Field Monitoring Guide

Visitor Use and Impacts Monitoring Program

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

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SECTION A: Introduction

A.1 BACKGROUND

The National Park Service is charged to protect the quality of park resources while providing for their enjoyment by this and future generations. This is the essential mission outlined in the 1916 Organic Act (Public Law 16 U.S.C. 1) establishing the National Park Service and it suggests that a balance be maintained between resource protection and visitor use. Today, there are hundreds of National Park units accommodating millions of visitors each year. This poses increasing challenges for area managers trying to achieve this balance. Managers must increasingly rely on scientific data and up-to-date information as to the extent of visitor use and related impacts so that they may make informed decisions that ensure that the resources and visitor opportunities they are charged to protect remain intact for future generations to enjoy.

The National Park Service strives to address a variety of visitor use-related issues including user capacity. The National Parks and Recreation Act of 1978 (P.L. 95-625) stipulates that National Park units “identify and implement commitments for visitor carrying capacities for all areas of the unit”. Originally, the carrying capacity concept referred to the level of use by a particular species that a particular land area could effectively accommodate. As applied to visitor use in national parks and other protected areas this concept has also been known as “user capacity” and refers to the types and levels of visitor use that a given protected area can accommodate before the values for which the area had been established are unacceptably affected (NPS 1997; Manning 1999; Manning et al. 2006).

Since the early 1990s, an adaptive management process has been initiated and / or implemented in several National Park units across the country. This process is to be carried out in a variety of ways including the Limits of Acceptable Change framework used by the National Forest Service and the Visitor Experience Resource Protection (VERP) utilized by the National Park Service (Hoff and Lime, 1997). In Yosemite, the adaptive management process has been applied to develop plans for the future of Yosemite Valley and the Merced River Corridor (YOSE 2000; 2001; 2004). Additionally, it is being applied to the Tuolumne River Corridor. It represents a significant effort of the park in tackling visitor impacts and other visitor-related issues through a systematic and adaptive management framework (NPS 1997). In Yosemite we are implementing several indicators and monitoring protocols through our Visitor Use and Impact Monitoring Program.

The objective of this monitoring program is to provide park managers with up-to-date, scientific data and information on visitor use and related impacts. The Visitor Use and Impact Monitoring Program is a key component of a cyclical process of adaptive visitor use management in the park. It also provides a means to inform park partners and the public as to the current status of resource and visitor use conditions.

A.2 INDICATORS AND STANDARDS

In an adaptive management process and subsequently in Yosemite's Visitor Use and Impact Monitoring Program, *indicators* are measurable, manageable variables that reflect the condition of park resources and the quality of visitors' experiences. *Standards* reflect the desired condition of these variables (Manning 2007). The Visitor Use and Impact Monitoring Program for the Merced Wild and Scenic River defined a suite of eight selected indicators. (YOSE 2001; YOSE 2004). These indicators were first monitored in 2004. With the ongoing development of the Tuolumne River Plan, additional indicators have been selected along with measureable standards. Some of these indicators overlap with current efforts in the Merced River Corridor, however, some represent monitoring opportunities unique to the Tuolumne River corridor.

INDICATOR 1: Water Quality

Visitor impacts include pollutants into the rivers are known to create resource degradation. Such constituents are monitored to identify potential changes over time. The following water quality parameters are 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.

Draft Standard:

The standards developed from 2005-2008 baseline data are intended to be anti-degradation for each segment for E. coli, nutrients (total dissolved nitrogen, nitrate + nitrite, total dissolved phosphorous, and total phosphorus), and total petroleum hydrocarbons per sampling period. Additionally, the park must comply with the proposed state standard for E. coli for recreational contact at all times.

INDICATOR 2: Riverbank Erosion

Degree of riverbank erosion along the Merced River. This will be assessed through a combination of vegetative cover condition and substrate erosion condition characteristics.

Draft Standard:

1. Channel Morphology: No greater than 10 percent increase in cross-sectional area due to bank scour in 80 percent of sites.
2. Vegetation Condition (Trend): No greater than 10 percent cover of bare ground in 80 percent of sites. This trend will be determined using the 2008 data to reflect current condition as compared to future assessments. This will help determine our desired condition and to detect change.
3. Vegetation Condition (Status): No greater than 20 percent of (strata-based) sites will have less than C percent green understory cover.

INDICATOR 3: Wildlife Exposure to Human Food

Wildlife impacts are heavily caused by access to food. Understanding visitors' abilities to comply with food storage regulation has been developed as a proxy for these wildlife impacts.

Draft Standard:

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

INDICATOR 4: Extent and Condition of Informal Trails

This indicator monitors the proliferation and condition of informal trails in meadows and the resulting fragmentation of meadow habitat. Informal trail monitoring has been applied to both river corridors to identify trampling related impacts to Yosemite's unique meadow habitat.

Draft Standard:

Two draft standards have been developed for the Tuolumne River Corridor. Standard development for the Merced River Corridor is ongoing. Fragmentation Standard: Meadows with informal trailing in the Tuolumne River Corridor will display fragmentation represented through a specific landscape index: the Largest Patches Index Five (LPI5) of no more than 92.84%. Decreasing percentages will indicate a increased degree of fragmentation.

Meadow Condition Standard: Trend data will demonstrate improvement of condition for recorded informal trails in meadows.

INDICATOR 5: Wilderness Encounters

Encounters with other parties gauge the density levels and opportunities for solitude that visitors experience in designated Wilderness areas.

Draft Standard:

No more than two encounters with another party per hour, 80 percent of the time. This standard will be evaluated based on study sites that reflect the range of use levels with varying distances from roads and trailheads within the Tuolumne River Corridor.

INDICATOR 6: Extent of Visitor Use

Visitor use monitoring serves as a gauge of park visitor use activity along the river. This indicator reflects visitor use levels and behaviors that potentially cause negative impacts such as crowding, user conflict, noise and other visitor caused disturbances on both natural resources and the visitor experience. Visitor count measures overall recreation use in the river corridor and helps to protect the Merced River's Outstandingly Remarkable Values.

Draft Standard:

This indicator is still in development stages and encompasses a variety of visitor use studies throughout Yosemite.

INDICATOR 7: Archeological Resource Integrity

This work evaluates the condition, stability, and integrity of archeological sites within the Merced and Tuolumne Wild and Scenic River corridors. This work explored the applicability of the National Park Service's Archeological Site Monitoring Information System (ASMIS) to monitor visitor use impacts to archeological resources.

Draft Standard:

Visitor impacts to archeological sites with low data potential may not exceed a “partial loss-repairable” disturbance effect at more than 10% of sites visited in a field season. Visitor impacts to archeological sites with high data potential may not exceed a “negligible” disturbance effect at any site visited in a field season.

INDICATOR 8: Parking Availability

In addition to the typical monitoring collection with parking, transportation studies continue throughout Yosemite Valley, Tuolumne Meadows, entrance stations and key intersections to develop a simulation model of the transportation system in the park. The intent of this study is to outline other aspects of this system that are key to the visitor experience and measurable.

Draft Standard:

A standard for parking availability has yet to be determined.

INDICATOR 9: Natural Soundscapes

Soundscapes as measured by (1) the change in sound levels from natural ambient in areas more than 100 feet from roads, and (2) the amount of time above speech interference thresholds in areas more than 100 feet from roads.

Draft Standard:

The proposed standard will look at hourly change in sound levels exceeding 3 dB(A) and 6dB(A) to assess cumulative noise impacts, and at noise events exceeding 60 dB(A) to assess speech interference. Different standards will be proposed for frontcountry vs. backcountry areas, and for day-time vs. night-time hours.

Monitoring Requirements

Monitoring these indicator variables requires the development of protocols that allow NPS staff to collect data in order to understand current use, impact, and trends. Creating a robust and accurate measurement strategy requires a good sampling plan. Sampling is a systematic approach to collecting data. A good sample will accurately represent estimates of population values. Watson et al (2000) outlined seven components of a good sampling strategy.

- Bias in the sampling can be eliminated by randomization.
- Probability sampling can be used to measure precision sample results.
- Probability sampling can be used to measure precision sample results.
- Patterns and landscape characteristics of wilderness use usually do not allow for census measurements in a field season.
- Good sampling strategies require fewer personnel hours.
- Well designed sampling leads to higher accuracy in the data.

- Flexibility is very important to managers who are challenged to multi-task and maximize productivity with minimal personnel resources.
- Sampling should not burden visitors.

These sampling strategy components can be generalized to all indicators measured. However, as with all monitoring programs some constraints exist including time, limited budgets, or other stochastic events such as weather, medical emergencies, and unforeseen circumstances. Therefore, NPS staff should know the standard error associated with the number of days or times that an indicator is measured. Generally, the higher the sample size, the lower the standard error. For several of the indicators, the standard error can be calculated to help NPS staff be informed about such conditions. All of these components of a good sampling strategy were incorporated into development of this field guide. Sampling strategies were developed for each indicator that will be efficient yet provide the data required to address whether a standard has been exceeded.

Although all of these considerations were incorporated into the development of this field guide, it is understood that it takes time to develop monitoring protocols that truly address changes in the natural or social environment. Recent research by United States Geological Survey and National Park Service staff concluded that long-term monitoring protocols take several years of field work and revisions to develop the level of confidence in the data for long-term monitoring (Oakley, et al, 2003).

The following maps present the various sampling sites for each indicator monitored:

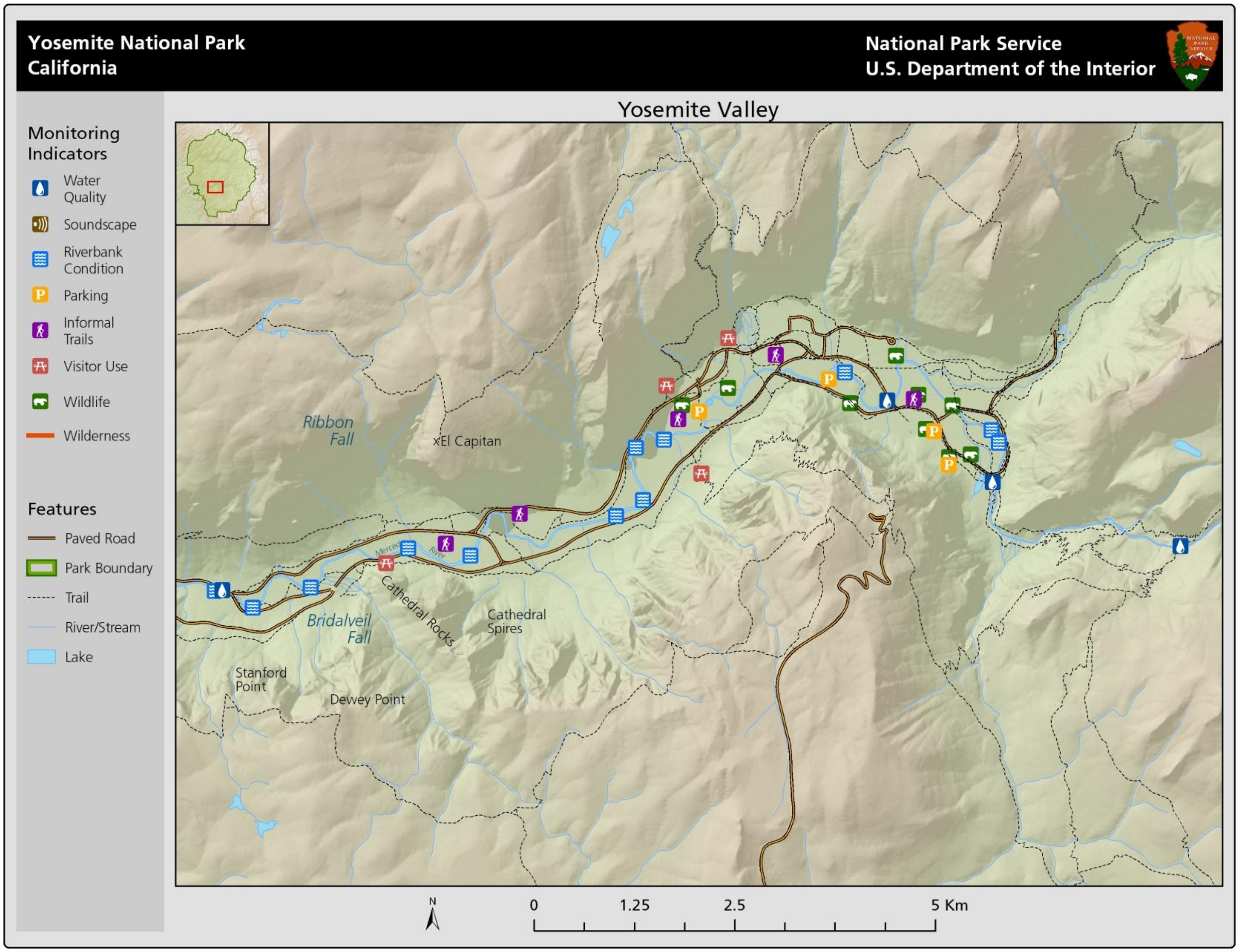


Figure A.2.1 Monitoring Sites in Yosemite Valley

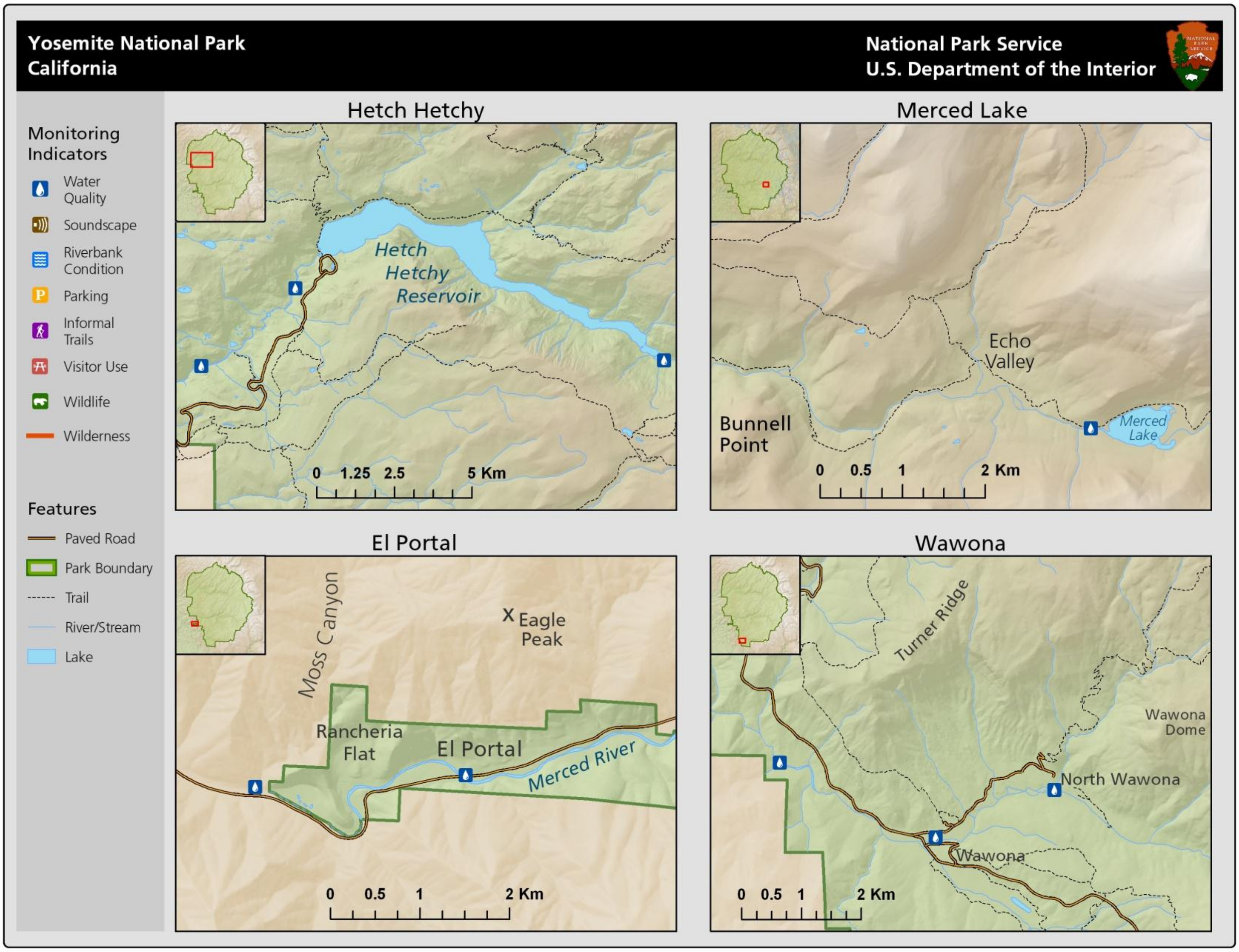


Figure A.2.2 Monitoring Sites in Wawona, El Portal, Hetch Hetchy, and Merced Lake.

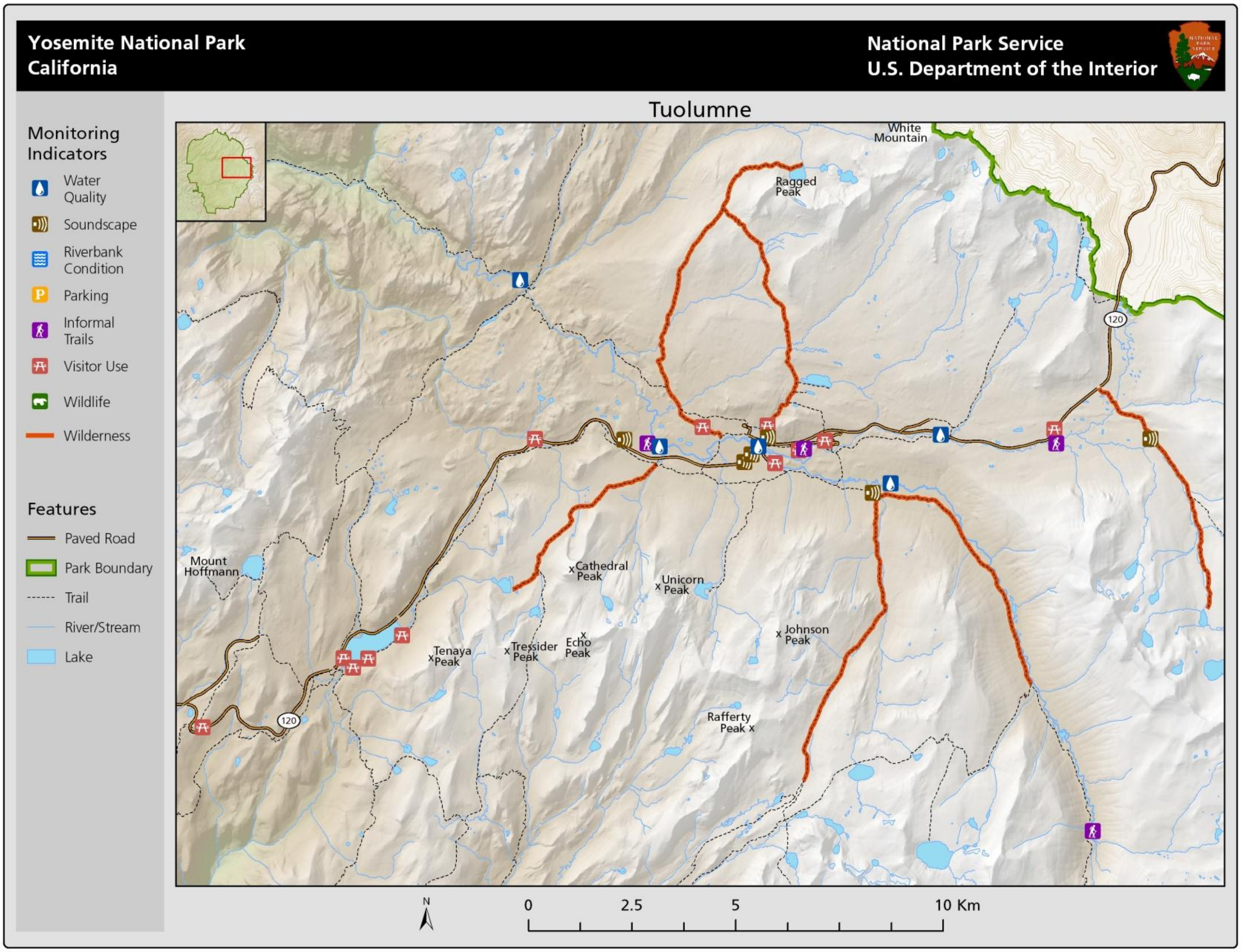


Figure A.2.3 Monitoring Sites in the Tuolumne Meadows Area.

A.3 THE 2009 FIELD SEASON AND BEYOND

Summary:

This version of the field guide was originally prepared for use during the 2009 season. Readers will note continued improvements are being made in the protocols from earlier field seasons. This field guide will remain as the comprehensive field guide unless In some cases we have moved from the inventorying of baseline conditions to sampling-based strategies. Still in other cases we have refined measurement techniques. Further development of these and additional indicators continue as additional information and technology expands. This process of improvement and refinement is essential to an on-going monitoring program and will continue in subsequent years.

This field guide is organized into the following sections:

Section A — Introduction.

Provides background on the Visitor Use and Impact Monitoring and introduces the indicators monitored each year forward from 2009.

Section B — Monitoring Protocols.

This guide describes the field monitoring protocols employed for each indicator for the 2009 season and subsequent years. Updates will be added to the protocols when appropriate

Appendices

The appendices section includes a glossary and a list of acronyms.

Compliance Statement:

Compliance with institutional requirements and regulatory processes was completed for the 2009 Visitor Use and Impact Monitoring effort. National Park Service research permits were obtained to comply with institutional requirements for conducting field research and monitoring activities in a National Park unit. Two permits were obtained as follows: 1) General monitoring activities **permit #YOSE-2008-SCI-0179**); and 2) Water quality sampling (**permit #YOSE-2008-SCI-0032**). Both permits are detailed and accessible at the National Park Service Research Permit and Reporting System site at https://science1.nature.nps.gov/research/ac/ResearchIndex.

Additionally, since the 2009 field monitoring season this program has pursued a number of activities that required the National Park Service to demonstrate compliance with the National Environmental Protection Act (NEPA). The specific types of data collected for the Tuolumne Wild and Scenic River Comprehensive Management Plan, as part of the Visitor Use and Impact Monitoring, included continued water quality sampling of the Tuolumne Wild and Scenic River, soundscapes data collection, observation of vulnerability at archeological sites, and documentation of informal trails in the Tuolumne Meadows area.

For example, collection of water samples from the Dana Fork of the Tuolumne Wild and Scenic River requires an identification of where those sampling locations will be, and the amount of water expected to be removed from the river for each sample. The use of Geographic Information Systems (GIS) equipment to document the location of social trails required staff traversing through sensitive habitats (i.e., places the NPS would like to see people avoid). Because of the scale and duration of these types of monitoring activities were considered to be at a negligible (i.e., non-detectable) level of intrusion into the "human environment," a Categorical Exclusion (CE) was the appropriate level of NEPA compliance.

The types of activities covered under the CE received for Visitor Use and Impact Monitoring data collection included: (1) Non-destructive data collection by fewer than 5 people together at one time in one area; and (2) The temporary installation of small, unobtrusive data collection devises in and adjacent to the Tuolumne River and its tributaries.

Work Plan:

The following work plan (Table A.3.1) provides an overview of the activities associated with carrying out the monitoring of indicators during the 2009 field season.

Table A.3.1 Annual Field Monitoring Work Plan

ID	Task	Deliverable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.0	**Planning and Development Phase**	**Field Monitoring Guide**												
1.1	Monitoring protocol development													
1.2	Conduct development workshop													
1.3	Obtain data collection permits and conduct appropriate compliance													
1.4	Acquire data collection instruments													
1.5	Select and prepare sampling locations													
1.6	Field test data collection methods and instruments													
1.7	Conduct public meeting on indicator planning and development													
2.0	**Implementation Phase**	**Data and Information**												
2.1	Conduct field data collection													
2.2	Conduct quality control checks of data collection													
2.3	Enter data including quality control check													
2.4	Conduct public meeting on data collection efforts													
3.0	**Reporting Phase**	**Annual Report**												
3.1	Data analysis													
3.2	Prepare annual report													
3.3	Conduct public meeting on monitoring results													
3.4	Conduct Reporting Winter Workshop													

SECTION B: Monitoring Protocols

B.1 WATER QUALITY

B.1.1 Background

Purpose of the Water Quality Monitoring Protocol:

Human use has the potential to affect water quality. Horse manure (at stables or on trails) or people swimming in the river can increase fecal coliform (i.e. bacteriological) levels; people bathing in the river with soap can increase phosphorus/phosphate (i.e. nutrients) levels; and surface water runoff from campgrounds and stables can affect both fecal coliform and nutrient levels. These activities, as well as hydrocarbon pollution associated with roads and other development, all may occur in Yosemite Valley.

The goal of this plan is to monitor water quality data along the Merced and Tuolumne River corridors. Specific objectives are to sample backcountry sections of river downstream of heavy use areas and above and below heavy use areas in Yosemite Valley, El Portal, and Wawona. A final objective is to collect high quality data that is comparable to data collected in other parks and in the Sierra Region as a means to protect water resources from human-use impacts.

Water quality standards have been established by the State of California, in accordance with the Clean Water Act, for surface waters in the San Joaquin River Basin, which includes the Merced River. Similar standards that are much more restrictive for certain indicators such as fecal coliforms have been established for Lake Tahoe under the Clean Water Act's anti-degradation policy that mandates protection of waters with existing high quality (see Lahontan Region Basin Plan). The NPS currently monitors water quality above and below the treated water discharge points for the wastewater treatment plants in El Portal (monthly) and Wawona (weekly), to assure attainment with state standards and to carry out the requirements of the operating permits. In the event of a sewage spill or direct discharge of treated water to the river, the monitoring is more frequent (potentially daily).

Description of Indicator and Standard

Indicator:
Water quality as measured by the following constituents: E. coli, nutrients (total dissolved nitrogen, nitrate and nitrite, total dissolved phosphorous, and total phosphorus), and total petroleum hydrocarbons.

Draft Standard:
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.

B.1.2 Sampling Design

Rationale for sampling design:

The initial sampling regime has been designed to inventory spatial and temporal water quality conditions on the Merced and Tuolumne Rivers with an emphasis on areas of the river adjacent to the heaviest development. Intensive sampling will take place for at least three years before standards of quality will be established. Until such time, applicable state and federal water quality standards will apply as minimum acceptable water quality standards.

Site selection (selection criteria and procedures):

Sample locations are depicted in Figure B.1.1 and listed in Table 3. Sites were selected based on location, co-location with other sampling efforts, and existing water quality data. In general, locations were selected to be upstream and downstream of developed areas, in order to better isolate impacts. Ongoing water quality sampling by the U.S. Geological Survey at Happy Isles Bridge, top of Nevada Falls, and below Merced Lake make these good sites for collocation of sampling. Similarly, the waste water treatment plants in El Portal and Wawona sample regularly at the Highway 41 South Fork Bridge, the Highway 140 Bridge, and the Foresta Bridge. Finally, sample sites where sampling could take place in the middle of the channel even at high flow were more desirable for accurate sampling.

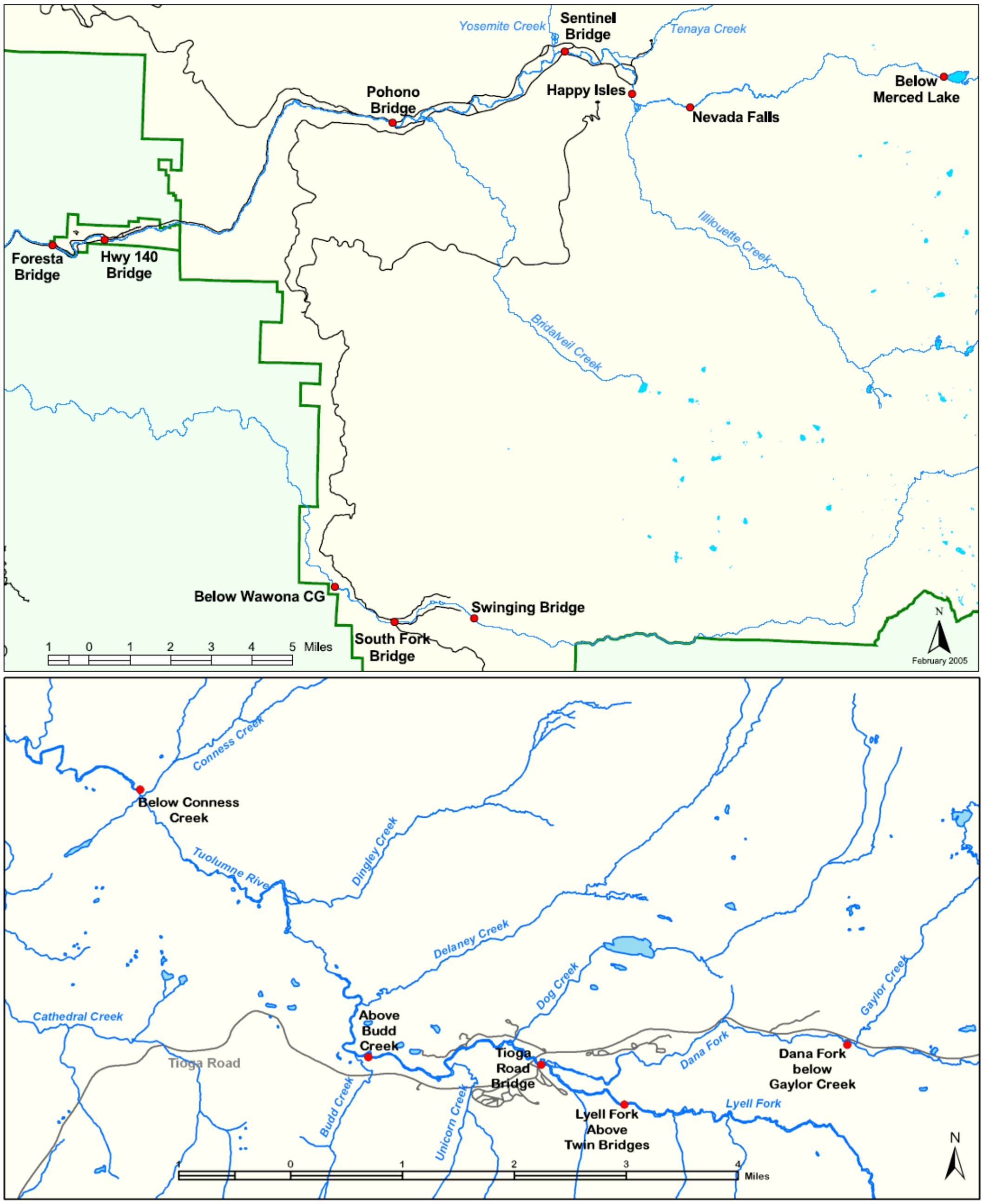


Figure B.1.1 Water Quality Sampling Locations for the Merced and Tuolumne Rivers

Sampling schedule:

In order to understand seasonal variations in water quality, monthly sampling is conducted on the Merced River at all sites except the two wilderness sites (Below Merced Lake and Above Nevada Falls) and monthly during the summer at all sites on the Tuolumne River. Tuolumne River sites are sampled bimonthly during the winter. Finally, sampling is conducted during or following a storm event that causes a major change in flow conditions on the river. Fixed interval sampling generally takes place on the same days each week or month, but these times can be adjusted to accommodate schedule conflicts or personnel availability. An attempt is made to sample storms during the rising limb of the hydrograph.

