Annual Report

User Capacity Management Monitoring Program

United States Department of the Interior
National Park Service
Yosemite National Park
California

2007

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EXECUTIVE SUMMARY

2007 represented the fourth year of collecting baseline information for the long-term monitoring of indicator variables related to visitor use and its impact throughout the park. This year, indicators and standards were improved upon; field monitoring and data collection built upon operational efficiencies; and two workshops were held to evaluate and refine monitoring protocols and improve program administration. The information collected in this report will be used by park managers, planners and the public alike to ensure that the quality of park resources and visitor experiences in Yosemite National Park are maintained.

A summary of results from indicator monitoring in 2007 are as follows:

- **Water Quality:** Monitoring efforts continued to build a rich dataset from which to establish baseline water quality conditions. Results from 2007 suggest a continuation of a high degree of water quality throughout the Merced corridor.
- **Riverbank Condition:** This marked an important year for this protocol as a pilot study was initiated on several sites in Yosemite Valley. Midway through the season, a symposium was held which gathered experts from throughout the region to help with the definition and refinement of this protocol.
- **Wildlife Exposure to Human Food:** Monitoring procedures worked well and efficiently in 2007. Results from the field season suggest that food storage compliance rates at most major locations approached or exceeded the proposed standard.
- **Extent and Condition of Informal Trails:** In order to streamline data collection efforts and improve operational efficiencies a rotational sampling plan was initiated this year. A subset of meadows was monitored this year with rotations to occur on a bi-annual basis.
- **Wilderness Encounters:** Monitoring efforts for wilderness encounters were improved with more attention given to following established protocols. However, concerns over sample size remain. Results for three trail segments suggest periodic, but frequent encounters with more than one group per hour.
- **Visitor Use Crowding:** Numerous studies were conducted that monitored visitor use conditions throughout the park. Much of these data collections expanded the scope of this indicator from it previous title of People-At-One-Time to encompass a wider variety of crowding/congestion/encounter type variables.
- **Parking Availability:** Increased training and attention to following a revised and expanded protocol marked the improvements for this indicator in 2006 and 2007. Results, suggest that the day use parking area did not fill to capacity nearly as frequently as it did in 2005. Reasons for this may include more efficient parking due to direction from attendants, expanded parking footprint, and/or changes in vehicle composition at the site.
- **Archaeological Integrity:** Archeological sites, recognized as part of the Cultural Outstandingly Remarkable Values (ORV) for the Merced and Tuolumne Wild and Scenic Rivers were monitored for the first time in 2007 under the User Capacity Program monitoring framework.

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1.0 INTRODUCTION AND BACKGROUND

The Organic Act established the National Park Service to, "conserve the scenery and the natural and historic objects and the wild life therein" while at the same time providing for "the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (NPS Organic Act 1916 - 16 USC 1). Thus, park planners and managers are charged to protect resources while providing for their enjoyment. How do we strike this balance?

The User Capacity Management Monitoring Program (UCMMP) has been developed to serve as a report for the park on how we are managing the natural, cultural and social resources (visitor experience). The indicators that have been developed for this program have been identified as impacted by visitor use, measurable, non-destructive to collect, and sensitive to change (Hof et al. 1994, NPS 1995, NPS 1997). The monitoring program and process is dynamic and constantly being updated with the advent of technological advances, changes in visitor behavior and the successes that management action yields. Figure 1.1.2 displays the process that a multitude of protected areas, including Yosemite National Park, go thru to manage and provide meaningful data from their long-term visitor use management programs.

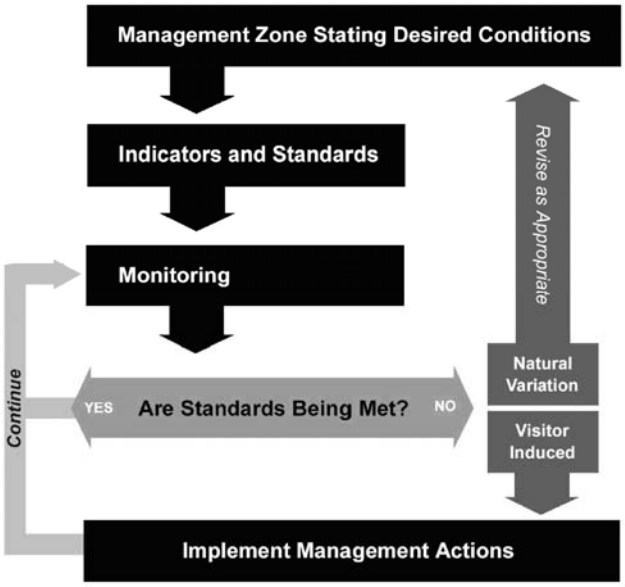


Figure 1.1.1. User Capacity Management Monitoring Framework.

Indicators are measurable, manageable variables that reflect the condition of park resources and visitor experiences, while standards represent the desired condition of indicator variables (Manning 1999, Manning 2007). Monitoring indicator variables provides important information to park planners and managers on the condition of park resources and human experiences (Hof and Lime 1997). Collectively, defining indicator variables, setting standards, and monitoring serve as an early warning system informing park managers of potentially unacceptable changes in resource and social conditions.

1.1 PROGRAM DEVELOPMENT IN 2007

2007 marked the fourth year of the UCMMP. Table 1.2.1 below presents the list of indicators and standards for this year.

Table 1.1.1. Indicators and Standards in 2007.

Indicators	Standards
Water Quality	Anti-degradation for each segment, for *E. coli,* nutrients (total dissolved nitrogen, nitrate and nitrite, total dissolved phosphorous, and total phosphorus), and total petroleum hydrocarbons. Absolute minimum for all segments: State *E. coli* standard for recreational contact. Yosemite-specific standards, which will be much more protective than available state and federal standards, will be established once sufficient data has been obtained through this sampling protocol.
Riverbank Condition	A peer review of the existing monitoring protocol revealed the need for a more rigorous approach to riverbank condition monitoring and assessment. As a result, standards are being developed that take into account a new protocol under development in late 2007.
Wildlife exposure to human food	95% or greater compliance with food storage regulations in selected campgrounds and parking areas.
Extent and Condition of Informal Trails	No net increase in density of informal trails when compared with baseline (for Yosemite Valley). Baseline established in 2004 and 2005. In Tuolumne Meadows, 2007 mapping will add to data collected in 2005 and 2006 to increase baseline dataset. Baseline will be updated as restoration actions are implemented and data are re-collected to reflect restoration efforts. In addition, a range of density threshold values of disturbed areas and trailing will be developed through consultation with professionals specializing in recreation and meadow ecology. The resulting standard will be developed through a combined effort from scientists and park management/planning specialists and will be based on desired conditions associated with particular management zones designed to protect Wild and Scenic River ORV's.
Wilderness Encounters	Untrailed: No more than 1 encounter with another party per hour, 80% of the time. Trailed: No more than 1 encounter with another party per 4 hour period, 80% of the time.
Visitor Use Monitoring	Findings from 2007 use studies indicate predictable crowding/congestion conditions at key attraction sites to that of vehicle arrivals at entrance stations earlier in the day. As a result of this, the visitor use monitoring indicator is exploring a way to be collected in tandem with a developing transportation indicator.
Archaeological Condition and Stability	No deterioration in site stability or condition related to visitor threats or disturbances. No new visitor related (including park management actions related to visitor use) threats or disturbances to archeological sites that have the potential to degrade stability or condition. No change in condition from baseline to current as a result of visitor use.
Parking Availability	A standard has yet to be determined. Additional transportation-related work will yield valuable understanding in addition to the current parking availability indicator thru the 2008 and 2009 data collection seasons.

The indicators presented above were monitored at a variety of locations representing a broad spectrum of management zones. Figure 1.2.1-1.2.7 show all monitoring locations throughout the park, excluding the archeological sites protected from disclosure. Sampling locations were chosen to be representative of the various management zones and coincide with areas of resource or experiential concern.

Figure 1.2.1. Monitoring locations in 2007 in west Yosemite Valley.

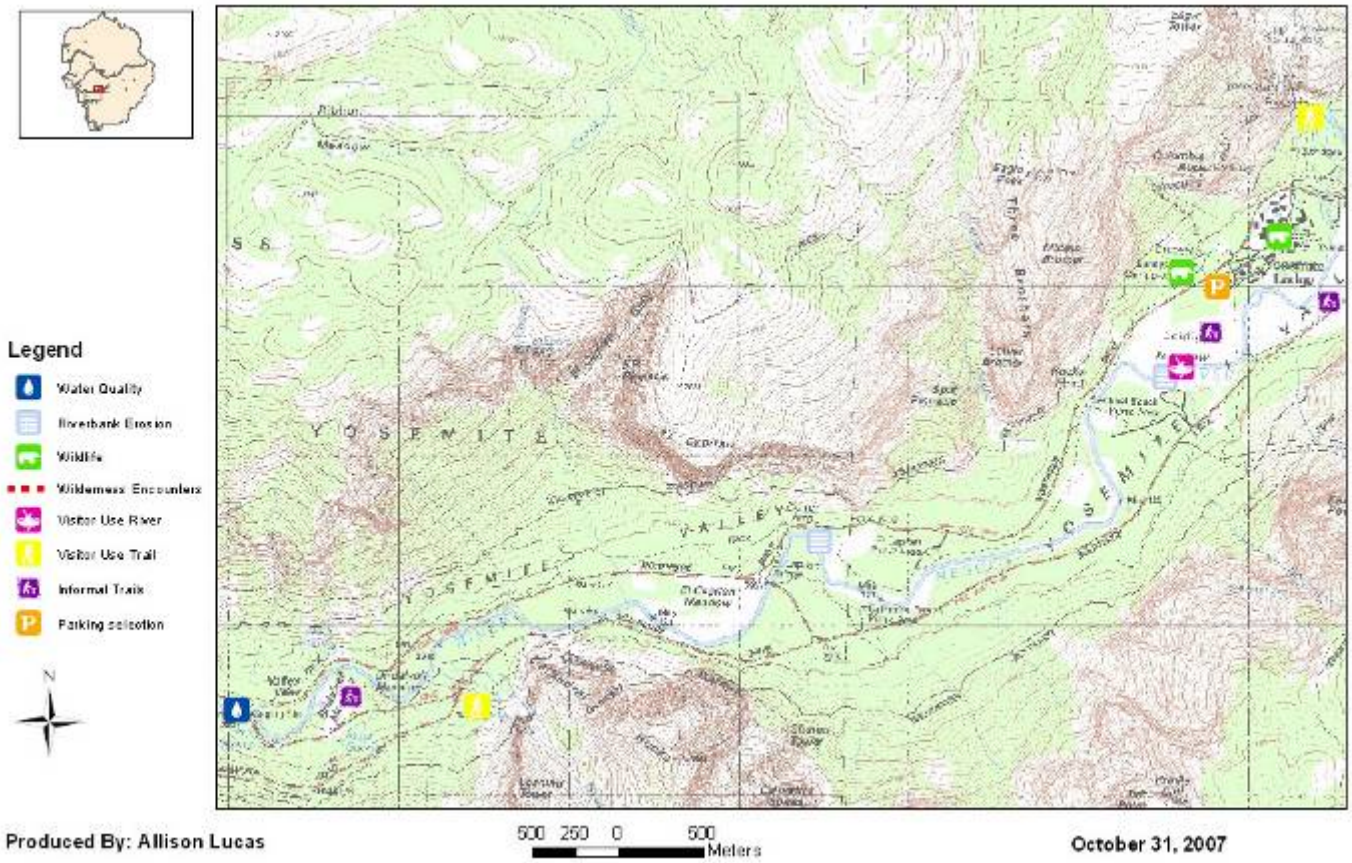


Figure 1.2.2. Monitoring locations in 2007 in east Yosemite Valley.

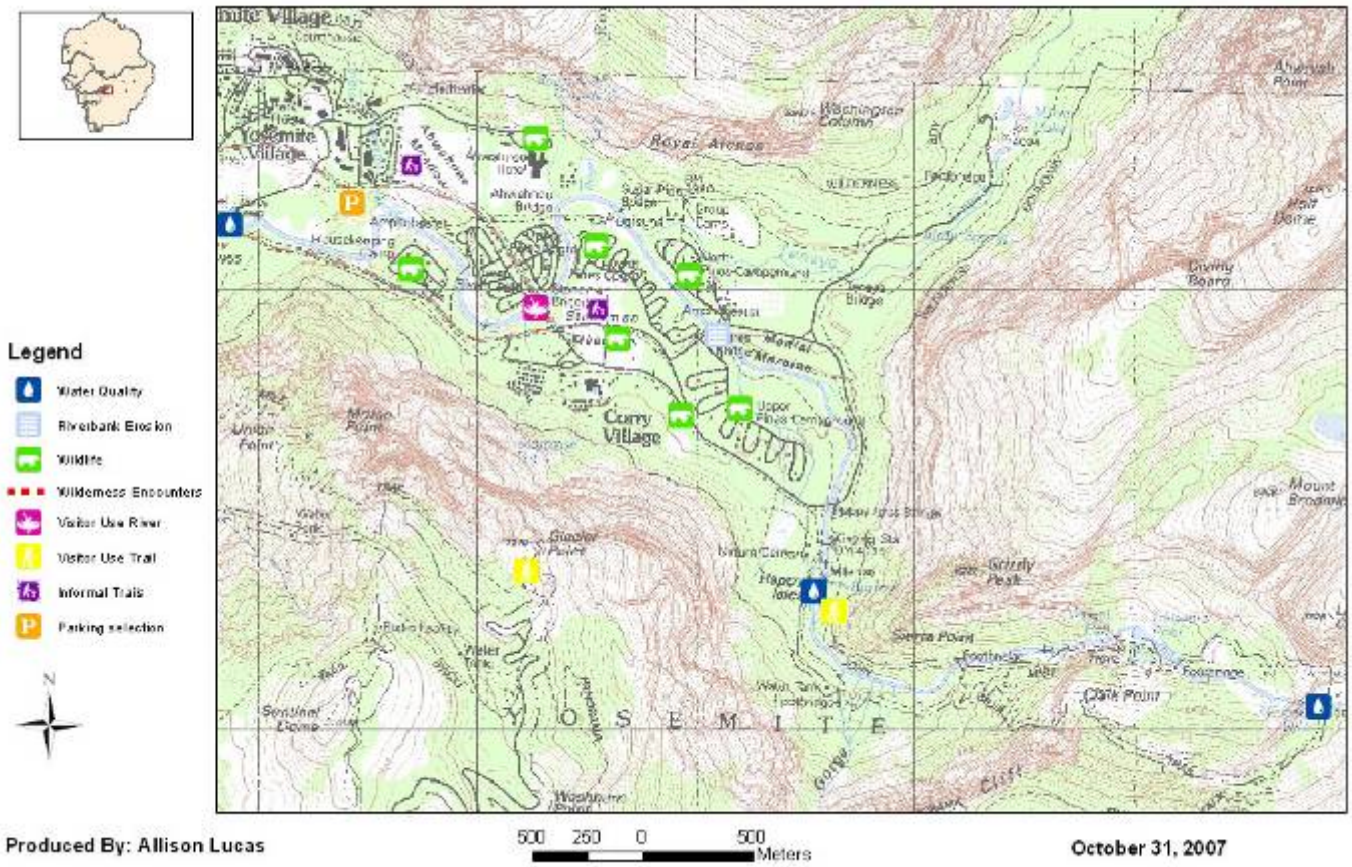


Figure 1.2.3. Monitoring locations in 2007 in El Portal.

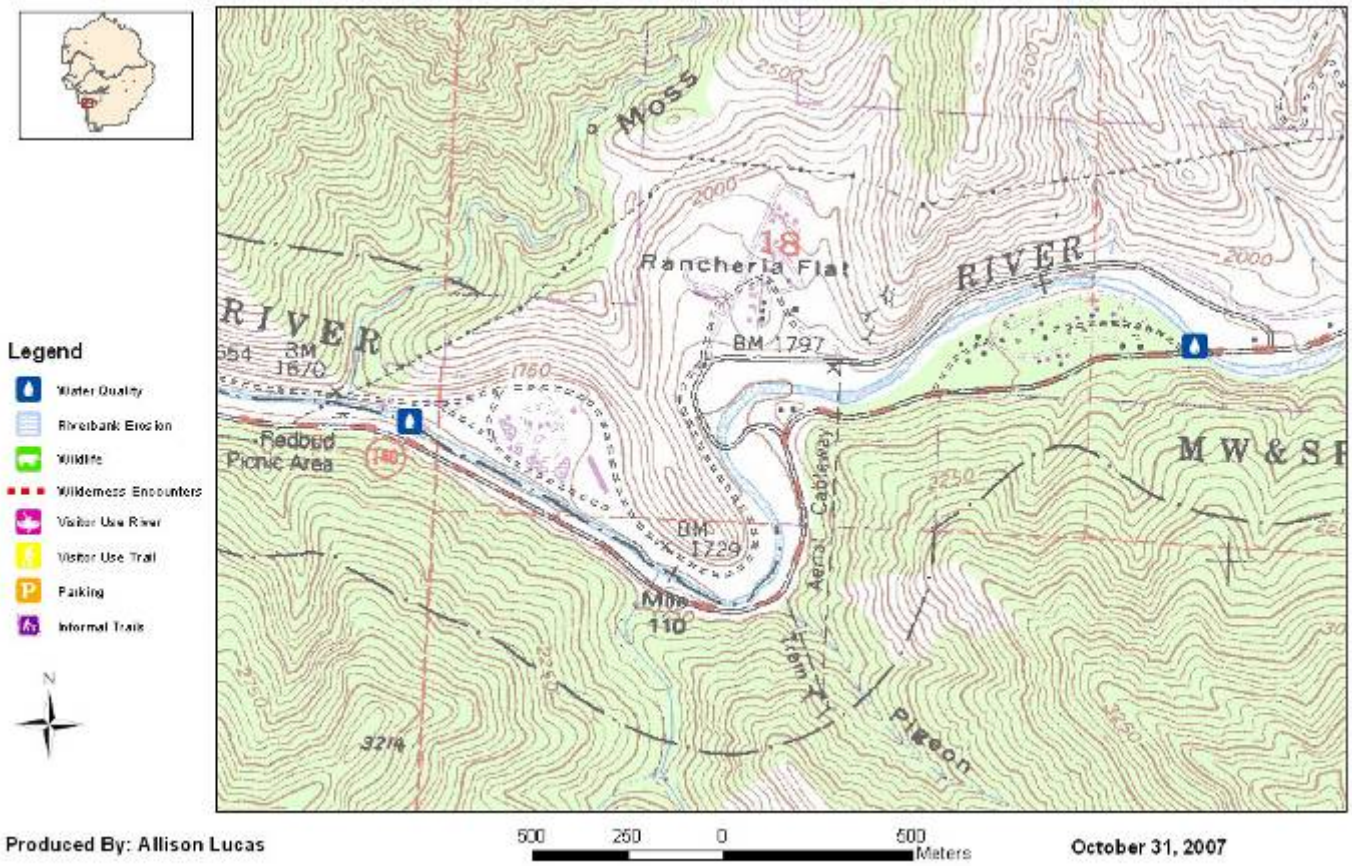


Figure 1.2.4. Monitoring locations in 2007 in Merced Lake area.

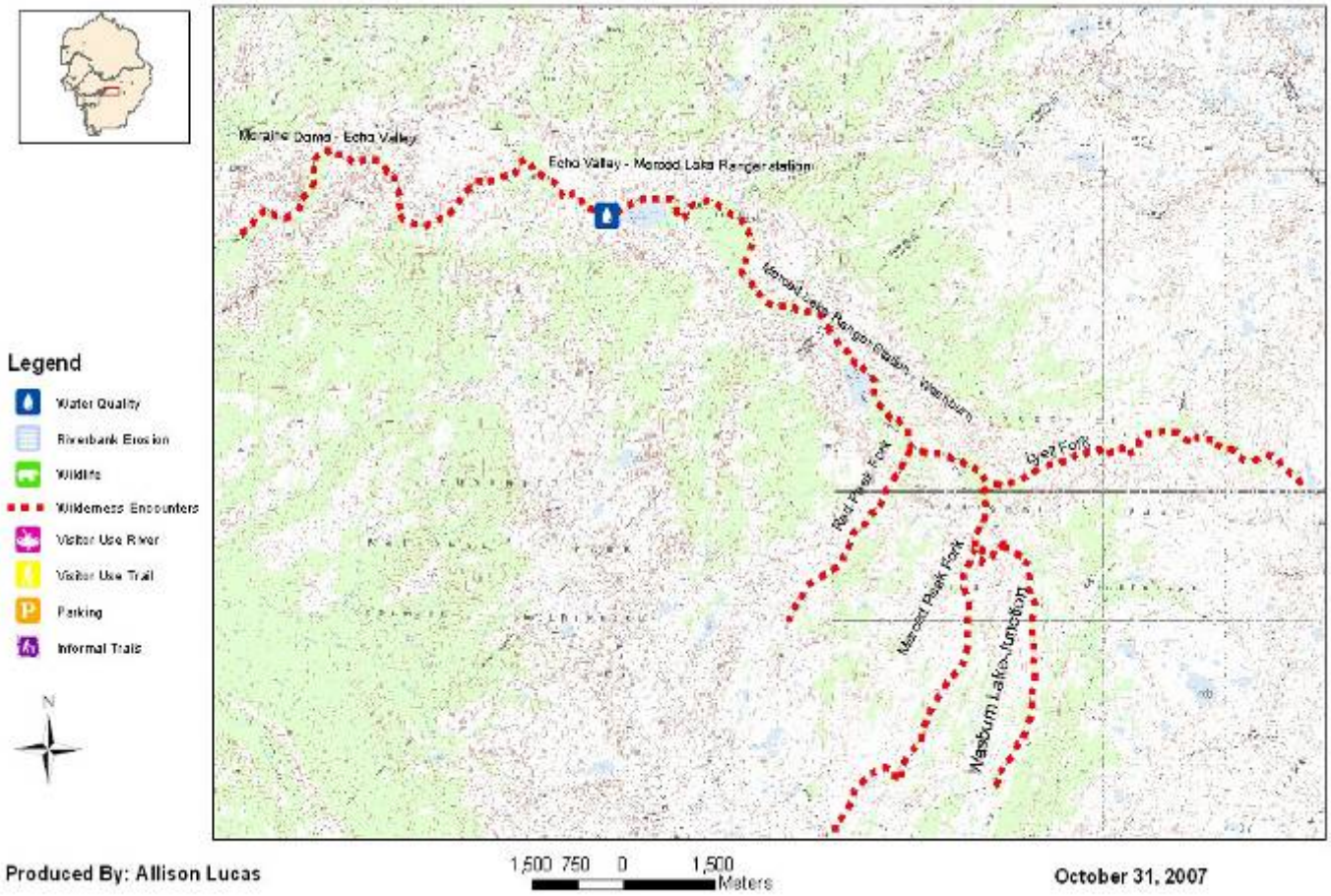


Figure 1.2.5. Monitoring locations in 2007 in Wawona.

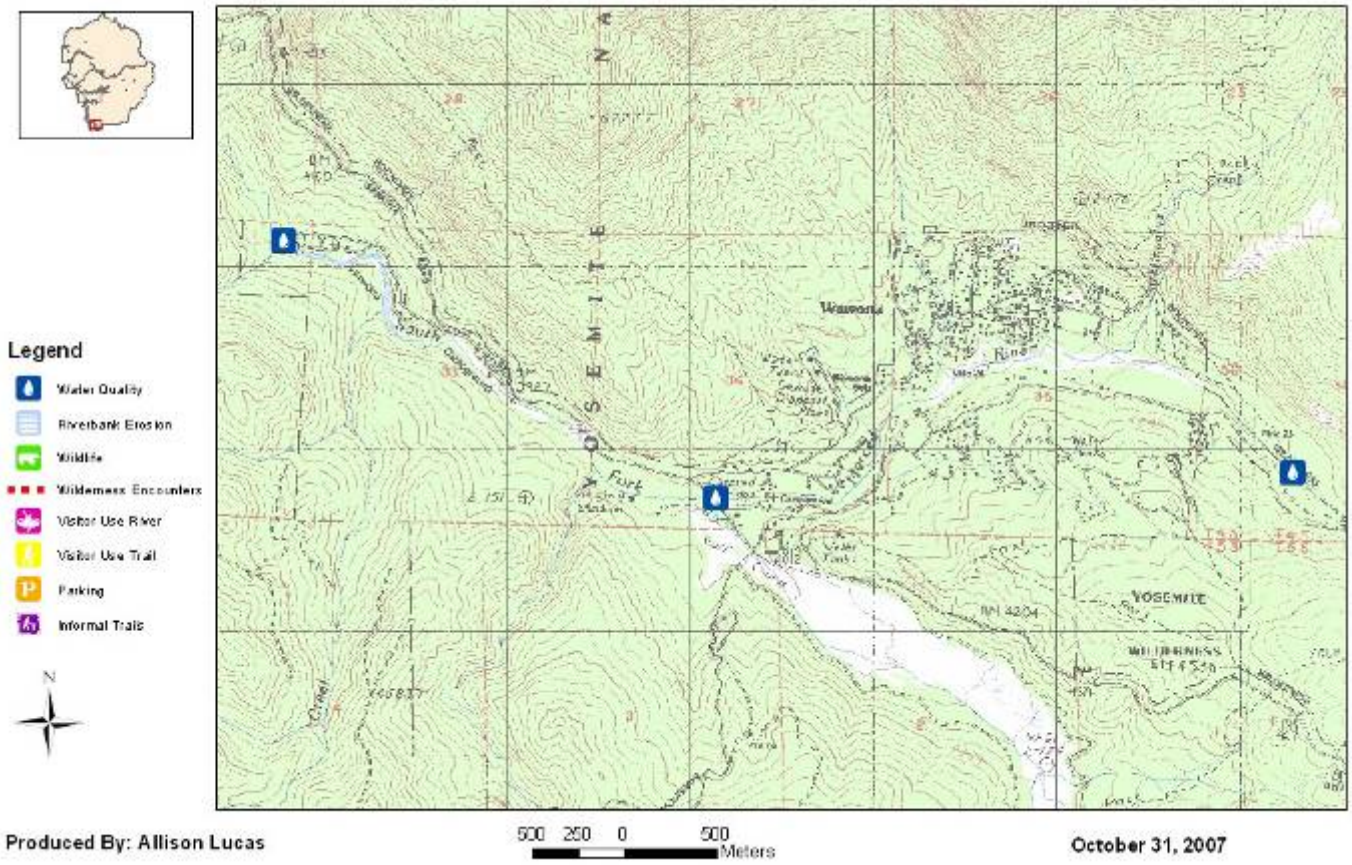


Figure 1.2.6. Monitoring locations in 2007 in Tuolumne.

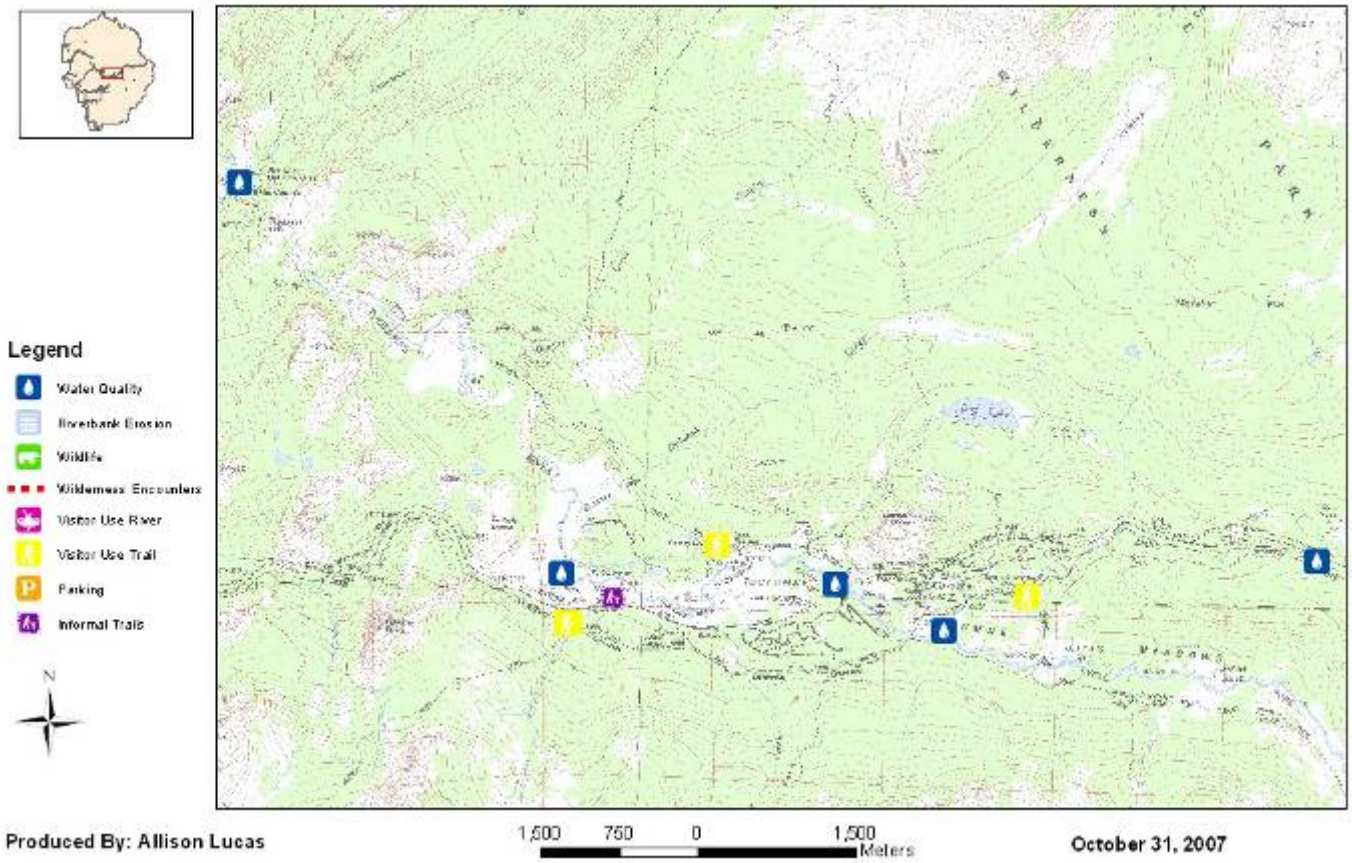
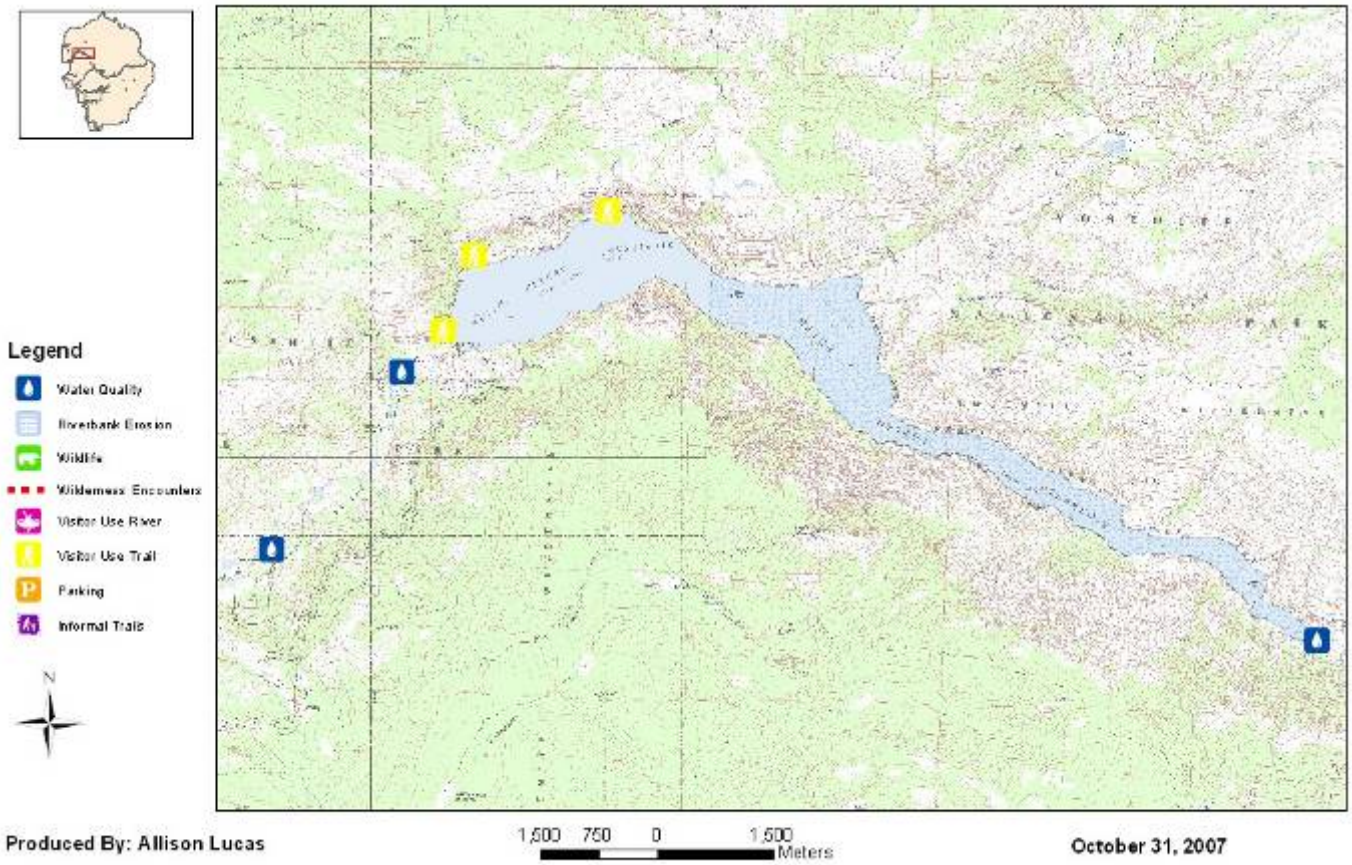


Figure 1.2.7. Monitoring locations in 2007 in Hetch Hetchy.



Similar to previous years, the User Capacity Management Monitoring Program (UCMMP) followed a timeline as represented in Figure 1.2.8 below. Generally, the late winter and early spring months were spent refining and improving monitoring protocols. In the spring preparations were made for data collection including hiring field staff, recruiting and organizing volunteers, preparing data sheets and finalizing protocols, checking and obtaining equipment, etc. The majority of data collection efforts took place during the summer and early fall. In the fall data were coded, analyzed and incorporated into a draft report. The annual report was finalized during the winter months concluding the program year.

Figure 1.2.8. Program timeline.

<table>
<tr><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>June</th><th>July</th><th>Aug</th><th>Sept</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td colspan="3">Complete Annual Report from previous year</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="4">Refine monitoring protocols, prepare for new field season</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="6">Finalize Field Monitoring Guide, conduct field monitoring and collect data</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Compile and analyze data, report writing, Fall workshop</td></tr>
<tr><td colspan="3">Progress report</td><td colspan="3">Progress report</td><td colspan="3">Progress report</td><td colspan="3">Progress report</td></tr>
<tr><td colspan="12">Implement management actions throughout as stipulated in action plan</td></tr>
</table>

1.2 2007 VISITOR USE SUMMARY

Understanding that user capacity refers to the types and levels/amounts of visitor use that may appropriately be accommodated in a particular park unit, it is important to include in the beginning of this report a characterization of visitor use for 2007 as this may assist in understanding the results.

In 2007, Yosemite National Park received 3,503,428 recreation visits. Compared to 2006, recreation visits increased by 144,043 visits. However, this figure is slightly lower than use levels in 2005 (source: NPS Public Use Statistics Office). Table 1.3.1 presents visitor use statistics by month throughout 2007. It is important to note that Tioga Road opened on May 11th and closed on December 7th. Glacier Point Road opened on May 3rd and closed December 7th. The peak visitation season (Memorial Day to Labor Day weekends) is best described as dry with occasional peak temperatures over 100 degrees Fahrenheit at 4,000 feet.

Table 1.2.1. Recreation Visits to Yosemite National Park in 2007.

Month	Recreation Visits
January	99,892
February	100,941
March	135,925
April	219,854
May	374,184
June	466,054
July	543,235
August	550,172
September	417,882
October	298,122
November	178,846
December	118,321
Total	**3,503,428**

For more information on Yosemite NP's visitor use statistics please visit http://www.nature.nps.gov/stats/.

1.3 Collaboration and Consultation

The UCMMP relies on the efforts of a diversity of park staff, park partners, cooperating institutions, interns, volunteers and other members of the public.

The National Park Service collaborated with Colorado State University, North Carolina State University and Virginia Polytechnic Institute and State University under cooperative agreements for technical expertise and academic support on monitoring protocol development, data collection and analysis, and reporting. Applying monitoring methods that have undergone academic rigor, the UCMMP was able to make substantial progress in its iterative capacity.

The monitoring program also benefited in 2007 from the efforts of two Student Conservation Corps (SCA) volunteers. The SCAs provided crucial field and technical support for data collection and monitoring. Additionally, the program relies heavily on intern and volunteer support to provide data collections and input while providing a key educational component on the parks visitor use management issues.

1.4 Report Overview

This Annual Report presents UCMMP activities and data collection results for the 2007 calendar year. It is organized into the following sections: 1) Introduction, 2) Monitoring Results, 3) Program Evaluation, 4) Summary, and 5) Appendices. The reader will note that a section outlining the various methods used to collect and analyze data is absent from this report. This information is compiled in the 2007 UCMMP Field Monitoring Guide. This guide and other documents pertaining to the UCMMP may be found on the park's website at: **www.nps.gov/yose/planning**. Data collected from the 2007 field season is available on request from the UCMMP Coordinator, Todd Newburger at (209)379-3285 or todd_newburger@nps.gov. In the coming years, data will be posted on the park website with brief descriptions on how to interpret the indicator datasets. Additional analysis from research institutions and other interested organizations of the UCMMP datasets is encouraged.

2.0 MONITORING RESULTS

This section presents the findings from indicator monitoring in 2007. Results are organized by indicator variable including the following information: indicator and standard description; indicator performance summary; monitoring activities; results; discussion; and management implications.

2.1 WATER QUALITY

Excellent water quality was identified by the Merced River Plan as part of the hydrologic processes Outstandingly Remarkable Value in three segments of the river corridor: in the wilderness reaches of the main stem and South Fork, as well as in the impoundment segment of the South Fork (above Wawona).

Water quality sampling on the Merced River initiated in June 2004 continues to be a solid and usable indicator for the purposes of the User Capacity Management Monitoring Program. We monitored the constituents listed in Table X because of their direct connection with human-caused impacts on water quality. Results through October 2007 are incorporated into this report. On the Tuolumne River, water quality sampling has been conducted from the summer of 2005 to present including the winter of 2006-2007. Additional sampling was done above and below Hetch Hetchy Reservoir in 2007. Nutrient concentrations at all locations were generally quite low, often below the reporting limit for the analytical method. Table X summarizes the analytical methods used, reporting limits, and any applicable standards. For comparison purposes, the highest values of Nitrate + Nitrite, sampled at Foresta Bridge in El Portal, contained between 0.58 and 0.71 mg/l in 2005.

Table 2.1.1. Water quality constituents sampled in 2007.

Constituent	Analytical Method	Analytical Reporting Limit	California Standard	Source Document
Total Dissolved Nitrogen	USGS/NWQL[1] 2754	0.06 mg/l	None	
Nitrate + Nitrite	USGS/NWQL[1] 1979	0.016 mg/l	10 mg/l (Drinking water)	State of California Regulations, Title 22 – Drinking water standards, Maximum Contaminant Levels - Inorganic Chemicals
Total Phosphorous	USGS/NWQL[1] 2333	0.008 mg/l	None	
Total Dissolved Phosphorous	USGS/NWQL[1] 2331	0.003 mg/l	None	
E. coli	SM 9221F[2]	2 MPN/100ml (MPN = Mean Probable Number of bacterial colonies)	Geometric Mean of 5 samples taken over a 30-day period shall not exceed 126 MPN/100 ml. No single sample shall exceed 235 MPN/100 ml.	State of California, 1998. The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board, Central Valley Region. Fourth Edition—1998. California Regional Water Quality Control Board.
Total Petroleum Hydrocarbons	EPA 306M[3]	13 µg/l	Waters shall not contain oils, greases, waxes, or other materials in concentrations that cause nuisance, result in a visible film or coating on the surface of the water or on objects in the water, or otherwise adversely affect beneficial uses.	State of California, 1998. The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board, Central Valley Region. Fourth Edition—1998. California Regional Water Quality Control Board.

[1] U.S. Geological Survey National Water Quality Laboratory
[2] Standard Methods for the Examination of Water and Wastewater
[3] Environmental Protection Agency Standard Method

Measurement

The following water quality parameters were measured: Nutrients (total dissolved nitrogen, nitrate + nitrite, total phosphorous, and total dissolved phosphorous), *E. coli*, and total petroleum hydrocarbons. Associated field data collected with each water quality sample included water temperature, specific conductivity, dissolved oxygen, and pH.

Standards

Anti-degradation for each segment for fecal coliform (*E. coli*), nutrients (total dissolved nitrogen, nitrate + nitrite, total dissolved phosphorous, and total phosphorus), and total petroleum hydrocarbons per sampling period. Absolute minimum, all segments: State *E. coli* standard for recreational contact at all times.

Sampling

Field staff sampled at ten locations monthly on the Merced River and South Fork Merced (Figure x), 5 locations on the Tuolumne River near Tuolumne Meadows (Figure x), and 3 locations on the Tuolumne River near Hetch Hetchy Reservoir. In addition, several storm events were sampled including spring run-off. The latter was conducted weekly for a period of 6 weeks in 2007. Nutrients (total dissolved nitrogen, nitrate, total phosphorous and total dissolved phosphorous) were sampled at all sites. *E. coli* was sampled only at front-country sites due to the maximum six-hour hold time for these samples. Total petroleum hydrocarbons (TPH) were sampled at three locations downstream of developed areas. *E. coli* and TPH were not sampled at the Hetch Hetchy sites. In addition to collecting samples, field staff measured the basic water quality parameters water temperature, specific conductivity, pH, and dissolved oxygen as well as river stage where possible.

Results

Figures 2.1.1a – 2.1.1r depict a time series plot summarizing nutrient data for all sites for the entire collection period (June 2004 – October 2007).

All concentrations continue to be very low indicating excellent water quality. Relatively elevated levels of total dissolved nitrogen (TDN) and nitrate plus nitrite (NO3+NO2) are evident during the winters of 2005-2006 and 2006-2007, perhaps the result of greater storminess during these periods. The highest values of TDN and NO3+NO2 observed during the reporting period (November 2006 – October 2007) were 0.437 and 0.482 mg/l, respectively, found at Foresta Bridge on October 2, 2007.

Gaps indicate periods of no data collection. Concentrations below the reporting limit have been assigned a value of zero. TDN = Total Dissolved Nitrogen, NO3 + NO2 = Nitrate plus Nitrite, TP = Total Phosphorous, TDP = Total Dissolved Phosphorous.

Figure 2.1.1.a. Summary of nutrient data below Merced Lake from June 2004 – October 2007.

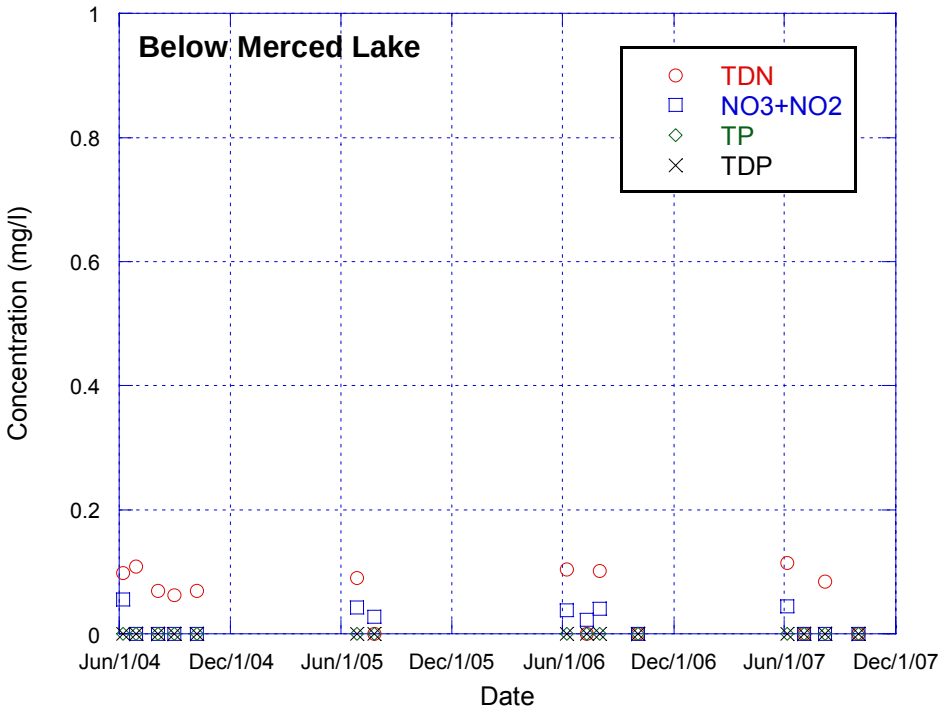


Figure 2.1.1.b. Summary of Nevada Fall nutrient data from June 2004 – October 2007.

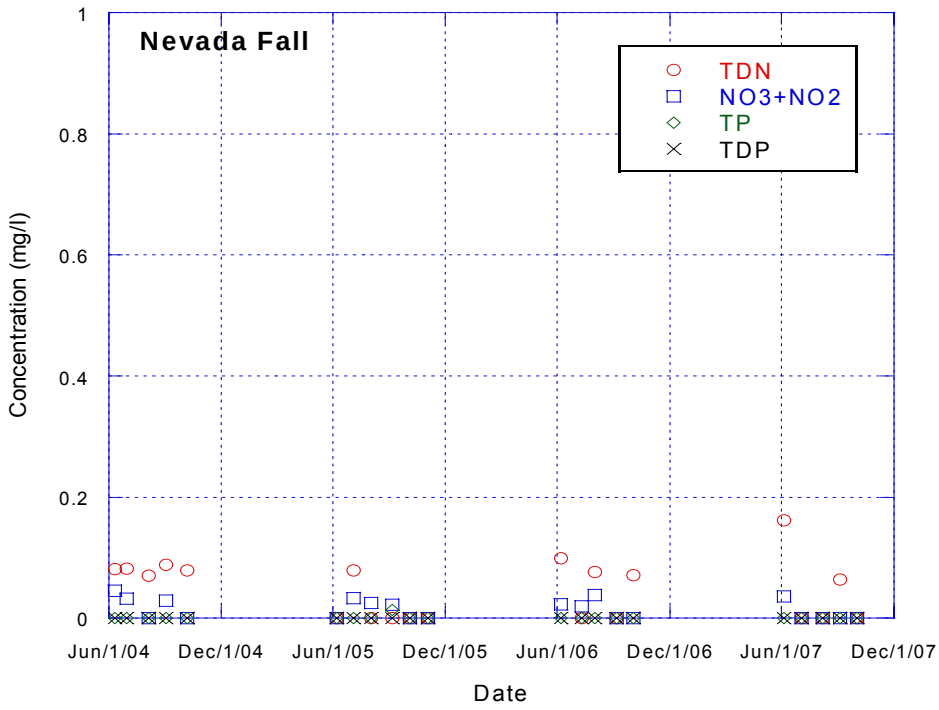


Figure 2.1.1.c. Summary of Happy Isles nutrient data from June 2004 – October 2007.

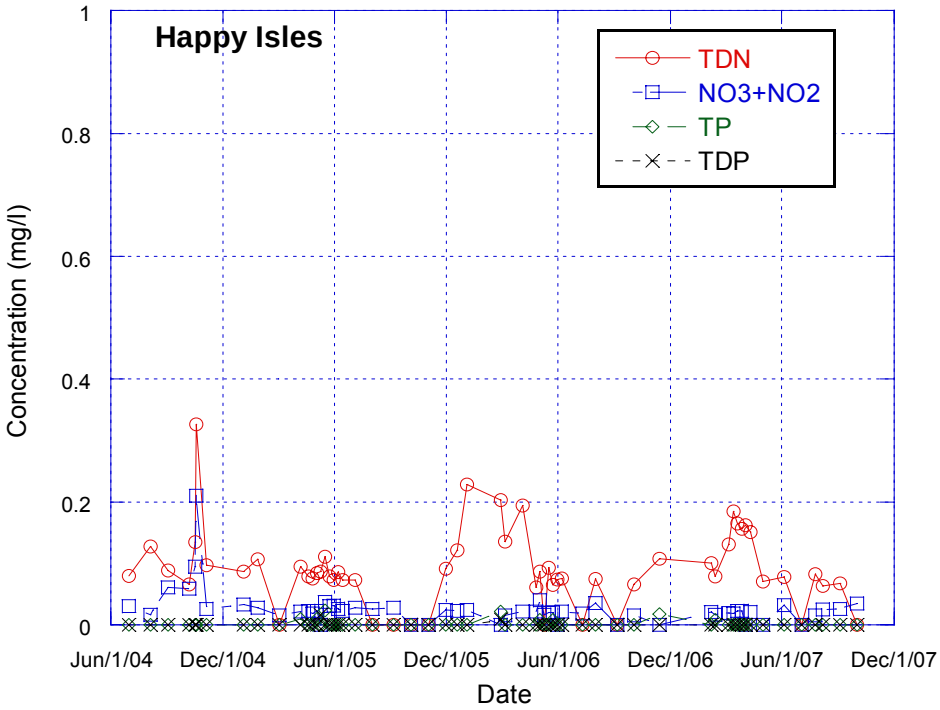


Figure 2.1.1.d. Summary of Sentinel Bridge nutrient data from June 2004 – October 2007.

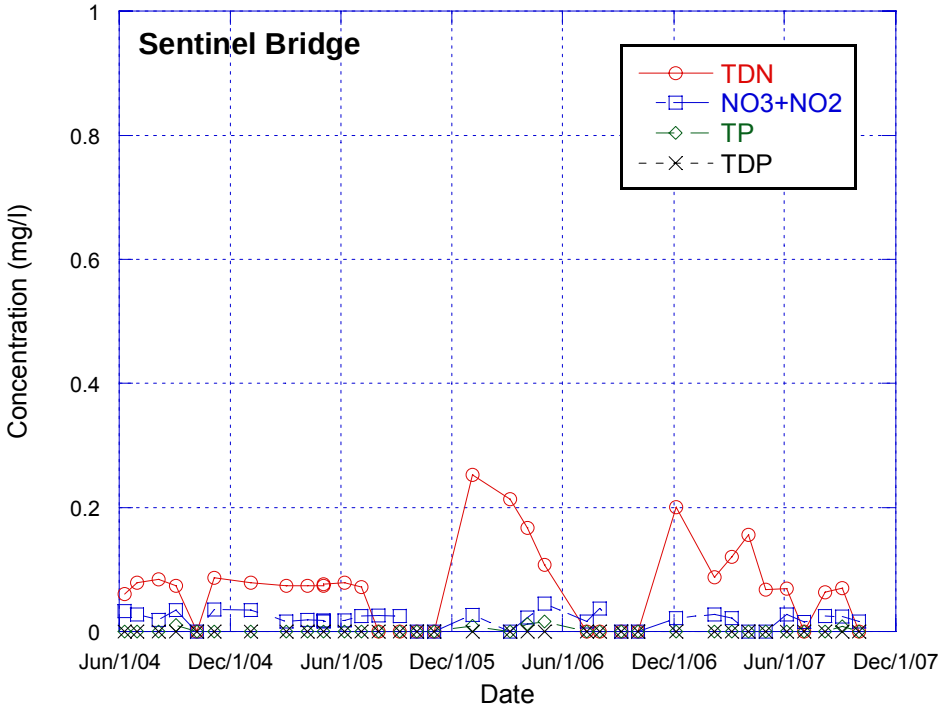


Figure 2.1.1.e. Summary of Pohono Bridge nutrient data from June 2004 – October 2007.

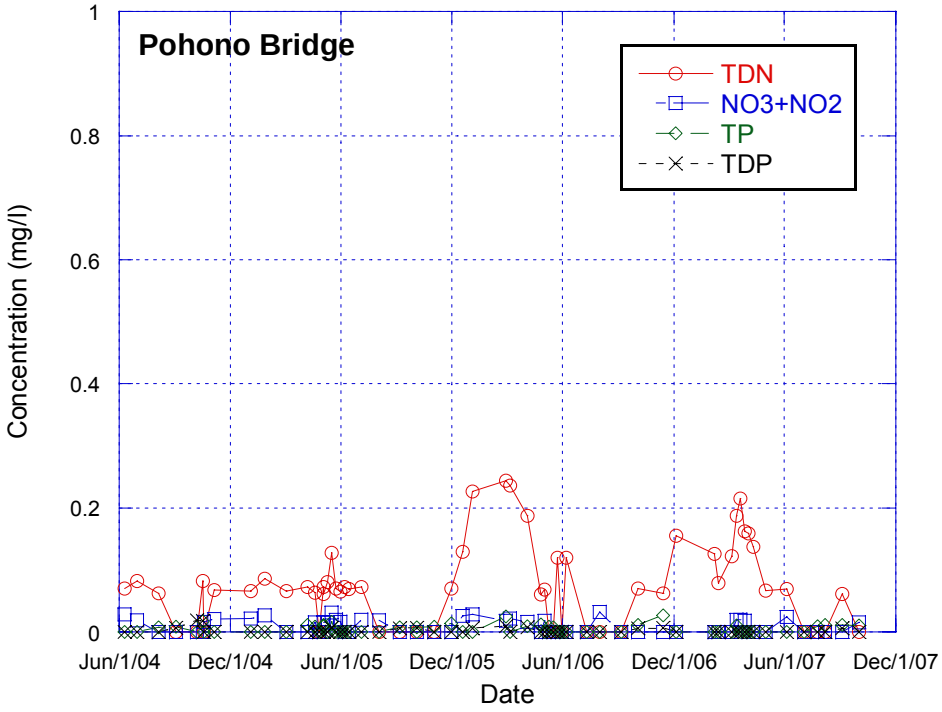


Figure 2.1.1.f. Summary of Highway 140 Bridge nutrient data from June 2004 – October 2007.

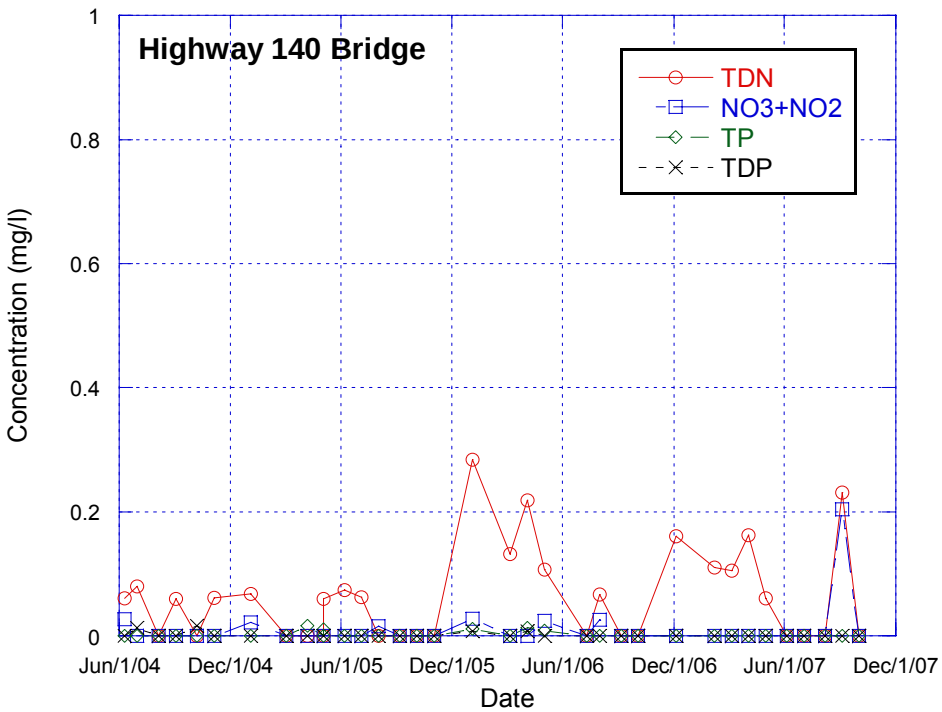


Figure 2.1.1.g. Summary of Foresta Bridge nutrient data from June 2004 – October 2007.

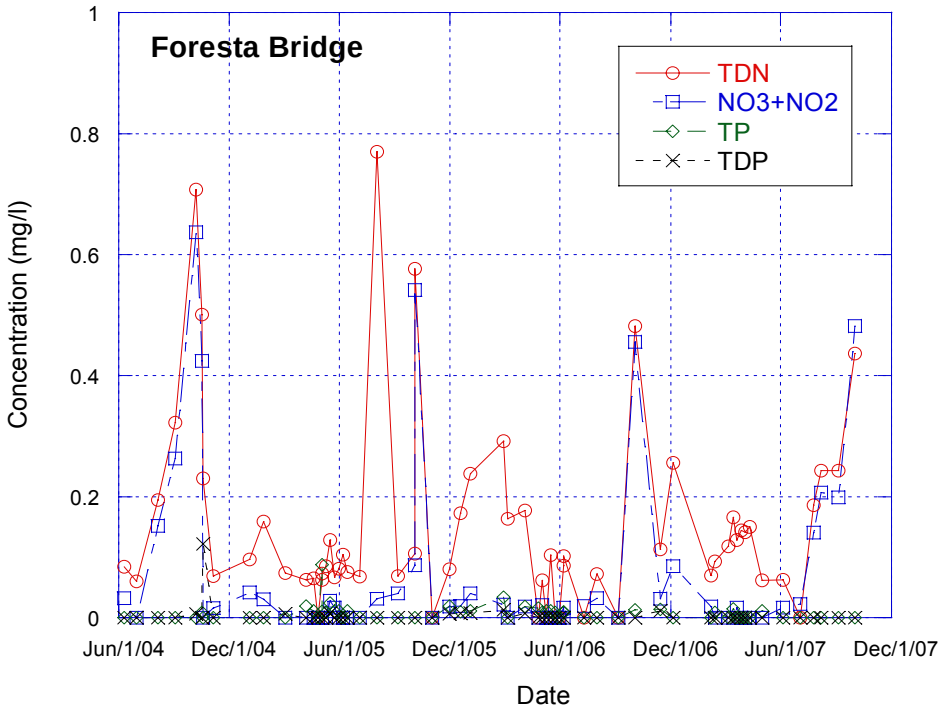


Figure 2.1.1.h. Summary of Swinging Bridge nutrient data from June 2004 – October 2007.

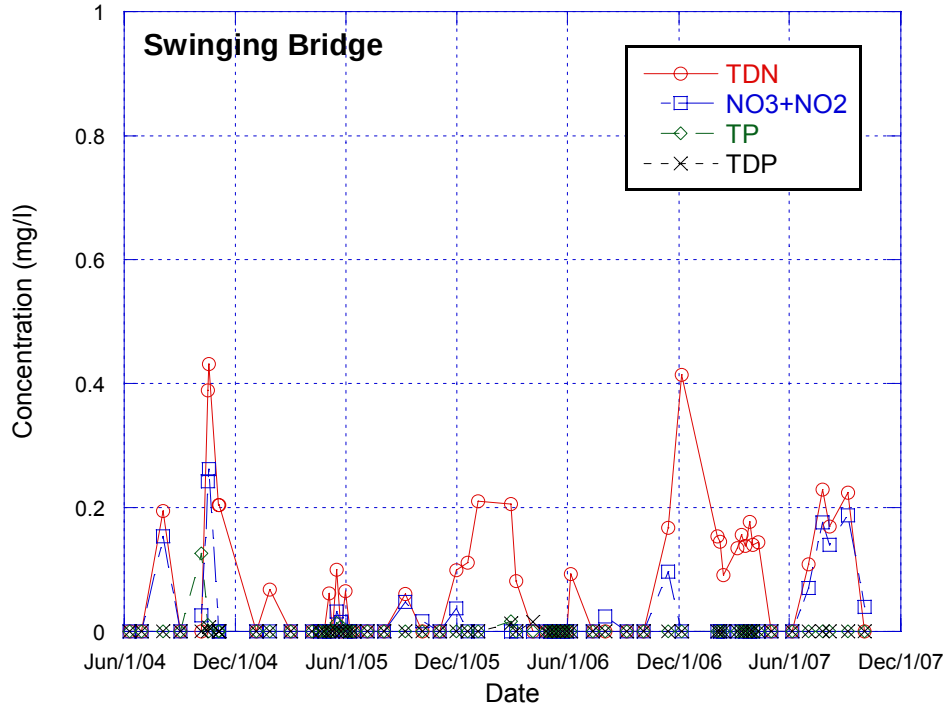


Figure 2.1.1.i. Summary of South Fork Bridge nutrient data from June 2004 – October 2007.

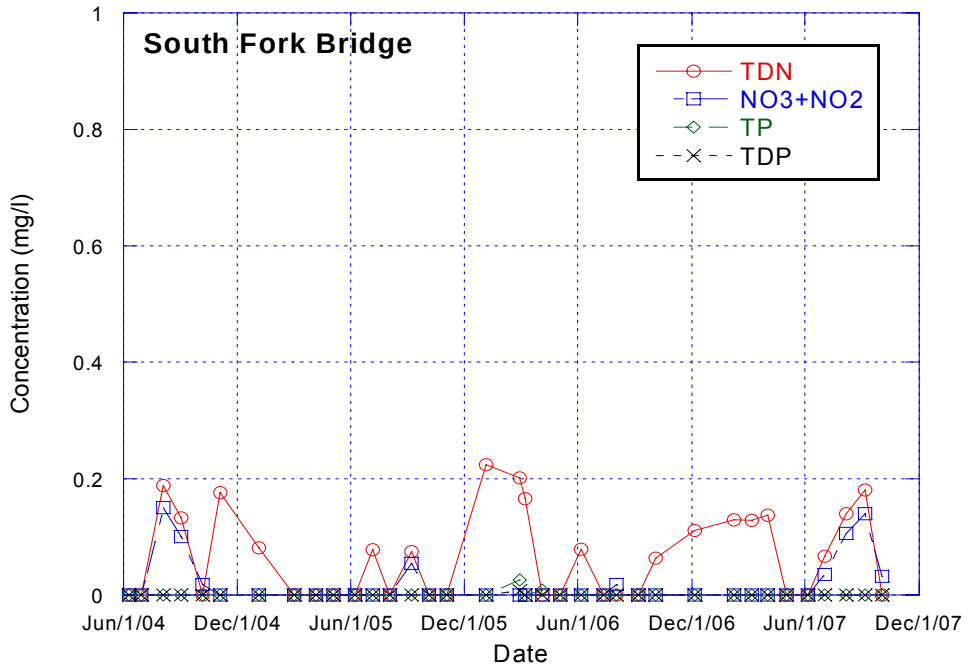


Figure 2.1.1.j. Summary of nutrient data Below Wawona Campground from June 2004 – October 2007.

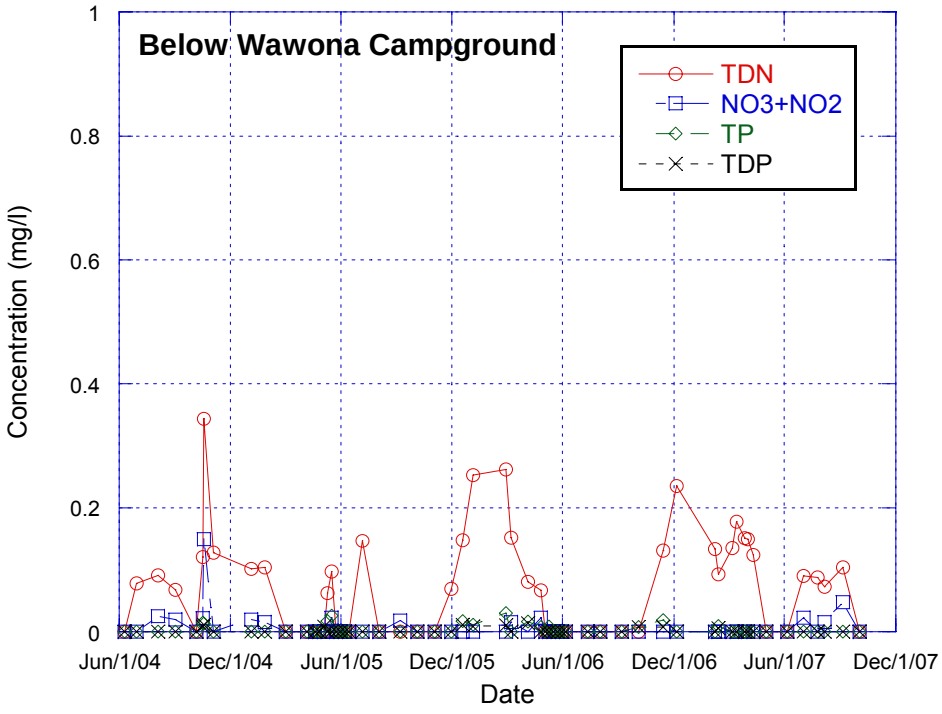


Figure 2.1.1.k. Summary of Dana Fork, below Gaylor Creek, nutrient data from June 2004 – October 2007.

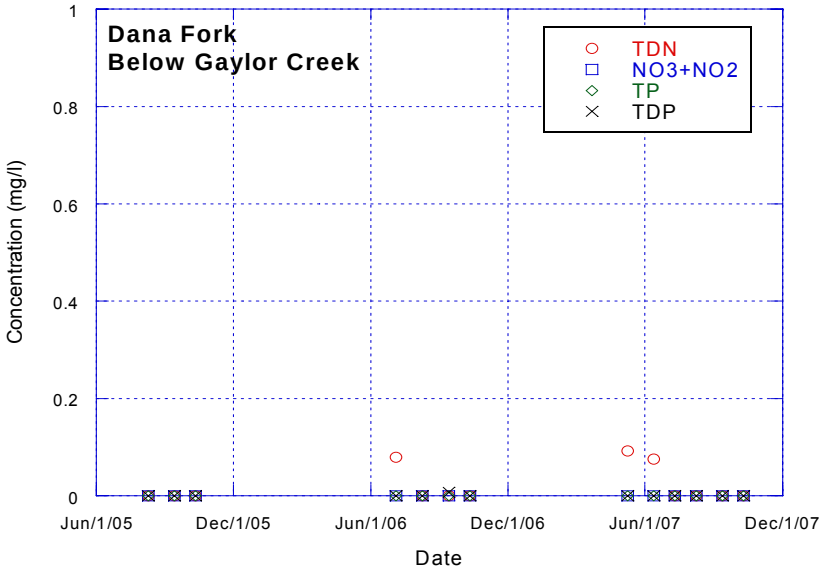


Figure 2.1.1.l. Summary of Lyell Fork, above Twin Bridges, nutrient data from June 2004 – October 2007.

