

Sustainable Camping Research for the Pacific Crest Trail: Preliminary Findings from Fieldwork

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Introduction

This research project is a collaboration between the U.S. Forest Service, National Park Service, Bureau of Land Management, Pacific Crest Trail Association, and the U.S. Geological Survey, Virginia Tech, and Applied Trails Research. This study is employing a phased approach, with the initial two phases of work focusing on developing sustainable Best Management Practices for resolving camping resource impacts at high use/high impact locations, including the southernmost 100 miles of the PCT and at three locations in the Sierra Mountains. This research was funded by the USFS and BLM through the Aldo Leopold Wilderness Research Institute to the U.S. Geological Survey and Virginia Tech University. It is being coordinated by Beth Boyst, USFS Pacific Crest Trail Program Manager, and Dr. Susan Fox, Director of the Interagency Aldo Leopold Wilderness Research Unit. We also acknowledge the assistance and support of Togan Capozza and Beth Hahn, USFS, and Mike Dawson, PCTA.

Phase 1: Field Research

Our field research is designed to resolve camping impact management problems through a process of field measurements and assessment of select camping sites, exploration of adjacent areas, and consultation with land management staff, PCT Association staff, and other stakeholders. Based on our collaborations to date, the most pressing camping impact management problems generally occur at popular destination areas, exacerbated by the thru-hiker “bubble” passing through each year. Campsite proliferation, expansion and related resource impacts such as vegetation loss, soil exposure, and improperly disposed human waste can occur at unacceptable levels within areas of high-density use, with visitors also experiencing degraded experiential conditions.

Research Objective: This collaborative research study is intended to yield effective Best Management Practice (BMP) guidance for improvement and augmentation of professional camping management strategies and practices to reduce resource and experiential impacts in both high- and low-density camping locations along the PCT. In addition to general strategies these BMP’s will include specific management practices such as suggested campsite management actions, regulations, and educational messaging.

Southern California: The team conducted field research along the southernmost 100 miles of the PCT from March 6-13, 2017 to assess camping impacts at several high-use, high impact camping locations along the PCT, including Hauser Canyon, Fred Canyon, Barrel Springs, and at a potential Air Force Base camping site, with additional site visits at Lake Morena County Park campground, Burnt Rancheria campground, Mt. Laguna campground, and Scissor’s Crossing. This field work sought to investigate solutions to the substantial PCT early season “bubble” of camping pressure that this region experiences annually. A PowerPoint slide show was developed to communicate the work and findings associated with this fieldwork:

<https://drive.google.com/open?id=0ByQ0Dtg-7IJPu3NSY2NLT21NcmM>

Sierra Mountains: The team conducted field research in the Sierra Mountains in the Mt. Whitney area, 1000 Island Lake Basin, and in Yosemite National Park from July 27 to August 17. Preliminary findings from this trip

are reported in this document. In selecting our Sierra study areas we sought to assess and evaluate camping conditions and management options in several unique settings that receive high use: 1) trailside camping (Yosemite NP), 2) a backcountry campground (Yosemite NP, Glen Aulin), a lake basin (Inyo NF, 1000-Island Lake Basin), camping around a meadow (Sequoia NP, Crabtree Meadows), and in “staging” areas below a mountain summit or pass (Inyo NF, Trail and Outpost Camps). We expected to find different camping impact management challenges and solutions within these differing high-use environmental settings.

Methods: Campsite Measurements

In each study area our field crew conducted comprehensive off-trail searches for all campsites, which we defined as areas of human impact associated with camping activities resulting in visually obvious reductions in vegetation cover ($\geq 10\%$) compared to adjacent environmentally similar undisturbed areas, or the removal of rocks and/or organic materials to create visually obvious tent pads. Note that we did not include meadows or locations with old campfire sites unless we found a visually obvious reduction in vegetation cover or clear tent/use area spots. Our campsites aggregated proximate groupings of tent pads and cooking areas, generally those within 75 feet, occasionally 100 feet.

