

A SPATIAL ANALYSIS OF WILDERNESS CAMPSITES IN LYELL CANYON, YOSEMITE NATIONAL PARK

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Abstract: During the summer of 1999, Yosemite National Park staff collected GPS data to inventory the number and distribution of wilderness campsites in Lyell Canyon, Yosemite National Park. The data were collected after one month of campsite restoration work had been conducted by a student work crew. This study integrated the GPS data with digital raster graphics data for Lyell Canyon to create a wilderness campsite monitoring system tool based on a Geographic Information System (GIS). The monitoring tool developed in this study gives resource managers the ability to identify the number and spatial distribution of campsites in Lyell Canyon that are within and out of compliance with park guidelines for wilderness campsites. The monitoring tool can also be used to record the history of specific campsites from season to season, track changes in visitor use patterns, and identify potential problem areas. Further, this monitoring tool provides managers with insight into the successes and potential failures of management efforts.

Introduction

Yosemite National Park is located in the heart of the Sierra Nevada, in east central California. Yosemite National Park was established in 1890, and is considered to be one of the "crown jewels" of the National Park system. The establishment of Yosemite National Park as the second park in the National Park system (Yellowstone National Park was established in 1872) represents one of the nation's first significant commitments to wilderness preservation (Nash, 1967).

Today, approximately 94 percent of Yosemite National Park's 760,000 acres of land are designated as wilderness under the 1964 Wilderness Act (Yosemite National Park, 1999). The 1964 Wilderness Act mandates the National Park Service to maintain designated wilderness areas in their natural condition "...where the earth and its community of life are untrammelled by man, where man himself is a visitor who does not remain" (1964 Wilderness Act).

As part of their effort to meet the mandates of the 1964 Wilderness Act, Yosemite National Park officials have developed guidelines for the location of campsites in designated wilderness areas of the park. The guidelines

require that all campsites established in wilderness areas be located 100 feet or further from the nearest water body (i.e., river, stream, lake, pond). In addition, the guidelines require that wilderness area campsites in Yosemite National Park be located 100 feet or further from the nearest trail.

The study area for this research project is Lyell Canyon, located in designated wilderness in eastern Yosemite National Park. Lyell Canyon is formed by the Lyell Fork of the Tuolumne River and runs north to south at an elevation of approximately 9000 feet. Park visitors can access Lyell Canyon by hiking the John Muir Trail from Tuolumne Meadows. The Lyell Canyon section of the John Muir Trail is considered by many to be a highlight of the Pacific Crest Trail, which runs from Mexico to Canada. The canyon is an easy hike from Tuolumne Meadows, and as a result, sees intense use during the summer months.

In an effort to manage the physical and social impacts of intense visitor use, Yosemite National Park operates a trail head permit system. During weekends from June through Labor Day, Lyell Canyon's trailhead is typically at capacity (i.e. all available permits for the area are issued to park visitors). The intense use of Lyell Canyon is accompanied by a high demand for places to camp in the Canyon. The high demand for campsites in Lyell Canyon presents a challenge to park managers who must minimize recreation-related impacts to the resources while providing places for visitors to camp. This study focuses on providing managers with a wilderness campsite monitoring tool that will assist them in meeting this challenge.

Specifically, one of the goals of this study is to provide Yosemite National Park officials with spatial information about the existing campsites located in Lyell Canyon. This information will allow park officials to determine whether the campsites located in Lyell Canyon meet their guidelines for wilderness campsites. Three objectives were identified to achieve this goal:

1. Identify the number and location of existing campsites in Lyell Canyon.
2. Identify the number and location of existing campsites in compliance with wilderness campsite regulations (i.e., distance from water, distance from trails).
3. Identify the number and location of existing campsites not in compliance with wilderness campsite regulations.

During the summer of 1999, Yosemite National Park staff removed approximately 30 campsites from Lyell Canyon. The primary purpose of this management action was to remove campsites that violated the park's guidelines for wilderness campsites (i.e. were located within 100 feet of trail or water). The second goal of this study was to provide Yosemite National Park staff with information to help them assess the effectiveness of management actions taken to meet park guidelines for campsites located in Lyell Canyon. Three objectives were identified to meet this goal:

1. Identify the number and location of campsites removed from Lyell Canyon during the summer of 1999.

2. Identify the number and location of campsites removed from Lyell Canyon during the summer of 1999 that were in compliance with wilderness campsite regulations.
3. Identify the number and location of campsites removed from Lyell Canyon during the summer of 1999 that were not in compliance with wilderness campsite regulations.