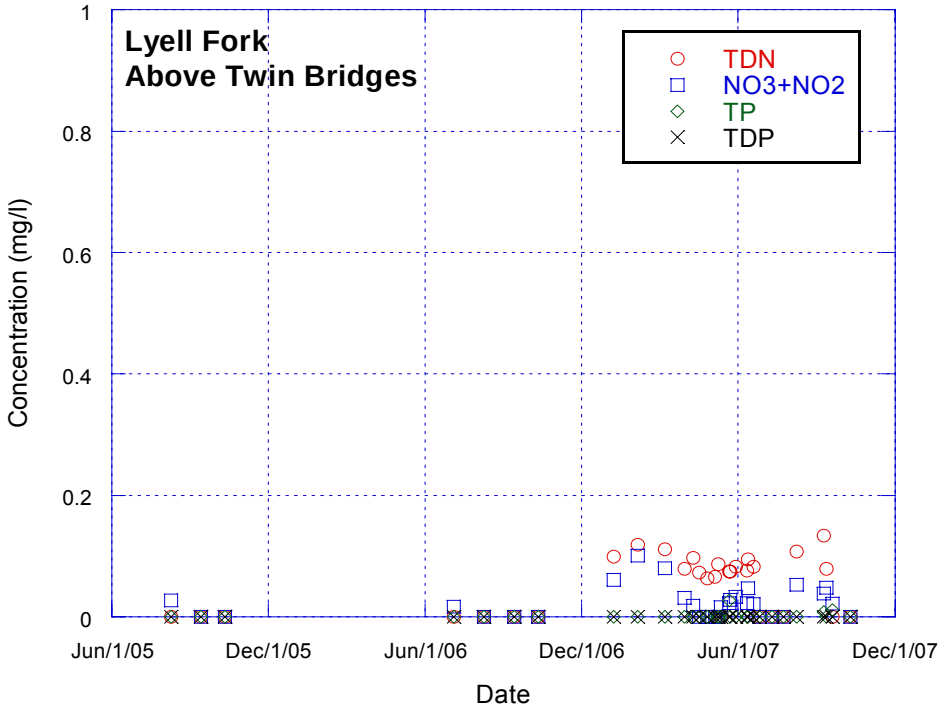


Figure 2.1.1.m. Summary of Tuolumne River, at Tioga Road Bridge, nutrient data from June 2004 – October 2007.

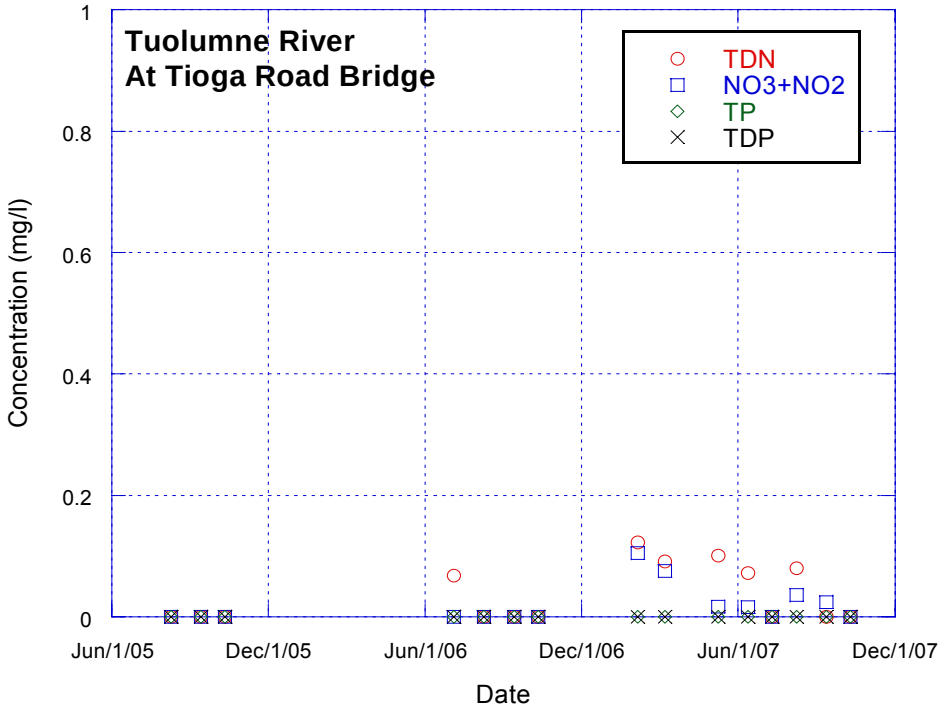


Figure 2.1.1.n. Summary of Tuolumne River, above Budd Creek, nutrient data from June 2004 – October 2007.

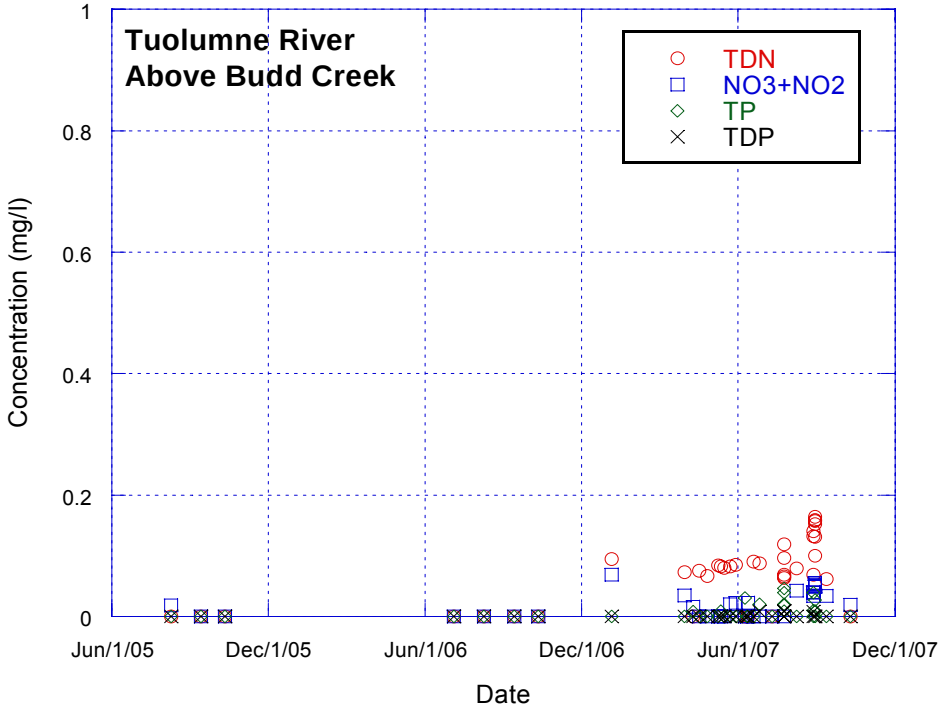


Figure 2.1.1.o. Summary of Tuolumne River, below Conness Creek, nutrient data from June 2004 – October 2007.

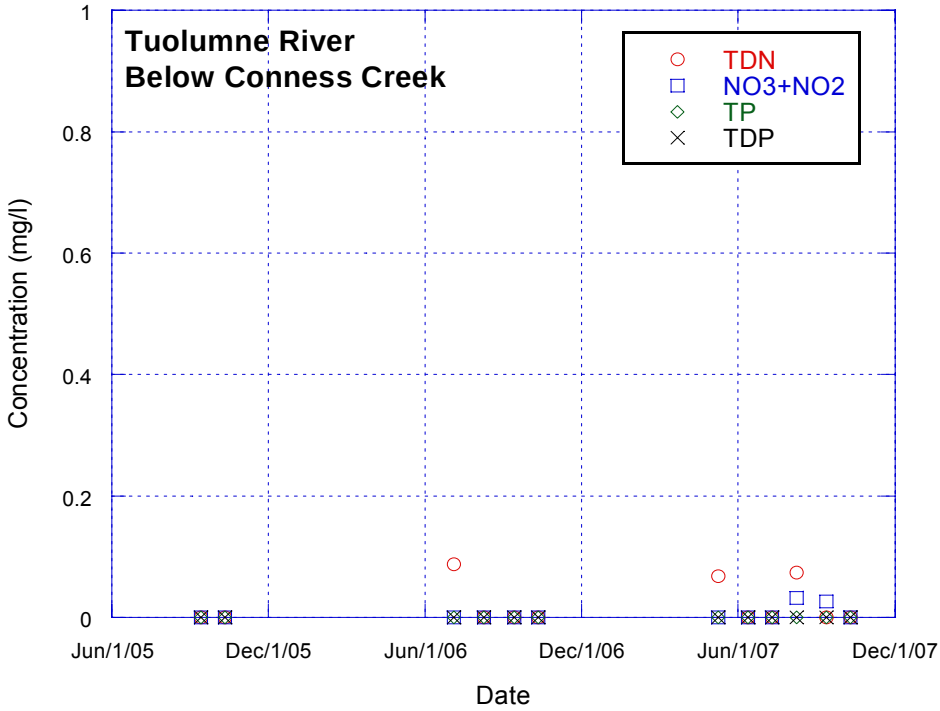


Figure 2.1.1.p. Summary of Tuolumne River, above Hetch Hetchy Reservoir, nutrient data from June 2004 – October 2007.

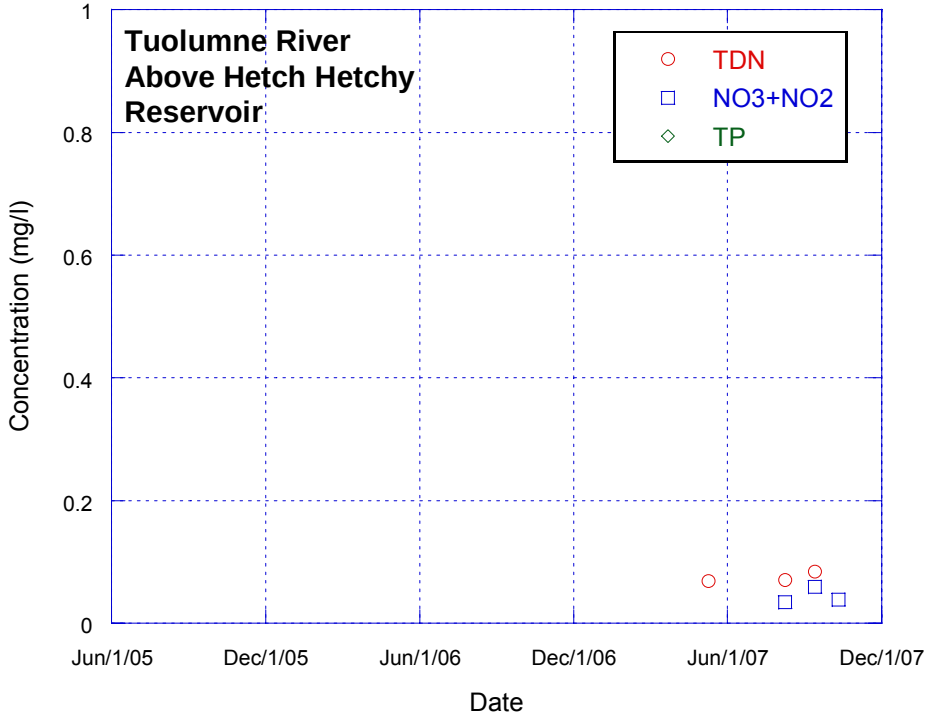


Figure 2.1.1.q. Summary of Tuolumne River, below Hetch Hetchy Reservoir, nutrient data from June 2004 – October 2007.

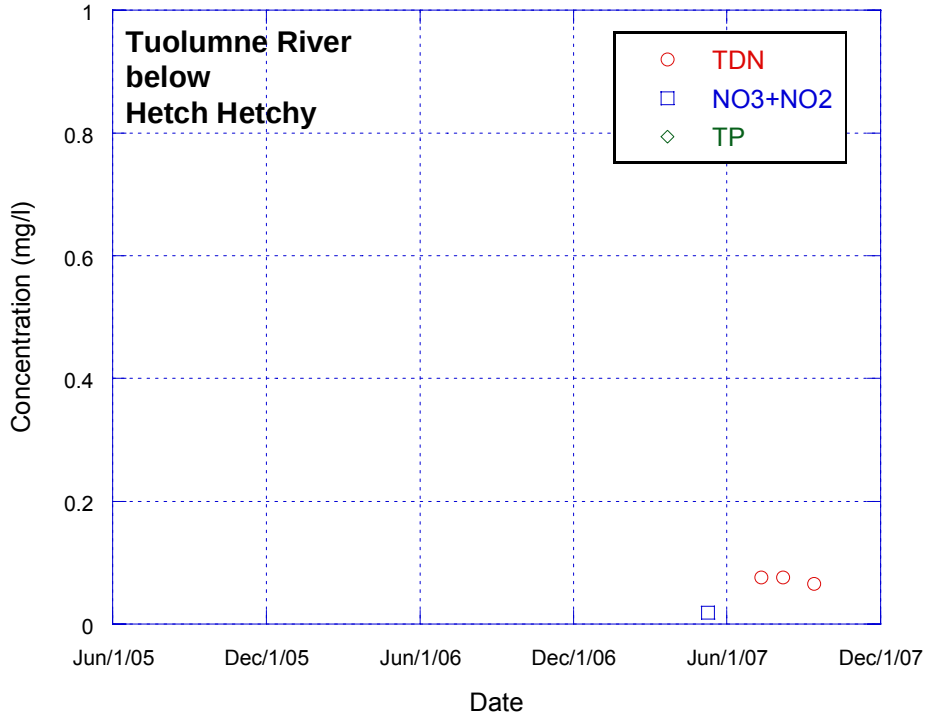
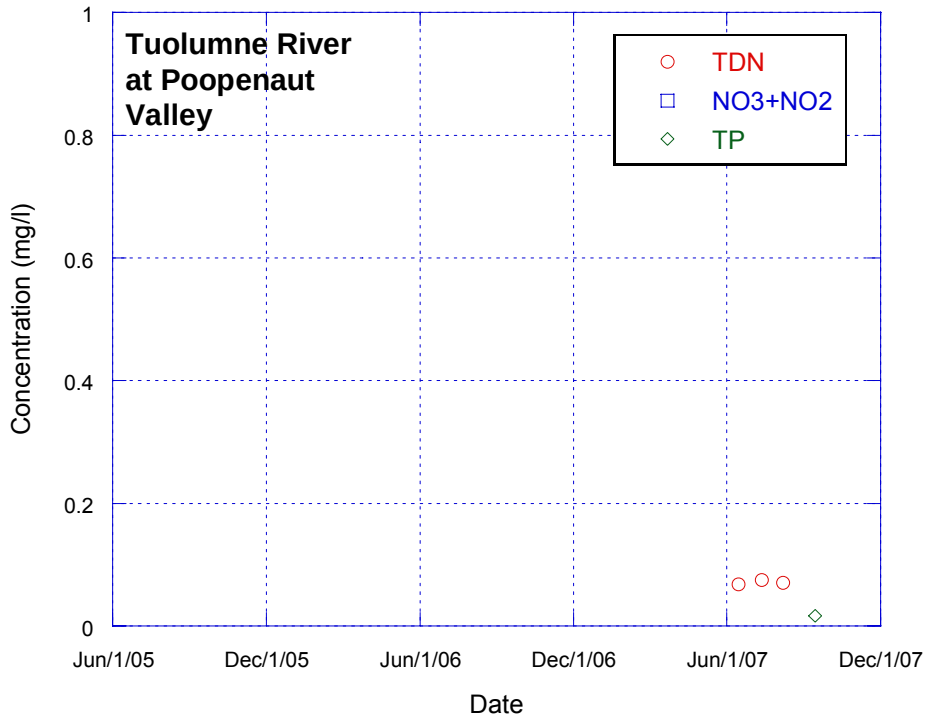


Figure 2.1.1.r. Summary of Tuolumne River, at Poopenaut Valley, nutrient data from June 2004 – October 2007.



Bacterial content (*E. coli*) has been measured since April 2005. Table x summarizes *E. coli* concentrations measured from November 2006 to October 2007 (previous data is summarized in the 2005 and 2006 UCMMP Annual Reports). *E. coli* concentrations continue to be very low with 88% of samples in the <1 to 10 MPN/100ml range. No single sample exceeded the state standard for recreational contact of 235 MPN/100ml.

Table 2.1.2. Summary of E. coli data, November 2006 to October 2007.

Site Name	Date	*E. coli* (MPN/100ml)*
Merced River above Happy Isles Bridge	14-Nov-06	45.7
	06-Feb-07	1
	12-Feb-07	7.5
	06-Mar-07	<1
	14-Mar-07	1
	21-Mar-07	1
	28-Mar-07	<1
	03-Apr-07	<1
	11-Apr-07	1
	01-May-07	3
	05-Jun-07	1
	03-Jul-07	6.3
	25-Jul-07	29.6
	07-Aug-07	2
	04-Sep-07	8.6

Site Name	Date	*E. coli* (MPN/100ml)*
	02-Oct-07	<1
Merced River above Sentinel Bridge	06-Feb-07	1
	06-Mar-07	3.1
	03-Apr-07	<1
	01-May-07	<1
	05-Jun-07	5.2
	03-Jul-07	4.1
	07-Aug-07	8.6
	04-Sep-07	26.9
	02-Oct-07	14.6
Merced River above Pohono Bridge	14-Nov-06	45
	06-Feb-07	<1
	12-Feb-07	2
	06-Mar-07	1
	14-Mar-07	3
	21-Mar-07	1
	28-Mar-07	2
	03-Apr-07	1
	11-Apr-07	3
	01-May-07	4.1
	05-Jun-07	4.1
	03-Jul-07	2
	25-Jul-07	17.5
	07-Aug-07	<1
	04-Sep-07	10.9
	02-Oct-07	6.3
Merced River above SR140 Bridge	06-Feb-07	2
	06-Mar-07	2
	03-Apr-07	3.1
	01-May-07	2
	05-Jun-07	2
	03-Jul-07	<1
	07-Aug-07	2
	04-Sep-07	2
	02-Oct-07	2
Merced River above Foresta Bridge	14-Nov-06	58.6
	06-Feb-07	<1
	12-Feb-07	8.6
	06-Mar-07	1
	14-Mar-07	3
	21-Mar-07	<1
	28-Mar-07	<1
	03-Apr-07	6.3
	11-Apr-07	1
	01-May-07	3.1

Site Name	Date	*E. coli* (MPN/100ml)*
	05-Jun-07	8.6
	03-Jul-07	1
	25-Jul-07	4.1
	07-Aug-07	4.1
	02-Oct-07	52
S. Fork Merced River above Swinging Bridge	14-Nov-06	43.7
	07-Feb-07	<1
	12-Feb-07	2
	07-Mar-07	2
	14-Mar-07	3.1
	21-Mar-07	<1
	28-Mar-07	<1
	02-Apr-07	1
	11-Apr-07	1
	02-May-07	<1
	06-Jun-07	<1
	02-Jul-07	9.7
	25-Jul-07	12
	06-Aug-07	1
	05-Sep-07	2
	03-Oct-07	1
S. Fork Merced River above South Fork Bridge	04-Oct-06	9.7
	07-Mar-07	<1
	02-Apr-07	1
	02-May-07	<1
	06-Jun-07	2
	02-Jul-07	7.5
	06-Aug-07	21.3
	05-Sep-07	27.2
	03-Oct-07	14.8
S. Fork Merced River above Swinging Bridge	14-Nov-06	43.7
	07-Feb-07	<1
	12-Feb-07	2
	07-Mar-07	2
	14-Mar-07	3.1
	21-Mar-07	<1
	28-Mar-07	<1
	02-Apr-07	1
	11-Apr-07	1
	02-May-07	<1
	06-Jun-07	<1
	02-Jul-07	9.7
	25-Jul-07	12
	06-Aug-07	1
	05-Sep-07	2

Site Name	Date	*E. coli* (MPN/100ml)*
	03-Oct-07	1
S. Fork Merced River below Wawona Campground	14-Nov-06	104.6
	07-Feb-07	1
	12-Feb-07	12.2
	07-Mar-07	<1
	14-Mar-07	<1
	28-Mar-07	<1
	02-Apr-07	1
	11-Apr-07	<1
	02-May-07	1
	06-Jun-07	1
	02-Jul-07	4.1
	25-Jul-07	7.4
	06-Aug-07	9.6
	05-Sep-07	6.3
	03-Oct-07	3.1
Dana Fork Below Gaylor Creek	09-May-07	<1
	13-Jun-07	<1
	11-Jul-07	2
	08-Aug-07	4.1
	12-Sep-07	3.1
	10-Oct-07	<1
Lyell Fork above Twin Bridges	09-May-07	<1
	13-Jun-07	<1
	11-Jul-07	1
	08-Aug-07	<1
	12-Sep-07	3.1
	10-Oct-07	<1
Tuolumne River above Tioga Road Bridge	09-May-07	<1
	13-Jun-07	<1
	11-Jul-07	2
	08-Aug-07	19.9
	12-Sep-07	4.1
	10-Oct-07	<1
Tuolumne River above Budd Creek	09-May-07	<1
	13-Jun-07	<1
	11-Jul-07	<1
	08-Aug-07	<1
	12-Sep-07	1
	10-Oct-07	2
Tuolumne River below Conness Creek	08-Aug-07	<1
	12-Sep-07	1
	10-Oct-07	<1

*Most Probably Number of bacteriological colonies per 100 ml.

Table 2.1.3 summarizes total petroleum hydrocarbon (TPH) data from November 2006 to October 2007. Earlier data is contained in the 2005 and 2006 UCMMP Annual Reports. Sample frequency has been reduced to quarterly sampling at the three sites listed in Table X. Storm events continue to be sampled and sampling is conducted monthly during spring runoff. Only one sample contained detectable petroleum hydrocarbons during the sampling period (Wawona Campground, November 6, 2006).

Table 2.1.3. Summary of total petroleum hydrocarbon data, November 2006 to October 2007 (ND = non-detect).

Site Name	Date	Total Petroleum Hydrocarbon Concentration (µg/l)
Merced River above Pohono Bridge	14-Nov-06	ND
	06-Feb-07	ND
	06-Mar-07	ND
	03-Apr-07	ND
	01-May-07	ND
	05-Jun-07	ND
	03-Jul-07	ND
	25-Jul-07	ND
	02-Oct-07	ND
Merced River above Foresta Bridge	14-Nov-06	ND
	06-Feb-07	ND
	12-Feb-07	ND
	06-Mar-07	ND
	03-Apr-07	ND
	01-May-07	ND
	05-Jun-07	ND
	03-Jul-07	ND
	25-Jul-07	ND
	02-Oct-07	ND
S. Fork Merced River below Wawona Campground	14-Nov-06	13.5
	07-Feb-07	ND
	12-Feb-07	ND
	07-Mar-07	ND
	02-Apr-07	ND
	02-May-07	ND
	06-Jun-07	ND
Tuolumne River above Budd Creek	02-Jul-07	ND
	03-Oct-07	ND
	09-May-07	ND
	13-Jun-07	ND
	08-Aug-07	ND
	12-Sep-07	ND
	10-Oct-07	ND

Discussion

As of the completion of this reporting period (November 2006 – October 2007), all sampling necessary to establish baseline conditions on the Merced River and the South Fork of the Merced has been completed. Data presented in this report will now be used to construct water quality standards, specific to Yosemite National Park. Compared to existing state standards, these standards will be far more stringent given the overall high water quality found in park waters. In 2008, a comprehensive data review and statistical analysis will be conducted to determine the quality of baseline data with respect to the establishment of a standard as well as determination of a future sampling strategy to assure compliance with a given standard.

Nutrient concentrations at all sample sites were low, even during low water, storm, and spring runoff conditions. Sampling frequency has been decreased to once every three months plus storm events and monthly sampling in late summer when nutrient concentrations are at their highest.

E. coli concentrations were quite low during the reporting period. Sampling of this constituent will continue at the same frequency described for nutrient sampling.

Sampling for petroleum hydrocarbons revealed only one reportable amount in all sampling for the reporting period. Given that small amounts were also detected in the 2005 field season, sampling will continue at the frequency described above with particular emphasis on capturing storm events.

All data to date indicate very good water quality along the main stem and South Fork of the Merced River as well as along the Tuolumne River in the vicinity of Tuolumne Meadows and Hetch Hetchy. Funds secured through a cooperative USGS/NPS grant have allowed further characterization of water quality by measuring turbidity and automated sampling of storm events at select sites as well as sampling of water for the presence of synthetic organic contaminants commonly found in waste water discharge. These data along with the compiled data from the past three years of sampling will be analyzed by USGS and NPS personnel and reported to the NPS late in 2008.

2.2 RIVERBANK CONDITION

Introduction

The 2007 field season marked was a challenging though successful year for monitoring this indicator. Many monitoring components developed in 2005 and 2006 were proving unsatisfactory. The rapid assessment protocol lacked sensitivity and it was difficult to compare the same site from year to year. The permanent site protocol, while quite rigorous, was extremely time intensive limiting its long-term feasibility.

Given the importance of this indicator as one of the more direct measures of river health, the resource managers held a two-day workshop and invited experts from the NPS, USGS, and the University of California at Berkeley to critically evaluate the existing protocol and suggest other approaches. The primary results of this workshop were:

Permanently marked river reaches are critical to evaluate trends in riverbank condition. The system is highly variable and permanent sites help reduce the overall variance.
Riparian vegetation condition is a key component of the strength of a riverbank and its ability to resist erosional forces. A monitoring protocol needs to assess the integrity of riparian vegetation.
Channel morphology, as defined by cross-sectional area or other means, is essential complimentary data to document the extent of bank erosion or accretion.
Sample reaches should be stratified by level of visitor use or management zone as well as geomorphic regime to reduce variance.
To provide a qualitative means of assessing impacts to riverbanks, photo documentation of riverbanks should also be implemented- especially in areas outside of sample reaches.

In addition, the group defined the objective of this indicator as:

To assess the status of and to detect change in riverbank condition associated with visitor use.

Proposed standards for the indicator as it is now defined are:

1. Channel Morphology: X percent increase in cross-sectional area due to bank scour will lead to management action.
2. Vegetation Condition (Trend): No greater than Y percent decrease in green understory cover as compared to a 200x baseline.
3. Vegetation Condition (Status): No greater than A percent of B (strata-based) sites will have less than C percent green understory cover.

The remainder of this section is dedicated to reporting the results of a pilot study initiated in September 2007, the purpose of which was to test the recommendations of the workshop group. First, we present a brief overview of methods (complete methodology can be found in the 2007 UCMMP Field Guide) followed results from the two main assessments: 1) Channel Morphology, and 2) Vegetation Condition. Many ideas and approaches remain to be fully developed during 2008.

Channel Morphology Assessment

Methods

The channel morphology assessment of the pilot study was carried out using three deliberately chosen 200-meter reaches. These reaches were selected because they contain established river cross-sections, thus, making it possible to focus on testing the vegetation assessment protocol as well as the use of ground-based LiDAR (Light Detecting and Ranging) topographic survey methods. These sites were originally selected to represent a range of current and antecedent visitor use. The Pines Campground reach, located just downstream of Clark's Bridge is bounded on both banks by campgrounds and represents heavy overnight use. The Sentinel Beach site is a major raft takeout location and represents heavy day use. The El Capitan Dump site is the former site of a historic dump and later used as a picnic area. The area has been partially restored to natural conditions and thus represents low current visitor use and high antecedent visitor use.

Figure 2.2.1. Reach Locations for both the Channel Morphology and Vegetation Assessment (red boxes) along the Merced River in east Yosemite Valley.

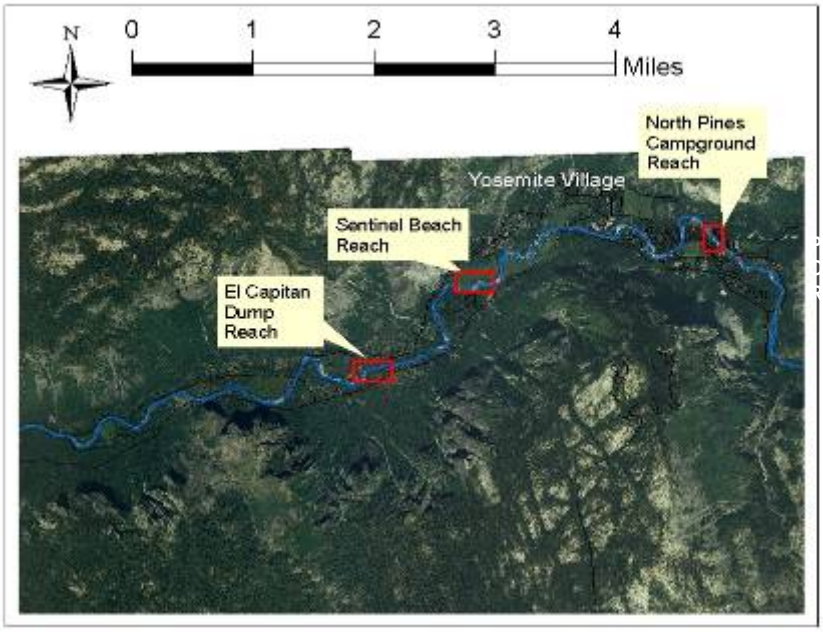
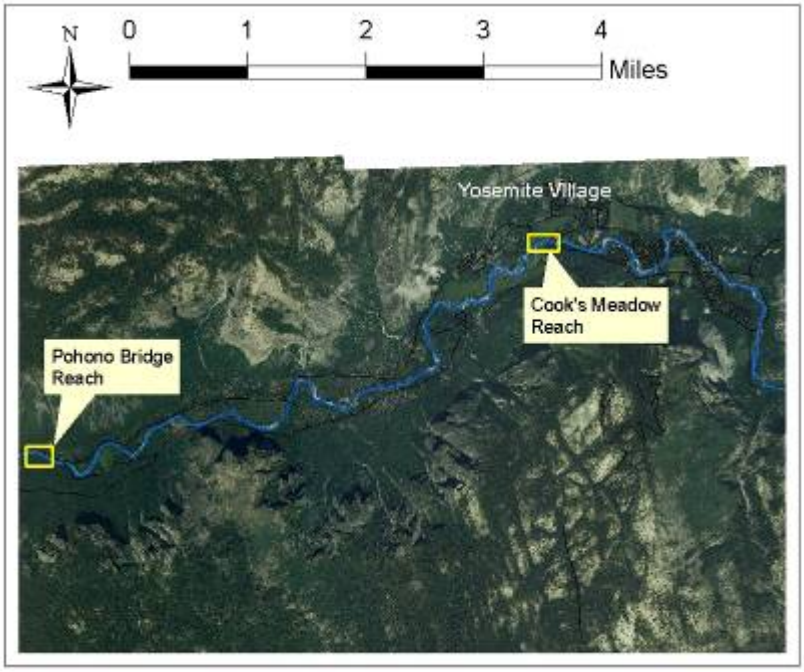


Figure 2.2.2. Additional reach locations for the Vegetation Assessment (yellow boxes) along the Merced River.



Four to five channel cross-sections were established at each reach location in 2006 using standard methods (see UCMMP 2006 Annual Report). While cross-sections are fundamental means of surveying

river morphology, they depict only a single slice across the river. One can imagine that changes invariably take place between cross-sections that might not be detected until such changes have grown to incorporate the cross-section location. For this reason, each reach was scanned using ground-based LiDAR (Light Detection and Ranging), a means of quickly surveying riverbanks in three dimensions. This data can then be compared to future scans of the same area allowing a precise determination of where bank erosion is occurring and what volume of material has been lost or gained.

The LiDAR unit used in this study was an I-Site 4400CR, a time-of-flight pulsed rangefinder that uses a 905 nm wavelength laser to measure approximately 4400 points per second. As with other units, the 4400LR is limited to "line of sight," so it cannot scan behind objects or through water. All cross-sections and LiDAR scans were georeferenced so that this data can be accurately compared to future data from these locations.

LiDAR scans include the soil surface, vegetation, and infrastructure. As a result, one can also map the locations of trees, snags, and large woody debris along the channel. Commercial LiDAR units use infrared light and therefore cannot penetrate water. Channel cross-sections help to overcome this limitation and compliment the detailed bank morphology from a LiDAR survey by providing essential information about the nature of the channel bed below the water surface.

Results

The three river reaches and associated cross-section data are shown in Figures 2.2.3-2.2.8e below.

Figure 2.2.3. Pines Campground Reach and the location of river cross-sections 10-13.

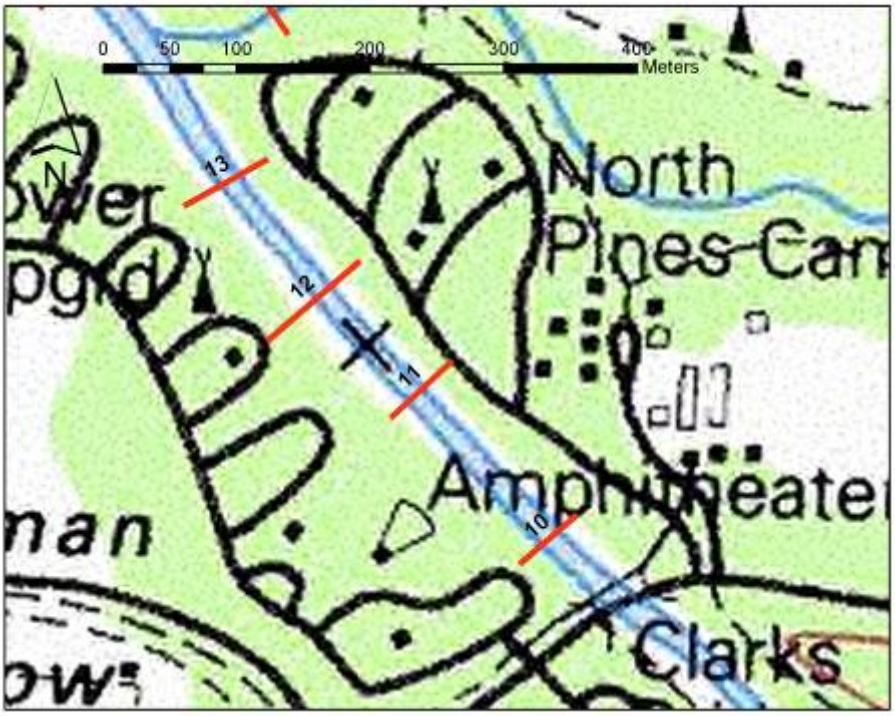


Figure 2.2.4a. North Pines Campground river cross section 10.

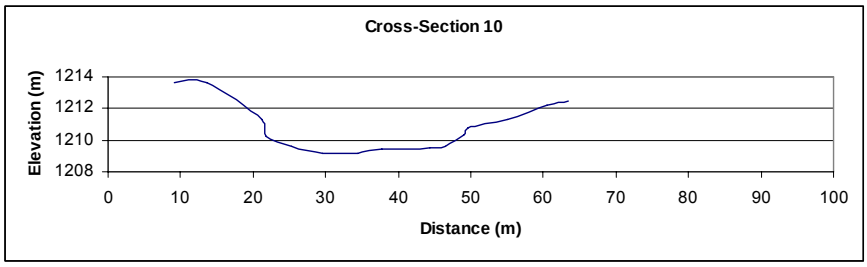


Figure 2.2.4b. North Pines Campground river cross section 11.

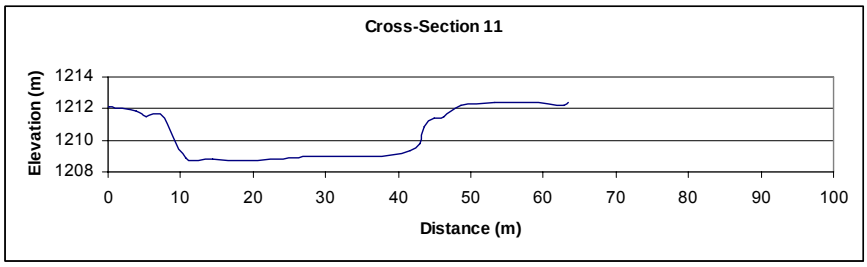


Figure 2.2.4c. North Pines Campground river cross section 12.

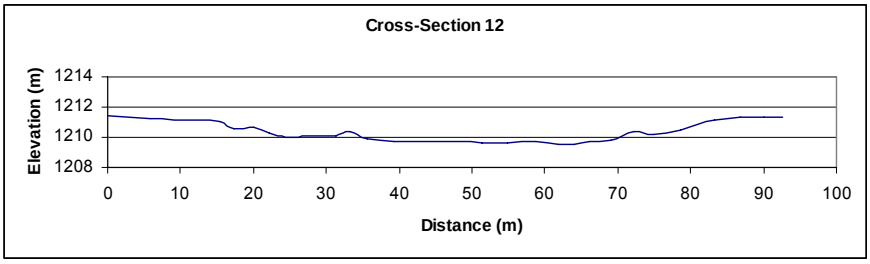


Figure 2.2.4d. North Pines Campground river cross section 13.

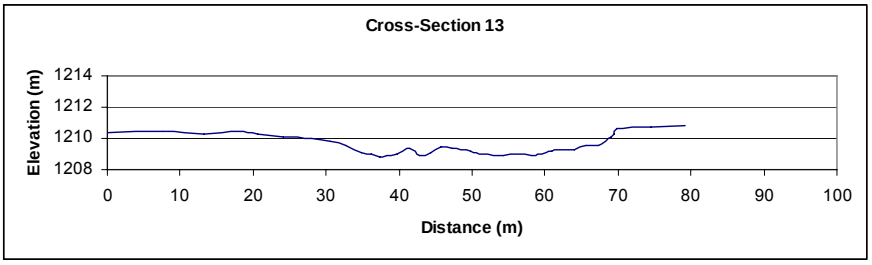


Figure 2.2.5. Location of Sentinel Beach Reach and river cross-sections 70-73.

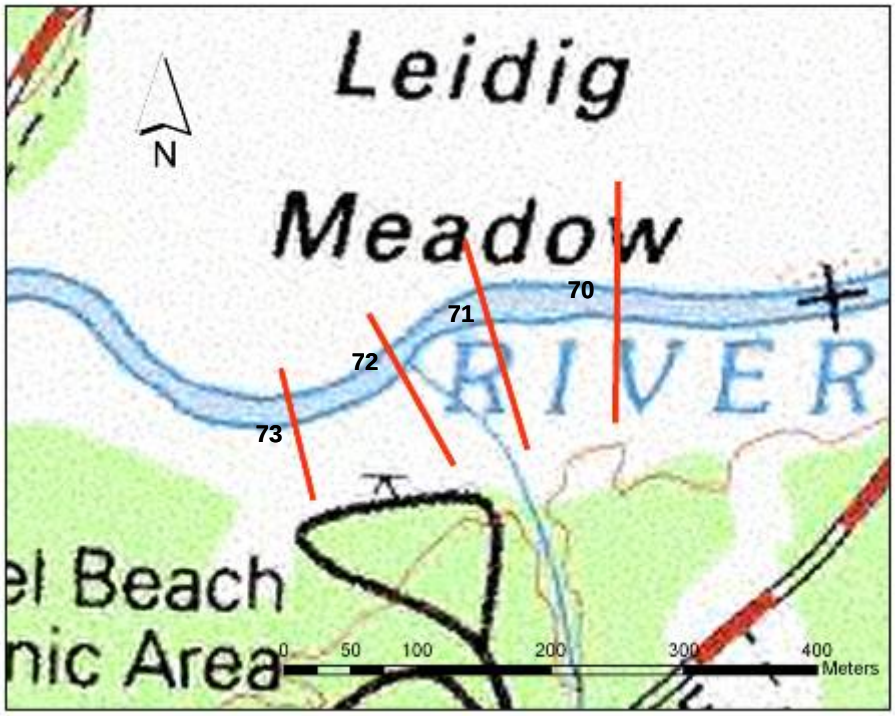


Figure 2.2.6a. Sentinel Beach river cross section 70.

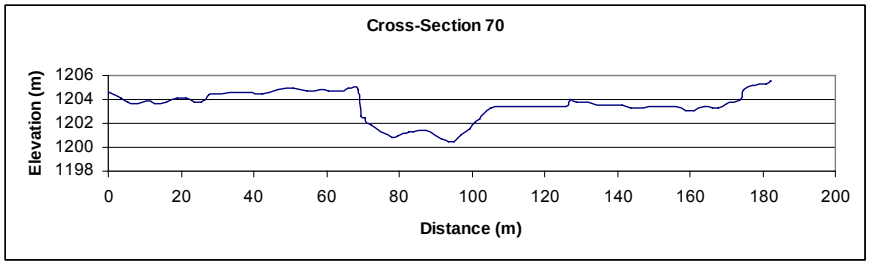


Figure 2.2.6b. Sentinel Beach river cross section 71.

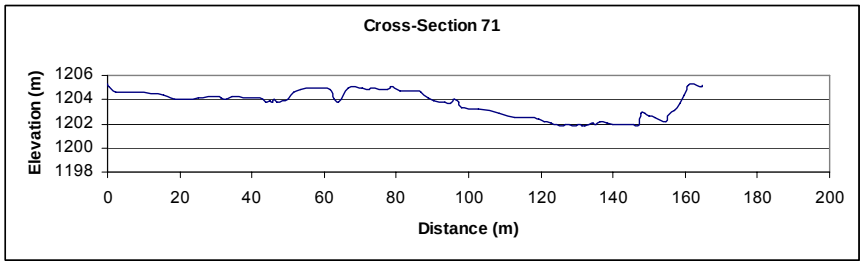


Figure 2.2.6c. Sentinel Beach river cross section 72.

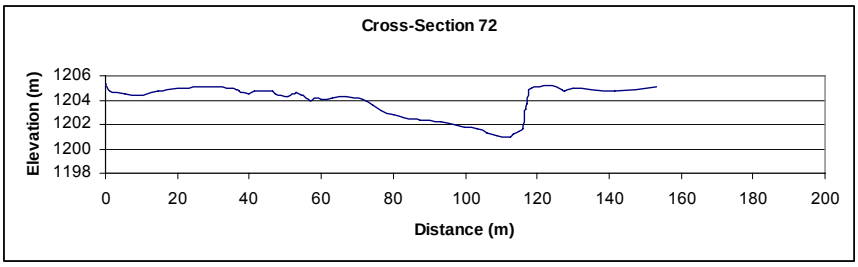


Figure 2.2.6d. Sentinel Beach river cross section 73.

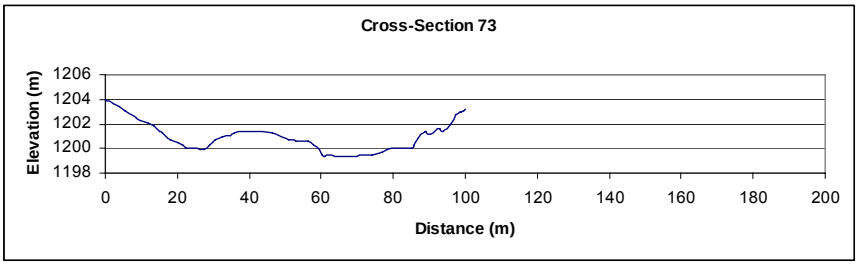


Figure 2.2.7. Location of El Capitan Dump Reach and river cross-sections 30-34.

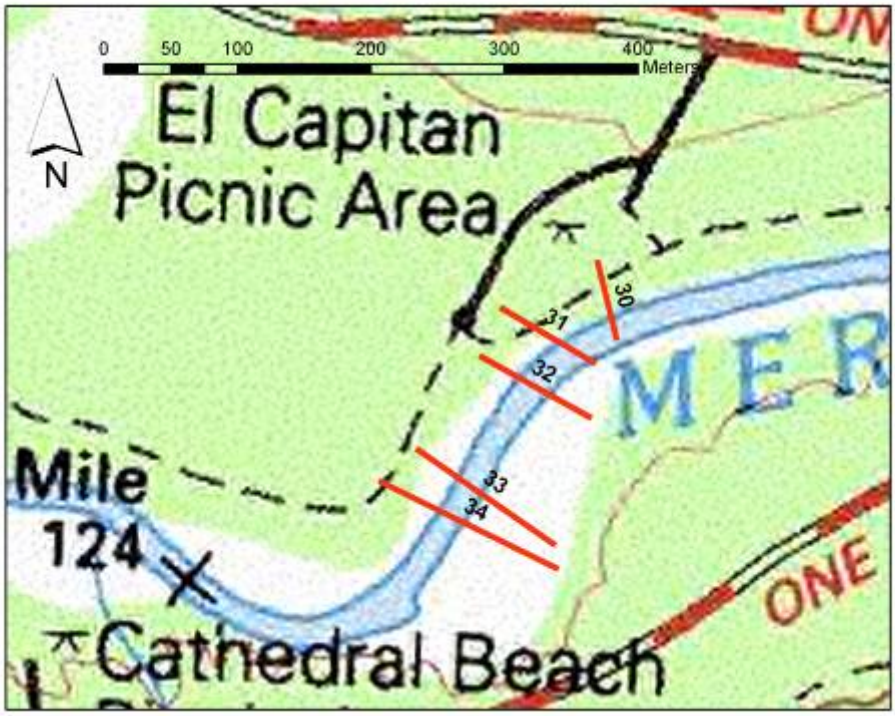


Figure 2.2.8a. El Capitan Dump river cross section 30.

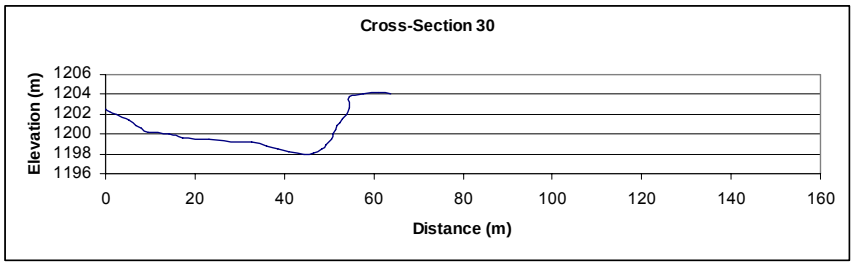


Figure 2.2.8b. El Capitan Dump river cross section 31.

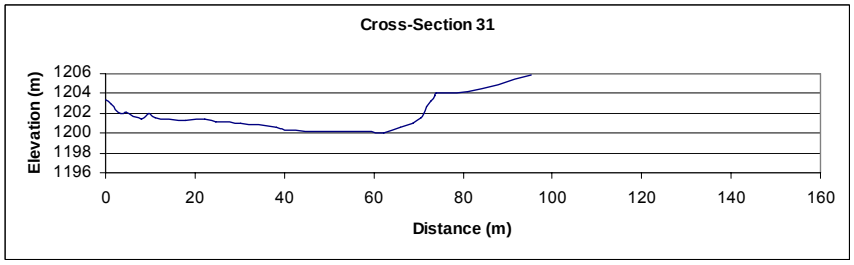


Figure 2.2.8c. El Capitan Dump river cross section 32.

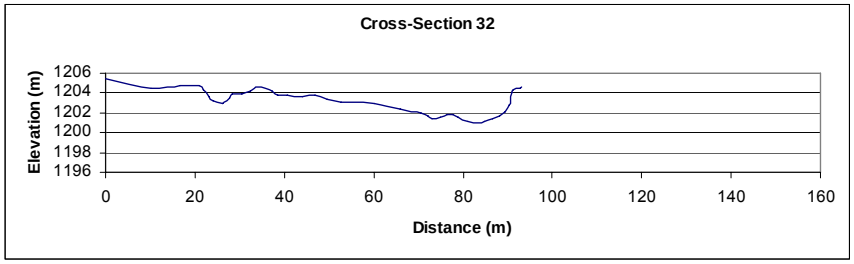


Figure 2.2.8d. El Capitan Dump river cross section 33.

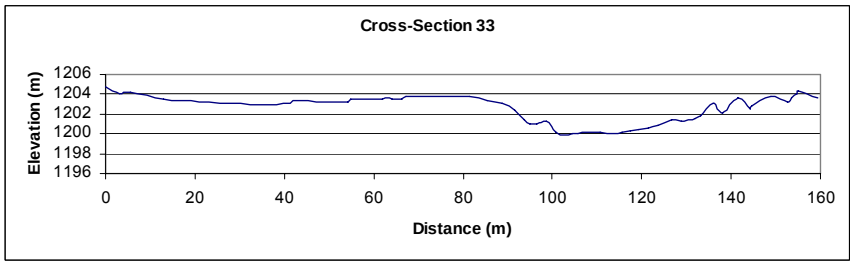
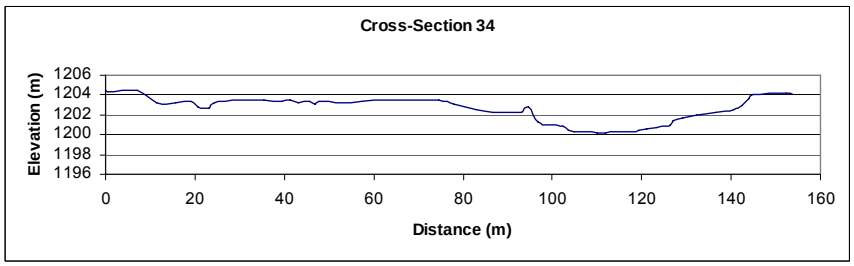


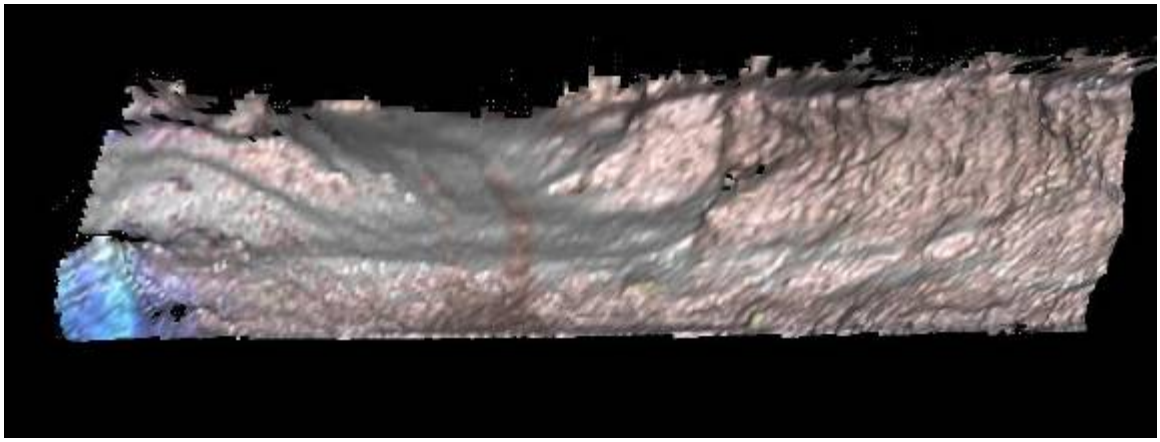
Figure 2.2.8e. El Capitan Dump river cross section 34.



Typical LiDAR results for each reach are shown in Figures 2.2.9 and 2.2.10.

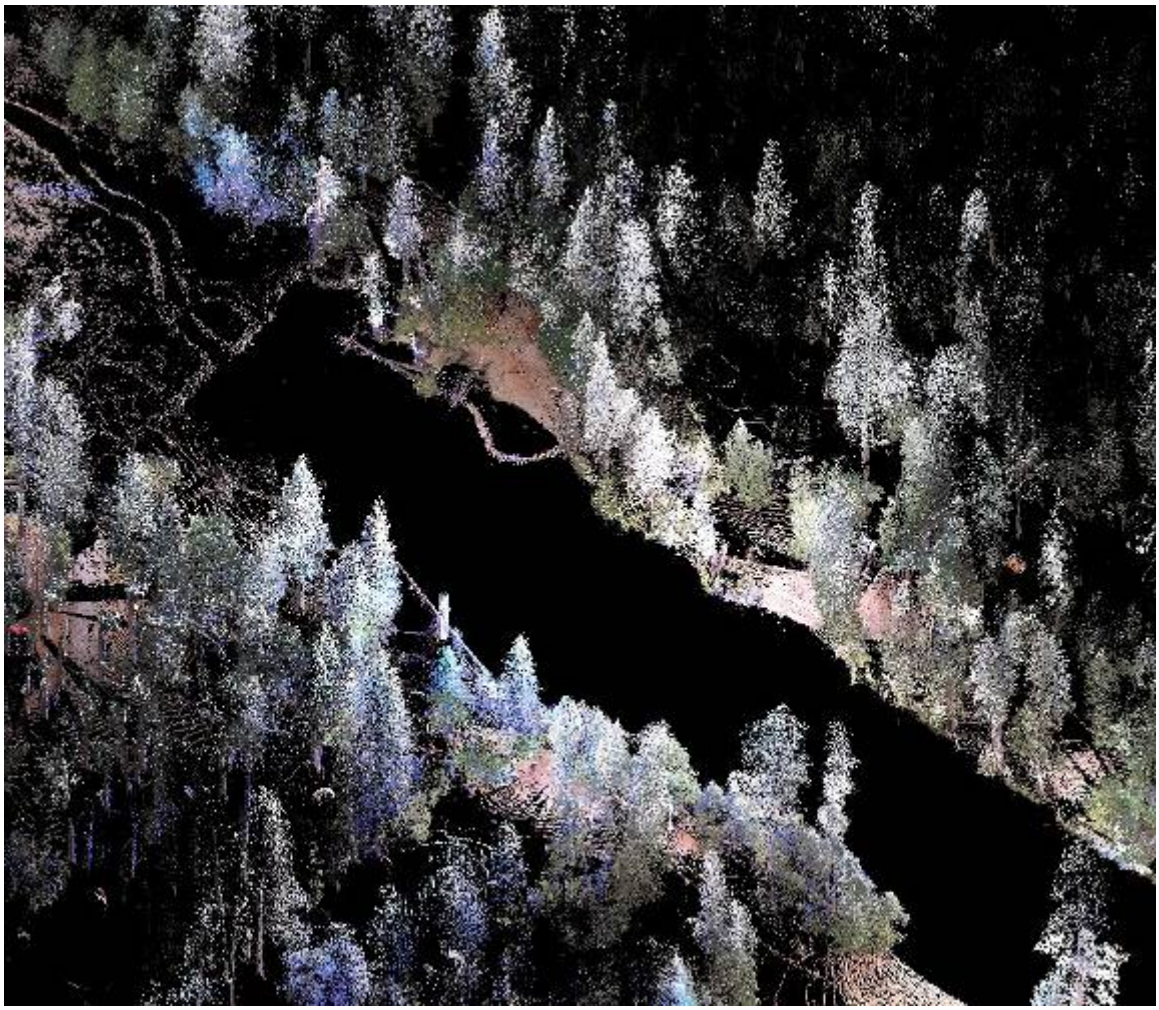
Figure 2.2.9a. Photograph of informal trails on the riverbank across from Sentinel Beach.

Figure 2.2.9b. LiDAR scan (lattice of point data) of informal trails on the riverbank across from Sentinel Beach.



The two informal trails on the riverbank are 5-10 centimeters deep. This difference from the rest of the surface is detected in the LiDAR scan.

Figure 2.1.10. Oblique aerial view of North Pines Campground reach (Composite of LiDAR point data from 5 scans). Downstream is located in the top left corner of the photograph.



Notice the large wood in the river channel and the constructed soaking pools adjacent to North Pines Campground.

Figure 2.2.11. Oblique aerial view of El Capitan Dump reach (Composite of LiDAR point data from ten scans) looking upstream.

Notice the large wood in the river channel and on the riverbanks.

Figure 2.2.12. Oblique aerial view of Sentinel Beach looking up river (Composite of LiDAR point data from ten scans). Dark circular areas are scanner locations.

Vegetation Condition Assessment

Methods:

The vegetation assessment portion of the pilot study was carried out using the same three 200-meter reaches as were used, and described above, in the channel morphology assessment (see Figure 2.2.1) as well as two other reaches. The other two reaches are Pohono Bridge and Cook's Meadow, see Figure 2.2.2. These two additional sites were chosen to test comparability. A total of nine plots, within a total of five reaches were surveyed.

At each sample reach and on both sides of the river, a one-hundred meter plot was established. Within the one hundred meter plot, a point-intercept sampling of functional vegetation groups was conducted to assess the condition of the vegetation (see the Riverbank Condition section of the 2007 UCMMP Field Guide for complete procedures).

Metrics:

A total of twelve metrics were recorded: Substrate size, Litter, Bare Ground, Exposed Roots, Non-Vascular Plants, Annual Biennial Plants, Fibrous Rooted Perennial, Taprooted Perennial, Shrub, Woody Plant less than 1.5 meters, Evergreen Canopy, Deciduous Canopy. Also, it was noted if the point was located on the terrace or the bank.

Site Descriptions and Photos:

1. North Pines Reach, Plot RX11
Abbreviation: NP RX11
Reach Location and Description: North Pines Reach is located in an active campground with high visitor use.
Plot Location and Description: Plot RX 11 is located on a relatively straight section of the river bank. However, the plot did encroach on populated camping areas. Consequently, technicians should be aware of the impact this may have on visitor experience.
General observations: There is a robust conifer canopy in the area; the deciduous canopy is mainly black oak; shrubs and herbs are sparse, yet still present in clusters; the ground appears to be compacted; and there are multiple scalloped river bank areas.
Plot size: 100 meter baseline length
Shape: Rectangle
Number of transects: 10
Number of points: 109
Notes: To test method repeatability, the plot was repeated twice using the same plot set up protocol. (Note: site was monitored a total of three times).
Name: North Pines Reach, Plot RX11a
Abbreviation: NP RX11a
Plot size: 100 meter baseline length
Shape: Rectangle
Number of transects: 10
Number of points: 123
Note: This is the first of two replicas of NP RX11.
Name: North Pines Reach, Plot RX11b
Abbreviation: NP RX11b
Plot size: 100 meter baseline length
Shape: Rectangle
Number of transects: 10
Number of points: 115
Note: This is the second of two replicas of NP RX11

Plot Photos:

Figure 2.2.13. Photographs of North Pines Reach Plot RX 11.

North Pines Reach Plot RX 11
Looking Downstream

North Pines Reach Plot RX 11
Looking Downstream

2. North Pines Reach Plot RX13
Abbreviation: NP RX13
Reach Location and Description: North Pines Reach is located in an active campground with high visitor use.
Plot Location and Description: Plot RX 13 is located downstream of RX11 (approximately 20 meters west of the downstream endpoint) on a relatively straight section of the river bank. However, the plot did encroach on populated camping areas. Consequently, technicians should be aware of the impact this may have on visitor experience. A small portion (one transect) is located within a fenced restoration area.
General observations: There is a robust conifer canopy in the area; the deciduous canopy is mainly black oak; shrubs and herbs are sparse, yet still present in clusters; the ground appears to be compacted; and there are multiple scalloped areas along the river bank.
Plot size: 100 meter baseline length
Shape: Rectangle
Number of transects: 10
Number of points: 48
Notes: The right side of the river (RX13) was deliberately chosen, instead of the left (LX11). The rationale being that vegetation was recently planted in a restoration area on the left river bank within what would be the LX 11 plot location. Furthermore, since the purpose was to pilot and test the protocol, and not to collect baseline data, preventing damage to the vegetation was the priority.

Plot Photos:

Figure 2.2.14. Photographs of North Pines Reach Plot RX 13.

North Pines Reach Plot RX 13
Looking Upstream

North Pines Reach Plot RX 13
Looking Downstream

3. Sentinel Beach Reach Plot RX71
Abbreviation: SB RX71
Reach Location and Description: Sentinel Beach Reach is located in the vicinity of the Sentinel Beach Picnic area. This area is considered a medium use area, and is also a restoration site.
Plot Location and Description: Plot RX 71 is located on the border of Leidig Meadow and the bank of the Merced River.
General observations: The plot is on an outside curve with steep banks and fine substrate. The bank is actively eroding. During the data collection timeframe, leaning trees uprooted and fell over, most likely due to apparent beaver damage and a recent prescribed burn. In September, at which time the data collection was taking place, a prescribed fire was conducted in Leidig Meadow. The burn was hot and successfully burned the understory.
Plot size: 150 meter baseline length
Shape: narrow rectangle
Number of transects: 16
Number of points: 208
Notes:

Plot Photos:

Figure 2.2.15. Photographs of Sentinel Beach Reach Plot RX 71.

Sentinel Beach Reach Plot RX 71
Looking Upstream

Sentinel Beach Reach Plot RX 71
Looking Downstream

4. Sentinel Beach Reach Plot LX 71
Abbreviation: SB LX 71
Reach Location and Description: Sentinel Beach Reach is located in the vicinity of the Sentinel Beach Picnic area. It is considered to be a medium use area, and is also a restoration site. In the summer months, it is used as the raft take out staging area.
Plot Location and Description: Plot LX 71 is located at the conifer line bordering the Sentinel Beach day use parking area. It encompasses an inside curve with a point bar.
General observations: A diverse group of features can be found within the plot: a small creek bed, riparian and meadow vegetation, an apparent oxbow, a high use picnic area located on a sandy beach, multiple terraces, fine substrate, and gentle slopes.
Plot size: 80 meter baseline length
Shape: wide rectangle
Number of transects: 4 (points at 2 meter intervals)
Number of points: 204
Notes: The multiple terraces presented a challenge when determining the location of the top of the bank and terrace. For purposes of this work, the conifer line was used to determine the top of the terrace. The bank was defined as the break in slope close to the mean annual high water line.

Plot Photos:

Figure 2.2.16. Photographs of Sentinel Beach Reach Plot LX 71.

Sentinel Beach Reach Plot LX 71
Looking Downstream

Sentinel Beach Reach Plot LX 71
Looking Upstream

5. El Capitan Dump Reach Plot RX 30
Abbreviation: ECD RX30
Reach Location and Description: El Capitan Dump Reach is located at the site of an historic dump and heavily used picnic area. The dump is no longer in use and the picnic area was removed and the area restored to natural conditions. It currently receives low visitor use.
Plot Location and Description: The plot is located on an outside curve with steep banks and fine substrate.
General observations:
Plot size: 170 meter baseline length
Shape: polygon (rectangle with 1 midpoint)
Number of transects: 17
Number of points: 173
Notes: The bank was actively eroding and too steep to walk on safely or without causing further erosion. Due to this fact, it was necessary to use a less objective point intercept method on 24 points. The points were collected by tossing a weighted rope with one-meter markings along the bank and then recording observations.

Plot Photos:

Figure 2.2.17. Photographs of El Capitan Dump Reach Plot RX 30.

El Capitan Dump Reach Plot RX 30
Looking Upstream

El Capitan Dump Reach Plot RX 30
Looking Downstream

6. El Capitan Dump LX30
Abbreviation: ECD LX30
Reach Location and Description: El Capitan Dump Reach is located at the site of an historic dump and heavily used picnic area. The dump is no longer in use and the picnic area was removed and the area restored to natural conditions. This site is accessed by visitors at a pullout and used for swimming. It is currently receives low visitor use.
Plot Location and Description: The plot encompasses an inside curve with a point bar. It is a depositional area with fine substrate, gentle slopes and several side channels.
General observations: The wide point bar consists of mostly bare ground and deciduous cover.
Plot size: 100 meter baseline length
Shape: wide polygon with 2 midpoints
Number of transects: 5 (points at 2 meter intervals)
Number of points: 186
Notes: The top of bank terrace was determined to be located at the conifer line. A prescribed burn was conducted in June on the bordering conifer forest area.

Plot Photos:

Figure 2.2.18. Photograph of El Capitan Dump Reach Plot LX 30.

El Capitan Dump Reach Plot LX 30
Looking Downstream

7. Pohono Bridge Reach Plot Left Bank
Abbreviation: PB LB
Reach Location and Description: Pohono Bridge Reach is located downstream of Pohono Bridge, directly across the road from Pohono Pit, and at the site of an unmarked pullout. The pullout on the right bank of the river receives a high level of visitor use. The reach encompasses a relatively straight river channel.
Plot Location and Description: The plot is located on river left, across the river from a high-use pullout. However, the left bank receives a low level of visitor use.
General observations: The bank is steep with a very large substrate of boulders 2-3 ft. in diameter. The plot contains woody seedlings, exposed roots, and is the only site with a significant amount of nonvascular cover.
Plot size: 110 meter baseline length
Shape: rectangle
Number of transects: 11
Number of points: 179
Notes: The conifer line was used to determine the top of the terrace.

Plot Photos:

Figure 2.2.19. Photographs of Pohono Bridge Reach Plot Left Bank.

Pohono Bridge Reach Plot Left Bank
Looking Downstream

Pohono Bridge Reach Plot Left Bank
Looking Upstream

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8. Pohono Bridge Reach Plot Right Bank
Abbreviation: PB RB
Reach Location and Description: Pohono Bridge Reach is located downstream of Pohono Bridge, directly across from Pohono Pit, and at the site of an unmarked pullout on the right bank. The pullout receives a high level of visitor use. The reach encompasses a relatively straight river channel. The left bank of the river is not easily accessible to visitors, unless they ford the river.
Plot Location and Description: The plot is located near the west end of the unmarked pullout and continues downstream.
General observations: The bank and surrounding area are undergoing apparent erosion, with obvious loss of soil and many exposed roots. The substrate is very large.
Plot size: 70 meter baseline length
Shape: rectangle
Number of transects: 7
Number of points: 195
Notes: Determining where to establish the top of the bank terrace was a challenge. There were multiple terraces that continued beyond the conifer line. To capture on-going erosion, we deliberately chose the second terrace beyond the conifer line, rather than starting at the conifer line. The baseline was then set up 3 meters above the (chosen) terrace, as per the protocol.

Plot Photos:

Figure 2.2.20. Photographs of Pohono Bridge Reach Plot Right Bank.

Pohono Bridge Reach
Plot Right Bank
Looking Upstream

Pohono Bridge Reach
Plot Right Bank
Looking Upstream

9. Cook's Meadow Reach Plot Right Bank
Abbreviation: CM RB
Reach Location and Description: The reach is located downstream of Sentinel Bridge, where the restoration fence ends.
Plot Location and Description: The plot is located at the west corner of the restoration fence. The plot is located on a relatively straight section of the river bank with soft substrate and steep banks approximately eight feet high.
General observations: There was abundant vegetation in the bordering restoration area.
Plot size: 100 meter baseline length
Shape: rectangle
Number of transects: 10
Number of points: 57
Notes: 57 data points were collected; due to the homogenous nature of the site, fewer than 200 points are probably acceptable.

Plot Photos:

Figure 2.2.21. Photograph of Cook's Meadow Reach Plot Right Bank.

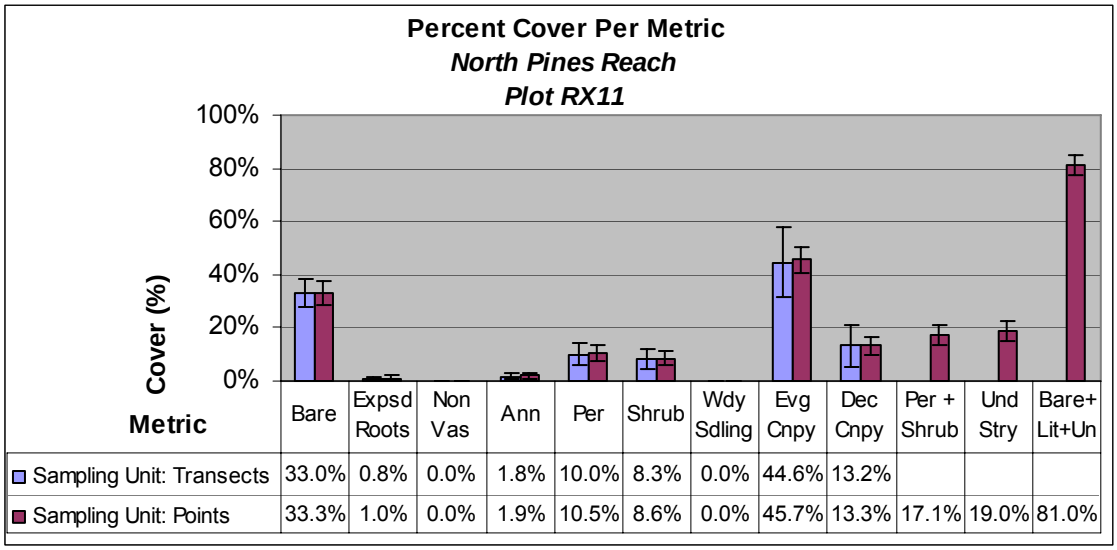
Cook's Meadow Reach Plot Right Bank
Looking Downstream

Results

The following figures (Figures 2.2.22 – 2.2.24) summarize the results of the vegetation surveys. They illustrate the percent cover of each metric. Figure 2.2.22 depicts percent cover of each metric for each site. Figure 2.2.23 shows an intersite comparison for each metric. Finally, Figure 2.2.24 displays intersite comparisons of combined metrics. For most of the metrics, data was analyzed in two ways: with points used as the sampling unit, and with transects used as the sampling unit. However, when metrics were combined (perennial and shrub; understory; bare ground, litter and understory) the data was analyzed with only the points as the sampling unit.

