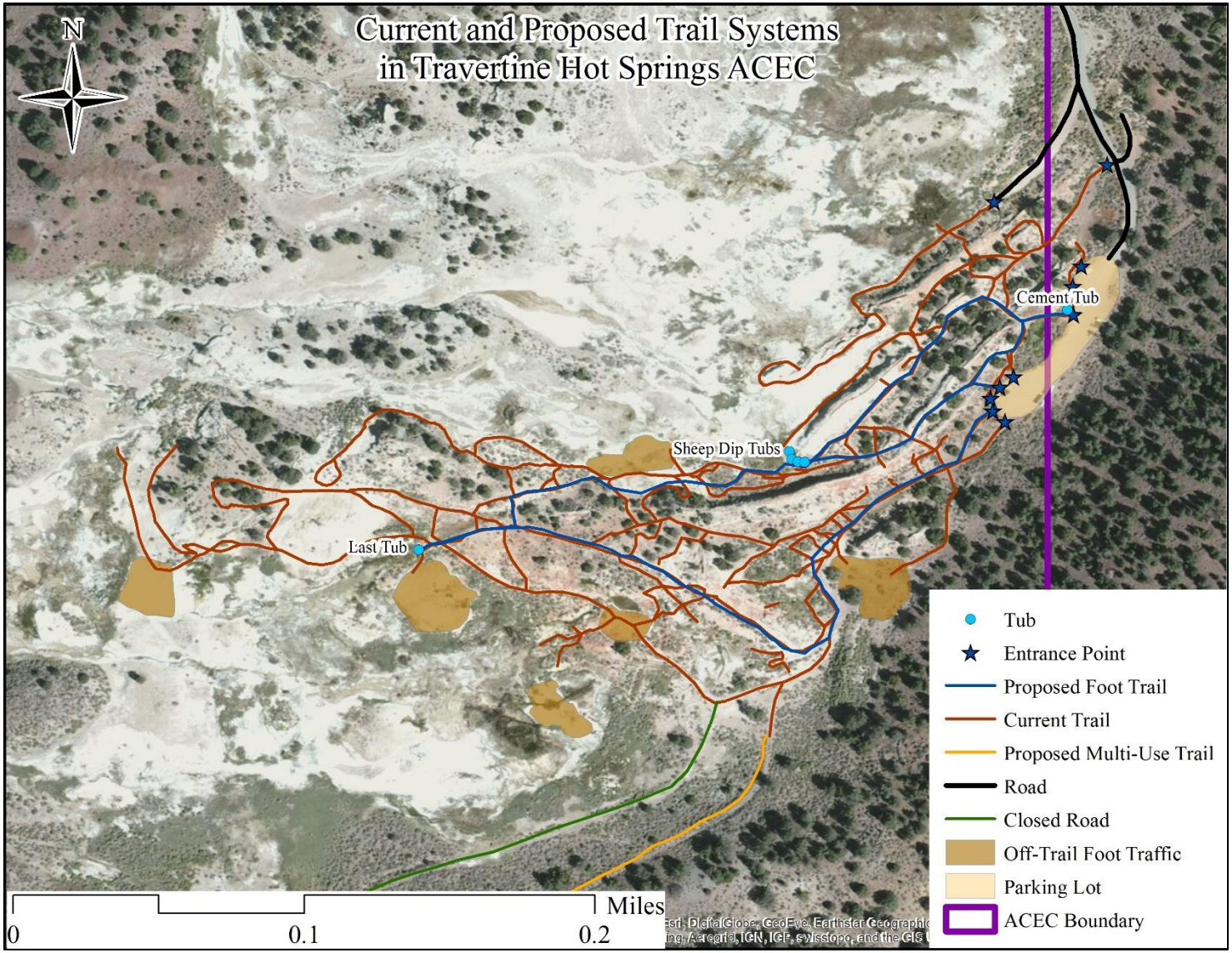

Figure 3. Current and proposed trail systems in the ACEC.

Figure 4.

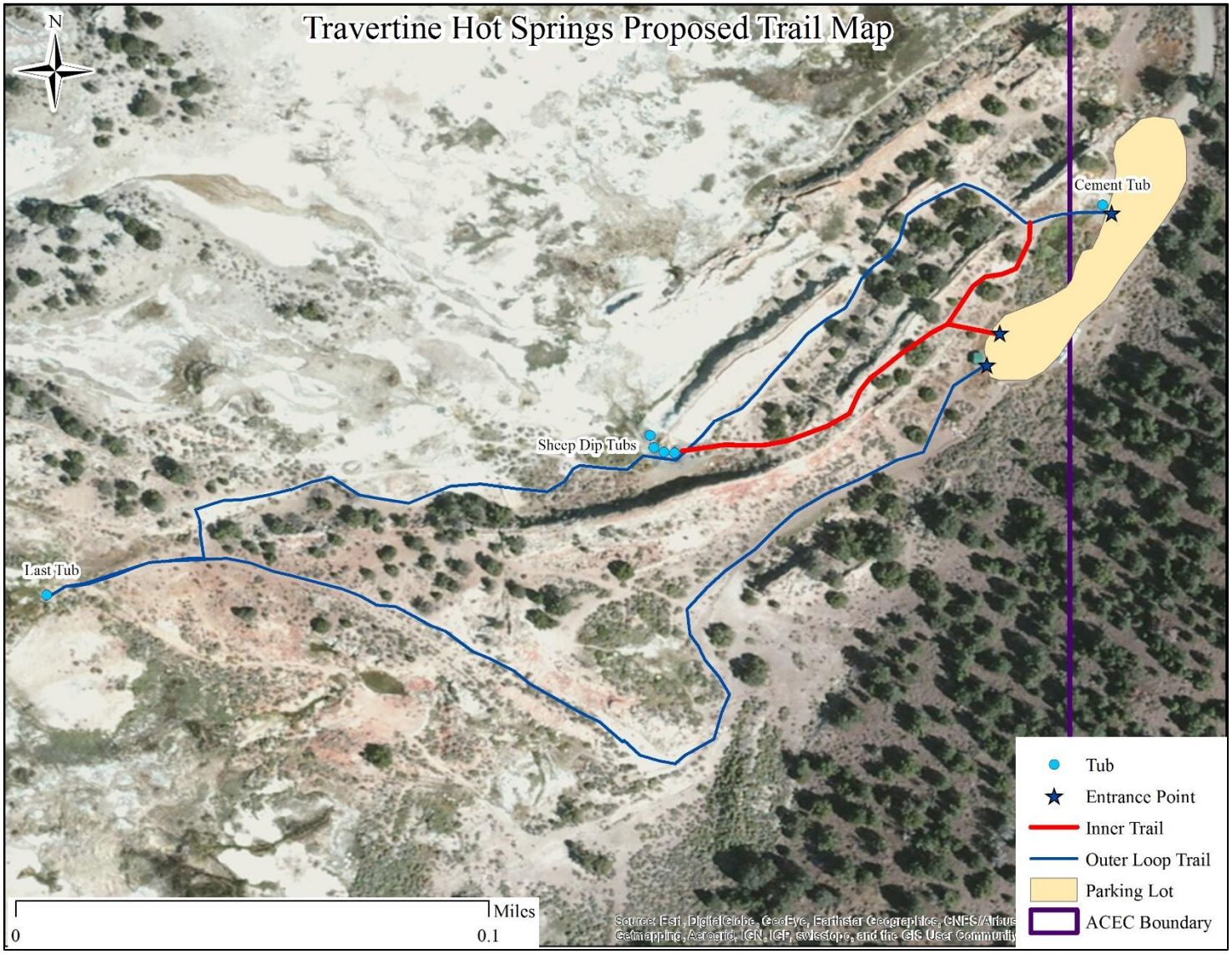

Figure 4. Proposed trail system for the ACEC.

Figure 5.