All campsites were numbered and the boundaries of each campsite use area were individually logged with a Trimble Geo7x GPS unit to document their locations, shape and obtain site size data. We note that the Trimble had excellent reception with more than 15 satellites and in-situ review of the data suggested a high degree of spatial accuracy (the Trimble data will be post-processed and edited). Several indicators were assessed on campsites and in adjacent environmentally similar but undisturbed “control” sites: vegetation cover, grass/sedge cover, and exposed soil. These measures allow for computation of comparative absolute difference values by subtracting onsite from offsite values. This method produces data which more accurately characterize actual human impacts to vegetation and soil. Other indicators were assessed only within campsites: substrate type, rock substrate, use level, site expansion potential (2 indicators), tree damage, root exposure, tree stumps, access trails, campfire sites, condition class rating, site photographs, and proximate improperly disposed human waste. Data were recorded on smartphones using data-entry forms created with Fulcrum software, which allows data and photos to be linked and uploaded to the cloud for back-up and storage. All data collected are paired with the Trimble data using a key field for spatial reference and will be made available for transmittal to any project collaborator.

Finally, we evaluated the sustainability of each campsite using several criteria and professional judgement. Campsite sustainability was assessed in our study primarily by examining the topography surrounding each campsite (we employed two different indicators). Higher ratings were indicative of sites that had relatively flat camping areas surrounded by steeper topography or rockiness that would inhibit campsite expansion under conditions of more intensive site use. We also examined the resistance of the campsite substrates and vegetation cover.

Yosemite National Park

Our crew began at Tuolumne Meadows and surveyed all campsites heading north along the PCT for 23 miles, including the Glen Aulin backcountry camp. Here’s a brief summary of our findings:

Glen Aulin: We assessed conditions on 27 campsites with an aggregate area of disturbance of 29,386 ft² and average size of 947 ft². This backcountry camp had commercial use areas (included in our assessment) and non-commercial campsites in the same general area and serviced by a large centrally located toilet. We thought that this area was well-designed and managed, though some site locations were not optimal with respect to sustainability and proximity to other sites. This area has a toilet facility and we found no occurrences of improperly disposed human waste.

PCT Segment: We assessed 66 campsites along this 23-mile segment with an aggregate area of disturbance of 69,051 ft² and average size of 735 ft². It became evident during our survey that park staff have achieved fairly high compliance with their visitor guidance to select a “previously impacted campsite at least 100 ft from water sources and trails.” We encountered two rangers on patrol during our 5-day engagement and presume that their presence is a likely explanation. We also discovered considerable evidence of Yosemite’s campsite restoration program, finding many campsites located >100 ft from the trail and water with small cleaned and even unused fire rings, many situated out of sight from the trail. Some had no visible or measureable impact and could be viewed as “proposed” campsites created by the restoration crew. We found only 7 occurrences of improperly disposed human waste sites and 4 instances of toilet paper, indicating high compliance with cat-hole disposal practice regulation.

The majority of campsites found were small in size and many had low levels of resource impact. The campsites ranged across a gradient of sustainability; some were situated in diverse topography that would limit their potential for future site expansion, but most were located in larger areas of flat terrain with greater expansion potential. We collected several indicators that will allow us to rank these sites by camping sustainability and will be suggesting that aggregate camping impact could be further reduced by shifting use to a subset of the most sustainably located campsites.

1000 Island Lake Basin

We conducted a thorough comprehensive survey of Inyo National Forest campsites around the entire 1000 Island Lake Basin, from the lakeshore up to and including portions of the surrounding higher elevation forested areas. We located and measured 85 campsites, including 142 separate tenting and other camping use areas. The aggregate area of camping disturbance was 28,034 ft² with an average campsite size of 198 ft². Despite extensive searching we found only 2 instances of improperly disposed human waste and 2 instances of toilet paper. We encountered Wilderness Ranger CJ Blankenship at the lake and he indicated that USFS staff had not cleaned the area of exposed human waste or TP in any recent patrols. However, we note that this area has received less use compared to prior years at this time due to late snowmelt from substantial winter snow cover, road closures (Reds Meadow), and partial trail closures (Rush Creek drainage).