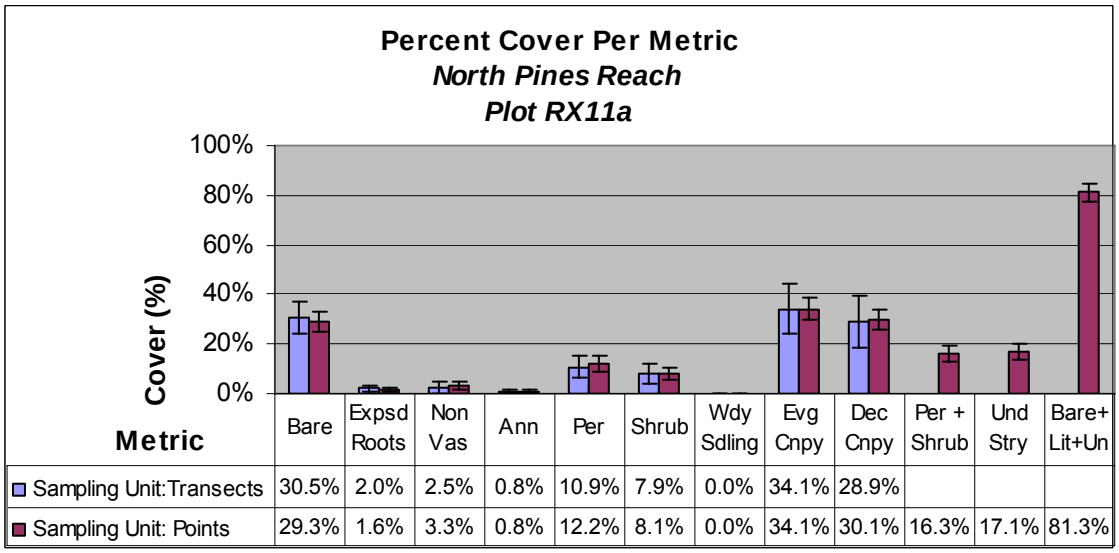
Below is a key to the abbreviations used in Figures 2.2.22-2.2.24:
Bare = bare ground; Expsd Roots = exposed roots; Non Vas = nonvascular plants; Per = perennial herbaceous plants; Wdy Sdling = woody seedling; Evg Cnpy = conifer canopy; Dec Cnpy = deciduous canopy; Per + Shrub = perennial herbaceous plants and shrubs; Und Stry = understory; and Bare + Lit + Un = bare ground + litter + understory.

Figure 2.2.22a. Percent Cover of each metric for North Pines Reach Plot RX 11.



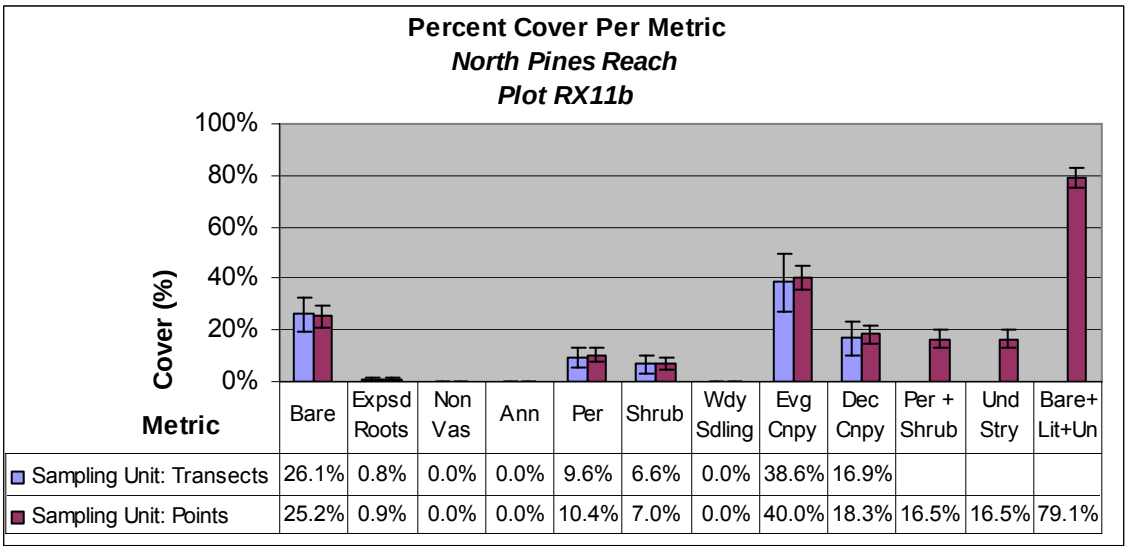
Metric	Bare	Expsd Roots	Non Vas	Ann	Per	Shrub	Wdy Sdling	Evg Cnpy	Dec Cnpy	Per + Shrub	Und Stry	Bare+ Lit+Un
Sampling Unit: Transects	33.0%	0.8%	0.0%	1.8%	10.0%	8.3%	0.0%	44.6%	13.2%			
Sampling Unit: Points	33.3%	1.0%	0.0%	1.9%	10.5%	8.6%	0.0%	45.7%	13.3%	17.1%	19.0%	81.0%

Figure 2.2.22b. Percent Cover of each metric for North Pines Reach Plot RX 11a. Plot RX 11a is the first of two replicas of Plot RX 11.



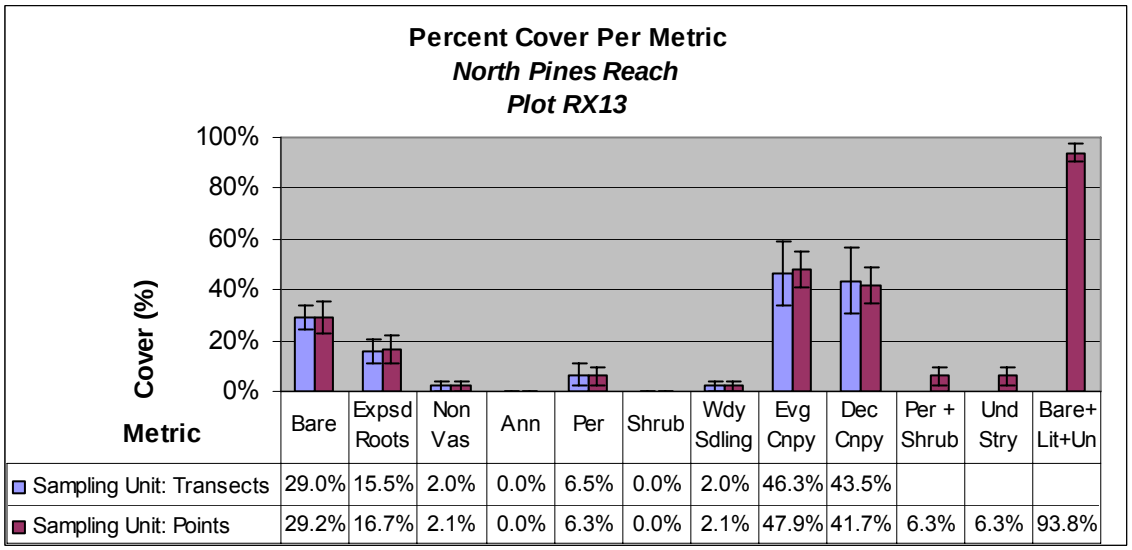
Metric	Bare	Expsd Roots	Non Vas	Ann	Per	Shrub	Wdy Sdling	Evg Cnpy	Dec Cnpy	Per + Shrub	Und Stry	Bare+ Lit+Un
Sampling Unit:Transects	30.5%	2.0%	2.5%	0.8%	10.9%	7.9%	0.0%	34.1%	28.9%			
Sampling Unit: Points	29.3%	1.6%	3.3%	0.8%	12.2%	8.1%	0.0%	34.1%	30.1%	16.3%	17.1%	81.3%

Figure 2.2.22c. Percent Cover of each metric for North Pines Reach Plot RX 11b. Plot RX 11b is the second of two replicas of Plot RX 11.



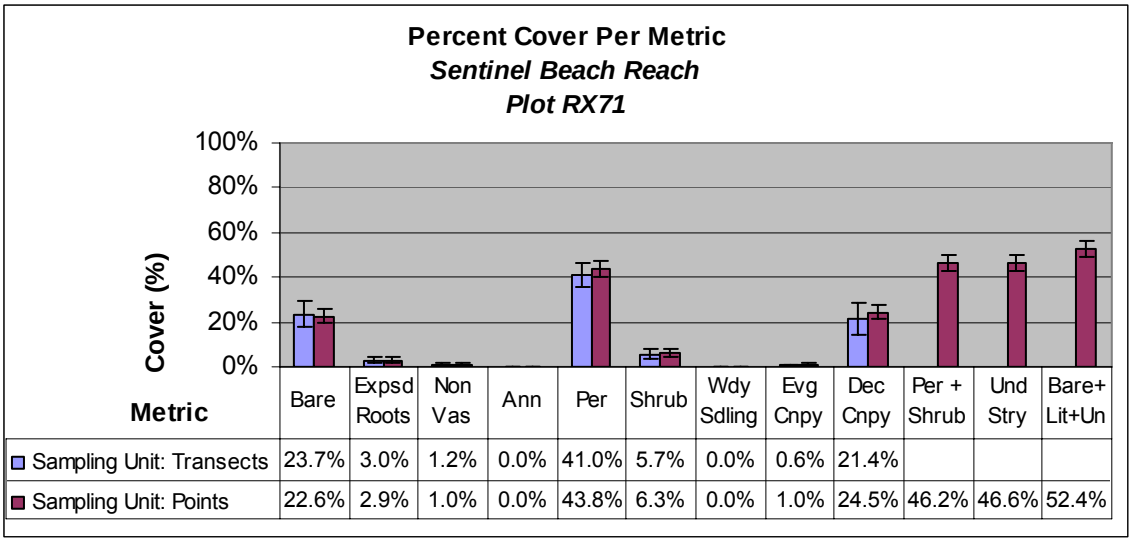
Metric	Bare	Expsd Roots	Non Vas	Ann	Per	Shrub	Wdy Sdling	Evg Cnpy	Dec Cnpy	Per + Shrub	Und Stry	Bare+ Lit+Un
Sampling Unit: Transects	26.1%	0.8%	0.0%	0.0%	9.6%	6.6%	0.0%	38.6%	16.9%			
Sampling Unit: Points	25.2%	0.9%	0.0%	0.0%	10.4%	7.0%	0.0%	40.0%	18.3%	16.5%	16.5%	79.1%

Figure 2.2.22d. Percent Cover of each metric for North Pines Reach Plot RX 13.



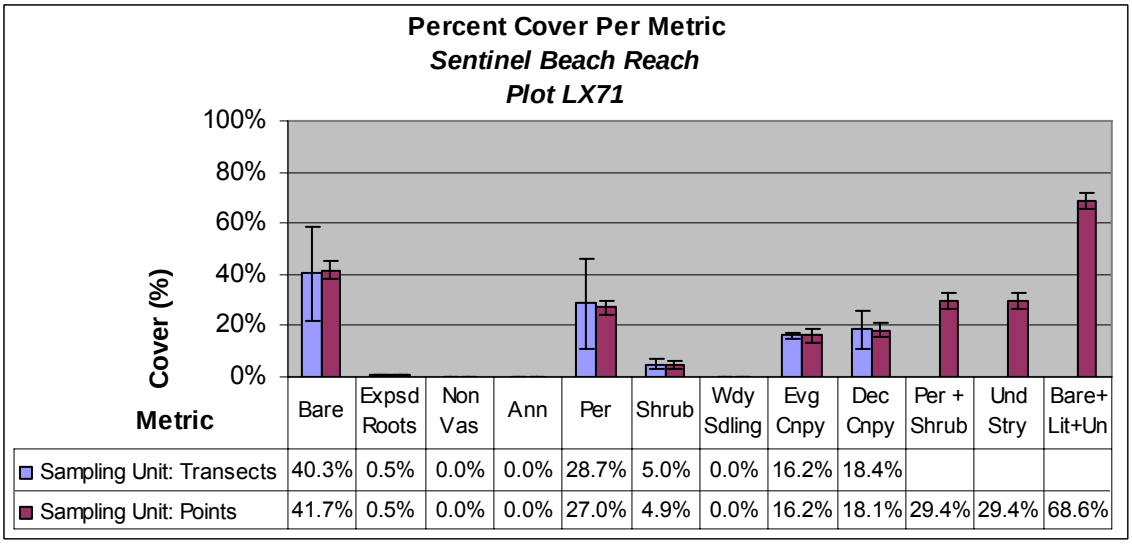
Metric	Bare	Expsd Roots	Non Vas	Ann	Per	Shrub	Wdy Sdling	Evg Cnpy	Dec Cnpy	Per + Shrub	Und Stry	Bare+ Lit+Un
Sampling Unit: Transects	29.0%	15.5%	2.0%	0.0%	6.5%	0.0%	2.0%	46.3%	43.5%			
Sampling Unit: Points	29.2%	16.7%	2.1%	0.0%	6.3%	0.0%	2.1%	47.9%	41.7%	6.3%	6.3%	93.8%

Figure 2.2.22e. Percent Cover of each metric for Sentinel Beach Reach Plot RX 71.



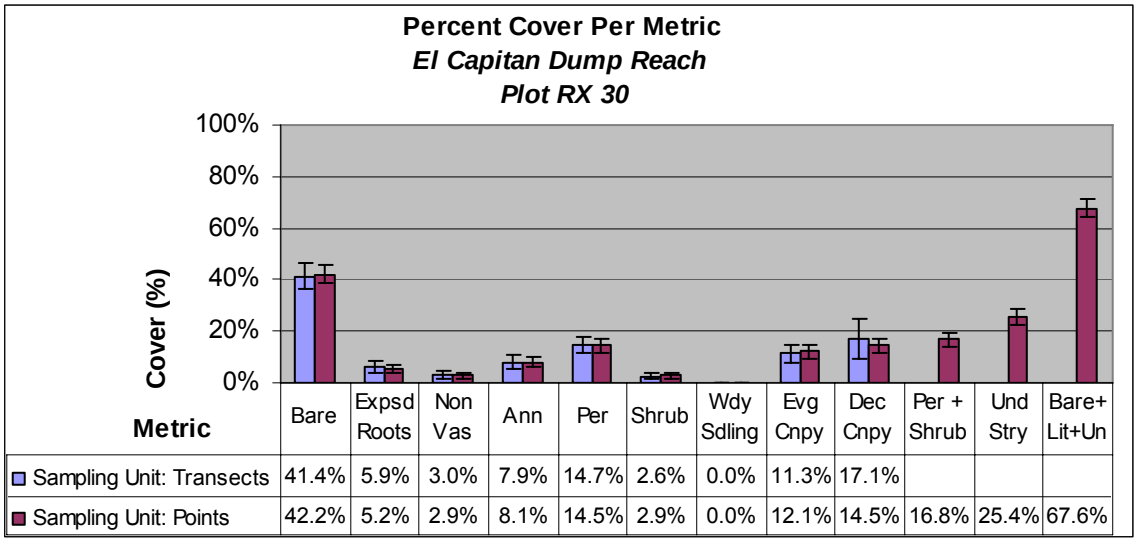
Metric	Bare	Expsd Roots	Non Vas	Ann	Per	Shrub	Wdy Sdling	Evg Cnpy	Dec Cnpy	Per + Shrub	Und Stry	Bare+ Lit+Un
Sampling Unit: Transects	23.7%	3.0%	1.2%	0.0%	41.0%	5.7%	0.0%	0.6%	21.4%			
Sampling Unit: Points	22.6%	2.9%	1.0%	0.0%	43.8%	6.3%	0.0%	1.0%	24.5%	46.2%	46.6%	52.4%

Figure 2.2.22f. Percent Cover of each metric for Sentinel Beach Reach Plot LX71.



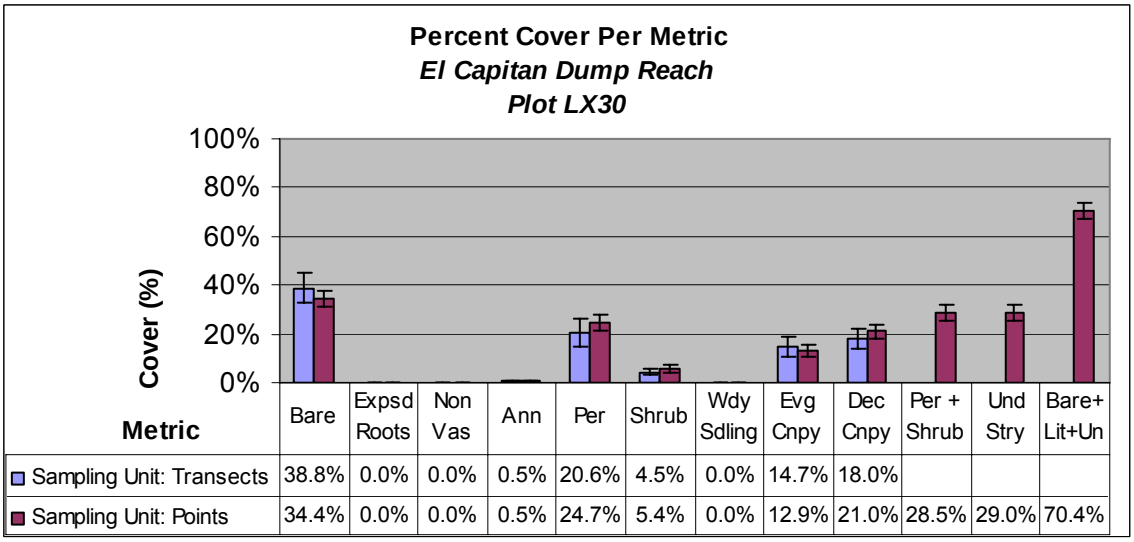
Metric	Bare	Expsd Roots	Non Vas	Ann	Per	Shrub	Wdy Sdling	Evg Cnpy	Dec Cnpy	Per + Shrub	Und Stry	Bare+ Lit+Un
Sampling Unit: Transects	40.3%	0.5%	0.0%	0.0%	28.7%	5.0%	0.0%	16.2%	18.4%			
Sampling Unit: Points	41.7%	0.5%	0.0%	0.0%	27.0%	4.9%	0.0%	16.2%	18.1%	29.4%	29.4%	68.6%

Figure 2.2.22g. Percent Cover of each metric for El Capitan Dump Reach Plot RX 30.



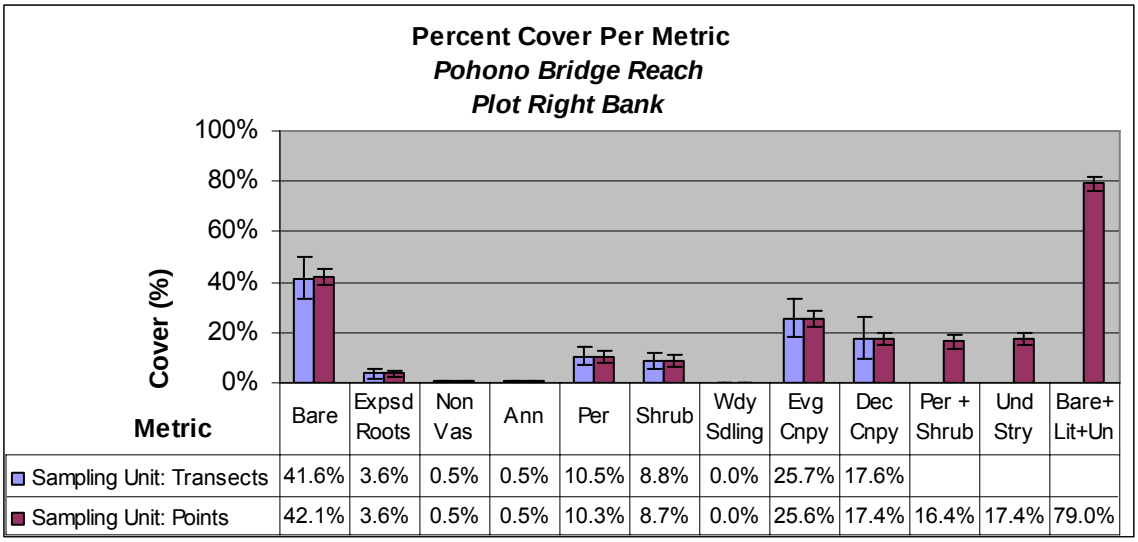
Metric	Bare	Expsd Roots	Non Vas	Ann	Per	Shrub	Wdy Sdling	Evg Cnpy	Dec Cnpy	Per + Shrub	Und Stry	Bare+ Lit+Un
Sampling Unit: Transects	41.4%	5.9%	3.0%	7.9%	14.7%	2.6%	0.0%	11.3%	17.1%			
Sampling Unit: Points	42.2%	5.2%	2.9%	8.1%	14.5%	2.9%	0.0%	12.1%	14.5%	16.8%	25.4%	67.6%

Figure 2.2.22h. Percent Cover of each metric for El Capitan Dump Reach Plot LX30.



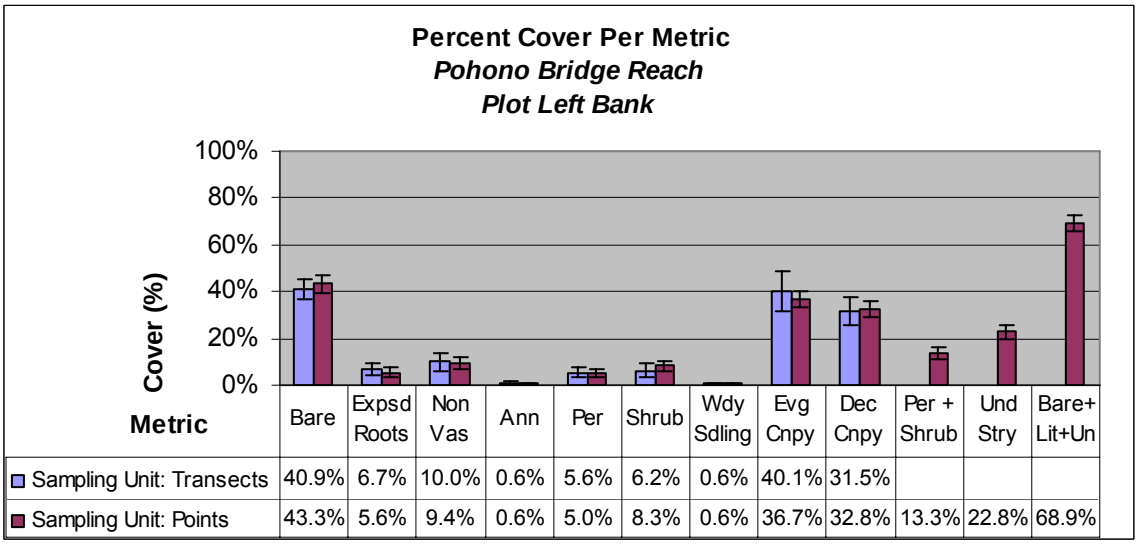
Metric	Bare	Expsd Roots	Non Vas	Ann	Per	Shrub	Wdy Sdling	Evg Cnpy	Dec Cnpy	Per + Shrub	Und Stry	Bare+ Lit+Un
Sampling Unit: Transects	38.8%	0.0%	0.0%	0.5%	20.6%	4.5%	0.0%	14.7%	18.0%			
Sampling Unit: Points	34.4%	0.0%	0.0%	0.5%	24.7%	5.4%	0.0%	12.9%	21.0%	28.5%	29.0%	70.4%

Figure 2.2.22i. Percent Cover of each metric for Pohono Bridge Reach Plot Right Bank.



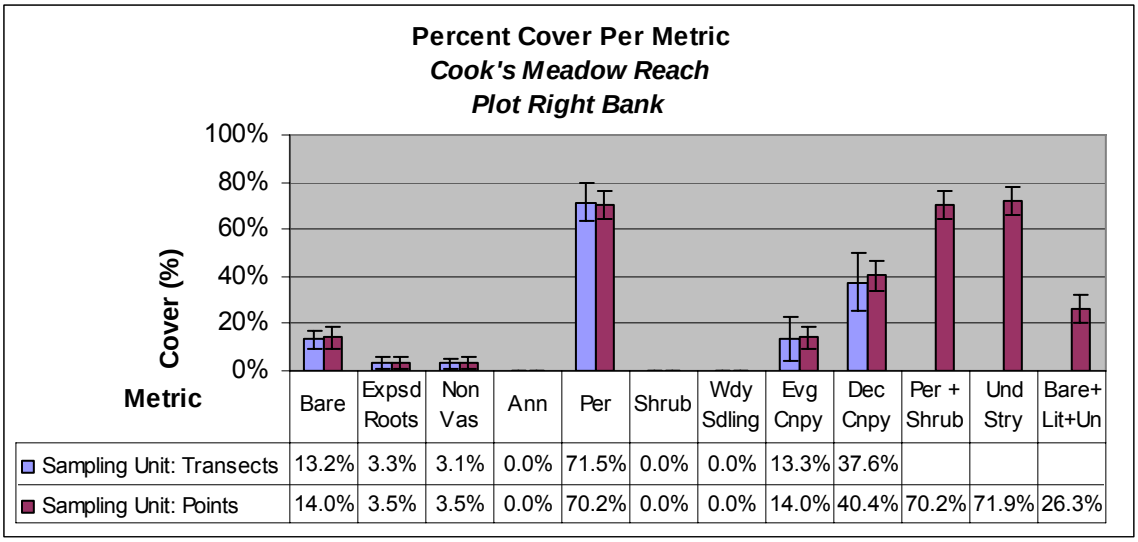
Metric	Bare	Expsd Roots	Non Vas	Ann	Per	Shrub	Wdy Sdling	Evg Cnpy	Dec Cnpy	Per + Shrub	Und Stry	Bare+ Lit+Un
Sampling Unit: Transects	41.6%	3.6%	0.5%	0.5%	10.5%	8.8%	0.0%	25.7%	17.6%			
Sampling Unit: Points	42.1%	3.6%	0.5%	0.5%	10.3%	8.7%	0.0%	25.6%	17.4%	16.4%	17.4%	79.0%

Figure 2.2.22j. Percent Cover of each metric for Pohono Bridge Reach Plot Left Bank.



Metric	Bare	Expsd Roots	Non Vas	Ann	Per	Shrub	Wdy Sdling	Evg Cnpy	Dec Cnpy	Per + Shrub	Und Stry	Bare+ Lit+Un
Sampling Unit: Transects	40.9%	6.7%	10.0%	0.6%	5.6%	6.2%	0.6%	40.1%	31.5%			
Sampling Unit: Points	43.3%	5.6%	9.4%	0.6%	5.0%	8.3%	0.6%	36.7%	32.8%	13.3%	22.8%	68.9%

Figure 2.2.22k. Percent Cover of each metric for Cook's Meadow Reach Plot Right Bank.



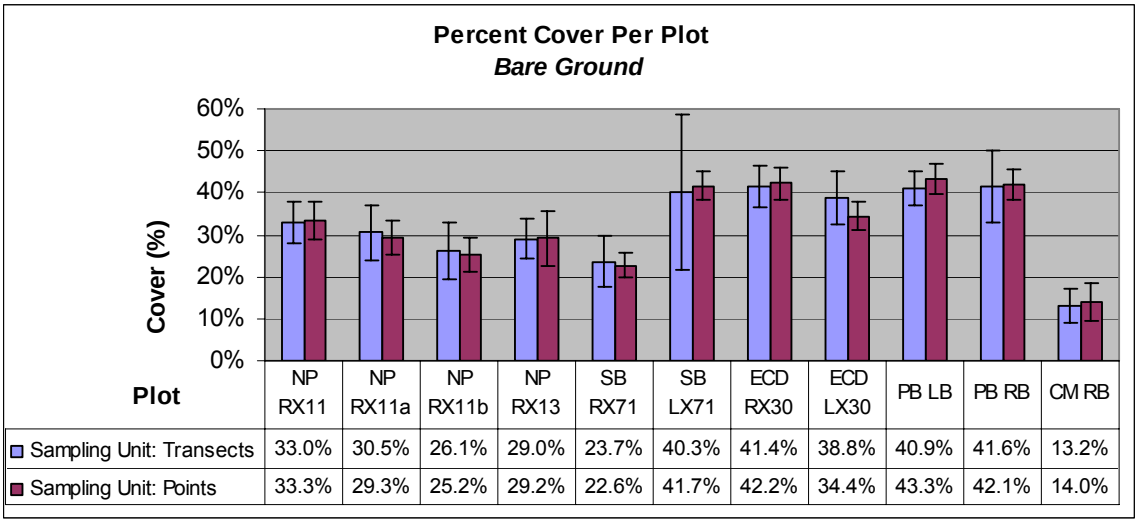
Percent Cover Intersite Comparison

In this study, we measured percent cover at high, medium and low use sites. The following table provides the level of use associated with each site.

Table 2.2.1. Approximate use level per site.

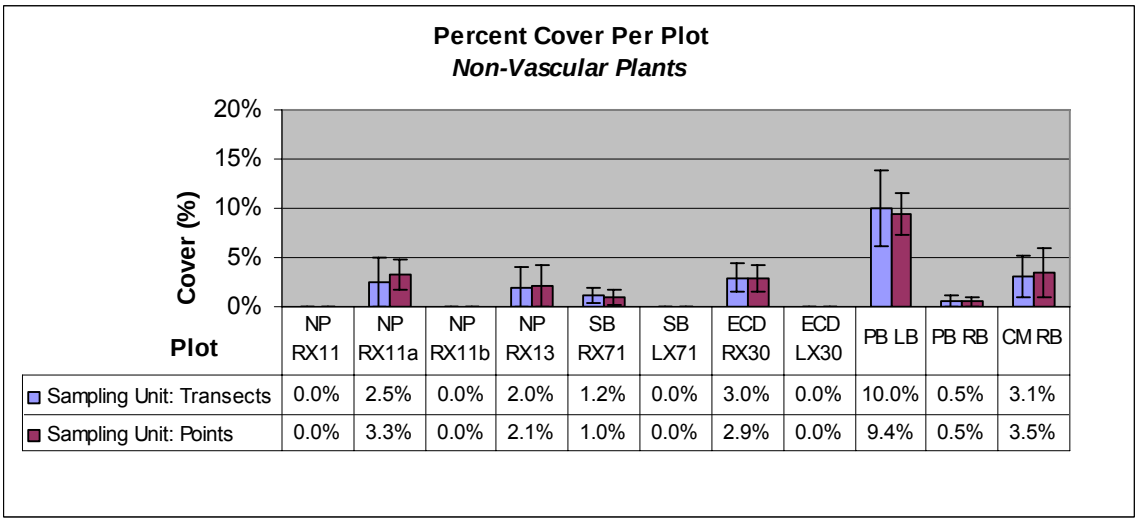
Site	Level of Use
North Pines Reach Plot RX11	High
North Pines Reach Plot RX11 Duplicate A	High
North Pines Reach Plot RX11 Duplicate B	High
North Pines Reach Plot RX13	High
Sentinel Beach Reach Plot RX71	Medium
Sentinel Beach Reach Plot LX71	Medium
El Capitan Dump Reach Plot RX30	Medium
El Capitan Dump Reach Plot LX30	Low
Pohono Bridge Reach Plot Left Bank	Low
Pohono Bridge Reach Plot Right Bank	High
Cook's Meadow Reach Plot Right Bank	Medium

Figure 2.2.23a. Percent cover of bare ground for each plot.



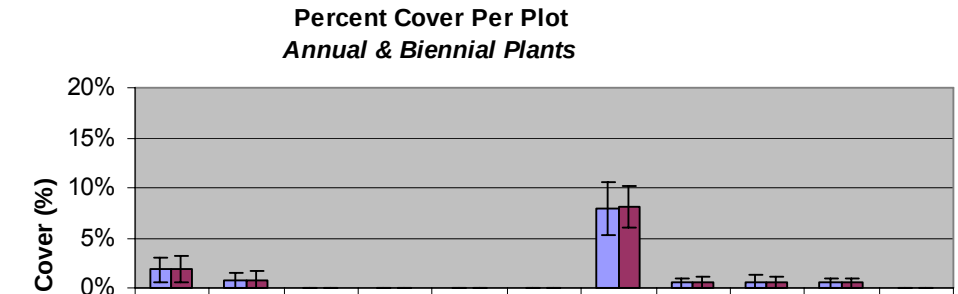
Plot	NP RX11	NP RX11a	NP RX11b	NP RX13	SB RX71	SB LX71	ECD RX30	ECD LX30	PB LB	PB RB	CM RB
Sampling Unit: Transects	33.0%	30.5%	26.1%	29.0%	23.7%	40.3%	41.4%	38.8%	40.9%	41.6%	13.2%
Sampling Unit: Points	33.3%	29.3%	25.2%	29.2%	22.6%	41.7%	42.2%	34.4%	43.3%	42.1%	14.0%

Figure 2.2.23b. Percent cover of non-vascular plants for each plot.



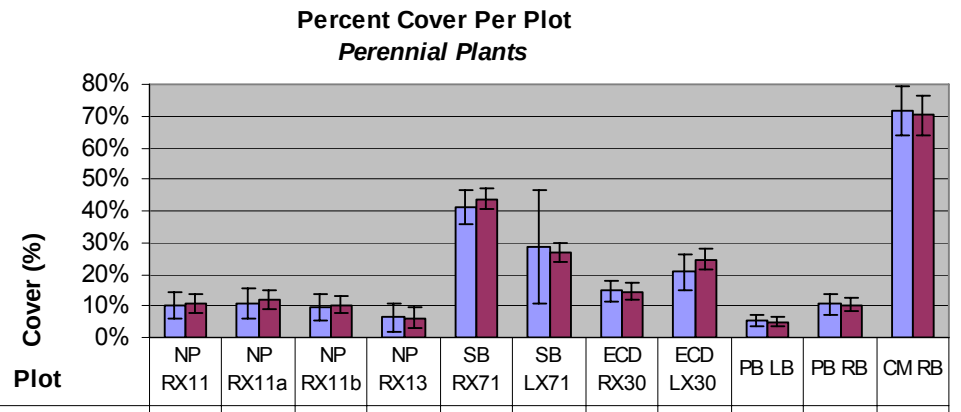
Plot	NP RX11	NP RX11a	NP RX11b	NP RX13	SB RX71	SB LX71	ECD RX30	ECD LX30	PB LB	PB RB	CM RB
Sampling Unit: Transects	0.0%	2.5%	0.0%	2.0%	1.2%	0.0%	3.0%	0.0%	10.0%	0.5%	3.1%
Sampling Unit: Points	0.0%	3.3%	0.0%	2.1%	1.0%	0.0%	2.9%	0.0%	9.4%	0.5%	3.5%

Figure 2.2.23c. Percent cover of annual and biennial plants for each plot.



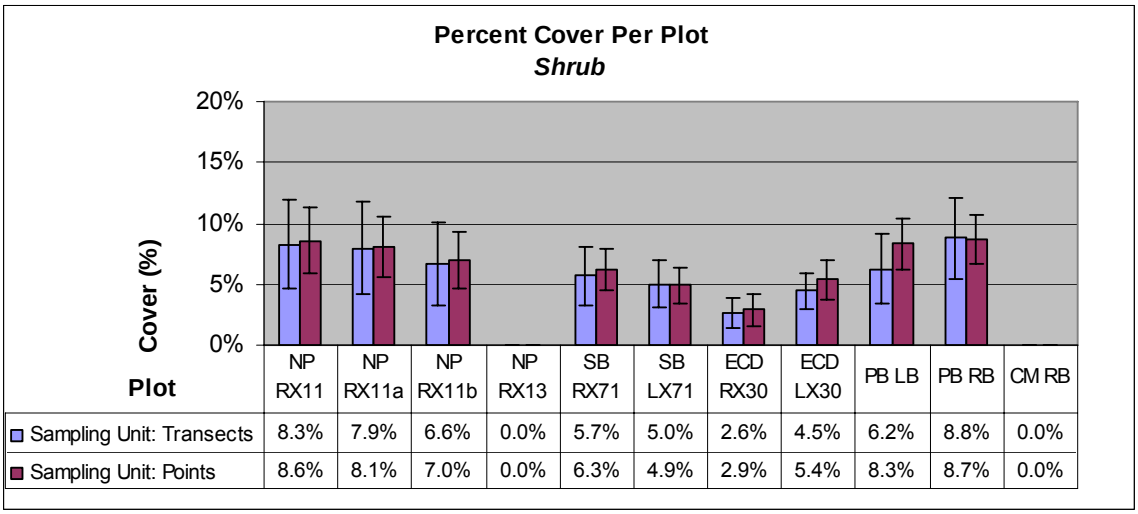
Plot	NP RX11	NP RX11a	NP RX11b	NP RX13	SB RX71	SB LX71	ECD RX30	ECD LX30	PB LB	PB RB	CM RB
Sampling Unit: Transects	1.8%	0.8%	0.0%	0.0%	0.0%	0.0%	7.9%	0.5%	0.6%	0.5%	0.0%
Sampling Unit: Points	1.9%	0.8%	0.0%	0.0%	0.0%	0.0%	8.1%	0.5%	0.6%	0.5%	0.0%

Figure 2.2.23d. Percent cover of perennial plants for each plot.



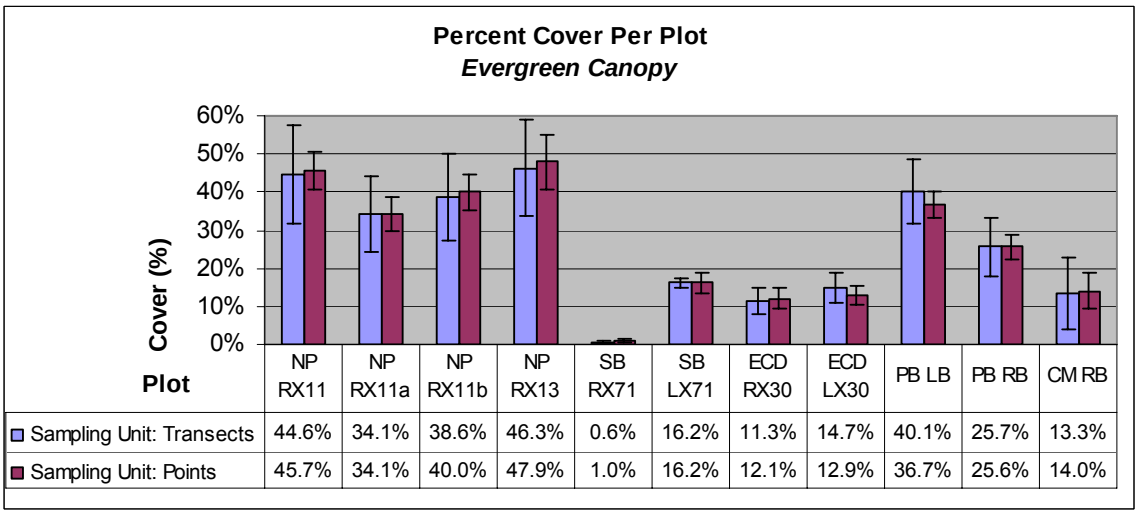
Plot	NP RX11	NP RX11a	NP RX11b	NP RX13	SB RX71	SB LX71	ECD RX30	ECD LX30	PB LB	PB RB	CM RB
Sampling Unit: Transects	10.0%	10.9%	9.6%	6.5%	41.0%	28.7%	14.7%	20.6%	5.6%	10.5%	71.5%
Sampling Unit: Points	10.5%	12.2%	10.4%	6.3%	43.8%	27.0%	14.5%	24.7%	5.0%	10.3%	70.2%

Figure 2.2.23e. Percent cover of shrub for each plot.



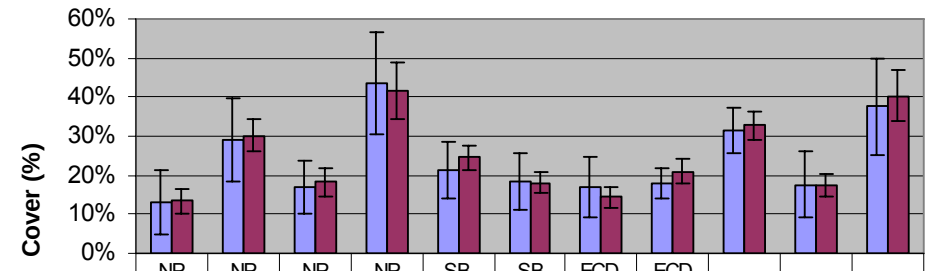
Plot	NP RX11	NP RX11a	NP RX11b	NP RX13	SB RX71	SB LX71	ECD RX30	ECD LX30	PB LB	PB RB	CM RB
Sampling Unit: Transects	8.3%	7.9%	6.6%	0.0%	5.7%	5.0%	2.6%	4.5%	6.2%	8.8%	0.0%
Sampling Unit: Points	8.6%	8.1%	7.0%	0.0%	6.3%	4.9%	2.9%	5.4%	8.3%	8.7%	0.0%

Figure 2.2.23f. Percent cover of evergreen canopy for each plot.



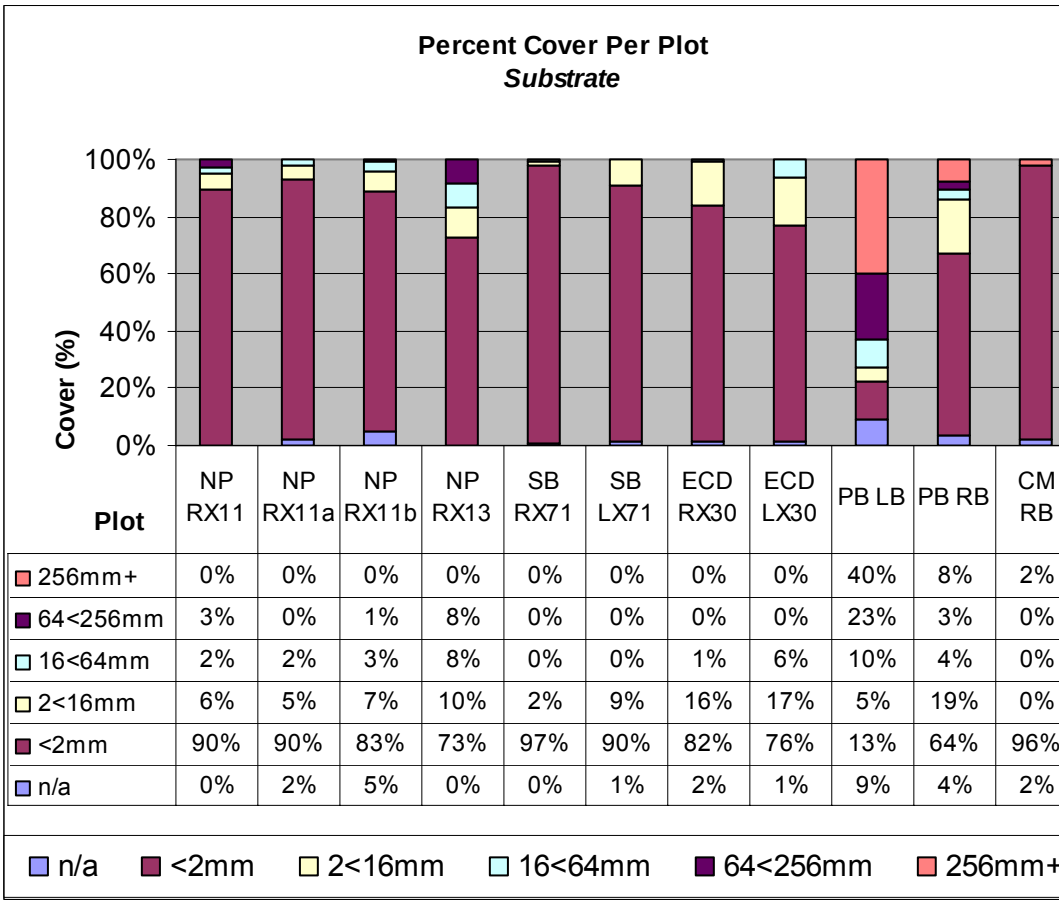
Plot	NP RX11	NP RX11a	NP RX11b	NP RX13	SB RX71	SB LX71	ECD RX30	ECD LX30	PB LB	PB RB	CM RB
Sampling Unit: Transects	44.6%	34.1%	38.6%	46.3%	0.6%	16.2%	11.3%	14.7%	40.1%	25.7%	13.3%
Sampling Unit: Points	45.7%	34.1%	40.0%	47.9%	1.0%	16.2%	12.1%	12.9%	36.7%	25.6%	14.0%

Figure 2.2.23g. Percent cover of deciduous canopy for each plot.



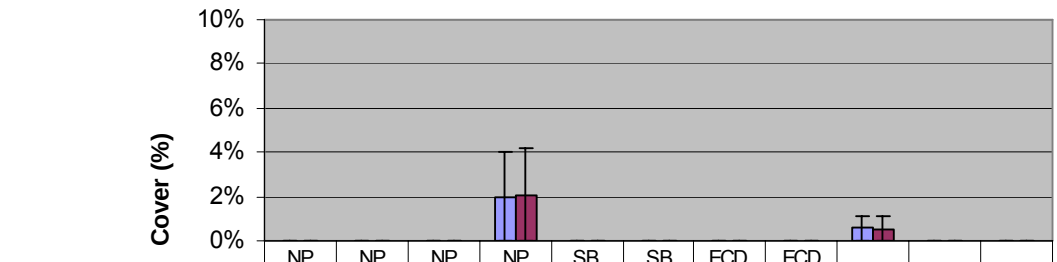
Plot	NP RX11	NP RX11a	NP RX11b	NP RX13	SB RX71	SB LX71	ECD RX30	ECD LX30	PB LB	PB RB	CM RB
Sampling Unit: Transects	13.2%	28.9%	16.9%	43.5%	21.4%	18.4%	17.1%	18.0%	31.5%	17.6%	37.6%
Sampling Unit: Points	13.3%	30.1%	18.3%	41.7%	24.5%	18.1%	14.5%	21.0%	32.8%	17.4%	40.4%

Figure 2.2.23h. Percent cover of substrate for each plot.



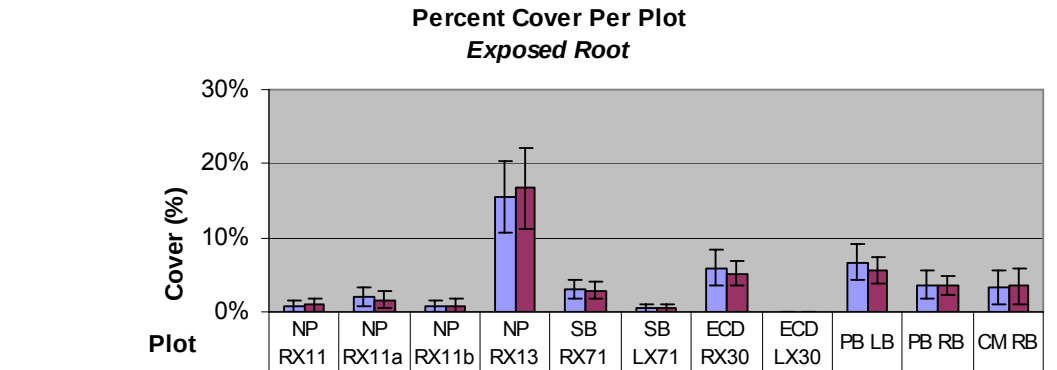
Plot	NP RX11	NP RX11a	NP RX11b	NP RX13	SB RX71	SB LX71	ECD RX30	ECD LX30	PB LB	PB RB	CM RB
256mm+	0%	0%	0%	0%	0%	0%	0%	0%	40%	8%	2%
64<256mm	3%	0%	1%	8%	0%	0%	0%	0%	23%	3%	0%
16<64mm	2%	2%	3%	8%	0%	0%	1%	6%	10%	4%	0%
2<16mm	6%	5%	7%	10%	2%	9%	16%	17%	5%	19%	0%
<2mm	90%	90%	83%	73%	97%	90%	82%	76%	13%	64%	96%
n/a	0%	2%	5%	0%	0%	1%	2%	1%	9%	4%	2%

Figure 2.2.23i. Percent cover of woody seedlings (less than 0.5 meters tall) for each plot.



Plot	NP RX11	NP RX11a	NP RX11b	NP RX13	SB RX71	SB LX71	ECD RX30	ECD LX30	PB LB	PB RB	CM RB
Sampling Unit: Transects	0.0%	0.0%	0.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.6%	0.0%	0.0%
Sampling Unit: Points	0.0%	0.0%	0.0%	2.1%	0.0%	0.0%	0.0%	0.0%	0.6%	0.0%	0.0%

Figure 2.2.23j. Percent cover of exposed root for each plot.



Plot	NP RX11	NP RX11a	NP RX11b	NP RX13	SB RX71	SB LX71	ECD RX30	ECD LX30	PB LB	PB RB	CM RB
Sampling Unit: Transects	0.8%	2.0%	0.8%	15.5%	3.0%	0.5%	5.9%	0.0%	6.7%	3.6%	3.3%
Sampling Unit: Points	1.0%	1.6%	0.9%	16.7%	2.9%	0.5%	5.2%	0.0%	5.6%	3.6%	3.5%

At Sentinel Beach Reach Plot LX 71, there is high variability with transects being used as the sampling unit, whereas, there is low variability when points were used as the sampling unit. There were only 4 transects at this site with one of those transects lying on a stretch of sandy beach and another encompassing an oxbow.

Combined Metrics

Following an initial data analysis, two metrics were lumped together for analysis. These are live understory (a combination of nonvascular, annual, biennial, perennial, and shrub cover); and bare ground plus litter up to 10 meters in length. This analysis was done to help differentiate between sites, see figure 2.2.24. These additional metrics were analyzed with points as sampling units.

Figure 2.2.24a. Percent cover of live understory for each plot.

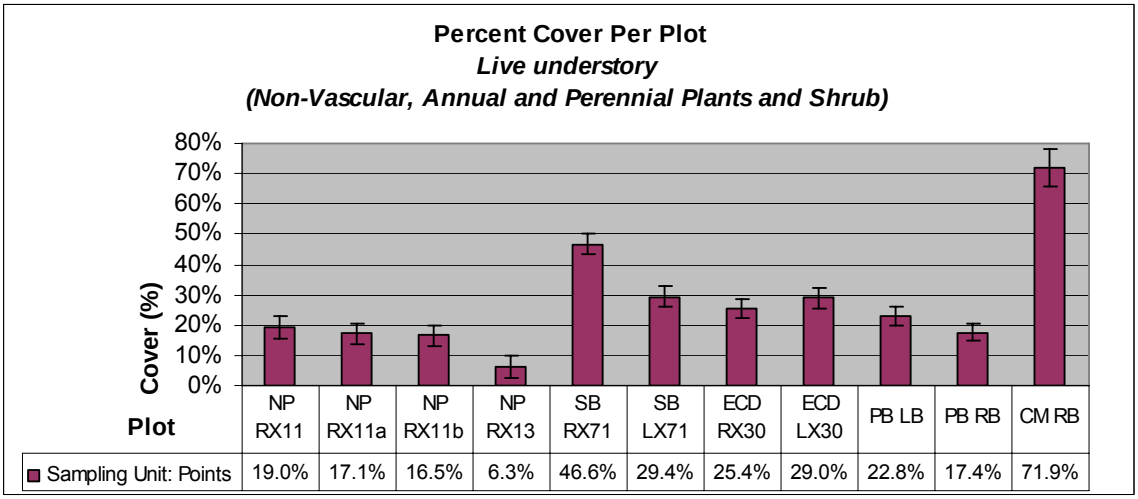
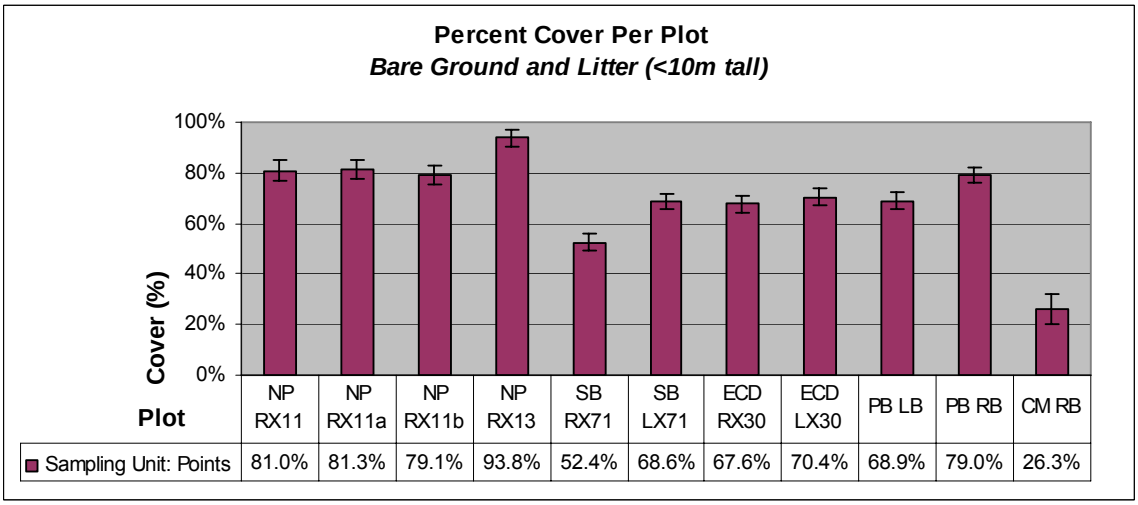


Figure 2.2.24b. Percent cover of bare ground combined with litter less than 10 meters in height for each plot.



By combining nonvascular plants, annuals/biennials, perennials, and shrubs into a live understory class there is more of a distinction between sites than there is when analyzing these metrics separately. For example, the three North Pines replicates are similar to each other, and are distinctly different from Cooks Meadow Reach Plot Right Bank. With nonvascular plants included in the metric combination, a difference in vegetation cover between the right and left banks of Pohono are shown.

When combining bare ground and litter into one metric, there is a distinct difference between sites. The highest percent cover being 93.8% and the lowest being 26.3%.

North Pines replicates

Data was collected three times at the North Pines Reach Plot RX 11 to determine the repeatability of the plots and answer the question: Do observers collect similar data on the same plot when repeated? Chi-square was used as the statistical test to determine if there was a significant change. Points were used as the sampling unit. The data for second and third replicates were collected two weeks after the first. One person in the two person team remained constant. The null hypothesis is that there is no difference between data collected in replicate 1 and 2, replicate 1 and 3, and replicate 2 and 3 for the selected metrics. Results are displayed in Table 2.2.2.

Table 2.2.2. Chi-square comparison using selected metrics for the three North Pines Reach Plot RX 11 replicates 1, 2, and 3.

	Metric	Bare Ground + Litter	Perennial	Shrubs	Perennial + Shrubs	Understory	Deciduous Canopy	Evergreen Canopy
Replicates Compared								
1 -2		0.947	0.684	0.904	0.859	0.699	0.002	0.075
1-3		0.736	0.992	0.654	0.902	0.624	0.318	0.392
2-3		0.674	0.669	0.732	0.957	0.909	0.034	0.234

P-values are reported in the table above and were calculated with an alpha of .10 and df =4.

There was no significant change among most metrics measured which means that our sampling design is repeatable. The exception is the deciduous and evergreen canopy which shows a significant difference between replicates; see Table 2.2.2 (p-values in yellow). This can be rectified by combining the two canopy types into one metric which reduces the variability in canopy cover at this site (shown in Table 2.2.3).

Table 2.2.3. Combined canopy cover replicate comparison.

Replicate	Evergreen cover	Deciduous cover	Combined canopy
RX 11	45.71%	13.33%	59.05%
RX 11a	34.15%	30.08%	64.23%
RX 11b	40.00%	18.26%	58.26%

Discussion

Testing of methodologies recommended at the Riverbank Condition Workshop has shown them to be promising. LiDAR scanning and cross-sections are straightforward and will require little additional development to incorporate into a monitoring protocol. As analysis of the vegetation data suggests, however, further work is needed to refine this critical component. In particular, the role of antecedent conditions within a reach may be quite important.

Channel Morphology

LiDAR works quite well in most areas of the river where vegetation density is relatively low. A single scan that takes about a minute to collect would take more than a day of effort using traditional survey techniques. The utility of LiDAR is limited by dense vegetation and water. The latter cannot be penetrated by current models, though some experimental models using green lasers show considerable promise in this area. Heavy vegetation on a riverbank makes it less likely that the LiDAR unit can 'see' the underlying soil. Despite these limitations, however, ground-based LiDAR surveys offer a cost-effective method for

accurately surveying the full three dimension morphology of riverbanks. The real power of LiDAR data will be in differential analysis when comparing data from two different years. Figure 2.2.9 illustrates the sensitivity of LiDAR scans at the Sentinel Beach site.

Cross-section data compliments LiDAR scans, by providing detail about subsurface morphology of the river. Cross-sections are marked by permanent benchmarks that serve as the primary survey control for future surveys, vegetation and topographic alike. In many cases, sample locations will overlap an extensive network of permanent cross-sections in east Yosemite Valley established in the early 1990's. These data will facilitate analysis of future changes that might occur in the sample reaches.

Vegetation Assessment

2007 was a year for testing a new more rigorous vegetation protocol. As such, our discussion centers on what we learned and what we envision for the full implementation of the protocol in 2008. In the following paragraphs, we examine each component of the protocol.

Sampling Unit

The protocol was originally envisioned with the points being used as sampling units. However, transects were placed more than twice the distance apart as the interval between points on each transect. Thus, they do not qualify as independent points.

If points are used as the sampling unit, a minimum of 200 points will give an absolute confidence interval of 12.2%, alpha = 0.1. This means that given 50% cover, there is an assurance of 90% that the actual value is somewhere between 43.9 and 56.1%. 150 points yields an absolute confidence interval of 14.2%; and 100 points yields 17.4%. These confidence intervals will become narrower as cover estimates move away from 50%.

If we choose to use points as the sampling unit, we will need to alter the plot design so that points can be considered independent. This increases our sample size with the same amount of data (n = number of points vs. n = number of transects), which decreases the variability in the data. A correction to the design could be to set transects 4 meters apart, with points sampled at 2 meter intervals. If the baseline tape remains constant, for example at 100 meters, then the number of points collected will exceed 200, which in turn will be more time consuming. Or, if the points collected remains constant, at 200, then the baseline length will shorten, as will reduce the encompassing area of the plot.

If we choose to use transects as the sampling unit, the number of transects needed will increase. This could be cost prohibitive on wide point bars where a single transect can be 100 meters long.

Sample Metrics

When observing the presence of exposed roots, the type of exposed root was not taken into account. For example, an exposed root from a coniferous tree is recorded the same as an exposed root from an herbaceous plant. However, these types of vegetation play different roles in bank stabilization. Conifers general do not contribute to bank stabilization while roots of herbaceous plants do.

There is a measurable difference between deciduous canopy percent cover of the three NP RX11 replicates. Since NP RX 11a and NP RX 11b were repeated two weeks after NP RX 11, the loss of leaves cannot be attributed to the decrease in canopy cover for NP RX11. Differences could be attributable to wind, which makes collecting canopy point intercept data difficult, or the overlapping layer of evergreen and deciduous canopy in the campgrounds. It is nearly impossible to interpret two canopy hits using a densitometer.

Canopy cover was selected as an index for calculating the population of deciduous trees. This is important because the roots of deciduous trees can stabilize banks. However, looking at canopy may not be the best way to estimate percent cover of trees. For example, NP RX13 and CM RB exhibit similar deciduous canopy cover. However, NP RX13 is largely black oaks, while CM RB is mainly cottonwoods. Black oaks have a wider canopy than do cottonwoods, so while the canopy of cottonwoods may produce

less hits, the population may be greater. Perhaps, this metric would be more useful if oaks were pulled out of this category. Or, a new category of riparian-deciduous (cottonwoods, alders, treelike willows) were added.

When considering which metrics to eliminate, litter and woody plants under 0.5 meters tall may be good candidates. Litter is fairly evenly distributed among sites, and woody plants were too sparse at nearly all sites to show up in the data, so they do not appear to detect change. Also, litter is not expected to contribute to bank stability until lengths of more than 10 meters (class 3 and 4) are reached.

Combining shrub and perennial plant cover may prove to be a useful metric for distinguishing between levels of use. Shrub cover is less than 10 percent in all plots, with NP RX 13 and CM RB exhibiting zero percent cover. NP RX 13 is located in an active high use campground, so the lack of shrubs is most likely due to trampling. Whereas, CM RB is located in a meadow, so the lack of shrubs is most likely due to natural meadow conditions. Both metrics are clearly important for determining the health of riparian vegetation, yet their influence depends on the setting. Combining them appears to limit variability and provide a more robust indicator of change.

Sample stratification

We recommend that resources be focused on establishing permanent plots based on a complex stratification method. A combination of river morphology, vegetation types, and bank slope followed by a visitor use overlay will provide the best chance of detecting change at the earliest onset. For example, river morphology takes into account the natural differences between outside bends and point bars; considering vegetation types takes into account the variances between meadow and coniferous zones as it relates to the characteristics of their associated vegetation; varying degrees of bank slopes will also have characteristics natural to them, and should be taken into account.

Sample timing

Sampling should be conducted late in the growing season, before herbaceous plants die back and before deciduous trees and shrubs lose their leaves. Herbaceous cover is predicted to be similar between heavily and lightly trampled areas early in the growing season. As the season progresses, however, heavily trampled areas are predicted to experience cover reductions, while untrampled areas are predicted to increase cover due to plant growth. Thus, sampling late in the growing season is more likely to detect impacts caused by trampling. Specifically, we recommend sampling from mid-August through the end of September.

Conclusions and Future Work

Though many refinements of this protocol must take place before full implementation, it is clear that the methods used are far less subjective than previous efforts to quantify riverbank conditions. The introduction of permanently marked sample reaches that can be relocated in the future coupled with quantitative measurements of bank and channel morphology and bank vegetation will add significant rigor to this indicator. Though implementation of this protocol will initially be more time intensive than the previous index-based assessment, it will likely prove more cost-effective, as a result of enhanced repeatability and less inherent variability.

Full implementation of this indicator will take place in 2008 along the Merced River in Yosemite Valley. In the winter of 2007 and spring of 2008, the riverbank condition monitoring team will make site selections and stratify them according to use levels and river morphology. Vegetation personnel will continue to refine the vegetation protocol including relevant statistical analyses required for development of a standard. It is expected that field crews will establish 15-20 200 meter long monitoring reaches in Yosemite Valley.

2.3 WILDLIFE EXPOSURE TO HUMAN FOOD

The Merced River corridor provides habitat for a variety of animal species. Myriad insects, birds, amphibians and mammals depend on the river and its surroundings for survival. This wildlife is part of the Merced River's Biological Outstandingly Remarkable Values. However, studies have shown that human use may have an adverse impact on wildlife (Decker et al. 1992, Manfredo et al. 1995). Impacts include loss of habitat and food, predation, habituation, and others.

Of particular concern in many national park units is the feeding of wildlife. In Yosemite Valley human-bear interactions have been of concern. The Black Bear (*Ursus americanus*) is quite common in the park and human interaction with them is frequent. These interactions, however, have not always been positive. Often visitors will make their food available to bears by leaving it un-attended at their campsite or in their car. There are documented instances of bears breaking into visitors' vehicles or rummaging through their camp to obtain this food. Bears can become conditioned to human food and are intelligent enough to pursue this food source to the detriment of both the animal and the visitor. A bear's ability to successfully survive in the wild is diminished when it becomes conditioned to human food. And bear "break-ins" to visitors' vehicles and campsites can cause significant impacts to personal property and the quality of a visitors' experience.

Therefore, an indicator was developed in 2004 to measure visitor compliance with food storage regulations. Compliance rates provide meaningful information as to the extent to which human food may be available to bears. This indicator is thought to be the best proxy to understand the extent to which human use in the Merced River corridor is causing negative impacts to bear populations.

Measurement

Percent compliance with food storage regulations at selected sights.

Standards

95% or greater compliance with food storage regulations in selected campgrounds and parking areas.

Sampling

The monitoring data for this indicator was collected and incorporated into the Bear Patrol Log Database (BPLD). The BPLD was developed for the Human-Bear Management Program (HBMP) in 2005 to ensure accountability with HBMP-funded employees and to collect data on bear monitoring and management activities in the field. In Yosemite Valley, there are an average of 15 HBMP-funded employees that spend at least 80% of their time on bear related issues between the months of May and September. These employees include Visitor Protection, Campground and Interpretation Rangers, and Wildlife Technicians. While the primary duties differ among work units, all employees share the common goal of mitigating human-bear conflicts and protecting wildlife from exposure to human food. This is accomplished through proactive patrols between the hours of 5 p.m. and 4 a.m. when bear activity is the greatest. During patrols, visitors are educated about proper food storage through one-on-one interpretive contacts, campsites and vehicles are checked for food storage compliance, and food storage regulations are enforced through verbal or written warnings and citations. Non-compliance includes the following violations:

1. Feeding human food to wildlife – Knowingly offering human food or baiting wildlife.
2. Improper food storage – Human food stored in locations that are considered inappropriate, such as inside vehicles after dark or in containers that are not approved by the park as wildlife resistant;
3. Improper use of food locker – Food is put in food locker but the locker is wide open, unlocked, or not latched in a way consistent with the instructions provided and the visitors are either away from their site or asleep.
4. Leaving food unattended – Food left in open locker, out in campsite, or other location where the food is out of arms reach, is not actively being prepared or eaten, and/or the food is not visible to any of the camp occupants.

Campground inspections to determine compliance rates were generally conducted after 10 p.m. when most visitors were finished eating dinner and food was put away. Inspections conducted earlier than 10 p.m. often resulted in a very low compliance rate because most people preparing dinner had their food lockers open and food items out of arms reach. These incidents were documented in the BPLD as educational contacts rather than violation or inspection records.

Parking lot inspections were conducted throughout the night, but because food stored inside vehicles during daylight hours is legal, compliance checks on vehicles could only be performed after dark.

Average compliance rates were determined by inspecting either a certain number of campsites or vehicles. The number of food storage violations was also documented, but not necessarily as part of an inspection. On many occasions, especially when responding directly to bear activity, food storage violations were found, corrected and documented, but were not calculated in the average compliance rate for an area because they were not part of an inspection. In the BPLD, food storage violation records can either stand alone or be part of an inspection record.

Figure 2.3. Bear control food storage lockers.