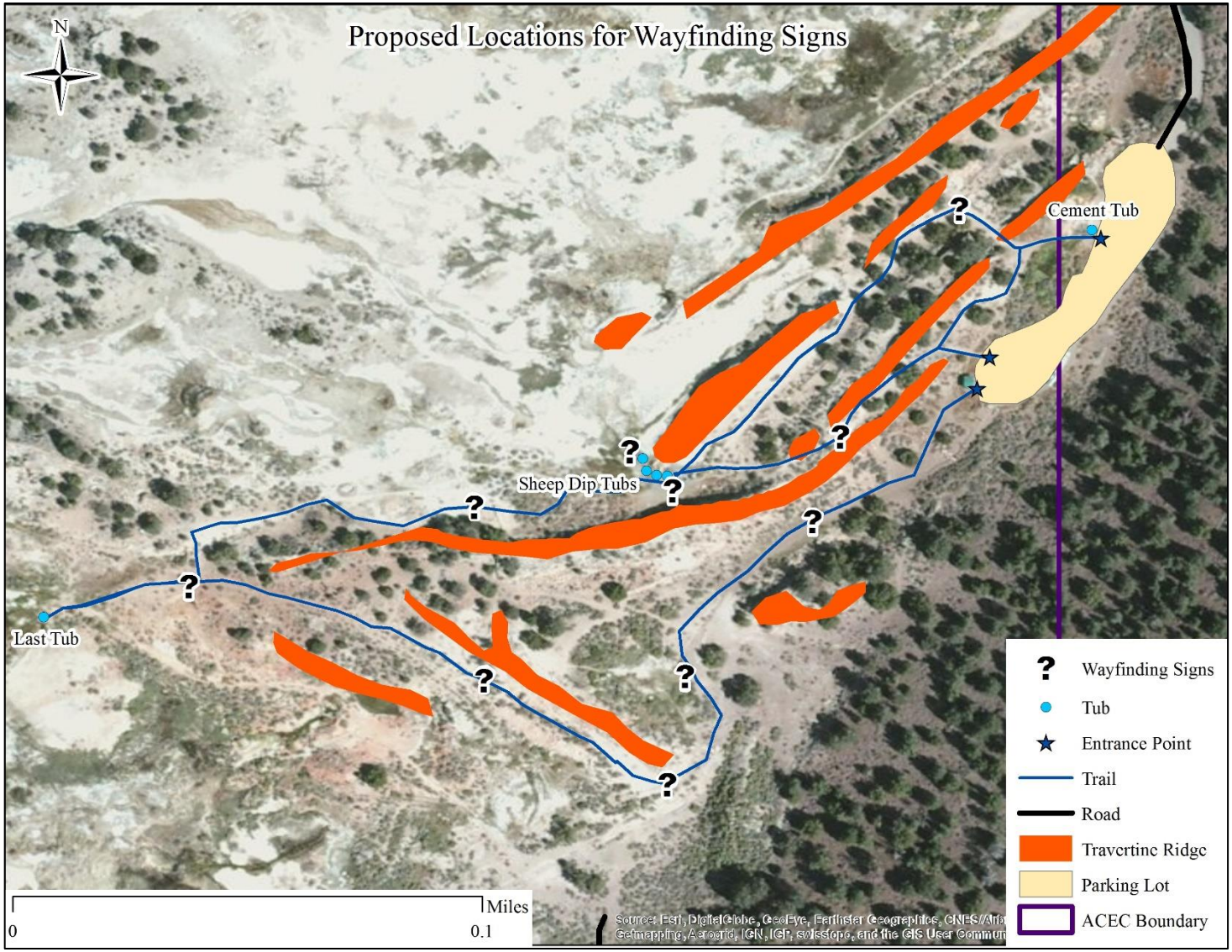

Figure 5. Possible locations for small wayfinding signs along the proposed loop trail.

Figure 6.

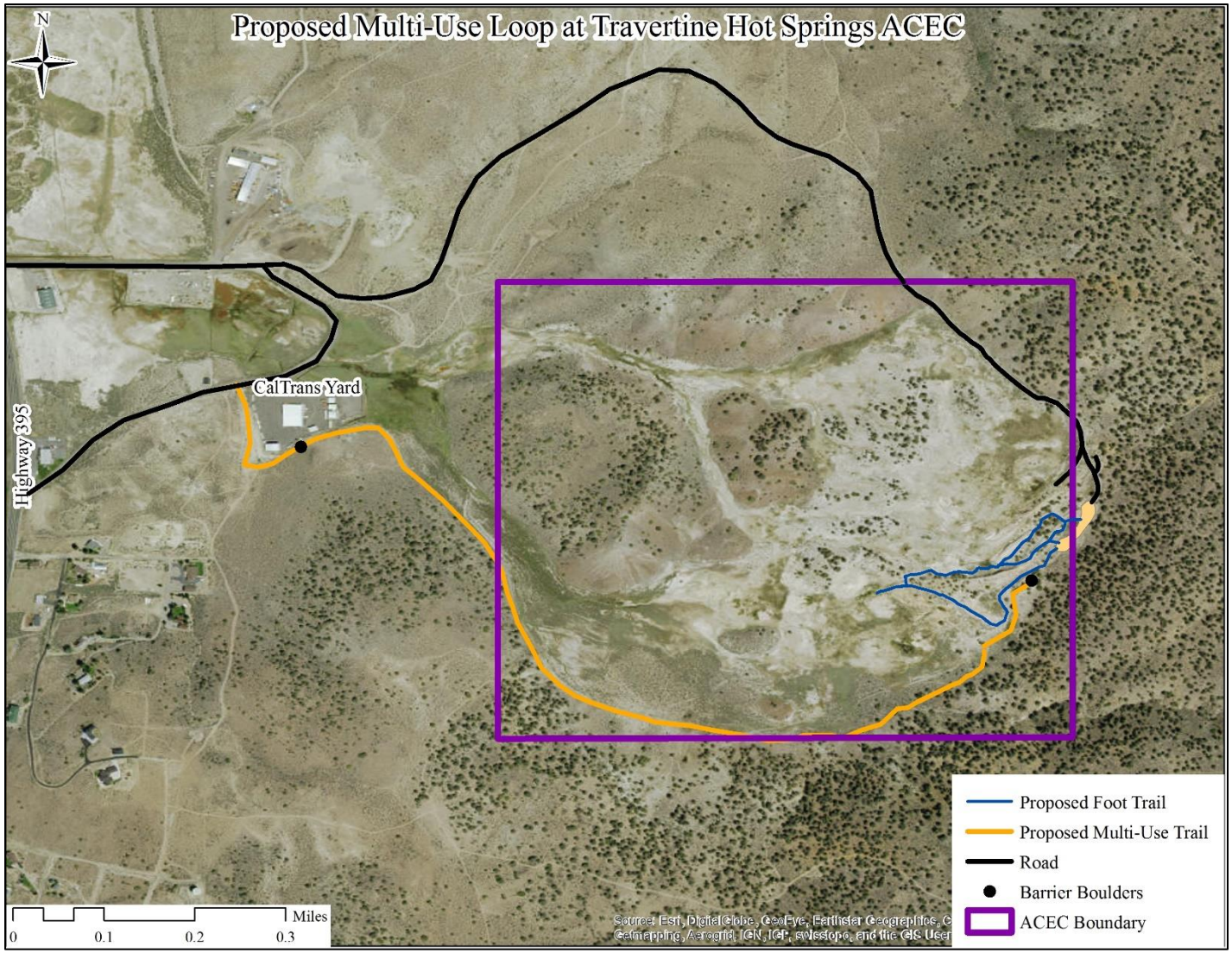

Figure 6. ACEC access road and proposed multi-use recreational trail.

Figure 7.