Preliminary campsite sustainability results are: 29 campsites rated as “good,” 22 as “fair,” and 34 rated as “poor,” many received the poor rating due to proximity to water (<100 ft), making them illegal based on current Inyo NF regulations. The most sustainable campsites at 1000 Island Lake Basin were often located on small flat benches surrounded by either sloping or rocky terrain.

Mount Whitney Area

Mt. Whitney is the highest mountain in the lower 48 states and an 11-mile well-maintained trail to the summit has made it a popular destination for both day-hikers and overnight campers. We surveyed three separate areas in the Mt. Whitney area, including Crabtree Meadows and a trail loop including Lower Crabtree Meadows (Sequoia National Park), and all campsites at Trail Camp and Outpost Camp on the Inyo National Forest side. We found only 38 campsites on the Sequoia NP side, which allowed time to assess Inyo NF campsites at Trail Camp (n=59) and Outpost Camp (n=10), which were not originally planned. Due to the extreme popularity of this area, special zoning has been established for visitors to the high-elevation Mt. Whitney Zone, requiring that overnight and day-use hikers obtain rationed permits, and carry out their solid human waste. A lottery is used to limit use to 100 day-hikers and 60 overnight visitors during the peak use period. Overnight visitors are also required to store food and smellables in bear-proof canisters carried in their backpacks.

The summit, Trail Camp, and Outpost Camp used to have toilets beginning in the 1960’s. However, the high elevation and cold temperatures, high use, poor visitor compliance (discarding trash in toilets), poor functioning

of the solar dehydrating/composting toilets at the camps, and management need for helicopters to fly out more than 4,000 pounds of human waste each year necessitated their removal. A waste pack-out program using WAG (Waste Alleviation and Gelling) bags was implemented in 2004, and the toilets were removed from Outpost Camp and the Whitney summit in 2006, and from Trail Camp in 2007.

Crabtree Meadow: We assessed 21 campsites around the meadow and 7 campsites on the opposite (north) side of Whitney Creek. These sites included 65 separate tenting and other uses areas totaling 15,704 ft², with an average campsite size of 242 ft². This area has a pit toilet; we found 2 instances of improperly disposed human waste and 2 instances of toilet paper. We also surveyed all campsites located along a 2.6 mile triangular trail loop that included the Lower Crabtree Meadow, a segment of the PCT, and a segment of the JMT. This loop yielded 10 additional campsites, including 14 use areas with an aggregate area of 5,746 ft² and an average campsite size of 391 ft². No improperly disposed human waste or toilet paper was found in the areas around these sites.

Trail Camp: This Inyo NF camping area, also known as High Camp, is located 6 miles up from Whitney Portal at 12,000 feet of elevation and is the highest staging camp for Whitney hikers. Annually, approximately 16,000 hikers attempt to climb Mt. Whitney from Whitney Portal (another 4,000 approach from the west side). We assessed 59 campsites with 87 separate use areas, a total area of disturbance of 28,280 ft², with an average campsite size of 325 ft². This camping area is highly resistant to impact, consisting largely of exposed rock with small patches of soil which are sparsely vegetated even in undisturbed settings. However, a significant and consequential finding for this location were 56 instances of improperly disposed human waste, 362 instances of toilet paper, and 37 discarded WAG bags. Many of these instances occurred in a rock field through which snow melt water flows and near the shoreline of the nearby tarn.

We observed that this area has a large number of food-conditioned pika, marmots, ground squirrels, mice, and even American marten that frequently chew into tents, packs, and used WAG bags. We suspect that few visitors are willing to pack out leaking WAG bags that have been chewed and “opened” by animals. This problem is of great concern because few visitors appear to be willing to store used WAG bags in their bear canisters with their food. Animal-proof WAG bag containers may also be necessary, unless toilets are restored. Improved and expanded visitor education related to this topic appears to be necessary.

Outpost Camp: We also surveyed all campsites at this camp, located at 10,400 feet of elevation and 3.8 mi from the Whitney Portal trailhead. We assessed 10 campsites with 40 separate use areas, a total area of disturbance of 9,003 ft², with an average campsite size of 225 ft². We found 3 instances of improperly disposed human waste, 17 instances of toilet paper, and 0 WAG bags in the vicinity of these campsites.