Results

1. General Compliance

The primary measure for this indicator is *compliance rate*, or the extent to which visitors comply with Yosemite's food storage regulations. Table 2.3.1 presents results of compliance analysis based on the wildlife patrol log database. In 2007, five additional locations were inspected, along with the six locations inspected since 2005. Data represents inspections and violations that occurred between May 15, 2007 and November 10, 2007. Inspections included only those with over 50% of the average units inspected. Campsite inspections were also only included if they occurred after 10 pm May through August and after 8 pm September through November. Among these eleven locations a total of 711 inspections were conducted in 2007. During these inspections 31,616 vehicles and 27,086 campsites were inspected. Results show that Upper Pines Campground and Yosemite Lodge Parking Lot had the highest overall compliance rates of 98.6% and 97.4%, respectively, for campsite and vehicle inspections, whereas Camp 4 campsites had the lowest overall compliance rate of 89%. It should be noted that Camp 4 is different than the other campgrounds surveyed. It is similar to other campgrounds in that there are only six visitors allowed per campsite. It is different in that these visitors may or may not be associated with each other. It is possible on a given night that all six visitors are more like individual campsites. Because of this, it may be possible that the number of campsites inspected is not an accurate picture of compliance rate. It may be more accurate to determine the average number of parties per night and use that as the number inspected.

Table 2.3.1. Results of general compliance analysis.

Location	Inspection Type	# Inspected	Overall Compliance Rate (Red indicates location met 95% standard)
Ahwahnee Parking Lot	Vehicle	4866	94.6%
Camp 4 Parking Lot	Vehicle	9584	94.6%
Curry Orchard Lot	Vehicle	4712	96.5%
Curry Village – DNC	Vehicle	2217	94.6%
Wilderness Lot	Vehicle	2328	96.3%
Yosemite Lodge Parking Lot	Vehicle	7909	97.4%
Camp 4 Campground	Campsite	3964	89.0%
Housekeeping Camp	Campsite	6495	95.2%
Lower Pines Campground	Campsite	2728	98.2%
North Pines Campground	Campsite	3478	97.7%
Upper Pines Campground	Campsite	10421	98.6%

2. Monthly Compliance:

Detailed results of monthly compliance are provided in Table 2.3.2. All locations achieved a compliance rate of over 90%. Upper Pines Campground was the only location to exceed the 95% standard during all five months.

Table 2.3.2. Monthly compliance rates by location.

Location	Inspection Type	# Inspected	Compliance Rate
May			
Ahwahnee Parking Lot	Vehicle	233	96.3%
Camp 4 Parking Lot	Vehicle	730	95.9%
Curry Orchard Lot	Vehicle	275	99.3%
Curry Village – DNC	Vehicle	0	0%
Wilderness Lot	Vehicle	238	97.9%
Yosemite Lodge Parking Lot	Vehicle	831	98.8%
Camp 4 Campground	Campsite	315	90.8%
Housekeeping Camp	Campsite	798	96.1%
Lower Pines Campground	Campsite	455	98.2%
North Pines Campground	Campsite	594	96.6%
Upper Pines Campground	Campsite	1410	98.9%
June			
Ahwahnee Parking Lot	Vehicle	73	94.5%
Camp 4 Parking Lot	Vehicle	1667	94.1%
Curry Orchard Lot	Vehicle	1030	98.3%
Curry Village – DNC	Vehicle	90	100%
Wilderness Lot	Vehicle	145	97.2%
Yosemite Lodge Parking Lot	Vehicle	3641	97.3%
Camp 4 Campground	Campsite	875	90.3%
Housekeeping Camp	Campsite	1464	96.2%
Lower Pines Campground	Campsite	131	98.5%
North Pines Campground	Campsite	323	97.2%
Upper Pines Campground	Campsite	930	99.2%
July			
Ahwahnee Parking Lot	Vehicle	853	94.6%
Camp 4 Parking Lot	Vehicle	1871	93.8%
Curry Orchard Lot	Vehicle	963	98.2%
Curry Village – DNC	Vehicle	641	93%
Wilderness Lot	Vehicle	448	96.7%
Yosemite Lodge Parking Lot	Vehicle	1622	96.4%
Camp 4 Campground	Campsite	889	90.6%
Housekeeping Camp	Campsite	682	96.8%
Lower Pines Campground	Campsite	190	98.4%
North Pines Campground	Campsite	455	96.7%
Upper Pines Campground	Campsite	1526	98.7%

Table 2.3.2. Monthly compliance rates by location (continued).

August			
Location	**Inspection Type**	**# Inspected**	**Compliance Rate**
Ahwahnee Parking Lot	Vehicle	729	95.9%
Camp 4 Parking Lot	Vehicle	1538	95.1%
Curry Orchard Lot	Vehicle	1545	95.2%
Curry Village – DNC	Vehicle	200	98%
Wilderness Lot	Vehicle	757	97.5%
Yosemite Lodge Parking Lot	Vehicle	872	95.9%
Camp 4 Campground	Campsite	454	89.7%
Housekeeping Camp	Campsite	1423	96.2%
Lower Pines Campground	Campsite	198	98%
North Pines Campground	Campsite	376	97.3%
Upper Pines Campground	Campsite	1097	98.6%
September			
Location	**Inspection Type**	**# Inspected**	**Compliance Rate**
Ahwahnee Parking Lot	Vehicle	1518	94%
Camp 4 Parking Lot	Vehicle	1762	95.9%
Curry Orchard Lot	Vehicle	899	94%
Curry Village – DNC	Vehicle	534	94.4%
Wilderness Lot	Vehicle	605	94.2%
Yosemite Lodge Parking Lot	Vehicle	274	100%
Camp 4 Campground	Campsite	663	87.5%
Housekeeping Camp	Campsite	2128	93%
Lower Pines Campground	Campsite	1318	98.3%
North Pines Campground	Campsite	1563	98.5%
Upper Pines Campground	Campsite	3603	98.5%
October			
Location	**Inspection Type**	**# Inspected**	**Compliance Rate**
Ahwahnee Parking Lot	Vehicle	1390	95.1%
Camp 4 Parking Lot	Vehicle	1745	93.6%
Curry Orchard Lot	Vehicle	0	0%
Curry Village – DNC	Vehicle	752	94.4%
Wilderness Lot	Vehicle	135	94.1%
Yosemite Lodge Parking Lot	Vehicle	505	99.4%
Camp 4 Campground	Campsite	523	84.5%
Housekeeping Camp	Campsite	0	0%
Lower Pines Campground	Campsite	436	97.9%
North Pines Campground	Campsite	167	98.8%
Upper Pines Campground	Campsite	1615	98.3%

Table 2.3.2. Monthly compliance rates by location (continued).

November			
Location	**Inspection Type**	**# Inspected**	**Compliance Rate**
Ahwahnee Parking Lot	Vehicle	70	100%
Camp 4 Parking Lot	Vehicle	271	95.9%
Curry Orchard Lot	Vehicle	0	0%
Curry Village – DNC	Vehicle	0	0%
Wilderness Lot	Vehicle	0	0%
Yosemite Lodge Parking Lot	Vehicle	164	100%
Camp 4 Campground	Campsite	245	88.2%
Housekeeping Camp	Campsite	0	0%
Lower Pines Campground	Campsite	0	0%
North Pines Campground	Campsite	0	0%
Upper Pines Campground	Campsite	240	99.6%

Figure 2.3.2 portrays the overall compliance rates of vehicle inspection locations from June through September. Data was incomplete for some locations in May, October and November, therefore those months were eliminated from the graph. The parking lots exhibited less stability compared to campground compliance rates. Upper Pines Campground (campsite inspection) exhibited high levels of stability over the use season, while the compliance at the other five locations was less stable. For example, the Curry (DNC) Parking Lots ranged from 94% to 100% throughout the season. The only parking lot locations that maintained the 95% standard throughout the season were Yosemite Lodge and the Wilderness Lot (Trailhead Parking).

Figure 2.3.1. Overall vehicle compliance rates by month and location.

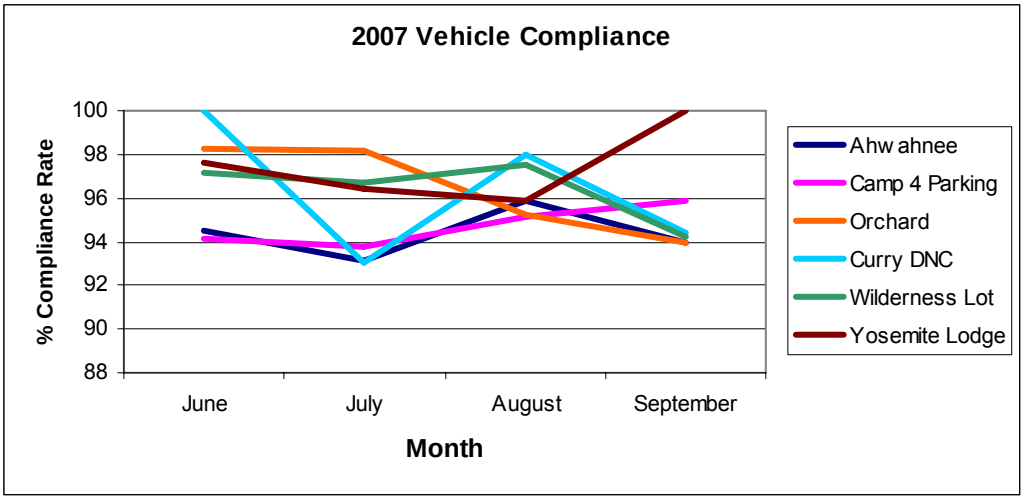


Figure 2.3.2. Overall vehicle compliance rates by month and location.

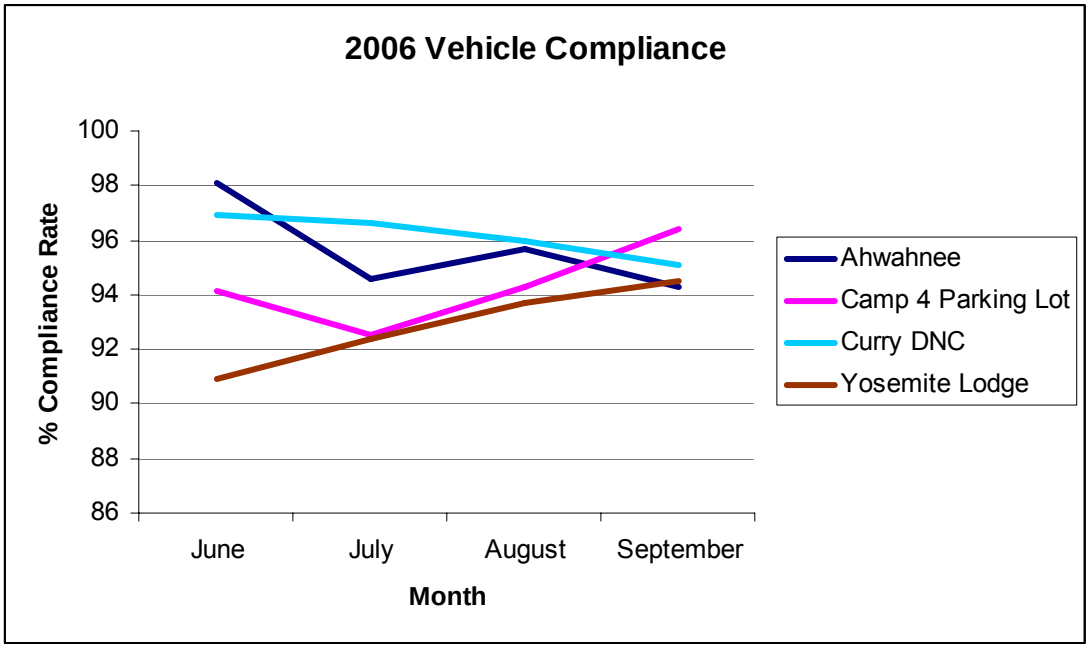
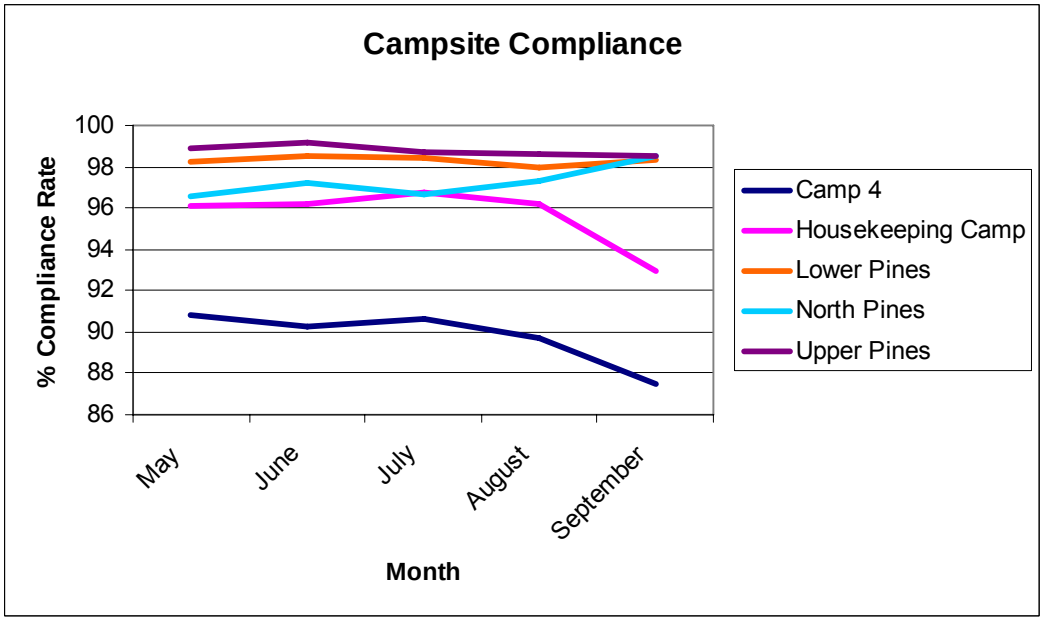


Figure 2.3.3. portrays the overall compliance rates of campsite inspection locations from May through September. Data was incomplete for some locations in October and November due to campground closures; therefore those months were eliminated from the graph. The campsites exhibited higher levels of stability compared to vehicle compliance rates. Camp 4 Campground never reached a compliance rate greater than 90.8% and Housekeeping Camp fell below the 95% standard in September.

Figure 2.3.3. Overall campsite compliance rates by month and location.



3. Types of Violations:

The BPLD documented the type of violation for each non-compliance record. An understanding of the distribution of violation types in different locations can help customize management and public communication strategies at specific facilities and use areas. Table 2.3.3. displays the distribution of violation types across six vehicle inspection locations and across the seven different violations that are tracked during inspections.

Table 2.3.3. Frequencies of violations by type and location for vehicle inspections.

Violation Type	Ahwahnee	Camp 4 Parking	Orchard Parking	Curry Village	Wilderness Lot	Yosemite Lodge	Total (Type)
Unattended food or attractant in vehicles	274	577	168	120	85	335	1559
Unattended food or attractant	1	2	0	0	0	2	5
Food Locker/left open	0	0	0	0	0	0	0
OB camper w/ food in vehicle		0	3	0	0	0	3
Visitors too far from food	0	3	0	0	1	0	4
Food Locker/Improperly locked	0	0	0	0	0	0	0
Baiting	0	0	0	0	0	0	0
Total *(Location)*	**275**	**582**	**171**	**120**	**86**	**337**	**1571**

The results indicate that unattended food or attractant in vehicles was the most common type with 1559 counts of violation. Camp 4 Parking Lot appears to have a significant problem with visitors leaving their food or attractant unattended in vehicles.

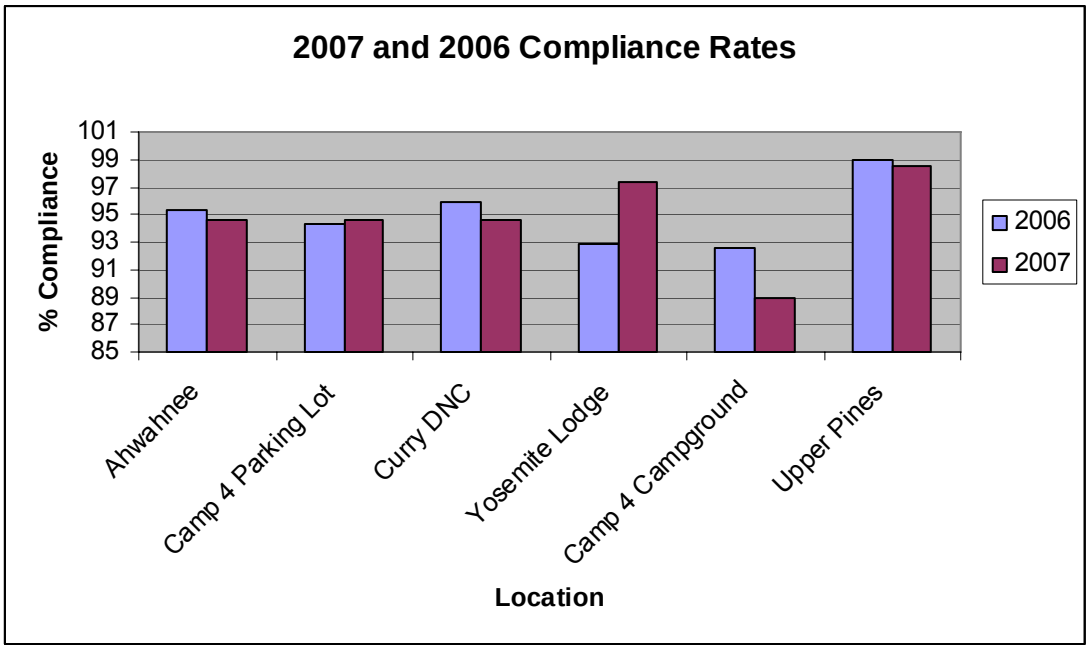
Table 2.3.4. Frequencies of violations by type and location for campsite inspections.

Violation Type	Camp 4 CG	Housekeeping Camp	Lower Pines	North Pines	Upper Pines	Total (Type)
Unattended food or attractant in vehicles	0	4	4	13	20	41
Unattended food or attractant	122	61	11	20	27	241
Food Locker/left open	21	10	6	10	10	57
OB camper w/ food in vehicle	0	1	0	0	65	66
Visitors too far from food	281	15	3	13	65	377
Food Locker/Improperly locked	147	160	22	23	42	394
Baiting	0	0	0	0	0	0
Total *(Location)*	**571**	**251**	**46**	**79**	**229**	**1176**

Campgrounds had a wider range of violations, especially those related to food locker use and visitors too far from food. Food lockers improperly locked, visitors leaving food unattended, and visitors too far from their food were the most common violations. Camp 4 Campground appears to have the most significant problem with visitors not storing food properly.

Year to year comparison:
In 2007, compliance rates dropped slightly compared with 2006 compliance rates. Yosemite Lodge increased their compliance rate by 4.6% while Camp 4 Campground had a 3.6% decrease in overall compliance rate. Factors that could have influenced the increase at Yosemite Lodge include better training for front desk staff on giving a good bear message. The decrease in compliance at Camp 4 campground could have been the result of the campground hosts leaving their volunteer positions mid-season. The campground hosts play an important role in mitigating food storage violations and their absence no doubt affected the compliance in the campground.

Figure 2.3.4. Overall 2007 compliance rates compared with 2006 compliance rates.



Discussion

Results from the 2007 field season suggest that food storage compliance rates at seven out of the eleven inspection locations exceeded the proposed standard of 95%. Management attention is needed for certain locations, such as Camp 4 Campground, especially towards the end of the summer months. As previously mentioned, the lower compliance rate in Camp 4 may have been the result of not having campground hosts to help mitigate food storage violations and provide educational messages about bears during the later summer months.

This year, five additional locations in Yosemite Valley were inspected as part of the User Capacity Monitoring protocol for this indicator. The Interdivisional Bear Team was patrolling these locations on a regular basis as a normal part of their routine so it made sense to add these locations to the locations inspected for User Capacity Monitoring. In the protocol, inspections were to be completed once a week per location, May 15th through November 10th. However, due to several factors including staffing levels, campground closing dates, high bear activity during the day, and bear activity in other areas of the park,

inspections were not always completed once a week for every location. Table 2.3.5. portrays the number of inspections completed throughout the season for each location and the percentage of weeks that were inspected. Many times, locations were inspected more than once a week, but due to bear activity in other areas, the same location would not be inspected at all the following week. Depending on bear activity in 2008, a better effort could be made to ensure all locations are inspected each week.

Table 2.3.5. Inspections Completed.

Location	Total Inspections Completed (May 15 – Nov 10)	Percentage of Weeks Inspected
Ahwahnee Parking Lot	150	73%
Camp 4 Parking Lot	132	100%
Curry Orchard Lot	30	58%
Curry Village – DNC	20	38%
Wilderness Lot	53	73%
Yosemite Lodge Parking Lot	59	84%
Camp 4 Campground	114	100%
Housekeeping Camp	26	76%
Lower Pines Campground	38	68%
North Pines Campground	43	86%
Upper Pines Campground	46	84%

In 2008, accomplishing the following objectives may improve food storage compliance rates:

- Campground hosts for Camp 4 will be hired from the Wildlife Management volunteer applicant pool to better ensure candidates have a wildlife background and are dedicated to working for a NPS wildlife program.
- Recognizing the importance of good training, DNC employees at front desks will again be trained to give effective wildlife messages to visitors checking into lodging.
- Additional employees will be hired to respond to bear activity during the day and in outlining areas of the park.
- Increased messaging through Interpretation and Campground staff on the importance of ensuring food lockers are latched properly.
- Increased presence of protection rangers in all Valley campgrounds to enforce food storage compliance.

2.4 EXTENT AND CONDITION OF INFORMAL TRAILS

Informal trails (or visitor-created "social" trails) may be defined as discernible and continuous trail segments that were created by visitors and which do not follow a park's formal trail system (Leung et al. 2002). Since informal trails are not planned or constructed they are usually poorly located with respect to terrain. These trails also receive very little or no maintenance. These factors substantially increase their potential for degradation in comparison to formal trails. The proliferation of informal trails may increase habitat fragmentation and can directly threaten sensitive habitats when crossed or accessed by unplanned trails (Tylser and Joghson 2004). From a social perspective, a web of informal trails creates a visually scarred landscape and may lead to safety and liability concerns. Due to their ecological and social significance, informal trails are a common indicator selected in different implementations of NPS's UCMMP planning framework and Vital Signs monitoring program.

Monitoring can provide timely information on the extent, distribution and condition of informal trail segments. The findings from data collection combined with established minimum acceptable conditions can serve as warning signs of resource degradation and habitat intrusion. In turn, such information can trigger management action.

Most previous informal trail monitoring studies focused on proliferation (number of places they occurred) throughout the park landscape. These studies did not include any added information about the trail. For example, trail length, width, or classification was not recorded. This approach made it difficult to assess the effect the trails may have on the resources. Fortunately, three main monitoring approaches have been developed specifically for informal trails. One approach is to include informal trails as part of an overall visitor impact study. In this type of study, the level of informal trail proliferation is assessed by tallying the occurrence of informal trail segments extending from formal trail networks or recreation sites (Marion 1994; Leung et al. 2002). Another approach is to inventory and map the entire informal trail network of a park or selected portions of a park (Cole et al. 1997; Leung et al. 2002). Yet another approach, used to enable temporal evaluation and used in a few studies, is to actually monitor informal trail networks more than one time (YOSE 2005). Most of these studies incorporated condition class ratings and assessments into their protocol.

Due to the extensive nature of some informal trail networks, the efficiency of field assessments is of particular concern. The advent of geospatial techniques such as geographic information systems (GIS), global positioning system (GPS), and remote sensing will provide potential solutions to this challenge. These technologies are particularly relevant to informal trail monitoring due to their dispersed spatial distribution. In 2004, Witztum and Stow demonstrated the utility of multi-spectral imagery and digital image processing techniques in extracting informal trails in a coastal sage scrub community (Witztum and Stow 2004).

This report presents the findings from the data collected through surveying the extent and condition of informal trails in selected sites in Yosemite Valley and Tuolumne Meadows. In 2007, baseline data was further expanded with monitoring conducted in the high use areas between the Lyell and Dana forks of the Tuolumne River.

The original methods were refined and repeated in 2005 to confirm 2004 mapping results. Particular attention was placed on clarifying condition class definitions. Resulting from workgroups in 2005 through 2007, it has been decided that the *extent* of informal trails (as represented by density of informal trails) is a more meaningful parameter than solely *length* of informal trails because it is relative and allows for cross-meadow comparisons. In 2007, condition classes were again assigned to all mapped trails. However, "barely discernible trail" and "flattened vegetation" were eliminated and the remaining condition classes included stunted vegetation, some bare ground, barren and braided. Rutted and braided also remained as condition class attributes. Disturbed areas were delineated as polygon shapes so that an integrated parameter of "density of disturbed area" can also be achieved. Otherwise, our collection methods remained consistent with the 2006 protocols.

Description of indicator and standard

Indicator: Extent (density) and condition of informal trails in the meadows of Yosemite Valley and in the meadows and high use areas of Tuolumne Meadows. These are specific areas of concern due to their location within the corridors of the Merced and Tuolumne Rivers, which have been given the congressional status of "Wild and Scenic", thereby requiring compliance with the regulations protecting rivers of this designation.
Standard: No net increase in density of informal trails when compared with baseline (for Yosemite Valley). Baseline established in 2004 and 2005. In Tuolumne Meadows, 2007 mapping added to data collected in 2005 and 2006 to increase baseline dataset. Baseline will be updated as restoration actions are implemented and data are re-collected to reflect restoration efforts. In addition, a range of density threshold values of disturbed areas and trailing will be developed through consultation with professionals specializing in recreation and meadow ecology. The resulting standard will be developed through a combined effort from scientists and park management/planning specialists and will be based on desired conditions associated with particular management zones designed to protect Wild and Scenic River ORV's.
Zone(s): 2B Discovery, 2C Day Use, and Tuolumne Meadows Concept Plan area.

Rationale for indicator: Monitoring the extent and condition of informal trails in meadows contributes to the protection and enhancement of many of the Outstandingly Remarkable Values (ORV) of the Merced River Corridor. The biological ORV is represented through the following rationale: the extent and condition of informal trails is indicative of the contiguity and ecological health of meadows and wetland areas, and impacts to wildlife habitat, including special-status species. The cultural ORV is represented through the fact that archaeological sites and traditional gathering areas used by American Indian groups exist in some meadows, and could be affected by the proliferation and length of informal trails in meadows. The recreation ORV is represented through the belief that informal trails in meadows may affect visitor experience, as meadows are enjoyable areas in which to engage in a variety of recreational opportunities—including nature study, photography, etc. And lastly, but not finally, the scenic ORV is represented by the extent to which informal trails may impact the scenic interface of river, rock, meadow, and forest.

Objectives

To document the extent and condition of informal trails in meadows of Yosemite Valley and Tuolumne Meadows; to further establish baseline data on these impacts; and to compare results (where applicable) to data collected in 2004 through 2007. Results will be used to inform management decisions regarding protection of meadow health.

Sampling Design

In 2004, a GPS inventory of informal trails in the meadows of Yosemite Valley was undertaken. Monitoring was repeated in 2005 to verify results and explore potential factors that could cause variation in collected data (e.g. monitoring post-deer rut, which potentially skewed results; weather variability influencing soil moisture and trailing patterns, etc.

In Tuolumne Meadows, no data existed on informal trails until mapping was conducted in the main meadow area (north of Highway 120, east of Pothole Dome, and west of Lembert Dome) in 2005. In 2006, monitoring efforts focused on expanding this baseline data in high use areas to the east of the Highway 120 Bridge. In 2007, additional baseline data was collected in the high use areas between the Dana and Lyell forks of the Tuolumne River. This inventory of informal trails in the Tuolumne Meadows area is needed to create a baseline to which data from subsequent monitoring efforts can be compared. It will also be used in the Tuolumne Meadows Concept Plan planning efforts. Later, assessments may involve monitoring selected meadow areas via a sampling scheme similar to the one described above for Yosemite Valley.

Site selection

In 2007, five Yosemite Valley meadows were monitored: Stoneman, Leidig, Sentinel, Ahwahnee, and Bridalveil. Stoneman meadow exhibited a slight increase in trail length so it was monitored to confirm trends in informal trail development. Leidig was chosen using a random table. Sentinel, Ahwahnee and Bridalveil were selected since they were last monitored in 2005.
Also in 2007, additional baseline data was collected in Tuolumne Meadows in the high use areas between the Dana and Lyell forks of the Tuolumne River.

Sampling schedule

In Yosemite Valley, monitoring was conducted over a four-week period, between mid-July and mid-August (before the fall deer rut). In Tuolumne Meadows, monitoring was conducted between September and October.

Data Analysis Procedures
(For detailed data analysis procedures see the Informal Trails section of the 2007 UCMMP Field Guide.)

Due to the large amount of attributes that may influence the integrity, functioning and quality of landscape, ecosystem or park environment, indices are commonly used to integrate various attributes for data reporting and communication in such fields as ecology, landscape ecology, conservation studies and environmental sciences. There is a large body of literature on landscape indices (Chust et al. 2004; Forman 1995; McGarigal & Mark, 1995) as well as indices developed for characterizing visitor impacts (Leung & Marion, 1998). One of the most comprehensive references on this topic was published by McGarigal and Marks (1995) in which more than 50 landscape indices were identified and described.

An initial review of landscape indices suggested that *three* indices were closely related to the key issues and concerns about informal trails. The indices were chosen due to their reflection of *proliferation* and *fragmentation* in a landscape (meadow), and for their relative ease to derive from GIS/GPS data using common GIS software such as ESRI ArcGIS. These three indices, Mean Patch Size, Core Area Index and Largest Patch Size (McGarigal and Marks, 1995), were tested in ArcGIS with El Capitan Meadow's 2006 data and results reported to the Park staff in October 2007.

Based on the discussion with the Park staff and particularly the GIS specialist, two of the three indices, Mean Patch Size and Largest Patch Size, were modified to better reflect the nature of informal trail impacts. The modified indices are named *(1) Weighted Mean Patch Index (or WMPI) and (2) Largest Patches Index (or LPI-5)*. The Core Area Index was eliminated from consideration because of the difficulties of its interpretation. Efforts will continue to be made to identify other appropriate metrics so that the most informed choice of informal trail indices can be made at the end of the pilot monitoring program (2009). The following is a description of each selected index:

A. Weighted Mean Patch Index (WMPI)
Definition: This index was built on the Mean Patch Size (MPS) metric described in McGarigal and Marks (1995). Despite its intuitiveness, MPS suffers an important limitation in that it is not sensitive to the shrinking of patches without informal trials as a whole as informal trails proliferate in a landscape. To address this limitation, a weighting factor was added to adjust for the spatial extent of informal trail network. It is defined as the average area (in square meters) of all patches without informal trails in a landscape, weighted by the extent of disturbed areas associated with informal trail impacts. In other words, this index is indicative of the average size of patches without informal trials with consideration of the dominance of informal trail features in a landscape.

Metric: $WMPI = wf * (\sum aij / n) * (1/10000)$

where $wf = (\sum aij / A)$

Notations: aij = area (m2) of patch ij, n = total # of patches without informal trails, wf = weight factor, A = landscape/meadow area
Unit: square meters
Range: 0 to infinity
Interpretation: Decreasing values indicate increasing degrees of fragmentation. Increasing spatial extent of informal trails would result in reduced index values even if the average patch size does not change.

B. Largest Patches Index – Five (LPI-5)
Definition: Adapted from the concept of Largest Patch Index (McGarigal and Marks 1995), this index is derived from the sum of areas of the five largest patches without informal trails, divided by total landscape (meadow) area. The main purpose of including the largest patches as a group, rather than merely the largest patch, is to reduce the index's over-sensitivity to changes in one single patch. Three and ten largest patches (LPI-3, LPI-10) were also considered, and five was chosen by the research team and park staff to achieve a balance between simplicity and representativeness. This index could be easily adapted if a different number of patches was desired in a later date.

Metric: $LPI\text{-}5 = \sum max5 (aij) / A * 100\%$

Notations: maxi = the largest i patches; aij = area (m2) of patch ij, A = area (m2) of the landscape (meadow)
Unit: Percent
Range: 0-100
Interpretation: Decreasing values would suggest increasing degrees of fragmentation

Meadow Boundary

In 2005, the meadow boundary of each of the eight Yosemite Valley meadows was mapped using a GPS mapping device. The boundary location was determined (delineated?) through vegetation classification, the location of roads, and historic meadow boundaries.

Additionally, beginning in 2007, infrastructure such as formal trails, boardwalks, and roads will be used to determine meadow boundaries, and in some cases will result in meadows being separated into sub-meadows for purpose of analysis. Also for analysis purposes, infrastructure will not be included as part of the meadow, because infrastructure does not fit the definition of meadow nor are they informal trails or disturbed areas. The following steps summarize these procedures and can be viewed in more detail in the Informal Trails section of the 2007 UCMMP Field Guide.

First, if the meadow contains infrastructure, the infrastructure is erased from the meadow area and meadow segments are created. The area of the resulting segments are then calculated and compared to the area of the original meadow. If the segment area is greater than five percent of the original meadow area, then a sub-meadow is created. If the segment area is less than or equal to five percent of the original meadow area, then the segment remains part of the original meadow and a sub-meadow is not created. In both cases, infrastructure is not included as data to be analyzed.

Lastly, based on work by Jeff Holmquist in x-x, a five meter buffer was added to the informal trails and disturbed areas to illustrate these findings.

Results

Figures 2.4.1 through 2.4.11 depict informal trails and disturbed areas observed through GPS inventory in Ahwahnee, Bridalveil, Leidig, Sentinel and Stoneman meadows in 2007; figures 2.4.1 through 2.4.7 depict the actual width of informal trails and disturbed areas, whereas, figures 2.4.8 through 2.4.11 depict the informal trails and disturbed areas with a five meter buffer added to the outside boundary.

Figure 2.4.1. Extent and condition of informal trails and disturbed areas observed in Ahwahnee Meadow in 2007.

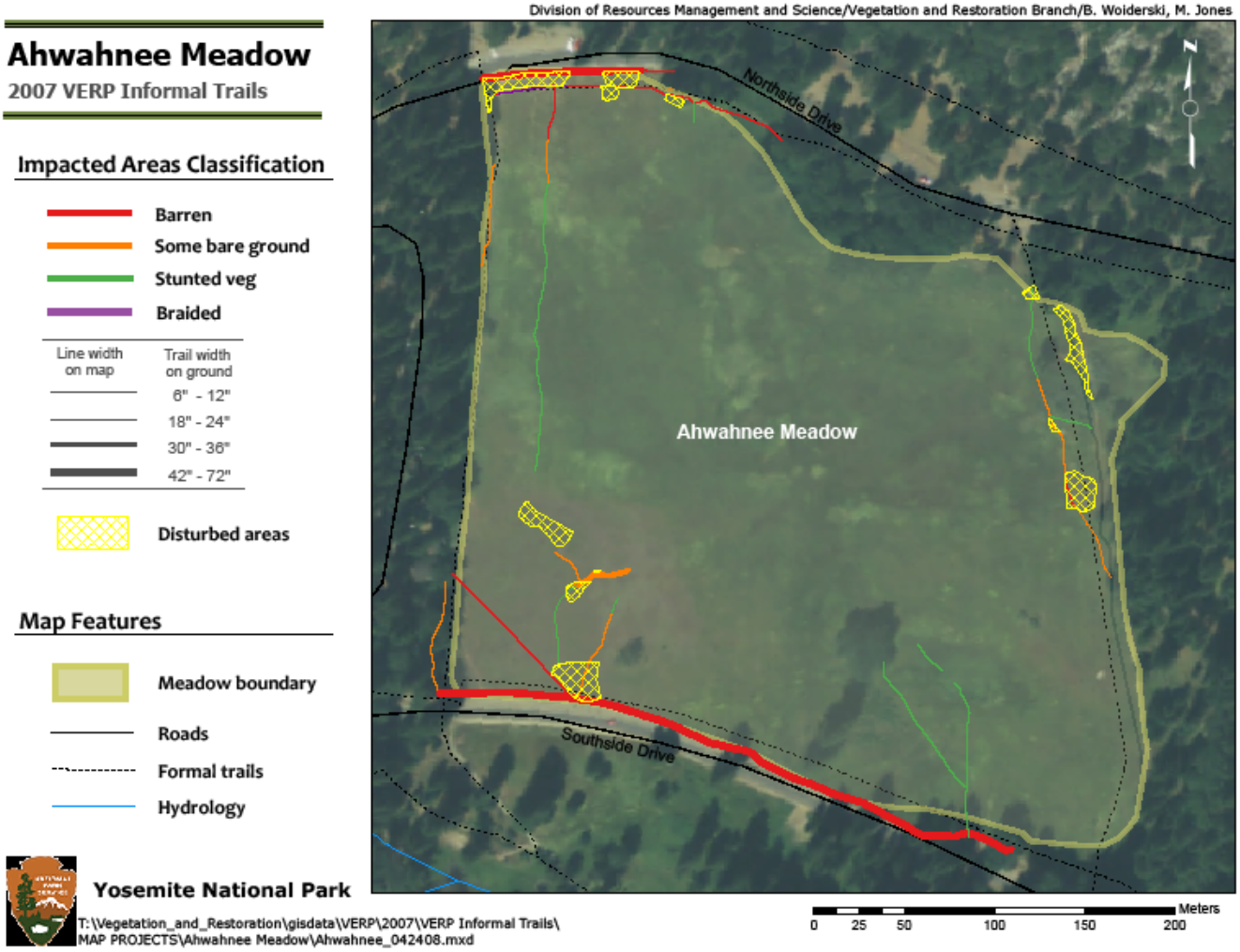


Figure 2.4.2. Extent and condition of informal trails and disturbed areas observed in Bridalveil Meadow in 2007.

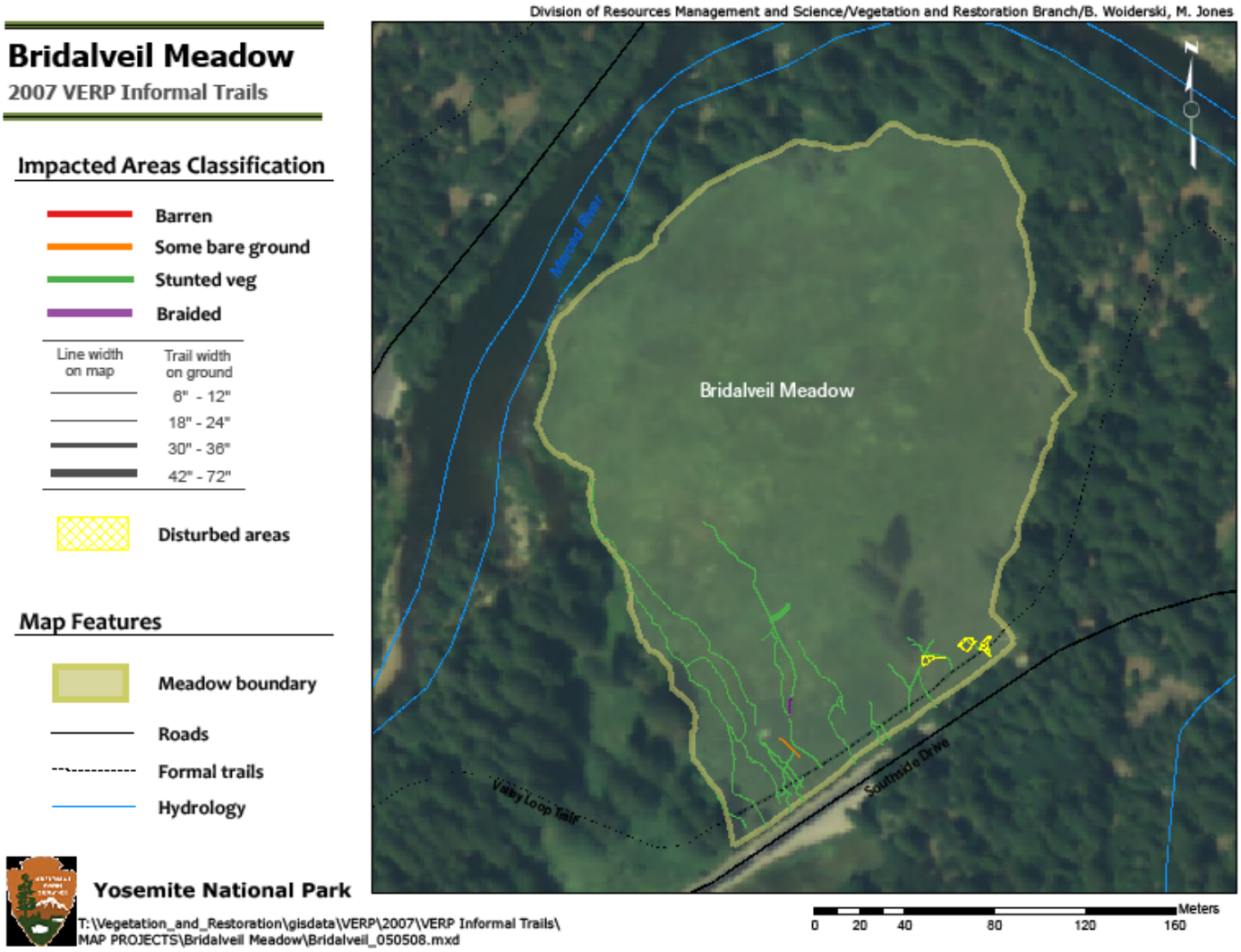


Figure 2.4.3. Extent and condition of informal trails and disturbed areas observed in Leidig Meadow in 2007.

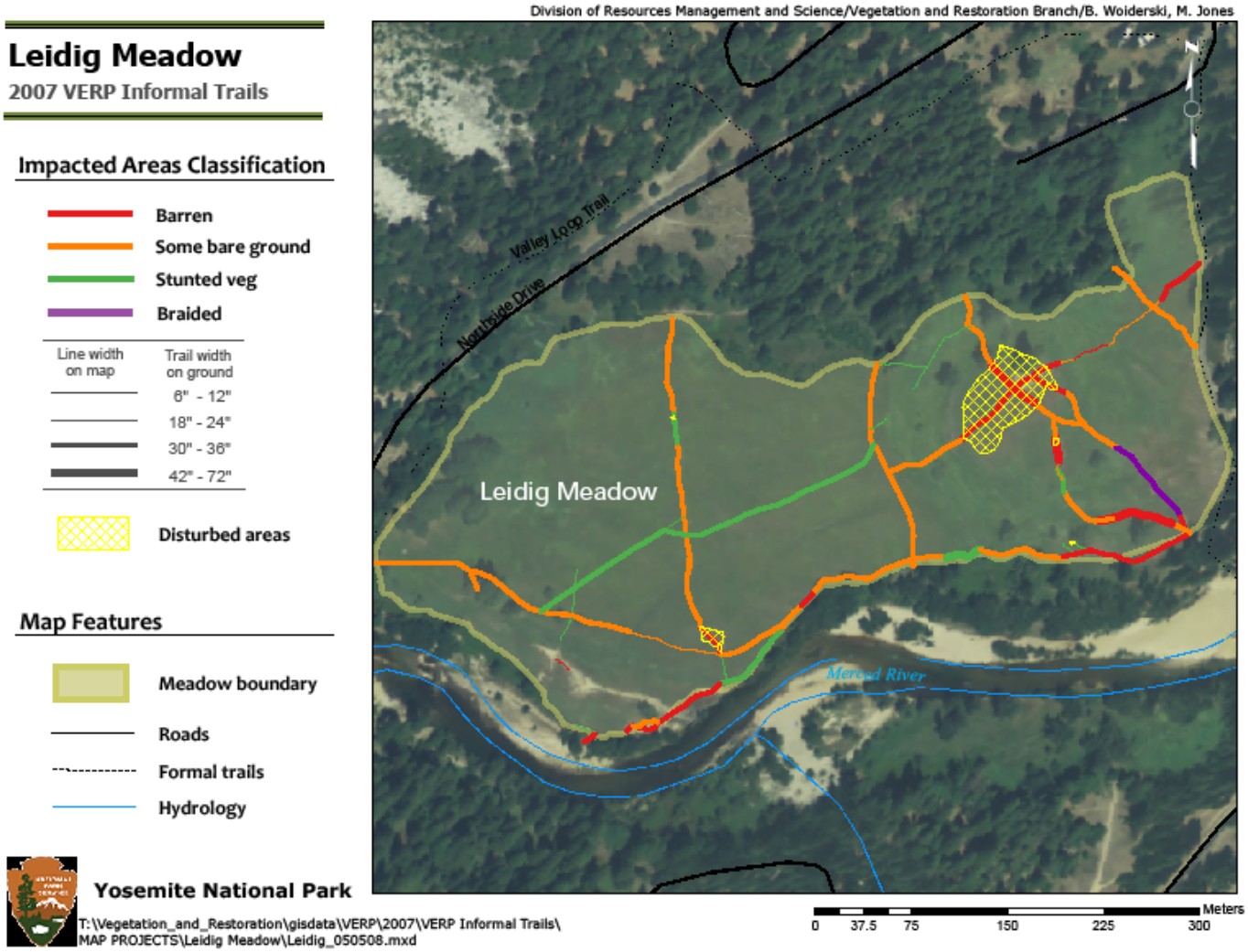


Figure 2.4.4. Extent and condition of informal trails and disturbed areas observed in Sentinel Meadow A in 2007.

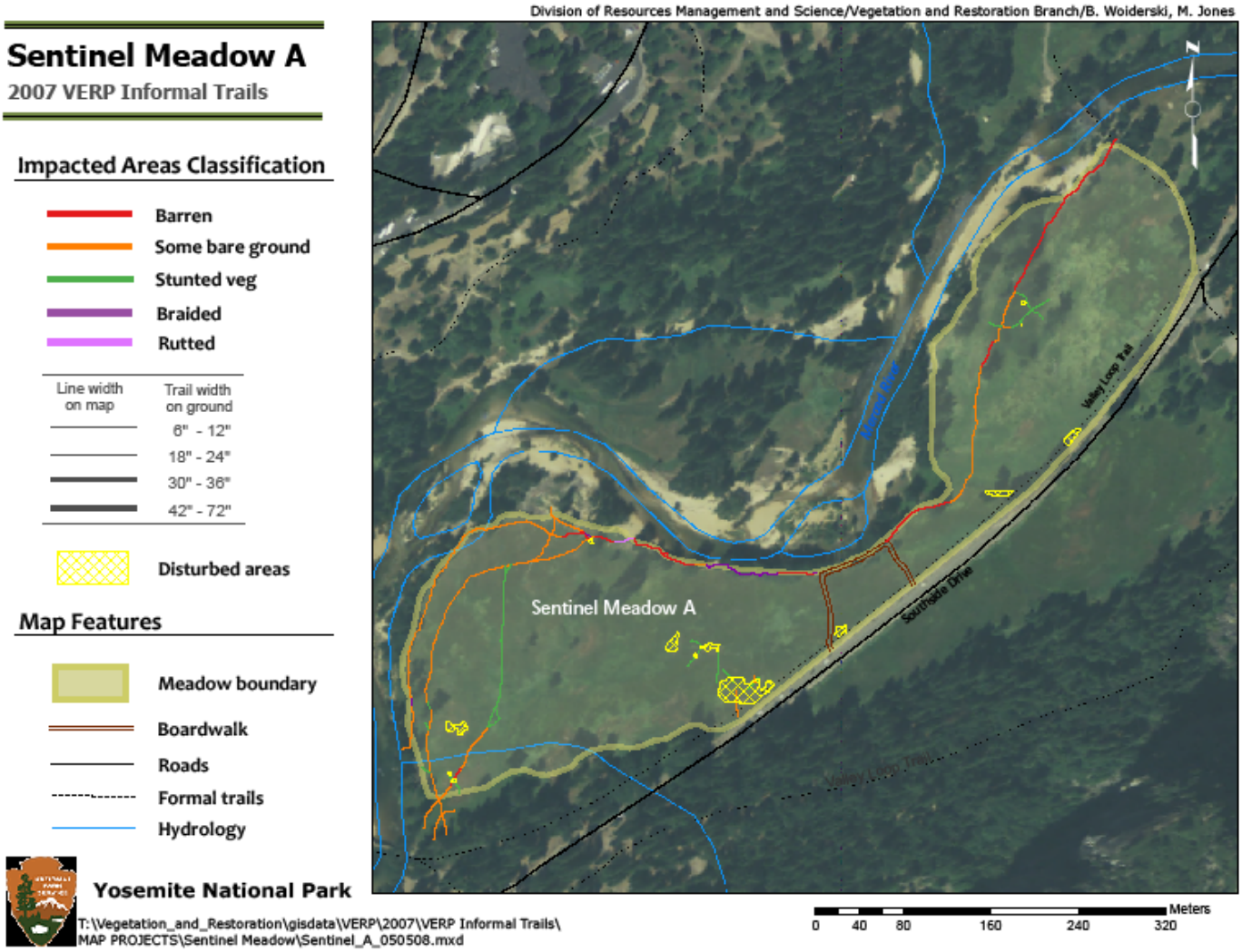


Figure 2.4.5. Extent and condition of informal trails and disturbed areas observed in Sentinel Meadow B in 2007.

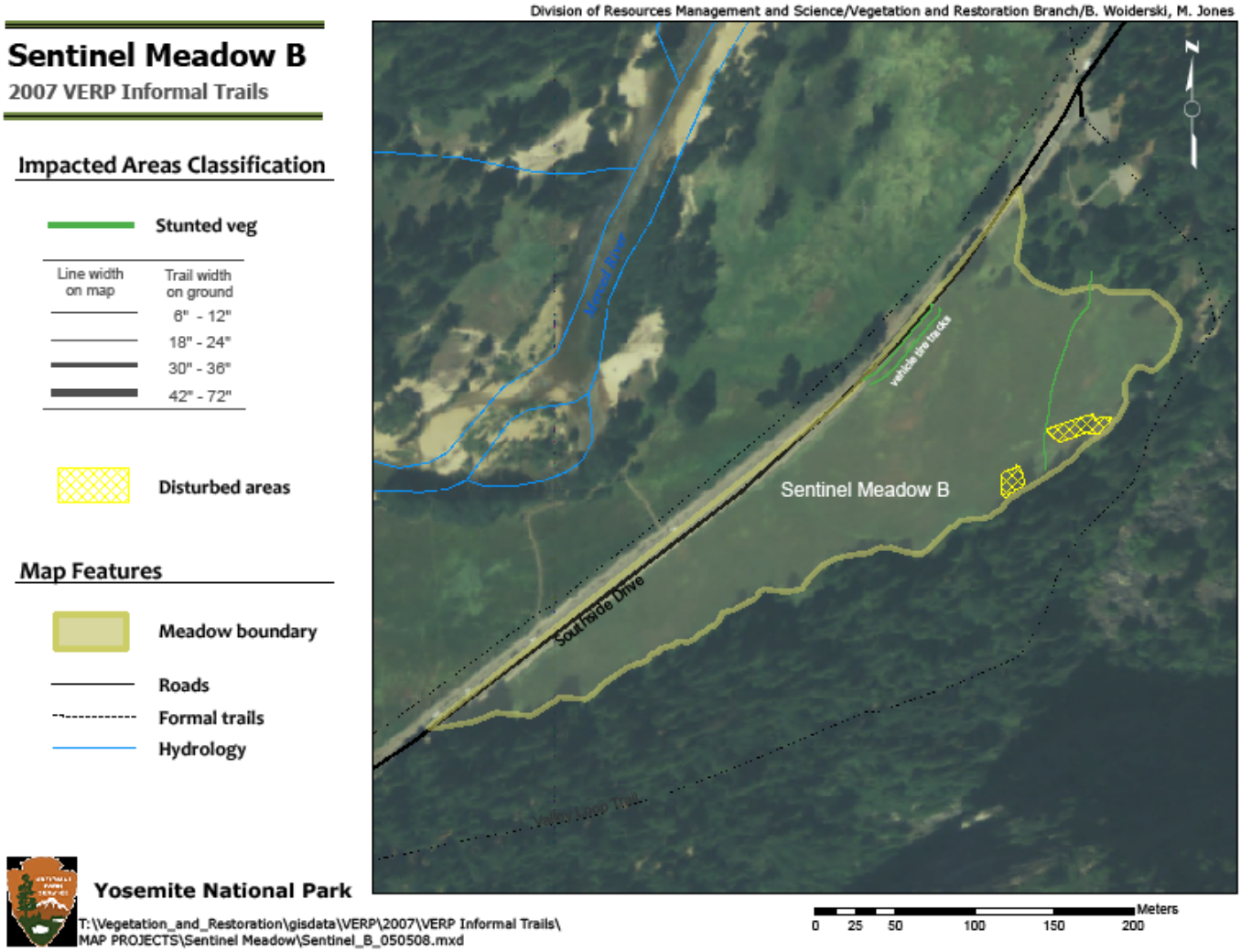


Figure 2.4.6. Extent and condition of informal trails and disturbed areas observed in Stoneman Meadow A in 2007.

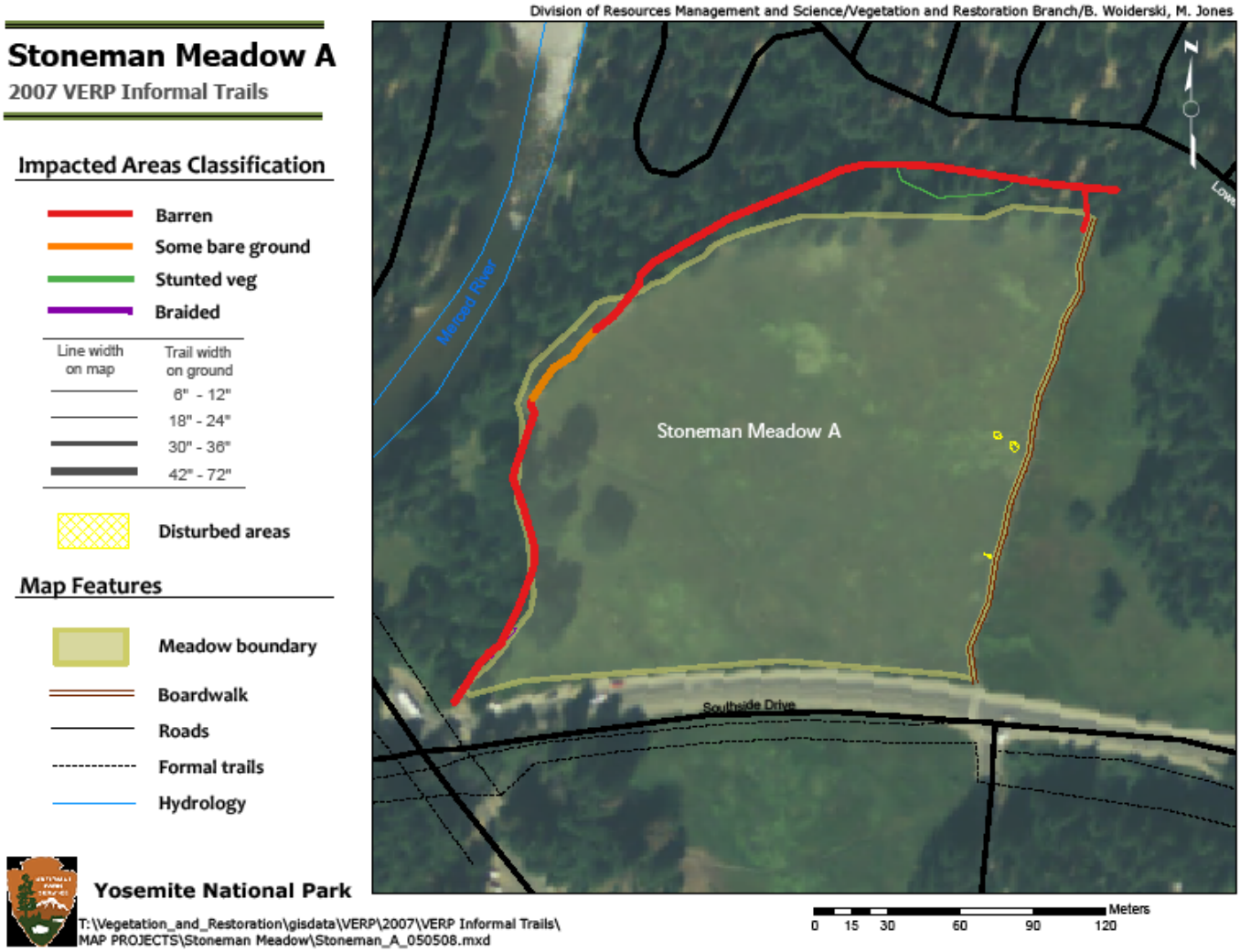


Figure 2.4.7. Extent and condition of informal trails and disturbed areas observed in Stoneman Meadow B in 2007.

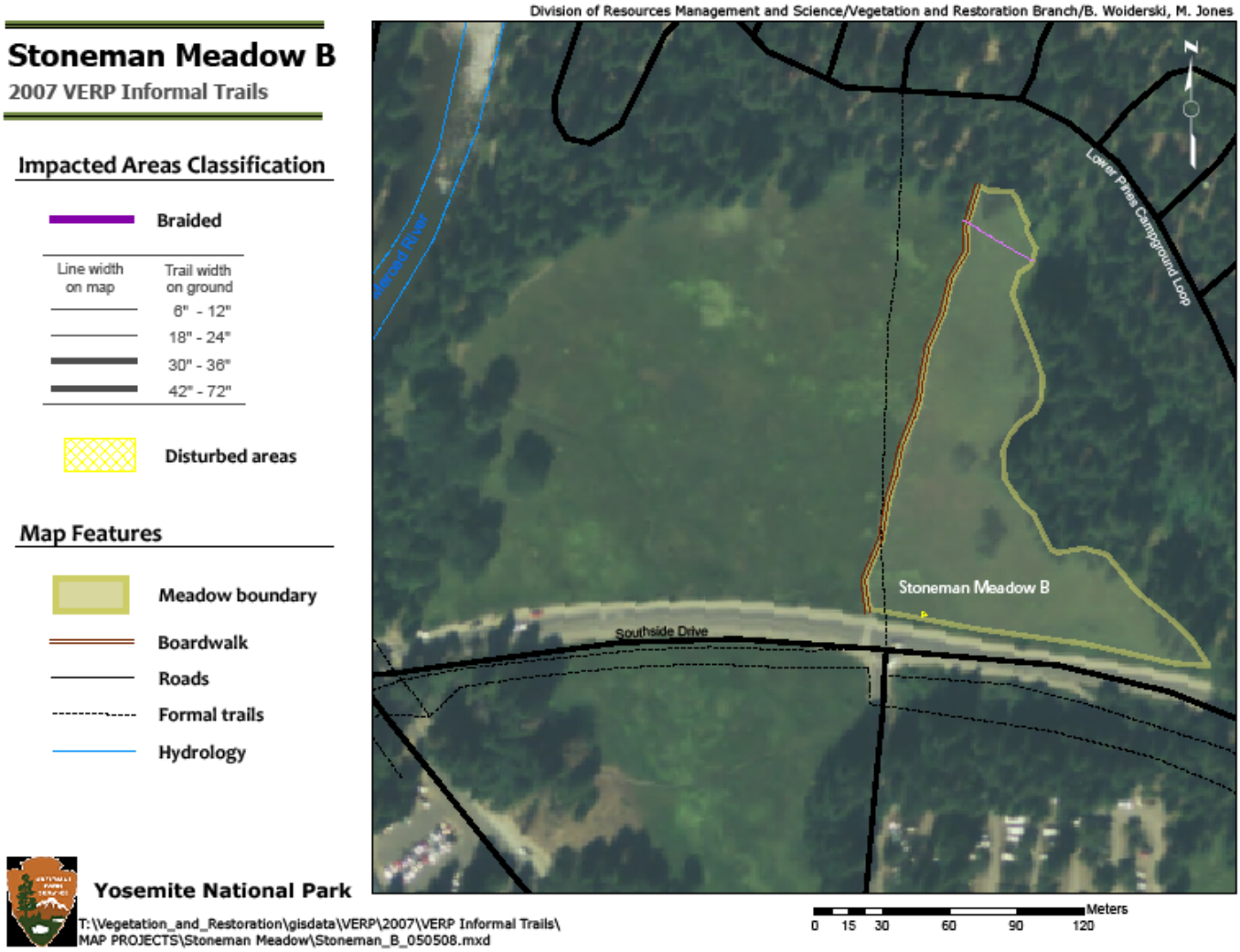


Figure 2.4.8. Map of Ahwahnee Meadow with a five meter buffer added to the outside boundary of the informal trails and disturbed areas that were observed in 2007.

Figure 2.4.9. Map of Bridalveil Meadow with a five meter buffer added to the outside boundary of the informal trails and disturbed areas that were observed in 2007.

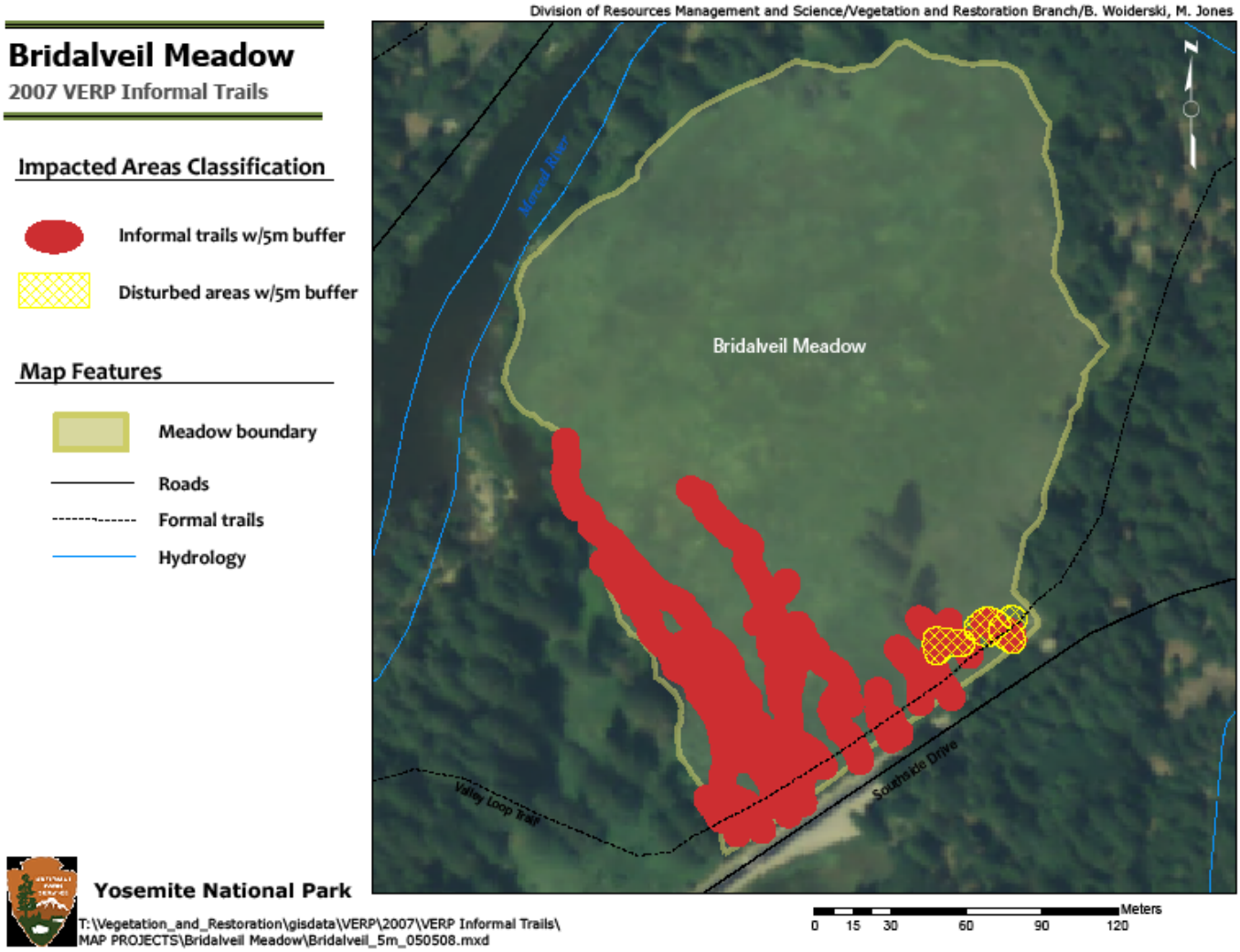


Figure 2.4.10. Map of Leidig Meadow with a five meter buffer added to the outside boundary of the informal trails and disturbed areas that were observed in 2007.

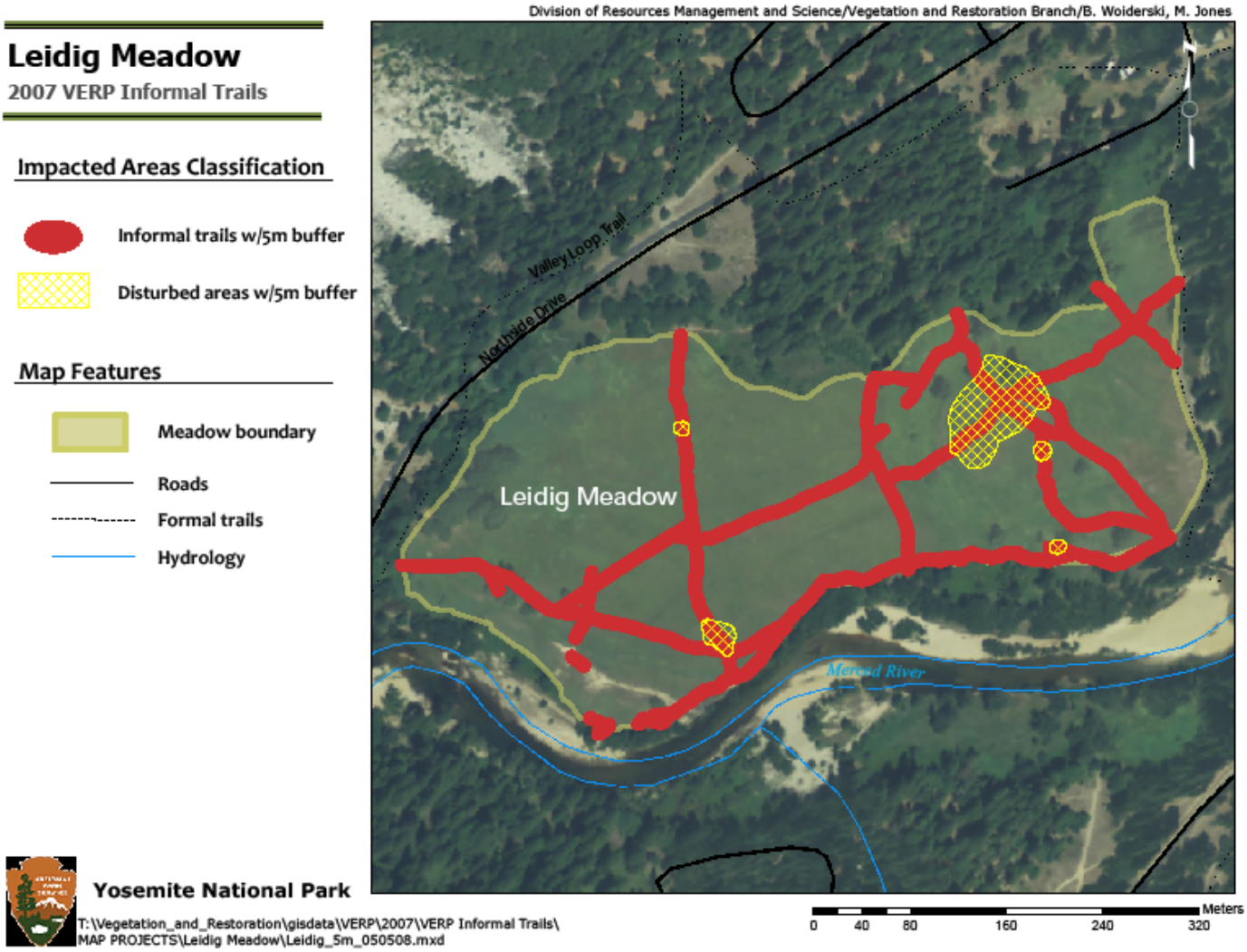


Figure 2.4.11. Map of Sentinel Meadow A with a five meter buffer added to the outside boundary of the informal trails and disturbed areas that were observed in 2007.