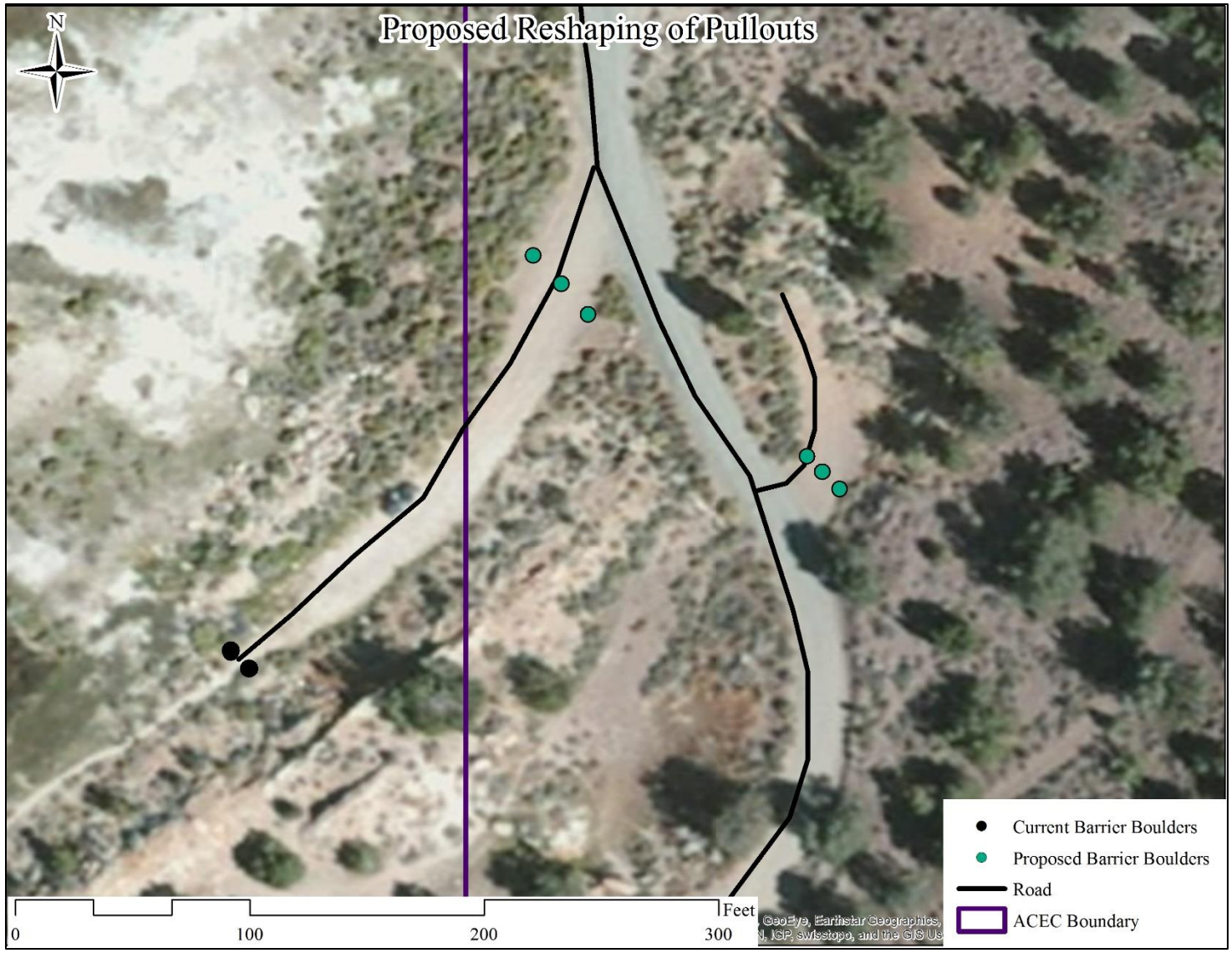

Figure 7. Proposed relocation of barrier boulders to reshape pullouts.

Figure 8.

Figure 8. Proposed reshaping of ACEC parking lot.

Figure 9.

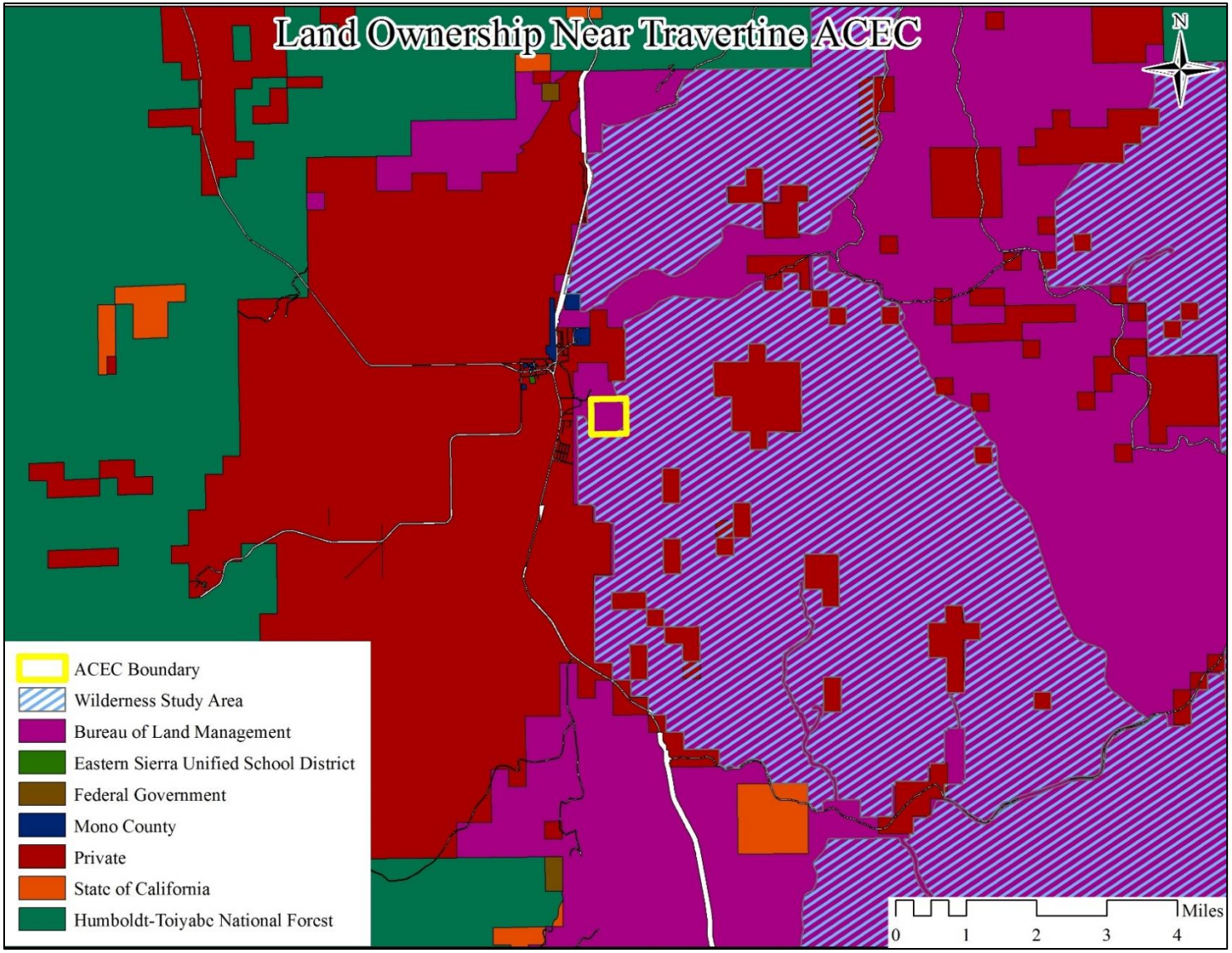

Figure 9. Public and private land ownership and Wilderness Study Areas in the vicinity of the ACEC.

Figure 10.