B.1.3 FIELD METHODS

The field methods described in the following section assures the collection of quality data that meets the purpose of monitoring described in the previous section. The components include data quality objectives, instrument calibration procedures, sampling procedures, and quality control procedures. Special "Quick Guides" that encapsulate specific operational instructions are included in this section.

Data Quality Objectives:

High data quality will be achieved through proper training of field technicians and adherence to the foregoing discussion of accuracy, precision, representativeness, and completeness.

Chemical and Physical Parameters:

Accuracy describes how close the measurement is to its true value. Accuracy is the measurement of a sample of known concentration compared with a measured value. The accuracy of field measurements will be checked by performing tests on standard check solutions as a part of calibration procedures. Standard calibration and check solutions will be purchased from commercial labs. In addition, the accuracy of chemical measurements should be verified through use of blind audit samples. Check standards and audit samples should be in the mid-range of typical values for the Merced River.

Biological Parameters:

Accuracy for bacteria will be determined by analyzing a positive control sample twice annually. A positive control is similar to a standard, except that a specific discreet value is not assigned to the bacterial concentrations in the sample. This is due to the fact that bacteria are alive and capable of mortality and reproduction. Instead of a specific value, an approximate target value of the bacterial concentration is assigned to the sample by the laboratory preparing the positive control sample. In general, these checks are performed as a part of a certified laboratory routine quality control.

Chemical and Physical Parameters:

The precision objectives apply to duplicate and split samples taken as part of normal sampling and repeated field parameter measurements on the same sample. Precision describes how well repeated measurements agree. Duplicate or split samples prepared in the lab or field will comprise at least 5% of the samples or one set per sampling day (about 10%). Repeated field measurements on a single sample will be conducted once per sampling day.

Biological Parameters:

Precision for bacterial parameters will be determined by having the same analyst complete the procedure for laboratory duplicates of the same sample. At a minimum this should be done once per day, or run duplicates on a minimum of 5% of the samples if there are over 20 samples run per day. The results of the duplicates should be within the confidence limits supplied by the manufacturer.

Comparability:

Comparability is the degree to which data can be compared directly to similar studies. Sample collection methods and field parameter measurements outlined in this protocol are derived from the USGS National Field Manual and the Surface Water Ambient Monitoring Program of the California State Water Resources Control Board. Laboratory analyses will be conducted by the USGS National Water Quality Laboratory or similar USGS approved contact laboratory or, at minimum, a National Environmental Laboratory Accreditation Program (NELAP) approved laboratory. These measures should ensure broad data comparability, particularly with the National Park Service Inventory and Monitoring and Vital Signs Programs (National Park Service- Freshwater Workgroup Subcommittee 2002).

Method Detection Limit and Sensitivity:

The Method Detection Limit (MDL) is the lowest possible concentration the instrument or equipment can detect. This is important to record because we can never determine that a pollutant was not present, only that we could not detect it. Sensitivity is the ability of the instrument to detect one concentration from the next. Detection Limits and Sensitivities are noted in Tables B.1.1 and B.1.2. Some labs use reporting limits in addition to the method detection limits. A reporting limit is typically 2-5 times the MDL.

Table B.1.1 Water Quality Parameter Measurement

Parameter	Method/ Range	Units	Detection Limit	Sensitivity	Precision	Accuracy	Completeness
Temp.	Electronic thermometer (-5 to 50)	°C	-5	0.01 °C	± 0.01 °C	± 0.15 °C	80%
Dissolved Oxygen	Electronic meter/probe	mg/l	0.1	0.01 mg/l	± 0.01 mg/l	± 0.2 mg/l	80%
pH	pH meter	pH units	0	0.01 unit	+ 0.01 units	+ 0.2 units	80%
Conductivity	Conductivity meter	µS/cm	1	1 µS/cm	± 0.5%	± 5%	80%

Table B.1.2 Water Quality Laboratory Parameters

Parameter	Method	Units	Detection Limit	Reporting Limit	Completeness
Total Dissolved Nitrogen	USGS/NWQL 2754	mg/l	0.015	0.03	80%
Nitrate and Nitrite	USGS/NWQL 1979	mg/l	0.008	0.016	80%
Total Phosphorous	USGS/NWQL 2333	mg/l	0.002	0.004	80%
Total Dissolved Phosphorous	USGS/NWQL 2331	mg/l	0.002	0.004	80%
E. coli	SM9221F	MPN/100 ml	2	2	80%
Total Petroleum Hydrocarbons	306 MEPA SW 846	µg/l	13.0	NA	80%

Representativeness:

Representativeness describes how relevant the data are to the actual environmental condition. Problems can occur if:

Samples are taken in a non-standard collection area such as downstream of a bridge

Samples are not representative of the entire flow due to sampling in a backwater area, or not properly assuring an integrated sample

Samples are not analyzed or processed appropriately; causing conditions in the sample to change (e.g. water chemistry measurements are not taken immediately).

Sampling locations have been selected to minimize local impacts due to a bridge or other adjacent structure. Foresta Bridge is the only location where samples are collected downstream of the bridge both for safety reasons and to sample at the same location as El Portal Waste Water treatment plant personnel. Integrated sampling has been done when possible from bridges or by wading using a centroid sample. Otherwise, grab samples are collected as close to the main flow as possible to minimized backwater effects. Side-by-side comparison of grab sampling and centroid sampling or equal-width interval sampling has been and continues to be conducted to characterize the variability associated with grab sampling alone. All field parameter measurements are conducted at the sampling sites. All samples are to be held at 4°C and analyzed within the specified hold times.

Completeness:

Completeness reflects the ratio of valid laboratory results to number of samples actually sampled. The goal is 80% sample validity. This ratio may be increased as this program matures.

Before modifying these methods, or developing alternative or additional methods, technical advisors will evaluate and review the effects of the potential modification. It will be important to address their concerns about data quality before proceeding with the monitoring program.

Instrument Calibration Procedures:

Instrument calibration and checks should be conducted at least twice per day, including a check of the calibration following collection of the last sample. Calibration checks are intended to verify the calibration of the instrument. The following table (Table B.1.3) specifies post calibration check error limits. If the instrument does not read within these limits, perform the calibration sequence again.

Table B.1.3 Post Calibration Check Error Limits

Parameter	Value
Dissolved oxygen	± 0.5 mg/L, ± 6% saturation
pH	± 0.2 standard units
Specific conductance	± 5%
Temperature	± 0.2 °C, annual calibration check

Instruments to calibrate will be the multi-parameter probe for measuring temperature, pH, specific conductivity, and dissolved oxygen and the smaller packable unit for temperature and conductivity. Calibration procedures will vary by instrument but the following provides a general outline of the procedure and a form to record calibration results.

Temperature:

Conductivity, pH, and dissolved oxygen are all temperature compensated qualities and therefore it is critical that temperature be measured accurately. Temperature accuracy should be verified periodically via a side-by-side comparison with a NIST-traceable thermometer every three months during regular field measurements and then document in the notes section on the calibration form.

Both the multi-parameter probe and the NIST-traceable thermometer should be sent to the manufacturer once per year to verify or adjust calibration. All calibration certificates should be filed with field data for the period that the calibration was valid.

Specific Conductivity:

Calibration should be performed once per sampling day. The calibration should be checked after the last sample has been collected to ensure the instrument has maintained its calibration.

- If the probe has been in storage, soaking in deionized (DI) water may be necessary to ensure the probe is thoroughly wetted prior to use. Equilibrating the probe in DI water for 10 minutes is recommended. Consider immersing the probe in DI water in a clean durable container before heading to the field.
- To calibrate the meter for specific conductivity, use a conductivity standard solution of around 1000 µS/cm. A single point calibration will be adequate.
- Immerse the probe into the standard and agitate vertically to ensure no air bubbles trapped. Allow time for the reading to stabilize.
- Record the value of the calibration standard, the manufacturer and lot number, and the expiration date.
- Triple rinse the probe with DI water and then with the check solution. This solution should be another conductivity standard around 750 µS/cm.
- Record the manufacturer’s value for the check solution, the solution temperature, the manufacturer and lot number, and the expiration date.
- Immerse the probe in the check solution and record the measured value. This is the Initial Calibration Check (ICC).
- Record Continuing Calibration Checks (CCC) at the end of the day and record this value and the time. The difference should be less than 5%.

pH:

Calibrate the pH meter before the start of sampling. In addition, the meter accuracy should be verified using a check standard close in value to the river water. A final check of the instrument should be done after the last sample is taken.

- Triple rinse electrode with DI water.
- Calibrate and operate in temperature-compensation mode using pH = 4.00 and 7.00 buffer solutions. Record the value of each buffer standard, the manufacturer and lot number, and the expiration date.
- Rinse the probe with DI water and blot the excess.

- Check using a buffered check solution of pH 5-6. Immerse the electrode into the solution and stir briefly.
- Record the manufacturer's value, the measured value (ICC or CCC), temperature, the manufacturer and lot number, and expiration date.
- Rinse the probe with DI water, blot dry, and make field measurement.

Dissolved Oxygen:

Clean the sonde and stirrer under running *tap water* to remove debris. Swab the DO membrane and pH probe with a cotton ball soaked in Alconox or methanol. This removes surface films that may cause the calibration to drift. Check the condition of the membrane. Ensure the membrane is intact; free of wrinkles, bubbles, and surface films; and not discolored below the membrane.

- Fill the calibration cup with water to just below the O-ring, securing the DO membrane.
- Carefully remove any water droplets from the membrane with a Kimwipe or soft towel.
- Cap the calibration cup and allow it to stabilize for about five minutes.
- Select Calibrate, (%) Saturation, and then enter the correct barometric pressure (mm-Hg) and hit Enter.

Data Collection, Measurement, and Post-collection Processing:

Locations

Merced River

Eight frontcountry (accessible by vehicle) sites will be sampled monthly. Five of these eight sites will be sampled following major storm events and weekly during the peak spring runoff period. An additional two backcountry sites will be sampled seasonally on a monthly basis. Each sampling event will take place over 1-2 days. Sample collection at two backcountry sites will require one technician two days per event. Sampling should also be coordinated with more comprehensive sampling conducted at Happy Isles by the USGS as part of the Hydrologic Benchmark program to provide a quality control check.

Nutrients (dissolved nitrogen species, total phosphorous and total dissolved phosphorous) will be sampled at all sites. Petroleum hydrocarbons will be sampled quarterly at three downstream locations only (Pohono Bridge, Foresta Bridge, and Below Wawona Campground). Additional petroleum hydrocarbon sampling will take place on a monthly basis during spring runoff sampling. *Escherichia coli* (*E. coli)* bacteria will only be sampled at the eight frontcountry sites due to the short 6-hour hold time on these samples. All sampling and sample hold times will conform to published USGS and EPA procedures. Storm and spring runoff sampling will be conducted at five sites only, to facilitate delivery and processing of samples at the El Portal Waste Water Treatment Plant. Storm event sampling should take place for each precipitation event that causes a doubling of discharge at the USGS Happy Isles Gage. In the case where a storm follows an extended dry period, one may wish to collect a sample prior to the point at which the discharge has doubled. During large storm events that last many days, two sample sets should be collected as the discharge increases.

Tuolumne River

Three frontcountry (accessible by vehicle) and two backcountry sites will be sampled monthly between June and October. The Budd Creek site is equipped with an autosampler to capture storm events during the summer. The Budd Creek and Twin Bridges sites are sampled bimonthly from December through April.

Nutrients (dissolved nitrogen species, total phosphorous and total dissolved phosphorous) will be sampled at all sites. Petroleum hydrocarbons will be sampled monthly during the summer at the Budd Creek site only. *Escherichia coli* (*E. coli)* bacteria will be sampled at all sites. All sampling and sample hold times will conform to published USGS and EPA procedures.

Table B.1.4 Represents the Water Quality Sampling Locations

Sampling Location [Latitude, Longitude, Elevation, (NAD27 Datum)]	Sampling Schedule
Merced River at Merced Lake, below High Sierra Camp 37° 44’ 119° 25’ 7,200 ft	Monthly between June 15 and October 15
Merced River at top of Nevada Fall (below Little Yosemite Valley 37° 43’ 119° 31’ 5,920 ft	Monthly between June 15 and October 15
Merced River in Yosemite Valley at Happy Isles Gaging Station 37° 43’ 119° 33’ 4,016 ft	Monthly and during rainfall-generated high flows (e.g. summer thunderstorms)
Merced River in Yosemite Valley at Pohono Bridge 37° 43’ 119° 39’ 3,862 ft	Monthly and during rainfall-generated high flows (e.g. summer thunderstorms)
Merced River in El Portal at Foresta Bridge 37° 40’ 119° 48’ 1,640 ft	Monthly and during rainfall-generated high flows (e.g. summer thunderstorms)
South Fork Merced River in Wawona at Swinging Bridge 37° 32’ 119° 37’ 4,180 ft	Monthly and during rainfall-generated high flows (e.g. summer thunderstorms)
South Fork Merced River in Wawona below Wawona campground 37° 33’ 119° 37’ 3,860 ft	Monthly and during rainfall-generated high flows (e.g. summer thunderstorms)
Dana Fork below Gaylor Creek 37° 52' 45" 119° 18' 07" 9,230 ft	Monthly June – October and bimonthly December – April
Lyell Fork above Twin Bridges 37° 52' 05" 119° 19' 30" 8,670 ft	Monthly June – October and bimonthly December
Tuolumne River above Hwy 120 Bridge 37° 52' 34" 119° 21' 14" 8,580 ft	Monthly June – October and bimonthly December
Tuolumne River above Budd CK Confluence 37° 52' 34" 119° 22' 59" 8,610 ft	Monthly June – October and bimonthly December. Autosampler used to capture summer storm events.
Tuolumne River below Conness CK Confluence 37° 54' 33" 119° 25' 09" 7,870 ft	Monthly June – October and bimonthly December

At each sampling location, field measurements will also be recorded. These include water and air temperature, pH, specific conductivity, and dissolved oxygen. River stage or discharge will also be recorded where feasible. Nutrients will be sampled at the flow centroid when and where possible. Otherwise, a grab sample taken from the bank where the thalweg is accessible will suffice.

Hydrocarbons and *E. coli* will be sampled as grab samples due to sampling requirements. Field replicates and blanks will be prepared according the requirements for each analyte.

Field staff will properly store and ship water samples within 24 hours or as soon as possible such that the samples remain below 4°C until analysis takes place. All field forms, calibration forms, and chain-of-custody forms will be photocopied and stored according to protocol. All equipment problems should be documented and addressed immediately.

What follows is a detailed description of monthly sampling. Event sampling is much smaller in scope due to time restrictions. At the end of this section are two Quick Guides to sampling: 1) monthly and 2) event. Once the more detailed information is learned, one can simply take the quick guide to the field as a reference.

Before Going to the Field**:**

- Confirm with the El Portal Waste Water Treatment Plant laboratory that they will be expecting to receive samples that day. Ideally, all sampling trips should be scheduled at least one month ahead of time.
- Calibrate and check pH, conductivity, and dissolved oxygen (DO) meters according to the calibration methods discussed above. Record this data on the Calibration/Check form and place in binder. Calibrating the conductivity and pH meters once per sample day is sufficient. The DO meters should be calibrated and checked at each sample site. This procedure will be reviewed as sampling progresses to assure proper meter calibration.
- Gather bottle sets, gloves, collection device, meters, forms, cooler, and blue ice. Use at least one blue ice block per sample set to assure the samples remain at or below 4°C.

Sampling Technique Overview:

For each site, there should be a designated sampling location. The sample should be representative of the whole river at this location so collect the sample from water moving downstream, possibly in a location where the thalweg impacts the river’s edge. Time constraints dictate the collection of a centroid sample (depth-integrated) where possible and a grab sample in other locations. When possible, dual sets of samples (centroid or Equal-Width Interval and grab) should be collected to assess their relative differences.

In general, collect the samples before making field measurements to avoid contamination of the site. Also, when possible, collect samples starting at the most downstream location and working upstream to avoid contamination due to sampling activities. Wear a new set of gloves at each site. Sample upstream of bridges to avoid contamination from the bridge. (Except in the case of Foresta Bridge, where grab samples are more safely collected below the bridge.) For each grab sample, open the bottle and plunge beneath the water surface about 1.0 feet and move the mouth upstream until the container is nearly full. If wading, collect the sample upstream of you. If water depth is less than 1.5 feet deep immerse the sample bottle one third of the depth. Cap the bottle and label properly. Once the samples have been collected, place the pH, conductivity, temperature, and DO probes (or multi-probe) in the water to equilibrate. Take field readings. In order to expedite *E. coli* sample transport to the laboratory and to minimize the potential for contamination, sample processing (acidification, filtration, documentation) should be delayed until back in the laboratory.

Table B.1.5 Represents the Sample Processing Requirements

Bottle Number	Analyte(s)	Collection Method	Container	Preservation
1	Dissolved	Grab	125 ml brown	Filter within 2-3 hours using 0.45 µm filter; chill to

	Nitrogen and Phosphorous Species		plastic (FCC)	4°C. Hold time = Ship as soon as possible
2	Total Phosphorous	Grab	125 ml clear plastic (WCA)	Acidify with 1 ml 4.5 N H_2SO_4; chill to 4°C Hold time = 28 days
3	E. coli	Grab	Container provided by lab	Chill to 4°C Hold time = 6 hours
4	Total Petroleum Hydrocarbons	Grab	Baked borosilicate glass 1000ml	Chill to 4°C Hold time = Ship as soon as possible

Specific Tasks for Each Sample Site:

A. Collect *E. coli* sample

B. Collect dissolved nitrogen sample

C. Collect total phosphorous sample

D. Collect total petroleum hydrocarbon sample (at Pohono, Foresta, below Wawona Campground, and Budd Creek sites only). See operational plan.

E. Collect quality control sample(s)

F. Collect field measurements

A. *E. coli* Sampling Protocol (USGS National Field Manual for the Collection of Water-Quality Data (NFM), Chapter 7). Never pre-rinse the sample container. When submerging the sample container, take care to avoid contamination by surface scums. The surface film is enriched with particles and bacteria not representative of the water mass. *E. coli* samples will always be collected as grab samples**.**

1. Establish a consistent sampling location at each site, preferably where there is a consistent downriver current and enough depth to avoid collecting any sediment.
2. For each sample set, wear a new pair of exam (latex, nitrile, vinyl or similar) gloves.
3. Open the sample container and collect a sample from the surface, moving the bottle forward upstream until full. Always hold the mouth of the sample container upstream of the sampler and any disturbed sediments. Avoid contact with the sediment.
4. Place sample immediately in cooler. Fill out sample form.

B. Nutrient Sample - Total Dissolved Nitrogen Sampling Protocol (NFM, Chapter 5.2.1.A):

1. Collect a grab sample at a location where the thalweg impacts the bank.
2. For each sample set, wear a new pair of gloves.
3. Collect sample in a 1-liter Nalgene bottle that had been rinsed 3 times with deionized (not distilled) water. Rinse the bottle 3 times with river water before collecting the sample.
4. Filter the sample using a 0.45 μm filter. Note that filtering may take place in the field or back in the laboratory. Keep samples cold and in the dark.

5. Place samples immediately in cooler. Fill out sample form.
6. *(Note that the nitrogen and the phosphorous samples may be derived from the same 1-liter sample)*

C. Nutrient Sample - Total Phosphorous Sampling Protocol (NFM, Chapter 5.2.1.A):

1. Collect a grab sample at a location where the thalweg impacts the bank.
2. For each sample set, wear a new pair of gloves.
3. Collect sample in a 1-liter Nalgene bottle that had been rinsed 3 times with deionized (not distilled) water. Rinse the bottle 3 times with river water before collecting the sample.
4. Acidify the sample per directions from the laboratory.
5. Place sample immediately in cooler. Fill out sample form.
6. *(Note that the nitrogen and the phosphorous samples may be derived from the same 1-liter sample)*

D. Hydrocarbon/Petroleum Sampling Protocol (NFM, Chapter 5.4.2):

1. Sample at the same location as the *E. coli* sample. This sample will always be collected as a grab sample.
2. For each sample set, wear a new pair of gloves.
3. Open the sample bottle not touching the opening. Do not pre-rinse bottle. Plunge the bottle into the river fully below the surface facing the opening upstream. Move the bottle slowly forward under the surface until nearly full. Leave a small amount of head space.
4. Place sample immediately in cooler. Fill out sample form.

E. Quality Control Samples:

1. Field Replicate (Collect one replicate per sampling trip).
   a. Collect two separate nutrient samples at one location. Rotate sites at which a replicate is collected.
2. Filter or acidify as appropriate.
3. Field Equipment Blank (Collect one blank per trip).
   a. Rinse a 1-L sample bottle with DI water 3 times. Fill with DI water. This is the 'blank' nutrient sample. Transport bottle as you would other samples in the cooler.
   b. Once back at the laboratory, filter and acidify as if the sample were being processed for nitrogen and phosphorous species.

F. Field Measurements:

1. Measure temperature (air and water), specific conductivity, pH, and dissolved oxygen (DO). In addition make an estimate of the discharge (NFM Chapter 6). Record all calibration information on calibration forms and place in notebook.

Temperature:

- Measure the temperature at 5-10 cm beneath the water surface, approximately the same location where the samples were collected.

- Report the value to the nearest 0.2 °C.

Specific Conductivity:

- Immerse probe into the water at approximately the same location as where the samples were taken.
- Once it has stabilized, record the specific (temperature compensated) conductivity values to nearest tenth µS/cm.

pH:

- Immerse probe into the water at approximately the same location as where the samples were taken. Agitate the probe continuously.
- Once it has stabilized, record value to the nearest tenth of a pH unit.

Dissolved Oxygen:

- Calibrate the probe at each sample location.
- Immerse probe into the water at approximately the same location as where the samples were taken. Agitate the probe continuously.
- Once it has stabilized record value to the nearest 0.1 mg/L.

Discharge Estimate:

- At Happy Isles and Pohono Bridge use the USGS gaged flows. Note the time of your site visit and find the discharge later via the USGS web-sites: Happy Isles: http://nwis.waterdata.usgs.gov/nwis/uv/?site_no=11264500&agency_cd=USGS and Pohono Bridge: http://nwis.waterdata.usgs.gov/nwis/uv/?site_no=11266500 & agency_cd=USGS
- At Foresta Bridge, use the wire-weight gage to determine stage. Use the stage-discharge table for this site to determine discharge.
- For the Wawona sites, record the discharge from website: http://cdec.water.ca.gov/jspplot/jspPlotServlet.jsp?sensor_no=15500&end=&geom=&interval=&cookies=

QUICK GUIDE TO WATER QUALITY SAMPLING

(MONTHLY SAMPLING)

Before Field Day:

1) Charge MiniSonde Controller (turn on to assure charging; leave power on)
2) Print and copy on waterproof paper: field forms (12).and calibration forms (3). Make sure you have a chain of custody form (1) and Sampling Log (1). All forms are at MS01/EP Commons/VERP/Field Activities Commons/Water Quality/Forms. Note that some field forms have a back side with reference codes.
3) Assure you have 7 NWQL bottle sets (2 FCC, 1 WCA each), 2 1-L amber bottles, and at least 6 *E. coli* sample bottles. One bottle set is for Merced Lake.

4) Fill 5-gal DI bottle at El Portal Waste Water Treatment Plant (call El Portal Waste Water Treatment Plant @ 379-1828).
5) Verify that the waste water treatment plant is prepared to receive and process samples.
6) Fill a 1-L bottle with DI water for calibrating the DO when in the field.
7) Assure adequate supply of all calibration and check solutions standards.

Day 1 – Merced River (First Wednesday of the Month)

Before going into field:

1) One person needs to go to Nevada Fall. This person should take the calibrated handheld conductivity meter and a clean 1-L Nalgene bottle to collect the sample. Record the specific conductivity, water temperature, and time of collection. Process back at lab.
2) Assemble 6 *E. coli* sample bottles, 2 TPH brown glass bottle. Prepare cooler with blue ice in which to store 6 1-L bottles each in a zip-lock bag. You may want to prelabel these bottles for each site. One will be a replicate. Fill one 1-L bottle with DI water, place in plastic bag, and carry with other bottles during sampling. This is the equipment blank.
3) Clipboard with field forms, chain-of -custody form, calibration forms, and sample log form.
4) Calibrate multiprobe in laboratory. Calibrate pH (pH 7 and 4, check at pH 5.00), and conductivity (1000 uS/cm and check at 750 uS/cm). **Record all information on calibration form.**
5) Pack large monthly sample bin, DI Water, Hydrolab with cord and controller.

In the field:

1) Calibrate DO. Record on calibration form.
2) Collect grab sample for nutrient analysis. Cap sample bottle, label, and store for processing later. Collect one *E. coli* sample. Collect one TPH sample at specified sites on a quarterly basis. **Record TPH samples on TDI Chain-of-Custody Form.**
3) Measure pH, water and air temperatures, DO (mg/l), and conductivity at each site. **Fill out field form.**
4) Collect samples indicated in the following table. Following collection of the samples deliver *E. coli* samples to the El Portal Waste Water Treatment Plant.

Table B.1.6 Designates the Type of Sampling at Individual Monitoring Sites

Site	NWQL Sample	Total Pet Sample	*E. coli* Sample	Measure Stage
Happy Isles (HB204)	**1**	**0**	**1**	**Online or in field.**
Pohono Bridge (HB317)	**1**	**1**	**1**	**Online or in field.**
Foresta Bridge (NP184)	**1**	**1**	**1**	**Wire weight gage on bridge.**
Below Wawona Campground (NP187)	**1**	**1**	**1**	**Gage in river near golf course (use binoculars).**
Swinging Bridge (NP185)	**1**	**0**	**1**	**Gage in river near golf course (use binoculars).**
Above Nevada Fall (NP201)	**1**	**0**	**0**	
Replicate (any site)	**1**	**0**	**1**	
Blank	**1**	**0**	**0**	

5) **Fill out the Sampling Log Form as you go.**
6) Back at the lab, process NWQL Samples. Filter the sample for the 2 FCC bottles (125 ml brown bottle). Acidify an unfiltered sample in the WCA (125 ml clear bottle). Rinse bottles three times before filling. Label and chill immediately. **Change filters between samples. On the USGS Field form check analyses 2754, 1979, 2333, 2331, and the alkalinity, pH, and SC analyses.**
7) Process the replicate sample as above.
8) Process one blank sample (use DI water for 2 FCC and 1 WCA).
9) Check the multimeter pH probe using pH 5.00 solution. Check conductivity probe using 750 uS/cm solution. **Record these values and solution temperature on the Calibration Form.**
10) Rinse multimeter. Place a small amount of *tap water* in the calibration cup for storage. Unplug cord and cap conductors for protection.
11) Make copies of all field forms and calibration forms. Verify that each sample bag has the proper field form. Include calibration forms in a separate plastic bag.
12) Store all equipment properly. Rinse all filtering equipment and bottles and allow to air dry before storage.

Day 2 – Tuolumne River (second Wednesday of each month, June – October)

Before going into field:

1) One person needs to go to Glen Aulin to the Tuolumne River below Conness Creek site. This person should take the calibrated handheld conductivity meter and a clean 1-L Nalgene bottle to collect the sample. Also collect an *E. coli* sample. Record the specific conductivity, water temperature, and time of collection. Process back at lab.

2) Assemble 6 *E. coli* sample bottles, 2 TPH brown glass bottle. Prepare cooler with blue ice in which to store 6 1-L bottles each in a zip-lock bag. You may want to prelabel these bottles for each site. One will be a replicate. Fill one 1-L bottle with DI water, place in plastic bag, and carry with other bottles during sampling. This is the equipment blank.
3) Clipboard with field forms, chain-of-custody form, calibration forms, and sample log form.
4) Calibrate multiprobe in laboratory. Calibrate pH (pH 7 and 4, check at pH 5.00), and conductivity (1000 uS/cm and check at 750 uS/cm). **Record all information on calibration form.**
5) Pack large monthly sample bin, DI Water, Hydrolab with cord and controller.