Data

During the summer of 1999, Yosemite National Park staff recorded the location of existing and removed campsites in Lyell Canyon, using a Trimble Pro-XR GPS device. Park staff used the software package GPS Pathfinder Office (version 2.10) to correct the GPS data. The resulting output included two vector coverages (existing and removed campsites) represented as point features. The campsite point data were obtained from Yosemite National Park division of Resources Management for this study.

In addition to the vector data coverages of existing and removed campsites in Lyell Canyon, digital raster graphics for the entire park were obtained from the park staff. The digital Vogelsang Peak Quad was used to heads-up digitize the Lyell Fork of the Tuolumne River, smaller tributaries, wetland/lake areas and the John Muir hiking trail. Digitizing output included three vector coverages - a coverage of line features representing streams and rivers in Lyell Canyon; a coverage of polygon features representing wetland/lake areas in Lyell Canyon; and a coverage of line features representing the John Muir trail in Lyell Canyon. The "Clean" command in ARC/INFO was used to build topology for the three digitized vector coverages.

The completed GIS database contains a total of six coverages, each at a scale of 1:24,000. The projection and datum of all six data coverages are Universal Transverse Mercator and NAD 1927, respectively. Five of the coverages are vector data, and the sixth coverage is raster. The vector data coverages are existing campsites, campsites removed during the summer of 1999, rivers and streams, wetland/lake areas, and the John Muir Trail. The raster data coverage is the digital Vogelsang Peak Quad.

Analysis

The spatial analysis operations for this study were performed using ArcView Version 3.1 and ARC/INFO (version 7.2). The analysis was conducted in two stages. First, analysis of existing campsites data was conducted. Second, analysis of campsites removed during the summer of 1999 was conducted.

In the first stage of the analysis, the "Theme on Theme Selection" command was used to identify existing campsites located within 100 feet of any water body (i.e., rivers, streams, lakes, ponds). A second "Theme on Theme Selection" was performed to identify existing campsites located within 100 feet of the John Muir hiking trail.

In the second stage of the analysis the "Theme on Theme Selection" command was used to identify campsites removed during the summer of 1999 that had been located within 100 feet of water. A second "Theme on Theme Selection" was performed to identify campsites removed during the summer of 1999 that had been located within 100 feet of the John Muir hiking trail.

Three dichotomous variables were added to the attribute table for existing campsites and to the attribute table for campsites removed during the summer of 1999. The dichotomous variables were developed based on the results of the theme on theme selections. The first variable indicated whether or not a campsite was located within 100 feet of water, the second indicated whether or not a campsite was located within 100 feet of the nearest trail, and the third indicated whether or not a campsite was either within 100 feet of water, within 100 feet of the nearest trail, or both.

In addition to the theme on theme selections described above, the "Join" command was used to derive the distance from each existing campsite to the nearest river or stream, and to the nearest trail. The distance of existing campsites to the nearest river or stream and to the nearest trail were added to the table of attributes for existing campsites by the "Join" command. This procedure was repeated for the data set of campsites removed during the summer of 1999.

Results

The results of the data analysis suggest that further management actions need to be taken in Lyell Canyon to meet Yosemite National Park's guidelines for the location of wilderness campsites. Analysis of the data indicate that park officials have been relatively effective at locating campsites in Lyell Canyon relative to water bodies - more than three-quarters (77.1%) of existing campsites are greater than 100 feet from the nearest river, stream, lake, or pond (Table 1). However, park managers have been less effective at locating campsites in Lyell Canyon with respect to trails - more than two-thirds (65.7%) of existing campsites are within 100 feet of the John Muir Trail (Table 1).

Table 1. Number and percent of existing campsites in compliance with Yosemite National Park regulations*

	Greater than 100 feet from nearest water		Greater than 100 feet from nearest trail		Full compliance	
	Yes	No	Yes	No	Yes	No
Number of existing campsites	27	8	12	23	11	24
Percent of existing campsites	77.1%	22.9%	34.3%	65.7%	31.5%	68.5%

*Park regulations require that campsites be located at least 100 feet from water bodies and trails.