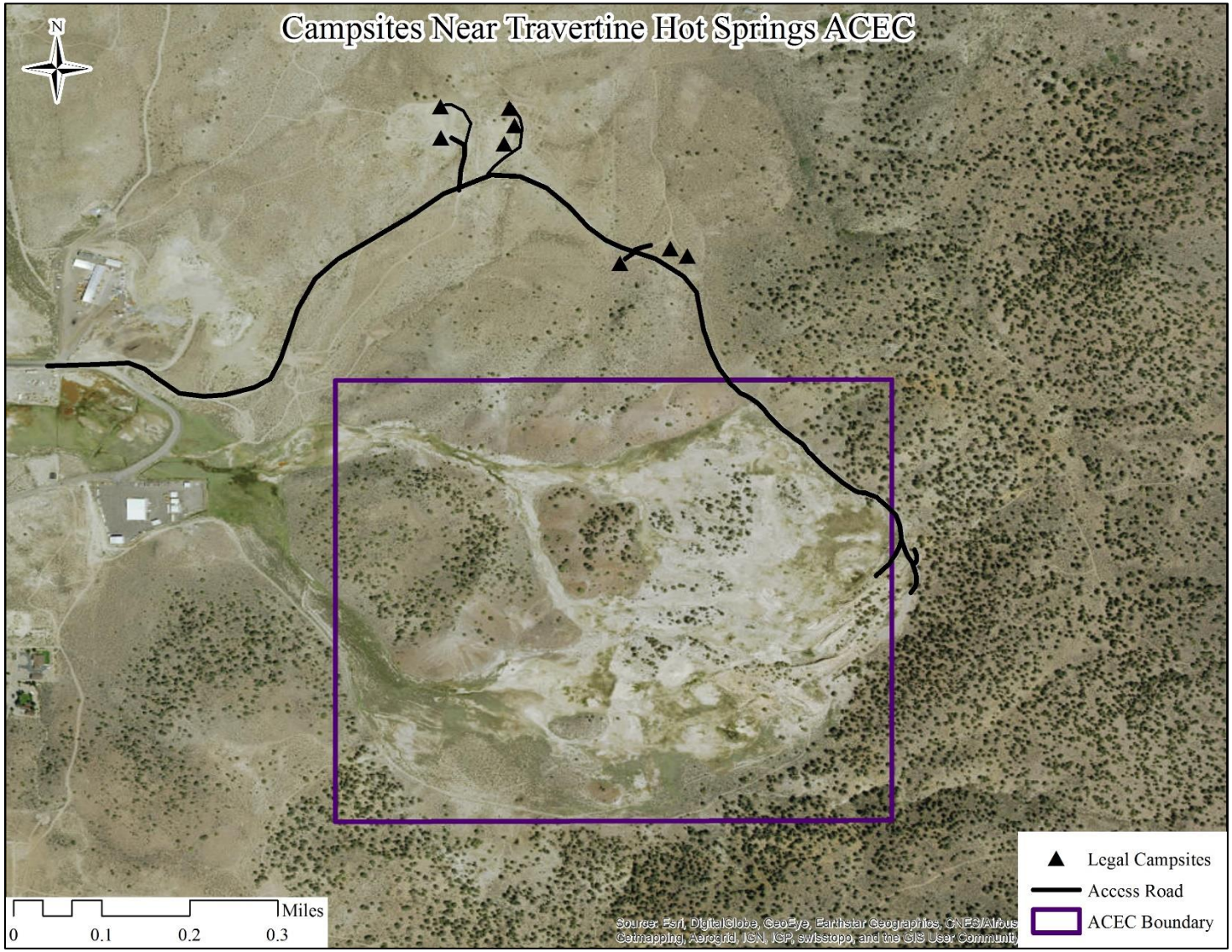

Figure 10. Locations of campsites along the access road outside the ACEC boundary.

Figure 11.

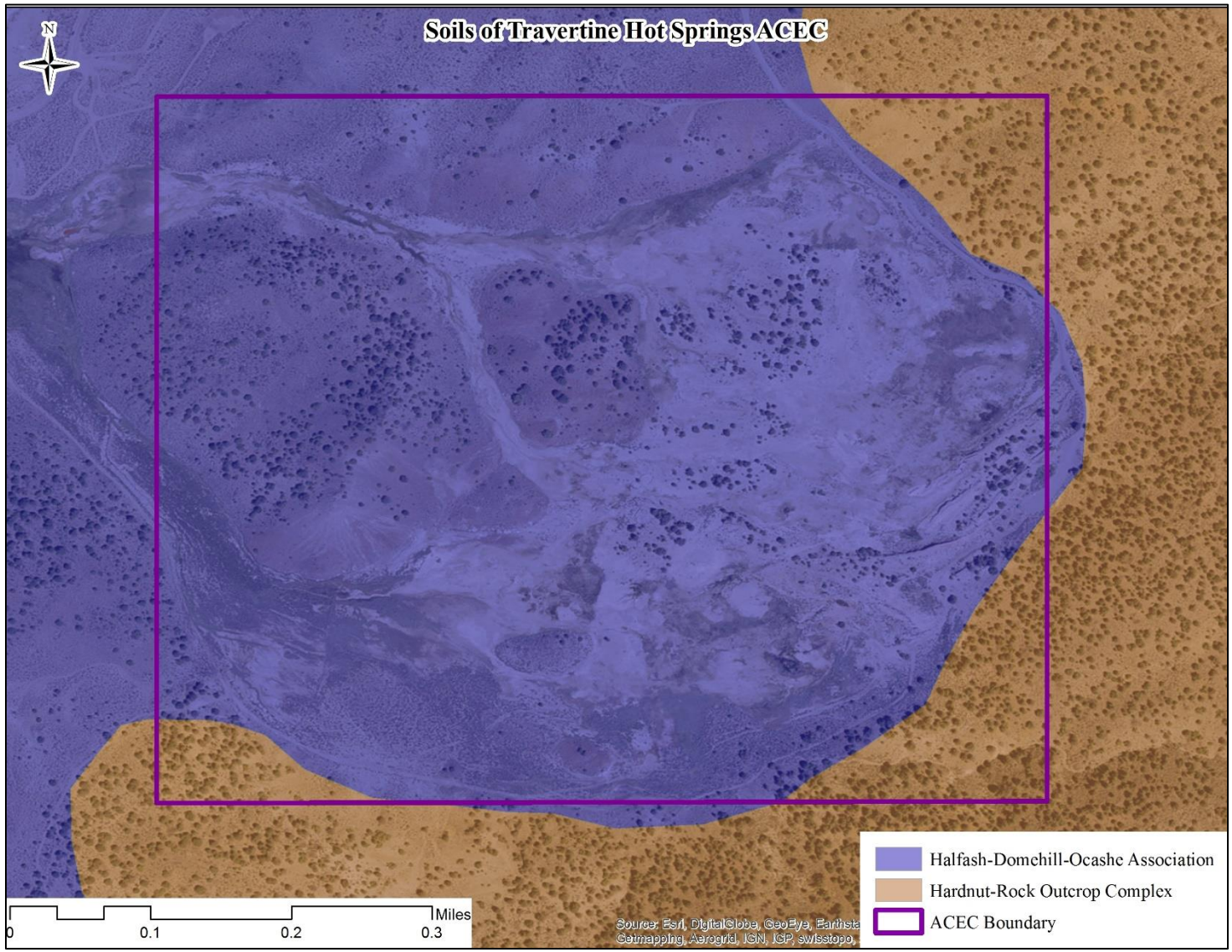

Figure 11. Soils mapped within the ACEC; NRCS soil survey data.

Figure 12.

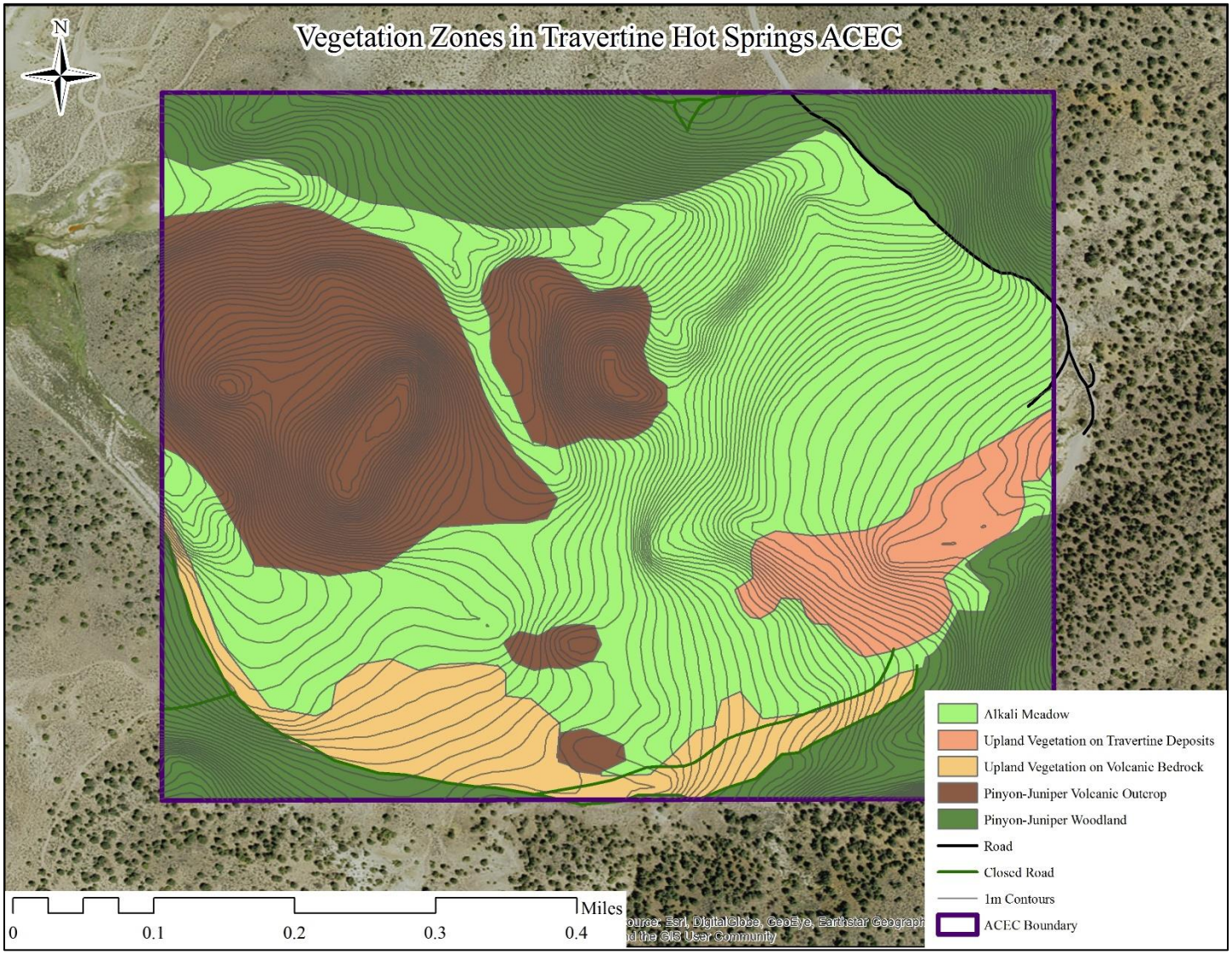

Figure 12. Coarse-scale vegetation communities within the ACEC; 2016 field survey data.