In the field:

6) Calibrate DO. Record on calibration form.
7) Collect grab sample for nutrient analysis. Cap sample bottle, label, and store for processing later. Collect one *E. coli* sample. Collect one TPH sample at specified sites on a quarterly basis. **Record TPH samples on TDI Chain-of-Custody Form.**
8) Measure pH, water and air temperatures, DO (mg/l), and conductivity at each site. **Fill out field form.**
9) Collect samples indicated in the following table. Following collection of the samples deliver *E. coli* samples to the El Portal Waste Water Treatment Plant.

Table B.1.7 Designates the Types of Sampling at Individual Monitoring Sites

Site	NWQL Sample	Total Pet Sample	*E. coli* Sample	Measure Stage
Dana Fork below Gaylor Creek (NP 235)	**1**	**0**	**1**	
Lyell Fork above Twin Bridges (HB 269)	**1**	**0**	**1**	
Tuolumne River above Hwy 120 bridge (NP 238)	**1**	**0**	**1**	**Read gage on bridge**
Tuolumne River above Budd CK Confluence (NP 237)	**1**	**1**	**1**	
Tuolumne River below Conness CK Confluence (NP 239)	**1**	**0**	**1**	
Replicate	**1**	**0**	**1**	
Blank	**1**	**0**	**0**	

10) **Fill out the Sampling Log Form as you go.**
11) Back at the lab, process NWQL Samples. Filter the sample for the 2 FCC bottles (125 ml brown bottle). Acidify an unfiltered sample in the WCA (125 ml clear bottle). Rinse bottles three times before filling. Label and chill immediately. **Change filters between samples. On the USGS Field form check analyses 2754, 1979, 2333, 2331, and the alkalinity, pH, and SC analyses.**
12) Process the replicate sample as above.
13) Process one blank sample (use DI water for 2 FCC and 1 WCA).
14) Check the multimeter pH probe using pH 5.00 solution. Check conductivity probe using 750 uS/cm solution. **Record these values and solution temperature on the Calibration Form.**
15) Rinse multimeter. Place a small amount of *tap water* in the calibration cup for storage. Unplug cord and cap conductors for protection.
16) Make copies of all field forms and calibration forms. Verify that each sample bag has the proper field form. Include calibration forms in a separate plastic bag.
17) Ship NWQL samples as soon as possible using overnight FedEx to Dave Clow (forms are in lab). Use plenty of blue ice. Ship TPH samples as soon as possible using overnight FedEx to Dr. Thomas McDonald at TDI Brooks.
18) Store all equipment properly. Rinse all filtering equipment and bottles and allow to air dry before storage.

QUICK GUIDE TO WATER QUALITY SAMPLING

(EVENT SAMPLING on Merced River)

1) Weekday: Call the El Portal Waste Water Treatment Plant 379-1828 to tell them you are coming with 5 E. coli samples. Tell them approximately what time you will arrive.

   Weekend: Do not collect E. coli samples.

2) Gather bottles sets, forms, two coolers, and blue ice:
   a. 7 WCA (clear 125 ml bottles + acid)
   b. 7 FCC (brown 125 ml bottles)
   c. 6 *E. coli* sample bottles
   d. 2 amber glass bottles (total petroleum hydrocarbons) + 1 spare in case one is broken
   e. Forms: 1 chain-of-custody TDI form, 1 sample log form, 1 calibration form, 7 field forms (all on waterproof paper)

3) Collect field items:
   a. Big black Tuff box: orange vests, towels, lifejacket, grab sample bottles (1-liter) with labels (6), ziplock bags, *E.coli* sample bottles, gloves, conductivity meter
   b. One cooler and blue ice for samples
   c. Clipboard – all forms, example forms, calibration instructions
   d. Binoculars – for the Wawona staff gage by the golf course
   e. Prepare one 1-L bottle filled with DI water. Carry this bottle with the other samples. This is the field equipment blank.

4) Calibrate meter – use simple Oakton meter for specific conductivity and temperature only. Calibrate with 1000 uS/cm solution or equivalent and check using 750 uS/cm solution or equivalent.

5) Sample sequence (collect one replicate sample at any site):
   a. Swinging Bridge— *E. coli*, FCC, and WCA (collect 2 1-L bottles of river water, 1 sample and 1 replicate)
   b. Wawona Campground— *E. coli*, TPH, FCC, and WCA
   c. Happy Isles Bridge— *E. coli*, FCC, and WCA
   d. Pohono Bridge— *E. coli*, TPH, FCC, and WCA
   e. Foresta Bridge— *E. coli*, TPH, FCC, and WCA

   [*E. coli* = Sample bottle for *E. coli*, TPH = Total Petroleum Hydrocarbon (1L bottle), FCC = Filtered Chilled (125 ml brown), and WCA = Whole water acidified (125 ml clear)]

6) At each site:
   a. Note stage **(try to collect sample at location in main current where it is safe to do so)**
   b. Collect *E. coli* sample -- (no rinsing!)
   c. Collect TPH using 1-L amber bottle— (no rinsing!)

d. Collect one liter of water in plastic bottle for FCC and WCA (rinse 3 times)

e. Label bottles with date, time, and sample location

f. Measure temperature, conductivity

g. Finish field form(s)

h. Store samples in cooler

Immediately following collection of last sample at Foresta Bridge, take E. coli samples to the El Portal Waste Water Treatment Plant.

7) Back at the lab:

a. Filter samples for FCC bottles

b. Acidify sample for WCA bottles

c. Label all bottles with site name, number, date, time

d. Finish field form

e. Process replicate sample as others, label as such, and fill out separate field form, place sample in separate bag

f. Process field equipment blank as others, label as such, and fill out separate field form, place sample in separate bag

g. Copy field forms

h. Place original waterproof field forms with their respective samples

i. Check calibration of the meter using 750 uS/cm solution or equivalent

j. Copy calibration form. Place a copy with the samples (in a separate bag). Mail with samples sent to Dave Clow at the USGS.

k. Complete sample log form

l. Refrigerate samples

m. Place all copies of forms in the Visitor Use and Impact Monitoring Drawer at the Physical Sciences Office.

8) Mail nutrient samples to Dave Clow and total petroleum hydrocarbons to Dr. Thomas McDonald as soon as possible. Send in a cooler with plenty of blue ice. If after 12:00 p.m. on Thursday, mail the following Monday so samples don’t sit over the weekend.

QUICK GUIDE TO WATER QUALITY SAMPLING

(EVENT SAMPLING at Autosampler at Budd Creek)

As soon as possible following an event, collect samples from the autosampler.

Gather bottle sets, forms, two coolers, and blue ice:

a) 5 WCA (clear 125 ml bottles + acid)

b) 5 FCC (brown 125 ml bottles)

c) 5 Field forms (all on waterproof paper)

2) Collect field items:

a) Big black Tuff box: orange vests, towels, lifejacket, grab sample bottles (1-liter) with labels (5), ziplock bags, gloves. Triple rinse 1-liter bottles with DI water and bag each separately.

b) One cooler and blue ice for samples

c) Clipboard – all forms, example forms

d) 5-L bottle of DI water

3) At the site, first download the datalogger and inspect stage and event data. If more than one sample was collected, collect all samples up to a maximum of 5 per event. If there are more than 5 samples, try to select 3 from the rising limb and 2 from the descending limb. Decant samples into pre-rinsed 1-L bottles and store in cooler. Empty unused autosampler bottles.

4) Triple rinse all autosampler bottles with DI water and place back in autosampler.

5) Reset autosampler so that the first sample bottle is #1.

6) Back at the lab:

a) Filter samples for FCC bottles

b) Acidify sample for WCA bottles

c) Label all bottles with site name, number, date, time

d) Finish field form

e) Copy field forms

f) Place original waterproof field forms with their respective samples

g) Complete sample log form

h) Refrigerate samples

i) Place all copies of forms in the Visitor Use and Impact Monitoring Drawer at the Physical Sciences Office.

7) Mail nutrient samples to Dave Clow. Send in a cooler with plenty of blue ice. If after 12:00 p.m. on Thursday, mail the following Monday so samples don’t sit over the weekend.

Quality Control:

Quality control (QC) of field measurements and sample integrity are outlined in this section. In general, at least one set of QC samples and one set of duplicate field measurements should be taken per sampling trip (one per the eight front-country sites and two back-country sites). In addition, one field blank should be processed per sampling trip.

Sample Replicates (Once per Sampling Trip):

For nutrients (nitrogen species and total phosphorous) collect sample replicates at one site per sampling event. Process both samples as normal, labeling one as the replicate sample.

For the *E. coli* sample, a replicate will be prepared in the laboratory. This should be the same sample location as the replicate sample for the other analysis. Standard laboratory positive and negative tests should be reported for each sample batch.

For the total petroleum hydrocarbon sample, the laboratory conducting the analysis will perform quality assurance.

Field Equipment Blanks (One per Trip):

Process one sample set using DI water in exactly the same way as a normal river water sample. Rinse a 1 L bottle with DI water three times. Fill with DI water. Fill the total phosphorous bottle from this “sample” bottle. Acidify the sample and store as normal. Filter the “sample” water into a dissolved nitrogen species bottle following normal filtration protocols. Store and label as normal.

Repeated Field Measurements (Once per Trip):

Repeat field measurements of temperature, pH, conductivity, and dissolved oxygen once per sampling trip. If taking measurements from a bridge, take the first set of readings as normal. Remove sensors from the water and rinse thoroughly with DI water and return to the same location as the first set of readings. Record these readings in the space provided on the field form.

External Audit Samples:

None scheduled at this time.

B.1.4 Equipment Maintenance

The following is a schedule and procedural guide to maintenance of water monitoring field equipment.

Daily (After Sampling):

Buffers and Standards Solutions:

- Store buffers and standards solutions according to manufacturer’s directions. Some solutions may have to be refrigerated when not in use.
- Check the expiration dates and order new solutions well in advance. Do not use expired solutions.

Sample Bottles and Collection Devices:

- Rinse all sampling devices (bottles, caps, nozzles, filtering systems, and tubing) with DI water after each sampling day. **Do not use soap.** Store in clean zip-lock bags or a clean dust-free container.
- Inspect sampling bottles regularly for scratches or other damage. Do not use bottles that are excessively scratched as these may be difficult to clean.

Annually (January or February):

Buffers, Standards Solutions, and Other Chemicals:

- Order sufficient buffer and standards solutions for the coming year. This includes pH 4.00, 7.00, check solution and conductivity standard and check solutions.
- Order sufficient acid and methanol.

Sample Bottles and Collection Devices:

- Inspect sampling bottles regularly for scratches or other damage. Do not use bottles that are excessively scratched as these may be difficult to clean.
- Order new sample bottles if necessary.

Hydrolab MiniSonde 4a

Follow this schedule for minimum maintenance. This schedule has been developed from the record of instrument performance and consultation with the manufacturer.

After Each Sampling Trip:

These are important steps in preventive maintenance that are done each day the instrument is used.

- Post-calibrate the instrument before general cleaning and maintenance.
- Following post-calibration, rinse off the sensors and store them in *tap water*. Do not use deionized or distilled water for storage.
- Keep the water-tight rubber cable connectors well lubricated and dry on the inside. The best procedure is to store the instrument with all connectors separated and open to the air until dry.
- Check rubber cable connectors regularly to ensure that the mated surfaces are covered with a thin film of white silicone.
- As necessary, use some tissue paper to remove old traces of silicone and dirt and then reapply the silicone.

Before Calibrating:

Clean off the sensors. Use a cotton pad and methanol. Cotton swabs or gauze pads are the only materials that will not scratch the soft glass of the pH probes. Paper, including lens paper, is not suitable.

Conductivity:

Every two months or once every 15 field trips clean the conductivity sensor with a Q-tip soaked with methanol.

pH:

Every two months or once every 15 field trips:

- Wipe the pH probe with a Q-tip soaked in methanol.
- Replace the solution in the pH reference sleeve with a standard electrolyte (3.5 molar KCl saturated with silver chloride).
- Clean the plastic reference probe sleeve and fitted end piece inside and out with a Q-tip soaked in methanol.
- Rinse everything with deionized water before filling and reassembling.
- Always apply a thin layer of silicone to the O-rings.
- When replacing the sleeve, point the sensor down and push the sleeve up until it just covers the O-ring, then point the sensor up and continue to push the sleeve all the way to the base of the probe. This will purge air out of the sleeve and force electrolyte through the Teflon junction.
- Inspect the reference sleeve for air bubbles by observing the sensor while inverting the Sonde. If bubbles are present, repeat the filling procedure.
- Place the instrument sensor upright and fill the reference sleeve with solution until overflowing. As the Teflon junction is screwed in place observe electrolytes coming through.

Every 12 Months:

- Replace Teflon junctions on pH reference sleeve.
- Store spare junctions in a 2 to 5 molar (> 50,000 µmhos/cm) KCl solution.
- Inspect the O-ring at the bottom of the Teflon junction and at the base of the reference sleeve. Replace them if they appear flattened or have small nicks or cuts.

pH Troubleshooting:

If pH still doesn't calibrate correctly, do the following:

- Evaluate the condition of the Teflon junction on the terminal end of the pH reference sleeve. The sleeve should slide on easily with some force applied. If the sleeve is difficult to apply, then the junction may have become clogged. In contrast, if the sleeve slides on too easily with little resistance, the junction is too porous. In both instances the junction must be replaced.
- If replacing the junction does not solve pH problems, then clean the probe by alternately soaking it in 0.1 N HCl (hydrochloric acid), and then in 0.1 N NaOH (sodium hydroxide) five minutes in each solution. Use the small black caps that protect display unit terminals to isolate the probes for soaking with these solutions.

Safety Note: Wear safety glasses and gloves when working with the corrosive chemicals.

Batteries:

Every two months or once every 15 field trips:

- Review the calibration and replacement schedule for batteries.
- Recharge the 6-volt NiCad Gelcell batteries (nickel-cadmium or nickel-metal hydride) for 12 to 24 hours, regardless of the voltage displayed by the instrument. Ensure that NiCad batteries are recycled or disposed of properly. They should not be put in the regular trash.

Stirrer:

Every two months or once every 15 field trips:

Remove the magnetic metal wheel from the stirrer post.

- Thoroughly clean all lubricant, dirt, and debris from the inside of the wheel and stirrer post with a paper towel and Q-tip.
- Reapply a very small amount of white silicone lubricant to the tip of the stirrer post.

Dissolved Oxygen:

Every six months or once every 15 field trips:

- Change the DO membrane and add fresh KCl solution.
- Invert the Sonde on a ring stand.
- Remove the guard, the O-ring, and the membrane. Shake out old electrolyte.
- Rinse DO cavity twice with deionized water and twice with DO electrolyte.
- Fill the cell with DO electrolyte and gently tap the side to release any trapped air bubbles.
- Replace the membrane and secure with the O-ring.
- Inspect the membrane for wrinkles or trapped air bubbles.

Whenever there is anything but a rapid and stable oxygen calibration, replace the membrane as a first step in troubleshooting. The new Teflon membrane is stretched during the replacement procedure. This affects the rate of diffusion for oxygen through the membrane to the internal sensing components. As the membrane relaxes, the rate of diffusion changes in an unpredictable manner. It is preferable to allow the membrane to relax overnight before calibrating. A minimum of 30 minutes must be allowed before the initial calibration.

If the gold cathode ring is discolored or tarnished, polish lightly with a lint-free cloth or pencil eraser. If the white ceramic post in the DO sensor is discolored (ages from white to gray to black):

- Clean with a 1:1 solution of household ammonia and deionized water.
- Remove the membrane from the sensor and pour out the electrolyte.
- Rinse with deionized water. Invert the Sonde on a ring stand and with a small eye dropper fill the cell with the ammonia solution until the white ceramic post is covered. Be careful not to get the solution on the gold anode ring. Have a moist towel close by when conducting this procedure so that the solution can be quickly wiped from the gold ring.
- Let stand for 10 minutes.

- Rinse twice with deionized water and refill according to the standard procedure described above.
- If it is necessary to use the DO probe before the new membrane has 12 hours to relax, carefully recalibrate the dissolved oxygen immediately before each set of measurements.
- **Sonde:** Every 12 months: Replace desiccant inside the display and Sonde units.

B.1.5 Data Management

Each sampling trip will generate field forms, calibrations forms, and chain-of-custody forms. In addition, there will be laboratory analysis of results. All information must be stored in a convenient and secure manner.

Sample Site Files:

Each sample site will have its own folder that will contain site metadata and all field forms. Field forms will likely be required to accompany the samples to the laboratory. Therefore, make copies of each before sending samples.

File the following items in the sample site file:

- Copy of field form
- Copy of the instrument calibration form that corresponds to field measurements taken at that location
- Copy of the corresponding chain-of-custody file(s)
- Copy of laboratory analysis results.

These files should be stored in a secure fireproof location.

Instrument Calibration Notebook:

All instrument calibration sheets should be stored in a 3-ring binder that is stored in the lab.

Instruments Maintenance Notebook:

All notes regarding instrument maintenance should be stored in a 3-ring binder and kept in the lab. This binder should be organized by instrument. Notes to be included are battery changes, maintenance performed in-house, and any manufacturer servicing of the devices.

Forms:

1. USGS Field Form (Figure B.1.2 and Figure B.1.3)
2. Instrument Calibration Form (Figure B.1.4)
3. Water Quality Sampling Log (Figure B.1.5)

AHRG Lab number (entered at login)

SITE INFO

Site Code (see list)

Site Name (see list)

New site (y / n)? if yes, enter new site info below

DATE INFO

Collection date

Collection time

Field Filtered?

If no, date/time filtered

BULK PRECIPITATION DATA (circle units)

Begin date

Begin time

Precip volume L / ml

LAKE DATA

Sampling depth ft / in m / cm

NEW SITE INFO (complete only for new sites)

Latitude/Longitude (or UTM, specify)

Elevation ft / m

Datum, method (GPS, digitizer)

Accuracy ft / m

County, State

FIELD DATA Circle units, below

Sample Type (see list)

If blank, note water lot#

Sample Method (see list)

Sampler Type (see list)

Filter lot #

Staff (1) @ hh:mm @ ft / in m / cm

Description

Staff (2) @ hh:mm @ ft / in m / cm

Description

Tape down @ hh:mm @ ft / in m / cm

Description

Sensor @ hh:mm @ ft / in m / cm

Description

Depth of water thru weir @ hh:mm @ ft / in m / cm

Discharge cfs / cms

Air temp. °C

Water temp. °C

Field S.C. µS/cm

Field D.O. mg/L

Susp. sediment collected? y / n

If yes, volume filtered L / ml

BOTTLES	# of each	**Preservation**	**lot #**
125 ml FA		filter, acidify in lab (0.5 ml Ultrex HNO_3)	
125 ml RU		none	
125 ml FU		filter	
125 ml FCC		filter, chill	
60 ml FCC		filter, chill	
125 ml DOC		filter, chill	
125 ml WCA		acidify in field (1 ml 5N H_2SO_4)	
PETG (mercury)		acidify in field (5 ml Omnitrace HCl)	
1L or 2L RU (circle)		none	
15 ml vial (^{18}O)		none	
$^{34}S/^{32}S$		none	
Septums (dissolved gas)		none	
Other: specify			

PERSONNEL

Sampling team

Team lead signature

Date signed

PROJECT NAME **ACCOUNT # (if known)**

NOTES

ANALYSES	
AHRG Lab	Check
ICP	
IC Anions	
IC Cations	
alkalinity, pH, SC	
DOC	
NWQL	
HBN (schedule 1671)	
VERP (schedule 2027)	
TDN (lab code 2754) (FCC)	
Total N (lab code 2756) (WCA)	
Nitrate (lab code 1979) (FCC)	
Ammonia (lab code 3116) (FCC)	
ortho-P (lab code 3118) (FCC)	
TDP (lab code 2331) (FCC)	
Total P (lab code 2333) (WCA)	
Other:	
Other:	
Other:	

FieldForm; modified 12/6/07

Figure B.1.2 USGS Field Form (front)

Sample Type	Description
S	Streamwater
R	Springwater (eg., talus springs)
G	Groundwater (eg., wells)
B	Bulk precipitation
W	Wet-only precipitation
P	Snowpack
O	Lake Outflow
E	Lake Epilimnion
H	Lake Hypoliminion
F	Field Blank
K	Lab Blank

Sample Method	Description
M	Grab
E	EWI
A	Autosampler
R	Replicate
B	Blank
W	Weir
G	Gage
C	Composite
30	Centroid

Sampler Type
(surface water samples)
1L or 2L bottle
DH81
Autosampler
(precipitation samples)
Carboy
Funnel
Aerochem
Shovel/scoop

Site Info Site Code	Site Name
HB259	Merced River below Merced Lake
HB201	Merced River above Nevada Fall
HB204	Merced River above Happy Isles Bridge
NP182	Merced River above Sentinel Bridge
HB317	Merced River above Pohono Bridge
NP183	Merced River above SR140 Bridge
NP184	Merced River above Foresta Bridge
NP185	S. Fork Merced River above Swinging Bridge
NP186	S. Fork Merced River above South Fork Bridge
NP187	S. Fork Merced River below Wawona Campground
NP235	Dana Fork below Gaylor Creek
HB269	Lyell Fork above Twin Bridges
NP238	Tuolumne River above Hwy 120 Bridge
NP237	Tuolumne River above Budd Creek
NP239	Tuolumne River below Conness Creek

Figure B.1.3 USGS Field Form (back)

Date: ____________________

Analysts: ____

Instrument (circle one):

Hydrolab MiniSonde 4a serial# 040900071937

Oakton Con400 serial# 161539

Other:____

pH

Time ____________

1st Level Calibration: **pH 7.0** @ _____°C; Mfr/Lot# __________________Exp. Date______

2nd Level Calibration: **pH 4.0** @ _____°C; Mfr/Lot# __________________Exp. Date______

Calibration Check: (true value) **pH 5.0**; Mfr/Lot# ____________________Exp. Date_____

Initial Calibration Check (measured): pH _____ @ ______°C

Diff <0.2 units? Cal. accepted by (initials/date/time): ________________

Continuing Calibration Check (measured): pH _____ @ ______°C

Diff <0.2 units? Cal. accepted by (initials/date/time): ________________

Conductivity

Time ____________

1st Level Calibration: **991 µS/cm** @ _____°C; Mfr/Lot#________________Exp.Date______

Calibration Check: (true value) **717 µS/cm**; Mfr/Lot#_________________Exp.Date______

Initial Calibration Check (measured): ________ µS/cm @ ______°C

Diff <5%? Cal. accepted by (initials/date/time): _______________

Continuing Calibration Check (measured): ________ µS/cm @ ______°C

Diff <5%? Cal. accepted by (initials/date/time): _______________

Dissolved Oxygen

Calibrations at each site:

Time _______ Barometric Pressure _____________ (mm Hg) Temperature ___________°C

Time _______ Barometric Pressure _____________ (mm Hg) Temperature ___________°C

Time _______ Barometric Pressure _____________ (mm Hg) Temperature ___________°C

Time _______ Barometric Pressure _____________ (mm Hg) Temperature ___________°C

Time _______ Barometric Pressure _____________ (mm Hg) Temperature ___________°C

Figure B.1.4 Instrument Calibration Form.

Site Name	Site Code	Date	Time	Samples Collected (Number) FCC	WCA	1-L TPH	Fecal Coliform
Merced River Above Happy Isles Gaging Station	HB204						
Merced River Above Pohono Bridge	HB317						
Merced River Foresta Bridge	NP184						
S. Fork Merced River Above Swinging Bridge	NP185						
S. Fork Merced River Below Wawona C.G.	NP187						
Dana Fork below Gaylor Creek	NP235						
Lyell Fork above Twin Bridges	HB269						
Tuolumne River above Hwy 120 Bridge	NP238						
Tuolumne River above Budd Creek	NP237						
Tuolumne River below Conness Creek	NP239						
FCC - Filtered, Chilled, Integrated							
WCA - Unfiltered, Acidified, Integrated							
1-L TPH - Amber Glass Bottle, Acidified, Total Petroleum Hydrocarbons, Grab Sample							
Fecal Coliform - 100ml Whirl Pak, Grab Sample							

Site Name: ____

Date: _________________________

Site Location: UTM ____________ E ______________N Datum NAD27 NAD83

Lat/Long ______ N ______ W

Site Elevation: _______________ meters feet

USGS Site Number: ____________________________

Other Relevant Site Numbers ____

Site Description:

Figure B.1.5 Water Quality Sampling Log

Data entry:

As soon as is feasible, a record of the sampling event should be recorded in the Visitor Use and Impact Monitoring water quality database. Enter one new record for each sample location as well as one record for the duplicate sample and one record for the field blank. Once laboratory data becomes available, this too should be entered into these records.

Data analysis:

Data analysis consists of first checking data against all hard copy field forms and laboratory results. Once this is complete, data should be censored to exclude duplicates, blanks, and values below detection limits. For each site, prepare a summary plot of all concentrations of each analyte (total dissolved nitrogen, nitrate plus nitrite, total dissolved phosphorous, total phosphorous, E. coli, and total petroleum hydrocarbon) or report in the form of a table. Summary statistics (mean, standard deviation, maximum, and minimum) should be prepared for field parameters such as water temperature, specific conductivity, pH, and dissolved oxygen. This summary data will be reported as a part of the Visitor Use and Impact Monitoring Annual Report. In the annual report, notable findings should be mentioned as well as any exceedance of existing water quality standards.

B.1.6 Personnel Requirements and Training

Roles and Responsibilities (tasks and time commitments):

Yosemite National Park, through the Division of Resource Management and Science will be responsible for the administration of this monitoring plan. Management of this project will be conducted by the branch chief of Physical Sciences and GIS within the division of Resources Management and Science. Responsibilities are:

- Preparation of an annual implementation plan and budget
- Training of field personnel
- Purchase and maintenance of field equipment
- Review of data and procedures
- Maintenance of data, field forms, equipment repair and maintenance logs, and updating protocols

Preparation of an Annual Implementation Plan and Budget:

The annual plan should include a sampling schedule, the laboratory(s) used, anticipated personnel needs and time. There should be a comprehensive list of equipment, repair or calibration needs, and a list of disposables such as calibration and check solutions. A budget should be included. If possible, there should also be a summary of the previous season's problems and possible solutions. This plan provides a record of data gathering activities.

As each new or returning technician enters on duty, they should receive comprehensive training on field and office water sampling procedures. The project manager should document this training for each technician for each season.

The project manager or a designated technician should be responsible for ordering new equipment and consumables, repairing or calibrating existing equipment (beyond routine actions), maintaining a supply of fresh buffers and calibration solutions, and maintaining a log of all equipment repairs.

Every two months, the project manager should review the laboratory data and the QC sample data in particular. This information, coupled with discussions with field staff, should be used to review or modify procedures to improve data quality.

All field data forms should be photocopied and stored as office copies or archive copies. Office copies are photocopies of the originals and are intended as an operational reference. Original data forms, chain-of-custody forms, and calibration forms should be stored as archives in a fire-safe location.

Each instrument should have a logbook to document calibrations, repairs, and factory calibrations. As sampling protocols are modified, former protocols should be archived with the dates that they were in effect.

Training procedures:

Each technician collecting water samples and field data associated with this project must have demonstrated the following:

The ability to calibrate and operate conductivity, pH, and dissolved oxygen (DO) meters.

- Proper sample collection, preservation, and handling.
- A safety conscious approach to field work around rivers.
- Knowledge of proper documentation procedures.

These skills may be verified through assisting a qualified technician or by a means deemed satisfactory to the branch chief for Physical Sciences and GIS. This training should be documented at least once a year for each technician.

B.1.7 Operational Requirements

Work plan:

Monthly sampling will be conducted on the first Tuesday and Wednesday of the month except December and February. Event samples should be collected as soon as is feasible. Spring runoff samples are to be collected weekly for a period of 8-10 weeks following that start of spring runoff.

Safety:

A job hazard analysis (JHA) has been completed**.** See job hazard analysis table below (

Table B.1.8 Job Hazard Analysis for Water Quality Data Collection).

Table B.1.8 Job Hazard Analysis for Water Quality Data Collection

United States Department of Interior NATIONAL PARK SERVICE	1. WORK PROJECT/ACTIVITY	2. LOCATION	
	Water Quality Sampling	Main Stem and South Fork Merced River	
Job Hazard Analysis (JHA)	**3. NAME OF ANALYST**	**4. JOB TITLE**	**5. DATE PREPARED**
	Laura Clor	Technician	April, 2005
6. TASKS/PROCEDURES	**7. HAZARDS**	**8. ABATEMENTS ACTIONS** ENGINEERING CONTROLS – SUBSTITUTION – ADMINISTRATIVE CONTROLS – PPE	
a. Driving to, from, and around sampling sites.	a. Collision resulting in damage, injury, or death.	a. Drive defensively, obey traffic laws, lights on, seatbelt on, be alert for pedestrians, wildlife, and distracted drivers. Know procedures for installing snow chains. Always carry and know how to use a Park radio.	
b. Using bridge board and leaning out over bridge railings to lower/retrieve sampler.	b. Back injury due to lifting heavy DH-95 sampler, falling from bridges into water, injury due to loss of control of bridge board as heavy sampler drops from bridge into a suspended position.	b. Use proper lifting techniques to prevent back strain, employ a second person to aid in lifting or to serve as a spotter for the lifter, a third person should stand on the bridge board foot pegs to anchor it firmly to the ground.	
c. Carrying DH-95 sampling device to and from bridge locations.	c. Back strain or other injury.	c. Stop to rest, lift with legs rather than back, and use two people to carry for longer distances.	
d. Working on bridges.	d. Accidents and injury resulting from being hit by a car.	d. Wear orange safety vests, be cautious of traffic.	
e. Wading in river to collect samples.	e. Tripping, falling or being swept away due to slippery, uneven river bottom surfaces and strong currents.	e. Use extreme caution in watching footing, wear life vest, only wade if the water level/current strength is low enough to permit it, collect sample from river edge if water is too high and/or swift.	
f. Working and walking along riverbanks.	f. Tripping and/or falling due to wet and slippery rocks or sloping ground surfaces, contact with poison oak, etc.	f. Watch footing, know how to identify and avoid all poison oak, rinse immediately in stream if contact occurs.	
g. Acidifying water samples with sulfuric acid.	g. Skin or eye contact resulting in irritation, rashes or chemical burns.	g. Use dropper bottle to minimize potential for contact, acidify samples at counter level, rather than holding up to eye level, flush immediately in lab sink if contact occurs.	
h. Working outdoors in cold and/or wet weather.	h. Hypothermia, reduced resistance to illness.	h. Stay dry. Use rubberized raingear if possible. Stay hydrated preferably with warm liquids. Stop work to warm up if necessary. Snack often.	
10. SUPERVISORS SIGNATURE	**11. TITLE**	**12. DATE**	

Equipment and materials: All equipment and materials are stored with the Branch of Physical Sciences and GIS. The lead technician and the park hydrologist are responsible for making sure that adequate supplies are available and in working order prior to each sample event.