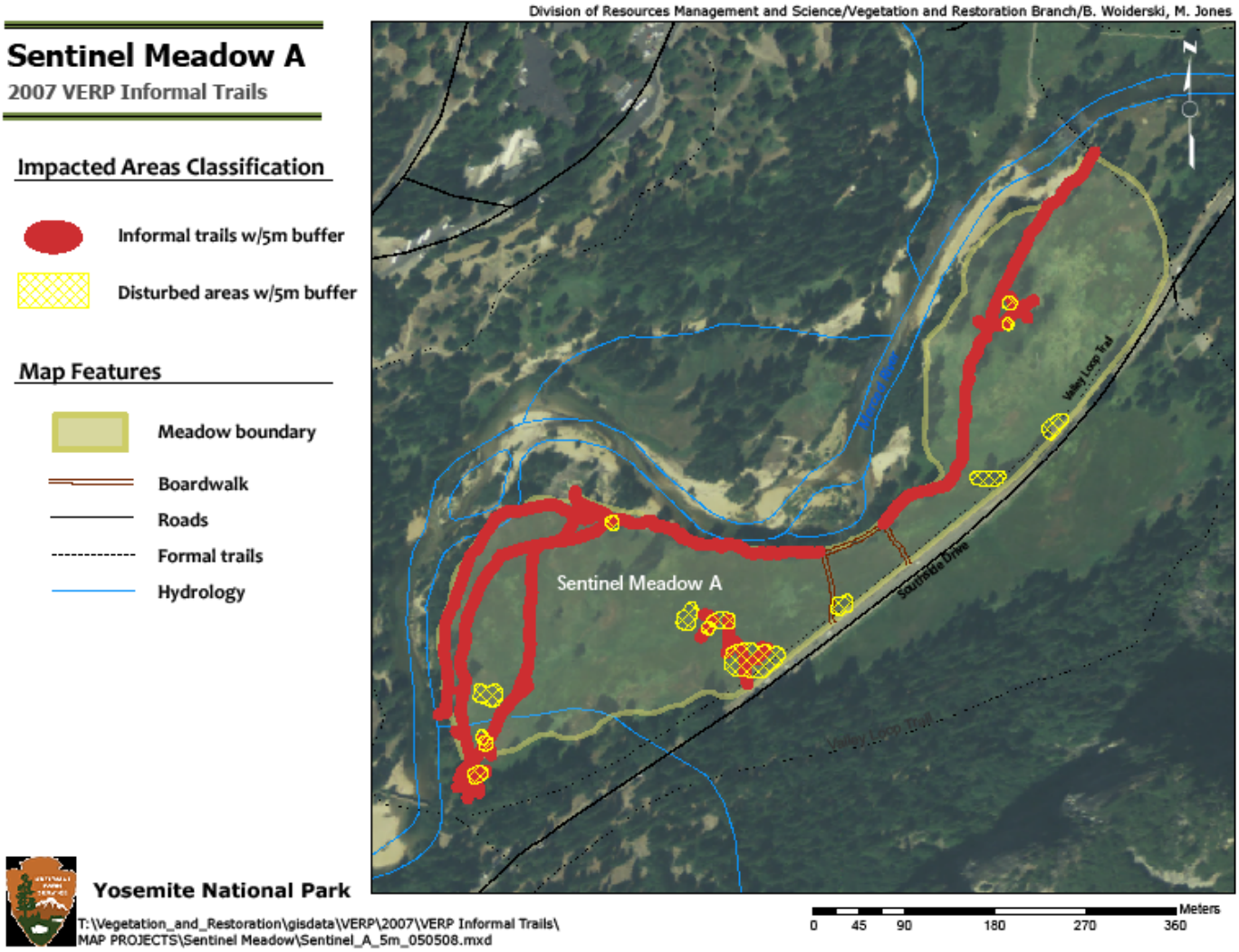


Figure 2.4.12. Map of Sentinel Meadow B with a five meter buffer added to the outside boundary of the informal trails and disturbed areas that were observed in 2007.

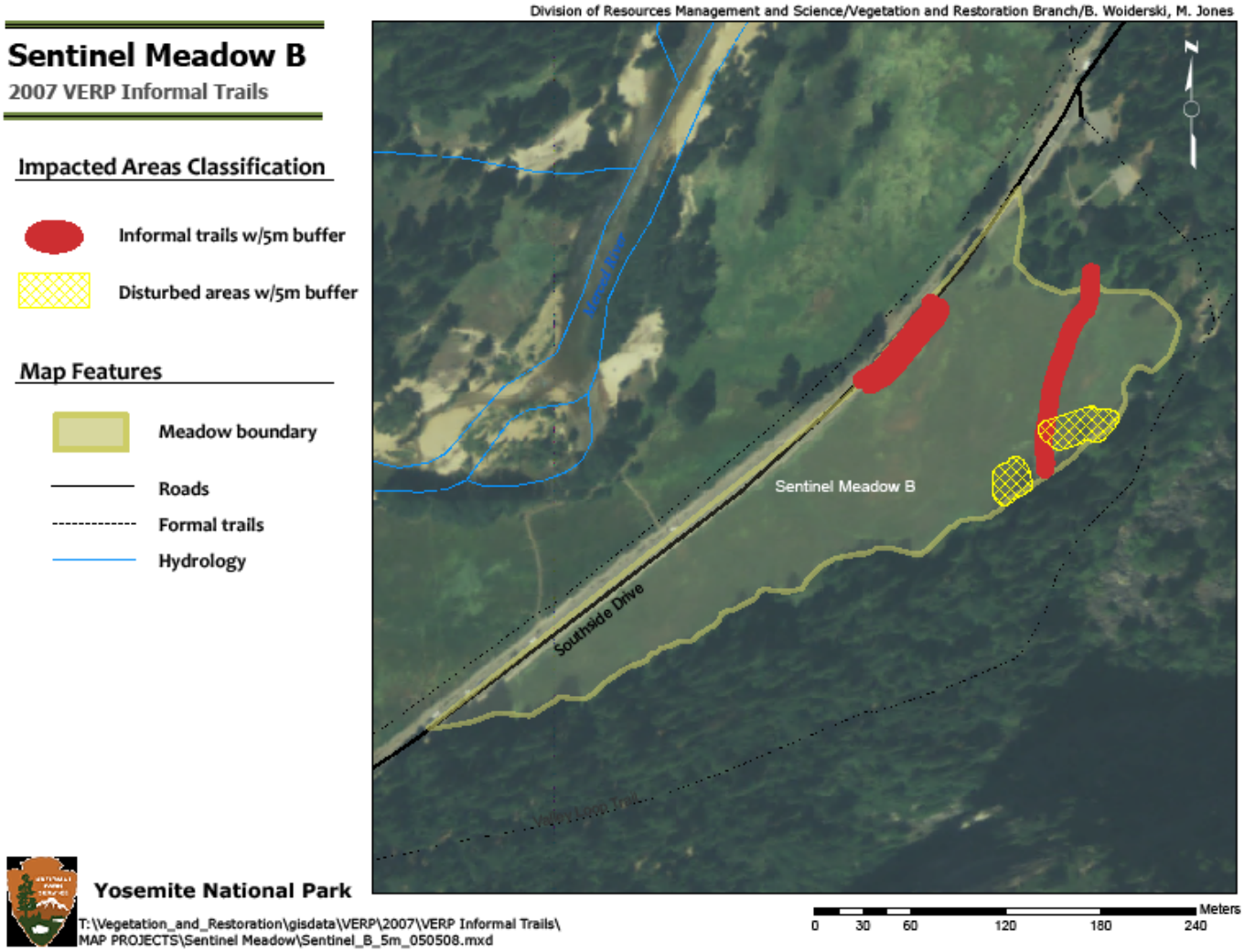


Figure 2.4.13. Map of Stoneman Meadow A with a five meter buffer added to the outside boundary of the informal trails and disturbed areas that were observed in 2007.

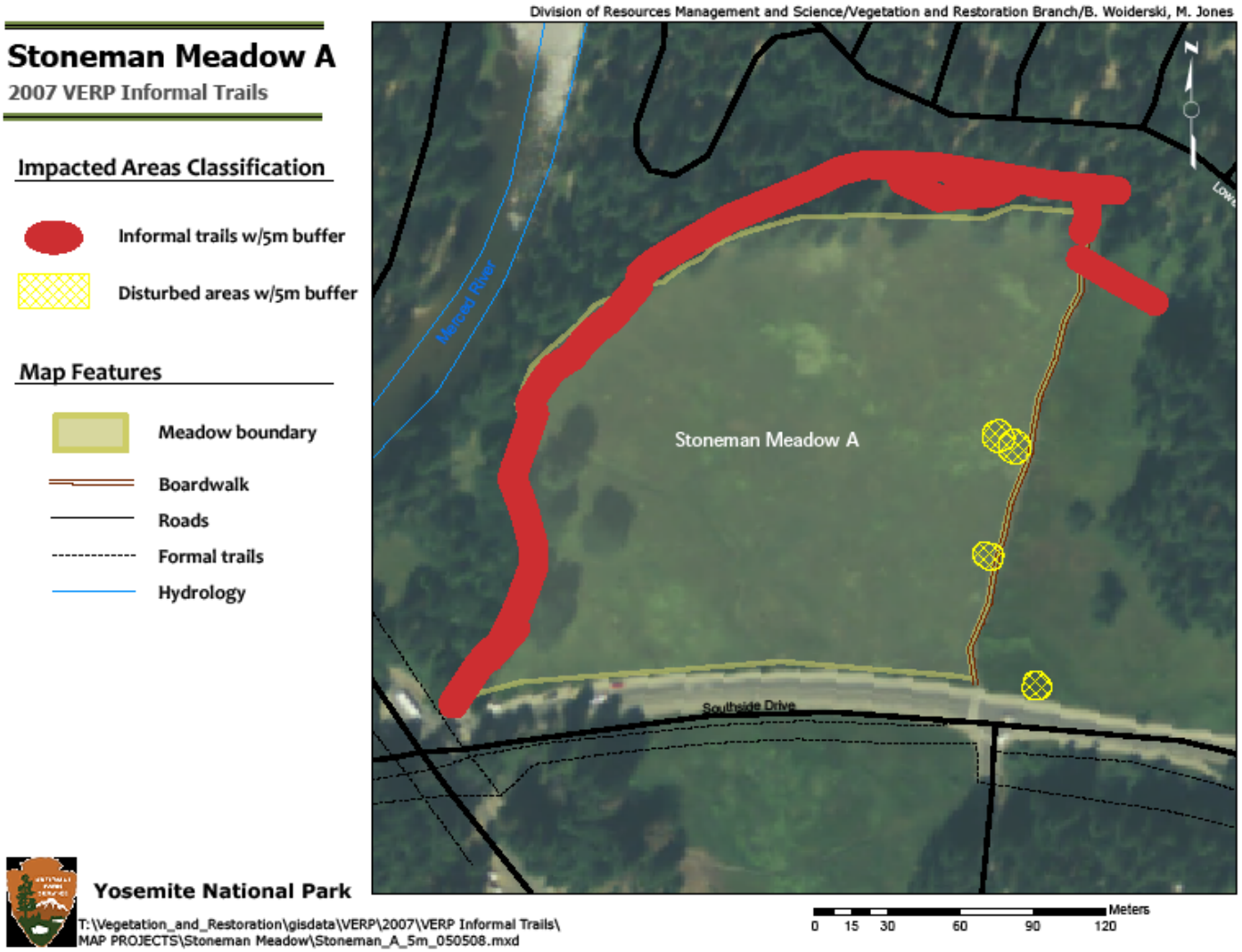


Figure 2.4.14. Map of Stoneman Meadow B with a five meter buffer added to the outside boundary of the informal trails and disturbed areas that were observed in 2007.

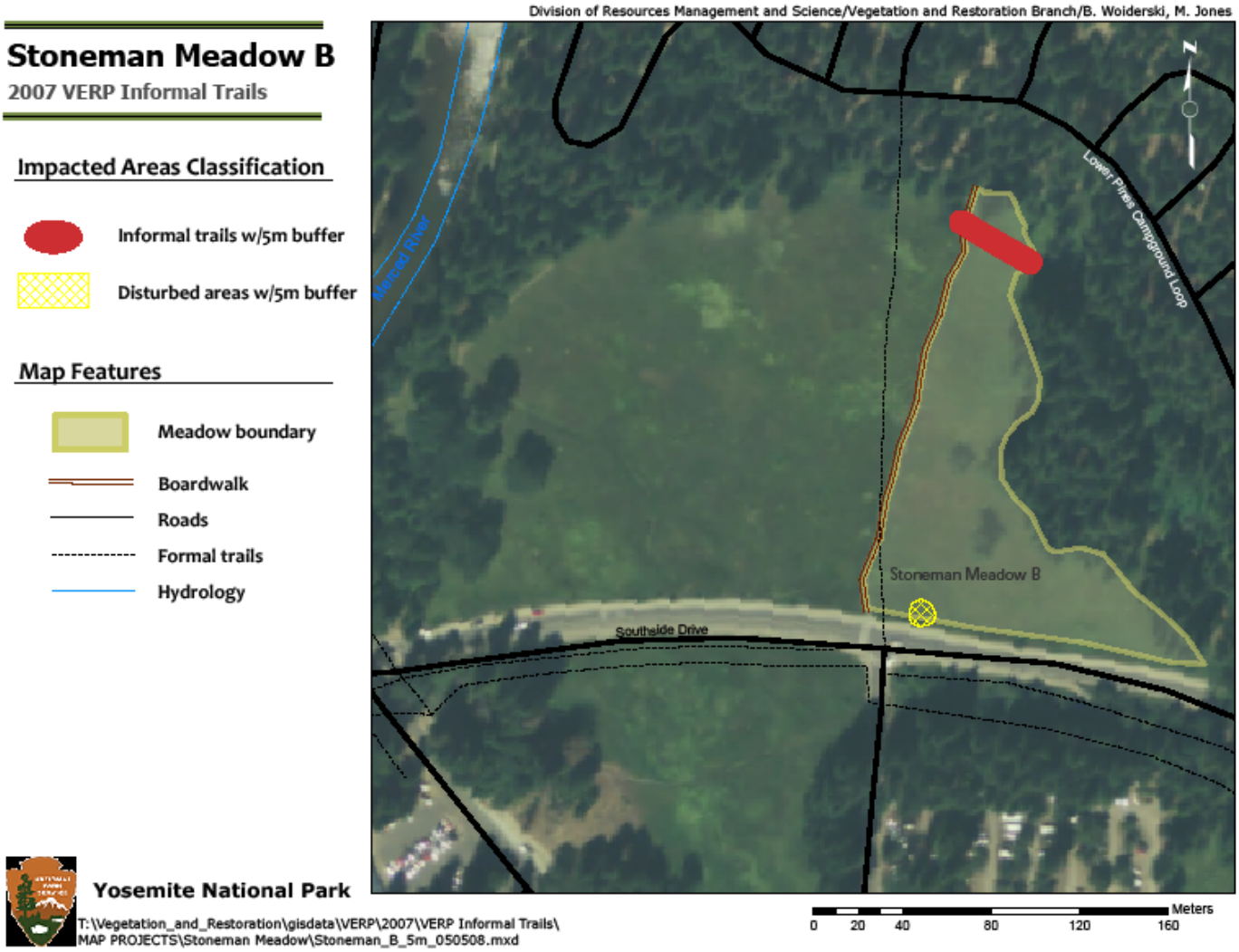


Figure 2.4.15. Total length of informal trails monitored in Yosemite Valley in 2007.

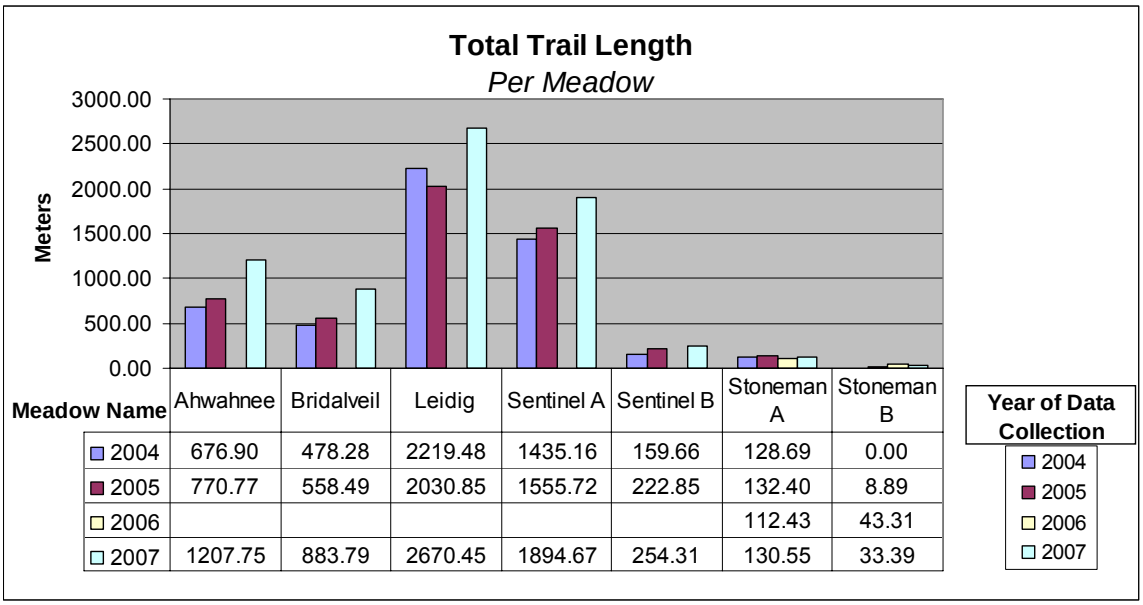


Table 2.4.1. Difference between years of total length (in meters) of informal trails monitored in Yosemite Valley in 2007.

Years Compared	Ahwahnee	Bridalveil	Leidig	Sentinel A	Sentinel B	Stoneman A	Stoneman B
2004-2005	94m	80m	-189m	121m	63m	4m	9m
2005-2006						-20m	34m
2006-2007						18m	-10m
2005-2007	437m	325m	640m	339m	31m	-2m	25m

Figure 2.4.16. Percent change between years of total length of informal trails monitored in Yosemite Valley in 2007.

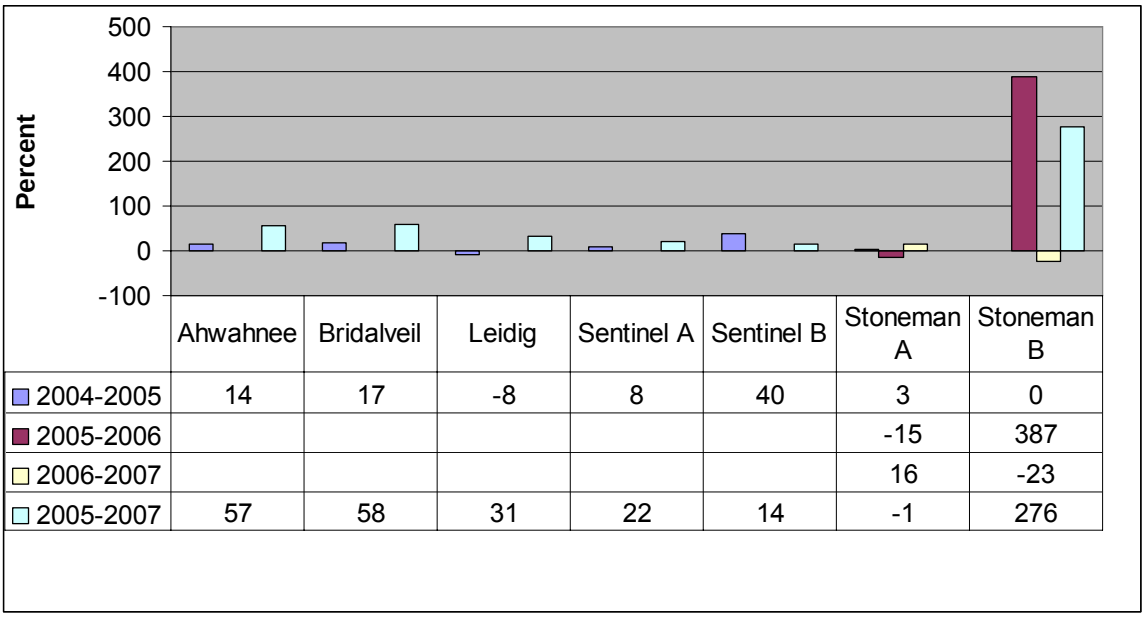


Figure 2.4.17. Density of informal trails monitored in Yosemite Valley meadows in 2007.

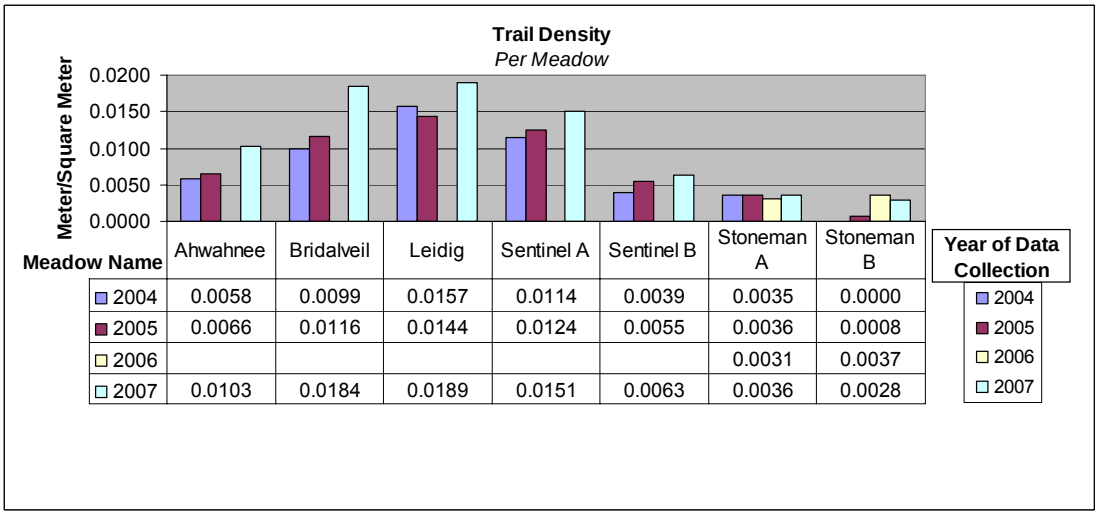
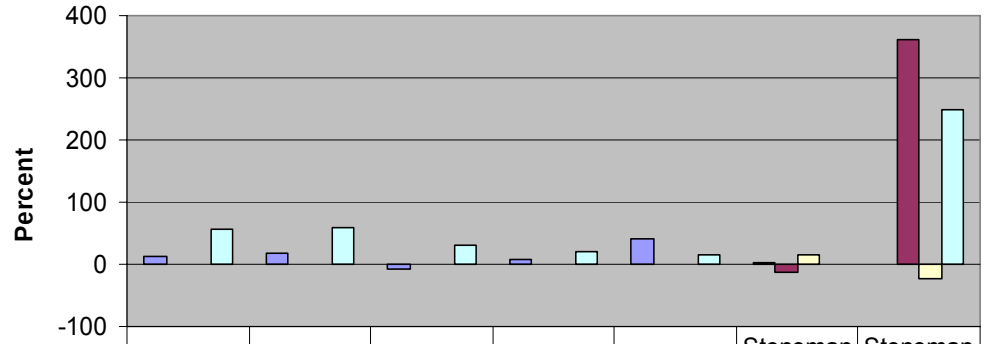


Table 2.4.2. Difference between years of density of informal trails monitored in Yosemite Valley meadows in 2007.

Years Compared	Ahwahnee	Bridalveil	Leidig	Sentinel A	Sentinel B	Stoneman A	Stoneman B
2004-2005	0.0008	0.0017	-0.0013	0.001	0.0016	0.01	0.0008
2005-2006						-0.0005	0.0029
2006-2007						0.0005	-0.0009
2005-2007	0.0037	0.0068	0.0045	0.0027	0.0008	0	0.002

Figure 2.4.18. Percent change between years of density (meters/square meters) of informal trails monitored in Yosemite Valley meadows in 2007.



	Ahwahnee	Bridalveil	Leidig	Sentinel A	Sentinel B	Stoneman A	Stoneman B
2004-2005	14	17	-8	9	41	3	0
2005-2006						-14	363
2006-2007						16	-24
2005-2007	56	59	31	22	15	0	250

Tables 2.4.3 through 2.4.9 summarize results from the fragmentation analysis which is further explained in the methods section of this document.

Table 2.4.3 Patches in Ahwahnee Meadow without informal trails or disturbed areas observed in 2007.

Index	***2007* Without Buffer**	***2007* With Buffer**
Meadow Area	117,491 m^2	117,491 m^2
Number of Patches	14	8
Median Patch Size	73.76 m^2	421.84 m^2
Weighted Mean Patch Index	0.802 m^2 (wf= 0.977)	1.120 m^2 (wf= 0.873)
5 Largest Patches Index	97.47%	87.34%

Table 2.4.4 Patches in Bridalveil Meadow without informal trails or disturbed areas observed in 2007.

Index	***2007* Without Buffer**	***2007* With Buffer**
Meadow Area	48,072 m^2	48,072 m^2
Number of Patches	25	18
Median Patch Size	46.57 m^2	26.27 m^2
Weighted Mean Patch Index	0.189 m^2 (wf= 0.991)	0.191 m^2 (wf= 0.847)
5 Largest Patches Index	96.95%	84.16%

Table 2.4.5 Patches in Leidig Meadow without informal trails or disturbed areas observed in 2007.

Index	***2007*** **Without Buffer**	***2007*** **With Buffer**
Meadow Area	141,026 m^2	141,026 m^2
Number of Patches	25	18
Median Patch Size	671.78 m^2	4,116.47 m^2
Weighted Mean Patch Index	0.526 m^2 (wf=0.966)	0.498 m^2 (wf= 0.797)
5 Largest Patches Index	74.05%	56.78%

Table 2.4.6 Patches in Sentinel Meadow A without informal trails or disturbed areas observed in 2007.

Index	***2007*** **Without Buffer**	***2007*** **With Buffer**
Meadow Area	125,451 m^2	125,451 m^2
Number of Patches	23	22
Median Patch Size	132.88 m^2	78.44 m^2
Weighted Mean Patch Index	0.527 m^2 (wf= 0.982)	0.394 m^2 (wf= 0.831)
5 Largest Patches Index	95.46 %	79.71%

Table 2.4.7 Patches in Sentinel Meadow B without informal trails or disturbed areas observed in 2007.

Index	***2007*** **Without Buffer**	***2007*** **With Buffer**
Meadow Area	40,498 m^2	40,498 m^2
Number of Patches	1	3
Median Patch Size	39, 811.10 m^2	3,747.14
Weighted Mean Patch Index	3.913 (wf=0.983)	1.116 (wf=0.909)
5 Largest Patches Index	98.30 %	90.92 %

Table 2.4.8 Patches in Stoneman Meadow A without informal trails or disturbed areas observed in 2006 and 2007.

Index	*2006* Without Buffer	*2007* Without Buffer	*2006* With Buffer	*2007* With Buffer
Meadow Area	36,467.5 m^2	36,467.5 m^2	36,467.5 m^2	36,467.5 m^2
Number of Patches	3	4	2	2
Median Patch Size	332.83 m^2	235.12 m^2	17,452.18 m^2	17,277.26m^2
Weighted Mean Patch Index	1.206 m^2 (wf= 0.996)	0.902 m^2 (wf=0.994)	1.670 m^2 (wf=0.957)	1.637 m^2 (wf=0.947)
5 Largest Patches Index	99.64 %	99.47 %	95.71 %	94.75 %

Table 2.4.9 Patches in Stoneman Meadow B without informal trails or disturbed areas observed in 2006 and 2007.

Index	*2006* Without Buffer	*2007* Without Buffer	*2006* With Buffer	*2007* With Buffer
Meadow Area	11,809.2 m^2	11,809.2 m^2	11,809.2 m^2	11,809.2 m^2
Number of Patches	2	2	1	2
Median Patch Size	5,880.82 m^2	5,898.66 m^2	11,184.80 m^2	5,696.84 m^2
Weighted Mean Patch Index	0.585 m^2 0.995	0.589 m^2 0.998	1.059 m^2 0.947	0.549 m^2 0.964
5 Largest Patches Index	99.60 %	99.90 %	94.71 %	96.48 %

Discussion

This year's data marks an improvement for our ability to monitor the extent and density of informal trails in meadows within Yosemite Valley. While 2006 marked a streamlined effort from previous years, 2007 built on the expertise of our observers and refined protocols to successfully monitor valley meadows. As noticed in our collections from previous years, most recorded trails originated from roadways, parking areas, designated trails, and boardwalks, which suggests that planning should focus on accommodating visitor use radiating from these areas.

Last year's field season was the first year that we were able to provide a more in-depth comparative analysis of the meadows that were measured two years prior. This allows us to begin looking at trends and to assess if this indicator is an effective way to assess the standard. With the realization that all but one meadow has a noticeable level of increase, we are beginning to see the scope in which trails can increase between years. When comparing density from this past season and data from 2005 (See Table 2.4.2), all meadows with the exception of Stoneman and the Sentinal B section exhibited a larger increase in trail density that previous years comparisons. With the exception of Stoneman Meadow A all meadows monitored during the 2007 season demonstrated a noticeable increase of both extent and density of informal trails (See Table 2.4.1 and 2.4.2).

Of all the meadows monitored in 2007, Stoneman Meadow A was the only area to exhibit a decrease in total trail length and density. While the decrease is relevant, it is not significant, as it reflects only a one percent decrease from when it was last monitored in 2005. The greatest significance in change can be seen in the other six areas. All of these meadows or sub-meadows, as previously defined, show an increase well over ten percent and an average percent change of 36.4, if Stoneman Meadow B is not included in the equation, and an average percent change of 182, if Stoneman Meadow B is included.
For the sake of simplicity, let's look at Stoneman Meadow separately, since Stoneman Meadow A and Stoneman Meadow B represent the two extreme ends of the spectrum. Stoneman Meadow A is the only meadow to show a decrease in total trail length and density. Stoneman Meadow B also exhibited a decrease in total trail length from 2006 to 2007; however, the percent change between 2005 and 2007 is still a 276 percent increase.

The other five meadows or sub-meadows are more closely related in their trend toward exhibiting an increase in informal trails and disturbed areas. The average between these areas is an increase of 354 meters of total trail length over the course of two years time, with the average of a percent change between these two years of 182 percent increase. Future site selection will represent meadows exhibiting trends towards informal trail increase, as well as, on a rotational schedule. These sampling methods should prove to be useful in capturing the range of long and short-term impacts.

This was our first year utilizing the buffer addition based on research on biodiversity of macro-invertebrate population in Tuolumne Meadows (Holmquist and Schmidt-Gengenbach 2008). The results in the above tables demonstrate that this buffer decreases the number of patches per meadow, but there is little consistency in how patch sizes vary with or without the buffer addition. The hope is that with repeated monitoring of meadows we will have better information from the new added metrics. The goal with these new metrics is that we will be able to have better assessment of the fragmentation occurring of the habitat size for the ecology of the meadows. The buffer addition and the added metrics allow this study to effectively show correlations between extent of informal trail networks and the remaining patch sizes.

2.5 WILDERNESS ENCOUNTERS

One of the components of the recreational Outstanding Remarkable Value for the Merced River Plan is the opportunity for solitude. Solitude has been an enduring characteristic of a Wilderness experience (Lucas 1964). The Wilderness Act of 1964 stipulates that areas designated as such provide outstanding opportunities for the enjoyment of solitude. The trailed (1B) Wilderness zones of the Merced River should provide a high opportunity for solitude.

Expectations for solitude and actual numbers and types of groups encountered have been shown to have a significant effect on the quality of visitor experiences (Patterson and Hammitt 1990, Vaske et al. 1986, West 1982, Newman 2002). Encounters are also an excellent way to assess use levels and density, which can affect other Outstandingly Remarkable Values such as the biological, cultural, and scientific values set for the river corridor. For example, higher levels of use may result in compromised water quality.

Measurement

The number of encounters with other hiking parties on and off trails in designated Wilderness.

Standards

For trailed zones no more than one encounter with another party per hour 80% of the time.

Sampling

Encounters were recorded by a National Park Service Ranger hiking or on horseback along trails. Monitoring was conducted as part of the Ranger's routine patrol of the backcountry along the Merced Lake corridor. Encounters were recorded onto index cards and entered into a database.

Sampling was conducted along trails in the upper Merced River corridor (Table 2.5.1). It is important to note that in 2007 only trails in zone 1B were monitored. The previous years of data collection for off-trail encounters in zones 1A suggested that encounters were very infrequent in these areas. Also, considering the nature of hiking across country does not lend itself to encountering other hikers, and that it is time-consuming and in-efficient to gather data in remote areas of this kind, these areas were omitted from data collection this year. The three segments included in the analysis and presentation of results below include 1) Moraine Dome to Echo Valley, Echo Valley to Merced Lake Ranger Station, and 3) Merced Lake Ranger Station to Washburn Lake. These trail segments only were included in this analysis as they had a sufficient sample size from which to draw reliable conclusions.

Table 2.5.1. Wilderness Encounters Sampling Locations for 2007.

Wilderness Encounter Sampling Locations
1B Zone – Trailed Travel
Moraine Dome to Echo Valley
Echo Valley to Merced Lake Ranger Station
Merced Lake Ranger Station to Washburn Lake
Washburn Lake to Junction

Results

The following tables and graphs present the results of wilderness encounter monitoring in 2004 - 2007. Table 2.5.2 and figure 2.5.1 shows the percent of time the standard was met. The standard is displayed at the 80% with a bold red line. Points on or above the line indicate that the standard was met. Points below the line indicate that the standard was exceeded for that year. The standard was met only one time in 2005 with 85.7%. The standard was exceeded for 2004, 2006 and 2007. 2006 had the lowest percentage of meeting the standard.

Table 2.5.2. Percent of Time Standard was met for Years 2004 - 2007.

Trail Segment	Percent of Time (hours) Standard Met
2004	75.0%
2005	85.7%
2006	62.1%
2007	78.8%

Figure 2.5.1 Percent of Time Standard was met for Years 2004 - 2007.

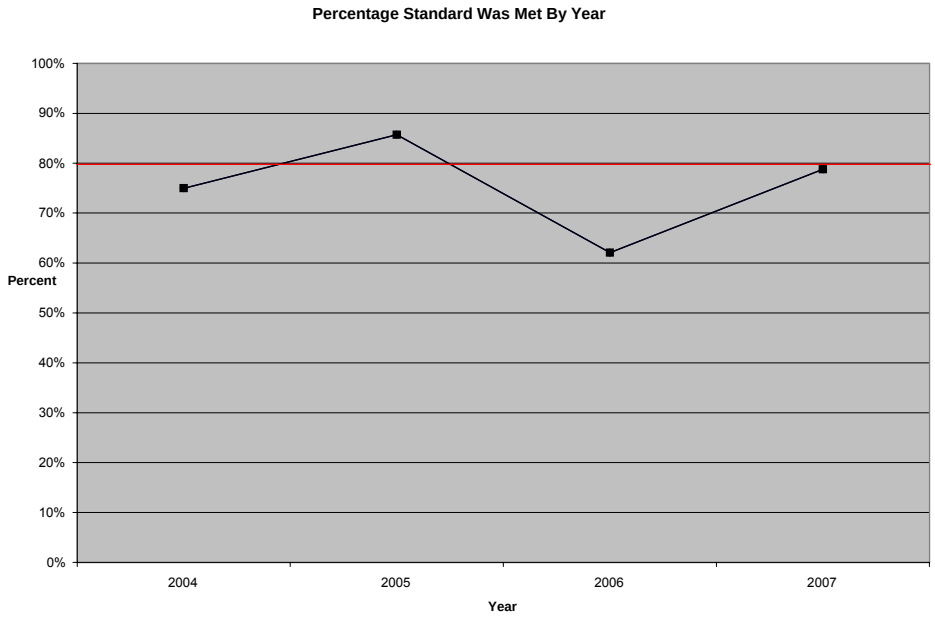


Table 2.5.3 presents the percent of time that the standard was met along the four trail segments for years 2004 - 2007. The standard is displayed at the 80% with a bold red line. Points on or above the line indicate that the standard was met. Points below the line indicate that the standard was exceeded for that year. Figure 2.5.3. shows the Moraine Dome to Echo Valley trail segment standard was not met for all years. Figure 2.5.4 shows the Echo Valley to Merced Lake Ranger Station trail segment standard was met only one time in 2005 with 88.5%. Figure 2.5.5 shows the Merced Lake Ranger Station to Washburn Lake trail segment standard was met three out of four years. The Washburn Lake to Junction trail segment standard was met all four years with 100% compliance rate.

Table 2.5.3 Percent of time that the standard was met for specific trail segments.

	Percent of time that the Standard was met			
Trail Segment	**2004**	**2005**	**2006**	**2007**
Moraine Dome – Echo Valley	60.0%	72.2%	64.3%	71.4%
Echo Valley – Merced Lake Ranger Station	71.4%	88.5%	58.6%	76.9%
Merced Lake Ranger Station – Washburn Lake	80.0%	100%	54.4%	83.3%
Washburn Lake - Junction	100%	100%	100%	100%

Figure 2.5.2. Percent standard was met on the Moraine Dome to Echo Valley trail segment for years 2004 - 2007.

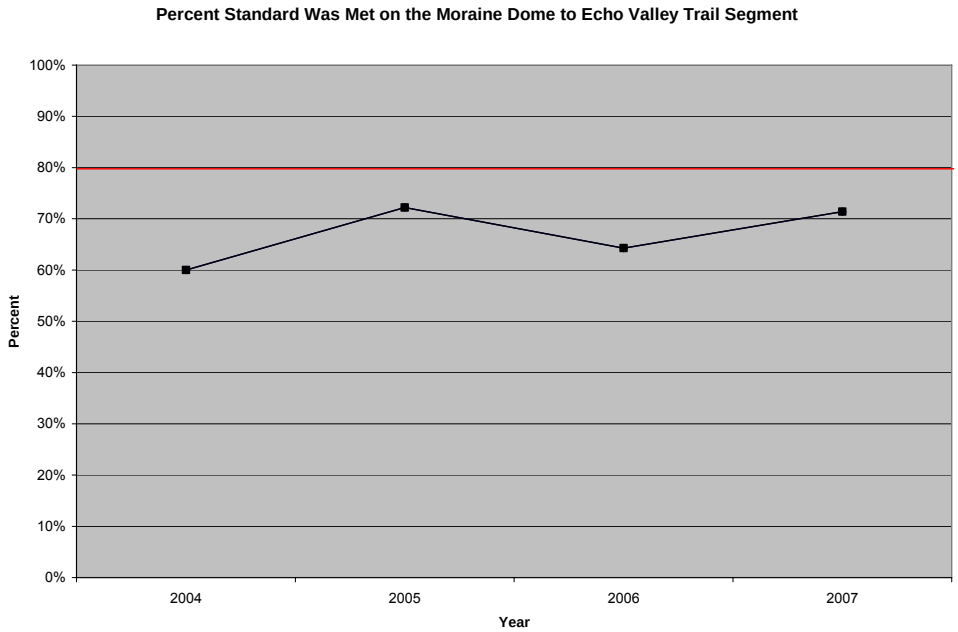


Figure 2.5.3. Percent standard was met on the Echo Valley to Merced Lake Ranger Station trail segment for years 2004 - 2007.

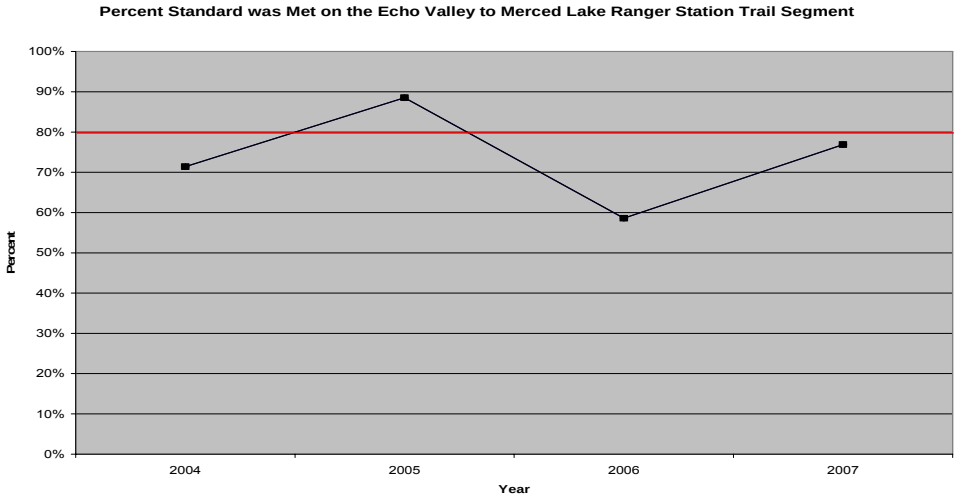
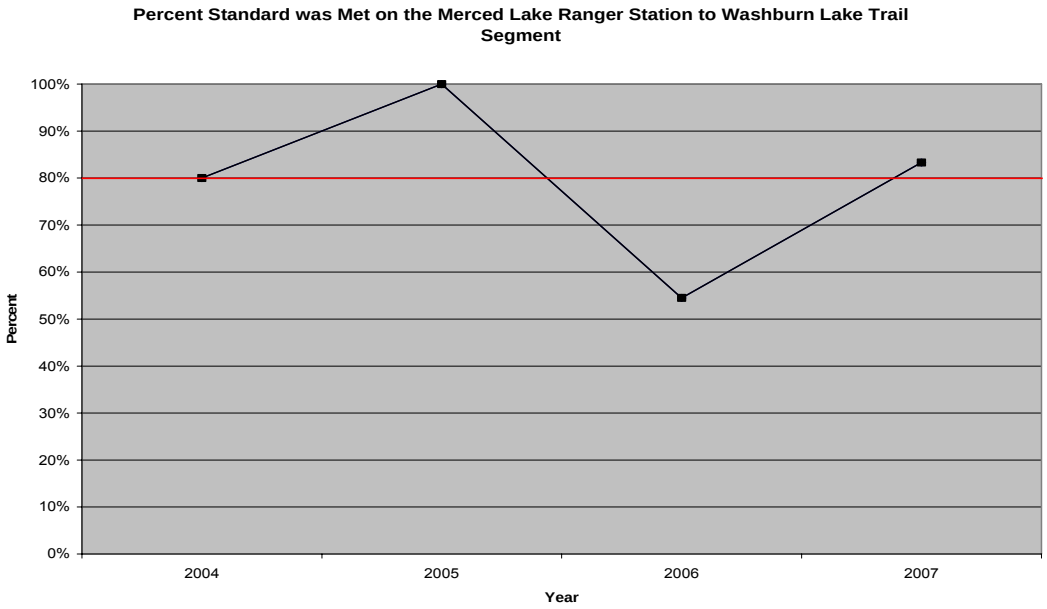


Figure 2.5.4. Percent standard was met on the Merced Lake Ranger Station to Washburn Lake trail segment for years 2004 - 2007.



Discussion

Wilderness encounter monitoring in 2007 suggests that visitors frequently encounter more than one other party while hiking through the Merced Lake area of the river corridor. This includes the area from Moraine Dome to the Merced Lake Ranger Station a highly used travel corridor for hikers, backpackers, and stock users. Along this route lies the Merced Lake High Sierra Camp, a popular overnight destination. However, caution should be taken when attempting to extrapolate these findings to a larger population. A small sample size and the number of sampling locations employed in this monitoring effort limit the robustness of these data. Continued monitoring is necessary in order to grow this dataset and improve its representativeness. More frequent counts conducted by Wilderness and other staff may provide a means to increase the sample size.

2.6 VISITOR USE/PEOPLE AT ONE TIME (PAOT)

This year's work with the Visitor Use/PAOT indicator has included research findings from related studies conducted during the 2007 season. With the assistance of Steve Lawson, Ph.D. from Virginia Tech and Peter Newman, Ph.D. from Colorado State University, the monitoring program was able to build on its current state of knowledge on the relationships that take place between vehicle arrivals at entrance to crowding/congestion conditions at key attraction sites. As a result, the People-At-One-Time (PAOT) indicator historically applied will be understood thru traffic counts at entrance stations. Additionally, visitor use monitoring along the Merced River, front-country trails, and other attraction sites where such relationships have not been concluded will continue as part of the indicator's standard monitoring practices. The summer data collection season of 2009 will further expand these locations to Mariposa Grove and Tuolumne locations. Until correlation analysis of these sites is finalized, the manual PAOT counts may have to be reinstituted in the meantime for the 2008 data collection season.

Discussed in this section are two projects that were applied to the greater transportation integration studies of the 2007 season 1) Computer Simulation Modeling at Key Attraction Sites 2) Visitor Use Estimation at Trailheads throughout the park. Both studies allowed for a robust amount of data to be collected while acting as a gauge of overall use on trails in addition to the amount of time that attraction sites exceeded social standards of quality derived from previous research at these locations.

Visitor Use Computer Simulation Modeling

The Computer Simulation Modeling Project comprised of four key attraction sites that were all first identified in Manning (1999) as being important areas for sightseeing and thus create crowding conditions. For the 2007 season, the fifth site of El Cap Meadow was added to the project as use creates notable impacts to the meadow. El Cap Meadow does not have social standards of quality derived, but the location was selected for its site composition and visitor access potential. Given these two aspects of the meadow, the concern for its vulnerability to use impacts drove this selection.

The workgroup wanted to identify duration of time, mode of travel to access the site, and location of entry/exit. The 2007 developed use models at the specific locations outlined in Figures 2.6.2., 2.6.3., 2.6.4., 2.6.8., and 2.6.10.

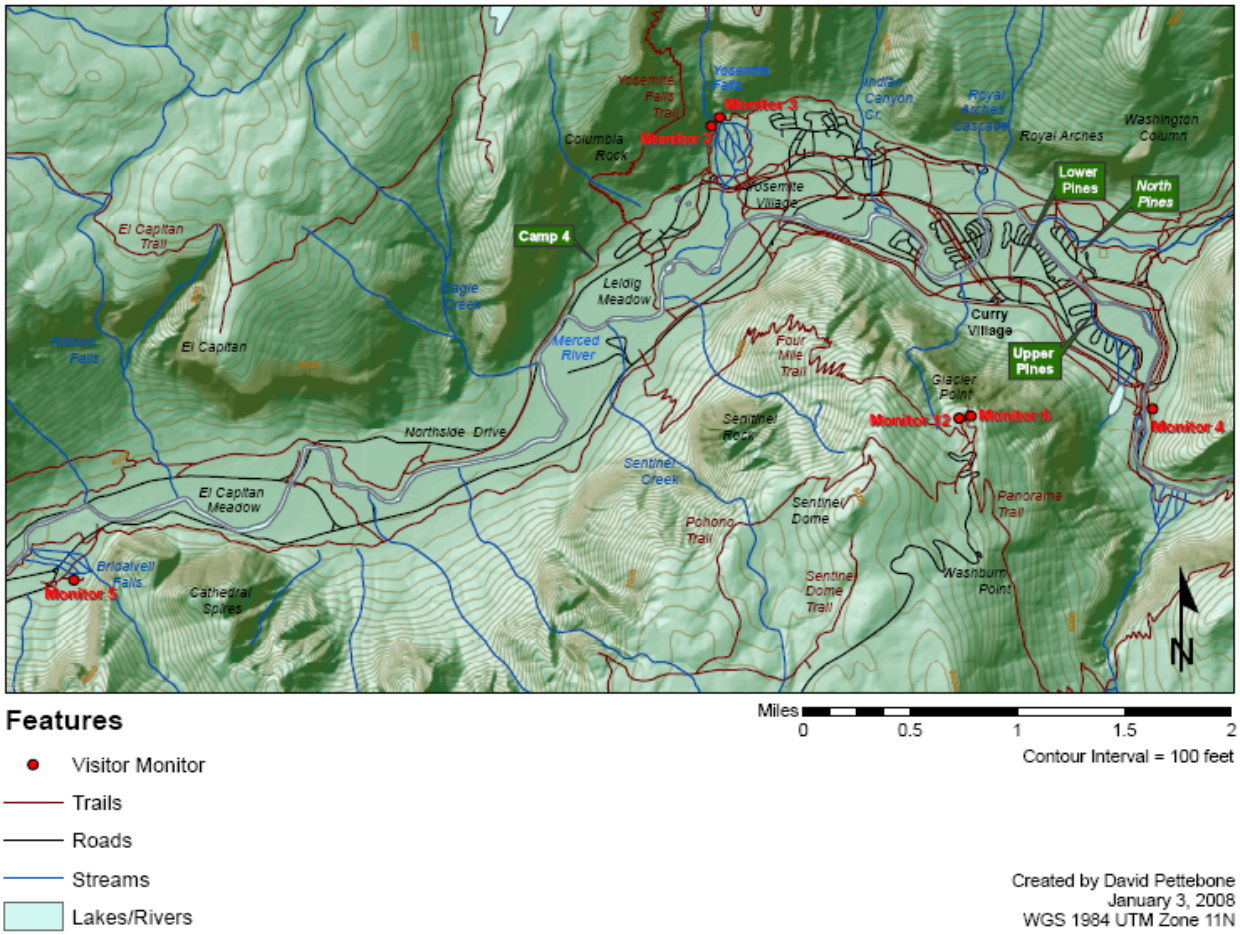
The five key attraction sites studied in Yosemite Valley include:

1) El Cap Meadow
2) Mirror Lake
3) Bridalveil Falls
4) Happy Isles/Vernal Falls
5) Yosemite Falls

Visitor Use Estimation

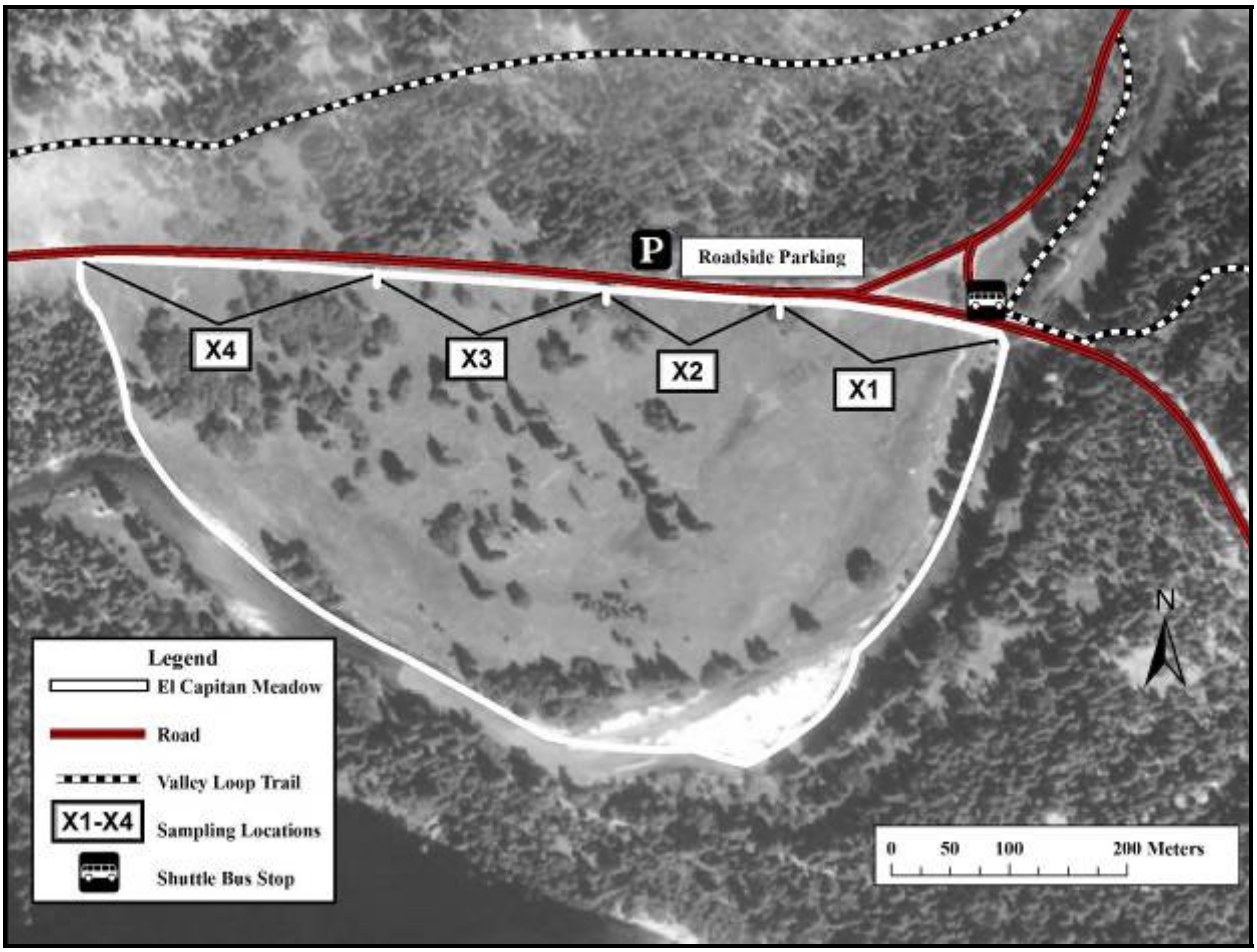
The Visitor Use Estimation Project conducted use counts by installing infrared trail monitors at twelve locations park-wide. These locations were thought to represent a varying degree of use locations as well as constituting areas of interest for park management. The exact locations are displayed in the following sections in Figures 2.6.1, 2.6.19, 2.6.20, and 2.6.33.

Figure 2.6.1. Locations of Visitor Use Monitors in Yosemite Valley.[1]



[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Figure 2.6.2. El Capitan Meadow study site schematic diagram.[2]



[2]From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). *Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park* (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Table 2.6.1. El Capitan Meadow visitor arrivals, by sampling date – 2007 (10 AM – 5 PM).[2]

Sampling Date	Day of Week	Access Point [a]	Roadside Parking [b]		Shuttle Arrivals [c]		Other [d]		Total Arrivals
			Number	Percentage	Number	Percentage	Number	Percentage	
07.28.2007	Saturday	X1	74	47.1%	57	36.3%	26	16.6%	157
		X2	218	80.4%	1	0.4%	52	19.2%	271
		X3	135	97.8%	3	2.2%	0	0.0%	138
		X4	12	100.0%	0	0.0%	0	0.0%	12
		Total	439	76.0%	61	10.6%	78	13.5%	578
07.30.2007	Monday	X1	38	30.4%	79	63.2%	8	6.4%	125
		X2	59	100.0%	0	0.0%	0	0.0%	59
		X3	61	82.4%	0	0.0%	13	17.6%	74
		X4	6	28.6%	0	0.0%	15	71.4%	21
		Total	164	58.8%	79	28.3%	36	12.9%	279
07.31.2007	Tuesday	X1	71	39.4%	100	55.6%	9	5.0%	180
		X2	201	97.6%	1	0.5%	4	1.9%	206
		X3	75	100.0%	0	0.0%	0	0.0%	75
		X4	1	100.0%	0	0.0%	0	0.0%	1
		Total	348	75.3%	101	21.9%	13	2.8%	462

[a] Refer to Figure 2.6.2 El Capitan Meadow of Lawson, et al., 2008 for the locations of access points.
[b] Arrivals from private vehicles and tour buses parked on roadside along El Capitan Meadow.
[c] Arrivals on foot from the El Capitan Bridge shuttle bus stop.
[d] Arrivals on foot or bicycle from any location other than the El Capitan Bridge shuttle bus stop or from roadside parking along El Capitan Meadow.

[2]From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Table 2.6.1. (continued). El Capitan Meadow visitor arrivals, by sampling date – 2007 (10 AM – 5 PM).[2]

Sampling Date	Day of Week	Access Point [a]	Roadside Parking [b]		Shuttle Arrivals [c]		Other [d]		Total Arrivals
			Number	Percentage	Number	Percentage	Number	Percentage	
08.01.2007	Wednesday	X1	50	66.7%	14	18.7%	11	14.7%	75
		X2	147	86.5%	0	0.0%	23	13.5%	170
		X3	43	87.8%	0	0.0%	6	12.2%	49
		X4	16	94.1%	0	0.0%	1	5.9%	17
		Total	256	82.3%	14	4.5%	41	13.2%	311
08.03.2007	Friday	X1	47	40.2%	62	53.0%	8	6.8%	117
		X2	79	71.8%	0	0.0%	31	28.2%	110
		X3	58	100.0%	0	0.0%	0	0.0%	58
		X4	11	100.0%	0	0.0%	0	0.0%	11
		Total	195	65.9%	62	20.9%	39	13.2%	296
Mean		Overall	280.4	71.7%	63.4	17.2%	41.4	11.1%	385.2
95% Confidence Interval		Overall	+/- 99.1	+/- 8.1%	+/- 28.1	+/- 8.4%	+/- 20.5	+/- 4.1%	+/- 114.1

[a] Refer to Figure 2.6.2 El Capitan Meadow of Lawson, et al., 2008 for the locations of access points.
[b] Arrivals from private vehicles and tour buses parked on roadside along El Capitan Meadow.
[c] Arrivals on foot from the El Capitan Bridge shuttle bus stop.
[d] Arrivals on foot or bicycle from any location other than the El Capitan Bridge shuttle bus stop or from roadside parking along El Capitan Meadow.

[2]From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Table 2.6.2. Mean and standard deviation of lingering time in El Capitan Meadow.[2]

Mode	Access Point [a]	Group Type	n	Mean (mm:ss)	Standard Deviation (mm:ss)
Private Vehicle	X1	NA [b]	173	17:24	13:11
Shuttle Bus	X1, X2, X3, X4				
Private Vehicle	X2, X3, X4	Small (1-3 People)	208	7:11	7:00
		Large (4-10 People)	94	12:19	9:09
Other [c]	X1, X2, X3, X4	NA	19	17:07	12:58

[a] Refer to Figure 2.6.2 El Capitan Meadow of Lawson, et al., 2008 for the locations of access points.
[b] Difference in lingering times between small and large groups is not statistically significant.
[c] Due to small number of observations, delays were entered into the model as an empirical distribution rather than as a theoretical distribution with parameters (i.e., mean and standard deviation) specified.

Table 2.6.3. Visitor group size distribution, by mode of arrival and access point [a] – El Capitan Meadow.[2]

Mode	Access Point	Group Size							N
		1	2	3	4	5	6	7+	
Private Vehicle	X1, X2, and X3	21.1%	31.9%	16.9%	17.8%	5.1%	3.9%	3.3%	332
	X4	34.8%	17.4%	4.3%	13.0%	13.0%	0.0%	17.4%	23
Shuttle Bus	X1, X2,X3, and X4	15.0%	36.7%	14.2%	10.0%	12.5%	5.0%	6.7%	120
Other [b]	X1, X2,X3, and X4	20.0%	33.3%	0.0%	20.0%	6.7%	6.7%	13.3	15
Chi-Square, $\chi 2 = 31.039$, $p = 0.002$ (test excludes "Other" due to low sample size)									

[a] Refer to Figure 2.6.2 of El Capitan Meadow for locations of access points.
[b] Includes tour bus, bicycle, pedestrian via the Valley Loop Trail, and unobserved modes.

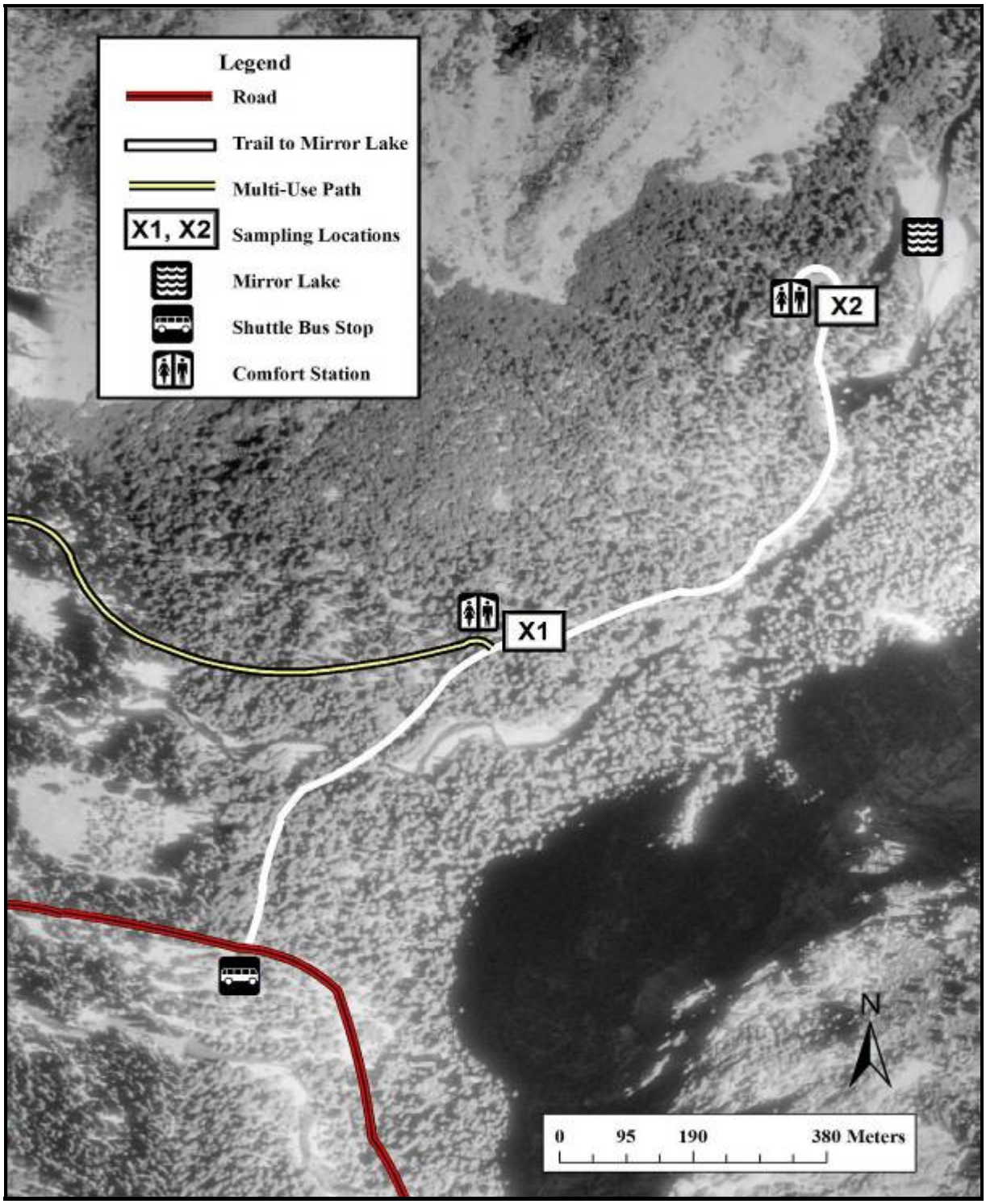
[2]From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Table 2.6.4. Transportation mode of arrival, by access point [a] – El Capitan Meadow.[2]						
	Private Vehicle [b]		Shuttle Bus		Other [c]	
Access Point	Number	Percentage	Number	Percentage	Number	Percentage
X1	47	27.6%	117	68.8%	6	3.6%
X2	227	94.5%	3	1.3%	10	4.2%
X3	58	100.0%	0	0.0%	0	0.0%
X4	23	88.5%	0	0%	3	11.5%
Chi-Square, $\chi 2 = 288.858$, $p = <0.001$						

[a] Refer to Figure 2.6.2 El Capitan Meadow of Lawson, et al., 2008 for the locations of access points.
[b] Private vehicles parked on roadside of Northside Drive.
[c] Includes tour bus, bicycle, pedestrian via the Valley Loop Trail, and unobserved modes.

[2]From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Figure 2.6.3. Mirror Lake study site schematic diagram.[2]



[2]From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Table 2.6.5. Mirror Lake visitor arrivals [a], by sampling date – 2007 (10 AM – 5 PM)[2]						
Sampling Date	Day of Week	Pedestrian Arrivals		Bicycle Arrivals		Total Arrivals b
		Number	Percentage	Number	Percentage	
08.10.2007	Friday	507	62.5%	304	37.5%	811
08.13.2007	Monday	516	61.1%	328	38.9%	844
08.14.2007	Tuesday	558	65.0%	301	35.0%	859
08.18.2007	Saturday	619	69.8%	268	30.2%	887
08.19.2007	Sunday	492	69.1%	220	30.9%	712
Mean		538	65.5%	284	34.5%	823
95% Confidence Interval		+/- 45.0	+/- 3%	+/- 36.6	+/- 3%	+/- 59.3

[a] Based on visitor counts at X1 access point noted on Figure 2.6.3 Mirror Lake of Lawson, et al., 2008. Average total arrivals to Mirror Lake between 10 AM and 5 PM during summer 1999 data collection = 1,189. Thus, 2007 data suggest a 31% decrease in average total arrivals to Mirror Lake between the hours of 10 AM and 5 PM.

Table 2.6.6. Mean and standard deviation of hiking and biking times on trail to Mirror Lake.[2]					
Mode of Travel	Activity	Group Type	n	Mean (mm:ss)	Standard Deviation (mm:ss)
Pedestrian	Hiking from trailhead ***a*** to Mirror Lake	Small Group (1-3 People)	54	7:09	3:01
		Large Group (4-10 People)	39	8:21	3:28
	Hiking from Mirror Lake to trailhead ***a***	Small Group (1-3 People)	37	4:06	2:03
		Large Group (4-10 People)	30	4:27	3:08
Bicycle	Biking from trailhead ***a*** to Mirror Lake	N/A [b]	94	7:39	3:14
	Biking from Mirror Lake to trailhead a	N/A [b]	68	4:23	2:46

[a] Refers to X1 access point noted on the Mirror Lake Figure 2.6.3.
[b] Difference in biking times between small and large groups is not significantly different.

[2]From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Table 2.6.7. Visitor group size distribution, by mode of arrival and access point [a] – Mirror Lake.[2]

X1 Access Point							
	Group Size						
Mode	1	2	3	4	5	6+	n
Shuttle	2.6%	34.7%	18.1%	21.3%	11.4%	11.9%	193
Walked From Overnight Accommodations	7.3%	43.9%	9.8%	14.6%	14.6%	9.8%	41
Private Vehicle and Other [b]	7.9%	44.7%	13.2%	21.0%	5.3%	7.9%	38
Bike	8.3%	34.0%	15.5%	23.7%	7.1%	11.4%	97
Chi-Square, $\chi 2 = 13.120$, $p = 0.593$							
X2 Access Point							
	Group Size						n
Mode	1	2	3	4	5	6+	
Pedestrian	3.5%	39.4%	14.6%	21.2%	7.7%	13.6%	287
Bicycle	10.5%	31.3%	13.4%	28.3%	6.0%	10.5%	67
Chi-Square, $\chi 2 = 8.302$, $p = 0.140$							

[a] Refer to the Mirror Lake Figure 2.6.3. for locations of access points.
[b] Includes visitors who parked private vehicles at day use parking locations and walked.