Figure 13.

a) **b)**

Figure 13. a) June 1996 and b) June 2016

Figure 14.
a) **b)**

Figure 14. a) August 1997 and b) June 2016.

Figure 15.
a) **b)**

Figure 15. a) June 1996 and b) June 2016.

Works Cited

Bureau of Land Management. 1993. Bishop Resource Management Plan Record of Decision. Bishop, CA: Bureau of Land Management Bishop Resource Area.

Bureau of Land Management. 1995. Travertine Hot Springs ACEC Plan. Bishop, CA: Bureau of Land Management Bishop Resource Area.

Bureau of Land Management. 2001. The Federal Land Management and Policy Act of 1976, as Amended. Washington, D.C.: United States Department of the Interior.

Bureau of Land Management. 2014. Categorical Exclusion Documentation DOI-BLM-CAC-070-2014-0025-CX. Bishop, CA: Bureau of Land Management Bishop Resource Area.

California Native Plant Society Rare Plant Program. 2016. Inventory of Rare and Endangered Plants (online edition, v8-02). Sacramento, CA. http://www.rareplants.cnps.org.

Executive Order 12898 of February 11, 1994: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. Federal Register 59.

Halford, F. K. 1998. A Cultural Prehistory of the Travertine Hot Springs Area of Critical Environmental Concern, Bridgeport California. Report Number CA-17-98-02. Bishop, CA: Bureau of Land Management Bishop Resource Area.

Massachusetts Department of Conservation and Recreation. 2014. Trail Guidelines and Best Practices Manual. Boston, MA: Massachusetts Department of Conservation and Recreation.

Mono County. 2009. General Plan. Bridgeport, CA. http://www.monocounty.ca.gov/planning/page/general-plan.

National Park Service. 1998. North Country National Scenic Trail: A Handbook for Trail Design, Construction, and Maintenance. Washington, D.C.: United States Department of the Interior.

Pritchett, D. W., and S. J. Manning. 2009. Effects of fire and groundwater extraction on alkali meadow habitat in Owens Valley, California. Madroño 56(2):89-98.

Secretarial Order 3226: Evaluating Climate Change Impacts in Management Planning. 2009. Washington, D.C.: United States Department of the Interior.

Soil Survey Staff. 2016. Natural Resources Conservation Service. United States Department of Agriculture. Web Soil Survey. http://websoilsurvey.nrcs.usda.gov.

TRAVERTINE HOT SPRINGS
PHOTO MONITORING PROTOCOL
FEBRUARY 2017

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» CONTEXT

With the click of a button, repeat ground photography at carefully chosen photo points can provide the land manager with volumes of information about changes in vegetative cover, plant species composition, trail proliferation, and soil erosion. Unlike more onerous field-based monitoring techniques, repeat photography can be accomplished in just a few minutes. Analysis of photo pairs can be qualitative or quantitative depending on the needs of the project, and a single photo can serve to document a wide variety of management concerns.

Travertine Hot Springs Area of Critical Environmental Concern (ACEC) provides an ideal opportunity for the development of a simple, efficient photo monitoring protocol to inform future adaptive management. Sixteen of the ACEC's 160 acres are heavily used by visitors and directly affected by the project proposed in Environmental Assessment # DOI-BLM-CA-C070-2017-0002-EA. Photo points established in 1996 offer a reference for conditions at the site prior to road closures that allowed substantial vegetation recovery.

The EA proposes a suite of recreation management and habitat restoration strategies to accommodate heavy visitor use of the ACEC. One component of this project emphasizes public education, introducing visitors to the ACEC's natural and cultural history via a series of interpretive signs located along a designated trail. Many of these signs will be placed in areas that could provide insight into vegetation recovery, erosion, or recreational use patterns. Wayfinding signs that coincide with photo points could incorporate a photo stand where visitors could place their cameras or smartphones and retake monitoring photographs at a fixed scale and perspective. Visitors could then share their photos with BLM staff via email or hashtag. Engaging visitors in citizen science and stewardship could provide land managers with a wealth of photo monitoring data, while nurturing an ethic of treading lightly in the ACEC.

Following a magnitude 5.6 earthquake on December 28, 2016, hydrologic alterations within the ACEC have left some tubs dry and changed the temperature and flow rate of others. It is uncertain how recreational use will respond to these new conditions. Given this hydrologic instability, it is vital that land managers monitor the short- and long-term effects of the proposed project and prepare to modify their plans if new impacts arise. Photo monitoring can serve as an alert system notifying managers of unanticipated developments at the ACEC.

This document provides a map of proposed photo point locations, qualitative and quantitative protocols for photo pair analysis, a literature review of photo monitoring methods, and broad goals, indicators, and management guidelines for each photo point. In addition to meeting the objectives laid out by the BLM's Assessment, Inventory, and Monitoring Strategy, a photographic archive will preserve an eloquent record of Travertine Hot Springs through time.

> *"Ecosystem management should be envisaged as a long-term experiment that builds on its results as it progresses."*
>
> -The Ecosystem Approach
> *Secretariat of the Convention on Biological Diversity*
> *Montreal 2004*

» QUALITATIVE METHOD

Vegetation monitoring photos should be taken every five years in June to capture the maximum extent of green vegetation. Photo points where the goal is to monitor erosion or invasive species should be taken every year. If possible, take photos around noon on a cloudless day. Shadows may interfere with the assessment of vegetative cover in photos taken early in the morning or late in the afternoon.

Save digital photos in a designated folder with a name that includes the photo point number and date. Some wayfinding signs may be located at photo points along the designated trail and may include instructions for visitors to send in photos they have taken at these points. Save any high-quality photos sent by visitors in a separate folder and include "visitor" in the filename.

To compare photos taken at the same photo point in different years, open the Powerpoint file Travertine_photomonitoring_archive and resave a copy, adding today's date to the filename. Ensure that each photo is sized appropriately (7.5" x 10" or 2448px x 3264px). Insert the photo on top of the photo you're comparing it to. Click the Animations tab and choose Wipe. Set the Effect Options to Left and the Duration to 07.00. Add a text box to the bottom right corner of the new photo, labeling it with the photo point number and date.

Crop the new photo so that landmarks line up well with those in the photo you're comparing it to. Landmarks need not line up exactly, but the closer you can get them the better you can compare the vegetated or eroded area in the two photos. You may need to open the file in a photo editing software such as Gimp in order to resize and crop it. It may also help to make the photo you're adding transparent. To do this, insert a rectangle that completely covers the previous photo. In the Format Shape menu, choose Fill → Picture or texture fill. Click the File button below this menu to insert the photo as a file. Then use the slider below the File button to change the Transparency so that you can see both photos at once and line them up.

Play the slideshow to compare the two photos. When you click, the new photo will replace the old photo, sliding slowly from left to right. You will be able to make a quick visual comparison of the area of interest in the old and new photos.

If you detect an undesirable change, you may need more details than a photo can provide. Visit the site to gain insight into the extent and probable cause of the problem before making any decisions. If action is needed, follow the management guidelines for each photo point described in Appendix A.

» QUANTITATIVE METHOD

If a qualitative assessment is insufficient to provide justification for management actions, it may be necessary to perform a quantitative assessment of monitoring photos. This method is more time-consuming and exacting, but will provide a more rigorous measure of change.

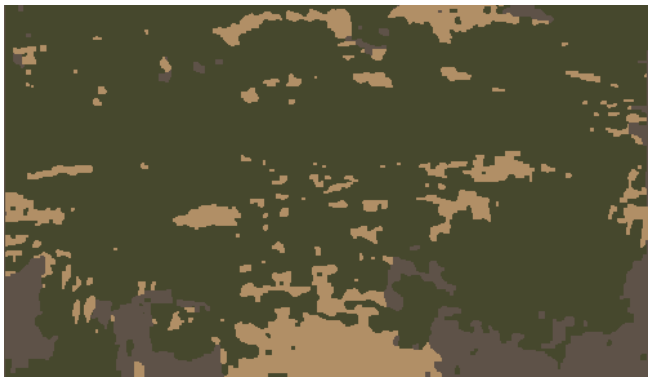
In order for two photos to be quantitatively comparable, it is essential that they be sized identically and that the distance from the camera location to the photographic field be identical. This requires a repeatable system for taking photographs (e.g. a tripod set at a certain height and angle and a compass to verify bearing).