B.2 RIVERBANK CONDITION

B.2.1 BACKGROUND

Riverbank condition has been selected as an indicator because soils and the vegetation that stabilizes them are integral to the integrity of riparian ecosystems. Although soil erosion occurs along a river as a result of natural river processes, such erosion can be accelerated and exacerbated by visitor use. Increasing visitor use on susceptible substrates often results in increased soil erosion. Therefore, this indicator is valuable for assessing a site's ability to sustain varying types and levels of visitor use as well as assessing the overall condition of riverbanks along a given segment of river.

Riverside soils and vegetation affect water quality by regulating the entry of groundwater, surface runoff, nutrients, sediments and other particulates, and fine and coarse organic matter to rivers and streams. Accelerated erosion associated with trampling and visitor access can alter these processes, leading to changes in hydrology and water quality.

In addition to indicating loss of soil, erosion may affect cultural Outstandingly Remarkable Values. The amount of riverbank erosion associated with visitor use will be used as an indicator of changes that may be occurring to any cultural resources—namely to archeological sites—that may exist along the river corridor. Riverbank soil erosion that occurs at archeological sites would suggest a potential loss of site stability and loss of intact archeological artifacts and features, critical components of archeological site integrity. Once artifacts and features are displaced from their original context or lost, the information inherent to those deposits is also lost.

Description of Indicator and Standard

Indicator:

Degree of riverbank erosion along the Merced River. This will be assessed through a combination of vegetative cover condition and substrate erosion condition characteristics.

Draft Standards:

1. Channel Morphology: No greater than 10 percent increase in cross-sectional area due to bank scour in 80 percent of sites.
2. Vegetation Condition (Trend): No greater than 10 percent cover of bare ground in 80 percent of sites. This trend will be determined using the 2008 data to reflect current condition as compared to future assessments. This will help determine our desired condition and to detect change.
3. Vegetation Condition (Status): No greater than 20 percent of (strata-based) sites will have less than C percent green understory cover.

Area of Interest:

Merced River in Yosemite Valley from Happy Isles Bridge to 1 km downstream of Pohono Bridge

Rationale for indicator

Riverbank erosion is accelerated by human trampling that causes loss of vegetation, compaction of soils, and loss of soil cohesion which are potential impacts to Outstandingly Remarkable Values of the river corridor.

Objectives

1) To assess the status of and to detect change in riverbank condition, and 2) identify a relationship between visitor use and riverbank condition in order to assess the relative contribution of visitor use to changes observed in the first objective. Our goals for the 2008 field season are to collect baseline data to ensure repeat measurability in future years. We have failed to find metrics in the available literature that meet the objectives of this particular indicator for formulating standards. Therefore, we hope to utilize the findings from our baseline and deliberately chosen index sites to assist in the development of standards that function best for our particular riverbank condition.

B.2.2 Sampling Design

Rationale for sampling design:

In order to achieve the objectives, we monitor factors that directly relate to riverbank erosion: 1) Channel morphology and 2) Vegetation cover on the banks. Sites are 200-meter reaches randomly chosen from a 17 km reach within Yosemite Valley such that inferences about the overall condition of riverbanks can be made. Next, we conduct a parallel study to determine a relationship between visitor use and riverbank condition. This study utilizes the same measures as the monitoring protocol, but we deliberately choose sites based on known levels of visitor use. Development of this relationship allows us to predict consequences of changing visitor use and helps us better understand variance due to factors besides visitor use in our randomly sampled sites.

The above methodology will be complemented by continuous digital photographs of each bank of the river from Happy Isles Bridge to the former site of the Cascades Dam. This qualitative data will assure that emerging impacts not captured by sampling are caught and addressed early. Such emerging impacts can be useful in determining future site selection for our index sites. These sites will complement our study in providing important information on the condition of sites on which we have additional visitor use information.

Measurement:

At each sample reach, vegetation condition along 100 meters of bank (both sides of the river) is evaluated as well as channel cross-sectional area. The condition of vegetation is assessed through a point-intercept sampling of functional vegetation groups (see field methods). Channel cross-sectional area is assessed by surveying three river cross-sections within the 200-meter reach. All monitoring locations will be marked with permanent site markers in order to accurately relocate and evaluate the same location every 3-5 years or following major flood events.

Continuous bank photography would involve using a high resolution digital camera and taking photos approximately every 50 meters along each bank or at such spacing as to allow stitching photos together without edge distortion. The resulting product would essentially be a long strip photo of the entire length of riverbank in Yosemite Valley.

Site selection (selection criteria and procedures):

Probabilistic Sample Design

For the first objective, we choose sample reaches from a sub-population of banks along the Merced River between Happy Isles Bridge and approximately 1 km downstream of Pohono Bridge. The population of all potential sites is reduced by eliminating sites with sinuosity greater than 1.1 and sites within 125 meters of bridges or other hardened banks (rip-rap, bedrock, or large boulders) longer than 50 meters. We then divide this subpopulation into two strata based on river slope: 1) Slope >= 0.005 and 2) Slope < 0.005 and make a sample site selection using a generalized random tessellation stratified (GRTS) spatially balanced design (Stevens Jr. and Olson, 2003, Stevens Jr. and Olson, 2004). This methodology allows us to make an ‘oversample’ or select many additional sites that will serve as replacement sites if some sites are rejected. Reasons for rejecting sites are discussed in the next paragraph.

The selected site represents a point at the middle of the 200-meter reach. Cross-sections are placed at 100 meters upstream of this point, at this point, and 100 meters downstream of this point. If any of the cross-sections grossly misrepresent the overall reach geometry, the site is rejected. Additionally, if a site is restored or protected through direct management action, it should be removed from the sample suite and replaced with another site.

Deliberately Chosen Sites

In order to meet the second objective we will deliberately select a number of index sites reflecting a known range of visitor use. The goal would be to develop a relationship between visitor use and riverbank condition that could be used to explain variance in the randomly selected sites as well as serve as a predictive tool for anticipated changes in visitor use. These sites will be subjectively chosen based on complementary information regarding visitation and use of these sites. Factors that will influence the selection of these sites will be access to parking, campgrounds as well as management zones and specific destination qualities of these sites (i.e. fishing holes, river put-ins, sandy beaches, etc.)

As a first step, we evaluate 9 random sites and 6 deliberately chosen sites in 2008. Data from these sites will help us determine the number of each type of site that will be required to meet this protocol’s objectives. If additional sites are required, those sites will be added in subsequent years. Through the utilization of the GRTS sampling program, we will pre-select a larger number of sites, and continue to sample as time and budget allows in order to achieve the best sample size available to us under the current conditions of this project.

Sampling Schedule:

Field work for this indicator is conducted in mid-August to mid-September, depending on accessibility due to river level. LiDAR scanning may be done later in October or November after the shrubs and trees have lost their leaves.

B.2.3 Field Methods

Site Selection

This year we will sample twelve new sites determined through the GRTS random sample method. After each site is pre-selected, observers will locate sites in the field and determine best locations for access and establishment of the baseline. Site safety will also be determined for each chosen location and sites that present obvious hazards will be eliminated from the sample.

Plot Set-Up

The following is a description of documenting and monitoring channel geometry using cross-sections and ground-based LiDAR; conducting vegetation assessments; and conducting photographic monitoring. The process of this intensive program is presented in a chronological order, and should be conducted as follows:

- FIRST: Locate sample reach.
- SECOND: Install river left cross-sections.
- THIRD: Install river left vegetation plots.
- FOURTH: Install river right cross-sections.
- FIFTH: Install river right vegetation plots.
- SIXTH: Survey cross-sections, collect vegetation assessment data and conduct photographic monitoring.
- SEVENTH: Conduct ground-based LiDAR.

FIRST: Locate Sample Reach

Equipment list:

- One 100-meter tape
- One 50-meter tape
- Four chaining pins
- Pin flags
- Pens/pencils/clipboard
- Documentation sheets
    - Site description template
    - Hand drawn map template
    - Photo documentation sheet
- Compass
- Digital camera, standard
- GPS unit
- Rebar, monument caps, mallet, and die set
- Sunscreen/water/lunch/personal gear
- Protocol and field instructions

Locate the sample reach and install the site benchmark on the **left bank**. To locate the sample reach, obtain accurate maps and air photos and use a GPS unit and compass to navigate to the midpoint of the reach. Field observers will be given the coordinates of a set of points representing each reach location (Figure B.2.1). Observers will need to download the coordinates onto a GPS unit and use this information to navigate to the corresponding point. It should be noted that the points are selected from the center of the river channel; observers should *not* enter the river. Rather, they should use the GPS unit and a compass to visualize the center point within the river channel. Next, determine the terrace location and the direction of river flow. The monument should be placed 3 meters from the terrace edge and perpendicular to river flow. This is the site benchmark, as well as the center cross-section left bank endpoint.

Note: to determine terrace location- consider break in slope as the edge of bank and terrace; compare the height of the opposite terrace; use the five year flood line as a guide; and if questions remain consult with the park hydrologist.

SECOND: Install cross section endpoints on River Left

Install 3 cross-sections: (1) at the site benchmark, (2) 100 meters upstream of the site benchmark, and (3) 100 meters downstream of the site benchmark (Figure B.2.1). The measurements are linear from mid-cross-section to endpoint cross-section; the measurement does not follow the curve of the riverbank. Similar to the benchmark, the cross-section endpoints should be placed 3 meters from the terrace edge. *(Note: Cross-sections may be extended more than 3 meters from the edge of the terrace in order to place the monuments close to the base of a tree for increased protection from erosion.)*

Label and document the monuments, see “Labeling Convention” and “Document Monument Locations” below.

THIRD: Install river left vegetation plots

Start from the site benchmark established above. Measure in a straight line 50 meters upstream and 50 meters downstream. Place monument markers at 3 meters from the terrace edge. These points mark the ends of the 100-meter vegetation plot baseline (Figure B.2.1).
Note: For each transect, at least one point should be collected on the terrace. Thus, if either 50-meter segment falls within 2 meters of the edge of the terrace an additional monument marker should be placed at 25 meters from the center point and 3 meters from the edge of the terrace. This will ensure an approximate equal area of terrace vegetation in each plot.

Label and document monument- see “Labeling convention” and “Document monument locations” below.

FOURTH: Install river right cross sections

Establish the right bank cross-section end points by stringing a line from the left bank cross-section endpoints to the right bank terrace, 3 meters from the terrace edge. The cross-section end points should be perpendicular to river flow.

Label and document monument- see “Labeling convention” and “Document monument locations” below.

FIFTH: Install river right vegetation plots

Start from the mid-point cross-section established above. Measure in straight line 50 meters upstream and 50 meters downstream. Place monument markers at 3 meters from the terrace edge. These points mark the ends of the 100-meter vegetation plot baseline (Figure B.2.1).

Label and document monument- see “Labeling convention” and “Document monument locations” below.

Labeling convention

To mark the monuments, use a 12-18 inches piece of rebar capped with an aluminum survey cap. Capped rebar should always be installed flush to the ground. Cross-section endpoints are marked using rebar with aluminum caps that are labeled with the reach number, cross-section abbreviation and letter, and an abbreviation of which side of the river it represents. Vegetation plots are labeled with reach number, vegetation plot abbreviation and letter, and an abbreviation of which side of the river it represents (Figure B.2.1). Cross-sections and vegetation plots letters are assigned from upstream to downstream. An example, of an entire reach would be: River Left, beginning upstream: RBC 20 LXA; RBC 20 LVA; RBC 20 LXB; RBC 20 LVB; RBC 20 LXC. River right, beginning upstream: RBC 20 RXA; RBC 20 RVA; RBC 20 RXB; RBC 20 RVB; RBC 20 RXC. If an additional/mid-vegetation monument is added (due to a 50-meter segment falling within 2 meters of the edge of the terrace, as described above) it should be labeled as “C”; the vegetation end points are always labeled A or B (Figure B.2.1).

DURING STEPS 1-5: Document monument locations

The location of the monument markers need to be documented using GPS, a hand drawn map (including reference points with distance and azimuth), and by photographing the site. To photograph the monument take the following photos:

1. Stand on the monument; orientate the camera north, east, south, and west, taking a photo at each direction.
2. Take at least one photograph of the monument itself. A written description of the site should also be made, using the “Site Description” document template.

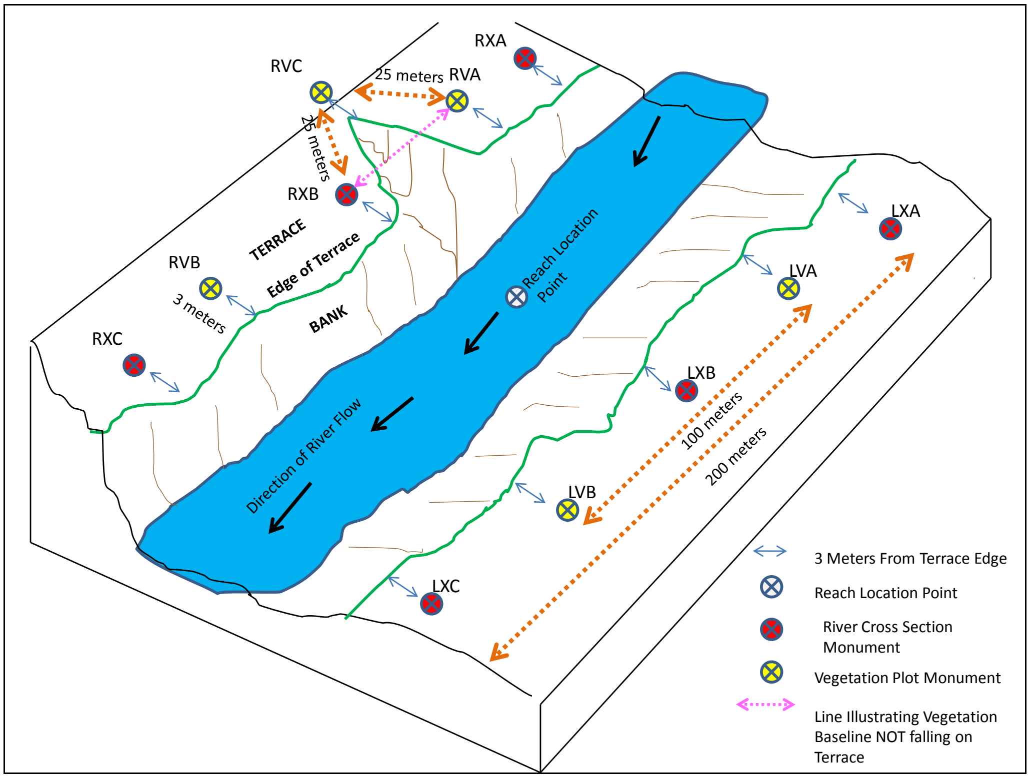


Figure B.2.1 Sample reach cross-section and vegetation plot setup.

SIXTH: Conduct Vegetation Assessment

Field personnel should be trained (see Training, below) and the following required tools and supplies should be acquired.

Equipment List:

- One 100-meter tape
- One 50-meter tape
- 4-6 chaining pins
- 10-20 Pin flags
- Densitometer
- Point intercept device
- Extender for densitometer
- Weighted rope with 1m markings
- Pens/pencils/clipboard
- Vegetation Assessment Data sheets
- Compass

- Sunscreen/water/lunch/personal gear
- Protocol and Field Instructions
- Random number table (generated in the office)

Baseline and Transect Set-up

1. Securely attach a 100-meter tape between the previously established vegetation plot endpoint monument markers. Place the 0-meter mark at endpoint "A" (upstream) and the 100-meter mark at endpoint "B" (downstream).
2. Use the first available number in the random number table to determine where on the baseline to start the first transect. For example, if placing transects every four meters, use a random number table that includes numbers 0 through 4. Use the first available number in the table, which will determine whether to place the first transect at 0m, 1m, 2m, 3m, or 4m along the baseline. The following transects will then be placed every four meters thereafter.
3. Place transects perpendicular to the baseline and extend towards the river, ending at the bottom of the river bank.
4. Additional Notes:
    a. For efficiency sake, it is not necessary to string an actual line for each transect. Instead, mark the start of each transect by placing a pin flag on the baseline tape. Then, mark the endpoint of each transect by placing a pin flag at the bottom of the bank. Intermediate pin flags may be helpful on long or heavily vegetated transects. Precise point placement is not critical.
    b. The bottom of the bank is not determined by the waterline, but by the break in slope. There is no need to sample the actual river bed.
    c. If a vegetation transect crosses a side channel, the transect line should extend through the side channel and end at the main river channel.

Data collection

1. Determine data collection point locations
    a. Data will be collected at points along the transect lines.
    b. The transect lines are located ON the ground, along the grounds contour. On level terrain, this may seem obvious. However, on steep terrain one could mistakenly set up a horizontal-mid-air transect line-DO NOT DO THIS.
    c. The ideal transect setup is to space transects 4 meters apart along the baseline and collect data points every 2 meters along each transect.
    d. The first point will be taken at 0 meters (ON the baseline). *Or, if the transect is moved upland to capture at least one terrace point, the first transect point will be a negative number distance from baseline.*
    e. Points will be spaced equally at 2m apart along the transect.
    f. Use a measuring device to determine spacing. This could be a 50m tape, a 1m stick, a rope with 1-meter markings and chaining pins on either end, or your own pacing (use a meter tape to determine how many of your steps is equal to one or two

meters). This can be used to efficiently move along the transect line by adjusting the marked rope in a leap-frog fashion. Again, precise point placement is not critical; however, it is important to remain objective.

g. A minimum of 200 points should be recorded for each plot. If it is apparent that 200 points will not be reached after recording data for all transects along the 100-meter baseline, then the vegetation plot may be extended to achieve the 200-point minimum. By looking at the average length of each transect, try to determine how many extra transects will be needed to reach the minimum. Divide the number of transects needed by two and extend the plot in BOTH directions to ensure that LXB or RXB remains the center point of the plot. Continue recording data along the extension transects, using positive numbers for extensions in the downstream direction and numbering backwards (into the negative) from the upstream direction.

2. Collect Data (*Note: For efficiency, two people will work together to collect data. One person will be the OBSERVER and the other the RECORDER. To lessen bias, rotate roles.)*

   a. RECORDER: record the location of the transect, as it pertains to the baseline.

   b. OBSERVER: place an objective point-intercept device on the first transect point (at 0 meters where the transect and baseline meet) with the scope on the upstream side of the transect, and use the attached leveler to level the scope.

   c. OBSERVER: look through the scope on the point-intercept device.

OBSERVER: use the cross-hairs to determine the exact point location. *The point is theoretically as small as possible,* extending from the ground to the canopy*.*

   d. OBSERVER: observe at the point.

   e. OBSERVER: dictate observations to RECORDER.

   f. RECORDER: record the following observations on the data sheet:

      i. Bank or terrace (if the transect lies in a drainage, “bank or terrace” should be recorded as N/A. An explanation should be included).

      ii. Substrate size

         1. Class 1: less than 2mm
         2. Class 2: at least 2mm and less than 16mm
         3. Class 3: at least 16mm and less than 64mm
         4. Class 4: at least 64mm and less than 256 mm
         5. Class 5: at least 256mm or greater

      iii. Record the following as presence (1) or absence (0) on the data sheet. Record each index only once.

      iv. Large wood (diameter of 25 centimeters or greater).

         1. Bare ground/ small litter (diameter of less than 25 centimeters).
         2. Exposed roots.
         3. Nonvascular plants.

4. Annual or biennial plants.
5. Fibrous-rooted/rhizomatous perennials.
6. Tap rooted perennials.
7. Shrubs (woody, multi-branched at base, life form adult stage typically a shrub).
8. Woody seedling (tree or shrub less than 0.5 meters tall and less than 0.5 meters wide).
9. Evergreen trees (0.5 meters or greater).
10. Deciduous trees (0.5 meters or greater).

g. OBSERVER: When all attributes for the point are recorded, move along the transect line toward the river and to the next data collection point.

3. *Notes:*

   a. *Use a densitometer to observe canopy.*

      i. *It should be in line with the ground point.*

      ii. *It can also be used to observe the shrub layer.*

      iii. *It may only be able to hit one canopy type.*

   b. *If standing water is encountered, continue to record indices, as well as, record "water" as a side note on the data sheet.*

   c. *RECORDER: Once the point-intercept device is in place, the recorder may move the measure device of choice or pace to the next location along the transect line.*

   d. *Steep banks can present accessibility problems.*

      i. *First and foremost, each slope should be assessed for worker safety. Do not work on a bank where a fall could produce an injury. Rocky deposits, riprap, and logjams must be carefully considered. Second, the potential for resource damage is high when working on steep slopes. It is NOT acceptable to negatively impact bank stability while collecting data. Potential solutions are:*

      ii. *In some cases an extension may work for the densitometer, but this has limited application, mainly due to its short reach and difficulty in leveling.*

      iii. *In many places a less objective method of data collecting is warranted:*

         1. *A weighted rope with 1-meter markings on it can be strung along the bank, with point data collected as best as possible.*

         2. *Many of the steep banks lack vegetation. Hence, this is not the worst case scenario for collecting accurate data.*

         3. *Canopy data will probably need to be eliminated; unless a reasonable method and appropriate equipment is discovered.*

Photographic Monitoring

The left and right banks, within the 100-meter vegetation plot range, will be photographed. Permanent photographic monitoring points should be established using rebar and stamped aluminum caps. A map of the location monument will be created for each monument.

List of Equipment:

- Personal Gear
- Radio
- Field Guide
- Digital SLR camera, lenses range from 18-55mm, batteries
- Tripod
- Measuring tape
- Compass
- Monument Installation Equipment
  - Rebar
  - Caps
  - Stamps
  - Mallet
  - Cap Protector
  - Protective eyewear
  - Leather gloves
- Pin Flags
- Flagging
- Clipboard
  - Photo Documentation Sheets
  - Photo Point Map Template
  - Pencil

Install the Photo Point Monument

1. Determine the monument marker location and install the marker:
   a. When possible, choose a location that is out of the way of disturbances (water flow, foot traffic, etc.)
   b. Install at the base of and as close as possible to permanent landmarks. For example: large healthy trees, large boulders, manhole covers, etc. Remember: fallen logs decay, small rocks get washed away, and due to nature, the landscape may change.

c. Install the marker where a tripod can be set-up centered over the marker and with enough room for the photographer to take the photograph, while still keeping as close to the permanent landmark as possible. Locating markers away from the photo point is confusing, but if circumstance dictates that the marker cannot be placed where the photo is needed to be taken, location descriptions need to be very clear, accurate, and concise.

d. Permanent markers should be ½” rebar driven into the ground to the point where they cannot be pulled out easily. For safety reasons, the rebar must always be capped. If photo point markers are in a visitor use area, you may want to drive them in all the way and use a metal detector for relocation. If this is done, location descriptions need to be very clear, accurate, and concise.

e. Install enough monuments to capture the extent of the riverbank, roughly between 2 to 3 for each side of the river. Keep in mind, the goal is to photograph the bank portion of the vegetation plot, not the terrace portion (Figure B.2.2).

2. Write a description of the monument locations by describing their location so that someone who has never been to the area can relocate them fairly easily. This means giving distances from “permanent” geographic points (roads, trails, bench marks), and “permanent” natural landmarks (large healthy trees, boulders, etc.) Take compass directions from these points. (Compass bearing should be recorded from true north, corrected for magnetic north difference).

3. Draw a map of the monument locations: Give distances (preferably in meters) from permanent geographic points and compass directions from these points; measure the diameter breast height of trees, vs. stating “large” tree; state type of tree/vegetation- using its scientific name; indicate direction of water flow, and always show the north arrow.

Label the photo point monument markers:

1. Assign the letters A-D to the markers. Work from the left bank upstream to the right bank downstream (Figure B.2.2). (For example: left bank upstream=A, left bank downstream=B, right bank upstream=C, right bank downstream=D).

   a. Label the markers as: PP (abbreviation for photo point), the site name, the photo point letter (Figure B.2.2).

   b. For example: PP8A (Site 8, photo point monument A).

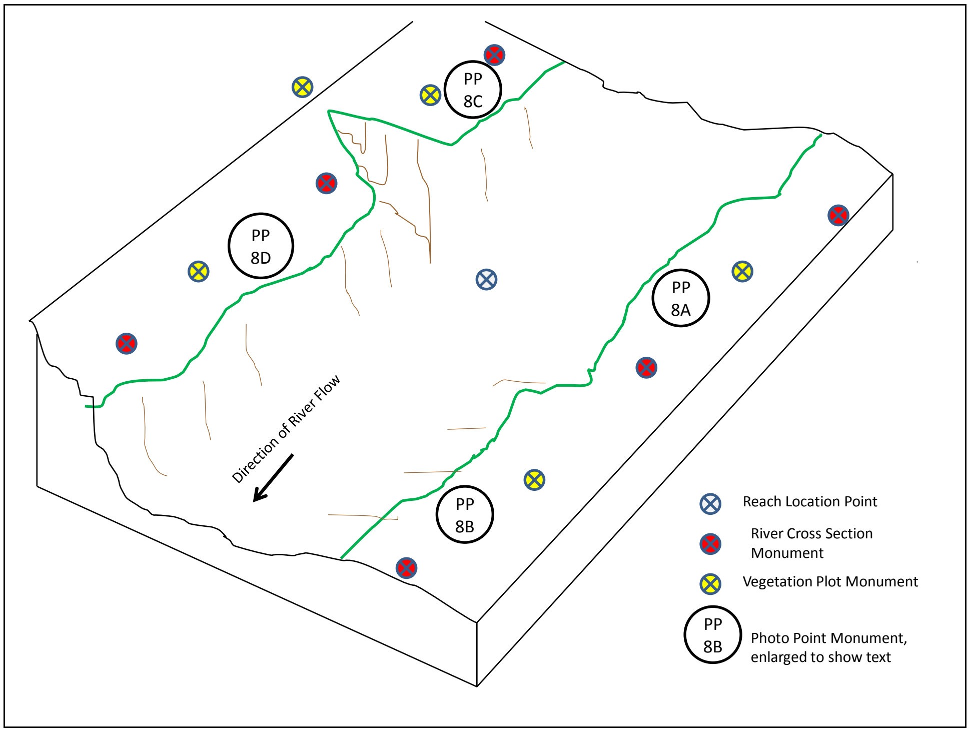


Figure B.2.2 Illustrated example of how to label and where to place photo point monuments.

Take the Photographs:

1. Take the first photograph of the upstream riverbank, using a wide angel lens (18mm). Record the azimuth (compass bearing). From the same azimuth, take the next photo using a telephoto lens (55mm). These will be photograph 1a and 1b, with the complete name being, for example: PP8A1a and PP8A1b (Figure B.2.3).
2. Next, with the telephoto lens (55mm) still on the camera, rotate the camera downstream, but do not take the photo yet. Change to the wide angle lens (18mm), take the photo and record the azimuth. From the same azimuth, take the next photo using a telephoto lens (55mm). These will be photograph 2a and 2b, with the complete name being, for example: PP8A2a and PP8A2b. Continue in this fashion.
3. RECORD, all information located on the photo documentation sheet, especially:
    a. site name
    b. monument name
    c. photo point name/number
    d. azimuth
    e. Is the photograph of the left or right bank
    f. Is the photograph upstream, downstream, or directly across from you
    g. Date, time, project, photographer's name, height of tripod
4. Note: When taking photos:
    a. It is very important to fill out all information on the photo documentation sheet.

b. Take horizontal photos.

c. Use a tripod and either a remote shutter release or the self-timer.

d. Take a panoramic of the riverbank in both telephoto and wide angle mode.

Label the Images

Use the following procedures for naming and labeling each image:

1. At each monument marker a series of photos will be taken. The series will consist of several different azimuths, with at least two different camera lens sizes used per azimuth. The series will be assigned one letter, which will correspond to the letter stamped on the monument marker; followed by a number, indicating a unique azimuth; then ending in a letter, referring to a change in lens size (Figure B.2.3). For example: PP8A1a30az18mm, PP8A1b30az55mm, PP8A2a45az18mm, PP8A2b45az55mm.

2. After downloading the images, complete the process by using the following standard operating procedures for assigning file names to images: YOSE_RBCPP8A1a30az18mm_YYYYMMDD (Figure B.2.3). See the ThumbsPlus user's manual for complete instructions.