These findings are reinforced by the fact that the average distance of existing campsites in Lyell Canyon from the nearest river or stream is greater than 100 feet (220 feet), while the average distance of existing campsites from the nearest trail is less than 100 feet (85 feet) (Table 2).

Overall, the spatial analyses indicate that of the thirty-five existing campsites in Lyell Canyon, more than two-thirds (68.5%) are not in compliance with one or both of the park's guidelines for siting wilderness campsites.

Table 2. Distance of existing campsites from nearest trail and water (feet)

	Distance from trail	Distance from water
Mean*	84.5	219.8
Standard Deviation	71.0	99.0
Median	73.9	201.4
Minimum	1.0	74.6
Maximum	285.4	433.0

*n = 35

The management actions taken by Yosemite National Park to remove non-compliant campsites from Lyell Canyon during the summer of 1999 appear to have been effective. More than half (53.3%) of the thirty campsites removed from Lyell Canyon during the summer of 1999 were within 100 feet of the nearest trail (Table 3). A much smaller percentage (26.7%) of the campsites removed from Lyell Canyon during the summer of 1999 were within 100 feet of

the nearest river or stream (Table 3). The most compelling evidence that the park has been successful in their selection of campsites to remove from Lyell Canyon during the summer of 1999 is the fact that nearly three-quarters (70.0%) of the campsites removed were not in compliance with one or both of the park's guidelines for siting wilderness campsites.

Table 3. Number and percent of removed campsites in compliance with Yosemite National Park regulations*

	Greater than 100 feet from nearest water		Greater than 100 feet from nearest trail		Full compliance	
	Yes	No	Yes	No	Yes	No
Number of removed campsites	22	8	14	16	9	21
Percent of removed campsites	73.3%	26.7%	46.7%	53.3%	30.0%	70.0%

*Park regulations require that campsites be located at least 100 feet from water bodies and trails.

Conclusions

The information generated by this study provide Yosemite National Park managers with an important backcountry campsite monitoring tool. Park managers can use the GIS database created in this study to accurately assess the number and spatial distribution of campsites in Lyell Canyon that are not in compliance with Park guidelines. This information can be used by Park managers to prioritize the location of future backcountry campsite management in Lyell Canyon. In addition, the GIS database can be used by park managers to assess their progress toward achieving backcountry campsite management objectives and protecting visitors' wilderness experiences.

The GIS database developed in this study enhances the Resource Management division's institutional memory. This is a significant contribution to Resource Management, given that a large amount of the division's field operations are conducted by a seasonal staff. This monitoring system tool, based on GPS Universal Transverse Mercator (UTM) coordinates, gives resource managers the ability to record the history of specific campsites from season to season in a consistent manner. Having a monitoring system that remains consistent from season to season allows managers to accurately track changes in visitor use patterns, identify potential problem areas, and evaluate the successes and potential failures of restorative efforts.

There are, however, several issues to consider in using a GIS database as part of a backcountry campsite monitoring system. First, wilderness management is not a black and white science. Rather, it is an art of balance. Some campsites identified in a GIS database as non-compliant with park guidelines might be maintained because they are better than the next closest option. Second, the accuracy of the spatial data used to monitor backcountry campsites must be taken into consideration. For example, USGS topographical maps are accurate to plus or minus 40 feet. Therefore, some campsites identified in the results of the data analysis as being in compliance with park guidelines may in fact be out of compliance, and vice versa. Lastly, perhaps the greatest challenge in developing a wilderness campsite GIS database is obtaining reliable and usable

spatial data. The data used in this study are the product of a systematic monitoring effort on the part of the Resources Management Division of Yosemite National Park. However, monitoring efforts in many other park and wilderness areas are constrained from collecting spatial data due to limitations on funding and/or staff. As a result, the data needed to create a wilderness campsite monitoring system based on a GIS database may be difficult to come by in some instances.

The results of our research indicate that Yosemite National Park officials have been successful in their efforts to reduce the number of campsites in Lyell Canyon that are not in compliance with their wilderness campsite guidelines. The GIS database developed in this study can be used to identify and remove non-compliant campsites in Lyell Canyon. Further research should focus on developing similar GIS databases for other wilderness camping areas in the park. By developing additional GIS databases, Yosemite National Park will be better equipped to manage the location of campsites in wilderness areas of the park, and act in accordance with the legal mandates of the 1964 Wilderness Act.

References

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