Comparing vegetative cover in photos can be done manually by overlaying each photo with a grid and estimating the percent vegetative cover in each grid square (if you're comparing erosion, flooding, or an invasive species outbreak, you will have to develop a different classification scheme). Then tally the percent cover of all grid squares and compare the totals or means between photos to quantify the extent of the change. You can also create an overlying grid in a photo editing software like Gimp (Goren 2009). Choose Filters → Render → Patterns → Grid to overlay each image with a grid. Specify a width that will allow you to detect what you're looking for at the appropriate scale, without creating grid squares so small it will be extremely onerous to classify and tally them (120 pixels is a good width). You may have to experiment with different grid sizes and monitor the consistency of your results. Ensure that the position of the affected area is identical (covered by the same grid squares) in both photos.

A less time-consuming method of quantitative photo comparison uses two softwares as described by Fenn (2015): an image classifier (available at https://www.inf.uszeged.hu/~kato/software/colormrfdemo.html; Kato et al. 2001) and a pixel counter (available for download at https://forums.civfanatics.com/threads/need-color-counting-tool.112771). First, crop each photo to the area you wish to classify, removing large areas of sky or distant background. The cropped area should be identical in both photos. For example, photo point 2 in 2016 might be cropped as follows:

Save the cropped photo as a .bmp file and open it in the image classifier. If the cropped photo is very large, you may need to reduce the size to around 500px by 500px. In the box labeled **Number of classes**, enter the number of distinct cover types visible in the photograph. In the example above, you might choose three classes: one for vegetation, one for bare ground and orange travertine, and one for grey travertine. Click the button labeled **Select classes** to draw a rectangle around a representative area of each class in turn. For the example above, the classes might look like this:

Once you've assigned a representative area to each class, click the button labeled **Do it** to generate a simplified image where each color represents a cover type:

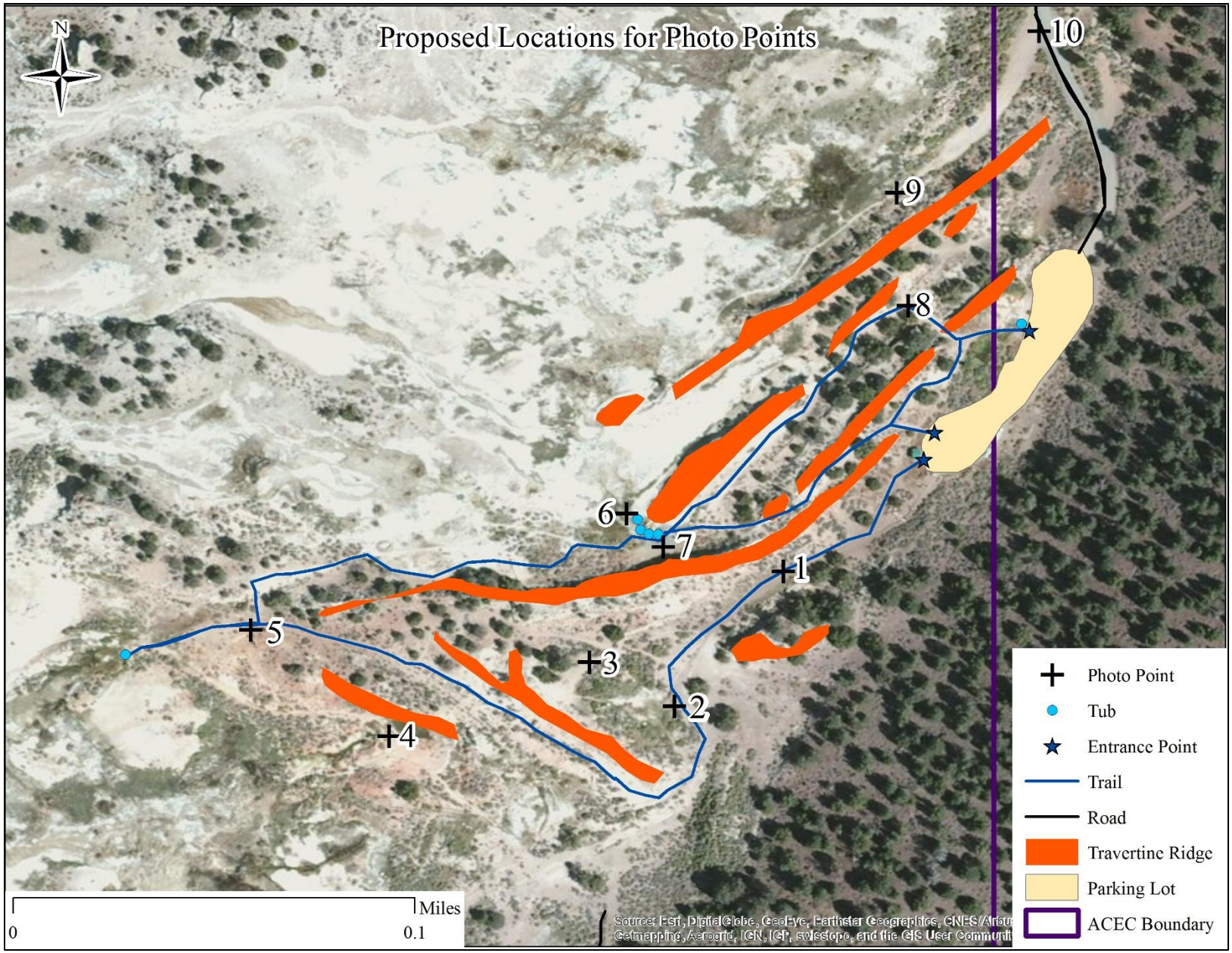


You may have to repeat this step several times before the software correctly classifies all pixels in the image. In the example above, the shadow cast by the rabbitbrush in the bottom right corner is too similar in color to the grey travertine rock, and the software has incorrectly classified the shadow as rock.

Once you're confident in the classification, save the resulting image and load it into the pixel counter software. This software will generate a list of the number of pixels per color, identifying the colors using three numbers: their red, green, and blue balance (for example, the green color in the example above is referred to as (70, 72, 45). A quick Google search can help you identify which color is which. Divide the number of pixels in each class by the total number of pixels to get a percentage for each cover class. Then compare the percentage vegetation in the two photos. In the example above, vegetation covers 78% of the pixels in the image. In the photo taken at this photo point in 1996, vegetation covered only 47% of the pixels in the image.

» PHOTO POINT COORDINATES

Photo Point Number and Description	Easting	Northing	Bearing
1 – trail from parking lot	307063	4235326	70°
2 – revegetated spring	307027	4235273	235°
3 – ridge crossover point	307000	4235292	210°
4 – potentially muddy spot	306936	4235263	325°
5 – steep hill	306893	4235308	250°
6 – meadow	307103	4235351	35°
7 – sheep dip tubs; two directions: west = meadow, north = Hot Tub Ridge	307024	4235337	West: 300° North: 45°
8 – old road	307103	4235434	35°
9 – path from old pullout	307101	4235480	230°
10 – old pullout	307147	4235543	215°


Proposed Locations for Photo Points
N
10
9
8
6
7
1
5
3
2
4
Photo Point
Tub
Entrance Point
Trail
Road
Travertine Ridge
Parking Lot
ACEC Boundary
Miles
0
0.1

» APPENDIX A: INDIVIDUAL PHOTO POINT GUIDELINES

Photo Point 1: Trail from Parking Lot

Description
Waypoint: 307063 E, 4235326 N. Bearing: 70°. Landmarks: path along right edge of photograph, ridge at left edge.
This area used to be a road, and is still one of the primary paths visitors take from the parking lot.

What to Look For
Goal: increase in native vegetation cover
Potential problems: vegetation damage due to foot traffic, proximity to invasive tansy mustard source in parking lot

Management Guidelines
If native vegetation cover decreases, consider reseeding or replanting.
If tansy mustard invades, remove it annually.

Photo Point 2: Revegetated Spring

Description
Waypoint: 307027 E, 4235273 N. Bearing: 235°. Landmarks: ridge ending in center of photograph, pinyon pine in top right corner, Twin Lakes Valley centered in background.
The spring in the left-center of this photo point attracts considerable foot traffic, but has revegetated substantially since 1996.

What to Look For
Goal: increase in native vegetation cover
Potential Problems: vegetation damage due to foot traffic, proximity to invasive tansy mustard source in parking lot

Management Guidelines
If native vegetation cover decreases, consider bordering the site with a symbolic fence of stones.
If tansy mustard invades, remove it annually.