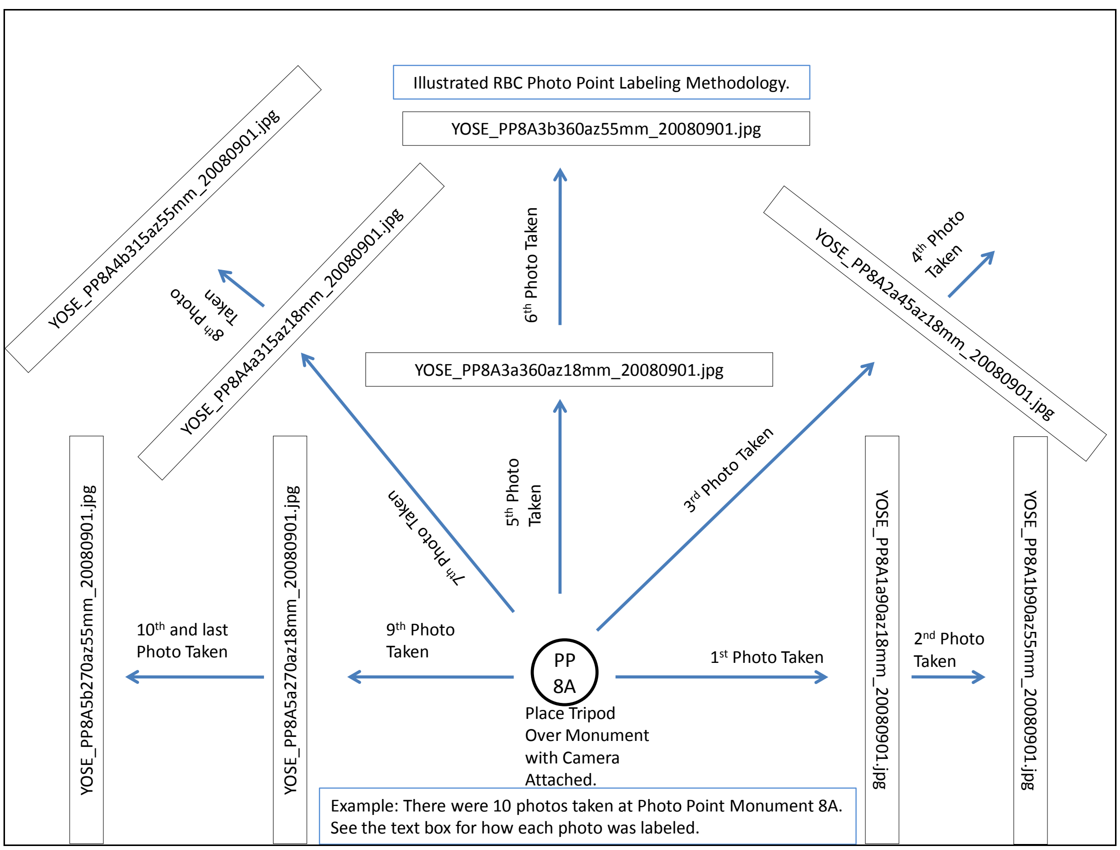


Figure B.2.3 Sequence in which to take photo points and the standard operating procedures for labeling the images.

Site Morphology

The profile survey procedure for cross-section surveys is based on Harrelson et al. (1994), Section 6 (pp. 26-32) and Section 8 (pp. 37-41). Please refer to the reference for surveying basics. If using total station surveying equipment, survey data (such as in the examples depicted below) may not be necessary.

Below are concise steps for cross-section surveys:

Cross-Sectional Profile (can be conducted at time of vegetation data collection)

1. For each reach, tie all surveying to the site benchmark established above. Record the exact location of each endpoint (permanent marker) based on its distance and direction to the corresponding benchmark. Draw a site map to indicate location of benchmark, endpoints, and other important features and record measurements.
2. Set up a taut tape across the cross section, with zero-end of the tape to the end point where elevation measurements will be taken. Starting on the left side of river is suggested for easier plotting of profiles later.
3. Begin the total station survey.
4. Be sure to record the correct height of the survey rod.
5. Start with the endpoint stake as zero. Begin shooting points with the total station.
6. Along the tape (cross-section), shoot a point at each change in elevation and at each important feature, on all slope breaks and at the edge of water.
7. Total station data should be downloaded upon return to office.
8. Figure B.2.4and Figure B.2.5 provide a graphical representation and sample data of a cross-section profile.

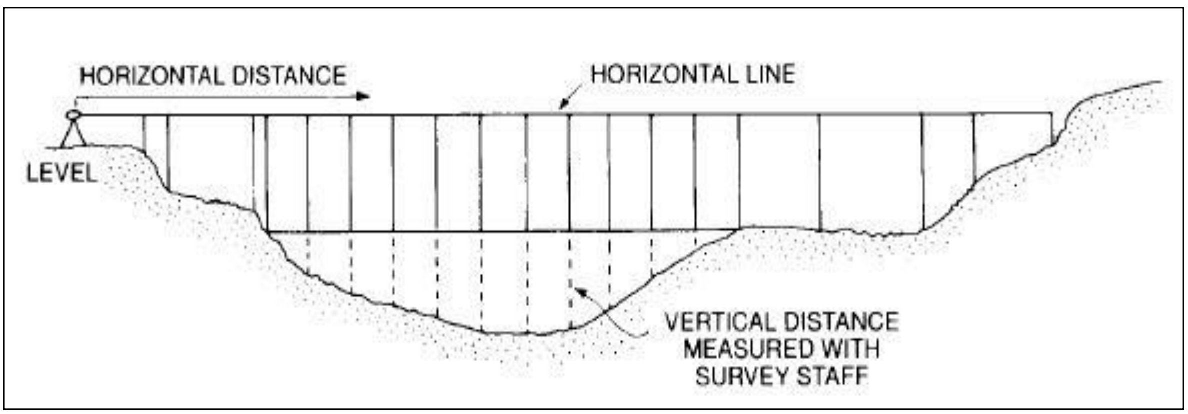


Figure B.2.4 Diagram of a cross-section survey (Harrelson et al. 1994).

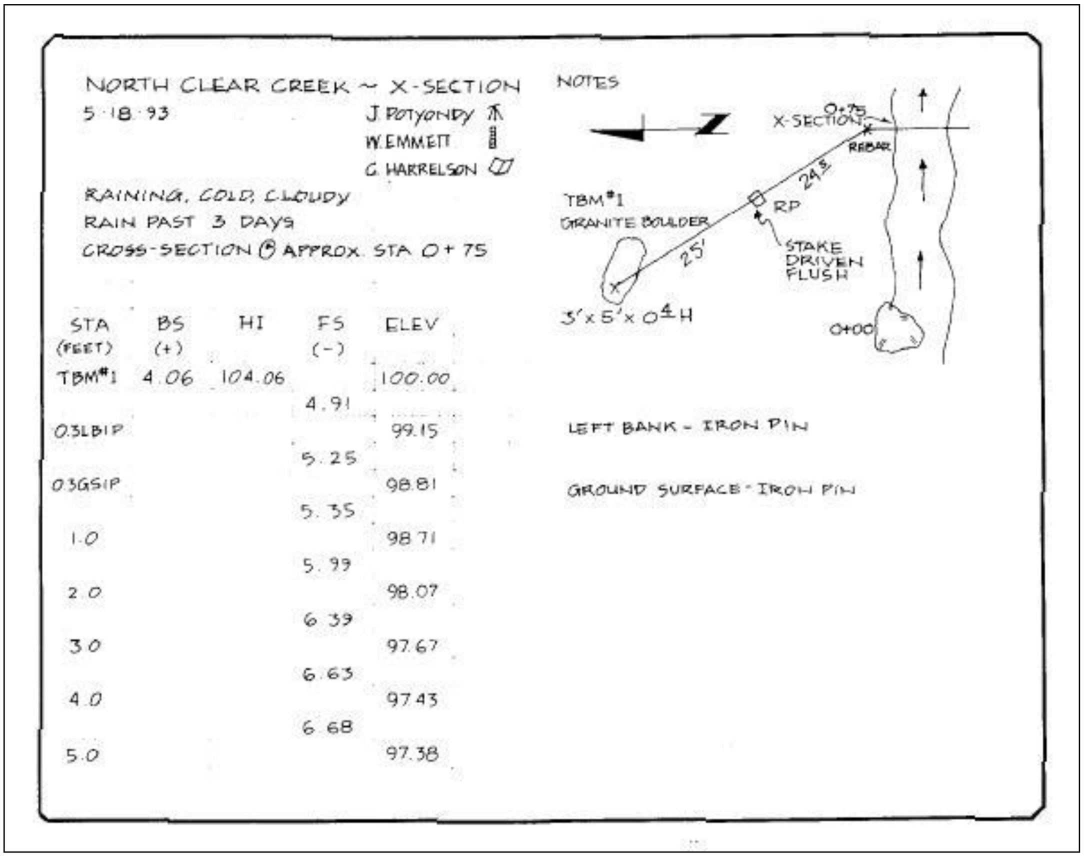


Figure B.2.5 Sample notes for cross-section survey (Harrelson et al. 1994).

SEVENTH: LiDAR scanning of sample reaches:

1. Each reach will be scanned using a ground-based LiDAR system.
2. In reaches with more than 25% shrub cover, it may be necessary to do LiDAR scans after the shrubs have lost their leaves.
3. A total surveying station is used to locate and orient the LiDAR unit in space. Set up the total station in a location where most/all of the reach is visible.
4. Set up the LiDAR station at the upstream end of the reach, level it, and turn it on. Back-sight the unit to the total station.
5. Scan the area. Move the LiDAR unit downstream scanning both banks by moving from one bank to the other bank in a zigzag pattern. 5-10 scan locations will be necessary to adequately capture the banks. Post-collection and Processing:

Site Morphology

Prepare detailed site maps using the LiDAR and cross-section data. Compute cross-sectional areas from cross-section data and LiDAR data. If previous cross-sectional data is available, compute the change in cross-sectional area using the definition of cross-sectional area below. If previous LiDAR data is available, compute changes in bank geometry and report in volume of bank material gained or lost from both left and right banks.

In order to compute changes in cross-sectional area, we define cross-sectional area as the area contained by the intersection of a horizontal line at the elevation of the lower bank cross-section monument and the cross-section perimeter below that line (Figure B.2.6). The computed cross-sectional area is then subtracted from the original cross-sectional area to obtain the amount of scour or accumulation.

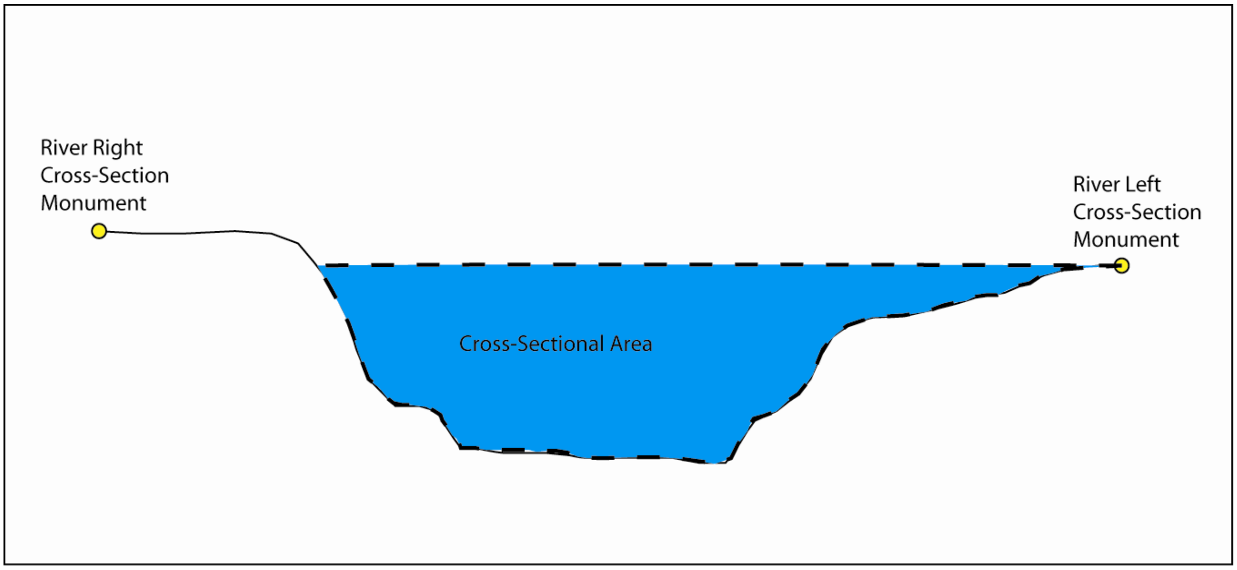


Figure B.2.6 Cross-sectional area determination.

Change in bank volume will be calculated by differencing filtered LiDAR data from two different measurements. Each scan of the river reach will be converted into a digital elevation model with vegetation filtered out to the extent possible. Subsequent scans of the same riverbank will be processed similarly, and the two separate scans differenced.

Vegetation Cover

All data will be entered into the database for further analysis. All complementary documentation including field notes, site coordinates, baselines, and photo points will be logged by observers at the office. Percent cover data will be analyzed for adherence to our established standards. Statistical protocols for these analyses are currently under development.

B.2.4 Data Management

Data entry:

Collected data will be entered into a database, and digital photographs will be labeled and filed electronically. Field notes will be transferred into digital form (i.e. word processed).

Data analysis:

Total station surveys will be converted into detailed profiles/maps of monitoring sites. GPS points delineating monitoring sites will also be displayed on a map. The data analysis of cross-section data consists of calculation the channel cross-sectional area and comparing this value to past values. The cross-sectional area is the area below a line drawn between the cross-section endpoints. In the case of LiDAR data, a reach volume would be calculated in a similar manner and the amount of volume change from the previous monitoring effort calculated.

Data reporting:

Reach locations and associated cross-sectional data including cross-sectional area will be reported in the 2009 and 2010 Visitor Use and Impact Monitoring Program Annual Report.

Data storage:

All collected data and compiled documentation will be stored on the YOSE NPS network (ms01/EP Commons/VERP/Monitoring Protocols/Riverbank Condition). GIS maps and project files can be found also be found on the YOSE NPS network. Original datasheets will be stored in the office of Vegetation and Restoration.

B.2.5 Personnel Requirements and Training

Roles and responsibilities (tasks and time commitments):

Supervisory GS-7 responsible for oversight of field work and training of personnel not familiar with indicator protocol and total station surveying. GS-7 field technician in charge of total station mapping, other tasks associated with assessment of permanent monitoring plots, and training and supervising other field staff. Other field staff will assist in total station mapping, as well as potentially providing quality control for rapid assessments (i.e. re-monitoring rapid assessment plots, independent from the other field technician).

Qualifications:

Supervisory GS-7 should be familiar with general river geomorphology and ecology principles, have experience in natural resource monitoring and vegetation monitoring, have experience in training personnel, and versed in GPS, GIS, and total station technologies. GS-7 field technician should have some experience with these topics, namely field implementation (GPS and total station, resource impact monitoring). Other field staff would optimally possess some of these same skills. All staff should be able to make informed condition class determinations and make appropriate recordings of riverbank attributes and conditions, such as bank type, ground vegetation cover, tree root exposure and erosion features.

Training procedures:

Two days will be dedicated to familiarizing field staff with indicator and protocol, GPS unit, and total station methods. Training will be conducted by staff well-versed in protocol, preferably someone who has implemented the methodology in the past.

B.2.6 Operational Requirements

Field work plan: Field work will be conducted mid-August through September when river flows are low enough to permit safe crossing. Protocol refinement will be conducted in June and July, and data analysis and reporting will be conducted in October and November. The following is an outline of the field work schedule:

Crew 1 (5 People)

- Days 1 & 2: Training

- Days 3-12: Plot setup, Cross-section installation, Vegetation Plot installation, Photo Point installation at 12 reaches
- Days 13-16: Data reduction and reporting

Crew 2 (2 People)

- Day 1: Field Preparation and receipt of LiDAR Unit
- Day 2 – 9 LiDAR scanning of 15 river reaches
- Day 10: Return LiDAR unit
- Day 10-20: LiDAR data reduction, analysis, and reporting

*Projections of time requirements are based on 10-hour workday.

Equipment and materials: see “Preparation” in the Field Methods section

Safety: A job hazard analysis has been completed and appears below (Table B.2.1).

Table B.2.1 Job Hazard Analysis for Riverbank Condition indicator.

United States Department of Interior **NATIONAL PARK SERVICE**	1. Work/Activity	2. Location	
	VERP Riverbank Erosion Monitoring	Merced River, Yosemite Valley, YNP	
Job Hazard Analysis (JHA)	3. Name of Analyst	4. Job Title	5. Date Prepared
	Christal Niederer	Technician	July, 2005
6. Tasks/Procedures	**7. Hazards**	**8. Abatement Actions** ENGINEERING CONTROLS – SUBSTITUTION – ADMINISTRATIVE CONTROLS – PPE	
a. Driving to, from, and around sampling sites.	a. Collision resulting in damage, injury, or death.	a. Drive defensively, obey traffic laws, lights on, seatbelt on, and be alert for pedestrians, wildlife, and distracted drivers. Know procedures for installing snow chains. Always carry and know how to use a Park radio.	
b. Walking, hiking and other physical exertion.	b. Exhaustion, muscle strain, dehydration and fatigue.	b. Drink plenty of fluids, bring snacks and/or meals if out during lunch hours, Take periodic rests and stretch before and after physical activity.	
c. Wading in river to assess riverbank conditions.	c. Tripping, falling or being swept away due to slippery, uneven river bottom surfaces and strong currents.	c. Use extreme caution in watching footing, wear life vest, only wade if the water level/current strength is low enough to permit it, collect sample from river edge if water is too high and/or swift.	
d. Working and walking along riverbanks.	d. Tripping and/or falling due to wet and slippery rocks or sloping ground surfaces, contact with poison oak, etc.	d. Watch footing, know how to identify and avoid all poison oak, rinse immediately in stream if contact occurs.	
e. Working outdoors in cold and/or wet weather.	e. Hypothermia, reduced resistance to illness.	e. Wear appropriate clothing and carry extra layers. Stay dry. Use rubberized raingear if possible. Stay hydrated preferably with warm liquids. Stop work to warm up if necessary. Snack often.	
f. Working outdoors in hot / extreme heat weather.	f. Fatigue, exhaustion, dehydration and heat stroke.	f. Wear appropriate clothing and use sunscreen. Drink fluids and snack throughout the day. Carry extra water and dehydration salts along with first aid kit.	
10. Supervisor’s Signature	11. Title	12. Date	

B.3 WILDLIFE EXPOSURE TO HUMAN FOOD

B.3.1 BACKGROUND

The most direct and prevalent way visitors adversely affect wildlife in Yosemite is by purposely feeding animals, leaving food improperly stored, or leaving food debris on the ground or picnic tables. This leads to alteration in the animals' behavior and roles in the ecosystem; as animals are exposed to human food, they continue to seek it out. In extreme cases, animals that are fed become aggressive and dangerous. as a result, must be killed to protect human safety. This modification of wildlife behavior and ecological roles adversely affects the biological Outstanding Remarkable Value (ORV) and that of the quality of recreation.

There is a likely correlation between the number of visitors in Yosemite Valley and the opportunities for wildlife to be exposed to human food. More visitors, in turn, means more people feeding wildlife, more people improperly storing food, and more food debris left behind. The proportion of visitors engaging in these behaviors remains constant over the range of visitor numbers. Also, trash cans and dumpsters are more likely to overflow, allowing animals to access garbage. The number of staff dispensing information about park regulations through personal contact and frequency of garbage removal remains relatively constant for many years, regardless of the number of visitors. Therefore, as the number of visitors goes up, the proportion of them who receive information and warnings likely goes down. The chance of overflowing trash receptacles increases and intentional feeding of wildlife increases, resulting in higher human-wildlife conflicts.

Description of indicator and standard:

Indicator:

Number of instances wildlife could be exposed to human food.

Standard:

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

Rationale for indicator:

Current management of human-wildlife conflicts call for "zero tolerance" for allowing animals access to human food. This is especially true for black bears, which quickly become conditioned to human food. As a result, they become dangerously aggressive and must be killed. The severity of this problem requires the expenditure of considerable funding and staff time; in order to provide visitor education, patrol to look for food left available to animals, enforce food storage regulations, and haze bears out of developed areas. Despite these extensive efforts, and the zero tolerance policy, it is unrealistic to believe that *all* availability of human food to wildlife can be controlled. Therefore, it has been decided that steady progress in removing human food from the diets of wildlife would be a reasonable measure of the effect of visitation level on wildlife exposure to human food.

Objectives:

Provide accurate assessment of food storage compliance rates and food storage violations in campgrounds and parking lots.

B.3.2 Sampling Design

Currently, statistics on the availability of human food to wildlife is documented through the park's Bear Patrol Log Database (BPLD). The BPLD was developed for the Human-Bear Management Program in 2005 to ensure accountability with bear-funded employees and to collect data on bear monitoring and management activities in the field. In Yosemite Valley, there is an average of 15 bear funded employees that spend a minimum 80% of their time on bear related issues between the months of May and October. These employees include 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 6 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. For this indicator, average compliance rates are determined by inspecting either a certain number of campsites or vehicles. Non-compliance is defined as an incident only when a violation of human food-related park regulations is observed by the field staff that necessitates immediate management action such as issuing verbal or written warning.

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 are generally conducted after 10 p.m. when most visitors are finished eating dinner and food is put away. Inspections conducted earlier than 10 p.m. often result in a very low compliance rate, because most people preparing dinner have their food lockers open and food items out of arms reach. These incidents are documented in the BPLD as educational contacts rather than violation or inspection records.

Parking lot inspections are conducted throughout the night, because food stored inside vehicles during daylight hours is legal. Compliance checks on vehicles can only be performed after dark.

Many instances have occurred, whereas, food storage violations are found, corrected and documented, but cannot be calculated in the average compliance rate for an area. This is due to the fact that they are not part of an inspection. In the BPLD, food storage violation records can either stand alone or be part of an inspection record.

Site Selection:

Inspections will take place in the following Yosemite Valley locations: Upper Pines Campground (C.G.), North Pines C.G., Lower Pines C.G., Camp 4 C.G., Housekeeping Camp (campsites only), Curry Village Parking Lots, Curry Orchard Parking Lot, Ahwahnee Parking Lot, Yosemite Lodge Parking Lot, Wilderness Lot, and Camp 4 Parking Lot.

Sampling Schedule:

Inspections will be performed as time permits, but no less than once a week for each location, from May 15, 2008 through November 10, 2008. Inspections will occur during weekdays and weekends.

Equipment and supplies:

- Flashlights and headlamps with extra batteries
- Park radio
- PDA or Field forms: Data sheets
- Clipboard/pencils
- Warning flyers/notices
- Manual counter.

B.3.3 FIELD METHODS

Preparation:

Gather the handheld computer (PDA).

Data collection and measurement:

Procedures listed below are taken from the Bear Patrol Log Database Manual on collecting and entering data.

Inspections

- All inspections will be entered into the Bear Patrol Log Database. Data will include the date, location, start and end time, number of campsites or vehicles checked, and the number of campsites or vehicles that are non-compliant.
- Inspections of campsites and Housekeeping Camp units should occur only after the dinner hour when visitors are not preparing food.
- Inspections of vehicles must be completed after dark.
- Inspections of concessions facilities (except Housekeeping Camp units) may be completed at any time of day or night.
- If non-compliant vehicles, campsites, facilities or trash cans are found, a food storage detail record must be completed for those violations. For example, if 300 cars are checked and 4 are found with food in them and the visitors are woken up because of food in their cars. An inspection detail will be completed along with a food storage detail. The food storage detail

will list the 4 violations of unattended food in the vehicle, and the action will be a verbal warning.

Food Storage Violations

- Spot checks for food storage violations occur on a nightly basis during patrols. All violations will be entered into the Bear Patrol Log Database. Data will include the date, location, time violation was found, type of violation, number of violations if more than one, and the type of warning issued.
- Violation Types:
  - **Baiting -** Knowingly offering or leaving human food for wildlife.
  - **Bear Box/Improperly Locked -** Food is put in food locker but the locker is not latched in a way consistent with the instructions. The visitors may be either away from their site, inside a tent or vehicle (RV) or asleep.**Bear Box/Left Open -** Food is put in food locker, but the locker is wide open or completely unlatched **and** the visitors are either away from their site, inside a tent or vehicle (RV) or asleep.**Unattended/Food or Attractant -** Food left out in campsite, or other location and the visitor is not in the campsite or asleep. Example: Camper at Upper Pines is no where to be found (i.e. in bathroom or sleeping) and there is a bag of marshmallows on his picnic table.
  - **Visitors Too Far From Food -** Visitor is in site and awake. 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. Example: Campers in Upper Pines are sitting around fire with their back turned to their food and are 10 feet away.
  - **Unattended/Food or Attractant in Vehicle. OB Camper w/Food in Vehicle.**

B.3.4 DATA MANAGEMENT

Data entry:

Patrol data will be recorded on PDA's. Data will then be synced with the Bear Patrol Log Database at the end of each patrol shift, or at the beginning of the next patrol shift.

Data analysis:

Data for this indicator will be queried and analyzed each November for the summary report. Quality control will be performed by the Wildlife Management Office at least once a week in May and June and once a month for the remainder of the season. Food storage compliance rates will be determined by taking the average compliance rate each month from May through October. Compliance rates will be analyzed for each monitoring site.

Data reporting:

Results will be compiled and presented in the Visitor Use and Impact Monitoring Annual Report. Additionally, information will be presented at a public meeting and made available on the park's website.

Data storage:

The Bear Patrol Log Database is stored on the park's network and can be accessed through Citrix.

B.3.5 Personnel Requirements and Training

Roles and responsibilities (tasks and time commitments):

Monitoring efforts and data collection will be performed by the Yosemite Interdivisional Bear Team. This team is comprised of employees from several different work units including Campground, Interpretation and Protection Rangers, and Wildlife Technicians. An average of 15+ individuals will be involved in the data collection. The Wildlife Management Branch is responsible for the Bear Patrol Log Database including maintenance, quality control, improvements, and training.

Qualifications:

Before data is collected, all employees, volunteers, and interns on the Interdivisional Bear Team will be trained in bear management and patrol activities, black bear biology, the Bear Patrol Log Database, and data collection methods.

Training:

Wildlife Management staff with experience surveying and monitoring non-compliance of food storage will be responsible for training any NPS staff or volunteers without prior monitoring experience. NPS staff and volunteers will be required to demonstrate the ability to:

- Navigate to inspection sites.
- Identify and differentiate various types of non-compliance.
- Make appropriate recordings for non-compliance and related attributes.
- Enter field data into the Bear Patrol Log Database.

These skills will be verified through field training and assistance of qualified Wildlife Management staff. In addition, all members of the bear team using the database will be given a copy of the Bear Patrol Log Database Manual.

B.3.6 Operational Requirements

Safety:

Particular attention will need to be given to collecting data in a safe manner as personnel will be working at night, alone in some occasions and within high use bear activity areas. A job hazard analysis has been completed and appears below (Table B.3.1).

Table B.3.1 Job Hazard Analysis for Wildlife Exposure to Human Food

United States Department of Interior NATIONAL PARK SERVICE	1. WORK PROJECT/ACTIVITY	2. LOCATION	
	Wildlife	Yosemite Valley, YNP	
Job Hazard Analysis (JHA)	3. NAME OF ANALYST	4. JOB TITLE	5. DATE PREPARED
	Tori Seher	Wildlife Biologist	July, 2006
6. TASKS/PROCEDURES	7. HAZARDS	8. ABATEMENTS ACTIONS ENGINEERING CONTROLS – SUBSTITUTION – ADMINISTRATIVE CONTROLS – PPE	
a. Driving to, from, and around sampling sites.	a. Collision resulting in damage, injury, or death.	a. Drive defensively, obey traffic laws, lights on, seatbelt on, be alert for pedestrians, wildlife, and distracted drivers. Know procedures for installing snow chains. Always carry and know how to use a Park radio.	
b. Walking, hiking and other physical exertion.	b. Exhaustion, muscle strain, dehydration and fatigue.	b. Drink plenty of fluids, bring snacks and/or meals if out during lunch hours, Take periodic rests and stretch before and after physical activity.	
c. Encountering / managing wildlife.	c. Bite, attack or other injury resulting from incidental or violent interaction with wildlife or the use of wildlife management tools such as firearms.	c. Work in coordination with trained wildlife staff, use caution when dealing with wildlife and follow appropriate safety procedures for the use of management tools such as firearms. Carry first-aid kit and radio during patrols.	
d. Working outdoors in cold and/or wet weather.	d. Hypothermia, reduced resistance to illness.	d. Wear appropriate clothing and carry extra layers. Stay dry. Use rubberized raingear if possible. Stay hydrated preferably with warm liquids. Stop work to warm up if necessary. Snack often.	
e. Working during nighttime hours.	e. Injury resulting from over-tired or exhausted condition due to late night working hours and working in the dark.	e. Maintain healthy sleeping habits. Eat and drink appropriate meals for consistent energy (coffee is not an appropriate food source). If overly tired, take breaks and rest. Always carry charged flashlights with extra batteries.	
10. SUPERVISORS SIGNATURE	11. TITLE	12. DATE	

B.4 EXTENT AND CONDITION OF INFORMAL TRAILS

B.4.1 BACKGROUND

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 VERP 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 their proliferation (number of places they occurred) throughout the park's 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 affect 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). Condition-class ratings and assessments were incorporated into most of the studies using these approaches.

Due to the extensive nature of some informal trail networks, the efficiency of field assessments is a particular concern. The advent of geospatial techniques seems to provide potential solutions to this challenge. Major developments are currently occurring with the rapid advancements of geospatial technologies, such as geographic information systems (GIS), global positioning system (GPS), remotely sensing and the digital spatial data. 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.