[2]From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

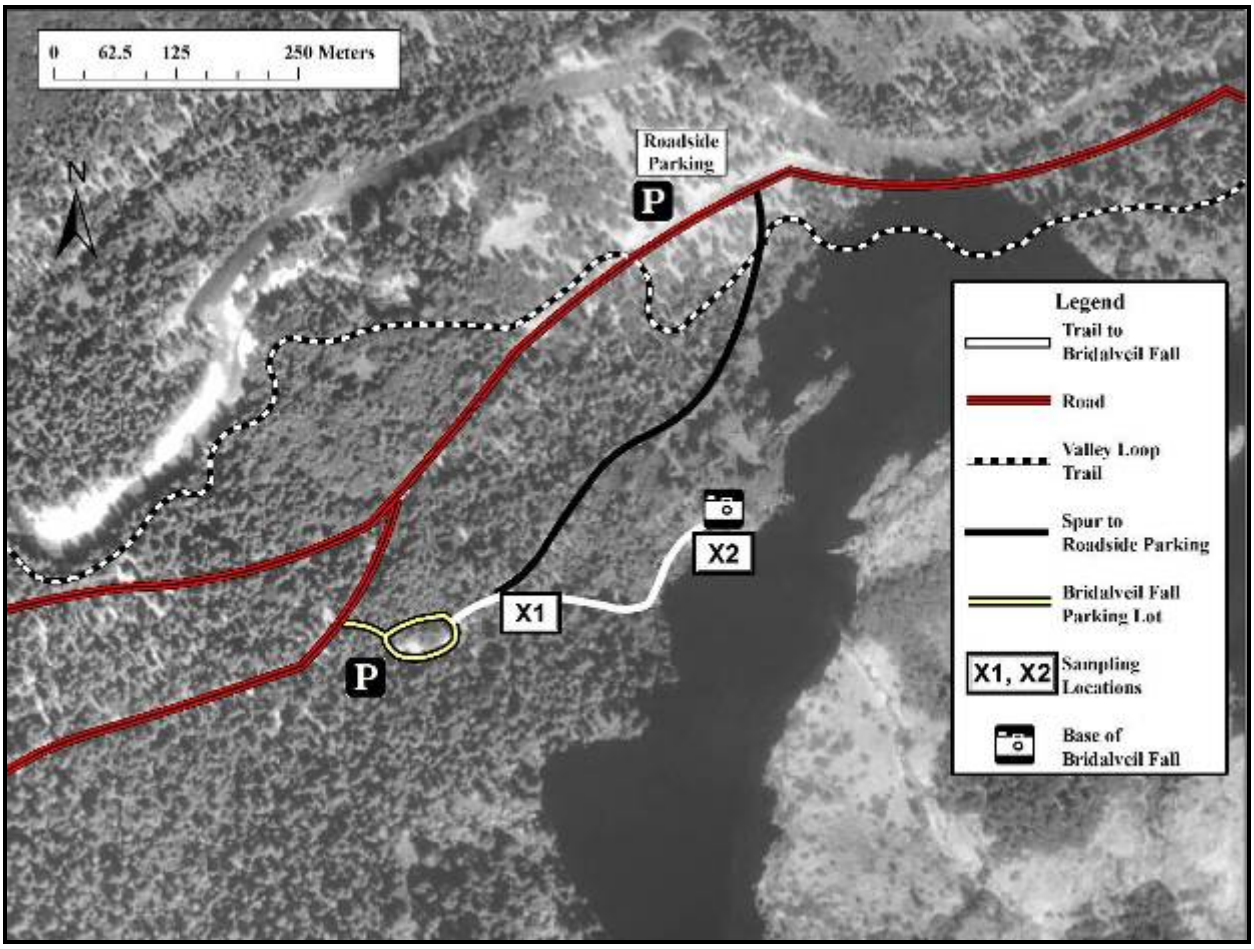
Table 2.6.8. Mean visitor arrivals to Mirror Lake, by time of day and access point [a] – 1999 and 2007.[2]

Time of Day	X1 – 2007	X2 – 2007	Total – 2007	X1 – 1999	X2 – 1999	Total – 1999
7:00 AM-7:30 AM	1	3	4	4	1	5
7:30 AM-8:00 AM	2	5	7	6	2	8
8:00 AM-8:30 AM	1	13	14	4	7	11
8:30 AM-9:00 AM	1	10	11	3	5	8
9:00 AM-9:30 AM	6	10	16	18	5	23
9:30 AM-10:00 AM	10	17	27	31	9	40
10:00 AM-10:30 AM	15	26	41	45	13	58
10:30 AM-11:00 AM	32	32	64	85	27	112
11:00 AM-11:30 AM	48	53	101	111	47	158
11:30 AM-12:00 PM	65	66	131	96	69	165
12:00 PM-12:30 PM	66	53	119	84	84	168
12:30 PM-1:00 PM	73	48	121	87	84	171
1:00 PM-1:30 PM	75	53	128	79	101	180
1:30 PM-2:00 PM	79	54	133	113	118	231
2:00 PM-2:30 PM	64	33	97	112	105	217
2:30 PM-3:00 PM	60	50	110	83	101	184
3:00 PM-3:30 PM	63	39	102	86	98	184
3:30 PM-4:00 PM	73	56	129	83	92	175
4:00 PM-4:30 PM	58	44	102	64	67	131
4:30 PM-5:00 PM	51	31	82	62	80	142
5:00 PM-5:30 PM	52	28	80	63	72	135
5:30 PM-6:00 PM	36	25	61	44	63	107
6:00 PM-6:30 PM	16	20	36	20	52	72
6:30 PM-7:00 PM	16	10	26	19	27	46
7:00 PM-7:30 PM	9	7	16	11	18	29
7:30 PM-8:00 PM	7	9	16	8	22	30
Total	979	795	1,774	1,421	1,369	2,790

Note: Numbers in italics denote estimated arrivals.
[a] Refer to Mirror Lake Figure 2.6.3. for the locations of access points.

[2]From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Figure 2.6.4. Bridalveil Falls study site schematic diagram.[2]



[2]From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Table 2.6.9. Bridalveil Falls visitor arrivals [a], by sampling date – 2007 (10AM- 5PM).[2]						
Sampling Date	Day of Week	Parking Lot Arrivals		Roadside Parking Arrivals		Total Arrivals ***b***
		Number	Percentage	Number	Percentage	
06.23.2007	Saturday	2,349	78.4%	649	21.6%	2,998
06.26.2007	Tuesday	2,027	82.6%	427	17.4%	2,454
06.27.2007	Wednesday	1,838	84.0%	349	16.0%	2,187
06.29.2007	Friday	1,767	85.6%	297	14.4%	2,064
07.01.2007	Sunday	2,055	86.6%	318	13.4%	2,373
Mean		2,007	83.4%	408	16.6%	2,415
95% Confidence Interval		+/- 198.8	+/- 3%	+/- 125.8	+/- 3%	+/- 315.5

[a] Based on visitor counts at X1 access point noted on Figure 2.6.4. Bridalveil Falls.
[b] Average total arrivals to Bridalveil Falls between 10 AM and 5 PM during summer 1999 data collection = 2,788. Thus, 2007 data suggest a 13% decrease in average total arrivals to Bridalveil Falls between the hours of 10 AM and 5 PM.

Table 2.6.10. Mean and standard deviation of hiking times on trail to Bridalveil Falls and lingering time at base of Bridalveil Falls.[2]				
Activity	Group Type	n	Mean (mm:ss)	Standard Deviation (mm:ss)
Hiking from trailhead a to the base of Bridalveil Fall	Small Group (1-4 People)	81	2:50	0:58
	Large Group (5-14 People)	252	3:08	0:56
Hiking from the base of Bridalveil Fall to trailhead [a]	Small Group (1-4 People)	81	2:50	1:08
	Large Group (5-14 People)	237	3:13	1:29
Lingering at the base of Bridalveil Fall	Small Group (1-4 People)	81	11:43	11:59
	Large Group (5-14 People)	246	16:53	14:14

[a] Refers to the X1 access point noted on the Figure 2.6.4. Bridalveil Fall.

[2]From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Table 2.6.11. Visitor group size distribution, by parking location – Bridalveil Fall.[2]

Origin	Group Size 1	2	3	4	5	6	7-9	10+	n
Roadside Parking	0.0%	29.2%	16.9%	21.3%	10.1%	7.9%	9.0%	5.6%	89
Parking Lot	1.8%	37.2%	12.8%	24.4%	8.9%	5.3%	5.7%	3.9%	282

Chi-Square, $\chi 2 = 6.377$, $p = 0.497$

Table 2.6.12. Mean visitor arrivals to Bridalveil Falls, by time of day – 1999 and 2007.[2]

Time of Day	Via Roadside Parking – 2007	Via Parking Lot – 2007	Total – 2007	Total – 1999
7:00 AM-7:30 AM	0	2	2	3
7:30 AM-8:00 AM	1	5	6	6
8:00 AM-8:30 AM	3	13	16	15
8:30 AM-9:00 AM	6	28	34	35
9:00 AM-9:30 AM	10	48	58	59
9:30 AM-10:00 AM	15	74	90	91
10:00 AM-10:30 AM	22	146	168	122
10:30 AM-11:00 AM	39	148	187	165
11:00 AM-11:30 AM	34	174	208	251
11:30 AM-12:00 PM	32	190	222	269
12:00 PM-12:30 PM	38	186	224	260
12:30 PM-1:00 PM	30	163	193	173
1:00 PM-1:30 PM	42	148	190	189
1:30 PM-2:00 PM	27	148	175	218
2:00 PM-2:30 PM	31	128	159	217
2:30 PM-3:00 PM	29	128	157	178
3:00 PM-3:30 PM	28	126	154	235
3:30 PM-4:00 PM	22	117	139	183
4:00 PM-4:30 PM	18	111	129	167
4:30 PM-5:00 PM	16	95	111	160
5:00 PM-5:30 PM	22	107	129	144
5:30 PM-6:00 PM	23	113	136	151
6:00 PM-6:30 PM	13	66	79	88
6:30 PM-7:00 PM	9	42	50	56
7:00 PM-7:30 PM	6	28	34	37
7:30 PM-8:00 PM	2	11	13	15
Total	518	2,545	3,063	3,487

Note: Numbers in italics denote estimated arrivals.

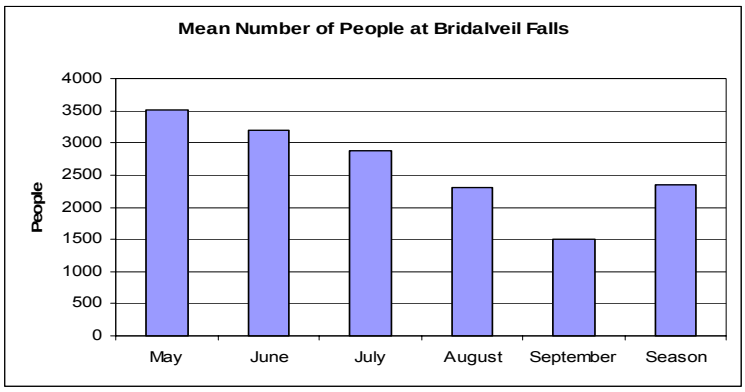
[2]From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Mean Number of People

Table 2.6.13. Statistics for the mean number of people per month at monitor 5—Bridalveil Falls.[1]

	N	n	Mean	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
May(5/25)	7	4	3,510	884	2,627±103	2,524	4,394±172	4,566
May(5/1)	31	4	3,510	1,260	2,251±88	2,163	4,770±187	4,957
June	30	24	3,188	82	3,106±121	2,985	3,271±128	3,399
July	31	27	2,870	40	2,830±111	2,720	2,911±114	3,025
August	31	24	2,307	109	2,198±86	2,112	2,415±94	2,509
September	30	30	1,505	0	1,505±59	1,446	1,505±59	1,564
Season	129	109	2,464	64	2,400±94	2,306	2,528±98	2,627

Figure 2.6.5. Mean number of people per month at Monitor 5.[1]



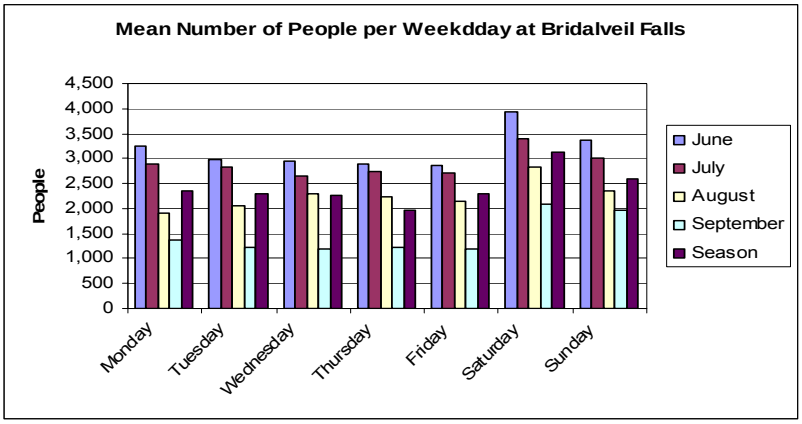
Mean Number of People per Weekday

Table 2.6.14. Statistics for the mean number of people per weekday at Bridalveil Falls.[1]

	N	n	Mean	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
Monday	18	13	2,361	255	2,107±82	2,025	2,616±102	2,718
Tuesday	18	14	2,295	211	2,084±82	2,002	2,506± 98	2,604
Wednesday	18	16	2,269	126	2,143±84	2,059	2,394± 94	2,488
Thursday	18	16	1,975	137	1,838±72	1,766	2,113± 83	2,196
Friday	19	17	2,280	116	2,164±85	2,080	2,396± 94	2,489
Saturday	19	17	3,131	161	2,970±116	2,854	3,291±129	3,420
Sunday	18	16	2,592	148	2,444±96	2,348	2,740±107	2,847

[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Figure 2.6.6. Mean number of people per weekday at Bridalveil Falls.[1]



Mean Visitation per Hour

Table 2.6.15. Statistics for hourly visitation to Bridalveil Falls for 2007 season.[1]

Hour	Mean	B (Error of Mean)	Lower Bound	Lower Bound Adjusted	Upper Bound	Upper Bound Adjusted
0	0	0	0+-0	0	0+-0	0
1	0	0	0+-0	0	0+-0	0
2	0	0	0+-0	0	0+-0	0
3	0	0	0+-0	0	0+-0	0
4	0	0	0+-0	0	0+-0	0
5	0	0	0+-0	0	0+-0	0
6	4	0	3+-0	3	4+-0	4
7	21	1	19+-1	19	22+-1	23
8	75	3	72+-3	69	79+-3	82
9	266	7	258+-10	248	273+-11	284
10	514	13	501+-20	481	527+-21	548
11	694	17	677+-26	651	711+-28	739
12	671	18	654+-26	628	689+-27	716
13	608	17	591+-23	568	626+-24	650
14	580	16	564+-22	542	596+-23	619
15	524	14	510+-20	490	538+-21	559
16	407	12	395+-15	379	419+-16	436
17	293	10	283+-11	272	303+-12	315
18	181	8	174+-7	167	189+-7	196
19	73	4	69+-3	67	77+-3	80
20	15	1	14+-1	13	17+-1	17
21	0	0	0+-0	0	0+-0	0
22	0	0	0+-0	0	0+-0	0
23	0	0	0+-0	0	0+-0	0

[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Figure 2.6.7. Hourly visitation to Bridalveil Falls for 2007 season.[1]

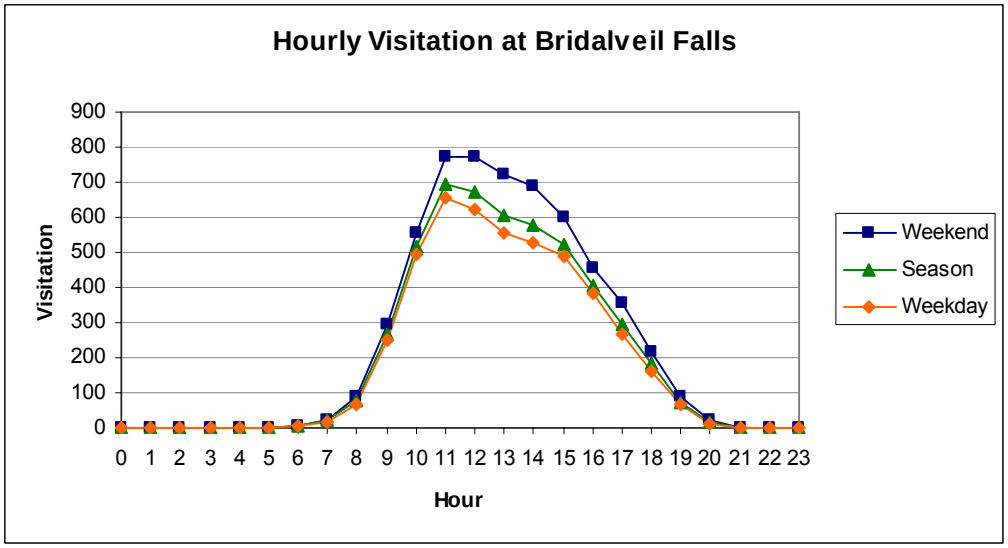
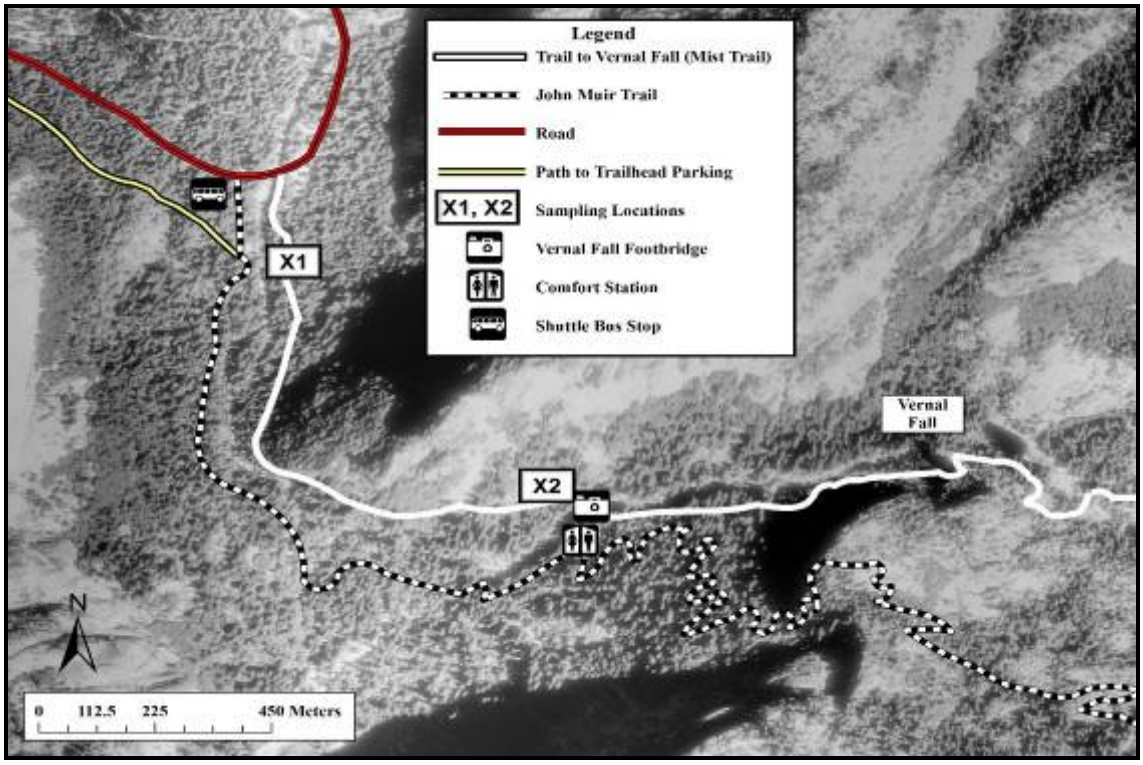


Figure 2.6.8. Vernal Falls study site schematic diagram.[2]



[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.
[2]From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Table 2.6.16. Vernal Falls visitor arrivals [a], by sampling date – 2007 (10 AM – 5 PM).[2]

Sampling Date	*Day of Week*	*Total Arrivals* [b]
07.19.2007	Thursday	1,524
07.20.2007	Friday	1,614
07.21.2007	Saturday	2,454
07.22.2007	Sunday	1,749
07.23.2007	Monday	1,755
08.11.2007	Saturday	2,370
Mean		**1,911**
95% Confidence Interval		**+/- 318.9**

[a] Based on visitor counts at X1 access point noted on Figure 2.6.8. Vernal Falls Study Site Schematic Diagram.
[b] Average total arrivals to Vernal Fall between 10 AM and 5 PM during summer 1998 data collection = 1,836. Thus, 2007 data suggest a 4% increase in average total arrivals to Vernal Fall between the hours of 10 AM and 5 PM.

Table 2.6.17. Mean and standard deviation of hiking time on the trail to Vernal Falls.[2]

Travel Direction	*Group Type*	*n*	*Mean* (mm:ss)	*Standard Deviation* (mm:ss)
Hiking from trailhead [a] to first bridge on Vernal Fall Trail	Small Group (1-3 People)	275	24:46	7:26
	Large Group (4-10 People)	202	28:37	7:59
Hiking from first bridge on Vernal Fall Trail to trailhead [a]	Small Group (1-3 People)	257	20:36	5:29
	Large Group (4-10 People)	175	22:13	5:60

[a] Refers to Happy Isles Trailhead, noted X1 on the Vernal Falls Study Site Schematic Diagram.

[2] From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Table 2.6.18. Visitor group size distribution, by mode of arrival and access point [a] – Vernal Falls. [2]								
X1 Access Point								
Mode	*Group Size*							*n*
	1	2	3	4	5	6	7+	
Shuttle	3.4%	43.9%	8.4%	21.0%	7.4%	5.4%	10.5%	296
Walked From Overnight Accommodations	8.3%	30.0%	11.7%	21.6%	6.7%	5.0%	16.7%	60
Trailhead Parking	4.6%	53.9%	13.8%	13.8%	7.7%	0.0%	6.2%	65
Other [b]	8.3%	36.7%	11.7%	26.7%	5.0%	3.3%	8.3%	60
Chi-Square, $\chi^2 = 21.595$(a), $p = 0.250$								
X2 Access Point								
Mode	*Group Size*							*n*
	1	2	3	4	5	6	7+	
Pedestrian	5.8%	40.4%	15.5%	20.6%	5.5%	5.3%	6.9%	432

[a] Refer to Figure 2.6.8. Vernal Falls Study Site Schematic Diagram for locations of access points.
[b] Includes visitors who parked private vehicles at day use parking locations other than Trailhead Parking and walked; and visitors who rode a bicycle.

Table 2.6.19. Transportation mode of arrival – Vernal Falls[2]							
Shuttle Bus		*Walked from Overnight Accommodations*		*Trailhead Parking*		*Other* [a]	
Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
296	61.5%	60	12.5%	65	13.5%	60	12.5%

[a] Includes visitors who parked private vehicles at day use parking locations other than Trailhead Parking and walked; and visitors who rode a bicycle.

[2] From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Table 2.6.20. Mean visitor arrivals to Vernal Falls, by time of day and access point [a] – 1998 and 2007.[2]

Time of Day	X1 – 2007	X2 – 2007	Total – 2007	X1 – 1998	X2 – 1998	Total – 1998
7:00 AM-8:00 AM	213	4	217	212	3	215
8:00 AM-8:30 AM	54	6	60	54	4	58
8:30 AM-9:00 AM	97	9	106	96	6	102
9:00 AM-9:30 AM	108	13	121	107	8	115
9:30 AM-10:00 AM	164	14	178	163	9	172
10:00 AM-10:30 AM	157	15	172	156	9	165
10:30 AM-11:00 AM	210	31	241	213	10	223
11:00 AM-11:30 AM	204	53	257	197	40	237
11:30 AM-12:00 PM	203	87	290	225	80	305
12:00 PM-12:30 PM	204	110	314	194	93	287
12:30 PM-1:00 PM	164	141	305	149	111	260
1:00 PM-1:30 PM	142	171	313	124	124	248
1:30 PM-2:00 PM	138	187	325	145	130	275
2:00 PM-2:30 PM	126	191	317	85	170	255
2:30 PM-3:00 PM	103	169	272	110	157	267
3:00 PM-3:30 PM	88	226	314	76	198	274
3:30 PM-4:00 PM	64	215	279	81	211	292
4:00 PM-4:30 PM	62	204	266	52	195	247
4:30 PM-5:00 PM	45	196	241	29	176	205
5:00 PM-5:30 PM	52	177	229	33	159	192
5:30 PM-6:00 PM	32	191	223	20	172	192
6:00 PM-6:30 PM	36	176	212	23	158	181
6:30 PM-7:00 PM	26	146	172	17	131	148
7:00 PM-7:30 PM	3	124	127	2	111	113
7:30 PM-8:00 PM	2	12	14	1	21	22
Total	2,697	2,868	5,565	2,564	2,486	5,050

Note: Numbers in italics denote estimated arrivals.
[a] Refer to Figure 2.6.8. Vernal Falls Study Site Schematic Diagram for the locations of access points.

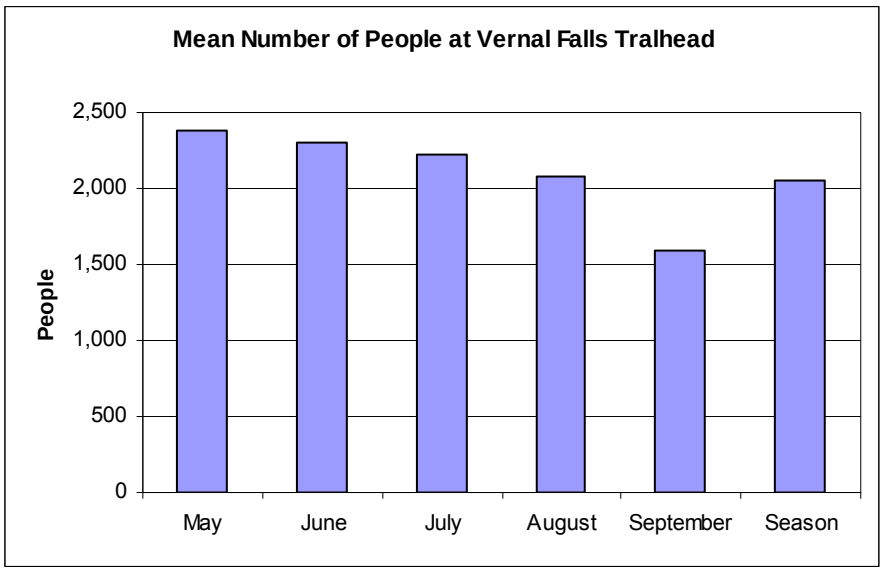
[2] From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Mean Number of People

Table 2.6.21. Statistics for the mean number of people at monitor 4—Vernal Falls Trailhead.[1]

	N	n	Mean	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
May(5/24)	8	8	2,377	0	2,377 – 53	2,324	2,324+ 53	2,430
May(5/1)	31	8	2,377	796	1,581±35	1,545	3,172±70	3,245
June	30	30	2,297	0	2,297 – 51	2,246	2,297+ 51	2,348
July	31	14	2,219	115	2,104±47	2,057	2,335±52	2,387
August	31	20	2,077	191	1,866±42	1,844	2,269±51	2,320
September	30	28	1,588	70	1,518±34	1,484	1,658±37	1,695
Season	133	100	2,050	77	1,973±44	1929	2,172±47	2,175

Figure 2.6.9. Mean number of people at monitor 4—Vernal Falls Trailhead.[1]



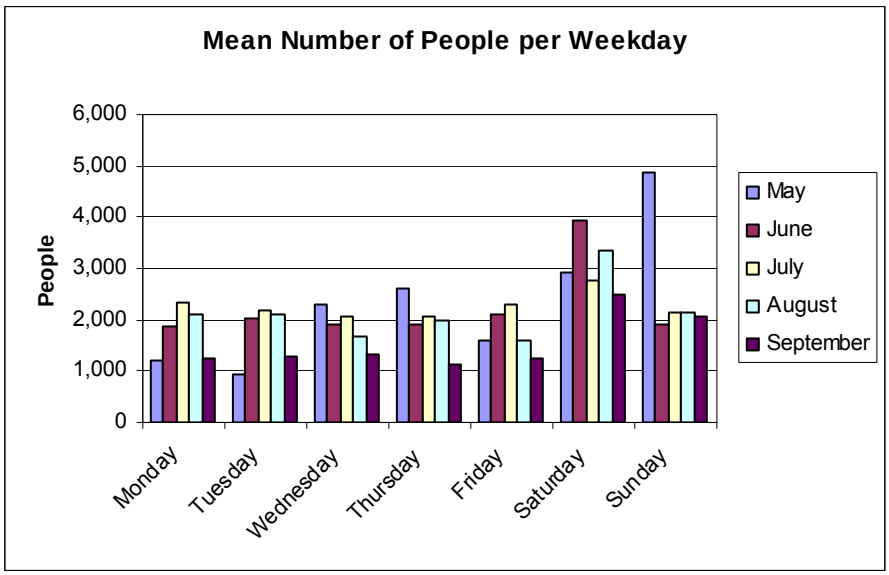
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Mean Number of People per Weekday

Table 2.6.22. Statistics for the mean number of people per weekday at Vernal Falls trailhead (Season).[1]

	N	n	Mean	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
Monday	18	12	1,784	172	1,611±36	1,576	1,956±44	2000
Tuesday	18	15	1,798	116	1,682±38	1,645	1,914±43	1,957
Wednesday	18	15	1,739	106	1,633±36	1,597	1,845±41	1,886
Thursday	18	16	1,844	107	1,736±39	1,698	1,951±44	1,995
Friday	19	14	1,782	126	1,656±37	1,619	1,908±43	1,950
Saturday	19	14	3,186	210	2,976±66	2,910	3,397±76	3,472
Sunday	18	14	2,249	272	1,977±44	1,933	2,522±56	2,578

Figure 2.6.10. Mean number of people per weekday at Vernal Falls trailhead (May 24-Sep 30).[1]



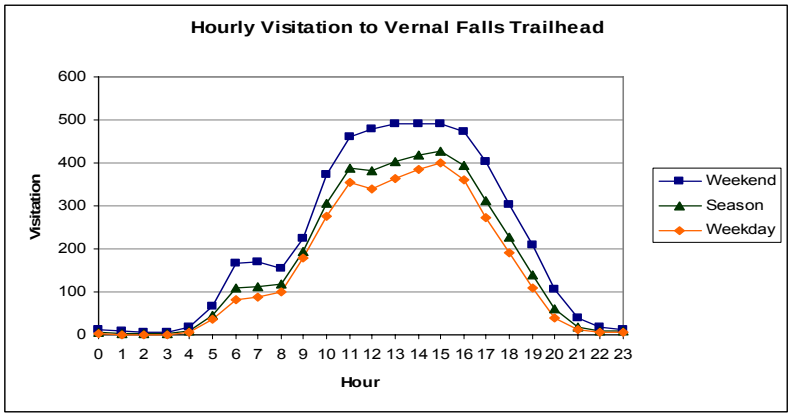
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Mean Visitation per Hour

Table 2.6.23. Statistics for hourly visitation to Vernal Falls Trailhead for 2007 season.[1]

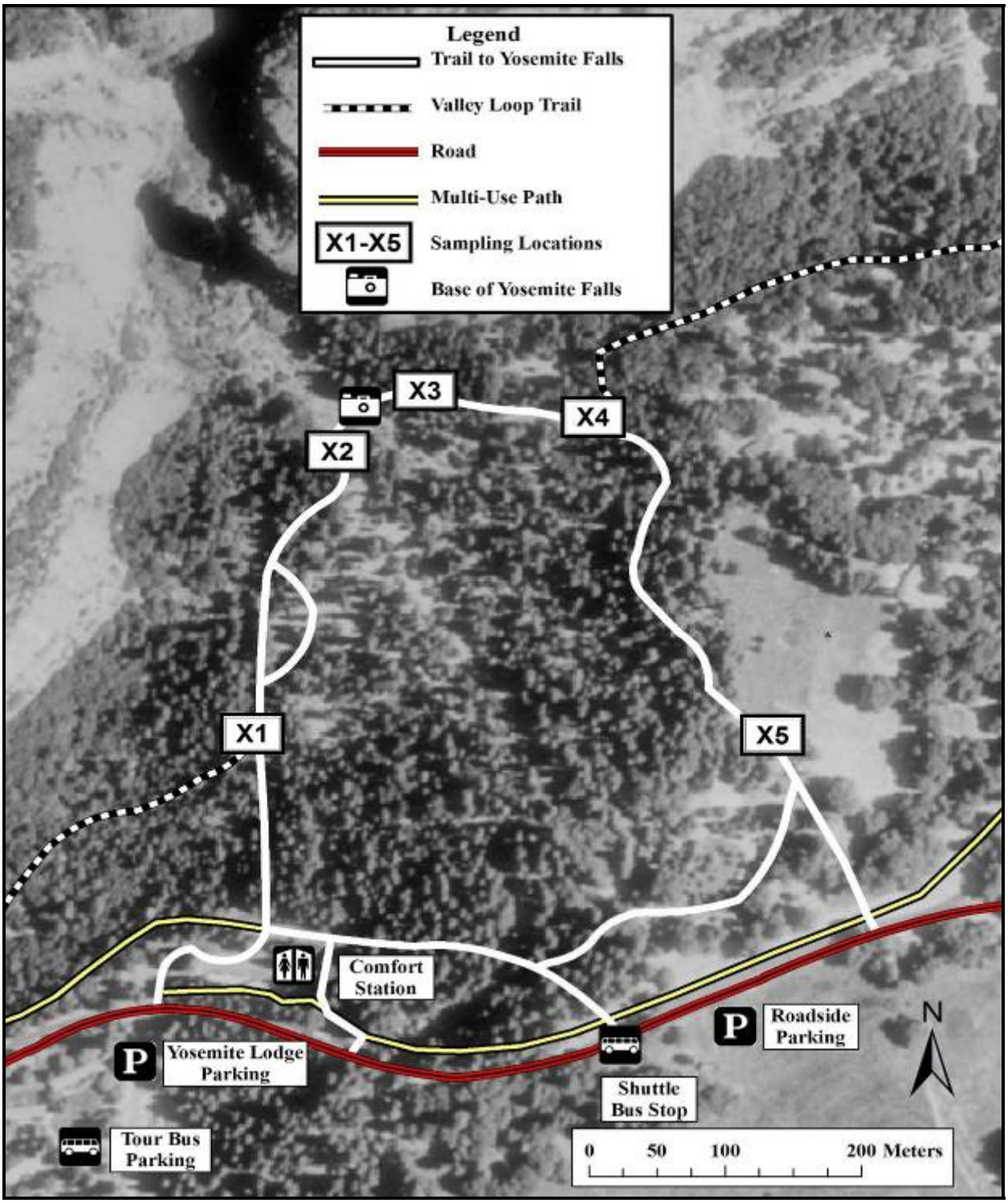
Hour	Mean	B (Error of Mean)	Lower Bound	Lower Bound Adjusted	Upper Bound	Upper Bound Adjusted
0	6	1	5+-0	5	7+-0	7
1	4	1	3+-0	3	4+-0	4
2	3	1	2+-0	2	4+-0	4
3	3	0	2+-0	2	3+-0	3
4	10	1	9+-0	9	11+-0	11
5	46	4	42+-1	41	50+-1	51
6	108	8	100+-2	98	116+-3	119
7	113	7	106+-2	104	120+-3	123
8	117	5	112+-2	109	123+-3	126
9	193	7	186+-4	182	200+-4	205
10	306	11	295+-7	288	318+-7	325
11	387	18	369+-8	361	406+-9	415
12	382	14	367+-8	359	396+-9	405
13	403	15	388+-9	379	418+-9	428
14	417	16	401+-9	392	434+-10	443
15	429	18	410+-9	401	447+-10	457
16	395	18	377+-8	369	413+-9	422
17	313	13	300+-7	293	326+-7	334
18	227	11	216+-5	211	238+-5	243
19	141	9	131+-3	129	150+-3	153
20	61	6	56+-1	54	67+-1	68
21	19	2	17+-0	17	22+-0	22
22	9	1	8+-0	8	10+-0	11
23	8	1	6+-0	6	9+-0	9

Figure 2.6.11. Hourly visitation to Vernal Falls Trailhead for 2007 season.[1]



[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Figure 2.6.12. Yosemite Falls study site schematic diagram.[2]



[2]From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Table 2.6.24. Yosemite Falls visitor arrivals, by sampling date – 2007 (10 AM – 5 PM).[2]

Sampling Date	*Day of Week*	*X1 Access Point* [a]		*X4 Access Point* [a]		*X5 Access Point* [a]		*Total Arrivals* [b]
		Number	Percentage	Number	Percentage	Number	Percentage	
07.12.2007	Thursday	2,023	64.0%	17	0.5%	1,120	35.4%	3,160
07.13.2007	Friday	1,943	65.6%	32	1.1%	986	33.3%	2,961
07.14.2007	Saturday	2,807	69.1%	42	1.0%	1,214	29.9%	4,063
07.15.2007	Sunday	2,201	67.0%	21	0.6%	1,064	32.4%	3,286
07.16.2007	Monday	1,971	68.0%	19	0.6%	909	31.4%	2,899
Mean		**2,189**	**66.7%**	**26**	**0.8%**	**1,059**	**32.5%**	**3,274**
95% Confidence Interval		**+/- 315.3**	**+/- 2%**	**+/- 9.3**	**+/- 0%**	**+/- 103.3**	**+/- 2%**	**+/- 409.8**

[a] Refer to Figure 2.6.12. Yosemite Falls Study Site Schematic Diagram for the locations of access points.
[b] Average total arrivals to Yosemite Falls between 10 AM and 5 PM during summer 1998 data collection = 4,147. Thus, 2007 data suggest a 21% decrease in average total arrivals to Yosemite Falls between the hours of 10 AM and 5 PM.

[2]From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Table 2.6.25. Mean and standard deviation of hiking times on trails to Yosemite Falls.[2]

Trail Segment	*Group Type*	*Mean* (mm:ss)	*Standard Deviation* (mm:ss)
Hiking from west trailhead[a] to base of Yosemite Falls	NA[b]	6:56	2:03
Hiking from east trailhead[c] to base of Yosemite Falls	Small group (1-4 people)	10:20	2:26
	Large group (5-10 people)	11:27	2:30
Hiking from the VLT[d] to base of Yosemite Falls	Small group (1-4 people)	5:04	1:12
	Large group (5-10 people)	5:36	1:14
Hiking from base of Yosemite Falls to west trailhead[a]	NA[b]	6:20	2:14
Hiking from base of Yosemite Falls to east trailhead[c]	NA[b]	10:21	3:17
Hiking from base of Yosemite Falls to VLT[d]	NA[b]	5:04	1:36

[a] Refers to the X1 access point noted on Figure 2.6.12. Yosemite Falls Study Site Schematic Diagram.
[b] Large group and small group hiking times did not differ significantly.
[c] Refers to the X5 access point noted on Figure 2.6.12. Yosemite Falls Study Site Schematic Diagram.
[d] Refers to the X4 access point noted on Figure 2.6.12. Yosemite Falls Study Site Schematic Diagram.

[2] From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Table 2.6.26. Mean and standard deviation of lingering time at base of Yosemite Falls.				
Mode	*Group Type*	*n*	*Mean* (mm:ss)	*Standard Deviation* (mm:ss)
Private Vehicle	Small group (1-4 people)	144	13:48	19:46
	Large group (5-10 people)	41	25:28	28:14
Shuttle Bus	Small group (1-4 people)	157	25:09	28:35
	Large group (5-10 people)			
Tour Bus	Small group (1-4 people)	30	11:11	11:28
	Large group (5-10 people)			
Walk	Small group (1-4 people)	147	15:52	17:11
	Large group (5-10 people)	35	29:37	27:13
Bike	Small group (1-4 people)	25	20:00	25:27
	Large group (5-10 people)	11	40:05	30:15

[2]From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Table 2.6.27. Visitor group size distribution, by mode of arrival and access point [a] – Yosemite Falls.

X1 Access Point

Mode	*Group Size* 1	2	3	4	5	6	7+	*n*
Private Vehicle [b]	2.3%	37.6%	12.0%	25.6%	13.5%	1.5%	7.5%	133
Shuttle Bus	0.0%	26.1%	15.3%	26.8%	10.8%	8.9%	12.1%	157
Tour Bus	16.7%	33.3%	6.7%	36.7%	0.0%	3.3%	3.3%	30
Walk [c]	5.7%	41.5%	11.3%	22.6%	11.3%	1.9%	5.7%	53
Bike	2.5%	40.0%	7.5%	25.0%	12.5%	0.0%	12.5%	28

Chi-Square [d], $\chi^2 = 8.529$, $p = 0.074$

X4 Access Point

Mode	*Group Size* 1	2	3	4	5	6	7+	*n*
Private Vehicle [b]	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Shuttle Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Tour Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Walk [c]	25.0%	40.0%	10.0%	10.0%	0.0%	5.0%	10.0%	20
Bike	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0

All visitors entering at X4 access point were pedestrians from the Valley Loop Trail.

X5 Access Point

Mode	*Group Size* 1	2	3	4	5	6	7+	*n*
Private Vehicle [b]	2.2%	36.3%	23.1%	16.5%	9.9%	4.4%	7.6%	91
Shuttle Bus	4.3%	45.7%	13.0%	15.2%	8.7%	4.3%	8.8%	46
Tour Bus	0.0%	25.0%	75.0%	0.0%	0.0%	0.0%	0.0%	4
Walk [c]	3.9%	32.3%	15.5%	29.0%	12.3%	3.9%	3.1%	155
Bike	0.0%	25.0%	6.3%	31.3%	6.3%	18.8%	12.3%	16

Chi-Square [d], $\chi^2 = 4.305$, $p = 0.401$

[a] Refer to Figure 2.6.12. Yosemite Falls Study Site Schematic Diagram for locations of access points.

[b] Includes visitors who parked a private vehicle at Yosemite Lodge or on roadside along Northside Drive

[c] Includes visitors who parked a private vehicle at or rode a shuttle bus to Yosemite Village, including Camp 6 day use parking, and walked; and visitors who walked on the paved bike path or Valley Loop Trail.

[d] Due to low counts in some cells, Chi-squares results are based on comparison of distributions of small (1-4 people) and large (5-13 people) groups.

[2] From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Table 2.6.28. Mean visitor arrivals to Yosemite Falls, by time of day and access point [a] – 1998 and 2007.

Time of day	*X1 – 2007*	*X4 – 2007*	*X5 – 2007*	*Total – 2007*	*Total – 1998*
7:00 AM – 8:00 AM	*8*	*0*	*4*	*12*	25
8:00 AM – 8:30 AM	*4*	*0*	*2*	*6*	13
8:30 AM – 9:00 AM	*18*	*0*	*10*	*28*	59
9:00 AM – 9:30 AM	*65*	*1*	*37*	*103*	211
9:30 AM – 10:00 AM	*39*	*1*	*22*	*62*	128
10:00 AM – 10:30 AM	57	1	32	90	185
10:30 AM – 11:00 AM	96	2	44	142	203
11:00 AM – 11:30 AM	169	2	79	250	282
11:30 AM – 12:00 PM	154	3	90	247	243
12:00 PM – 12:30 PM	140	1	101	242	336
12:30 PM – 1:00 PM	163	1	93	257	295
1:00 PM – 1:30 PM	202	1	106	309	270
1:30 PM – 2:00 PM	200	2	70	272	354
2:00 PM – 2:30 PM	177	1	68	246	375
2:30 PM – 3:00 PM	217	2	90	309	470
3:00 PM – 3:30 PM	174	2	81	257	252
3:30 PM – 4:00 PM	146	2	81	229	320
4:00 PM – 4:30 PM	150	2	62	214	304
4:30 PM – 5:00 PM	144	3	63	210	258
5:00 PM – 5:30 PM	*137*	*3*	*60*	*200*	245
5:30 PM – 6:00 PM	*105*	*3*	*46*	*154*	188
6:00 PM – 6:30 PM	*75*	*2*	*33*	*110*	134
6:30 PM – 7:00 PM	*48*	*1*	*21*	*70*	86
7:00 PM – 7:30 PM	*42*	*1*	*18*	*61*	75
7:30 PM – 8:00 PM	*31*	*1*	*14*	*46*	56
Total	**2,761**	**38**	**1,327**	**4,126**	**5,367**

Note: Numbers in italics denote estimated arrivals.

[a] Refer to Figure 2.6.12. Yosemite Falls Study Site Schematic Diagram for the locations of access points. It should be noted there was only one (1) access point to Yosemite Falls during the 1998 study, there are now three (3) access points due to changes in the design of the site.

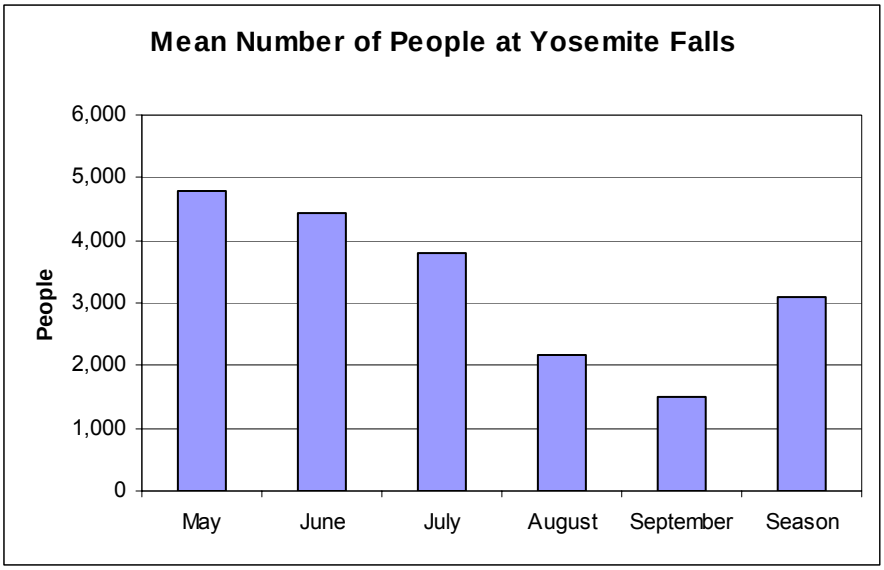
[2] From Lawson, S., Kiser, B., Hockett, K., Reigner, N., Chamberlin, R. & Choi, J. (2007). Visitor use computer simulation modeling to address transportation planning & user capacity in Yosemite Valley, Yosemite National Park (Final Report). Blacksburg, Virginia: Virginia Polytechnic Institute and State University.

Mean Number of People

Table 2.6.29. Mean daily number of people at Yosemite Falls.[1]

	N	Mean	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
May(5/19)	13	4,796	169	4,627 ± 98	4,528	4,965 ± 105	5,070
May(5/1)	31	4,796	566	4,231 ± 90	4,441	5,362 ± 114	5,476
June	30	4,425	33	4,392 ± 93	4,298	4,458 ± 95	4,552
July	31	3,782	81	3,701 ± 79	3,622	3,863 ± 82	3,945
August	31	2,174	0	2,174 – 46	2,128	2,174+ 46	2,220
September	30	1,504	19	1,484 ± 32	1,452	1,523 ± 32	1,555
Season	134	3,102	42	3,061 ± 65	2,996	3,145 ± 67	3,212

Figure 2.6.13. Mean daily number of people at Yosemite Falls.[1]



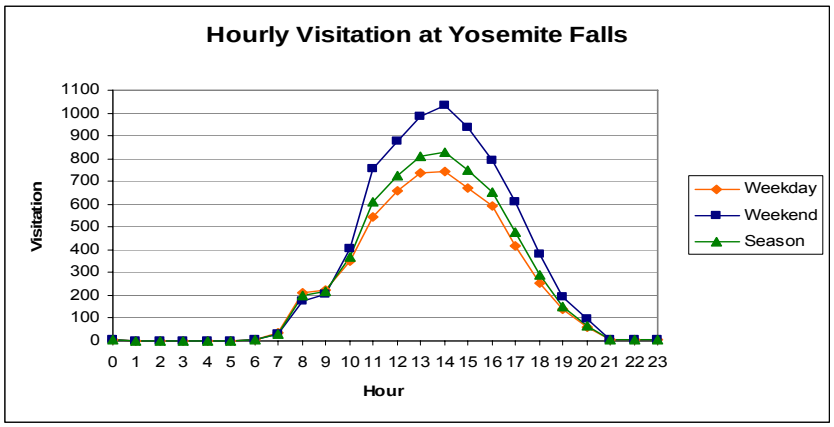
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Mean Visitation per Hour

Table 2.6.30. Hourly visitation to Yosemite Falls for 2007 season (N=134).[1]

Hour	Mean	B (Error of Mean)	Lower Bound	Lower Bound Adjusted	Upper Bound	Upper Bound Adjusted
0	5	1	4 ± 0	4	5 ± 0	5
1	2	0	2 ± 0	2	2 ± 0	2
2	1	0	1 ± 0	1	1 ± 0	1
3	0	0	0 ± 0	0	1 ± 0	1
4	0	0	0 ± 0	0	0 ± 0	0
5	1	0	0 ± 0	0	1 ± 0	1
6	6	0	6 ± 0	6	6 ± 0	6
7	30	1	29 ± 1	28	31 ± 1	32
8	197	5	191 ± 4	187	202 ± 4	206
9	217	3	214 ± 5	209	221 ± 5	226
10	367	5	362 ± 8	354	372 ± 8	380
11	608	8	600 ± 13	587	616 ± 13	629
12	726	9	716 ± 15	701	735 ± 16	751
13	812	11	802 ± 17	785	823 ± 18	841
14	828	12	815 ± 17	798	840 ± 18	858
15	748	12	736 ± 16	720	760 ± 16	776
16	652	11	641 ± 14	627	662 ± 14	676
17	476	8	467 ± 10	457	484 ± 10	494
18	292	6	286 ± 6	279	298 ± 6	304
19	151	4	148 ± 3	145	155 ± 3	158
20	64	2	62 ± 1	61	66 ± 1	67
21	8	1	7 ± 0	7	8 ± 0	8
22	7	1	7 ± 0	7	8 ± 0	8
23	6	1	5 ± 0	5	6 ± 0	6

Figure 2.6.14. Hourly visitation to Yosemite Falls for 2007 season.[1]



[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Total Number of People

Figure 2.6.15. Total number of people at Glacier Point overlook by month.[1]

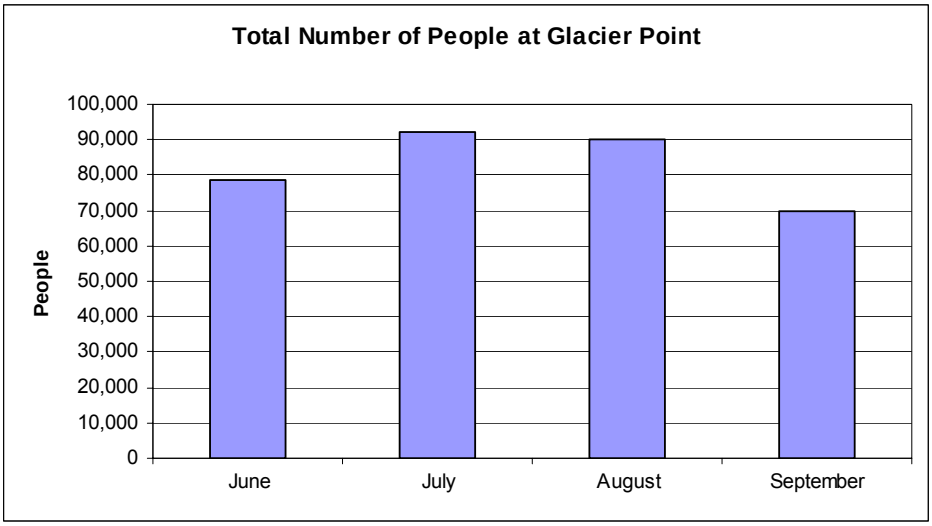


Table 2.6.31. Daily visitation means for Glacier Point.[1]

	N	Total	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
June	30	78,694	1,447	77,247 ± 4,358	72,888	80,140 ± 4,522	84,662
July	31	92,428	809	91,619 ± 5,144	86,475	93,237 ± 5,235	98,472
Aug	31	89,952	2,407	87,545 ± 4,900	82,645	92,359 ± 5,169	97,528
Sep	15	34,935	0	34,935 – 2,329	33,852	34,935+ 2,329	36,018
Sep	30	69,857	8,049	61,809 ± 3,457	58,351	77,906 ± 4,358	82,264
Season	122	336,986	5,826	331,161 ± 18,578	312,583	342,812 ± 19,231	362,043

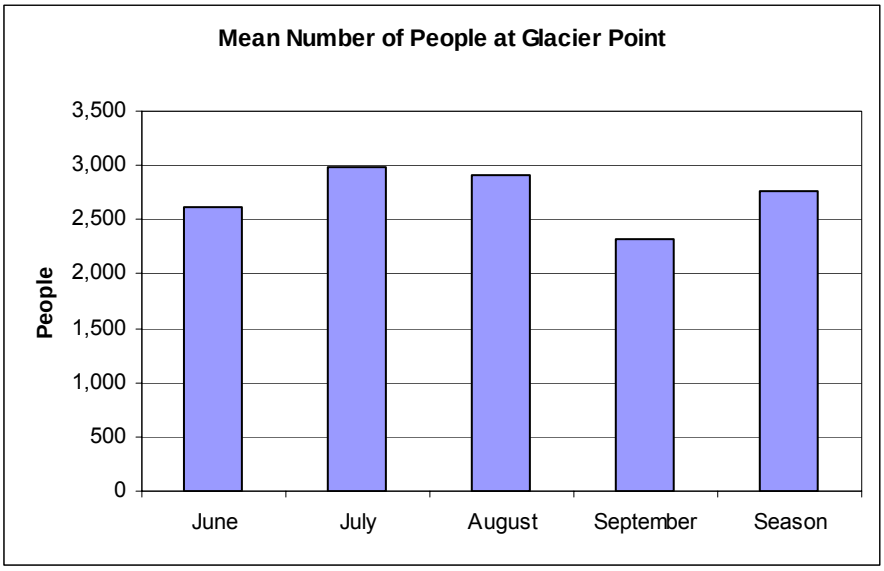
Mean Number of People

Table 2.6.32. Daily mean number of people for Glacier Point.[1]

	N	Mean	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
June	30	2,623	48	2,575 ± 84	2,490	2,671 ± 88	2,759
July	31	2,982	26	2,956+-96	2,859	3,008+-98	3,106
August	31	2,902	78	2,824+-92	2,732	2,979+-97	3,076
September	15	2,329	0	2,329 - 72	2,257	2,329+ 72	2,401
September	30	2,329	268	2,060 ± 67	1,993	2,597 ± 84	2,681
Season	122	2,762	48	2,714 ± 88	2,626	2,810 ± 92	2,902

[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Figure 2.6.16. Mean number of people per day at Glacier Point overlook.[1]



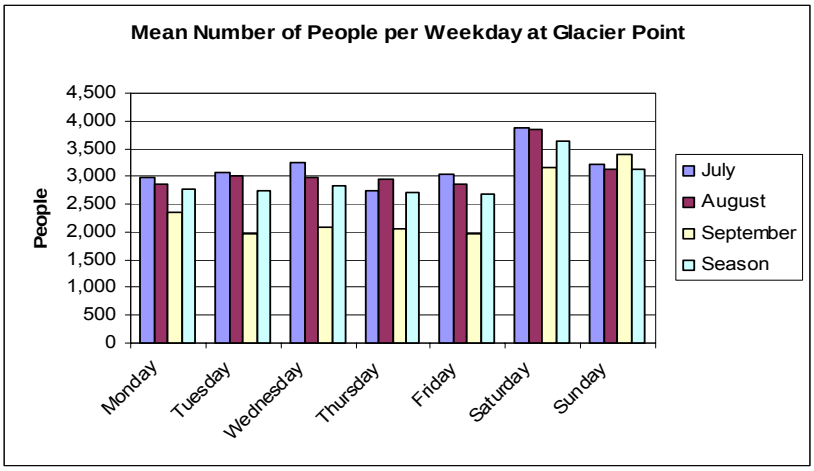
Mean Number of People per Weekday

Table 2.6.33. Statistics for the mean number of people per weekday at Glacier Point for 2007 summer season.[1]

	N	Mean	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
Monday	17	2,761	86	2,675 ± 58	2,617	2,847 ± 62	2,909
Tuesday	17	2,729	132	2,597 ± 56	2,541	2,861 ± 62	2,923
Wednesday	17	2,845	119	2,726 ± 59	2,666	2,964 ± 64	3,028
Thursday	17	2,703	120	2,583 ± 56	2,527	2,823 ± 61	2,885
Friday	18	2,687	124	2,563 ± 56	2,507	2,812 ± 61	2,873
Saturday	18	3,627	89	3,539 ± 77	3,462	3,716 ± 81	3,797
Sunday	18	3,137	130	3,007 ± 65	3,072	3,267 ± 71	3,338

[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Figure 2.6.17. Mean number of people per weekday at Glacier Point.[1]



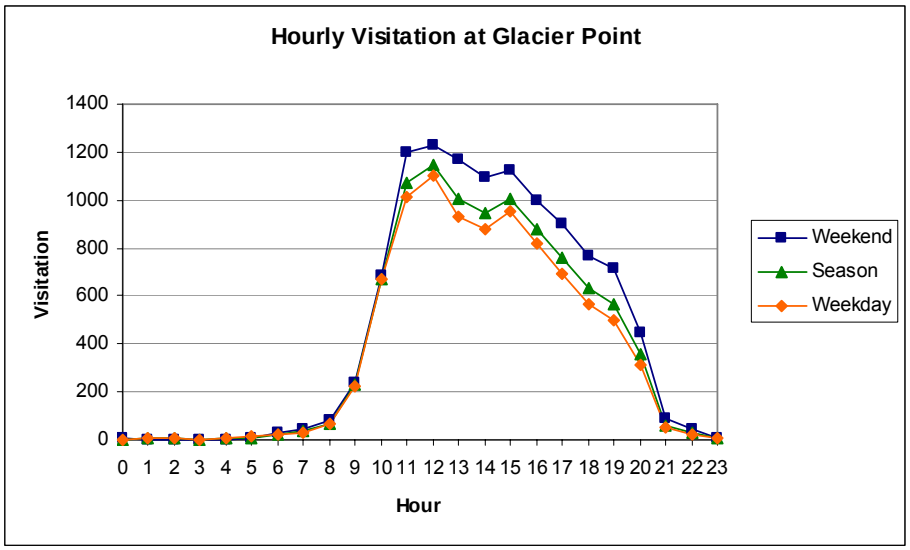
Mean Hourly Visitation

Table 2.6.34. Hourly visitation to Glacier Point for 2007 season (N=122).[1]

Hour	Mean	B (Error of Mean)	Lower Bound	Lower Bound Adjusted	Upper Bound	Upper Bound Adjusted
0	3	0	3 ± 0	3	3 ± 0	3
1	4	0	4 ± 0	4	4 ± 0	4
2	4	0	4 ± 0	4	4 ± 0	4
3	3	0	3 ± 0	3	3 ± 0	3
4	5	0	5 ± 0	5	5 ± 0	6
5	10	0	10 ± 0	10	10 ± 0	10
6	25	1	24 ± 1	23	26 ± 1	27
7	36	1	35 ± 1	34	37 ± 1	38
8	70	2	68 ± 2	66	72 ± 2	74
9	231	5	226 ± 7	219	236 ± 8	244
10	674	15	659 ± 22	637	689 ± 23	712
11	1071	24	1047 ± 34	1013	1096 ± 36	1131
12	1144	26	1118 ± 37	1081	1170 ± 38	1208
13	1006	23	983 ± 32	951	1028 ± 34	1062
14	947	21	926 ± 31	895	968 ± 32	1000
15	1005	23	982 ± 32	950	1028 ± 34	1062
16	877	20	857 ± 38	829	897 ± 29	926
17	759	17	742 ± 24	718	776 ± 25	802
18	631	14	617 ± 20	597	645 ± 21	666
19	568	13	555 ± 18	537	581 ± 19	600
20	356	8	348 ± 11	337	364 ± 12	376
21	63	1	62 ± 2	60	65 ± 2	67
22	28	1	27 ± 1	26	28 ± 1	29
23	7	0	7 ± 0	7	7 ± 0	7

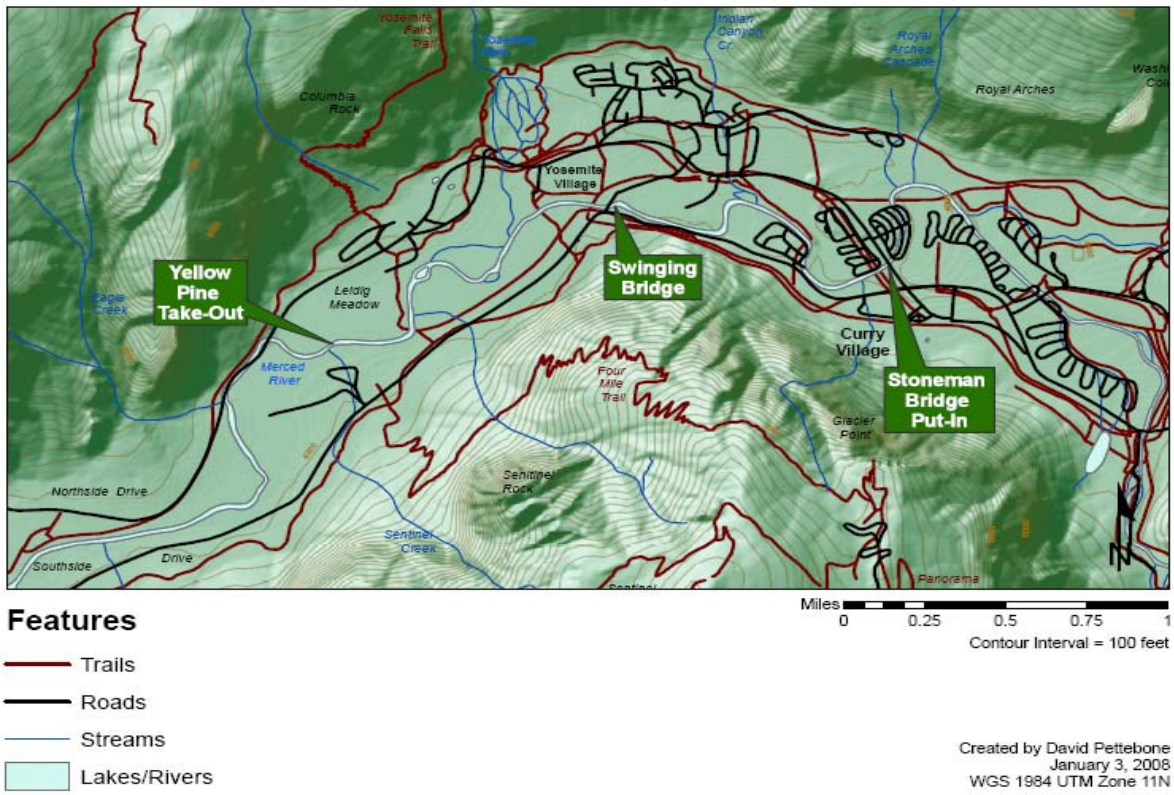
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Figure 2.6.18. Mean hourly visitation at Glacier Point.[1]



Merced River Use Study

Figure 2.6.19. Put-in and take out locations for Merced River use.[1]



[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Table 2.6.35. Total number of boats per day.[1]

Site	N (days)	Total	Standard Error	Lower Bound	Upper Bound
Stoneman (all study days)	35	7175	1228	8403	5947
Yellow Pine (all study days)	35	6745	939	7684	5806
Stoneman (Weekdays)	20	4520	1054.297	3465.703	5574.297
Yellow Pine (Weekdays)	20	4380	545.747	3824.253	4925.747
Stoneman (Weekend)	15	2655	629.484	2025.516	3284.484
Yellow Pine (Weekend)	15	2365	500.637	1864.363	2865.637

Table 2.6.36. Mean number of boats per day.[1]

Site	N (days)	Mean	Standard Error	Lower Bound	Upper Bound
Stoneman (all study days)	35	205	35	170	240
Yellow Pine (all study days)	35	193	27	156	220
Stoneman (Weekdays)	20	226	52.715	173.285	278.715
Yellow Pine (Weekdays)	20	219	27.287	191.713	246.287
Stoneman (Weekend)	15	177	41.966	135.034	218.966
Yellow Pine (Weekend)	15	157.6667	33.376	124.2907	191.0427

[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Table 2.6.37. Mean hourly boat use (All study days).[1]

Hour	Location	Mean	B	Lower Bound	Upper Bound
10	Stoneman	20.29	6.40	13.88	26.69
11	Stoneman	30.43	8.65	21.78	39.08
12	Stoneman	33.14	8.08	25.07	41.22
13	Stoneman	40.14	4.94	35.21	45.08
14	Stoneman	35.90	11.92	23.99	47.82
15	Stoneman	31.10	4.81	26.29	35.90
16	Stoneman	11.48	2.06	9.42	13.53
17	Stoneman	2.52	2.19	0.33	4.72
10	Yellow Pine	0.38	0.70	-0.32	1.08
11	Yellow Pine	8.19	1.85	6.34	10.04
12	Yellow Pine	19.95	3.01	16.94	22.96
13	Yellow Pine	23.62	6.00	17.62	29.62
14	Yellow Pine	32.29	8.81	23.47	41.10
15	Yellow Pine	37.71	6.13	31.58	43.85
16	Yellow Pine	38.48	5.23	33.24	43.71
17	Yellow Pine	32.10	10.52	21.57	42.62

Number of People on Merced River

Table 2.6.38. Total number of people per day.[1]

Site	N (days)	Total	Standard Error	Lower Bound	Upper Bound
Stoneman (all study days)	35	19,845	4,438	24,283	15,407
Yellow Pine (all study days)	35	18,655	3,539	22,194	15,116
Stoneman (Weekdays)	20	12,473	3,884	8,590	16,356
Yellow Pine (Weekdays)	20	12,060	3,198	8,862	15,258
Stoneman (Weekend)	15	7,390	2149	5,241	9,539
Yellow Pine (Weekend)	15	6,625	1,515	5,110	8,140

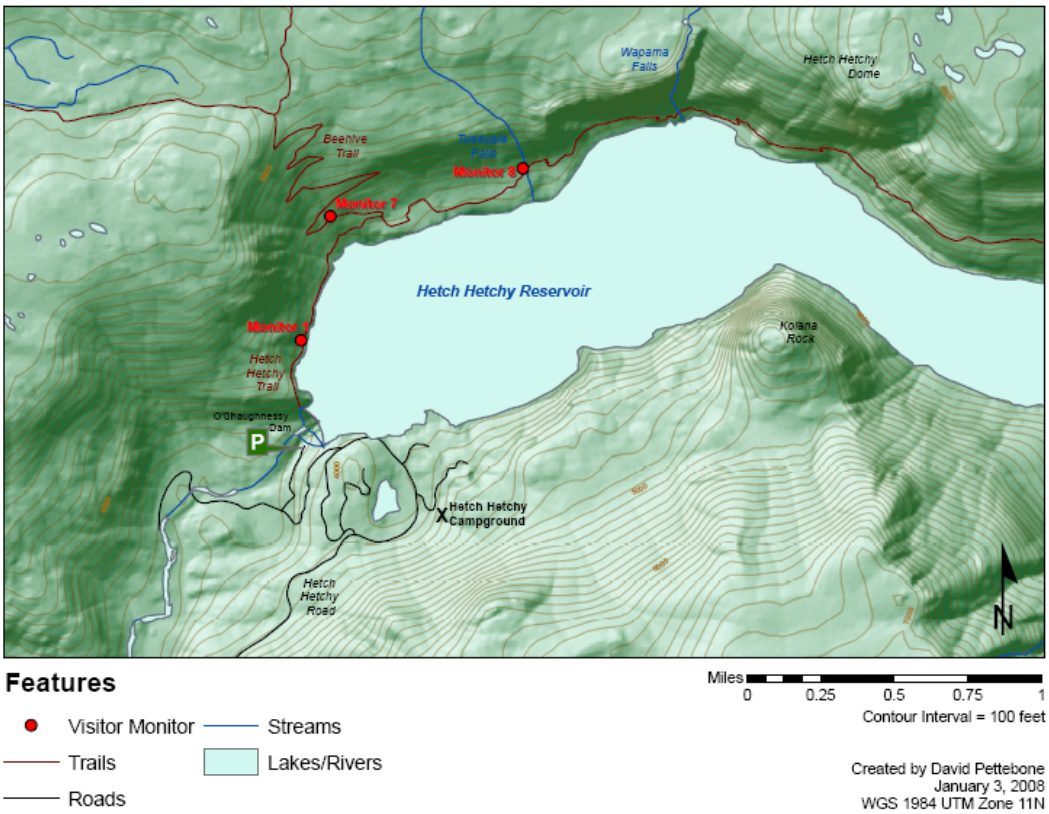
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Table 2.6.39. Mean number of people per day.[1]