Photo Point 2 in June 1996


Photo Point 2 in June 2016

Photo Point 3: Ridge Crossover Point

Description
Waypoint: 307000 E, 4235292 N. Bearing: 210°. Landmarks: low point in ridge at center of photograph, both vertically and horizontally.
Some pedestrians use this path as a shortcut to the last tub.

What to Look For
Goals: increase in native vegetation cover, halt in erosion of travertine ridge
Potential Problems: widening of path, soil compaction, continued erosion of travertine ridge, proximity to invasive tansy mustard source in parking lot

Management Guidelines
If native vegetation cover does not increase or path continues to widen, consider decompacting the soil using hand tools and reseeding or replanting.
If height of travertine ridge decreases substantially, consider installing a sign or symbolic fence to discourage visitors from crossing the ridge.
If tansy mustard invades, remove it annually.

Photo point 3 in June 2016

Photo Point 4: Muddy Spot

Description
Waypoint: 306936 E, 4235263 N. Bearing: 325°. Landmarks: end of ridge at left edge of photograph, edge of seep pond at right edge. Here an informal trail passes between a large seep and its drainage, and foot traffic may cause erosion (ruts, gullying, slope failure).

What to Look For
Goals: foot traffic limited to designated path, no evidence of erosion
Potential Problems: diversion of foot traffic to avoid mud, erosion from pedestrians crossing through muddy spot

Management Guidelines
If erosion is evident, consider installing stepping stones across muddy section.
If erosion is severe or hydrologic pathway is altered, consider installing a sign or symbolic fencing to discourage visitors from walking here.


Photo Point 4 in June 2016

Photo Point 5: Steep Hill

Description
Waypoint: 306893 E, 4235308 N. Bearing: 250°. Landmarks: path centered in photograph.
This is the top of the steepest part of the designated trail, leading uphill from the last tub. BLM will install stairs in this section.

What to Look For
Goals: no evidence of erosion
Potential Problems: storm events causing erosion (ruts or gullying)

Management Guidelines
If erosion is evident, consider installing water bars to reroute stormwater.
If erosion continues or worsens, consider reshaping the path with switchbacks to decrease slope steepness.

Photo Point 5 in August 2016

Photo Point 6: Meadow

Description
Waypoint: 307103 E, 4235351 N. Bearing: 35°. Landmarks: Hot Tub Ridge at right edge of photograph.
This meadow extends to the west of Hot Tub Ridge and the sheep dip tubs.

What to Look For
Goals: increase in native vegetation cover, decrease in visibility of informal path
Potential problems: continued use of informal path

Management Guidelines
If informal path is not substantially reclaimed by vegetation within 5-10 years, consider reseeding or replanting the trail tread.
Consider blocking the path and meadow with a symbolic fence of stones.

Photo Point 6 in June 1996

Photo Point 6 in June 2016

Photo Point 7: Sheep Dip Tubs

Description
Waypoint: 307024 E, 4235337 N. Bearing West: 300°. Bearing North: 45°. West landmarks: town of Bridgeport centered in photograph. North landmarks: Hot Tub Ridge at left edge, path to parking lot at right edge.
Until recently, the sheep dip tubs were the most popular area within the ACEC. After an earthquake on December 28, 2016, the flow of water to the sheep dip tubs decreased in volume and temperature. It is unclear how this change will affect recreational use patterns in this area. Take two photos here: one facing west toward the town of Bridgeport, and one facing north along Hot Tub Ridge.

What to Look For
Goals: increase in native vegetation cover, decrease in visibility of informal paths
Potential Problems: creation of more informal paths due to improved accessibility of sheep dip tubs, digging of new tubs, proximity to invasive tansy mustard source in parking lot

Management Guidelines
If informal paths remain visible or proliferate, consider reseeding or replanting the trail tread.
If visitors are digging new tubs, consider posting signs discouraging this activity.
If tansy mustard invades, remove it annually.

Photo Point 7 West

Photo Point 7 West in June 1996


Photo Point 7 West in June 2016

Photo Point 7 North

Photo Point 7 North in June 1996

Photo Point 7 North in August 2016

Photo Point 8: Old Road

Description
Waypoint: 307103 E, 4235434 N. Bearing: 35°. Landmarks: ridge at left edge of photograph, juniper at right edge.
This area was once part of a road that led directly to the sheep dip tubs. If the proposed project is implemented, the location of this photo point will mark the northern boundary of the designated trail system.

What to Look For
Goals: increase in native vegetation cover, decrease in visibility of informal paths
Potential problems: continued use of informal paths, proximity to invasive tansy mustard source in parking lot

Management Guidelines
If the informal path is not substantially reclaimed by vegetation within 5-10 years, consider reseeding or replanting the trail tread.

Photo Point 8 in August 2016

Photo Point 9: Path from Old Pullout

Description
Waypoint: 307101 E, 4235480 N. Bearing: 230°. Landmarks: path centered in photograph, Buckeye Canyon at right edge.
This path leads from the old pullout through a meadow to the sheep dip tubs.

What to Look For
Goals: decrease in visibility of informal path.
Potential problems: continued use of pullout and path

Management Guidelines
If the informal path is not substantially reclaimed by vegetation within 5-10 years, consider reseeding or replanting the trail tread.

Photo point 9 in August 2016

Photo Point 10: Old Pullout

Description
Waypoint: 307147 E, 4235543 N. Bearing: 215°. Landmarks: white knob in center, left edge of pullout at left edge of photograph, col north of Blacksmith Peak at right edge of photograph.
This pullout is used for camping and overnight parking, but will be closed if the proposed project is implemented.

What to Look For
Goals: increase in native vegetation cover
Potential problems: continued camping, severe soil compaction

Management Guidelines
If native vegetation cover does not increase, consider decompacting the soil using hand tools and reseeding or replanting.


Photo Point 10 in October 1996


Photo Point 10 in June 2016

» APPENDIX B: ANNOTATED BIBLIOGRAPHY

Image Classifying Software

Kato, Z., T. C. Pong, and J. C. M. Lee. 2001. Color image segmentation and parameter estimation in a Markovian framework. Pattern Recognition Letters 22(3-4):309-321.

Software tool that simplifies images into their predominant color components, assigning a single color value to each pixel within the image. Useful for quantifying cover types within an image.

Booth, D. T., S. E. Cox, and R. D. Berryman. 2006. Point sampling digital imagery with 'SamplePoint'. Environmental Monitoring and Assessment 123:97-108.

Software tool that classifies cover type per pixel in nadir photo plot images (where photos are taken from directly above a plot with the camera pointing down at the ground). The user identifies sample pixels for each cover class, and the software finds all pixels of each class within the image. This method could be effective at the ACEC if nadir photo plots were established.

Institutional Manuals

Elzinga, C. L., D. W. Salzer, and J. W. Willoughby. 1998. Measuring and Monitoring Plant Populations. Denver, CO: Bureau of Land Management National Operations Center.

Technical reference detailing protocols for monitoring a single plant species. "Photographs should be a routine part of all monitoring projects and can be the primary method for some." Pages 164-166 describe photo point protocols, but the equipment used is outdated.

Hall, F. C. 2002. Photo Point Monitoring Handbook: Part A—Field Procedures. Portland, OR: United States Department of Agriculture, United States Forest Service, Pacific Northwest Region.

Introductory guide to widely used photo point design and monitoring procedures. Equipment is outdated, but this technical reference provides a thorough conceptual and practical framework for sampling design and interpretation of photo points.

Herrick, J. E., J. W. Van Zee, K. M. Havstad, L. M. Burkett, and W. G. Whitford. 2005. Monitoring Manual for Grassland, Shrubland, and Savannah Ecosystems. Volume I: Quick Start. Las Cruces, NM: United States Department of Agriculture, ARS Jornada Experimental Range.

A basic guide to monitoring protocols for soil, water, and vegetation resources in situations wherein the land manager has clear, simple objectives for monitoring in a

predetermined location. These methods are applicable to the monitoring situation in the Travertine ACEC. Pages 6-8 describe a simple photo point protocol.

Herrick, J. E., J. W. Van Zee, K. M. Havstad, L. M. Burkett, and W. G. Whitford. 2005. Monitoring Manual for Grassland, Shrubland, and Savannah Ecosystems. Volume II: Design, Supplementary Methods and Interpretation. Las Cruces, NM: United States Department of Agriculture, ARS Jornada Experimental Range.