This field protocol presents the data requirements and data collection procedures for surveying the extent and condition of informal trails in selected sites in Yosemite Valley and Tuolumne Meadows, an indicator that was first implemented in 2004. The Visitor Use and Impact Monitoring Program identified two zones to be monitored in Yosemite Valley, (2B) Discovery and (2C) Day Use. The meadows to be monitored in those zones are: Stoneman, Ahwahnee, Cooks, Sentinel, Woskey Pond, Leidig, El Capitan, and Bridalveil. In 2005, the Visitor Use and Impact Monitoring Program added Tuolumne Meadows as an area of interest for informal trail monitoring. This was in part driven by the need to collect baseline data to be used in conjunction with the Tuolumne Meadows Concept Plan. Thus, in 2005, mapping began in the main sections of Tuolumne Meadow, north of Tioga Road. In 2006, monitoring included meadows on the South side of Tioga Road, and other areas encompassed by the Tuolumne Wild and Scenic corridor and the Tuolumne Concept Plan. 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 standards presented in the Visitor Use and Impact Monitoring Program are based on 1990 data. It was decided that data on current conditions should be used as the basis for future monitoring. This methodology described will be used to determine current conditions and to monitor them in the future. The standards were revised to develop a more rigorous data set from which future monitoring efforts will be measured.

Original methodology was 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 will again be assigned to all mapped trails. However, “barely discernible trail” and “flattened vegetation” will be eliminated and the remaining condition classes will include stunted vegetation, some bare ground, barren and braided. Rutted and braided will also remain as condition-class attributes. Disturbed areas will be delineated as polygon shapes so that an integrated parameter of “density of disturbed area” can also be achieved. Otherwise, most methodologies will remain consistent with 2006 protocol.

Description of Indicator and Standard

Indicator:

This indicator monitors the proliferation and condition of informal trails in meadows and the resulting fragmentation of meadow habitat. Informal trail monitoring has been applied to both river corridors to identify trampling related impacts to Yosemite’s unique meadow habitat.

Draft Standard:

Two draft standards have been developed for the Tuolumne River Corridor. Standard development for the Merced River Corridor is ongoing. Fragmentation Standard: Meadows with informal trailing in the Tuolumne River Corridor will display fragmentation represented through a specific landscape index: the Largest Patches Index Five (LPI5) of no more than 92.84%. Decreasing percentages will indicate a increased degree of fragmentation

Meadow Condition Standard:

Trend data will demonstrate improvement of condition for recorded informal trails in meadows.

Rationale for indicator:

Monitoring the extent and condition of informal trails in the meadow contributes to the protection and enhancement of many of the Outstandingly Remarkable Values of the Merced River Corridor. The biological Outstandingly Remarkable Value 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 Outstandingly Remarkable Values 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 Outstandingly Remarkable Value 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 Outstandingly Remarkable Value 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.

B.4.2 SAMPLING DESIGN

Rationale for 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 2006, four Yosemite Valley meadows were chosen to be monitored: El Capitan, Cooks, Stoneman and Woskey. El Capitan, Cooks, and Stoneman meadows exhibited an increase in trail length between 2004 and 2005, so they were monitored to confirm trends in informal trail development. Woskey Pond was chosen randomly. In 2007, five meadows will be monitored: Stoneman, Leidig, Sentinel, Ahwahnee, and Bridalveil. Stoneman exhibited a slight increase in trail length so it will be 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.

In the future, meadows to be chosen will be based on those that exhibit 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 caused by the many activities in these two very busy areas of the park.

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 will be 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 Yosemite Valley, five meadows will be monitored: Stoneman, Leidig, Sentinel, Ahwahnee, and Bridalveil. In Tuolumne Meadows, additional baseline data will be collected in the high use areas between the Dana and Lyell forks of the Tuolumne River.

Sampling schedule:

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

B.4.3 Field Methods

Preparation:

Field personnel should be trained (see Training, below) and the following required tools and supplies should be acquired:

- GPS
- Clipboard and pencils
- Notebook
- Measuring tape
- Copy of indicator protocol
- Map of area of interest
- Digital camera
- Photo-documentation sheets (on waterproof paper)
- Pin flags
- Radio
- Water
- Lunch

Data collection and measurement:

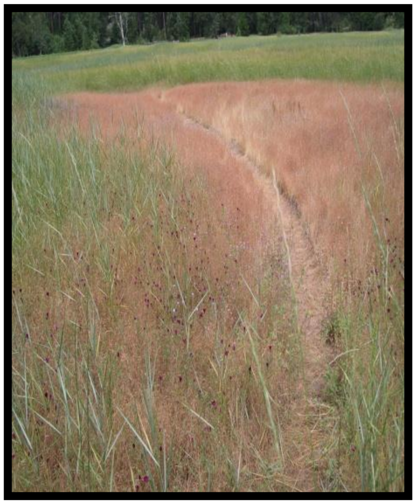
Field technicians should travel to the meadow to be monitored, and turn on GPS, so that it can begin to acquire satellites. Follow “Field Instructions” for complete, step-by-step data dictionary procedures.

Disturbed areas, regardless of size, should be entered as a polygon feature. Informal trail classifications should be entered into the GPS as a line feature. Additionally, the appropriate condition class and any subsequent features should be recorded for each trail segment. When choosing the appropriate condition class, use the following list of characteristics and photo examples as a guide. See figure below (Figure B.4.1).

Condition-Class: Stunted Vegetation

Data Dictionary field: Line Feature

Photo Examples:


General Characteristics:

- *Distinct trail* feature present
- Trail boundary *present*
- *Moderate* repeated human use evident
- *Trampled and matted* vegetation
- Noticeably *impeded* vegetation growth

Figure B.4.1 Informal Trails Condition Class: Stunted Vegetation

Condition-Class: Some Bare Ground

Data Dictionary field: Line Feature

Photo Examples:

General Characteristics:

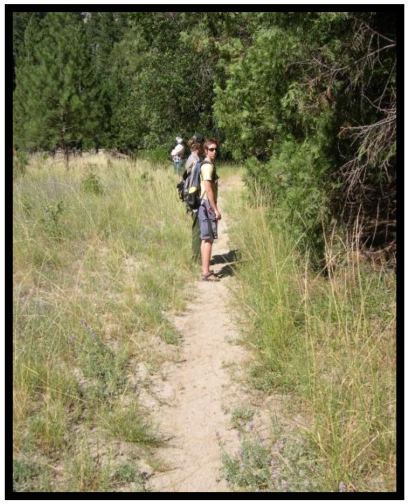
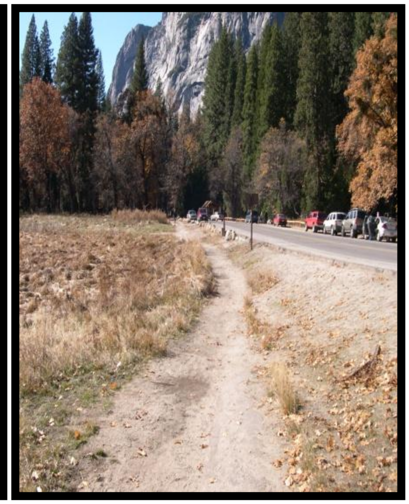
- *Distinct trail* feature present
- Trail boundary present and *in some areas, distinct*
- *Heavy* repeated human use evident
- *Trampled and matted* vegetation
- *Noticeably impeded* vegetation growth
- *Some bare ground* present in trail t*read*

Figure B.4.2 Informal Trails Condition Class: Some Bare Ground

Condition-Class: **Barren**

Data Dictionary Field: **Line Feature**

Photo Examples:

General Characteristics:

- *Distinct trail* feature present
- Trail boundary present and *distinct in most* areas
- *Extensive* repeated human use evident
- *No vegetation* present
- *Bare ground* present in trail tread *throughout*

Figure B.4.3 Informal Trails Condition Class: Barren

Informal Trail Feature: **Disturbed Area**

Data Dictionary Field: Polygon Feature

Photo Examples:

General Characteristics:

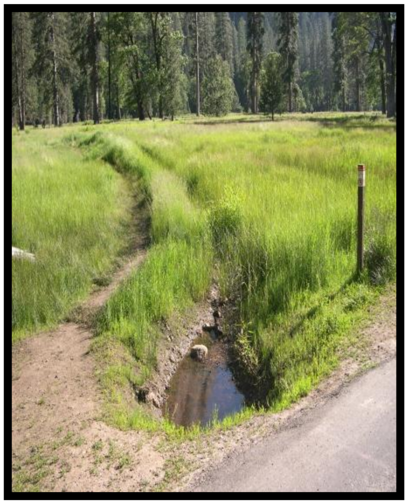
- Polygon-type shape
- High use area
- Must exhibit one of the following condition-classes: Stunted vegetation, some bare ground or barren

Figure B.4.4 Informal Trails Feature: Disturbed Area

Informal Trail Features: **Single Trail** (with braided trail as an attribute) and **Braided Segment**

Data Dictionary Field: **Line Feature**

Photo Examples:



General Characteristics:

- Two or more adjacent trails (5 feet apart maximum)
- Must be a minimum of 25 feet in length
- Must exhibit one of the following condition-classes: Stunted Vegetation, Some Bare Ground and/or Barren

Figure B.4.5 Informal Trails Feature: Braided Segment

Informal Trail Feature: **Single Trail**

Attribute of the informal trail feature: **Rutted**

Data Dictionary Field: **Line Feature**

Photo Examples:

General Characteristics:

- Trail with depth greater than 6 inches
- Must be a minimum of 25 feet in length
- Must exhibit on of the following condition: Stunted Vegetation, Some Bare Ground and/or Barren.

Figure B.4.6 Informal Trails Feature: Single Trail

General Mapping Plan:

Using the field maps you brought with you, orientate yourself and make a plan for data collection.

Informal Trails:

1. If in the first or fifth year of data collection, map meadow boundary/area of study first.
2. Next, map perimeter trails- placing pin flags at the beginning of side trails.
3. Then, map the longest trails- again placing pin flags at the beginning of side trails.
4. Next, map the side trails- removing the pin flag when you begin to map said trail. Additionally, if there is a sub-side trail, place pin flags at the beginning of said trail.
5. Continue in this fashion until all main trails and side trails are mapped.

Disturbed Areas:

1. Map the trail leading to the disturbed area first.
2. If a trail bisects a disturbed area, map the trail through the disturbed area.
3. Either immediately resume to mapping the disturbed area, or mark it with a pin flag and return later.
4. When walking the disturbed area boundary, always walk in the same direction and place a pin flag at the starting point- or at least take note of a distinguishing feature.

Note: For large meadows, you may want to break it into segments. Mark the segments on the map with a pen and on the ground by using pin flags.

Note: Use the map to keep track of the trails/disturbed areas you have mapped, by writing directly on the map.

Mapping Protocol:

Informal Trails:

1. DO NOT MAP FORMAL TRAILS (i.e. the Valley Loop trail, and formal hiking trails in Tuolumne).
2. Map the meadow boundary/area of study when it is in the first year of data collection (establishing a baseline) and then repeat every 5 years or if there has been a noticeable change in meadow boundary.
3. **Note:** There is no need to GPS meadow edges that abut a road or formal trail.
4. Map all informal trails, regardless of size/length.
5. Map all informal trail classifications from beginning to end.
6. If a trail changes in classification (and/or in width) **-*for at least 25 feet-** end/store the feature and start a new one.
7. ***Note**: The trail classification (and/or width) must change for at least 25 ft., otherwise, keep the original classification/width.

5. Make sure you **collect at least one point at each bend/vertex** in the trail, as well as, at the start and end of the trail.
6. Map trails through disturbed areas and return later to map the disturbed area.
7. Refer to "Mapping Plan" for supplemental instructions.

Braided Trails:

For braided trails, first map the main trail and then map each braided segment.

1. To map the main trail, choose the feature "informal trail". Enter classification, trail width, rutting depth, number of braids, braided complex width, braided total exposed ground, and any notes.
2. After mapping the main trail, map each braided segment.
3. Choose the feature "braided segment". Enter classification, trail width, rutting depth, and any notes.

Disturbed Area:

- A disturbed area is: A polygon-shaped high-use (typically a destination rather than a through route) as opposed to a trail.
- Enter the condition-class for the disturbed area (stunted vegetation, some bare ground, or barren).
- If the disturbed area is made up of more than one smaller disturbed area with different condition-classes, map these areas as separate polygons.
- Map all disturbed areas, regardless of size.
- You only need to collect points at the vertexes, not along the entire boundary line.
- Refer to "Mapping Plan" for supplemental instructions.

GPS Detailed Mapping Instructions:

1. Turn on GPS
2. Open TerraSync (double click)
3. Create a new File (create a new file at the beginning of each day)
    a. Open the "Skyplot" (default) screen
    b. Select "Status", from the drop-down menu.
    c. Select "Data"
    d. Hit "New" button
    e. Leave file type as Rover
    f. Use the keypad to name the new file
        i. Project name, meadow name, date mm/dd/yyyy data technician's initials (For example: ucm bv 06/02/2008 mj)

4. Use these abbreviations for meadow or study area
    a. AHW= Ahwahnee Meadow
    b. BV= Bridalveil Meadow
    c. CKA= Cook's Meadow A
    d. CKB= Cook's Meadow B
    e. CKC= Cook's Meadow C
    f. EC= El Capitan Meadow
    g. LD= Leidig Meadow
    h. SENA= Sentinel Meadow A
    i. SENB= Sentinel Meadow B
    j. SLHA=Slaughterhouse Meadow A
    k. SLHB= Slaughterhouse Meadow B
    l. STNA= Stoneman Meadow A
    m. STNB= Stoneman Meadow B
5. Choose the appropriate data dictionary
    a. Informal Trails (use this data dictionary for both YV and TM)
6. Log features
    a. Once the file and data dictionary are open, Hit "Create".
        i. Select the appropriate feature
            1. Informal Trail
            2. Disturbed Area
            3. Braided Segment
        ii. Select the appropriate classification
            1. Stunted Vegetation
            2. Some Bare Ground
            3. Barren
        iii. Select the appropriate trail width (in 6inch increments)
        iv. Select the appropriate rutting depth (in 6 inch increments)
        v. Select the number of braids
        vi. Select the braided complex width
        vii. Select the total exposed ground of the braided width
        viii. Enter any notes necessary.
        ix. Hit "Log"

7. Walk the feature, making sure the GPS is collecting points at least every 10m and at all vertexes. If not, **you must wait** until the point is collected.
    a. The GPS unit will beep and the point-count (in the upper right hand corner) will increase.
8. **Note:** If satellite coverage is sparse, and it is taking a long time to get points, you can start logging and then enter the feature fields as you are waiting in between points.

Editing GPS Data

1. Open Terra Sync.
2. Select and open the main file.
3. From the first tier, upper-left, drop-down menu, select “Data”.
4. From the second tier, upper-left, drop-down menu, select “update features”.
5. A list of all the features associated with the file will appear. Highlight and select (click once) the feature to be edited.
6. Click on the “begin” button.
7. When you have finished editing attributes, click “ok”.
8. The list of features will again appear. Either edit more features, or click on the “update” button (on the top left).
9. To resume collecting data, select “collect”

Deleting GPS Data

1. Open Terra Sync.
2. Select and open the main file.
3. From the first tier, upper-left, drop-down menu, select “Data”.
4. From the second tier, upper-left, drop-down menu, select “update features”.
5. A list of all the features associated with the file will appear. Highlight and select (click once) the feature to be deleted.
6. Click on the “options” button.
7. Select “delete”.
8. When you have finished deleting attributes, click “ok”.
9. The list of features will again appear. Either delete more features, or click on the “update” button (on the top left).
10. To resume collecting data, select “collect”

Data Dictionary Fields

1. **Feature Type (Required)**
    a) Informal Trail

   b) Disturbed Area
   c) Braided Segment
   d) Point Generic
   e) Line Generic
   f) Area Generic
2. **Classification (Required)**
   a) Stunted Vegetation
   b) Some Bare Ground
   c) Barren
3. **Trail Width (Required)**
   a) From the drop-down menu, choose the trail width (to the nearest 6 inches).
4. **Rutting Depth** (optional)
5. From the drop-down menu, choose the rutting depth (to the nearest 6 inches). **Braids, number of (optional, but required if the trail is braided)**
   a) From the drop-down menu, choose the number of trails in the braided complex (this includes the main trail and the braided segments).
6. **BraidComplxWidth (optional, but required if it is a braided trail)**
   a) From the drop-down menu, choose the braided complex width (to the nearest 6 inches).
   b) Note: the braided complex is the set of braided trails. The braided complex width is the width of the complex from one side to the other.
7. **BraidTotTrldGrnd** (optional, but required if it is a braided trail)
   a) From the drop-down menu, choose the total width of trailed ground within the braided complex.
   b) To calculate the “braided total trailed ground” add the width of each braided segment trail.

Post-collection and processing:

Each day following field work, technicians will return to the Vegetation and Restoration office to download the GPS (see “Downloading GPS” instructions), download photos, update photo-documentation and time spent records, and charge camera batteries.

End of season procedures:

Following completion field work, data will be managed properly (see Data Management section), and a report will be compiled.

B.4.4 Data Management

Data entry:

- GPS data will be downloaded at the end of each day. No later than one week after downloading, GPS files will be differentially corrected. Corrected files will then be exported and converted to GIS shapefiles. The shapefiles will then be used to create maps and for analyzing purposes.
- Photos shall be downloaded and labeled following the photo documentation protocol as outlined in the "ThumbsPlus Step-By-Step User's Guide. Photos will be stored following the "Photo Library File Structure Organizational Chart". All photos shall follow the "Standard Operating Procedures for Assigning Image File Names". The brief description, as part of the file name, should include the meadow name and the condition-class. (e.g. YOSE-LeidigMeadowBarren-20070721.tif). Keywords and notes should also be assigned to all photos.
- Time spent will be entered into the "time spent" word file, with a description of the work completed that day.

Data analysis:

GIS data will be converted into maps depicting informal trails in the areas being monitored. Calculations in ArcGIS 9 on informal trail features and meadow polygons will be completed to achieve informal trail density results.

Data reporting:

Maps, informal trail density, and other data will be formalized in the 2007 VERP Report.

Data storage (meta-data):

All GPS data (Trimble files) will be stored in ms01/EP Resources/Restoration Program Commons/GPS Data/VERP/2007/Informal Trails/Valley or Tuolumne. All GIS shapefiles will be stored in ms01/EP Resources/Restoration Program Commons/GIS Data/VERP/2007/Informal Trails/Valley or Tuolumne. All photos will be stored in ms01/EP Resources/00.Photo Library_RMS/Projects and Programs/Vegetation and Restoration/VERP. To follow the Resources Management and Science photo library file structure, all photos previously stored in ms01/EP Resources/Restoration Program Commons/VERP/2006/Informal Trails/Valley or Tuolumne/Photos will be moved to the aforementioned location.

B.4.5 Personnel Requirements and Training

Roles and responsibilities (tasks and time commitments):

Tasks:

- A Supervisory GS-7 will be responsible for the oversight of the Yosemite Valley and Tuolumne Meadows Informal Trails indicator. The duties will include: training of, managing, and supporting field technicians; attending monthly VERP team meetings; consulting with academic, agency, and other experts to further this indicator; assisting in analysis; and writing reports. They will serve as the point-of-contact, directly under the Branch Chief for this indicator.

- Assistant Supervisory GS-6 will be responsible for supporting the Supervisory GS-7. The duties will include: assisting the GS-7 with training of, managing, and supporting field technicians; attending monthly VERP team meetings; consulting with academic, agency, and other experts to further this indicator; assisting in analysis; and writing reports. They will serve as the point-of-contact, directly under the GS-7 for this indicator. They will also serve as the point-of-contact and support person for the field technician.
- Field Technician will be responsible for data collection and some data entry. The duties will include: mapping the informal trails; downloading GPS files; creating maps; and maintaining accurate and complete records of field work.

Projected time commitments are as follows:

- Supervisory GS-7: one week for training assistant supervisor and field personnel; one week for refining protocol; three to four weeks for mapping trails in Tuolumne Meadows; 2.5 hours per month for team meetings; one week for participating in workgroups; and one to two weeks for report writing.
- Supporting GS-6: total of 4-6 hours per week of oversight of field technician; three to four weeks for monitoring informal trails in selected areas in Yosemite Valley; 2.5 hours per month for team meetings; one week for participating in workgroups; and one to two weeks for report writing.
- Field technician (i.e. Americorp intern): one week for monitoring informal trails in selected areas of Tuolumne Meadows; and one to two weeks for creating maps.

Qualifications:

- Supervisory GS-7 should be knowledgeable of the overall VERP program; the protocol specifics of the VERP Informal Trails Indicator; and condition class characteristics. They should be comfortable in a supervisory role and should have background in the natural sciences or resources/recreation management.
- The supporting GS-6 should have experience in the fields mentioned above, be able to communicate well, and be comfortable in a leadership position. They should also be prepared to assist and fill-in with the duties assigned to the Supervisory GS-7.
- The field technician should also have experience in the fields mentioned above, as well as, posses the ability to pay attention to detail, follow instructions, work independently, and be computer savvy. Ideally, they will have experience operating a GPS unit and related GIS computer software.

Training procedures:

Experienced Vegetation and Restoration management staff, with professional knowledge of informal trail protocol and procedures, will be responsible for training non-experienced NPS staff, interns, and/or volunteers to bring their skills, ability and knowledge to a level that will allow them to monitor informal trails independently. NPS staff and volunteers will be required to demonstrate the ability to:

- Navigate to target sites at meadows

- Operate a GPS device
- Assign proper condition class and other trail attributes
- Download GPS data (see attached instructions)
- Document time spent and photos using the proper forms

These skills will be verified through field training and assistance from qualified Vegetation and Restoration Management staff.

B.4.6 Operational Requirements

Work plan:

Protocol refinements conducted prior to field season in April, May, and June over a one-week total time period. Field work conducted mid-July through mid-August in Yosemite Valley and in August in Tuolumne Meadows on the following schedule:

Yosemite Valley:

- Week 1 (field technician, GS-7 term, GS-6 seasonal): training and quality assurance
- Week 2-4 (GS-6 seasonal): mapping and assessments of informal trails and disturbed areas in Sentinel, Leidig, Stoneman, Ahwahnee, and Bridalveil meadows.
- Technician (AmeriCorps Intern): Creating maps conducted over a two-week time period following field work.
- GS-6 seasonal: Mapping and data reporting conducted over a two-week time period following field work.

Tuolumne Meadows:

- Week 1-2 (GS-7 term): mapping and assessments of informal trails between the Dana and Lyell forks of the Tuolumne River, near the high-use zones and encompassed by the Tuolumne Development Concept Plan.
- Technician (AmeriCorps Intern): Creating maps conducted over a one-week time period following field work.
- GS-6 seasonal: Mapping and reporting will be conducted over a one-week time period following field work.

Safety:

A job hazard analysis has been completed for this indicator. See table below (Table B.4.1).

Table B.4.1 Job Hazard Analysis for Extent and Condition of Informal Trails

United States Department of Interior **NATIONAL PARK SERVICE**	**1. WORK PROJECT/ACTIVITY**	**2. LOCATION**	
	VERP Informal Trail Monitoring	Yosemite Valley and Tuolumne Meadows, YNP	
Job Hazard Analysis (JHA)	**3. NAME OF ANALYST**	**4. JOB TITLE**	**5. DATE PREPARED**
	Crystal Elliot	Technician	June, 2006
6. TASKS/PROCEDURES	**7. HAZARDS**	**8. ABATEMENTS ACTIONS** ENGINEERING CONTROLS – SUBSTITUTION – ADMINISTRATIVE CONTROLS – PPE	
a. Driving to, from, and around sampling sites.	a. Collision resulting in damage, injury, or death.	a. Drive defensively, obey traffic laws, lights on, seatbelt on, be alert for pedestrians, wildlife, and distracted drivers. Know procedures for installing snow chains. Always carry and know how to use a Park radio.	
b. Hiking through and working in meadows.	b. Inclement weather, heat, dehydration; poison oak; insects and snakes.	b. Dress appropriately, drink plenty of fluids, bring snacks and/or meals if out during lunch hours, carry first-aid kit including snake-bite kit and Tecnu, in case of contact with poison oak. An Epi pen may be necessary to carry as well.	
c. Working and walking along riverbanks.	c. Tripping and/or falling due to wet and slippery rocks or sloping ground surfaces, contact with poison oak, etc.	c. Watch footing, know how to identify and avoid all poison oak, rinse immediately in stream if contact occurs.	
d. Working outdoors in hot, dry conditions.	d. Dehydration, heat exhaustion.	d. Stay hydrated. Take frequent breaks if weather is uncomfortably warm. Use sun protection (e.g. hat).	

e. Working outdoors in cold and/or wet weather.	e. Hypothermia, reduced resistance to illness.	e. Stay dry. Use rubberized raingear if possible. Stay hydrated preferably with warm liquids. Stop work to warm up if necessary. Snack often.
10. SUPERVISORS SIGNATURE	**11. TITLE**	**12. DATE**

B.5 WILDERNESS ENCOUNTERS

B.5.1 BACKGROUND

The Wilderness Act of 1964 mandates that designated wilderness will have "outstanding opportunities for solitude." While there is some disagreement about the value of monitoring encounters as a measure of wilderness experience quality (Stewart 2001; Cole, 1996), historically, wilderness managers have considered inter-group encounters as a primary threat to solitude (Watson 1998). In the most comprehensive study of visitor experience in the Yosemite Wilderness, Newman in 2002 found encounters with other parties to be the second most important attribute affecting the quality of experience in a trade-off analysis.

This field protocol presents the procedures, data requirements and data collection sheets for the number of encounters Yosemite NP rangers or volunteers have with visitors on trails. The Visitor Use and Impact Monitoring Program identified one area of the Merced corridor that should be monitored. In 2009, researchers from the University of Idaho performed a pilot study in the Tuolumne River Corridor. The results of this study have been included in the 2009 Visitor Use and Impact Monitoring Program annual report.

B.5.2 DESCRIPTION OF INDICATOR AND STANDARD:

Description of Indicator and Standard

Indicator:
Encounters with other parties gauges the density levels and flow rates of visitor use in designated wilderness areas.

Draft Standard:
No more than two encounters with another party per hour, 80 percent of the time. This standard will be evaluated based on study sites that reflect the range of front-country and backcountry use levels within the Tuolumne River Corridor.

Rationale for indicator: Crowding and solitude are important components of wilderness experience. Numerous studies explore the effect of encounters in wilderness settings as they affect the nature of visitor's experiences. Encounter rates are one vital part of the decision making matrix that would be used to review and possibly modify Yosemite's current overnight wilderness use limits.

Objectives:

1. To assess crowding and opportunities for solitude as a component of wilderness experience quality in the upper Merced River corridor.
2. To assess crowding and opportunities for solitude as a component of wilderness experience quality in both frontcountry and backcountry trail segments in the Tuolumne River corridor.

B.5.3 Sampling Design

In the Merced River corridor component of the study, data will be collected primarily by the Merced Lake Ranger. Sampling will attempt to mimic, as much as possible, the visitor's experience, while recording the number of groups encountered. Data will be collected as part of routine patrols. Sampling times and locations will be dictated by patrol priorities rather than data needs. Temporal and spatial variation in data collection will be attained by combining several years' data and filtering for a variety of spatial and temporal characteristics. If more people can be devoted to data collection, they will be assigned to mitigate any deficiencies that result from this type of opportunistic sampling.

2009 represented the beginning of the development phase of a sampling strategy for Wilderness Encounters in the Tuolumne River Watershed. Through a CESU cooperative agreement, researchers from the University of Idaho implemented a pilot study on determining the most effective and statistical significant methods to implement encounter measurement in the Tuolumne River Corridor. In 2010, this indicator was imlemented in the Tuolumne River Corridor.

Rationale for sampling design:

Most research on wilderness encounters considers encounters per day. A minority of visitors stay in the river corridor the entire day, therefore, encounters are recorded by trail segment, with sampling time in the segment noted. While a more robust schedule based on sampling priorities would obviously be preferable, funding and other operational limitations dictate that sampling must be coincident with ranger patrols.

Site selection:

A map of all indicator sampling locations is provided in the introduction to this field guide.

Trail segments sampled:

On trail

- Moraine-Echo
- Echo-MLRS
- MLRS-Washburn
- Washburn-Junction

Sampling Schedule (Merced Corridor):

The Merced Lake Ranger typically patrols the upper Merced Drainage from late May (depending on snowpack) to early October, and performs eight to nine day patrols during each two week period. Much of June is spent training in the front country. Encounters will be recorded during regularly scheduled ranger patrols.

B.5.4 Field Methods

Field methods for this indicator are currently being revised to better accommodate the use of volunteers and interns for the data collection. The field methods listed below are indicative of those currently in practice for the Merced River Corridor. For 2009, researchers from the University of

Idaho piloted implementation of this indicator as part of a CESU will be determined and represented in the 2010 field guide. Further refinement of this indicator will be made available in 2010.

Data collection and measurement

- Data collectors should attempt to match their travel speed to that of a typical visitor, approximately two miles per hour.
- Whenever a data collector enters a new trail segment, the time will be recorded on the data sheet/index card. Any encounters within that zone will then be recorded. Staff should record an end time at the end of the zone or each time one needs to leave the trail to perform administrative duties.
- Data collectors will only count parties that are close enough to establish verbal or eye contact without leaving the trail. Parties camped close to the trail that can be seen and talked to from the trail will count. Each party will be counted only once, even if encountered multiple times. Parties found by leaving the trail to specifically look for campers or to perform other administrative tasks will not count. Other administrative parties (rangers, concession employees, etc.) will not be counted.
- If the data collector is unsure about whether individuals hiking separately are part of the same party, they will ask. This is already done as part of routine patrol.

When encounters with parties occur along a trail or are visible from the trail, record the following data on the data sheet provided:

- **Field Monitor Name(s):** Record field monitor name(s).
- **Date:** Day/Month/Year (August 8, 2008 = 08/08/08).
- **Start Time:** Record time entering trail segment or following a side trip off the trail.
- **End Time:** Record time leaving trail segment or when leaving trail.
- **Segment:** Record the trail segment number.
- **Number of Parties Encountered:** Record the number of parties encountered along segment of trail monitored.
- **Notes:** Record any information pertinent to the collection of data on that day in that particular site (i.e., weather, access issues, special events, etc.)