Some Key Preliminary Findings:

Condition Class Ratings: Commonly applied Condition Class rating systems overestimate camping impacts in the Sierras due to its failure to compensate for undisturbed offsite locations that may have little to no vegetation cover due to standing water, dry substrates (shallow soil over bedrock), rockiness, or which lack organic litter. For example, when visitors simply remove rocks or surface organic materials in non-vegetated areas to create a tent pad the site is assessed at Condition Class 4 due to the complete exposure of soil. However, there is little actual environmental “impact” when compared to campsites in forested or meadow areas, where complete exposure of mineral soil signifies substantial impacts to previously present vegetation and organic litter.

In response, we employed a comparative research design with onsite and offsite (control) measures of vegetation cover, exposed soil, and rock using the following categories: 0-5%, 6-25%, 26-50%, 51-75%, 76-95%,

96-100%. For each campsite we selected a nearby “control area” that was environmentally similar with respect to topography, vegetation, and substrates and which exhibited no evidence of human use and impact. These comparative measures allow computation of absolute difference values by subtracting onsite from offsite midpoint values. This method produces data which more accurately characterize actual human impact in the Sierra settings. We will perform these calculations later but our preliminary findings suggest substantially less impact than our Condition Class data suggest.

Campsite Creation: In the 1000 Island Lake Basin we discovered that snowmelt and subsequent standing water play a significant role in forming many campsites by creating barren areas, which after drying out, have a “campsite-like” appearance that may attract camping use. Thus standard campsite impact assessments on these sites must account for the preceding effects of snow and standing water on vegetation, which can confound an accurate assessment of human impacts. We suspect that some standing water areas that do not receive camping use may have been counted as campsites by prior monitoring efforts. In response, we strove to limit our survey to locations that showed compelling evidence of human use and trampling and to account for snow and water effects through our selection of comparable control sites.

Confusion Regarding the Resistance and Resilience of Grasses and Sedges: At each study site we discussed our study and field research with agency field staff that we met. Through these discussions, and our separate reviews of agency websites, visitor centers, educational messaging, and permitting guidance, we discovered a widely communicated but erroneous perception that meadow vegetation is particularly susceptible to trampling impacts, with associated guidance that visitors should not camp in meadows. Both USFS and NPS Rangers encountered told us that such information was widely communicated during staff training and that they should actively discourage camping on grasses or sedges. Each one of them cited as “common practice” their patrol efforts to move campers off of meadows and into more forested or rocky settings. There may be legitimate reasons for these efforts but we want to stress that meadow grasses and sedges are substantially more resistant and resilient (ability to recover) than any forested vegetative ground cover, a scientific finding that has been consistently documented in experimental trampling studies throughout the U.S. and other countries.

While we had heard such guidance during prior work and personal trips in the Sierras we sought without success to identify the source of this erroneous information and guidance. In our final report we will include a more exhaustive review of the recreation ecology experimental trampling literature but we include here a few key quotes from relevant experimental trampling studies, as illustrated by Figure 1:

“The most resistant plants were caespitose (growing in clusters or turf) or matted graminoids (grasses and sedges); the least resistant plants were erect forbs. Tolerance, which measures the ability of vegetation to withstand a cycle of disturbance and recovery, was correlated more with resilience (the ability to recover) than resistance. The most tolerant plants were caespitose... The sizable variation in vegetation response to trampling suggests that managers of natural areas can minimize damage by confining recreational use to vegetation types that can tolerate trampling.” (Cole, 1995)

Campsites located under an open forest canopy and dominated by graminoids were highly resistant, while those located under a closed canopy and dominated by forbs were less resistant. This corroborates earlier studies which, almost without exception, have found vegetation types dominated by graminoids to be more resistant to trampling than those dominated by forbs. (Marion and Cole, 1996)