Site	N (days)	Mean	Standard Error	Lower Bound	Upper Bound
Stoneman (all study days)	35	568	127	441	695
Yellow Pine (all study days)	35	534	101	432	634
Stoneman (Weekdays)	20	624	194.1813	429.4854	817.848
Yellow Pine (Weekdays)	20	603	159.911	443.086	762.914
Stoneman (Weekend)	15	493	143.247	349.419	635.914
Yellow Pine (Weekend)	15	442	101.0311	340.6355	542.6978

Hetch Hetchy Area

Figure 2.6.20. Locations of Visitor Use Monitors in Hetch Hetchy.[1]



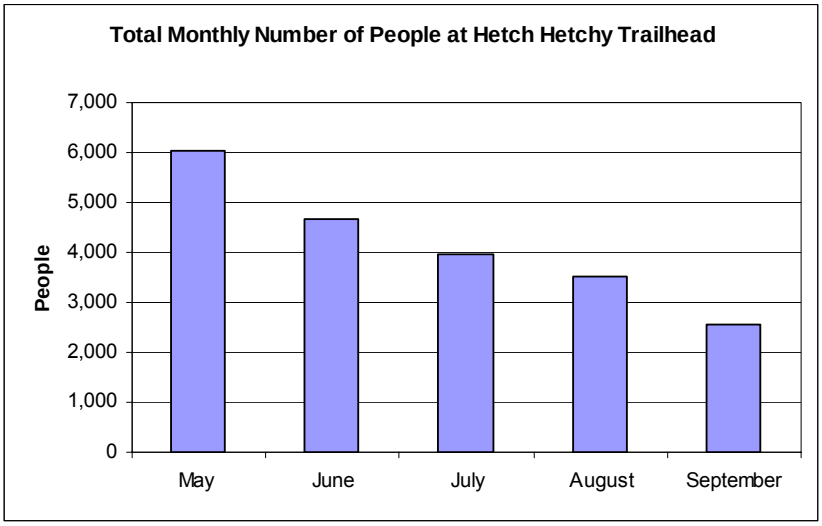
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Total Number of People

Table 2.6.40. Statistics for the total number of people per month at Hetch Hetchy trailhead.[1]

	N	n	Total	B	Lower Bound	Adj. LB	Upper Bound	Adj. UB
May	14	14	2,921	0	2,921 – 380	2,541	2,921+ 380	3,302
May	31	14	6,038	1,441	4,597 ± 598	3,999	7,479+-974	8,452
June	30	30	4,683	0	4,683 – 610	4,073	4,683+ 610	5,292
July	31	31	3,945	0	3,945 – 514	3,432	3,945+ 514	4,459
Aug	31	31	3,513	0	3,513 – 457	3,056	3,513+ 457	3,970
Sep	30	30	2,553	0	2,553 – 332	2,221	2,553+ 332	2,886
Season	138	138	17,616	0	17,616 – 2,293	15,323	17,616+ 2,293	19,909

Figure 2.6.21. Total Number of People at Hetch Hetchy trailhead by month.[1]



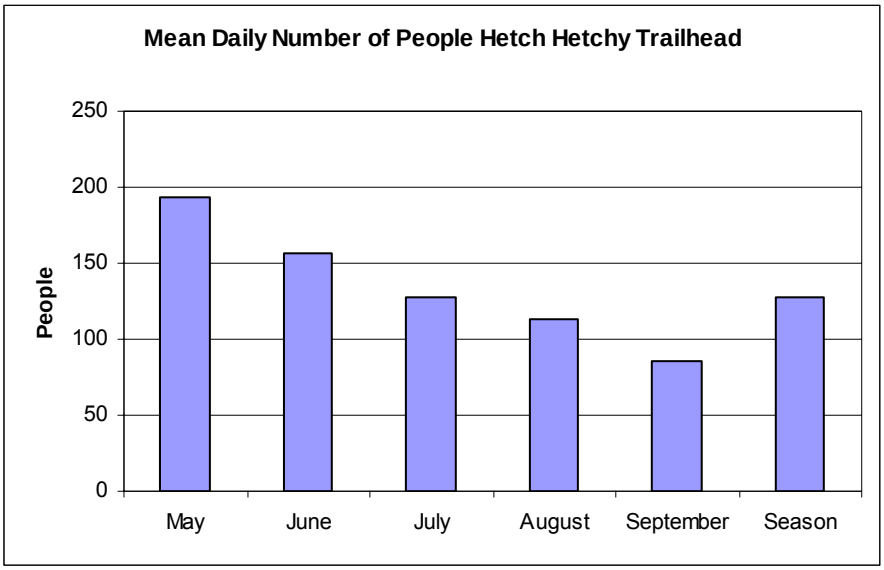
Mean Number of People

Table 2.6.41. Statistics for the mean number of people per month at Hetch Hetchy trailhead[1]

	N	n	Mean	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
May(5/19)	14	14	194	0	194 - 25	169	194+ 25	220
May(5/1)	31	14	194	46	148 ± 19	129	241 ± 31	273
June	30	30	156	0	194 - 20	136	194+ 20	176
July	31	31	127	0	194 - 17	110	194+ 17	144
August	31	31	113	0	194 - 15	98	194+ 15	128
September	30	30	85	0	194 - 11	74	194+ 11	96
Season	138	138	128	0	194 - 17	111	194+ 17	144

[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Figure 2.6.22. Mean Number of People per month at Hetch Hetchy trailhead.[1]



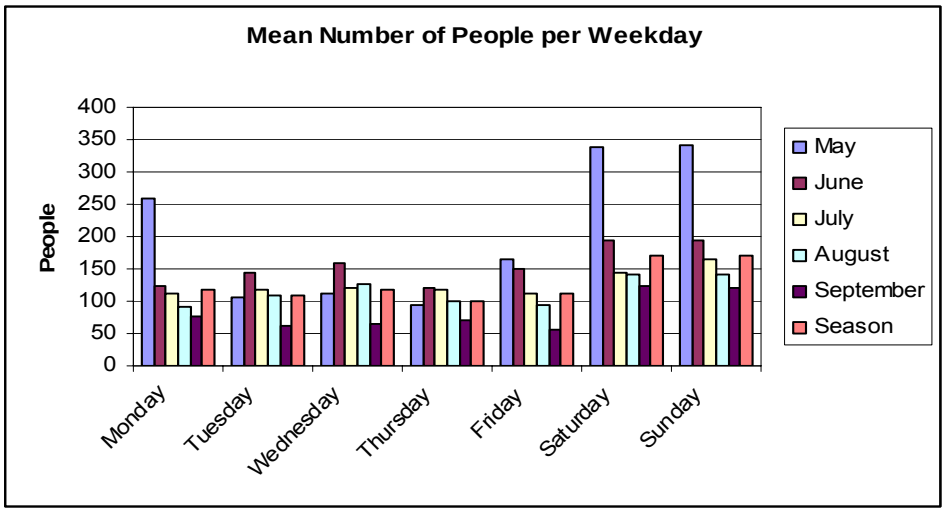
Mean Number of People per Weekday

Table 2.6.42. Statistics for the mean number of people per weekday at Hetch Hetchy trailhead.[1]

	Mean	B(Error)	Lower Bound	Upper Bound
Monday	118	15	103	133
Tuesday	109	14	94	123
Wednesday	117	15	102	132
Thursday	101	13	88	114
Friday	111	14	96	125
Saturday	171	22	148	193
Sunday	172	22	150	194

[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Figure 2.6.23. Mean number of people per weekday at Hetch Hetchy trailhead.[1]



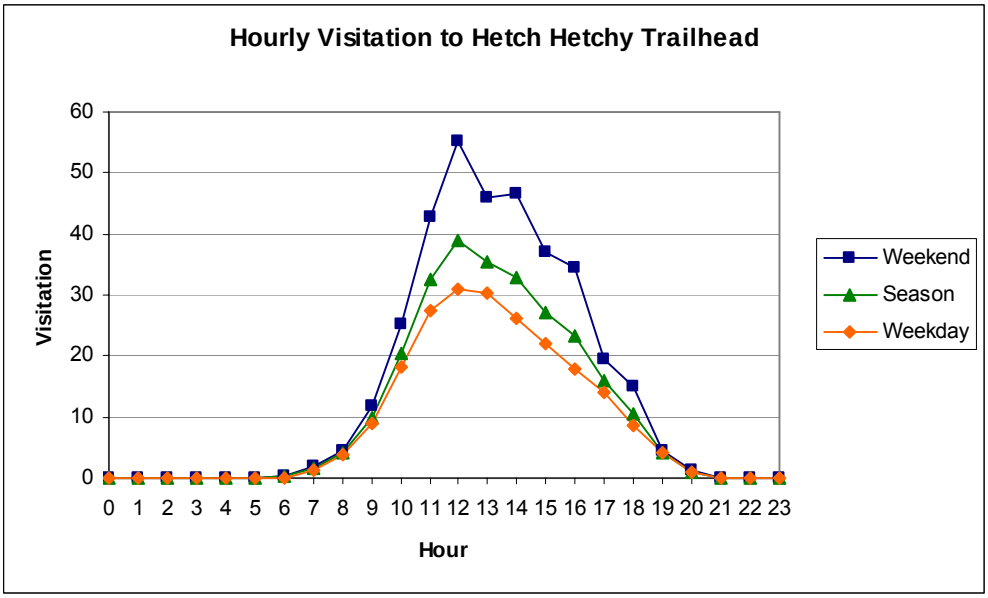
Mean Visitation per Hour

Table 2.6.43. Statistics for hourly visitation at Hecth Hetchy trailhead for 2007 season.[1]

Hour	Mean	B	Lower Bound	Upper Bound
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	2	0	1	2
8	4	1	3	5
9	10	1	9	11
10	21	3	18	24
11	33	4	29	37
12	39	5	34	44
13	35	5	31	41
14	33	4	29	37
15	27	4	23	31
16	23	3	20	26
17	16	2	14	18
18	11	1	10	12
19	4	1	3	5
20	1	0	1	1
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0

[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Figure 2.6.24. Mean visitation per hour at Hetch Hetchy trailhead[1]



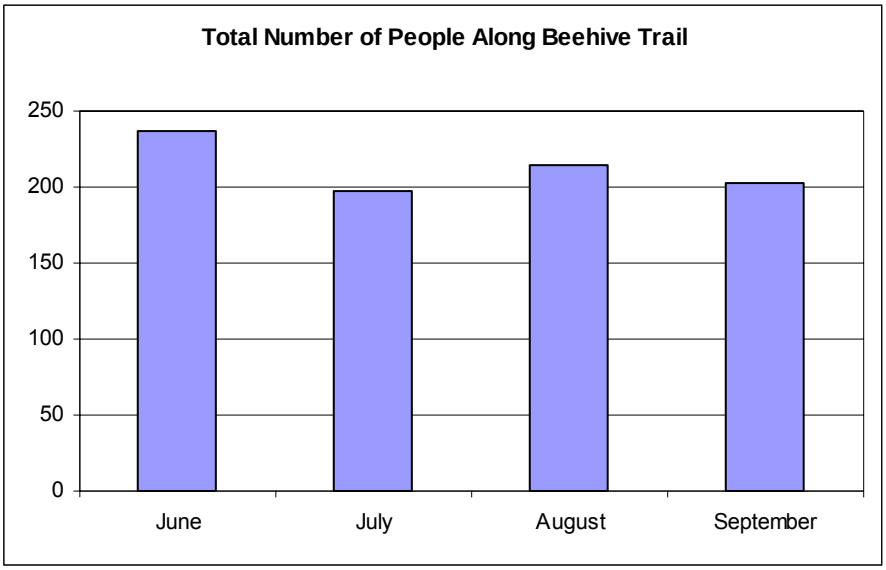
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Total Number of People

Table 2.6.44. Statistics for the total number of people per month along Beehive trail[1]

	N	n	Total	B	Lower Bound	Adj. LB	Upper Bound	Adj. UB
June	30	25	237	28	209 ± 13	196	265 ± 17	282
July	31	31	197	0	197 – 13	184	197+ 13	210
Aug	31	31	214	0	214 – 14	200	214+ 14	228
Sep	30	30	202	0	202 – 13	189	202+ 13	215
Season	122	116	853	24	829 ± 53	776	877 ± 56	933

Figure 2.6.25. Total number of people by month along Beehive trail.[1]



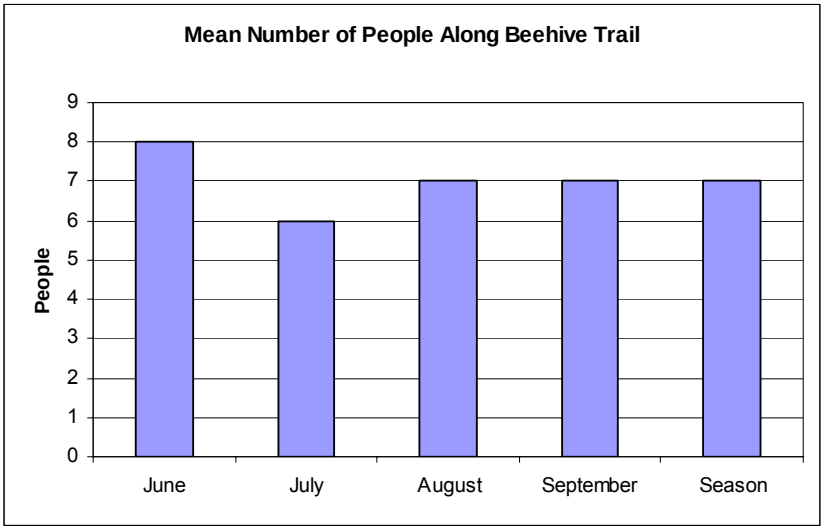
Mean Number of People

Table 2.6.45. Statistics for the mean number of people per month along the Beehive trail.[1]

	N	n	Mean	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
June	30	25	8	1	7 ± 0	7	8 ± 1	9
July	31	31	6	0	6 - 0	6	6+ 0	6
August	31	31	7	0	7 - 0	7	7+0	7
September	30	30	7	0	7 - 0	7	7+0	7
Season	122	116	7	<1	7 ± 0	7	7 ± 0	7

[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Figure 2.6.26. Mean number of people by month along Beehive trail.[1]



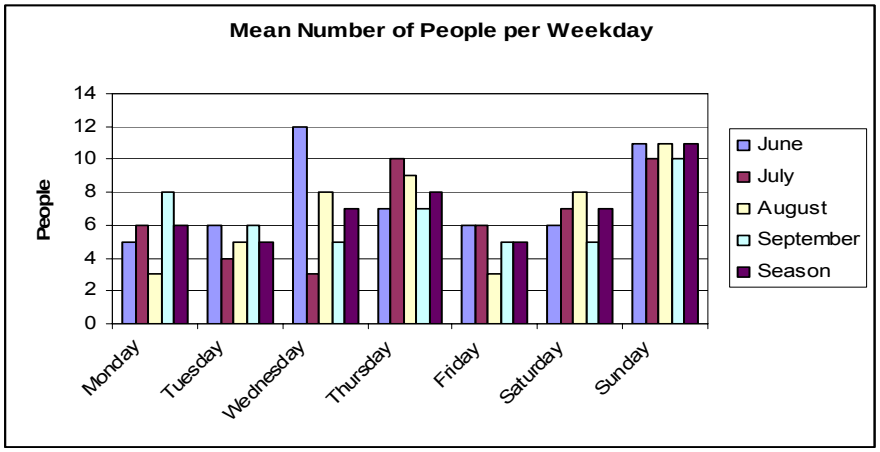
Mean Number of People per Weekday

Table 2.6.46. Statistics for the mean number of people per weekday along Beehive trail.[1]

	N	n	Mean	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
Monday	17	16	6	0	6 - 0	6	6+0	6
Tuesday	17	16	5	0	5 - 0	5	5+0	5
Wednesday	17	17	7	0	7- 0	7	7+0	7
Thursday	17	16	8	1	7 ± 0	7	9 ± 0	9
Friday	18	17	5	0	5 - 0	5	5+0	5
Saturday	18	17	7	0	7 - 0	7	7+0	7
Sunday	18	17	11	1	10 ± 1	9	10 ± 1	11

[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Figure 2.6.27. Mean number of people per weekday along Beehive trail.[1]



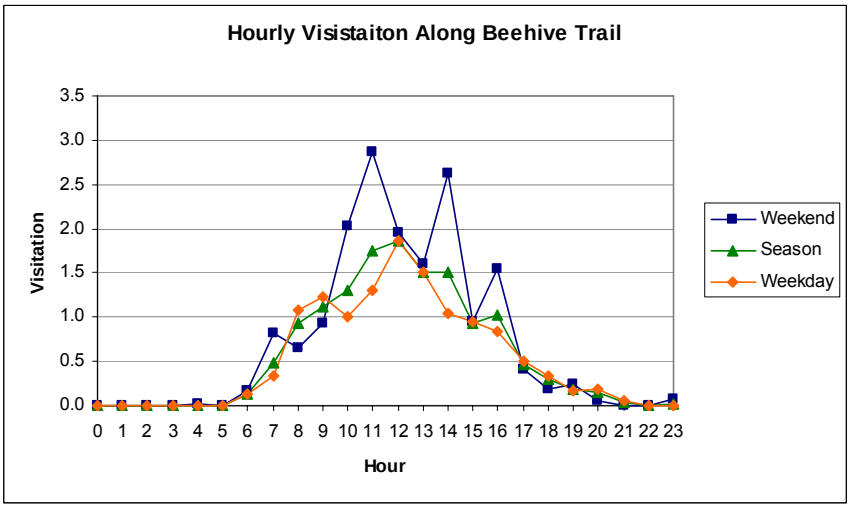
Mean Visitation per Hour

Table 2.6.47. Statistics for mean hourly visitation along Beehive trail.[1]

Hour	Mean	B	Lower Bound	Upper Bound
0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0
6	0.1	0.0	0.1	0.1
7	0.5	0.0	0.5	0.5
8	0.9	0.0	0.9	0.9
9	1.1	0.0	1.1	1.1
10	1.3	0.0	1.3	1.3
11	1.8	0.0	1.8	1.8
12	1.9	0.0	1.9	1.9
13	1.5	0.0	1.5	1.5
14	1.5	0.0	1.5	1.5
15	0.9	0.0	0.9	0.9
16	1.0	0.0	1.0	1.0
17	0.5	0.0	0.5	0.5
18	0.3	0.0	0.3	0.3
19	0.2	0.0	0.2	0.2
20	0.1	0.0	0.1	0.1
21	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0

[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Figure 2.6.28. Mean hourly visitation along Beehive trail.[1]

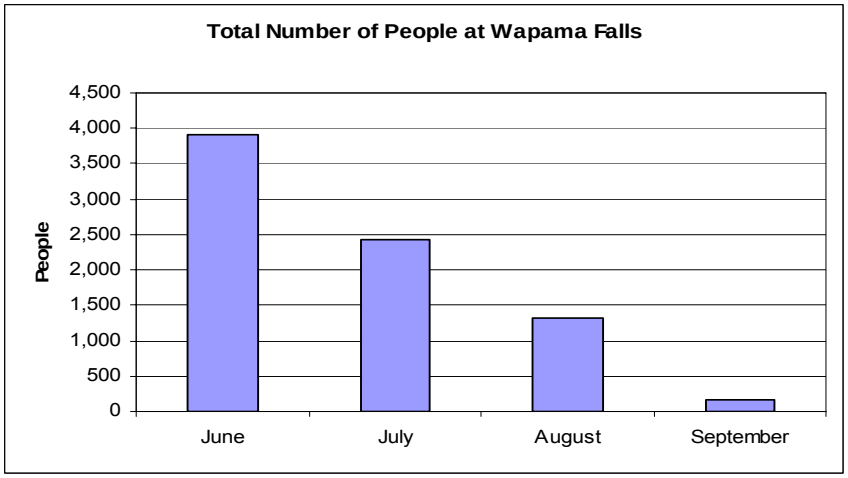


Total Number of People

Table 2.6.48. Statistics for the total number of people at Wapama Falls.[1]

	N	n	Total	B	Lower Bound	Adj. LB	Upper Bound	Adj. UB
June	30	17	3,922	408	3,514 ± 383	3,131	4,330 ± 472	4,802
July	31	26	2,417	139	2,278 ± 248	2,030	2,556 ± 279	2,835
Aug	31	31	1,329	0	1,329 - 145	1,184	1,329+ 145	1,474
Sep	6	6	172	0	172 – 19	153	172+ 19	191
Sep	30	6	861	359	501 ± 55	447	1,220 ± 133	1,353
Season	122	79	8,756	733	8,023 ± 875	7,148	9,489 ± 1,035	10,524

Figure 2.6.29. Total number of people by month at Wapama Falls.[1]



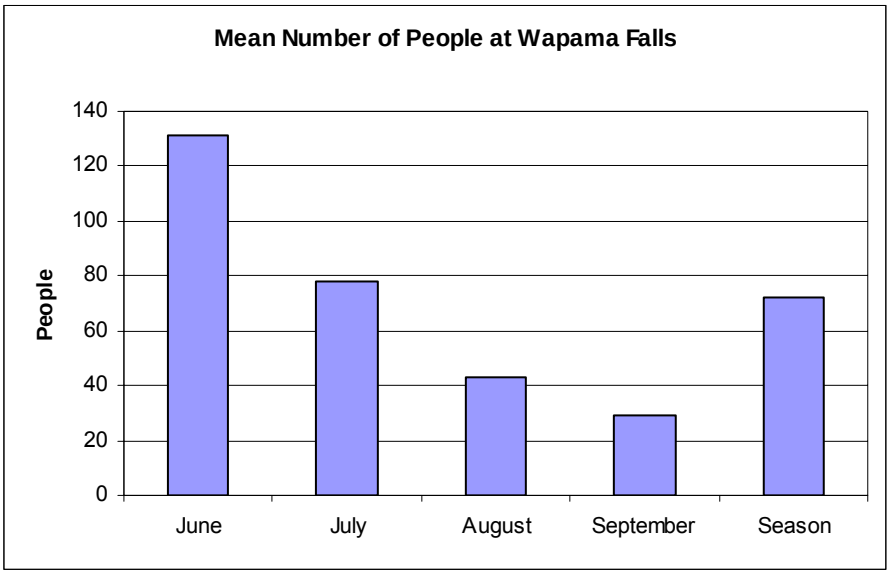
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Mean Number of People

Table 2.6.49. Statistics for the mean number of people per month at Wapama Falls.[1]

	N	n	Mean	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
June	30	17	131	14	117 ± 13	104	145 ± 16	161
July	31	26	78	5	73 ± 8	65	83 ± 9	92
August	31	31	43	0	43 - 5	38	43 + 5	48
September	6	6	29	0	29 - 3	26	29 + 3	32
September	30	6	29	12	17 ± 2	15	41 ± 5	46
Season	122	79	72	6	66 ± 7	59	78 ± 8	86

Figure 2.6.30. Mean number of people by month at Wapama Falls.[1]



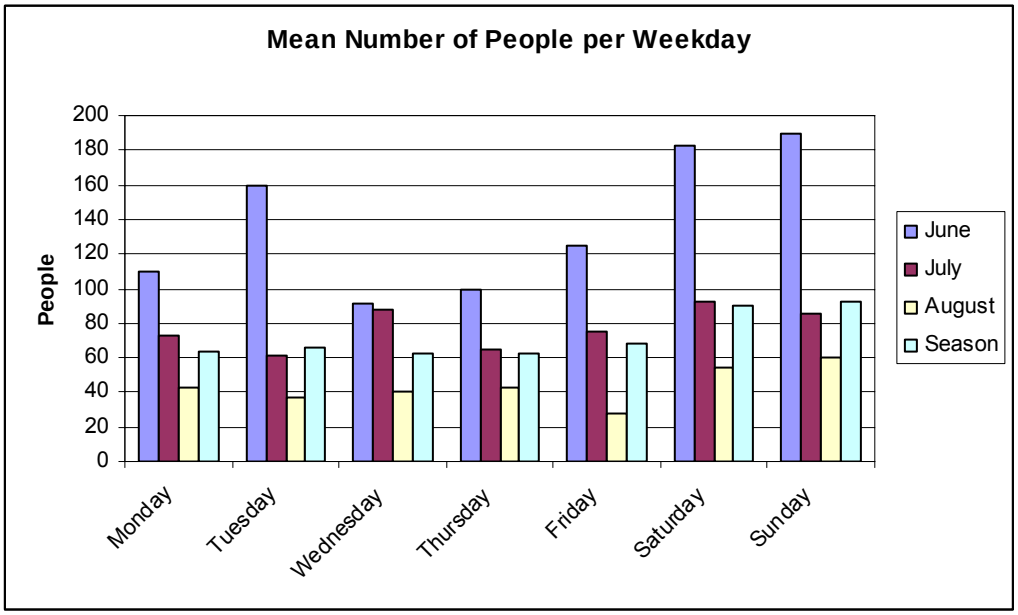
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Mean Number of People per Weekday

Table 2.6.50. Statistics for the mean number of people per weekday at Wapama Falls.[1]

	N	n	Mean	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
Monday	14	10	64	10	54 ± 6	48	74 ± 8	82
Tuesday	14	10	66	18	48 ± 5	43	84 ± 9	93
Wednesday	14	12	62	9	53 ± 6	47	71 ± 8	63
Thursday	14	13	62	5	57 ± 6	51	66 ± 7	73
Friday	14	12	68	10	58 ± 6	52	78 ± 8	86
Saturday	14	11	90	16	74 ± 8	66	106 ± 12	118
Sunday	14	11	92	15	77 ± 8	69	107 ± 12	119

Figure 2.6.31. Mean number of people per weekday at Wapama Falls.[1]



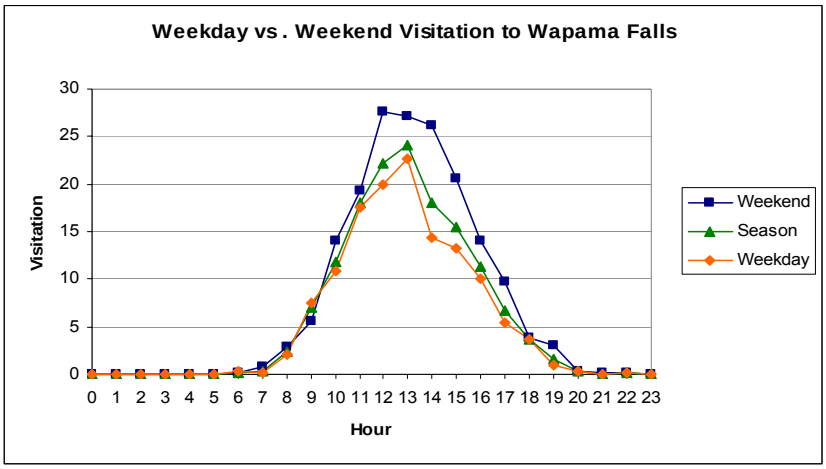
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Mean Visitation per Hour

Table 2.6.51. Hourly visitation to Wapama Falls for 2007 summer season.[1]

Hour	Mean	B (Error of Mean)	Lower Bound	Lower Bound Adjusted	Upper Bound	Upper Bound Adjusted
0	0	0	0+-0	0	0+-0	0
1	0	0	0+-0	0	0+-0	0
2	0	0	0+-0	0	0+-0	0
3	0	0	0+-0	0	0+-0	0
4	0	0	0+-0	0	0+-0	0
5	0	0	0+-0	0	0+-0	0
6	0	0	0+-0	0	0+-0	0
7	0	0	0+-0	0	0+-0	1
8	2	1	2+-0	2	3+-0	3
9	7	2	5+-1	4	9+-1	10
10	12	2	10+-1	9	14+-1	15
11	18	2	16+-2	14	20+-2	22
12	22	3	19+-2	17	25+-3	28
13	24	2	22+-2	20	26+-3	29
14	18	2	16+-2	14	20+-2	22
15	16	2	13+-1	12	18+-2	19
16	11	2	10+-1	9	13+-1	14
17	7	1	6+-1	5	8+-1	9
18	4	1	3+-0	3	4+-0	5
19	2	1	1+-0	1	2+-0	2
20	0	0	0+-0	0	1+-0	1
21	0	0	0+-0	0	0+-0	0
22	0	0	0+-0	0	0+-0	0
23	0	0	0+-0	0	0+-0	0

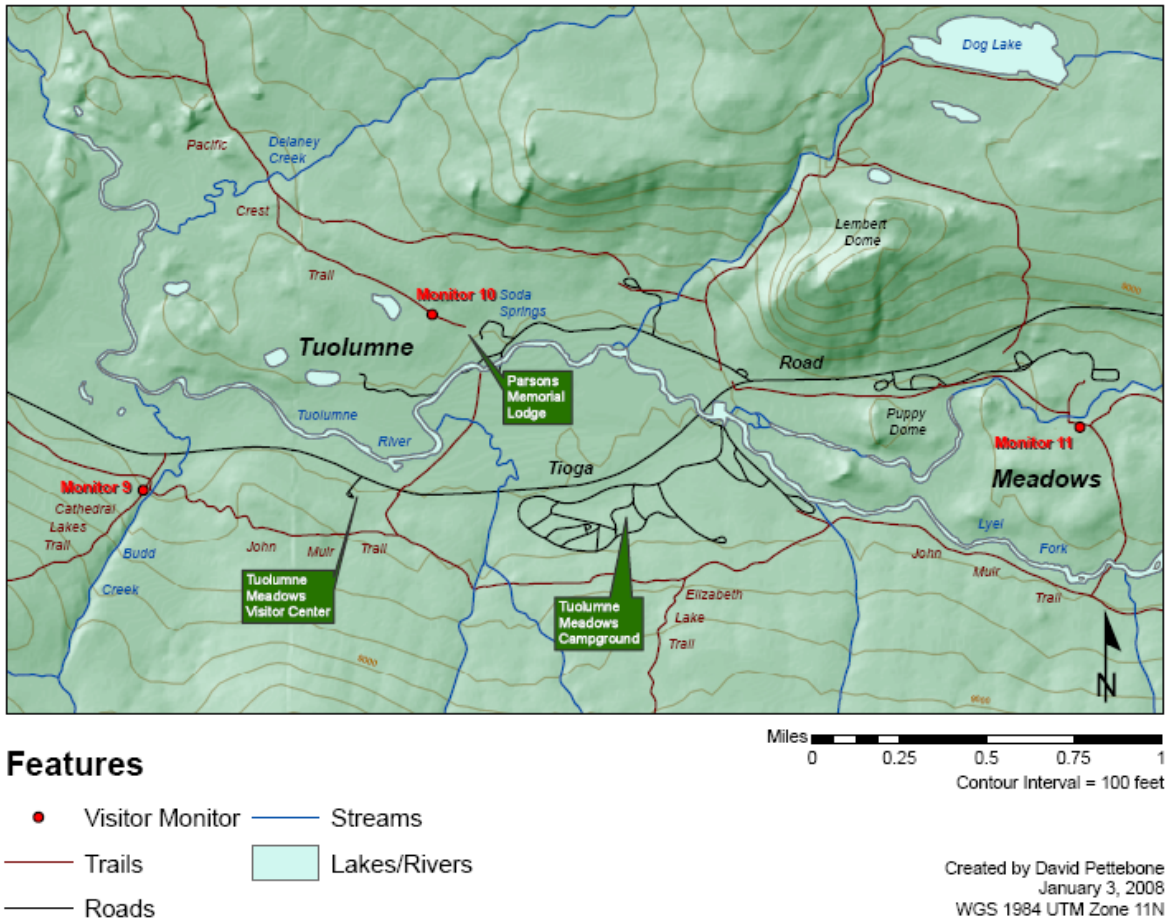
Figure 2.6.32. Hourly visitation to Wapama Falls for 2007 season.[1]



[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Tuolumne Meadows

Figure 2.6.33. Locations of Tuolumne Meadows visitor monitors.[1]



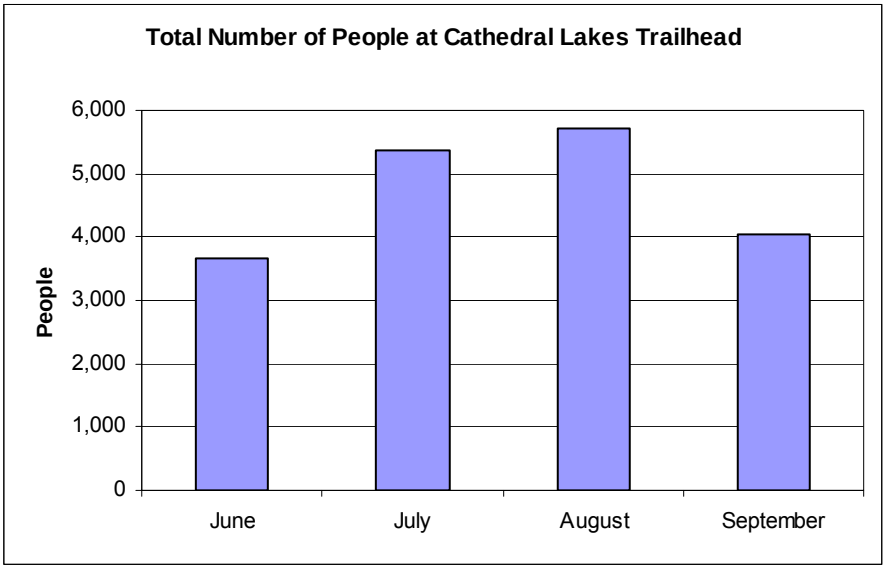
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Total Number of People

Table 2.6.52. Statistics for the mean number of people per month at Cathedral Lakes trailhead.[1]

	N	n	Total	B	Lower Bound	Adj. LB	Upper Bound	Adj. UB
June	30	25	3,660	255	3,405 ± 213	3,192	3,915 ± 245	4,160
July	31	28	5,375	145	5,230 ± 327	4,903	5,521 ± 345	5,866
Aug	31	26	5,712	276	5,436 ± 340	5,096	5,988 ± 375	6,363
Sep	30	30	4,038	0	4,038 – 253	3,786	4,038+ 253	4,291
Season	122	109	18,731	453	18,278 ± 1,143	17,135	19,183 ± 1,200	20,383

Figure 2.6.34. Total number of people by month at Cathedral Lakes trailhead.[1]



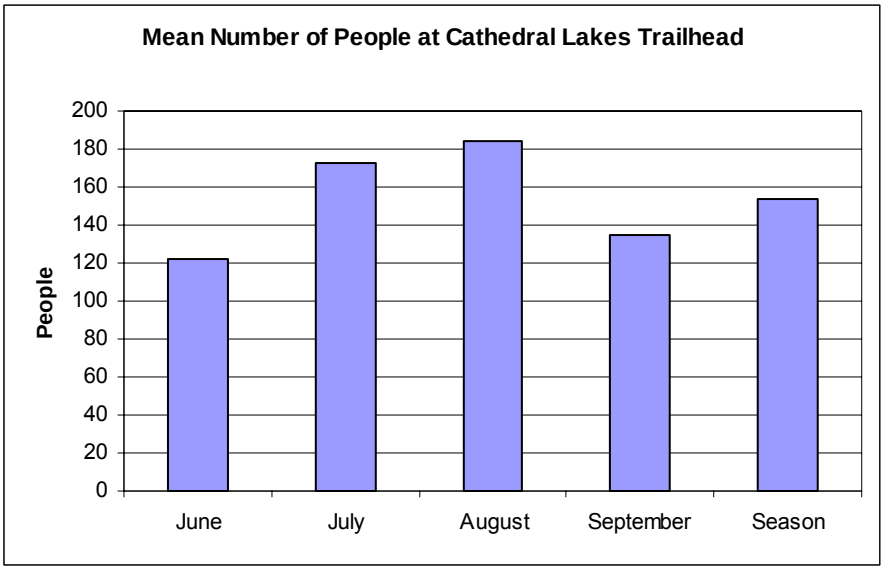
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Mean Number of People

Table 2.6.53. Statistics for the mean number of people per day at Cathedral Lakes trailhead.[1]

	N	n	Mean	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
June	30	25	122	8	114 ± 7	107	130 ± 8	138
July	31	28	173	5	169 ± 11	158	178 ± 11	189
August	31	26	184	9	175 ± 11	164	193 ± 12	205
September	30	30	135	0	135 – 7	128	135+ 7	142
October	13	13	33	0	33 – 2	31	33+ 2	35
Season	122	109	154	4	150 ± 9	141	157 ± 10	167

Figure 2.6.35. Mean number of people per day at Cathedral Lakes trailhead.[1]



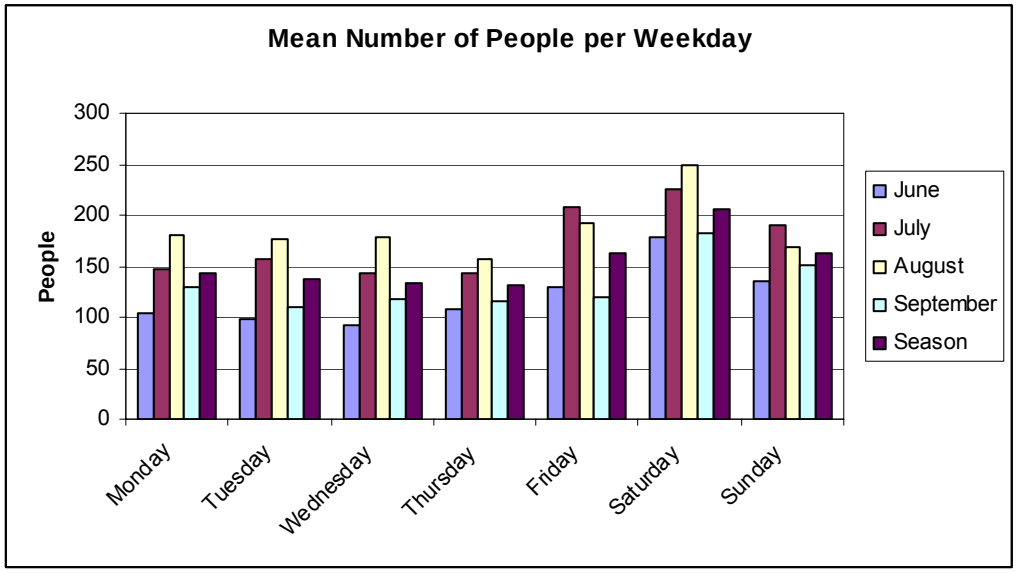
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Mean Number of People per Weekday

Table 2.6.54. Statistics for the mean number of people per weekday at Cathedral Lakes trailhead for 2007 season.[1]

	N	n	Mean	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
Monday	17	15	143	7	136 ± 9	125	150 ± 9	159
Tuesday	17	15	137	9	128 ± 8	120	146 ± 9	155
Wednesday	17	16	133	5	127 ± 8	119	138 ± 9	147
Thursday	17	16	131	7	124 ± 8	116	138 ± 9	147
Friday	18	16	163	10	153 ± 10	143	173 ± 11	184
Saturday	18	16	205	11	194 ± 12	182	216 ± 13	229
Sunday	18	15	162	15	148 ± 9	139	177 ± 11	188

Figure 2.6.36. Mean number of people per weekday at Cathedral Lakes trailhead.[1]



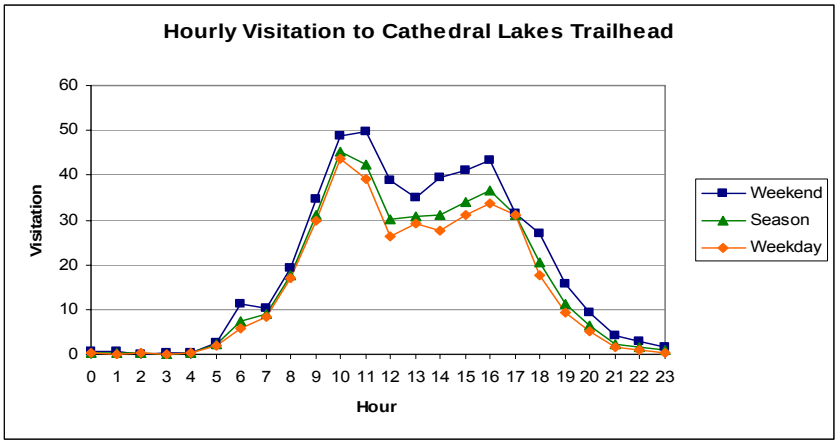
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Mean Hourly Visitation

Table 2.6.55. Hourly visitation to Cathedral Lakes trailhead for 2007 season.[1]

Hour	Mean	B (Error of Mean)	Lower Bound	Lower Bound Adjusted	Upper Bound	Upper Bound Adjusted
0	0.3	0.1	0.2+-0.0	0.2	0.4+-0.0	0.4
1	0.3	0.1	0.2+-0.0	0.2	0.3+-0.0	0.3
2	0.2	0.1	0.1+-0.0	0.1	0.3+-0.0	0.3
3	0.1	0.1	0.1+-0.0	0.1	0.2+-0.0	0.2
4	0.3	0.1	0.2+-0.0	0.2	0.3+-0.0	0.4
5	2.2	0.2	2.0+-0.0	1.9	2.4+-0.1	2.4
6	7.3	0.5	6.8+-0.2	6.7	7.8+-0.2	7.9
7	8.9	0.5	8.4+-0.2	8.2	9.4+-0.2	9.6
8	17.6	0.7	16.9+-0.4	16.5	18.3+-0.4	18.8
9	31.3	1.1	30.2+-0.7	29.5	32.4+-0.7	33.1
10	45.2	1.5	43.8+-1.0	42.7	46.7+-1.1	47.7
11	42.4	1.6	40.8+-0.9	39.9	44.0+-1.0	45.0
12	30.2	1.1	29.1+-0.7	28.5	31.3+-0.7	32.0
13	30.9	1.1	29.8+-0.7	29.1	32.0+-0.7	32.7
14	31.2	1.2	30.1+-0.7	29.4	32.4+-0.7	33.2
15	34.1	1.2	32.9+-0.8	32.2	35.3+-0.8	36.1
16	36.7	1.4	35.2+-0.8	34.4	38.1+-0.9	39.0
17	31.2	1.3	29.9+-0.7	29.2	32.5+-0.7	33.2
18	20.5	0.9	19.6+-0.5	19.1	21.5+-0.5	21.9
19	11.1	0.8	10.4+-0.2	10.1	11.9+-0.3	12.1
20	6.4	0.5	6.0+-0.1	5.8	6.9+-0.2	7.1
21	2.4	0.2	2.2+-0.0	2.1	2.6+-0.1	2.6
22	1.5	0.2	1.3+-0.0	1.2	1.7+-0.0	1.7
23	0.9	0.1	0.7+-0.0	0.7	1.0+-0.0	1.0

Figure 2.6.37. Hourly visitation to Cathedral Lakes trailhead for 2007 season.[1]



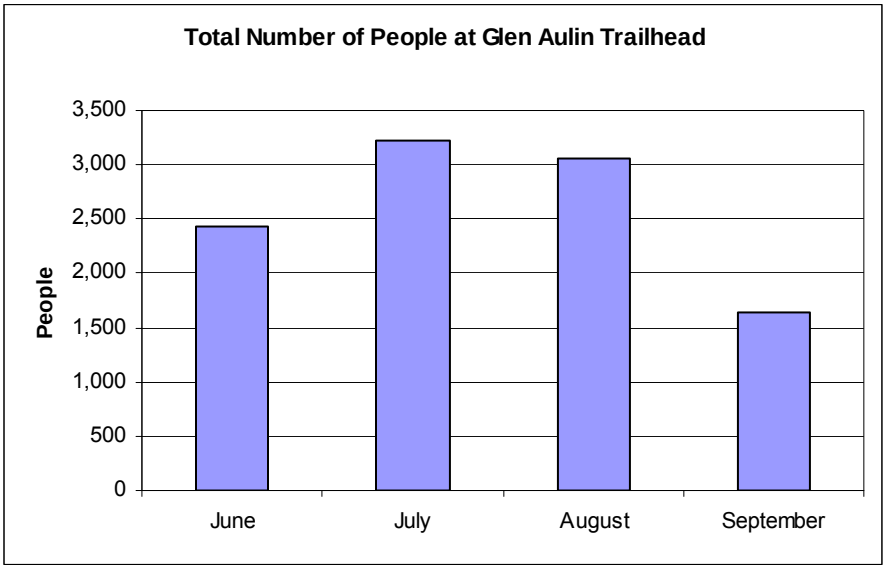
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Total Number of People

Table 2.6.56. Statistics for the total number of people at Glen Aulin trailhead.[1]

	N	n	Total	B	Lower Bound	Adj. LB	Upper Bound	Adj. UB
June	30	25	2,436	160	2,275 ± 122	2,153	2,596 ± 139	2,735
July	31	31	3,231	0	3,231 – 173	3,059	3,231+ 173	3,404
Aug	31	31	3,050	0	3,050 – 163	2,887	3,050+ 163	3,213
Sep	30	30	1,631	0	1,631 – 87	1,544	1,631+ 87	1,718
Season	122	117	10,368	163	10,205 ± 546	10,751	10,531 ± 563	11,094

Figure 2.6.38. Total number of people at Glen Aulin trailhead by month.[1]



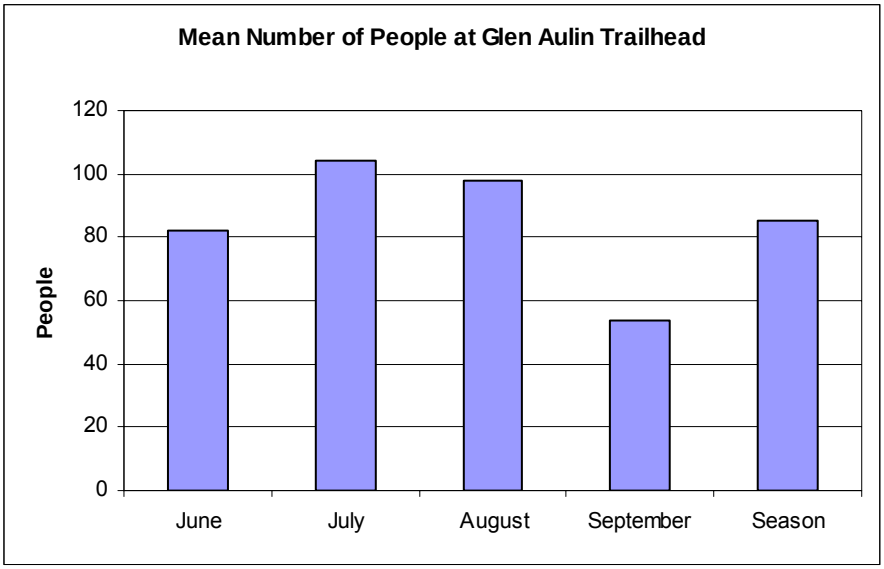
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Mean Number of People

Table 2.6.57. Statistics for the mean number of people at Glen Aulin trailhead.[1]

	N	n	Mean	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
June	30	25	81	5	76 ± 4	72	87 ± 5	92
July	31	31	104	0	104 – 6	98	104 + 6	110
August	31	31	98	0	98 – 5	93	98 + 5	103
September	30	30	54	0	54 – 3	51	54 + 3	57
Season	122	117	85	1	84 ± 4	80	86 ± 5	91

Figure 2.6.39. Mean number of people at Glen Aulin trailhead.[1]



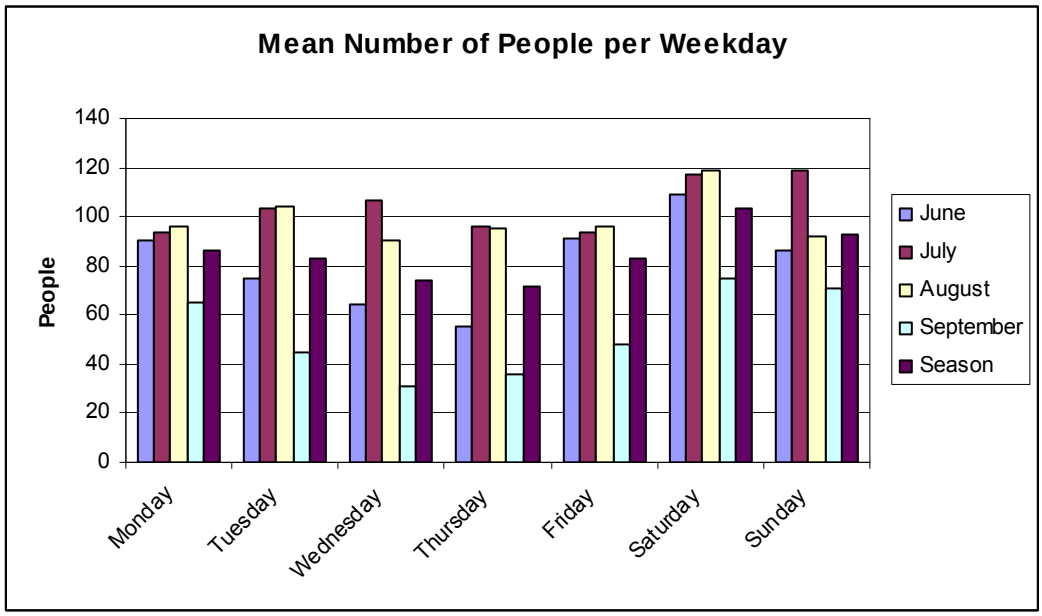
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Mean Number of People per Weekday

Table 2.6.58. Statistics for the mean number of people per weekday at Glen Aulin for 2007 season.[1]

	N	n	Mean	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
Monday	17	16	86	3	83 ± 4	79	89 ± 5	94
Tuesday	17	16	83	4	79 ± 4	75	87 ± 5	92
Wednesday	17	17	74	0	74 – 4	70	74+ 4	78
Thursday	17	17	72	0	72 – 4	68	72+ 4	76
Friday	18	17	83	4	79 ± 4	75	87 ± 5	82
Saturday	18	17	103	5	98 ± 5	93	108 ± 6	102
Sunday	18	17	93	5	88 ± 5	83	97 ± 5	92

Figure 2.6.40. Mean Number of People per weekday at Glen Aulin trailhead.[1]



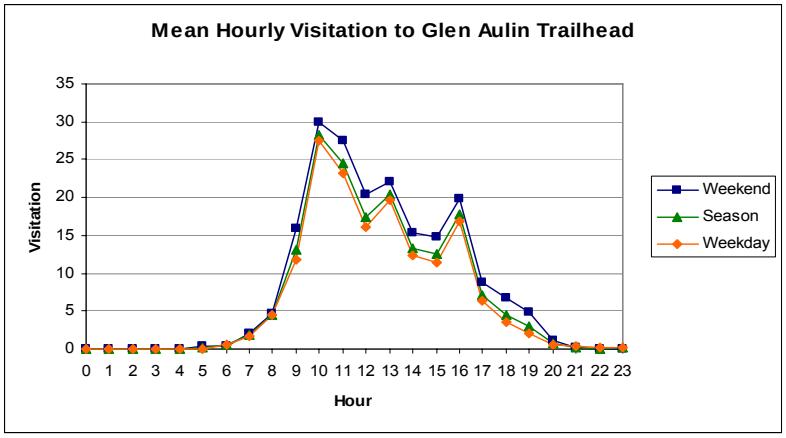
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Mean Hourly Visitation

Table 2.6.59. Hourly visitation to Glen Aulin trailhead for 2007 summer season (N=122, n=117).[1]

Hour	Mean	B (Error of Mean)	Lower Bound	Lower Bound Adjusted	Upper Bound	Upper Bound Adjusted
0	0.0	0.0	0.0+-0.0	0.0	0.1+-0.0	0.1
1	0.0	0.0	0.0+-0.0	0.0	0.0+-0.0	0.0
2	0.0	0.0	0.0+-0.0	0.0	0.1+-0.0	0.1
3	0.0	0.0	0.0+-0.0	0.0	0.0+-0.0	0.0
4	0.0	0.0	0.0+-0.0	0.0	0.0+-0.0	0.0
5	0.2	0.0	0.1+-0.0	0.1	0.2+-0.0	0.2
6	0.5	0.0	0.5+-0.0	0.5	0.6+-0.0	0.6
7	1.8	0.1	1.7+-0.1	1.6	1.9+-0.1	2.0
8	4.6	0.2	4.4+-0.2	4.2	4.7+-0.3	5.0
9	13.0	0.4	12.6+-0.7	11.9	13.4+-0.7	14.2
10	28.2	0.6	27.6+-1.5	26.2	28.8+-1.5	30.4
11	24.5	0.6	23.9+-1.3	22.6	25.0+-1.3	26.4
12	17.4	0.4	17.0+-0.9	16.1	17.8+-1.0	18.7
13	20.3	0.4	19.9+-1.1	18.8	20.8+-1.1	21.9
14	13.3	0.3	13.0+-0.7	12.3	13.7+-0.7	14.4
15	12.5	0.3	12.2+-0.7	11.5	12.7+-0.7	13.4
16	17.7	0.4	17.3+-0.9	16.4	18.2+-1.0	19.1
17	7.1	0.2	6.9+-0.4	6.5	7.3+-0.4	7.7
18	4.6	0.2	4.4+-0.2	4.2	4.8+-0.3	5.0
19	2.9	0.2	2.7+-0.1	2.6	3.1+-0.2	3.3
20	0.8	0.1	0.7+-0.0	0.7	0.9+-0.0	0.9
21	0.2	0.0	0.2+-0.0	0.2	0.3+-0.0	0.3
22	0.1	0.0	0.1+-0.0	0.1	0.1+-0.0	0.1
23	0.1	0.0	0.1+-0.0	0.1	0.2+-0.0	0.2

Figure 2.6.41. Mean hourly visitation to Glen Aulin trailhead for 2007 season.[1]



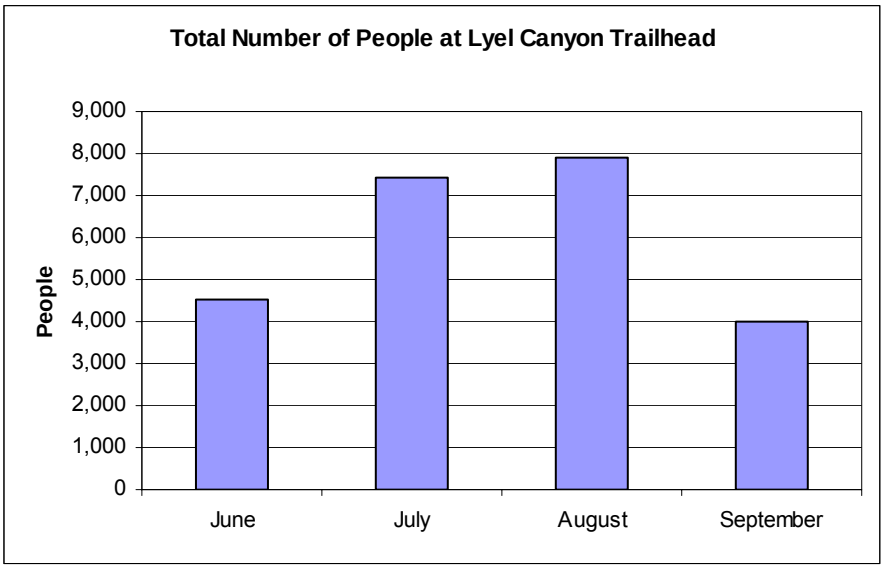
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Total Number of People

Table 2.6.60. Statistics for the total number of people at Lyell Canyon trailhead by month.[1]

	N	n	Total	B	Lower Bound	Adj. LB	Upper Bound	Adj. UB
June	30	25	4,530	257	4,274 ± 305	3,969	4,787 ± 341	5,128
July	31	29	7,424	125	7,299 ± 521	6,778	7,549 ± 538	8,088
Aug	31	31	7,926	0	7,926 – 565	7,361	7,926+ 565	8,491
Sep	30	30	4,003	0	4,003 – 286	3,717	4,003+ 286	4,281
Season	122	115	24,028	439	23,590 ± 1,682	21,907	24,467 ± 1,745	26,212

Figure 2.6.42. Total number of people at Lyell Canyon trailhead by month.[1]



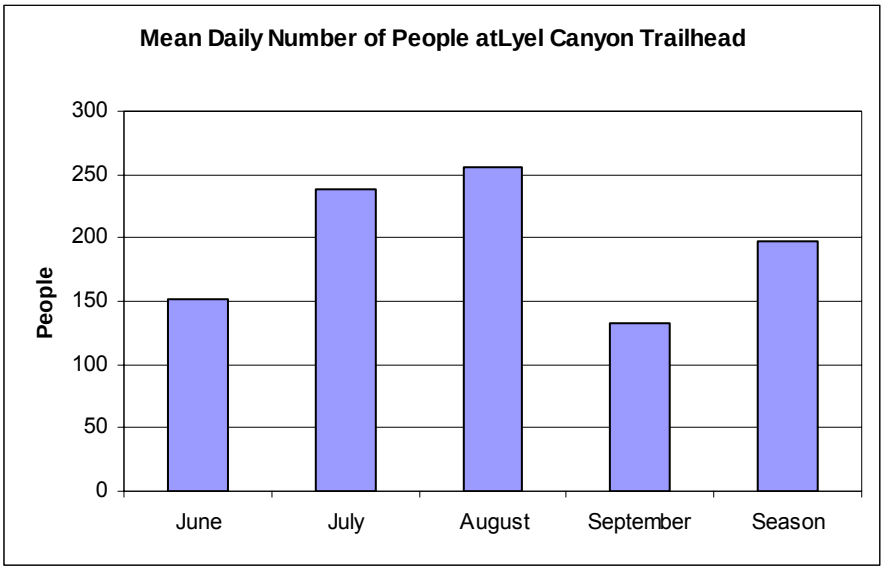
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Mean Number of People

Table 2.6.61. Statistics for the mean number of people per month at Lyell Canyon trailhead.[1]

	N	n	Mean	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
June	30	25	151	9	142 ± 10	132	160 ± 11	171
July	31	29	239	4	235 ± 17	218	244 ± 17	261
August	31	31	256	0	256 –14	242	256+14	270
September	30	30	133	0	133 – 7	126	133+ 7	140
Season	122	115	197	4	193 ± 14	179	201 ± 14	215

Figure 2.6.43. Mean number of people per month at Lyell Canyon trailhead.[1]



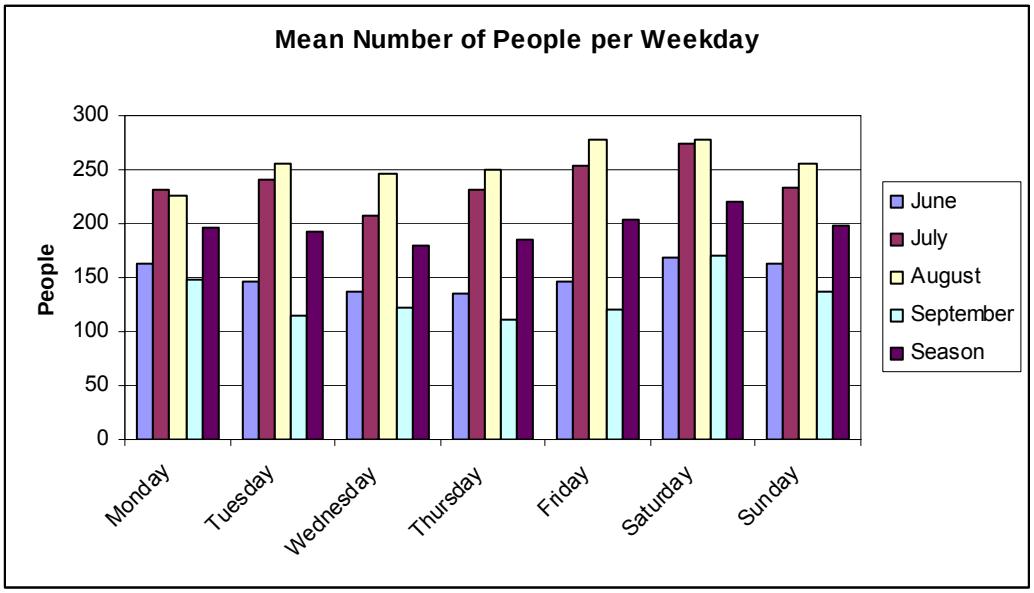
[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Mean Number of People per Weekday

Table 2.6.62. Statistics for the mean number of people per weekday at Lyell Canyon trailhead for 2007 season.[1]

	N	n	Mean	B	Lower Bound	Adjusted Lower Bound	Upper Bound	Adjusted Upper Bound
Monday	17	16	196	8	188+-13	175	205+-15	220
Tuesday	17	15	192	14	178+-13	191	207+-15	222
Wednesday	17	16	180	9	171+-12	159	190+-14	204
Thursday	17	17	186	0	186 – 13	173	186+ 13	199
Friday	18	17	204	11	193+-14	179	215+-15	230
Saturday	18	17	220	10	210+-15	195	230+-16	146
Sunday	18	17	198	8	190+-14	176	206+-15	221

Figure 2.6.44. Mean number of people per weekday at Lyell Canyon trailhead.[1]



[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

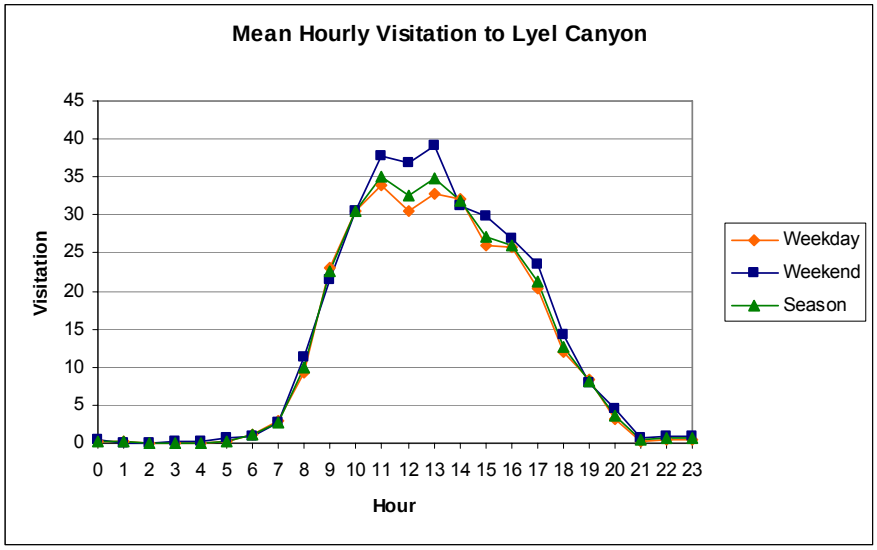
Mean Hourly Visitation

Table 2.6.63. Hourly weekend visitation to Lyell Canyon trailhead for 2007 season.[1]

Hour	Mean	B (Error of Mean)	Lower Bound	Lower Bound Adjusted	Upper Bound	Upper Bound Adjusted
0	0.3	0.0	0.2+-0.0	0.2	0.3+-0.0	0.3
1	0.1	0.0	0.1+-0.0	0.1	0.2+-0.0	0.2
2	0.1	0.0	0.0+-0.0	0.0	0.1+-0.0	0.1
3	0.1	0.0	0.1+-0.0	0.1	0.1+-0.0	0.1
4	0.1	0.0	0.1+-0.0	0.1	0.1+-0.0	0.1
5	0.3	0.0	0.3+-0.0	0.3	0.4+-0.0	0.4
6	1.1	0.1	1.0+-0.1	0.9	1.2+-0.1	1.3
7	2.8	0.2	2.6+-0.2	2.4	2.9+-0.2	3.1
8	9.9	0.3	9.6+-0.7	8.9	10.2+-0.7	11.0
9	22.6	0.6	22.0+-1.6	20.4	23.2+-1.7	24.9
10	30.6	0.8	29.7+-2.1	27.6	31.4+-2.2	33.6
11	35.1	0.8	34.3+-2.4	31.8	35.9+-2.6	38.5
12	32.5	0.8	31.7+-2.3	29.5	33.3+-2.4	35.7
13	34.8	0.9	34.0+-2.4	31.6	35.7+-2.5	38.2
14	31.9	0.8	31.1+-2.2	28.9	32.7+-2.3	35.0
15	27.2	0.7	26.5+-1.9	24.6	27.8+-2.0	29.8
16	26.1	0.7	25.4+-1.8	23.6	26.7+-1.9	28.6
17	21.2	0.6	20.7+-1.5	19.2	21.8+-1.6	23.4
18	12.7	0.4	12.3+-0.9	11.4	13.1+-0.9	14.0
19	8.2	0.3	7.9+-0.6	7.3	8.5+-0.6	9.1
20	3.6	0.2	3.4+-0.2	3.2	3.8+-0.3	4.1
21	0.6	0.1	0.5+-0.0	0.5	0.6+-0.0	0.7
22	0.6	0.1	0.5+-0.0	0.5	0.7+-0.1	0.8
23	0.6	0.1	0.5+-0.0	0.5	0.7+-0.1	0.8

[1]From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). *Estimating visitor use in Yosemite National Park.* Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training.

Figure 2.6.45. Mean hourly visitation to Lyell Canyon trailhead.[1]



[1]*From Pettebone, D., Newman, P., Beaton, P., Stack, D. & Gibson, A. (2007). Estimating visitor use in Yosemite National Park. Fort Collins, Colorado: Colorado State University, Center for Protected Area Management & Training*.

2.7. ARCHEOLOGICAL CONDITION AND STABILITY

Archeological sites, recognized as part of the Cultural Outstandingly Remarkable Values (ORV) for the Merced and Tuolumne Wild and Scenic Rivers were monitored for the first time in 2007 under the User Capacity Program monitoring framework.

Measurement

Frequency, intensity, and type of visitor-related impacts within archeological site boundaries

Standards

Currently baseline data is being developed in which standards can be developed. Standards development is expected to follow once the metrics within the indicator are formalized and completed.

Sampling

The most complete and accurate listing of all of the archeological sites recorded within Yosemite National Park is located in the "Archeological Sites" data layer in the park's GIS database. Recorded archeological sites located within both the Merced River and the Tuolumne River corridors were queried according to the two Wild and Scenic River Corridor boundaries. Estimated "use zones" for the two Wild and Scenic River corridors were determined based on the proximity to a road or trail corridor, established campground, and lakes. A buffer distance was subjectively chosen as follows for a "high use zone": 10 m on either side of centerline of a trail, 50 m on either side of centerline of a developed road, 30 m around established campgrounds, and 30 m around a lake. Everything in these areas was designated a high use zone, and everything outside of this was designated a low use zone. A 15% sample of archeological sites was randomly chosen using a random number table, stratified by use zone in each river corridor. This resulted in a total of 70 archeological sites chosen to assess visitor use impacts across four zones – Merced River high use zone (n=25), Merced River low use zone (n=11), Tuolumne River high use zone (n=13), and Tuolumne River low use zone (n=21) (Table 2.7.1).