Table B.5.1 Data Sheet Used for Wilderness Encounters

Field Monitor Name:	
Date:	

Trail Segment*	Start Time	End Time	# of Parties Encountered

Segments:	
1B Zone	
Moraine-Echo	1
Echo-MLRS	2
MLRS-Washburn	3
Washburn-Jct.	4

Post-collection and processing

- At the conclusion of the hike, the data should be transposed onto an Encounter Record Sheet, which should be filed until the end of the data collection period.
- Return data sheet/index cards to the wilderness management office and enter information in the Number of Encounters with other Parties database.

End of season procedures

- Data collectors should meet with the Visitor Use and Impact Monitoring Program Manager and Wilderness Specialist at the end of the season to discuss potential program improvements.

B.5.5 Data Management

Data entry:

All data will be entered into the Number of Encounters with other parties' database.

Data analysis:

Questions remain on the best method of analysis for this indicator. Most are due to the difference between the units (encounters/day) used in most studies on the subject and the visitor use patterns found in the Merced River corridor: Most visitors spend only part of the day traveling in the sampling area. The best way to analyze the data to represent a visitor day across all temporal and spatial variables still needs to be decided. One of the major goals of the establishment of the CESU agreement was to determine better experimental design, implementation and analysis of the encounters.

Data reporting:

Results from data analysis will be reported in the Visitor Use and Impact Monitoring annual report, at public meetings, and on the park's website.

Data storage (meta data):

Data will be stored in the wilderness patrol database. Data is entered into the User Capacity database by the indicator lead

B.5.6 Personnel Requirements and Training

Roles and responsibilities (tasks and time commitments):

The Merced Lake Ranger will be the primary data collector. Other volunteers may be able to supplement this effort as available. Because this sampling occurs only during routine patrols; time commitment is minimal; training (1hour), data transfer (10 minute/day), data entry (2-3 hours for the season), and debriefing (1 hour).

The indicator lead and program manager will be responsible for training data collectors (1 hour), providing logistics for any volunteers (3 hours each), quality control (one 3 day visit to the sampling area), debriefing (1 hour), and data analysis (1 day).

Qualifications:

Data collectors must be competent at living and traveling in a remote wilderness setting. They also need to be able to record data accurately and maintain records accordingly.

Training procedures:

The Visitor Use and Impact Monitoring Program Manager and/ or Wilderness Rangers with experience in recording encounters with parties will be responsible for training any NPS staff or volunteers without prior monitoring experience. NPS staff and volunteers will be required to demonstrate the ability to:

- Adjust hiking speed to approximate the typical speed of a visitor. Typical hiking speed would be approximately 2 miles per hour.
- Make appropriate recordings of encounter data on ranger patrol card.
- Enter data into the Number of Encounters database.

B.5.7 Operational Requirements

Work plan:

Sampling will take place during the summer season, approximately mid June through mid October.

Safety:

The job hazard analysis for this indicator is the same as for routine wilderness patrol.

Table B.5.2 Job Hazard Analysis for Wilderness Encounters

United States Department of Interior NATIONAL PARK SERVICE	1. WORK PROJECT/ACTIVITY	2. LOCATION	
	Wilderness Encounters	Yosemite Wilderness, YNP	
Job Hazard Analysis (JHA)	3. NAME OF ANALYST	4. JOB TITLE	5. DATE PREPARED
	Mark Fincher	Wilderness Mgr.	July, 2005
6. TASKS/PROCEDURES	**7. HAZARDS**	**8. ABATEMENTS ACTIONS** ENGINEERING CONTROLS – SUBSTITUTION – ADMINISTRATIVE CONTROLS – PPE	
a. Driving to, from, and around sampling sites.	a. Collision resulting in damage, injury, or death.	a. Drive defensively, obey traffic laws, lights on, seatbelt on, be alert for pedestrians, wildlife, and distracted drivers. Know procedures for installing snow chains. Always carry and know how to use a Park radio.	
b. Walking, hiking and other physical exertion.	b. Exhaustion, muscle strain, dehydration and fatigue.	b. Drink plenty of fluids, bring snacks and/or meals if out during lunch hours, Take periodic rests and stretch before and after physical activity.	
c. Hiking and camping in Wilderness.	c. Bite or attack from snakes, bees and or wildlife. Exposure to poison oak.	c. Use appropriate backcountry hiking and camping techniques. Use appropriate backcountry gear and clothing. Carry park radio and first aid kit. Leave travel itinerary with supervisor.	
d. Working outdoors in cold and/or wet weather.	d. Hypothermia, reduced resistance to illness.	d. Wear appropriate clothing and carry extra layers. Stay dry. Use rubberized raingear if possible. Stay hydrated preferably with warm liquids. Stop work to warm up if necessary. Snack often.	
e. Working outdoors in hot / extreme heat weather.	e. Fatigue, exhaustion, dehydration and heat stroke.	e. Wear appropriate clothing and use sunscreen. Drink fluids and snack throughout the day. Carry extra water and dehydration salts along with first aid kit.	
10. SUPERVISORS SIGNATURE	**11. TITLE**	**12. DATE**	

Equipment and materials:

- Pencils / sharpener
- Watch
- Data Sheet

B.6 EXTENT OF VISITOR USE

B.6.1 BACKGROUND

The visitor use monitoring indicator will allow managers to assess use densities, durations, and activity types along the Merced and Tuolumne Rivers and high use trails. This indicator directly represents both the Recreation and Scenic Outstandingly Remarkable Values (ORV) but is also correlated to all other values established for the river corridors. This indicator has been developed for a number of different purposes including: 1. assist in computer simulation outputs of people-at-one-time (PAOT) and people-per-viewscape (PPV) metrics; 2. estimate PAOT in order to understand the relationship between visitor use and natural resource impact; 3. identify specific locations at attraction sites (e.g. lakes and rivers) where visitors recreate.

Description of Indicator and Standard

Indicator:

For the Merced River, visitor use monitoring serves as a gauge of park visitor use activity along the river. This indicator reflects visitor use levels and behaviors that may potentially cause negative impacts such as crowding, user conflict, noise and others visitor caused disturbances on both natural resources and the visitor experience. Visitor count measures overall recreation use in the river corridor and helps to protect the Merced River's Outstandingly Remarkable Values.

River Standard:

Methods alteration**:** Developing baseline

Trail Standard:

Methods alteration: Developing baseline

Rationale for indicator:

Documenting visitor use levels and their activities is an essential component of user capacity and related monitoring programs. Visitor use monitoring serves as an indicator of overall visitor use levels at points of interest including trails, attraction sites, and in-river recreational sites. Crowding and congestion have been shown to degrade the quality of visitor experiences (Manning 1999; Manning 2007) and can have a negative impact on park resources (Hammit and Cole 1998).

Trail and Attraction Site Use Monitoring:

Additional methods to capture data for this indicator were developed during the 2009 field season. Aggregate counts of visitor use at discrete locations along the Merced River in Yosemite Valley are being monitored and Geographic Positioning Systems (GPS) are being used to capture spatially specific visitor use levels around Tenaya Lake. In addition, automated visitor counters are being used to estimate visitor use along various trail segments in Yosemite Valley, Tuolumne Meadows, and around Tenaya Lake.

Objectives:

To document the levels and types of visitor use at key areas on the river banks, on trails, and at attraction sites within the Merced and Tuolumne River Corridors.

B.6.2 Sampling Design

Rationale for sampling design:

The visitor use indicator is designed to quantify the number of visitors along trails, at attraction sites, and along river banks in Yosemite National Park. Visitor use at recreation areas where visitor use is dispersed (e.g. attraction sites, riverbanks, lakes) is measured differently than visitor use along trails and is described in the following paragraphs:

- **Dispersed visitor use:** Measured through direct observation of PAOT using a randomized sampling design. Sample days will be stratified by weekend (Saturday - Sunday) and weekday (Monday – Friday) and PAOT observations will be conducted over the course of a day using a systematic sampling design with a random start time (e.g. every 15 minutes from 9:00 am – 5:00 pm).
- **Visitor use along trails:** Measured using automated visitor counters. These devices can count continuously for up to 10 months, thus obtaining a census of visitor use during the study period. However, these devices are subject to counting error and direct observations of actual visitor use must be obtained to correct for miscounts by automated monitors. Previous research has shown automated monitor counting errors exhibit little variability among different levels of visitor use (Pettebone et al. 2008). Thus, a convenience based sampling approach can be taken to estimate correction factors for automated monitors.

Measurement:

PAOT:

At each study site, the total number of visitors will be documented throughout the day. These data will yield temporally and spatially specific estimations of visitor use levels (e.g. average daily visitor use, average hourly visitor use, weekday vs. weekend visitor use) and the different recreation activities taking place at a study site (e.g. boating, swimming, hiking).

Trails:

The measurement for visitor use along trails will be the total number of people using the selected trails. Automated visitor monitors are able to estimate the overall amount of use that the trail receives. Combined with calibration days (i.e. observed counts to determine automated visitor monitor counting error due to shoulder-to-shoulder walking, fast-paced walking, stopping on or near the infrared beam, etc), the park is able to identify time specific use levels over a longer period of time rather than manual counts that require extensive labor hours. In locations where automated monitors are not able to be used, staff and volunteers performed manual counts to capture use levels.

Site selection (selection criteria and procedures):

PAOT:

Merced River: Four of the deliberate sample sites from the riverbank condition study described in section B.2 were selected for study in 2009. PAOT will be documented within each vegetation plot at Tenaya Creek, Pohono Bridge, Sentinnel Beach, and Swinging Bridge. This study will complement the riverbank condition effort by providing estimates of visitor use in order to understand the relationship between visitor use and natural resource conditions.

Tenaya Lake: Little research has been conducted about visitor use around Tenaya Lake. Therefore, no assumptions will be made about when, where, and what activities take place at this study site and visitor use along the entire shoreline of Tenaya Lake will be documented using GPS.

Automated Visitor Monitors:

Trails were selected to coincide with concurrent studies being conducted. In Tuolumne Meadows, automated visitor monitors were installed at trailheads where a study to estimate wilderness encounters was being conducted. At Tenaya Lake, visitor counters were installed along the trail on the south side of the lake to complement the PAOT study described in the previous paragraph. Additionally, automated visitor monitors were installed at three locations in Yosemite Valley during June 2009: Upper Yosemite Falls, Four Mile Trail, and on the west end of the valley loop trail.

Sampling Schedule:

Field work for this indicator will be conducted on mornings and afternoons for weekdays, weekends, and holidays during peak season from June through September. Monday-Friday constitutes weekdays, while Saturday-Sunday constitutes weekend days. Automated visitor monitor calibrations will be conducted throughout the summer; this will consist of monitoring for approximately four hours during each sample period. Ten hours of observations will be conducted at each automated visitor monitor. Sampling with automated visitor monitors is continuous throughout the season and ensures a large sample to understand differences in hourly, daily, weekly, and seasonality in visitor use patterns.

B.6.3 FIELD METHODS

Preparation:

Field personnel should be trained (see Training guidelines section below) and the following required tools and supplies should be acquired.

- Map with location, photos, and directions to monitoring sites
- Field Forms: Data sheets on waterproof paper
- Clipboard/pencils/pens
- Watch with second hand
- Counter
- Sunscreen/insect repellant/first aid kit
- Water.

Training outline: YOSE data collection staff training form

- Supplies from shipped boxes
- Study overview
    - Purpose
    - Study sites
    - Types of information
    - Modeling
- Sampling schedule
    - NPS and VUSS staff
    - 7 hours of sampling, morning and evening study administration
- Logistics
    - Research supplies storage
    - Computer access
    - Transportation to and from study sites
    - Daily meeting time and location
        - With VPI too, after July 17
    - SCA housing
    - VPI camping location
    - NPS research permit
- Survey instruments
    - Route surveys and survey logs, by location
    - Visitor counts forms, by location
    - Site schematics
- Pocket PC's
    - Operation of each model
    - Name of each unit
    - Battery installation, battery life, and battery charging
    - Data entry
        - Event button and Pocket PC site legends
        - Naming files on Pocket PC
    - Data entry error log (Make photocopies if more logs are needed)
    - Hardcopy forms for backup
        - Battery capacity, event counter capacity, mechanical issues

- Data download and file organization
    - My Documents (Event Counter data files)
    - Program Files (Event Counter program)
    - Organizing and naming files on computer
- Daily routine
  - See handout
  - **Organization is everything!**
- Survey research
  - Consistency of administration is critical!
  - Response rates reflect data quality
    - Develop a good “come-on”
  - Clear, legible data recording key for data entry by other people
  - Observant to “problems” early in the study is important
    - Consult before revising methodology!
    - Organization is everything!

Data Collection

PAOT:

Sampling protocols will be developed based on site specific opportunities and limitations. There are a number of variables to consider when developing PAOT protocols for dispersed visitor use and include but are not limited to: 1) entrance and exit points; 2) visibility (or non-visibility) of study area from an observation point; 3) the type of recreation use being observed; and 4) size of the study area. Observers will count the total number of people in the study area from a designated point at study sites where visibility is not limited. Study sites should be well defined and easily identifiable from the observation point. In contrast, observers will count the number of people they see while walking through study sites where visibility is limited or visitor use cannot be estimated from a single observation point. All data will be recorded using a standardized format (either paper or electronic formats) (

Table B.6.1).

Table B.6.1 PAOT (People at One time) datasheet from the Merced River PAOT study

Date:		Name:		Location:		
Time	**Count 1**	**Count 2**	**Count 3**	**Count 4**	**Count 5**	**Comments**

Monitor Calibration Protocol:

1. Calibrations are set up as hour-long sampling periods, broken into four 15-minute sections. Each hour of calibration takes up four rows on the form. The "time start" and "time end" correlate with the four 15 minute sections (ex. 8:00-8:15, 8:15-8:30, 8:30-8:45, 8:45-9:00). See Table B.6.2.
2. The unit number and date are recorded in their respective columns.
3. At the start and end of each 15 minute section, the monitor number displayed is recorded into the "monitor start" and "monitor end" columns respectively.
4. The "monitor count" column is "monitor end" minus "monitor start".
5. For Bridalveil, use a single tally-clicker and count the number of people who hike the trail, both up and down. At the beginning of each 15 minute section, start the tally at zero and record the total count of that 15 minute section in the "total count" column.
6. When tallying with your clicker, count each person a total of two times, only once on the way up and once on the way down. This is important to know because if you see a person who checks out either of the monitor components and you notice that they trigger multiple monitor counts, you do not want to record on your clicker each count they make, only once on the way up and once down. Also, it is not necessary to stop the person from making multiple counts, as this is part of the natural error process, *unless* they are being destructive with the monitor.
7. *Calculating the R is not necessary*, as they are processed much easier in Excel, but for your understanding, the "R" column stands for ratio of total observed counts to monitor counts (e.g. 75 total counts divided by 50 monitor counts equals 1.5, so for each monitor count there is actually 1.5 people passing)

Table B.6.2 Visitor Monitoring Calibration Form

Monitor Number	Date	Start Time	End Time	Monitor Start	Monitor End	Total Count	Monitor Count	Ratio: (Total Count/Monitor Count)

Post-collection and processing:

Datasheets in electronic form will be e-mailed to the Visitor Use and Impact Monitoring Program office. Original datasheets (if manually completed) will then be copied and stored in the Visitor Use and Impact Monitoring Program programing office in El Portal.

B.6.4 Data Management

Data Entry:

Collected data will be downloaded or transferred into the appropriate computer software (e.g. StatPack, Excel, etc).

Data analysis:

Visitor use will be statistically analyzed via Statistical Package for the Social Sciences (SPSS) and incorporated into summary tables. Data should be presented by sampling location, date and time.

Data reporting:

Visitor use along the two river corridors and trails within has been presented in the 2009 Visitor Use and Impact Monitoring Annual Report as well as in the 2010 Visitor Use and Impact Monitoring update. More detailed reporting will be provided by the Cooperative Ecosystem Studies Unit as stated in the final agreements. Additionally, results will be applied to other aspects of park management.

Data storage:

All collected data and compiled documentation will be stored on the YOSE NPS network (ms01/EP Commons/VERP/VERP Indicators/Visitor Use/Data). GIS maps and project files can be found at (ms01/ EP Commons/VERP/VERP Indicators/General/VERP Site Maps Compiled). Datasheets can be found at (ms01/ EP Commons/VERP/VERP Indicators/Visitor Use/Visitor Use Trail/Visitor Use Datasheet) and originals will be stored in the VERP office in El Portal.

B.6.5 Personnel Requirements and Training

Roles and responsibilities (tasks and time commitments):

Supervisory GS-7 responsible for oversight of field work and training of personnel not familiar with protocol and surveying. GS-7 field technician in charge of tasks associated with visitor use surveys and training and supervising other field staff. Other field staff will assist in surveying visitor use.

Projected personnel needs for visitor use monitoring locations are six personnel for 12 weeks including training throughout the summer. Additional time will be contributed by CESU. The river sites will require a total of twenty days and each day requiring six to eight hours to monitor. A total of 50 hours will be needed to calibrate the automated visitor monitors.

Qualifications:

Data collectors must demonstrate the ability to accurately count the number of visitors, download data from automated visitor monitors using the necessary equipment, and efficiently conduct brief interviews with visitor groups. All data collectors will be required to work outdoors during inclement weather, stand for extended periods of time and may be required to hike or walk for long distances.

Staff Training:

Two days will be dedicated to familiarizing field staff with data collection procedures and the overall purpose of the study. Formalizing this process ensures interviewer/data collector accuracy.Operational Requirements

Work plan:

Sampling will take place during the summer season from mid June through August. Trail use data collection will continue throughout the summer and instrument calibration with rotate throughout this time.

Safety:

A job hazard analysis has been completed and appears below (

Table B.6.3).

Table B.6.3 Job Hazard Analysis for Extent of Visitor Use Data Collection

United States Department of Interior NATIONAL PARK SERVICE	1. WORK PROJECT/ACTIVITY	2. LOCATION	
	Visitor use Monitoring	Yosemite Valley, YNP	
Job Hazard Analysis (JHA)	3. NAME OF ANALYST	4. JOB TITLE	5. DATE PREPARED
	Bret Meldrum	Technician	May, 2008
6. TASKS/PROCEDURES	**7. HAZARDS**	**8. ABATEMENTS ACTIONS ENGINEERING CONTROLS – SUBSTITUTION – ADMINISTRATIVE CONTROLS – PPE**	
a. Driving to, from, and around sampling sites.	a. Collision resulting in damage, injury, or death.	a. Drive defensively, obey traffic laws, lights on, seatbelt on, be alert for pedestrians, wildlife, and distracted drivers. Know procedures for installing snow chains. Always carry and know how to use a Park radio.	
b. Walking, hiking and other physical exertion.	b. Exhaustion, muscle strain, dehydration and fatigue.	b. Drink plenty of fluids, bring snacks and/or meals if out during lunch hours, Take periodic rests and stretch before and after physical activity.	
c. Hiking through and working in meadows.	c. Inclement weather, heat, dehydration; poison oak; insects and snakes.	c. Dress appropriately, drink plenty of fluids, bring snacks and/or meals if out during lunch hours, carry first-aid kit including snake-bite kit and Tecnu, in case of contact with poison oak. An Epi pen may be necessary to carry as well.	
d. Working and walking along riverbanks.	d. Tripping and/or falling due to wet and slippery rocks or sloping ground surfaces, contact with poison oak, etc.	d. Watch footing, know how to identify and avoid all poison oak, rinse immediately in stream if contact occurs.	
e. Working outdoors in cold and/or wet weather.	e. Hypothermia, reduced resistance to illness.	e. Wear appropriate clothing and carry extra layers. Stay dry. Use rubberized raingear if possible. Stay hydrated preferably with warm liquids. Stop work to warm up if necessary. Snack often.	
f. Working outdoors in hot / extreme heat weather.	f. Fatigue, exhaustion, dehydration and heat stroke.	f. Wear appropriate clothing and use sunscreen. Drink fluids and snack throughout the day. Carry extra water and dehydration salts along with first aid kit.	
g. Hiking in Wilderness.	g. Bite or attack from snakes, bees and or wildlife. Exposure to poison oak.	g. Use appropriate backcountry hiking and camping techniques. Use appropriate backcountry gear and clothing. Carry park radio and first aid kit. Leave travel itinerary with supervisor.	
10. SUPERVISORS SIGNATURE	**11. TITLE**	**12. DATE**	

Equipment and materials:

- Map with location, photos and directions to monitoring sites
- Field Forms: Data sheets, route surveys, and smiley stickers
- Data Collectors-when downloading
- Clipboard/pencils/pens
- Watch with second hand (stopwatch optional).
- Hand Counter/PDA
- Sunscreen/insect repellant/first aid kit
- Water

B.7 ARCHEOLOGICAL SITE CONDITION, STABILITY, AND INTEGRITY

B.7.1 BACKGROUND

Problem statement

Under the National Historic Preservation Act (1966) and Director's Order #28A (2004), the National Park Service is committed to the conservation of archeological resources as elements of our national heritage. Along the Merced and Tuolumne Wild and Scenic Rivers, archeological sites have also been selected as cultural contributors to the Outstanding and Remarkable Values for the river corridors. Archeological site conditions, stability, and integrity were chosen as a potential indicator group because these characteristics are sensitive to visitor use impacts. Negative impacts can lead to the irretrievable loss of archeological research data. Typical visitor disturbances at archeological sites include: trampling and soil compaction from camping and social trails; artifact theft or movement; vandalism; fire ring construction; ground disturbance from digging, rock or feature displacement; and feature destruction

Despite numerous applications of the adaptive management framework to natural resources, there are few applications of this process to non-renewable elements such as cultural resources (see NPS 2000, 2001; Fairley and Downum 2000). For archeological sites listed or eligible for inclusion in the National Register of Historic Places (NRHP), no decline in data potential, significance, or integrity of site conditions is acceptable without working through a formal planning process as defined by NHPA or the National Environmental Protection Act (NEPA). This project explores the applicability of the National Park Service's Archeological Site Monitoring Information System (ASMIS) to measure visitor use-impacts to archeological resources.

Description of indicator and standard

Indicator: Archeological Site Condition, Stability, and Integrity

The indicator group includes the condition, stability and integrity of archeological sites within the Merced and Tuolumne Wild and Scenic River corridors. The terms "condition" and "stability" refer to the current physical state of the site and associated material remains and the potential for deterioration over time. Site "integrity" refers to the ability of the site to convey information potential. Integrity also refers to the site's ability to transmit the setting, feeling, and association of previous historical eras to researchers, the public and traditionally associated peoples

Draft Standard:

Visitor impacts to archeological sites with low data potential may not exceed a "partial loss-repairable" disturbance effect at more than 10% of sites visited in a field season. Visitor impacts to archeological sites with high data potential may not exceed a "negligible" disturbance effect at any site visited in a field season.

Rationale for indicator:

Archeological resources are the material remains of human life and activity "capable of providing scientific or humanistic understandings of past human behavior" (Grumet 1988). Those material remains include surface and sub-surface physical evidence of human habitation, use, and activities in locations (sites) on the landscape. The terms "condition" and "stability" refer to the current physical state of the site and associated material remains and the potential for deterioration over time. Site "integrity" refers to the ability of the site to convey information potential. Integrity also refers to the site's ability to transmit the setting, feeling, and association of previous historical eras to researchers, the public and traditionally associated peoples.

Archeological sites must retain the majority of features and artifacts that "convey key aspects of materials, workmanship, design and cultural-temporal association"... as well as "their physical relationships (location, setting) relative to the landscape and to one another" (Fairley and Downum 2000) or risk the irreparable loss of data/research potential and other intangible values.

Objectives

Project objectives include baseline site condition assessments and ongoing site monitoring of visitor impacts at archeological sites within the Merced and Tuolumne Wild and Scenic River corridors. Through a comparison of visitor-caused disturbances and baseline changes over time, problem trends and individual sites can be identified for future management corrective actions such as ground stabilization, data recovery, restoration, and/or access restrictions to prevent further site degradation. A long term project objective is the development of protocols for quantitative and systematic archeological site condition assessment focused on visitor use impacts.

Rationale for sampling design

The sampling design is limited to previously recorded archeological sites located within a half-mile wide corridor centered along the Merced and Tuolumne Wild and Scenic River segments. In-field research collects baseline site condition data and monitors visitor impacts through seasonal visits to a varied sample of archeological sites each year. Data collection protocol utilizes ASMIS, a nation-wide National Park Service database for assessment and management of archeological resources (NPS 2007). ASMIS documents site locations, conditions, research potential, current disturbances, and future threats, both natural and human related. ASMIS recording parameters have been augmented with visitor-specific impact measurements. Evaluation of monitoring protocol effectiveness and suitability will continue over multiple field seasons.

Sampling Schedule:

Sampling will take place during July and August of the summer field season.

Site selection (selection criteria and procedures)

Condition assessment locations include a yearly random sample of approximately 45-70 sites drawn from the population of all previously recorded archeological sites within the Tuolumne and Merced

Wild and Scenic River corridors. The sample is stratified by river corridor and site type vulnerability designations – “high” or “low” - based on research data potential and the fragility of site components. Calculations of data potential and fragility are assigned using information contained in the park’s ASMIS database; these designations are considered preliminary and subject to change based on future research. Additionally, 10-20 sites assessed during previous project field seasons are revisited to determine if short-term changes to baseline site condition can be observed. Table B. 7.1 below contains a list of sites assessed in the most recent field season (2010).

Table B.7.1 List of Archeological Sites Assessed in 2010, by River Corridor and Vulnerability Rating.

Merced River Corridor High Vulnerability sites (n=17)	Merced River Corridor Low Vulnerability sites (n=18)	Tuolumne River Corridor High Vulnerability sites (n=17)	Tuolumne River Corridor Low Vulnerability sites (n=18)
CA-MAD-2332	CA-MAD-2295	CA-TUO-0124	CA-TUO-3945/H
CA-MRP-0174/332/333	CA-MRP-0045/326	CA-TUO-0149	CA-TUO-3837
CA-MRP-0178	CA-MRP-0046/47/74	CA-TUO-0182	CA-TUO-0128/129/130/ 504
CA-MRP-0179/180/H	CA-MRP-0079/H	CA-TUO-0499	YOSE 1998 PV-01
CA-MRP-0181	CA-MRP-0160	CA-TUO-0764	YOSE 1994 C-02
CA-MRP-0207	CA-MRP-0290	CA-TUO-2821/H	CA-TUO-0127
CA-MRP-0288	CA-MRP-0328	CA-TUO-2823	CA-TUO-4511
CA-MRP-0343	CA-MRP-0652	CA-TUO-2826	P-55-006554
CA-MRP-0358/H	CA-MRP-0736	CA-TUO-2828	CA-TUO-0117
CA-MRP-0381	CA-MRP-0766H	CA-TUO-2839	CA-TUO-3828
CA-MRP-0811	CA-MRP-1580	CA-TUO-3831	P-55-004626
CA-MRP-1582H	CA-MRP-1624H	CA-TUO-3841	CA-TUO-4664
CA-MRP-1623H	CA-MRP-1704H	CA-TUO-3846	CA-TUO-2812
CA-MRP-1711H	CA-MRP-1705H	CA-TUO-3935H	CA-TUO-0116
CA-MRP-1806/H	CA-MRP-1733/H	CA-TUO-3943	CA-TUO-3827
P-22-001688	P-22-001685	CA-TUO-3959	P-55-006556
YOSE 1998 C	YOSE 1999 L-05	CA-TUO-3960	CA-TUO-3839
	YOSE 2000 I-07		CA-TUO-3839

B.7.2 Field Methods

This field guide presents the procedures, data requirements, and data collection sheets for conducting use impact monitoring on archeological sites within the river corridors.

Preparation

Field personnel should be trained (see Training, below) and the following required tools and supplies should be acquired.

- Copy of the most current ASMIS site report

- Most current site forms and map with location/directions to target sites
- Compass
- Blank ASMIS field form and cheatsheet
- Graph paper for mapping and blank paper for notes.
- Clipboard/pencils
- GPS Unit
- Camera
- Visitor Use Impact Monitoring field form and user guide (most current version)

Data collection and measurement:

Complete the Visitor Use-Impact Site Monitoring field form (

Table B.7.2) at every archeological site chosen to assess in the project area. Per field form procedures, document and quantify impact damage from visitor disturbances such as camping, climbing, social trailing, stock use, and vandalism as well as threats to site integrity such as destruction or displacement of artifacts and features. Additionally, collateral indicators such as soils compaction, vegetation damage, and erosion resulting from visitor use will be noted and monitored to provide threat warnings for future site stability and integrity. Impact disturbances at sites will be photographed and photo points noted on site sketch maps for comparison purposes in future site assessments.

Data from these field monitoring forms will be entered into a standard, relational use database using the protocol outlined below upon return to the Yosemite Archeology Office. Original field forms will be stored with individual projects and archived upon project completion.

Table B.7.2 Yosemite Visitor Use Impact Site Monitoring Field Form.