Resistance and Resilience: Forbs

Resistance and Resilience: Grasses

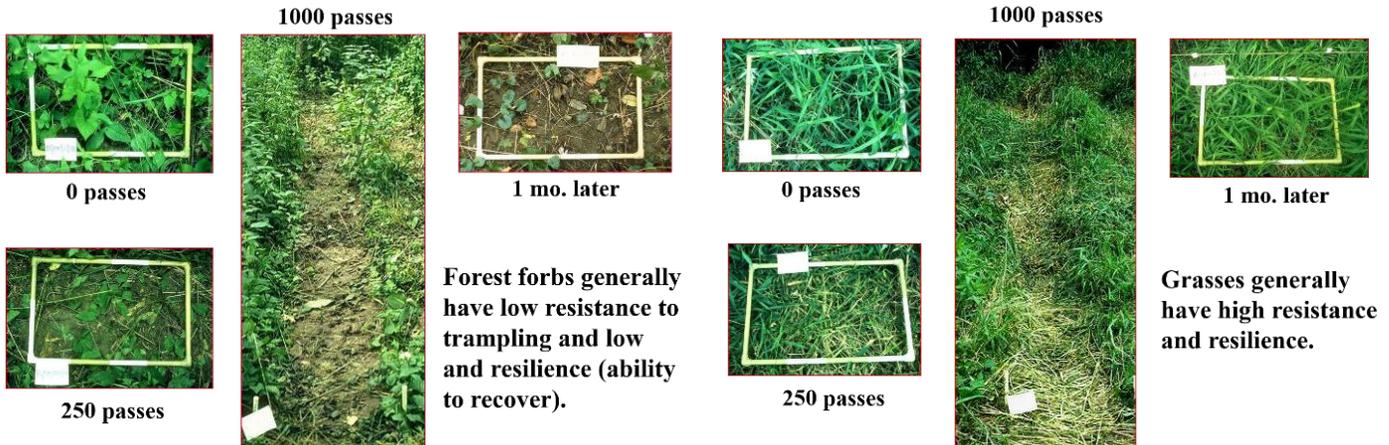


Figure 1. Photos of quadrats and lanes subjected to 250 and 1000 trampling passes, followed by 1 month of recovery (Cole and Marion, 1996).

During our research we verified the applicability of these findings by camping on grassy sites and returning one and two days later to find no evidence of tent locations or lasting grass damage. However, as indicated in Leave No Trace guidance (Marion 2014), we agree that camping activities should preferably be concentrated on more resistant, largely “non-vegetated” substrates, such as those occurring in dry open rocky areas or in densely forested settings that have little to no ground vegetation. There may also be social reasons for moving campers off meadows and into forested or rocky areas where they are less visible. We met and had discussions with the U.S. Geological Survey meadow research group while in Yosemite NP and they concurred with our findings, also noting that while Sierra meadows do have high plant diversity that they have relatively few rare species and are generally resistant to invasion by non-native plants due to their higher elevation. Their research also shows that meadows, particularly those with wet to moist soils, are resilient, and quickly recover from traffic and grazing.

Also of interest, was our recurring observation that Sierra campsites frequently consist of several small proximate cooking and tenting spots which are visually obvious due to the removal of smaller rocks and organic debris such as pine cones and sticks. Importantly, visitors seem to be naturally attracted to and readily concentrate their camping activities on these small proximate sites which, unlike campsites in the East, seem to resist aggregating and expanding into larger completely barren areas of intensive traffic and impact.

Use-Impact Relationships – Implications for Camping Impact Strategies: Numerous recreation ecology studies describe the relationship between amount of use and resource impacts as asymptotic (curvilinear), with the majority of impact to vegetation and soils occurring with initial and low levels of use (Marion et al. 2016). With respect to an individual campsite, after reaching a use level of approximately 15 nights of camping use per year, the use level can double or triple with only limited and diminishing levels of additional resource impact (Figure 2).