An expanded guide to monitoring program design, implementation, and interpretation, as well as a description of monitoring methods not covered in Volume I. Recommends the use of photo point monitoring when the objective is "qualitative documentation of large changes in vegetation structure." Notes that "it is extremely difficult to generate reliable quantitative data from photos, except under very controlled conditions."

Toevs, G. R., J. J. Taylor, C. S. Spurrier, W. C. MacKinnon, M. R. Bobo. 2011. Bureau of Land Management Assessment, Inventory, and Monitoring Strategy: For Integrated Renewable Resources Management. Denver, CO: Bureau of Land Management National Operations Center.

Statement of philosophy and detailed guide for design and implementation of the agency's institutionalized monitoring protocol for vegetation, soil, and water resources.

Relevant Photo Monitoring Methods

Booth, T., and S. E. Cox. 2008. Image-based monitoring to measure ecological change in rangeland. Frontiers in Ecology and the Environment 6(4):185-190.

The authors compare nadir imagery analysis using 2 photography methods (100m above ground level from an aircraft vs. 2m above ground level from a tripod) and 2 digital image processing softwares (SamplePoint and VegMeasure) to classify ground cover types. They found that SamplePoint (which has a manual classification component) performed better than VegMeasure (which is automated), but did not detect a difference between the cover estimates derived from photos taken 100m or 2m above ground level. Given the small size of the ACEC, aerial photography may not be cost-effective. Nadir photo plot monitoring using SamplePoint software could be a useful alternative to the quantitative methods presented above.

Debussche, M., J. Lepart, and A. Dervieux. 1999. Mediterranean landscape changes: evidence from old postcards. Global Ecology and Biogeography 8:3-15.

This study took repeat photographs of landscapes documented in old postcards, then classified each image into 3 zones based on estimated distance from photographer. The researchers then estimated the height of the tallest tree in each zone and visually estimated tree cover and land use type for each zone, comparing these metrics across photo pairs.

Fenn, E. 2015. Photo-monitoring in Mt. Mansfield's alpine zone. Waterbury Center, VT: Green Mountain Club.

Efficient, simple protocol and troubleshooting advice from photo monitoring of alpine vegetation on Vermont's tallest peak, in an area similar in size to the ACEC. The software-driven quantitative method on pages 4 and 5 (above) is closely modeled on the protocol described in this report.

Goren, J., and S. Jones. 2009. Photopoint monitoring in the Adirondack alpine zone. Lake Placid, NY: Adirondack Mountain Club.

Efficient, simple protocol and troubleshooting advice from photo monitoring of alpine vegetation on several summits in the Adirondack High Peaks region of New York. The grid analysis method on page 4 (above) is closely modeled on the protocol described in this report.

Hamilton, R., and K. Megown. Monitoring and quantifying weed cover using a dot-grid sampling technique. Salt Lake City, UT: Remote Sensing Applications Center, United States Forest Service.

Technical reference documenting a protocol more suitable to nadir photo plot monitoring or aerial imagery analysis. The dot-grid method could be adapted to analyze vegetative cover in landscape monitoring photos at the ACEC, but results would only be comparable across years if great care were taken to ensure the area of interest is sized and scaled identically in every photo. A statistical method of determining appropriate sample size is also presented.

Masubelele, M. L., M. T. Hoffman, W. Bond, and P. Burdett. 2013. Vegetation change (1988-2010) in Camdeboo National Park (South Africa), using fixed-point photo monitoring: the role of herbivory and climate. Koedoe 55, 16 pp.

This nadir photo plot method involves considerable concrete and metal infrastructure for relocating photo points; these materials would be out of keeping with the Roaded Natural character of the ACEC. Three experts independently estimated percent cover in each photo; then these estimates were ground-truthed with transect vegetation surveys. The article does not provide a comparison of the 2 methods.

Michel, P., R. Mathieu, and A. F. Mark. 2010. Spatial analysis of oblique photo-point images for quantifying spatio-temporal changes in plant communities. Applied Vegetation Science 13:173-182.

The authors compared the grid method of repeat photo analysis described by Roush et al. (below) with an object-oriented technique using a software called eCognition. The object-oriented technique divided the photos into "meaningful objects" based on the color heterogeneity of nearby pixels (i.e. once a user-defined threshold of heterogeneity is reached, the software assumes the boundaries of the object have been reached). The

grid technique was more robust to fine-scale variation in cover types, and the researchers found that this technique was less onerous to use and required less technical sophistication.

Munroe, J. S. 2003. Estimates of Little Ice Age climate inferred through historical repeat photography, Northern Uinta Mountains, U.S.A. Arctic, Antarctic, and Alpine Research 35(4):489-498.

Description of a grid-square method (similar to that in Goren and Jones, above) for analyzing change of elevation in alpine treelines. This method could be useful in the ACEC in situations where the objective is to monitor an abrupt and distinct change in vegetative cover (e.g. along the edges of a trail, pullout, or parking area).

National Park Service. Fire Photo Monitoring: Instructions for Citizen Scientists. Santa Monica Mountains National Recreation Area: United States Department of the Interior, National Park Service.

This 2-page handout could serve as a model for citizen science photo monitoring at the ACEC as described on page 2 (above). Camera stands have been placed at photo monitoring points in the Santa Monica Mountains, and visitors are instructed to place their smartphone cameras in the L-shaped bracket on each camera stand they encounter, then tag their photos with a relevant hashtag. The stands (which in the case of the ACEC could be incorporated into the design of the wayfinding signs) ensure the scale is identical between photos, and the inclusion of visitors promotes stewardship and provides many more photos than NPS or BLM staff could take on their own.

Nelson, J. K. 1999. Restoration monitoring—a simple photo monitoring method. Boulder, CO: Exponent.

Both photo plots and photo points were established, and photo series from each monitoring location were uploaded to a map embedded in an interactive, publicly available website. Users can see where photo points were taken on the landscape and scroll through an archive of all the photos taken at each location through time. This model could be an effective way of reaching out to the interested public with information about restoration activities at the ACEC.

Pilliod, D. S., and R. S. Arkle. 2013. Performance of quantitative vegetation sampling methods across gradients of cover in Great Basin plant communities. Rangeland Ecology and Management 66(6):634-647.

The researchers compared 3 methods of estimating vegetation cover: grid-point intercept (using nadir photography), line-point intercept, and point-quarter. Results derived from each method were strongly correlated and found to be reasonable estimates. The methods differed slightly in efficiency, but did not differ significantly in accuracy.

Rhemtulla, J. M., R. J. Hall, E. S. Higgs, and S. E. MacDonald. 2002. Eighty years of change: vegetation in the montane ecoregion of Jasper National Park, Alberta, Canada. Canadian Journal of Forest Research 32(11):2010-2021.

Ground photo pairs were matched using 8-12 point features that could be identified in both photos; then a grid was laid over the photos and the researchers assigned a cover type to each grid cell and compared each grid cell pair to identify any changes.

Roush, W., J. S. Munroe, and D. B. Fagre. 2007. Development of a spatial analysis method using ground-based repeat photography to detect changes in the alpine treeline ecotone, Glacier National Park, Montana, U.S.A. Arctic, Antarctic, and Alpine Research 39(2):279-308.

The aim of this study is similar to that in Munroe (above), but the methods differ. This article provides more detail about relocating historic photo points using the principle of parallax to determine the correct perspective. Photo point pairs were orthoreferenced to each other in ArcMap and overlain with a grid or "fishnet," and the cover type of each grid cell in each photo was assigned a code and entered into an attribute table. The values of each cell were compared between photo pairs and assigned to categories (no change, vegetation loss, infilling of vegetation, establishment of vegetation). This method would be fairly time-consuming, but storing data in ArcMap might be useful as a means of organization and of ensuring continuity of methods.

Vanha-Majamaa, I., M. Salemaa, S. Tuominen, and K. Mikkola. 2000. Digitized photographs in vegetation analysis—a comparison of cover estimates. Applied Vegetation Science 3(1):89-94.

A comparison of four methods of estimating vegetative cover: a manual sampling technique, a visual estimate (taking the mean of estimates made by 2 observers), manual delineation of vegetative cover using a transparency overlying a digital photo, and automated delineation of vegetative cover in digital photos using ERDAS software. The manual delineation method was treated as the reference. The manual sampling technique overestimated plant cover. The visual estimate method underestimated lichen cover but performed well as an estimate of dwarf shrub cover. The automated delineation technique overestimated dwarf shrub cover but performed well as an estimate of lichen cover. The authors suggest that the automated image analysis method may be less reliable in areas with tall, multilayer vegetation or numerous different plant species. While it would be time-consuming, the manual delineation method could be useful for estimating percent cover in monitoring photos at the ACEC.