Table 2.7.1. List of archeological sites monitored.

Archeological Sites Monitoring Locations			
Zone s- All			
Merced River Corridor High Use Zone sites (n=25)	Merced River Corridor Low Use Zone sites (n=11)	Tuolumne River Corridor High Use Zone sites (n=13)	Tuolumne River Corridor Low Use Zone sites (n=21)
CA-MRP-0064	CA-MRP-0049	CA-TUO-0022	CA-TUO-0115
CA-MRP-0069	CA-MRP-0190/191	CA-TUO-0179/2829	CA-TUO-0132
CA-MRP-0072	CA-MRP-0212	CA-TUO-0494	CA-TUO-0202
CA-MRP-0078	CA-MRP-0213	CA-TUO-0527/H	CA-TUO-0495/H
CA-MRP-0080	CA-MRP-1746H	CA-TUO-0737	CA-TUO-0497
CA-MRP-0088	CA-MRP-1751H	CA-TUO-0738	CA-TUO-0734
CA-MRP-0169	P-22-001645	CA-TUO-2811	CA-TUO-0765
CA-MRP-0242/H	P-22-001682	CA-TUO-2815/H	CA-TUO-2822
CA-MRP-0292/293/H	CA-MRP-291/751	CA-TUO-2832	CA-TUO-2835
CA-MRP-0314	CA-MRP-83/H	CA-TUO-2836	CA-TUO-3843
CA-MRP-0336	CA-MRP-655	CA-TUO-3934H	CA-TUO-3987
CA-MRP-0355		CA-TUO-4070	CA-TUO-3994
CA-MRP-0645		CA-TUO-47	CA-TUO-4510
CA-MRP-0734H			CA-TUO-4903
CA-MRP-0735			CA-TUO-134
CA-MRP-0737			CA-TUO-201
CA-MRP-0810			CA-TUO-4257
CA-MRP-0823			CA-TUO-4488
CA-MRP-0827/H			CA-TUO-3838
CA-MRP-1366/H			CA-TUO-4440
CA-MRP-1529H			CA-TUO-4888
CA-MRP-1572/H			
CA-MRP-1816			
P-22-001687			
YOSE 1994L-01			

Data Collection

Field work was conducted from July 16, 2007 through October 18, 2007 by program archeologist Jessica Middleton and NPS archeological technician James Retzer. National Center for Preservation Education (NCPE) intern Louis Wertz, NPS social scientist Bret Meldrum, Acting NPS Visitor Use and Social Science Branch Chief Adam Barnett, and NPS archeologist Peter Gavette accompanied the program archeologist individually on three separate trips. Additionally, NPS archeologists David Curtis and Barbara Buettner conducted the assessments on the three sites located in Little Yosemite Valley (Curtis 2007).

Seventy archeological sites were visited during the pilot 2007 field season. Data was collected at each site and recorded in two formats – a User Capacity monitoring field form, and an Archeological Sites Management Information System (ASMIS) form. Data collection was guided by the objectives discussed in the 2007 Field Monitoring Guide (NPS 2007d), toward the primary goal of determining the extent that archeological sites are being impacted by visitor use.

As a regular part of archeological research, inventory, and Section 106 of the National Historic Preservation Act (NHPA) compliance, Yosemite National Park utilizes a required management tool, the Archeological Sites Management Information System (ASMIS). ASMIS and the List of Classified Structures (LCS) are the primary monitoring tools for the condition of archeological sites and historic structure within the National Park Service (NPS 2006, 2007b). ASMIS data collection includes the qualitative assessment of overall site condition and stability, disturbances, and threats for each site, as well as information relating to the National Register of Historic Places. ASMIS is the NPS's database for the registration and management of park archeological resources (NPS 2007b). The system documents site condition, threats and disturbances, treatments, management actions, site description, and site location for all known archeological sites under NPS stewardship, and serves as a tool to support resource preservation, planning, protection, and decision-making. ASMIS also provides the ability to determine how well the NPS is achieving its long-term site management objectives. The system tracks changes in the condition of archeological resources and documents site-specific threats, disturbances, and recommended management actions (NPS 2007b). The NPS uses ASMIS systematically to document archeological sites and maintain a running record of site condition, and threats and disturbances (among other site attributes). ASMIS is also the means for annual reporting on national and park strategic planning goals to comply with the Government Performance and Results Act (GPRA) through the Program Management Database System.

At Yosemite National Park, ASMIS information is collected as a regular part of ongoing archeological inventory. This inventory work is typically conducted in support of special-funded projects such as development proposals, wilderness restoration, and fire management actions, and is usually collected opportunistically on a project-by-project basis. Starting in 2005 Yosemite National Park implemented a User Capacity monitoring program (NPS 2004, 2005a, 2005b; Bacon et al. 2006), however archeological sites as an indicator were not evaluated until 2007. Seeing that important site condition information is already collected for all inventory work done at Yosemite National Park through ASMIS, it is important to evaluate the ASMIS program to determine if it can be used within a User Capacity monitoring framework. In addition to developing a monitoring plan and completing the first season of fieldwork to use and evaluate this program, this project focused on the suitability of using ASMIS within a User Capacity monitoring framework to assess impacts to archeological sites at Yosemite National Park. As is discussed below, ASMIS data collection will continue to be augmented with more focused, quantitative visitor-related impact data collection.

The attributes chosen to measure or record were determined through review of similar programs (Grand Canyon National Park, and Flagstaff National Monuments), (Dierker and Leap 2006; Donnermeyer 2005) and then augmented or changed to fit Yosemite-specific site types and environment. An attempt was made to choose those indicators that would give meaningful data for archeological sites at Yosemite.

Variables

This pilot season sought to develop the most reliable, meaningful, and quantifiable monitoring protocols. Photopoints were established at each site assessed and photographs were taken of overall site conditions and any observed disturbances. Each site's proximity to an access point and formal lodging was recorded. The access point and proximity to formal lodging were recorded as falling into one of four categories. For public access point, the categories were as follows: within 100 meters, from 100 to 500 meters, from 500 to 1000 meters, and over 1 kilometer away. For proximity to formal lodging, categories were the following: within 100 meters, from 100 meters to 1 kilometer, and greater than 1 km. In addition to this, the distance at which a site was visible was recorded, as well as any visible archeological features on site (Table 2.7.2 lists all variables recorded at each site).

Various natural impacts were recorded including erosion, bioturbation, tree fall, and vegetation growth and these variables were used to determine the total site natural impact condition class. Natural impacts were recorded as part of the ASMIS data collection, and while only indirectly related to visitor use, act as collateral indicators of site stability, and can serve as an early warning system to degradation of site data potential, significance, and integrity. Several visitor-related impacts were assessed for each site visited. Variables measured included:

- The presence of artifact collection piles (collector's piles)
- The presence of social or informal trails either on site or leading to the site,
- Evidence of recent camping such as a fire ring, compacted soil, rearrangement of rocks or features, vegetation damage, trash, and "other"
- Evidence of park operations (facilities) work occurring as a direct result of visitor use of the area such as trails maintenance or a trails camp, wilderness restoration work, or stock use. An "other" category was also used for less common impact categories, such as hazard tree work or fire management
- In addition to these variables, any evidence of violations of the Archaeological Resources Protection Act (ARPA) or vandalism was noted.

Table 2.7.2. List of variables measured at archeological sites.

Variables Recorded or Measured at each Archeological Site	
Variable	Values Recorded
Use Zone	High/Low
Current ASMIS Condition Class	Good, Fair, Poor
Previous ASMIS Condition Class	Good, Fair, Poor
Proximity to Public Access Class	<100m-3, 100-500m-2, 500-1000m-1, >1km-0
Proximity to Public Access	Distance to access point in meters (from GIS)
Proximity to Formal Lodging Class	Within 100m-2, from 100m to 1km-1, >1km-0
Visibility from Access Class	Not visible-0, Visible from 10-50m-1, Visible from >50m-2
Rock Art Presence/Absence Class	Yes/No
Features Presence/Absence Class	Yes/No
Natural Impact Condition Class	None, Minor, Moderate, High, Severe
Erosion	None-0, Minor-1, Moderate-2, Extensive-3
Bioturbation	None-0, Minor-1, Moderate-2, Extensive-3
Rock Fall	None-0, Minor-1, Moderate-2, Extensive-3
Tree Fall	None-0, Minor-1, Moderate-2, Extensive-3
Vegetation Growth	None-0, Minor-1, Moderate-2, Extensive-3
Natural Impacts "Other"	None-0, Minor-1, Moderate-2, Extensive-3
Human Impact Condition Class	No Impact-0, Minimal-1, Moderate-2, High-3, Severe-4, Extreme-5
Collection Piles Presence/Absence	Yes/No
Social Trails	None, One, Multiple
Fire ring	None-0, Minor-1, Moderate-2, Extensive-3
Rearrangement of Features	None-0, Minor-1, Moderate-2, Extensive-3
Rearrangement of Rocks	None-0, Minor-1, Moderate-2, Extensive-3
Soil Compaction	None-0, Minor-1, Moderate-2, Extensive-3
Vegetation Damage	None-0, Minor-1, Moderate-2, Extensive-3
Trash	None-0, Minor-1, Moderate-2, Extensive-3
Camping Other	None-0, Minor-1, Moderate-2, Extensive-3
Facilities Stock Use	None-0, Minor-1, Moderate-2, Extensive-3
Facilities Trails Use	None-0, Minor-1, Moderate-2, Extensive-3
Facilities Wilderness Restoration	None-0, Minor-1, Moderate-2, Extensive-3
Facilities Other	None-0, Minor-1, Moderate-2, Extensive-3

Scoring:
The presence of collection piles and social trails were assigned a point score based on quantity (number of collection piles). The camping and facilities impacts were measured in terms of the percentage of the site area affected. For example, the categories included no impact, minor impact – affecting less than 10% of the site, moderate impact – affecting from 10 – 50% of the site, and extensive impact – affecting over 50% of the site. The summation of scores for all of the visitor-related impacts determined the total site visitor impact condition class, which in turn is used in combination with a natural impacts condition class score, to determine each sites' monitoring priority.

Condition Classes:
Condition classes of no impact; minimal; moderate; high; severe; and extreme (in the case of human use impacts) were assigned to both natural impacts and visitor use impacts on sites based on how many points the site received per variable measured. These condition classes were used to determine the monitoring schedule, or priority of each archeological site.

Monitoring schedule:
A monitoring schedule was established based on the quantitative score that a site received for all of the indicators on the form. Sites that have more impacts and disturbances, or have the potential for impacts should be monitored more frequently than sites that do not. Accordingly, sites for this field season were placed into one of four monitoring priority categories – monitor every year, monitor every 2-4 years, monitor every 5-7 years, or monitor every 10 years.

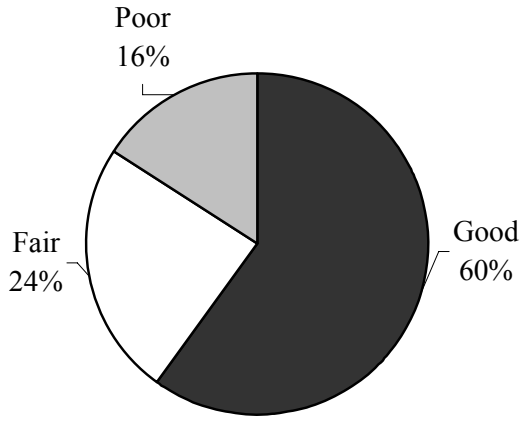
Results

The following tables and graphs present the results of archeological sites monitoring in 2007. Appendix A lists all of the impacts for each site visited.

Out of the 70 sites monitored, a User Capacity monitoring field form and ASMIS assessment were completed for all of them, documentation at eight sites was obtained to meet current Yosemite Archeology Office (YAO) standards (NPS 2007c), one new site was recorded, and three artifacts were collected for curation at the Yosemite National Park Museum. The sites were located in the following geographic areas of the park: in the Merced River corridor - El Portal, Yosemite Valley, Little Yosemite Valley and Wawona; and in the Tuolumne River corridor - Tuolumne Meadows, Lyell Canyon, Pate Valley, Glen Aulin, and Poopenaut Valley.

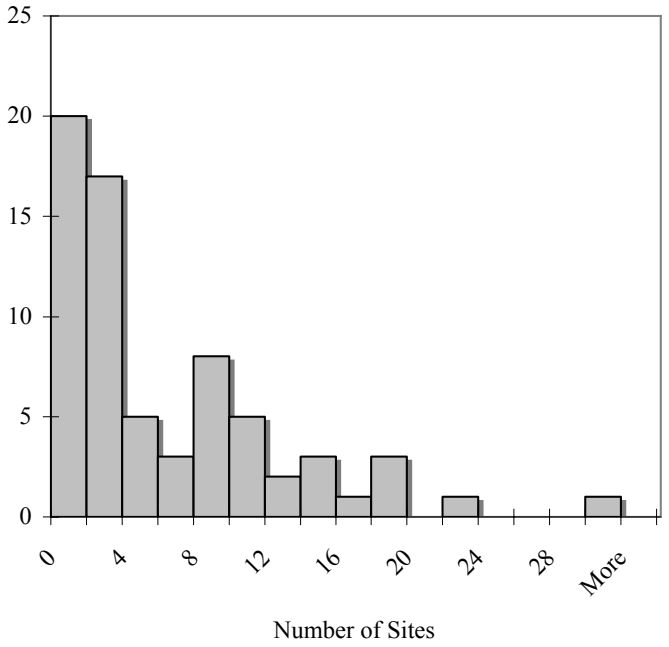
ASMIS:
The majority of sites assessed were recorded in “Good” condition according to ASMIS definitions (NPS 2006:47, NPS 2007a, see Appendix B for a list of ASMIS condition definitions) (Figure 2.7.1,). ASMIS site condition is only loosely associated to the specific user capacity visitor-related impacts and monitoring score a site receives. This was largely due to the fact that ASMIS site conditions are related to site stability rather than level of disturbance.

Figure 2.7.1. Current ASMIS Site Condition, n=70.



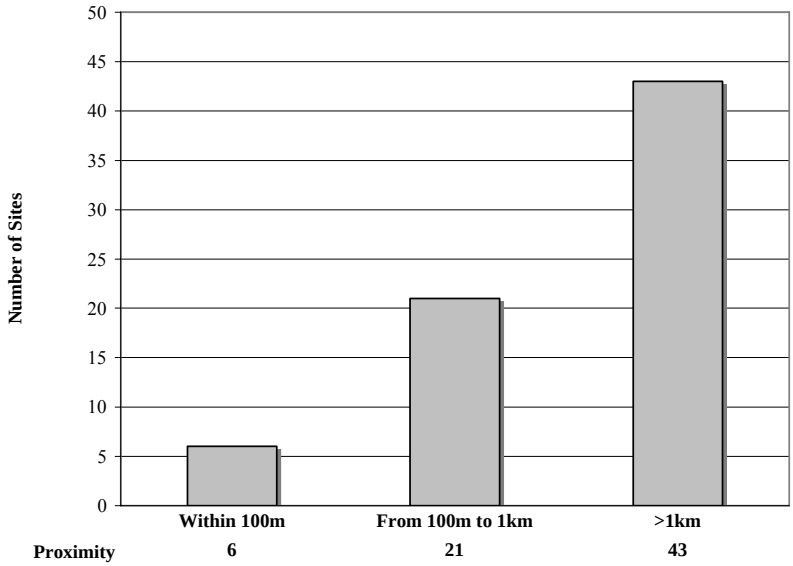
Proximity in Meters to an Access Point:
The proximity of each site monitored to a visitor access point (trail, road) was determined from the Yosemite Archeology Offices' GIS database. The distance in meters was determined by measuring a straight line from the nearest access point to the nearest border of the site. If a visitor access point bisected the site, the proximity was recorded as "zero". This was done to determine if impacts to sites were related to a site's proximity to a visitor access point. The distribution of metric site proximities is represented below (Figure 2.7.2). The proximity was also recorded as falling into one of four categories: within 100 m, from 100-500 meters, from 500-1000 meters, and over 1 km. Sites were predominantly located within 100 meters from an access point.

Figure 2.7.2. Frequency distribution of site proximities to public access points.



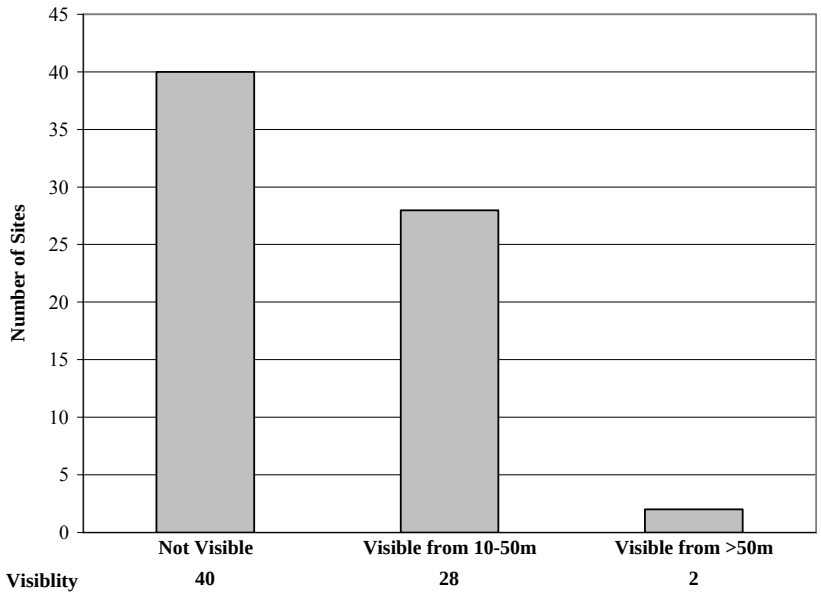
Proximity of Site to Formal Lodging:
The proximity of a site to formal lodging was recorded as one of three categories of proximity – within 100 meters, from 100 meters to 1 kilometer, and greater than 1 kilometer. The majority of sites (n=43, 61%) were located over 1 km away from formal lodging establishments (Figure 2.7.3), which is largely because the majority of sites monitored this year were within designated Wilderness areas.

Figure 2.7.3. Proximity of sites to formal lodging.



Visibility of Site from Visitor Access Point:
The visibility of a site was recorded as one of three categories: not visible, visible from 10-50 meters away, and visible from over 50 meters away. The majority (n=40, 57%) were not visible (Figure 2.7.4). This measurement will likely not be used in future field seasons due to its ambiguous and subjective definition and the subsequent difficulty in producing replicable measures.

Figure 2.7.4. Visibility of a site from a visitor access point.



Presence of Visible Features:
Visible features, usually in the form of milling features at prehistoric sites, and trash dumps at historic sites were present at 36 (51%) of sites monitored.

Collection Piles:
Collection piles were observed at two sites, both of them historic sites, and both piles contained ceramic shards.

Natural Impacts:
The majority of archeological sites monitored had some form of natural impacts present (n=67, 96%), only 3 sites (0.04%) had no observable natural impacts. While most sites did have impacts, the maximum condition class observed on site was moderate, with no site's exhibiting high or severe condition classes.

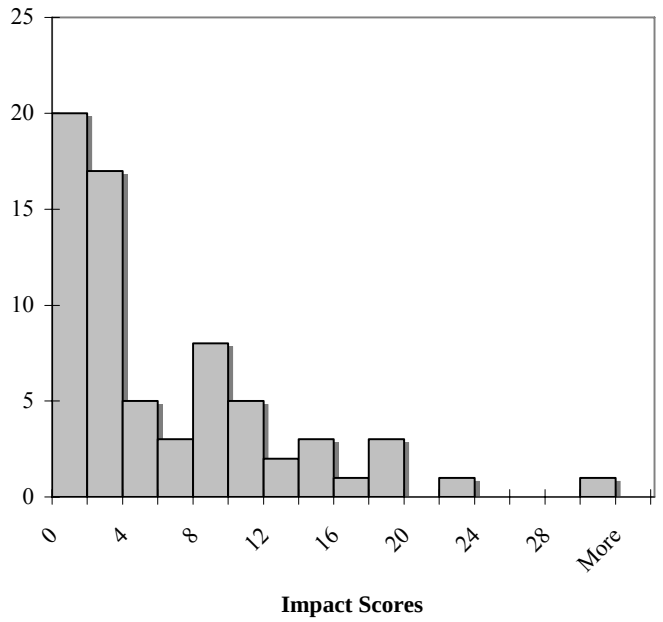
Out of those sites that did contain natural impacts, erosion and bioturbation are the most prevalent forms of natural impacts to archeological sites (n=50, 35% and n=52, 37% respectively), followed by tree fall, vegetation growth, and rock fall.

Visitor Related Impacts:
Each site received an aggregate visitor impact score (Figure 2.7.5) based on the presence of social trails, collection piles, and camping and facilities impacts. The distribution of visitor impact scores is displayed below. As can be seen, archeological sites assessed this season predominantly received impact scores below 10, indicating minimal visitor impacts present onsite. This score was used to determine the site's visitor use condition class, which in turn was used as a part of the monitoring priority score along with natural impacts, proximity scores, and visible features to determine how often the site should be monitored.

Scoring for visitor impacts was as follows. Numeric scores were assigned for the quantity of collection piles present, up to two points, and the quantity of social trails on site or leading to a site were scored, as well as how distinct each trail was (faint, distinct, or eroding), summing to a maximum per site of 15 points. Camping and facilities impacts were scored based on percentage of site area impacted (see

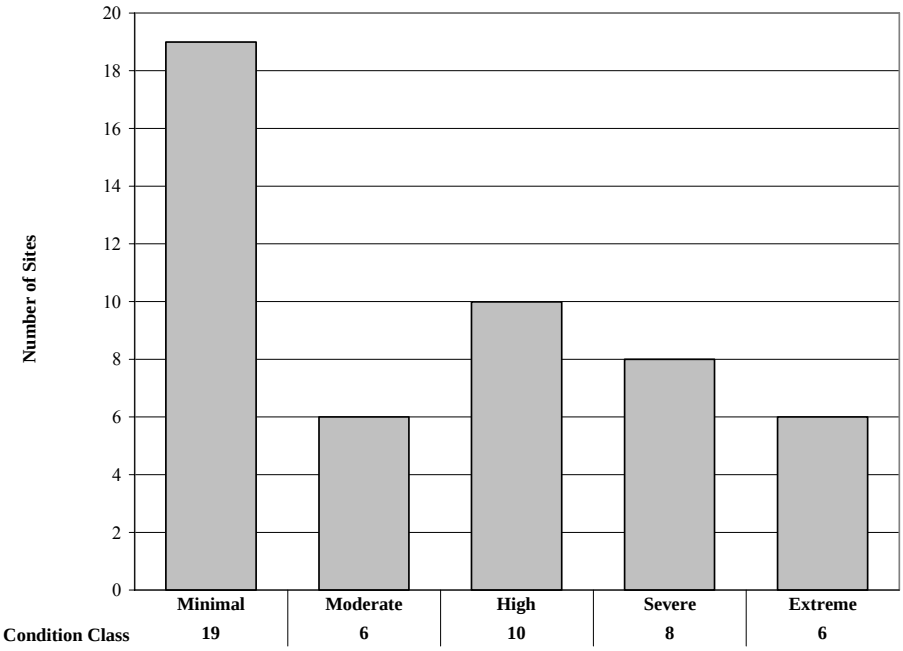
scoring for natural impacts) up to a maximum of 33 points. Vandalism or ARPA violations were scored according to the severity of the violation and if it was recent. These total visitor impact scores were summed, and used to place the site into one of six human impact condition classes – no impact (score of 0), minimal (score from 1-3), moderate (score from 4-6), high (score from 7-9), severe (score from 10-12), and extreme (scores greater than 12).

Figure 2.7.5. Frequency distribution representing visitor impact scores.



The majority of sites visited exhibited some type of visitor related impacts (n=49, 70%). Out of those sites that had observable visitor-related impacts, the most frequently occurring condition class was minimal (n=19), however all condition classes were represented at sites visited this field season (Figure 2.7.6).

Figure 2.7.6. Visitor Use Condition Class, N=70.



Camping Impacts:
Camping impacts were observed on 31 (44%) of the archeological sites monitored this field season. Figure 2.7.7 illustrates the distribution of total camping scores derived from summing the scores for each individual indicator of camping. The most prevalent indicators of camping-related impacts to archeological sites were camp-fire rings on site (n=17), and camp trash (n=18), followed by soil compaction, rearrangement of rocks, vegetation damage, rearrangement of features, and "other" comprised of a variety of indicators not represented above, including latrine digging, and digging of trenches around tent pads (Figure 2.7.8).

Figure 2.7.7. Frequency Distribution Representing Camping Scores on all sites.

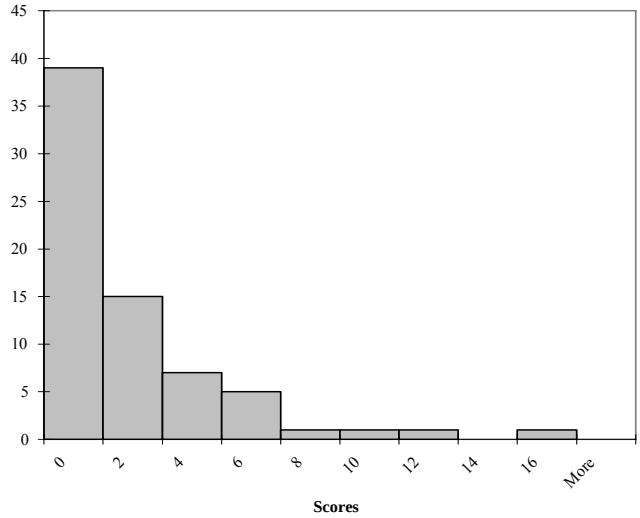
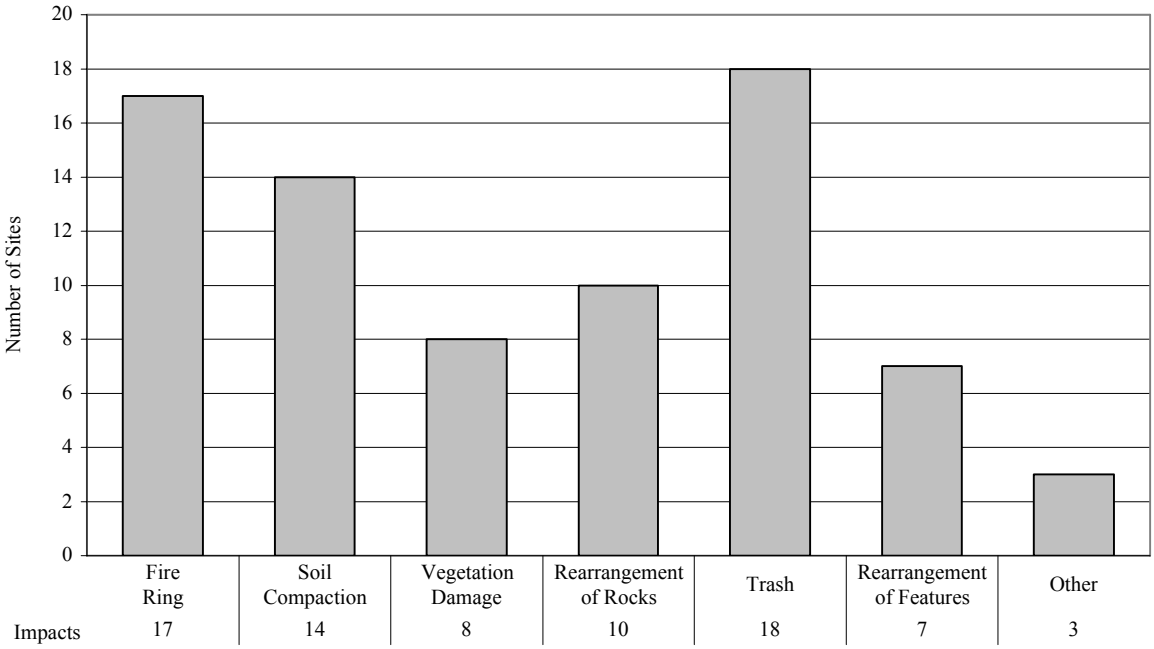


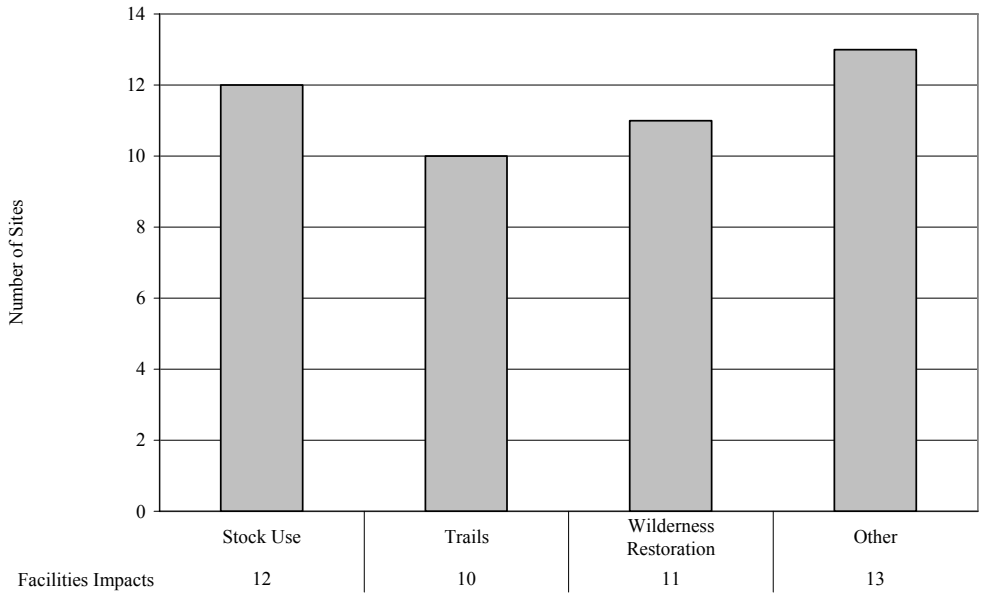
Figure 2.7.8. Impacts from camping on archeological sites.



Facilities Impacts:

Facilities-related impacts were observed on 34 (49%) archeological sites visited this field season (Figures 2.7.9). The majority of these impacts were in the "other" category (n=13), largely represented by forestry or fire management operations. This was followed by stock use (n=12), wilderness restoration (n=11), and trails work (n=10). The extent of these impacts on sites was predominantly in the minor category, impacting from 0-10% of the site area. It should be noted that it is difficult to discern private, commercial, and administrative stock use, and while most stock use occurring in the park is for administrative purposes, and was thus counted as a facilities-related impact, some of these impacts are likely a result of commercial or private stock use.

Figure 2.7.9. Facilities Impacts on Archeological Sites.



Social Trails:
Social, or non-formal, trails were observed on 29 sites (41%) this field season; out of these sites, one to two social trails were observed on 18 sites, and on 11 sites, more than two social trails were observed. Most of these trails were access paths to a river, or walking path such as a fisherman's access or shortcut.

Analysis

The statistical package JMP 5.1 was used to analyze data collected this field season. None of the variables measured were normally distributed; therefore it was inappropriate to use certain parametric statistical tests. Each of the variables were consequently subsumed into mutually exclusive categories of yes/no, near/far, etc in order to test for relationships using the chi square statistic.

Eleven dependent variables were measured on the nominal scale as present (Yes) or not present (No): (1) visitor impacts aggregate score, (2) social trails, (3) fire rings, (4) soil compaction, (5) rearrangement of features, (6) rearrangement of rocks, (7) trash, (8) vegetation damage, (9) other, (10) camping impacts as an aggregate, and (11) facilities impacts as an aggregate. Chi-square tests were run on all combinations of each of these dependent variables and four independent nominal variables: (1) proximity to a public access point (near – < 100 meters away/far - >100 meters away), (2) proximity to formal lodging (near - < 100 meters away/far - > 100 meters away), and (3) visibility of a site (visible/not visible, and (4) visible features (visible/not visible). The null hypothesis was for no difference in impact according to the different independent variables, and significance was set at a probability of 0.10.

Most of the chi square runs resulted in probability values well over 10%, so that the null hypothesis of no difference could not be rejected. However, 15 resulted in smaller probability values considered significant. These 15 are summarized in Table 2.7.3, and described in detail in the paragraphs below.

Table 2.7.3. Summary of Significant Chi-Square Results.

Independent Variable	Dependent Variable	Chi-square calculated statistic	Probability
Proximity to Access Point	Visitor Use Impacts	3.333	.0600
Proximity to Access Point	Soil Compaction	4.375	.0365
Proximity to Access Point	Facilities Impacts	8.235	.0041
Visibility of Site	Visitor Use Impacts	10.000	.0016
Visibility of Site	Other camping	4.179	.0409
Visibility of Site	Social Trails	11.910	.0006
Visibility of Site	Soil Compaction	9.115	.0025
Visibility of Site	Facilities Impacts	6.882	.0087
Visibility of Site	Camping Impacts	14.069	.0002
Visibility of Site	Rearrangement of Rocks	3.510	.0610
Proximity to Lodging	Vegetation damage	7.913	.0049
Proximity to Lodging	Social Trails	5.024	.0250
Proximity to Lodging	Camp Trash	2.758	.0967
Use Zone	Facilities Impacts	4.756	.0292
Visible Features	Other Camp	3.134	.0767

The distribution of visitor use impacts were significant when tested with both proximity to a visitor access point (χ^2=3.333, p=0.0679), and the visibility of a site (χ^2=10.000, p=0.0016). The aggregate camping impacts category was tested with the visibility of a site, and was significant (χ^2=14.069, p=0.0002). The individual indicators of camping impacts were also tested with the independent variables. Soil compaction was significant when compared with proximity to a public access point (χ^2=4.375, p=0.0002) and the visibility of a site (χ^2=9.115, p=0.0025). Rearrangement of rocks was significant when compared with the visibility of a site (χ^2=3.510, p=0.0610), vegetation damage was significant when compared with proximity to lodging (χ^2=7.913, p=0.0049), and the presence of camp trash was significant when compared with both visibility of a site (χ^2=5.609, p=0.0179) and proximity to lodging (χ^2=2.758, p=0.0967).

The dependent variable of facilities impacts (yes/no) was significant when tested with the variable proximity to a public access point (χ^2=8.235, p=0.0041), the visibility of a site (χ^2=6.882, p=0.0087), and when compared with use zone (χ^2=4.756, p=0.0292). Facilities impacts is the only dependent variable to have a significant difference when compared with use zone. Finally, social trails was significant when compared with the visibility of a site (χ^2=11.910, p=0.0006) and proximity to lodging (χ^2=5.024, p=0.0250).

At the outset of the data analysis for this thesis, it was assumed that at least two variables - proximity of a public access point in meters and visitor impact aggregate score, both continuous variables, could be analyzed using linear regression modeling to determine the strength or causality of the relationship between the two variables. However, it became apparent that this was not an appropriate use of the regression modeling, as the visitor use score is actually an aggregate of subjective rank-order data.

Discussion

The chi-square data analysis clarified some relationships between impacts on archeological sites and indicators of visitor use. The relationships between the independent variable visibility of a site, and the dependent variables site visitor impact score, camping impacts, soil compaction, rearrangement of rocks, facilities impacts, and presence of social trails all have statistical significance (associated p values of 0.0016, 0.0002, 0.0025, 0.0610, 0.0087, and 0.0006 respectively). However, the reliability of visibility of a site is suspect due to its ambiguous and subjective definition, and the subsequent difficulty in producing

replicable measures. During the course of fieldwork, it became apparent that the visibility of a site could not be consistently measured. Given that the variable visibility of a site might not have been actually measuring the visibility of a site as a site there could be some correlation between the visibility of the area as a nice camping spot and higher instances of camping, therefore leading to higher levels of impacts on the site.

It does appear that there is a relationship between the independent variable proximity of a site to a visitor access point, and dependent variables visitor use impacts, soil compaction, and facilities impacts due to their small associated p-values (p=0.06, 0.0365, 0.0041, respectively). The independent variable proximity to lodging was significant when tested with the presence of social trails, vegetation damage, and camp-related trash. An interesting note is that the independent variable visible archeological features was compared with each of the dependent impact variables, and no significant relationships came to light, except for with "other" camping impacts.

That facilities impacts was significant when compared with use zone is not surprising. The high use zone was relatively restrictive in its distance to developed areas and park maintained assets (formal trails), therefore, it is expected that those areas would contain more disturbances from facilities work. However, it is somewhat surprising that facilities impacts was the only variable that had a significant relationship with use zone. A relationship between use zone and presence of human impacts as an aggregate was anticipated.

It must be stressed here that the use of the chi-square statistic is to test for a relationship between variables, not to test the strength of that relationship (Drennen, 1987; Shennan, 1988). At this point, these chi-square results merely illuminate that a relationship does exist, however, there is no ability to discern causality, or strength.

Attempts to test each of the independent categorical (nominal) variables (proximity to visitor access in categories, visibility in categories, and proximity to lodging in categories) with the dependent categorical (nominal) variables (visitor use condition class, camping impacts, facilities impacts, and social trails) did not produce significant results due violations of the assumption of the chi-square test that fewer than 20% of the expected values are less than five. Further data collection is needed to enable more concrete understanding of the impacts visitor-related activities are having on archeological sites.

ASMIS:
This pilot season has indicated that ASMIS data collection alone is inadequate to determine, measure, and analyze visitor-related impacts. First and most importantly, ASMIS data collection is not quantifiable. It is subjective in nature and difficult to replicate. At any given visit, different archeologists will assess a site in varying ways. Additionally, the types of impacts and disturbances recorded as a part of ASMIS are not specific to visitor use, there are some categories that are similar such as use by hikers/horses and unauthorized collection, but more specific data is needed to understand the range of visitor-related disturbances. This is unfortunate as ASMIS data is required for all sites under the control of the NPS, however the goal and current application of ASMIS is as a tool to represent current site conditions, for Park reporting requirements, and to inform on limited management activities. At this point at Yosemite, ASMIS is not used to closely monitor and track changing conditions. It is precisely this monitoring and tracking of conditions that is important to a User Capacity monitoring framework to allow for and trigger management actions to slow down the degradation and disturbance to archeological sites before they reach a critical juncture. As can also be seen from this year's results, a site can be listed as being in good condition according to ASMIS definitions, but still have received damaging visitor-related disturbances. This is due to the fact that ASMIS condition data reflects the sites current stability and not level of disturbance. If a site has not received continued degradation and is therefore in "good" condition, it does not necessarily reflect that the site has no disturbances or impacts. As such, ASMIS site assessments will continue to be augmented with specific visitor-use data collection in future assessments to allow for more appropriate user capacity related, quantifiable, objective, and visitor-specific monitoring of archeological sites.

User Capacity Monitoring Protocols.
Many field protocols developed and tested this season worked well for the intended purpose of a user capacity monitoring program, and will continue in future field seasons. Conversely, some attributes recorded or measured at sites did not produce meaningful results. Particularly useful methods of assessing visitor use included tracking artifact collection piles, the measurement of the extent of social trails, the measurement of the extent of soil compaction, the measurement of the extent of fire rings, the measurement of the extent of vegetation damage, and measuring the extent of the rearrangement of rocks and features.

The presence of social trails on an archeological site is a valuable indicator of visitor-use. Not only does the associated soil compaction affect the site condition and integrity, but also this serves as a warning that people regularly visit the site area, and the potential is there for further, continued disturbances.

The recordation of artifact collection piles is important to begin to get quantifiable data regarding how many artifacts people collect. This information can additionally serve to answer important research questions such as how use on sites affects artifact diversity and numbers. Grand Canyon National Park (Coder et al. 1995) attempted to track artifact movement by establishing permanent 1x1 meter surface units to track artifact movement in a detailed manner; however, it was found to be time-intensive and expensive, as well as methodologically problematic. Assigning a cause to artifact movement is inherently challenging due to the several factors that can create artifact movement, and when completing artifact location tracking, it becomes difficult to discern what you are measuring. However, this is an option for future data collection with the caveat that protocols are developed that account for this apparent ambiguity in causes for artifact movement.

Monitoring specific indicators of visitor use impacts such as those related to camping, in the form of fire ring construction, rearrangement of rocks and features, and soil compaction, is important. These activities can be very destructive to archeological site condition and integrity. Monitoring facilities impacts that result from visitation is also important, as actions such as trails work, stock use, and wilderness restoration not only can be disturbing to archeological deposits, they can inform of visitor use of an area. The proximity of a site to a visitor access point is important to note in baseline condition data-gathering in order to answer important questions regarding site integrity and close proximity or ease of access to a site.

Some of the indicators of visitor use measured this season were found to be not meaningful to visitor-related impact data collection and analysis. These include the visibility of a site. This is a difficult variable to keep objective as it can be interpreted in several ways. As such, this variable will not be measured in future monitoring seasons. Instead this measurement will be replaced by the continued use of recording visible features that might act as “magnets” to attract visitors to an archeological site. Additionally, it is unclear at this point if it is necessary to continue to collect redundant data such as recording and quantifying natural impacts to sites. These variables were used to determine the site monitoring priority score; however more data is needed to determine if this information is meaningful. It is anticipated that in future seasons of baseline data collection and monitoring, a weighting system will be employed in the scoring of impacts at sites such that natural impacts will continue to be monitored, but impacts from visitor use will factor more into the monitoring priority and management actions or recommendations for a site.

Use Zones:
The use of arbitrarily chosen “use zones” to determine the site sampling strategy used this season is inadequate. It is necessary to develop an accurate visitor use model to discern and predict visitor use patterns across the park instead of arbitrarily buffering distance to roads and trails. This data has thus far not been collected, however it is anticipated that in the upcoming seasons the data will become available. One suggestion that will most likely be employed in next seasons site sampling strategy is the stratification by not only some type of visitor use zones, but also by either site type or some sort of site vulnerability rating. These suggestions will be further developed in the upcoming field season scope of work.

Workshop:
Yosemite National Park conducted a multi-agency workshop in January 2008 with the goal of refining baseline condition and monitoring protocols. Participants in the workshop included two archeologists from Grand Canyon National Park (Amy Horn and Jennifer Dierker), Jason Lyons, an integrated resource manager at Nez Perce National Historic Site, and Paul Jenkins, an archeologist at Daniel Boone National Forest. All of the participants have had experience developing and using archeological site condition monitoring programs, and their input and suggestions were extremely helpful in the revision of this indicator. Some of the information sharing that occurred will ensure that a site monitoring program at Yosemite National Park avoids pitfalls that have halted similar programs in other agencies. This workshop was especially helpful in identifying steps for future seasons of baseline data collection and monitoring. It is anticipated that some changes will be undertaken in next seasons' data collection, field form, database, and data analysis, as well as revisions to the monitoring protocols, including the following:

- Focus will turn to evaluating impacts to archeological sites within the context of impacts to specific attributes on sites and the attendant effects to archeological integrity and significance with respect to the National Register of Historic Places.
- A reevaluation of the measurements that inform on the impact to archeological integrity.
- A site selection strategy that will rely on not only proximity to road and trail corridors, but will use the concept of site vulnerability.
- Natural impacts will continue to be monitored, but assigning numeric scores to impacts will involve a weighting system so that visitor related impacts count more than natural impacts.

Conclusion

The visitor use at Yosemite National Park affects archeological resources in a variety of ways. This pilot field season sought to establish data collection and monitoring protocols to evaluate the extent of visitor-related impacts at archeological sites, and if they can be quantitatively measured. Based on information from literature review of other parks' and agencies' work in similar programs, and independent establishment of Yosemite-specific protocols, the indicators of visitor use were measured and assessed at a sample of 70 previously recorded archeological sites at Yosemite National Park. Through this data collection, it has been determined that archeological sites are being impacted from visitor-related use. Impacts that are occurring are loss of data from collection piles and the rearrangement of features; and disturbance of sediments containing archeological deposits due to soil compaction, vegetation damage, and the creation of social trails. The creation of a quantifiable way to assess these impacts is an important beginning in understanding the effects of many types of visitor-related impacts.

Additionally, important research questions developed during the workshop in January can be answered with continued site condition baseline data collection, and subsequent monitoring. Some of the questions that will be investigated in future field seasons are:

- How does social trailing affect archeological site integrity?
- How effective is social trail obliteration at decreasing impacts?
- Are visitor use impacts different based on proximity to trails, campsites, or trailheads?
- Do different categories of sites experience different categories of impacts?
- Are there different impacts from different kinds of user groups?
- What aspects of integrity are most at risk from visitation?
- Are resource closures effective in protecting sites?

The User Capacity monitoring program is a useful tool to support the practical visitor use related management of archeological resources at Yosemite National Park. Continued data collection will ensure that the foundation initiated this pilot season will develop into a long-term monitoring program with meaningful protocols targeted at informing the appropriate management of archeological sites. It is recommended that the long-term monitoring program implemented this year continue.

2.8. PARKING AVAILABILITY

Transportation has long played an important role in the National Park System (Percival 1999). Transportation issues have recently been studied at such parks as Yellowstone (Mings et al. 1992), Smoky Mountains (Sims et al. 2005), Blue Ridge Parkway (Vallier et al. 2003) as well as in Yosemite (Nelson and Tumlin 2000, YOSE 1999, White et al. 2006).

The vast majority of visitors to Yosemite arrive in private vehicles, and more than a million vehicles enter Yosemite Valley each year, resulting in significant traffic congestion. Traffic congestion can cause a variety of impacts to the Merced River's Outstandingly Remarkable Values including the natural and cultural resources as well as the quality of the visitor experience. Specific impacts include increased travel and waiting times, wildlife depredation, air pollution, noise, vegetation loss, and others. Therefore, an indicator was piloted in 2005 measuring the availability of parking facilities at the day use parking area. Parking availability serves as an indicator of overall traffic congestion in Yosemite Valley and, therefore, serves as an early warning sign suggestive of the extent to which the Merced River's Outstandingly Remarkable Values are affected by human vehicular use.

Measurement

Number of times (instances) each month the Day Use Parking area filled to capacity and alternative parking measures were implemented.

Standards

Standards have not been established for this indicator at this time. On-going monitoring efforts will provide needed baseline data from which to set standards.

Zones

- 2A Open Space
- 2B Discovery
- 2C Day Use
- 2D Attraction
- 3A Camping
- 3B Visitor Base and Lodging
- 3C Park Operations and Administration

Sampling

Park Rangers responsible for managing day use parking kept a daily log of information pertinent to this indicator. On days when parking reached capacity and the lot was closed, parking staff circulated the lot conducting a count of vehicles on the ground (VOG) at the time of closure. The time the lot closed and re-opened were also recorded.

Results

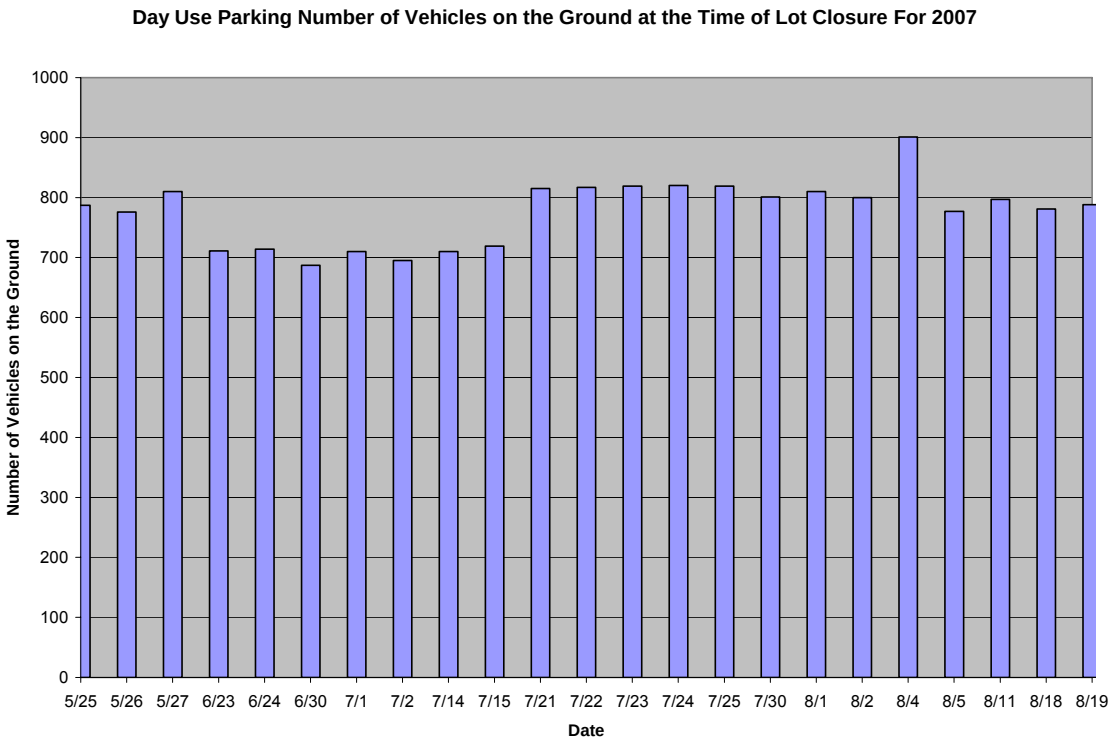
The day use parking area closed a total of 23 times during the summer of 2007 (Table 2.8.1). Closures occurred between the months of May and October, between the Memorial Day and Labor Day holidays. The reader should note that on two occasions the lot closed twice in a single day. However, only the first closure of the day was included in this analysis. The month of July saw the highest number of lot closures at 10. On average the lot was closed 2 hours 24 minutes on each occasion, and the average number of VOG at the time of closure was approximately 777.

Table 2.8.1. Summary data for parking capacity indicator in 2007.

VARIABLE	RESULT
Total number of closures	23
Average duration (hours) of closures	2 hours 24 minutes
Average Number of Vehicles On the Ground (VOG) at time of closure	777

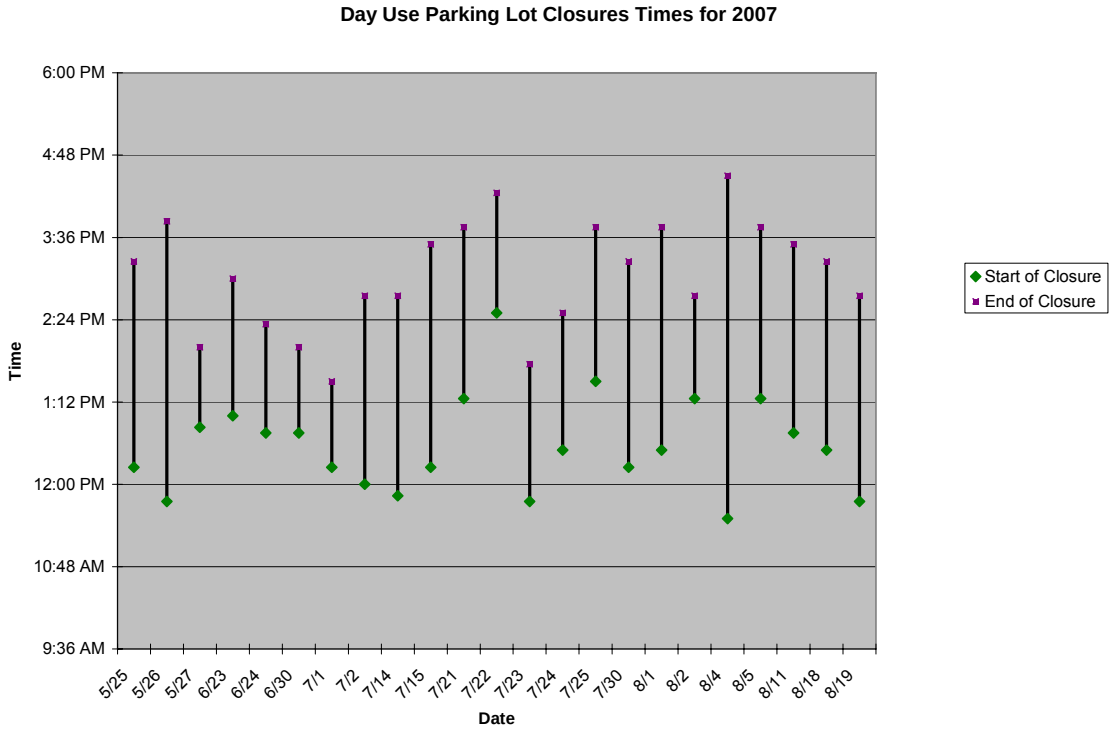
Figure 2.8.1 below shows the total number of VOG at the time of each of the 23 lot closures in 2007. On one occasion the lot reached a capacity of over 900 vehicles, and on ten other occasions the lot reached a capacity of 800 or more.

Figure 2.8.1. Vehicles on the Ground (VOG) at time of lot closures in 2007.



The following graph (figure 2.8.2) shows the time and duration of each of the 23 closures. In general, all closures occurred in the afternoon between 12:00 p.m. and 4:00 p.m. The earliest recorded closure time was 11:40 a.m. and the latest recorded re-opening time was 4:30 p.m.

Figure 2.8.2. Time and duration of lot closures in 2007



Discussion

2007 was the third year of implementation of an innovative traffic management program. This program includes the hiring of key traffic management staff who direct parking at the day use lot. It also includes the implementation of strategies such as rotating areas within parking areas, providing signs, and other management techniques to affect traffic flows and parking capacity. The effective implementation of this program may have reduced the number of closures of the day use lot due to more efficient use of the space. This point is evidenced in the total number of vehicles on the ground that the area accommodated at the time of closure. On most occasions the lot reached a capacity of approximately 800 vehicles before it was closed. This is an increase from 2005 where the lot was closed often at levels as low 500 vehicles. Caution should be taken, however, when considering this as this monitoring effort did not take into consideration the actual footprint occupied by parked vehicles from year to year. Nevertheless, the traffic manager suggests that the space used for parking has not changed significantly.

Therefore, in summary, the data presented here reflects the fact that the total number of vehicles that may be accommodated at the day use parking facility varies (see Figure 2.8.1 above). Attributes that contribute to this variance may include vehicle type, weather, and whether parking is directed (i.e., traffic management staff guide where and how visitors park in the allotted space) or whether it is not directed. This situation is most likely attenuated by the lack of formalization of the area. In the absence of well-designed and designated parking spaces, and left to their own auspices, visitors will use the space less efficiently than in a more formalized setting that is actively managed.

3.0 PROGRAM EVALUATION

The monitoring of indicator variables as described in this document is part of an on-going program to ensure the quality of park resources and visitor experiences. As mentioned earlier in this report, UCMMP is a planning and management process that focuses on visitor use. The UCMMP Handbook (NPS 1997) suggests that, "visitor use management begins with a plan, but it continues as a cyclical process involving monitoring, evaluation, and taking action to make adjustments." Monitoring is essential to "close the loop" in this overall process and ultimately inform management actions. Evaluative measures are, therefore, essential to continued UCMMP development and implementation, and to ensure that this program is indeed effective.

One workshop was held in the fall of 2007, to evaluate and improve upon the UCMMP for the Merced River corridor. The following section presents the results from these workshops. Overall, UCMMP development is expected to be continuous as described in the Handbook. However, it has been recognized that efforts to initiate the program will require more rigorous evaluation and analysis. For this reason, the workshop format has been employed in this the third year since the program's inception. This format is likely to continue in subsequent years until which time the program has been well established.

3.1. FALL WORKSHOP

A workshop was held on October 23 2007 at the Clark Community Hall in El Portal. Park personnel, and other individuals associated with the UCMMP attended the workshop.

This workshop kicked-off with an activity to identify the successes of the UCMMP during 2007. Significant achievements of the program identified in this activity were:

- Data was collected for eight indicators
- Establishment of the Visitor Use and Social Science Branch
- Presentations at the George Wright Society
- Four research projects were conducted this year (Pedestrian and Vehicle modeling, Social Science Survey and Protocol revision of the Social Trail Indicator).
- Riverbank Workshop
- LiDAR (Light Detection and ranging) mapping of the Merced River.

The workshop participants identified a series of broad objectives to achieve in the following year:

- Continue application of UCMMP process in Tuolumne.
- Exploring Visitor Use and establishing high and low use areas, using infrared cameras along the meadows and riverbank.
- Doubling our recruitment of SCA (Student Conservation Association) interns.
- Development of the transportation indicator.

The remainder of the workshop was spent in individual workgroups organized by indicator variable. These workgroups began by filling out a detailed evaluation form that addressed such issues as: indicator performance, indicator successes and challenges, suggestions for improvement, standards of quality, and other information.

4. SUMMARY

The data and information presented in this report is intended to inform planning and management decisions regarding visitor use and its impact to the Merced River's Outstandingly Remarkable Values within Yosemite National Park. This report has provided a descriptive presentation of results. Though still a young program, measuring and monitoring indicator variables has already provided park planners and managers with valuable scientific data and information to inform their decision making. The utility of this data and information, however, is not limited to the analyses reported here. Rather, additional analysis and synthesis of the data may be conducted in the future to verify results, test additional hypotheses, and otherwise further inform planning and management efforts on a continual basis. The UCMMP is an integral component of a broader adaptive visitor use management process. It is intended to evolve over time as new information, technologies, and methods are made available. This report helps to build the institutional memory that ensures this process continues.

Lastly, park managers have a variety of tools available to them to address visitor use and its impact to the park. Results contained in this report will provide important information to help managers select the best tools to affect desired outcomes. This "informed management action" closes the loop of the UCMMP framework and the process continues.

APPENDICES

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APPENDIX A: REFERENCES

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APPENDIX B: LIST OF ACRONYMS

ANOVA	Analysis of Variance
ASMIS	Archeological Sites Management Information Systems
BPLD	Bear Patrol Log Database
°C	Degrees Centigrade.
CMP	(Merced Wild and Scenic River) Comprehensive Management Plan
DO	Dissolved Oxygen
DOQs	Digital Orthophotos
GIS	Geographic Information System
GPS	Global Positioning System
ft.	Foot
HBMP	Human-Bear Management Program
km	Kilometer
l	Liter
m	Meter
MDL	Method Detection Limit
mg/l	Milligram per Liter
ml	Milliliter
mm	Millimeter
MLRS	Merced Lake Ranger Station
MPN	Most Probable Number (of bacterial colonies)
NO3 + NO2	Nitrate plus Nitrite
NPS	National Park Service
NWQL	National Water Quality Laboratory
PDA	Personal Data Assistant
PAOT	People at one time
pH	Potential Hydrogen
SOP	Standard Operating Procedure
TDN	Total Dissolved Nitrogen
TDP	Total Dissolved Phosphorous
TP	Total Phosphorous
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
µS/cm	Micro-Siemens (a measure of electrical conductivity)
UCMMP	User Capacity Management Monitoring Program
VOG	Vehicles On the Ground
WIMS	Wilderness Impacts Monitoring System

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Appendix D. Impact Totals from all Archaeological Sites Visited

	Natural Impacts							Visitor Use Impacts															Monitoring priority	
	Erosion	Bioturbarion	Rock Fall	Tree Fall	Vegetation Growth	Other	Condition Class	Collection Pile	Social Trail	Fire Ring	Rearrangement of	Rearrangement of	Soil Compaction	Vegetation	Trash	Other	Stock	Trails	Wilderness	Other	Vandalism	Condition Class	Monitoring Score	Priority in Years
MRP-0049	X	X	X				MOD															NO	7	5-7
MRP-0064	X	X					MIN				X	X	X		X					X		EXTR	11	2-5
MRP-0069				X			MIN													X		MIN	5	5-7
MRP-0072	X			X			MIN															NO	5	5-7
MRP-0078							NO															NO	5	5-7
MRP-0080	X	X		X			MOD	X	X	X			X	X	X	X	X	X			X	EXT	14	1-2
MRP-0083/H	X	X					MIN			X			X					X				HIGH	9	5-7
MRP-0088		X					MIN											X				MIN	6	5-7
MRP-0169	X			X			MIN		X	X					X							HIGH	10	2-5
MRP-0190/0191		X		X		X	MIN		X	X			X				X					SEV	12	2-5
MRP-0212	X			X			MOD															NO	6	5-7
MRP-0213	X	X		X	X		MOD															NO	6	5-7
MRP-0242/H						X	MIN												X			MIN	9	5-7
MRP-0291/0751	X	X					MIN		X				X	X	X		X			X		SEV	10	2-5
MRP-0292/0293/H		X	X				MOD		X				X		X		X	X	X			SEV	14	1-2
MRP-0314	X	X		X			MOD		X				X		X	X		X	X			HIGH	10	2-5
MRP-0336	X	X					MIN		X	X	X	X			X		X					EXTR	13	2-5
MRP-0355	X						MIN															NO	9	5-7
MRP-0645	X	X					MOD		X							X						MOD	9	5-7
MRP-0655		X					MIN		X					X						X		HIGH	9	5-7
MRP-0734H	X	X					MOD									X						MIN	10	2-5

	Natural Impacts							Visitor Use Impacts															Monitoring priority	
	Erosion	Bioturbarion	Rock Fall	Tree Fall	Vegetation Growth	Other	Condition Class	Collection Pile	Social Trail	Fire Ring	Rearrangement of	Rearrangement of	Soil Compaction	Vegetation	Trash	Other	Stock	Trails	Wilderness	Other	Vandalism	Condition Class	Monitoring Score	Priority in Years
MRP-0735		X		X			MIN															NO	6	5-7
MRP-0737	X	X					MOD		X											X		MOD	11	2-5
MRP-0810		X					MIN													X		MIN	6	5-7
MRP-0823				X			MIN													X		MIN	6	5-7
MRP-0827/H		X		X			MIN												X			MIN	7	5-7
MRP-1366/H	X	X					MIN		X		X				X					X		SEV	12	2-5
MRP-1529H							NO															NO	4	5-7
MRP-1572/H	X	X		X			MIN															NO	5	5-7
MRP-1746H		X		X	X		MOD															NO	6	5-7
MRP-1751H	X			X			MOD															NO	4	5-7
MRP-1816		X					MIN		X										X			SEV	9	5-7
TUO-0022	X	X					MOD		X	X			X				X	X	X	X		SEV	12	2-5
TUO-0047	X	X		X			MIN		X													MOD	5	5-7
TUO-0115	X	X					MIN		X					X								MOD	9	5-7
TUO-0132	X						MIN															NO	2	10
TUO-0134	X	X					MOD		X				X	X	X				X			SEV	11	2-5
TUO-0179/2829	X	X					MIN		X		X											MOD	8	5-7
TUO-0201	X	X					MIN															NO	3	2-5
YOSE2007H-01	X						MIN															NO	3	2-5
TUO-0494	X	X					MIN															NO	5	5-7
TUO-0495/H	X	X					MIN			X												MIN	4	5-7
TUO-0497	X	X					MIN															NO	4	5-7
TUO-0527/H	X	X		X			MIN															NO	6	5-7
TUO-0734	X	X		X			MIN		X	X					X							MOD	6	5-7

	Natural Impacts							Visitor Use Impacts															Monitoring priority	
	Erosion	Bioturbarion	Rock Fall	Tree Fall	Vegetation Growth	Other	Condition Class	Collection Pile	Social Trail	Fire Ring	Rearrangement of	Rearrangement of	Soil Compaction	Vegetation	Trash	Other	Stock	Trails	Wilderness	Other	Vandalism	Condition Class	Monitoring Score	Priority in Years
TUO-0737	X	X	X			X	MOD		X	X		X		X	X		X	X	X			EXTR	12	2-5
TUO-0738		X		X			MIN		X			X	X				X	X				SEV	9	5-7
TUO-0765	X	X					MIN		X													MIN	7	5-7
TUO-2811	X	X					MOD		X	X		X	X	X	X					X		EXT	13	2-5
TUO-2815/H	X	X		X			MOD													X		MIN	8	5-7
TUO-2822	X	X					MIN				X											MIN	6	5-7
TUO-2832	X	X					MIN															NO	4	5-7
TUO-2835	X	X		X			MOD					X										MIN	7	5-7
TUO-2836	X						MIN								X					X		MIN	6	5-7
TUO-3838	X	X		X			MOD			X		X	X	X	X				X			HIGH	8	5-7
TUO-3843	X	X		X			MOD										X					MIN	5	5-7
TUO-3934H		X		X			MIN	X	X	X	X		X		X		X	X				EXTR	12	2-5
TUO-3987	X				X		MOD		X	X		X										HIGH	8	5-7
TUO-3994	X	X		X			MOD								X							MIN	4	5-7
TUO-4070							NO															NO	4	5-7
TUO-4257	X						MIN										X					MIN	6	5-7
TUO-4440	X	X					MIN															NO	3	10
TUO-4488				X			MIN		X	X		X							X			HIGH	8	5-7
TUO-4510	X	X		X			MIN		X	X									X			HIGH	7	5-7
TUO-4888	X	X					MIN										X					MIN	5	5-7
TUO-4903	X	X					MIN															NO	6	5-7
P-22-001645	X	X					MIN		X	X	X	X			X							HIGH	6	5-7
P-22-001687		X			X		MIN											X				MIN	6	5-7

	Natural Impacts							Visitor Use Impacts															Monitoring priority	
	Erosion	Bioturbarion	Rock Fall	Tree Fall	Vegetation Growth	Other	Condition Class	Collection Pile	Social Trail	Fire Ring	Rearrangement of	Rearrangement of	Soil Compaction	Vegetation	Trash	Other	Stock	Trails	Wilderness	Other	Vandalism	Condition Class	Monitoring Score	Priority in Years
P-22-1682	X			X			MIN			X					X							MIN	6	5-7
YOSE1994L-01		X		X			MIN		X													HIGH	8	5-7

Appendix E: Archaeological Site Management Information System (ASMIS) Site Condition Definitions

GOOD - The site, at the first condition assessment or during the time interval since its last condition assessment, shows no evidence of noticeable deterioration by natural forces and/or human activities. The site is considered currently stable and its present archeological values are not threatened. No adjustments to the currently prescribed site treatments are required in the near future to maintain the site's present condition.

FAIR - The site, at the first condition assessment or during the time interval since its last condition assessment, shows evidence of deterioration by natural forces and/or human activities. If the identified impacts continue without the appropriate corrective treatment, the site will degrade to a poor condition and the site's data potential for historical or scientific research will be lowered.

POOR - The site, at the first condition assessment or during the time interval since its last condition assessment, shows evidence of severe deterioration by natural forces and/or human activities. If the identified impacts continue without the appropriate corrective treatment, the site is likely to undergo further degradation and the site's data potential for historical or scientific research will be lost.

DESTROYED - The site's formal condition assessment resulted in a professional determination that the site was destroyed or so severely damaged that the data potential/scientific research value was deemed insufficient to warrant further archeological monitoring or investigation. A destroyed site is excluded from Government Performance and Results Act (GPRA) and other national level reporting requirements and is recorded in ASMIS in the Local Resource Type field.

INUNDATED-UNCERTAIN – The deposits and condition of an inundated site, formerly in a terrestrial setting, are obscured and cannot be accurately assessed due to factors such as water turbidity or natural lack of clarity, wave action, growth of aquatic vegetation, and other conditions. Application of standard methods to assess the condition of an inundated site is not possible in these circumstances.

NOT RELOCATED–UNKNOWN - The location where the site was last documented was visited, but the site could not be relocated. Based on best professional judgment that considers standard site types in the park, geography, topography, site documentation, and other pertinent factors, the area is deemed to most likely be the location of the site. Further testing may be required to determine the site location. [NPS 2006:46, 2007a, 2007b].