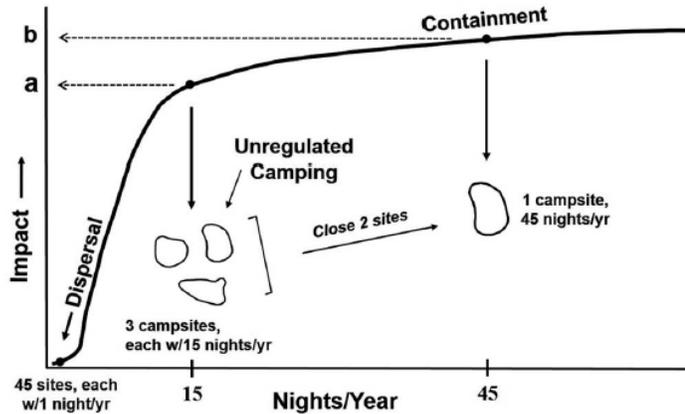


Figure 2. A generalized model of the use-impact relationship for trampling on vegetation and soil illustrating when use-reduction is and is not effective and the empirical basis for effective dispersal and containment strategies.

This use-impact relationship has significant implications for camping impact management strategies. At low levels of camping use a **dispersal strategy**, which seeks to avoid the creation of campsites by reducing traffic to levels that prevent the formation of lasting resource impacts. *Note:* We want to stress that we found alternate definitions for the word dispersal on the Inyo NF website. At moderate to high use levels, a **containment strategy**, which seeks to minimize the aggregate area of camping impact is preferred. Under this strategy camping activities should be spatially concentrated to the core areas of a limited number of resistant campsites. Visitors are encouraged or required to use the most sustainable “established” or “designated” campsites. Camping policy options under each strategy are described in the following sections and illustrated in Table 1.

Pristine Site Camping

This camping option is designed to disperse camping activities to levels that prevent the creation of lasting vegetation and soil impact, **or** shift camping to highly resistant substrates (e.g., rock, snow, gravel) that do not show impact. This option is most appropriate in remote or low use areas out-of-sight from designated trails. Visitors are asked to select the most durable substrates available, camp a single night, and restore the site to its original condition so as not to attract repeat use.

Designated Site Camping

Resource protection is greatest when a designated camping with reservations policy is used, which maximizes campsite occupancy rates and minimizes campsite numbers, but also significantly restricts visitor freedom. Designated site camping without site reservations increases visitor freedom somewhat, but requires a larger number of campsites to accommodate fluxes in use patterns, with lower occupancy rates and the tradeoff of increased aggregate camping impact. Designated campsites are generally shown on maps and have camping posts or fire rings on the ground to signify and fix the location of each site.

Established Site Camping

Removing the requirement to use only designated campsites increases visitor freedom further but an established site camping policy requires larger numbers of campsites to avoid the “musical chairs” dilemma of groups not having a well-established campsite available, *unless* campsite locations can be effectively communicated to them. Under this option campsites are generally not marked on the ground by posts or fire rings, though they may be shown on maps. Our discussion with managers and visitors at each study area revealed strong preferences for this camping management option.

Unregulated Camping

Under this option visitors can generally camp wherever they want, though managers often recommend or require camping to occur more than 100-200 ft from water, and sometimes from formal trails. Visitors may also create new campsites. Studies have frequently documented significant social and resource impacts associated with this policy at and above moderate levels of camping use. First, visitors generally select less sustainable campsites in flat terrain near water and attraction features, often creating large and unnecessary numbers of campsites (site proliferation) in the most attractive areas. Second, the high density of campsites in these areas create experiential problems with visitor crowding and conflict. And third, over time these campsites tend to enlarge (site expansion) and merge into large sprawling barren areas, often with complete removal of vegetative and organic ground cover, which contribute to extensive soil exposure and erosion. Depletion of woody fuel materials and damage to and felling of trees can also be substantial problems when campfires are permitted.

Table 1. Campsite policy options for the dispersal and containment strategies.

Campsite Policy	Use Level	Strategy Employed	Notes
Unregulated	Generally Low - Mod	None	Ineffective with increasing use level.
Established Site	All	Containment	Maximizes visitor freedom
Designated Site	Generally Mod - High	Containment	Mod impact to visitor freedom, must match site and visitor distribution patterns
Designated Site w/Reservation	High	Containment	High impact visitor freedom, must match site and visitor distribution patterns
Pristine Site	Low - Mod	Dispersal	Challenging to effectively implement, most appropriate for experienced campers

Side-hill Campsites

We will also describe in our report options for the construction of “side-hill” campsites in sloping terrain (generally terrain with a grade of >15-20%). Hundreds of side-hill campsites have been constructed with substantial success along the Appalachian Trail. We found one clearly constructed side-hill tent pad in the 1000 Island Lake Basin and another at Outpost Camp, most likely constructed by visitors.

Suggestions for PCT Camping: A *containment strategy* is preferable in moderate to high use areas along the PCT and the *established site camping* option seems preferable to unregulated camping, particularly in areas receiving moderate to high use. Designated site camping without reservations is another option in particularly high use locations.

The established site camping option is traditionally implemented by asking visitors to use only “well-established campsites” and avoiding lightly-used and closed/rehabilitated campsites. Field staff can then work to close and rehabilitate illegal campsites (those too close to water or the PCT), less sustainable campsites, and unnecessary sites. Such actions seek to shift use to a smaller set of legal and more sustainable campsites and reduce the aggregate area of camping impact.

During our field work we discussed and debated many additional options for encouraging the use of a subset of the most sustainable campsites, as identified by our field surveys and ongoing agency monitoring. The principal challenge is how to communicate the locations of preferred sustainable campsites; we suggest consideration of three innovative, inexpensive, and easily implemented options:

- 1) Employ existing phone apps by working with their developers to include only sustainable campsites (as determined by our surveys and approved by agency staff). For example, Appalachian Trail managers have collaborated with the Half-mile and Guthook developers to include only preferred campsites. Hikers using Guthook can use their phones with GPS satellite navigation to walk straight to each listed campsite, even without cellular coverage.
- 2) Create GeoPDF map files showing the locations of sustainable campsites and make them available for downloading and use in the Avenza PDF Maps phone app. As above, the Avenza PDF Maps would enable phone-based GPS satellite navigation to each campsite. The “Luddites” among us can also download and print the GeoPDF maps and take them into the field for use with traditional map and compass navigation. Campsite distance to trails and lakeshores and elevations can also be included to aid in determining site locations.
- 3) Create Garmin .gpx and Google Earth .kml/.kmz files of the locations of sustainable campsites and make them available for downloading from agency websites. As above, any GPS or mobile device that reads these files will enable visitors to navigate to each campsite.

Our staff can provide all of these products if requested. Agency staff would need to review and conduct their own assessments and approvals of the sustainable campsites that we identified in the field (our lists will be rank-ordered by various indicators). We also identified a small number of currently unused but proposed sustainable campsite locations in the study areas. Agency staff would then upload the various site location files and make them available on their websites, along with some simple guidance and associated camping regulation and low impact camping practices (*see Appendix 1 for some draft Leave No Trace guidance*). We note that these map files could also clearly communicate distance to water and trail boundaries showing visitors in real time exactly where they can legally camp, and include other relevant messages on regulations, camping guidance, and LNT practices. We are available to assist in such efforts. We believe that implementation of an entirely voluntary established site camping strategy by these three options would effectively “market” the most sustainable subset of campsites in the targeted areas, shifting use away from less sustainable campsites and allowing them to naturally recover. Recovery could be hastened by restoration work, though this is not a critical component if staffing is unavailable.

In many locations along the PCT there are an adequate number of environmental settings where experienced visitors could successfully practice *dispersed pristine site camping*, particularly in more remote and lower use areas. Three key elements required for successful implementation depend on the ability of managers to effectively communicate the following low impact camping practices:

- 1) Select a camping location that is at least 200 ft and preferably out of sight of the PCT that is unlikely to be found and reused by other groups,
- 2) select and use the most resistant substrates available (e.g., rock, snow, barren soil or organic litter, grasses), camping only one night, and
- 3) return any moved rocks and organic debris to erase traces of your stay and to avoid attracting repeat use.

Such practices could be effectively communicated to experienced outdoor visitors, particularly long-distance backpackers. For example, all backpackers granted thru-hiking or section-hiking permits could be required to take and pass an online short-course before reaching a permitting screen. The national Leave No Trace program

has developed an Online Awareness Course that provides an example: <https://Int.org/learn/online-awareness-course>. Our group could assist in developing such a course, which would also cover appropriate containment strategy camping options and PCT-specific regulations, camping guidance, and Leave No Trace practices.

Phase 2: Analysis & Report Writing

Phase two project work, covered by existing funding, will begin shortly, conducting additional analyses and writing needed to produce a technical report that more fully presents our findings, including photographs, tables, figures, and GIS maps illustrating our collected data for each study area, and presenting our management suggestions applicable to the study areas, the PCT, JMT, and other adjacent lands. We expect to complete this report by the end of May, 2018 (hopefully earlier).

Phase 3

An additional \$15,000 was added as a Phase 3 component during the summer of 2017 to compile, analyze, and model visitor use and permit data provided by the administrative units of the PCT/JMT overlap and surrounding trail networks. This work is underway through collaboration and outreach to Yosemite National Park GIS staff and contacts at each of the land managing units containing the PCT/JMT overlap. Preliminary findings will be communicated at the October meeting. It is anticipated that agency partner availability will increase after the busy summer visitation season concludes, and that data sharing, interface and review will be more effective during the fall and winter of 2017-18.

Other Phase 3 options are also possible. We hope that one or more of the agencies and units along the PCT will volunteer to implement one or more of our management suggestions noted above (and/or our additional suggestions to be incorporated into our full management report) as part of a collaborative adaptive management case study. With additional funding we would then work closely with agency staff to provide before-and-after measurements to evaluate management success and refine actions as needed. Alternately, with additional funding we could redirect our field research to examine the sustainability of the PCT trail design and management, similar to our work on the Appalachian Trail. This work could focus on specific regions or areas, or provide a spatially-based sample of the entire PCT. Other research needs and questions are also welcome.

Citations

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Appendix 1

Suggested Leave No Trace camping guidance for PCT hikers: These follow general Leave No Trace guidance based on the findings of recreation ecology research to concentrate use and impact in moderate to high use areas and to disperse use to levels that prevent permanent impact in low use areas.

Concentrate use in popular areas

Site Selection: In popular destination areas be sure to look for and follow the land management agency's guidance for selecting a legal campsite, group size limits, campfires, and food storage. Look for and adhere to any restrictions on campsite distance to water or trails. Choose a well-established site you can use without enlarging, avoiding lightly-impacted campsites or sites closed for restoration to promote their recovery. Never create a new campsite.

Site Use: Set your tents up on the most impacted "core" areas of the campsite to avoid enlarging the site. Avoid spots with dead or hazardous trees and branches. If there aren't enough tenting spots find a larger campsite or split your group across two or three campsites. Concentrate your camping activities, particularly cooking, to the core area or on adjacent bedrock when available. Avoid stepping on plants and traffic in adjacent offsite areas. If campfires are permitted use only pre-existing fire sites and collect only dead and downed wood you can break by hand; leave woods tools at home. Placing your stove on a flat rock away from organic litter is OK, but don't move other rocks and logs around to make chairs.

Leave your campsite clean and natural looking—as *you* would like to find it. Litter, graffiti, tree damage, unburied human and pet waste, spilled food, and fire rings with trash are all *avoidable* impacts. By taking the time to pick up after ourselves and others, we and the environment all benefit.

Disperse use in pristine areas

Site Selection: In low use areas it may be possible to practice "pristine site" camping. Recognize that when you venture away from well-established trails and campsites that the potential for impacting vegetation is substantially higher. Accept the personal responsibility to "Leave No Trace" of your visit if you must venture off-trail.

The objective of pristine site camping is to locate an area out-of-sight or distant from trails, water, and established campsites that has no evidence of prior camping use. Look for durable rock surfaces, areas with little to no vegetation, or dry grasses.

Site Use: Moving a few sticks or rocks to erect a tent is fine, just return them before you depart. In forested areas hammocks with wide straps make it even easier to "leave no trace" of your overnight stay. Or bring a free-standing tent and place it on bare bedrock. Concentrate your camping activities on the most durable surfaces available and avoid creating trails by varying your route to water, tents, and cooking areas. Camp only one night and naturalize your site before departing so that others are unlikely to find and reuse it. Add organic litter to scuffed up areas and replace or add branches and rocks to disguise the site.