Archeological Site Condition Field Form

Recorder(s): **Date:** **YOSE Project No. YOSE201_____**

Basics Check if this site has been combined with another: ☐

Trinomial: CA- **Temp. No.: YOSE** Last Date Monitored:

General Information

Site Distance to Access Point	☐<100 m = (3)	☐100-500m = (2)	☐500-1000m = (1)	☐>1km = (0)	**Score**
Features: Rock Art	☐Yes = (1)	☐No (0)			
Visible Features	☐Yes = (1)	☐No (0)			**Score**
Type of Use - Direct	☐Camping	☐Hiking	☐Climbing/Bouldering	☐River Recreation	
☐Stock Use	☐Picnicking	☐ Park Operations	☐None	☐Other	
Type of Use - 2nd	☐Camping	☐Hiking	☐Climbing/Bouldering	☐River Recreation	
☐Stock Use	☐Picnicking	☐ Park Operations	☐None	☐Other	
Evidence of Stock Use:	☐Grazing	☐Trampling	☐Social Trails	☐Soil Compaction	
	☐Roll Pit	☐ None	☐Other		
Previous Site Condition	☐Good ☐Fair	☐Poor ☐Destroyed	☐Not relocated/Unknown	☐Inundated/Uncertain	
Previous Site Disturbance Severity Level	☐Low (5)	☐Moderate (10)	☐Severe (15)	☐Unknown (2)	**Score**
Est. Site Vulnerability	☐ High (1)	☐Low (0)			**Score**
Site Condition:	☐Good (0) ☐Fair (1)	☐Poor (2) ☐Destroyed	☐Not relocated/Unknown	☐Inundated/Uncertain	**Score**
Natural Impacts	☐ Erosion ☐ Bioturbation	☐ Rock Fall	☐ Tree Fall ☐ Flooding	☐ Other	
Artifact Collection Piles	☐None	☐ One	☐ More than one		
Social Trails	☐None	☐ One or Two	☐ More than Two		
	☐Faint	☐ Distinct	☐ Eroding		
Evidence of Camping ☐	☐Fire ring/scar/pit/etc	☐ Soil Compaction	☐ Vegetation Damage	☐ Movement of Rocks	
	☐Movement of Features	☐ Trash	☐ Other	☐ None	
Evidence of Facilities ☐	☐ Wilderness Restoration	☐ Stock Use	☐ Utilities/Infrastructure Construction		
	☐ Other	☐ Trails	☐ None		
Evidence of Deliberate Vandalism	☐Yes = (1) ☐No	New?	☐Yes = (1) ☐No		**Score**
Estimate total Percentage of disturbance at site	☐ 0-15% = (2)	☐15-50% =(7)	☐ >50% =(10)		**Score**
				Sum All Scores	
Photopoint	☐Existing	☐New	Describe location:		

Monitoring Matrix

Impact Score	If Score is between	Then Dist Severity Level is (Plug into form)	Current Dist Severity score	Add in Scores For:		If Schedule score is between	Then Inspection schedule is
	1-19	☐Low →	2	Total Sum of Scores from above		1-3	☐15 years
	20-42	☐Moderate →	4	Current Dist Severity		4-6	☐10 years
	33-80	☐Severe →	3			7-15	☐5 years
	>80	☐N/A (Destroyed)→	1	Sum for Inspection Schedule Score:		16+	☐Once/year

Comments/Remarks: *Please provide narrative description of disturbances and threats observed, including location and extent of disturbance or Threat. Describe what the impact is to the archeological integrity of the site. Document any necessary treatments to the site. Also provide a narrative of overall site condition and disturbance severity level. Describe threat/disturbance, and relate it to the adverse effect on specific archeological values. It is helpful in this section to describe previous impacts to the site, and make an estimate of cumulative percentage of site impacted.*

Total Number of Impacts:

Total Number of Visitor-Related Impacts:

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Archeological Site Condition Field Form

AMIS Data Collection

Site Management

Disturbance Severity Level: ☐ Low ☐ Moderate ☐ Severe ☐ N/A (destroyed) ☐ Unknown

Disturbances: result from natural forces or human activities with an observed harmful effect on the integrity or research value of the site

Type (from list)	Area affected (m²)	Effect on resource	Effect on safety	Level	Effect to Stability	Suggested treatment/ and timeframe for implementation	Possible cause – if visitor related, weigh score by 2	Impact Score
		☐Negligible (1) ☐Partial Loss: Repairable (2) ☐Partial Loss: Irretrievable (3) ☐Total Loss: Irretrievable (4)		☐Low -<15%) (1) ☐Moderate 15-50% (2) ☐Severe ->50% (3) ☐Destroyed (4) ☐Undetermined	☐Removal of Archeological Matrix (2) ☐Removal of Ftr/Artifact/Element (2) ☐Destabilization of Ftr/Element (2) ☐Destruction of Ftr/Artifact/ Element (2) ☐Displacement of Ftr/Artifact/Element (2) ☐No Effect (0) ☐Other (0)			
		☐Negligible (1) ☐Partial Loss: Repairable (2) ☐Partial Loss: Irretrievable (3) ☐Total Loss: Irretrievable (4)		☐Low -<15%) (1) ☐Moderate 15-50% (2) ☐Severe ->50% (3) ☐Destroyed (4) ☐Undetermined	☐Removal of Archeological Matrix (2) ☐Removal of Ftr/Artifact/Element (2) ☐Destabilization of Ftr/Element (2) ☐Destruction of Ftr/Artifact/ Element (2) ☐Displacement of Ftr/Artifact/Element (2) ☐No Effect (0) ☐Other (0)			
		☐Negligible (1) ☐Partial Loss: Repairable (2) ☐Partial Loss: Irretrievable (3) ☐Total Loss: Irretrievable (4)		☐Low -<15%) (1) ☐Moderate 15-50% (2) ☐Severe ->50% (3) ☐Destroyed (4) ☐Undetermined	☐Removal of Archeological Matrix (2) ☐Removal of Ftr/Artifact/Element (2) ☐Destabilization of Ftr/Element (2) ☐Destruction of Ftr/Artifact/ Element (2) ☐Displacement of Ftr/Artifact/Element (2) ☐No Effect (0) ☐Other (0)			
		☐Negligible (1) ☐Partial Loss: Repairable (2) ☐Partial Loss: Irretrievable (3) ☐Total Loss: Irretrievable (4)		☐Low -<15%) (1) ☐Moderate 15-50% (2) ☐Severe ->50% (3) ☐Destroyed (4) ☐Undetermined	☐Removal of Archeological Matrix (2) ☐Removal of Ftr/Artifact/Element (2) ☐Destabilization of Ftr/Element (2) ☐Destruction of Ftr/Artifact/ Element (2) ☐Displacement of Ftr/Artifact/Element (2) ☐No Effect (0) ☐Other (0)			
		☐Negligible (1) ☐Partial Loss: Repairable (2) ☐Partial Loss: Irretrievable (3) ☐Total Loss: Irretrievable (4)		☐Low -<15%) (1) ☐Moderate 15-50% (2) ☐Severe ->50% (3) ☐Destroyed (4) ☐Undetermined	☐Removal of Archeological Matrix (2) ☐Removal of Ftr/Artifact/Element (2) ☐Destabilization of Ftr/Element (2) ☐Destruction of Ftr/Artifact/ Element (2) ☐Displacement of Ftr/Artifact/Element (2) ☐No Effect (0) ☐Other (0)			

Threats: detectable condition with a predicted or expected harmful effect. Only list threats not already listed as disturbances.

Type	Timeframe	Area Affected (m2)	Effect on resource	Effect on safety	Effect to stability	Suggested treatment	Possible cause (weighted by 2 for visitor use)	Impact Score
			☐Negligible (1) ☐Partial Loss: Repairable (2) ☐Partial Loss: Irretrievable (3) ☐Total Loss: Irretrievable (4)		☐Removal of Archeological Matrix (2) ☐Removal of Ftr/Artifact/Element (2) ☐Destabilization of Ftr/Element (2) ☐Destruction of Ftr/Artifact/ Element (2) ☐Displacement of Ftr/Artifact/Element (2) ☐No Effect ☐Other			
			☐Negligible (1) ☐Partial Loss: Repairable (2) ☐Partial Loss: Irretrievable (3) ☐Total Loss: Irretrievable (4)		☐Removal of Archeological Matrix (2) ☐Removal of Ftr/Artifact/Element (2) ☐Destabilization of Ftr/Element (2) ☐Destruction of Ftr/Artifact/ Element (2) ☐Displacement of Ftr/Artifact/Element (2) ☐No Effect ☐Other			
			☐Negligible (1) ☐Partial Loss: Repairable (2) ☐Partial Loss: Irretrievable (3) ☐Total Loss: Irretrievable (4)		☐Removal of Archeological Matrix (2) ☐Removal of Ftr/Artifact/Element (2) ☐Destabilization of Ftr/Element (2) ☐Destruction of Ftr/Artifact/ Element (2) ☐Displacement of Ftr/Artifact/Element (2) ☐No Effect ☐Other			

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Post-collection and processing

Data gathered in the field will be entered into the appropriate databases, digital photographs will be processed according to Yosemite Archeology Office standards (NPS 2002), a summary report will be written, and the entirety of the project will be archived according to Yosemite Museum standards and guidelines.

B.7.3 DATA MANAGEMENT

Each archeological site visit will generate field forms. All this information must be stored in a convenient and secure manner. All of the metadata will be stored in the Visitor Use Impact Monitoring database. Field forms will be archived at the end of each project.

Data entry

Upon return to the Yosemite Archeology office, each field form will be entered into the appropriate database. Existing ASMIS records will be updated accordingly. New records will be entered as is consistent with NPS ASMIS guidelines and procedures (NPS 2007), and visitor use-impact data will be entered according to established guidelines. Photographs will be downloaded according to office standards and site sketch maps will be digitized.

Data analysis and reporting

Summary statistics (mean, standard deviation, min, max) will be prepared for the impact categories measured, such as collection piles, camping impacts on sites, etc. The summary data will be reported as a part of the User Capacity Annual report. Preliminary recommendations will be made where field data indicate the draft standard has been exceeded. Additionally, a Yosemite Archeology Office-specific report will be completed and archived according to the standards and guidelines provided in the *Yosemite Archeology Office Guidelines for Survey and Reporting* (NPS 2002).

Data storage:

All collected data will be stored in the Archeology-Visitor Use Monitoring database located on NPS servers. Original datasheets will be archived with other original paperwork from this project. Printed ASMIS reports for each visited site will be kept on file with each site record at the Yosemite Archeology Office.

B.7.4 Personnel Requirements and Training

Roles and Responsibilities (tasks and time commitments):

Yosemite National Park, through the Division of Resources Management and Science will be responsible for the administration of this indicator monitoring plan. Management of this project will be conducted by the Branch Chief (or designated project lead) of Anthropology and Archeology within the Division of Resources Management and Science. Responsibilities are:

- Training of field personnel
- Review of data and procedures
- Maintenance of data, field forms, equipment repair and maintenance logs, and updating protocols

Data collection will be performed by qualified archeologists and archeological technicians or interns, meeting OPM standards. Individuals will be trained in archeological site documentation, ASMIS condition assessments, and the resources and material types common to archeological sites in the park.

As each new or returning technician/intern enters on duty, they should receive comprehensive training on field and office procedures, including the ASMIS database.

At the end of each fiscal year, the project manager should review the data and procedures. This will be done in conjunction with ASMIS federal reporting requirements. This information, coupled with discussions with field staff, will be used to review or modify procedures, reevaluate the system, and to improve data quality.

Training procedures

Each technician/intern collecting monitoring field data must have demonstrated the following:

The ability to prepare complete and accurate field forms.

- The ability to enter in field form information into the ASMIS database.
- A safety conscious approach to field work.
- Knowledge of proper archeological documentation procedures.
- Proficiency with identifying and recording archeological sites

Volunteers

Volunteers cannot be currently used for ASMIS documentation or visitor use-impact monitoring due to requirements of theASMIS/Archeology program. However, some aspects of site monitoring and visitor use data collection may be accomplished using volunteers, similar to site stewardship programs in other NPS units and state programs.

B.7.5 OPERATIONAL REQUIREMENTS

Work plan

A sample of previously recorded archeological sites within both river corridors will be drawn from Yosemite GIS databases. Once the sample of sites is selected, site assessments will begin. A visitor use impact site monitoring field form will be filled out at each site, as well as a current ASMIS condition assessment. This data will be entered into the ASMIS database, and analyzed.

Safety

A job hazard analysis (JHA) has been completed for front and backcountry archeological survey and monitoring (Appendix A). This document will be reviewed and discussed with all project participants prior to start of fieldwork, and periodically throughout the field season. Similarly, the JHA for data entry and general office work will be reviewed prior to the start of data input, processing and reporting.

Equipment and materials

All equipment and materials are stored with the Yosemite Archeology Office, Branch of Anthropology and Archeology. Each project archeologist is responsible for making sure that adequate supplies are available and in working order prior to each field recording.

Table B.7.3 Job Hazard Analysis Form

YOSEMITE NATIONAL PARK

Archeology Office

JOB/ACTIVITY: Backcountry Survey **RAC:**

DATE REVISED: 01/09/07

PRINCIPAL STEP	POTENTIAL SAFETY CONCERNS	RECOMMENDED CONTROLS
1. Travel in backcountry location	A. Physical fitness	i. Conduct orientation with crew to ascertain any relevant medical history, training, and skill level ii. Stretch before and after any strenuous activity
	B. Group Backcountry Travel	i. Scope and plan route - discuss hazards prior to trip ii. Make map of route (recommended to leave a copy if travel involves a complicated route and/or cross country travel) iii. Complete backcountry travel plan iv. Arrange a designated point of contact (POC) for the duration of your trip v. Notify POC of trailhead parking area you will be utilizing vi. All persons must carry a map and compass and know how to use them vii. Project Lead must carry a radio with spare batteries (it is desirable for all persons to carry radios, when possible) viii. Keep radio on at pre-determined times ix. Stop and wait for crew at trail junctions or pre-determined meeting locations x. Contact POC with travel plan deviations
	C. Solo Backcountry Travel	i. Must have demonstrated previous competency in the backcountry ii. Scope and plan route - discuss hazards with supervisor prior to trip iii. Complete backcountry travel plan to be filed with dispatch iv. Highly recommended to leave map of intended

PRINCIPAL STEP	POTENTIAL SAFETY CONCERNS	RECOMMENDED CONTROLS
		route (in addition to verbal description) v. Notify dispatch of trailhead parking area you will be utilizing vi. Identify other groups working in vicinity vii. Notify dispatch when leaving and returning to a designated trail (per *Yosemite Wilderness Travel Guidelines*), factoring for radio "dead zones" viii. Must carry a map and compass along with the knowledge of their use ix. Must carry a radio with at least one spare battery
	D. Carrying heavy loads	i. Pack sensibly, and use lighter gear when possible
	E. Strains, sprains, and falls	i. Use proper boots that are well-fitted to your foot ii. Lift pack with legs, not back iii. Place feet carefully and intentionally
	F. Travel on steep, loose talus	i. On steep, loose talus slopes, space crew laterally so that one person is not above the other ii. If you encounter a loose rock, be sure to warn others iii. If a rock starts rolling, loudly yell "rock" to warn others iv. Place feet carefully and intentionally
	G. Stream crossings	i. Look downstream and consider consequences of falling in the water when rock hopping or crossing logs ii. Don't wade in swift water deeper than your knee iii. Loosen pack for crossing, so that it may be dropped in case of a fall iv. Face upstream and use a stick for stability v. Place feet carefully and intentionally, slide feet across bottom of stream, do not lift feet in swift water
	H. Snow travel	i. Consider crossing snowfields later in the day when snow is softer ii. Use extra caution when crossing boulder fields, near trees, the edge of snowpack etc. – punching

PRINCIPAL STEP	POTENTIAL SAFETY CONCERNS	RECOMMENDED CONTROLS
		through the snowpack can cause serious injury
	I. Getting Lost	i. Scope and plan route - discuss hazards prior to trip ii. All persons must carry a map and compass *and know how to use them* iii. Stop and wait for crew at trail junctions or pre-determined meeting locations iv. Contact dispatch if completely lost
	J. High Altitude Pulmonary Edema, High Altitude Cerebral Edema, and Acute Mountain Sickness	i. Acclimatize at least 24 hours, if possible, before exertion at altitude ii. Go down if mountain sickness occurs iii. Stay hydrated iv. Recognize the symptoms which include: shortness of breath, nausea, vomiting, dizziness, and headache
	K. Hypothermia	i. Use layering techniques for conditions and activity level ii. Avoid cotton clothing iii. Avoid prolonged exposure to cold water iv. Stay hydrated v. Minimize exposure to precipitation vi. Carry and use adequate shelter (tent, pad and bag) vii. Be aware of the dangerous combination of high winds and precipitation
	L. Dehydration / heat related injuries (sunstroke, heat exhaustion)	i. Drink plenty of water ii. Wear loose fitting clothing with long sleeves and pants iii. Take rest breaks in the shade when working in hot weather
	M. Sunburn	i. Use sunblock, and/or wear loose fitting clothing with long sleeves and pants ii. Use sunglasses

PRINCIPAL STEP	POTENTIAL SAFETY CONCERNS	RECOMMENDED CONTROLS
		iii. Wear large brimmed hat iv. Use extra caution when on medications (e.g. antibiotics)
	N. Blisters	i. Use proper boots that are well-fitted to your foot with dry socks ii. Pre-treat areas which are being affected with mole-skin before blisters form iii. Carry extra socks
	O. Specific allergies (e.g. bee sting)	i. Conduct orientation with crew to find out medical histories ii. Ensure crew is aware of any specific allergies and proper treatment iii. Carry EPI pen and/or Benadryl if needed
	P. Poison oak	i. Learn to identify plant during all stages of growth ii. Avoid contact iii. Wash oils off with copious amounts of cool water iv. Change and wash clothing after contact v. Do not scratch or break blisters vi. Take ibuprofen for swelling vii. If rash, swelling, blisters, or eyes swelling shut develop within 4 to 12 hours after exposure or any breathing problems occur, seek medical attention immediately
	Q. Tetanus	i. Have tetanus updated ii. Avoid handling sharp rusty pieces of metal
	R. Animal encounters (e.g. bear, mountain lion)	i. Review appropriate behavior for specific animal encounters in *Wilderness Safety and Emergency Field Guide* ii. Use proper food storage techniques
	S. Rattlesnakes	i. Be aware of your surroundings especially early and late in the day ii. Rattlesnakes can blend in to their environment very well, watch where you step, they will usually warn you when you are too close iii. Stay calm

PRINCIPAL STEP	POTENTIAL SAFETY CONCERNS	RECOMMENDED CONTROLS
		iv. Seek immediate medical attention if bitten v. Elevate and cool the affected area to minimize circulation of venom
	T. Mosquitoes (see West Nile summary), ticks, and other nuisance insects	i. Use insect repellent, wear long clothes, headnet, etc. ii. Wear long, light-colored pants and conduct nightly tick checks
	U. Hazard trees/falling limbs	i. Be aware of environment ii. Be aware of hazard trees and the potential for falling tree limbs, especially during windy conditions iii. Do not walk near “widowmakers” or other tree hazards
	V. Inclement Weather	i. Carry and use adequate shelter for the conditions (tent, pad and bag) ii. Seek shelter at the advent of precipitation iii. Carry waterproof shell and pants or poncho iv. Use layering techniques for conditions and activity level v. Avoid cotton clothing vi. Carry lighter and backup matches for fire construction
	W. Lightning strikes	i. Stay away from high, exposed places and solitary trees or other high objects ii. Seek shelter in valley bottoms or in an even-height forest iii. If caught in the open near strikes, minimize your height and contact with the ground by squatting on your pack or other non-metallic insulation iv. Do not talk on your radio, transmitting can attract lightning
	X. Encounter Illegal activity (Marijuana cultivation)	i. Check with LE before entering an area. ii. Note, avoid and report: isolated tents away from recreational activity, trailers with no evidence of recreational activity, patterns of

PRINCIPAL STEP	POTENTIAL SAFETY CONCERNS	RECOMMENDED CONTROLS
		vehicle traffic or particular vehicle in isolated areas, unusual structures in remote areas with cultivation tools or supplies, signs of cultivation or soil disturbance in unlikely areas, black piping and modern trash scatters in remote areas. iii. Do not make contact with suspected growers. iv. Always use check-in and out procedures.
	Y. Medical emergencies	i. Carry first aid kit (with personal medications) ii. Carry radio with spare batteries iii. Contact dispatch immediately in case of an emergency iv. Keep CPR/First Aid certification updated
2. Conduct Survey	*same as 1. Travel to backcountry location*	*same as 1. Travel to backcountry location*
	A. Travel	i. Remain in eyesight or earshot of other crew members when conducting surveys (especially when off trail)
3. Make Camp	A. Giardia	i. Filter or boil all water ii. Wash hands after going to the bathroom and before cooking iii. Be aware of potential upstream water contamination
	B. Waste disposal	i. Designate latrine for large parties, protocol for others
	C. Hazard trees/falling limbs	i. Be aware of environment ii. Be aware of hazard trees and the potential for falling tree limbs, especially during windy conditions iii. Do not walk near or place tent under “widowmakers” or other tree hazards
	D. Flooding	i. Don’t camp too close to streams with flood potential
	E. Moving around in the dark	i. Carry flashlight with extra batteries

PRINCIPAL STEP	POTENTIAL SAFETY CONCERNS	RECOMMENDED CONTROLS
4. Travel from backcountry location	*same as 1. Travel to backcountry location*	*same as 1. Travel to backcountry location*
	A. Arrival at final destination	i. Contact POC upon arrival and inform of travel status

SAFETY EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
▪ Good well-fitted boots, dry wool or synthetic socks, adjusted pack, wool or synthetic clothes for layering, rain gear, water filter, stove, radio with spare batteries, sleeping bag, sleeping pad, tent/shelter, first aid kit (including Tecnu, tweezers for ticks) ▪ Wilderness Safety and Emergency Field Guide	▪ Inspect water filter, stove, sleeping pad, tent, radio batteries, boots	▪ Maintain physical fitness ▪ Stretch before and after strenuous activity ▪ Train with pack and other gear (compass) ▪ Basic first aid

RAC:

I – Death/Permanent Disability

II – Permanent Partial Disability

III – Lost Day Mishap

IV – First Aid Only

A – Likely To Occur

B – Probably Will Occur

C – Possible To Occur

D – Unlikely To Occur

E – Improbable to Occur

B.8 PARKING AVAILABILITY

B.8.1 Background

Traffic congestion in Yosemite Valley has been a well documented issue for many years. In fact, the reduction of traffic congestion was one of the primary goals of the 1980 General Management Plan (YOSE 1980). The number of vehicles in activity areas directly affects visitor experience (part of the recreational Outstandingly Remarkable Value) (Littlejohn et al. 2006, White et al. 2006). When the number of vehicles exceeds the supply of appropriate parking, drivers often resort to parking along the roadside and in other inappropriate areas (Thomas et al. 2005; Elliot et al. 2006). As a result, resources may be adversely affected. Therefore, it is important to define the point when these values become most at risk of degradation. It has been determined that these risks occur significantly when designated parking areas fill to capacity and staff perform Alternative Parking Measures (APM) to alleviate congestion and stopped traffic flows. Alternative parking actions are defined as the point when the Camp 6/Day Use parking lot is full and traffic staff begins directing people to park along the roadside or other alternative areas. Monitoring day use parking capacity provides park management with an indication that visitor use levels and corresponding vehicular use have reached unacceptable levels that may be causing unacceptable impacts to park resources and the quality of visitors' experiences.

Description of Indicator and Standard

Indicator:
This indicator is used to identify the conditions of the transportation system in Yosemite Valley and in Tuolumne Meadows. Parking lots monitored to identify the amount of time that they are at full capacity, forcing them to be shut down to incoming visitors.

Draft Standard:
Standards are being developed utilizing several years of past data, in addition to, other ongoing traffic related research in Yosemite Valley.

Rationale for indicator:

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). Traffic congestion was identified in the Yosemite Valley Plan as one of the principal human use impacts to mitigate (YOSE 2000).

Thousands of vehicles enter Yosemite Valley each year, resulting in significant traffic congestion. Traffic congestion can cause a variety of impacts to 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. 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 human vehicular use is negatively affecting the park.

Objective:

Provide expedient and accurate assessment of parking capacity at the Camp 6/Day Use parking area as an indicator of overall human vehicular use levels in Yosemite Valley.

B.8.2 Sampling Design

In 2009, traffic technicians employed one sampling strategy to monitor parking availability. When technicians are available, a daily log will be kept documenting the instances that the Camp 6/Day Use parking area fills to capacity and is closed. This will provide information as to the frequency and duration of parking area closures. In addition, vehicular use at the Yosemite Lodge bus lot will be monitored using vehicle counters. Vehicle counters have been placed at the Camp 6 parking lot, the bus lot and in the backcountry parking area. Each time a vehicle enters the parking area, this car is registered through the use of a pneumatic totalizing traffic encounter. Collectively, these areas represent the principal parking areas in Yosemite Valley. Measuring and monitoring their use will provide a more comprehensive view of overall parking capacity. For more specific Tuolumne Meadows related protocols please refer to the separate Tuolumne River corridor Field Monitoring Guide.

B.8.3 Field Methods

Pneumatic Totalizing Counters: Currently all data is being collected using traffic counters positioned at the entrance of several high-use parking lots in Yosemite Valley. Traffic technicians will download the data from data loggers at least once per week, in order to prevent data from being lost due to lack of data storage space. Each day a record for number of cars entering each lot is recorded. On days with large numbers of cars, lots are often closed. These closures will be easily identifiable as gaps in the data during busy summer days and weekends.

B.8.4 Data Management

Data entry:

Data will be collected from traffic counters each week. All data will be converted into the parking database by monitoring technicians.

Data analysis:

Data will be analyzed using statistical software (either Statistical Package for the Social Sciences – SPSS or JMP). Descriptive statistics will be used to present frequency distributions of the data. The length of time of parking area closures should be analyzed using both the mean and median of the distribution.

Data reporting:

Results will be compiled and presented in the Visitor Use and Impact Monitoring Annual Report. Additionally, information will be presented at a public meeting and made available on the park's website.

Data storage (metadata):

Data will be stored electronically on the MS10 server in the Yosemite National Park computer directory. Hard copies of counter printouts will remain on file with the Visitor Use and Social Science Branch in El Portal. These copies should be stored in a fire-safe area. The life cycle should be 3 years for printed materials after which time all data and report should be physically and electronically archived to allow for future longitudinal analysis and documentation.

B.8.5 PERSONNEL REQUIREMENTS AND TRAINING

Roles and responsibilities (tasks and time commitments):

Visitor Use and Impact Monitoring personnel will work collaboratively with traffic management staff in the Protection Division to conduct monitoring activities.

Safety:

Particular attention will need to be given to collecting data in a safe manner as personnel will be working in close proximity to moving vehicles. A job hazard analysis has been completed and appears below (

Table B.8.1).

Table B.8.1 Job Hazard Analysis for Parking Availability Data Collection

United States Department of Interior NATIONAL PARK SERVICE	1. WORK PROJECT/ACTIVITY	2. LOCATION	
	Transportation	Yosemite Valley, YNP	
Job Hazard Analysis (JHA)	3. NAME OF ANALYST	4. JOB TITLE	5. DATE PREPARED
	Dave Henderson	Facilities Mgr.	June, 2006
6. TASKS/PROCEDURES	7. HAZARDS	8. ABATEMENTS ACTIONS ENGINEERING CONTROLS – SUBSTITUTION – ADMINISTRATIVE CONTROLS – PPE	
a. Driving to, from, and around sampling sites.	a. Collision resulting in damage, injury, or death.	a. Drive defensively, obey traffic laws, lights on, seatbelt on, be alert for pedestrians, wildlife, and distracted drivers. Know procedures for installing snow chains. Always carry and know how to use a Park radio.	
b. Standing, walking, hiking and other physical exertion.	b. Exhaustion, muscle strain, dehydration and fatigue from prolonged standing or physical exertion.	b. Drink plenty of fluids, bring snacks and/or meals if out during lunch hours, Take periodic rests and stretch before and after physical activity.	
c. Working outdoors in cold and/or wet weather.	c. Hypothermia, reduced resistance to illness.	c. Wear appropriate clothing and carry extra layers. Stay dry. Use rubberized raingear if possible. Stay hydrated preferably with warm liquids. Stop work to warm up if necessary. Snack often.	
d. Working outdoors in hot / extreme heat weather.	d. Fatigue, exhaustion, dehydration and heat stroke.	d. Wear appropriate clothing and use sunscreen. Drink fluids and snack throughout the day. Carry extra water and dehydration salts along with first aid kit.	
10. SUPERVISORS SIGNATURE	11. TITLE	12. DATE	

B.8.6 Operational Requirements

Work plan:

Monitoring efforts associated with the parking capacity indicator should follow a general work plan as presented in Table A.3.1 in the introduction to this field guide. Generally, two traffic management seasonal staff (wage grade) will be responsible for placing traffic counters in proper locations prior to peak season. These counters will be removed at the end of October. Data will need to be collected between May and October, or the peak season of visitor use in the park. All data is automatically collected using stationary pneumatic traffic counters.

Equipment and materials:

- Pneumatic Totalizing Traffic Counters

B.9 NATURAL SOUNDSCAPES

B.9.1 Background

Soundscape, or sounds, is a potential indicator of user capacity for the Tuolumne Wild and Scenic River (TWSR). A draft comprehensive management plan/EIS for the TWSR that will be released in 2010 contains proposed standards of quality for a sounds indicator. Possible metrics for a sounds indicator include:

- Percent time audible – percentage of time that human-caused sounds are audible.
- Noise-free interval – time intervals where human-caused sounds are not audible.
- Energy equivalent sound level (Leq) - level of a constant sound over a specific time period.
- Maximum Sound Level (Lmax) – the maximum sound pressure level in a given period.
- Time above 35 dB(A) – the amount of time above 35 dB(A), the level at which sleep is disturbed. A threshold of 35 dB(a) is used as an example, higher thresholds could be used.

B.9.2 Sampling Design

Each field season, the NPS collected sounds data at diverse locations in the TWSR corridor to evaluate the usefulness of these metrics, to explore new and cheaper technologies (i.e. digital audio recorders, or DARs) for collecting sounds data, and to develop methodologies for data collection. The DARs were used to collect sounds data at 6 sites. These DARs are small, inexpensive, and experimental, and were configured with the assistance of the NPS Natural Sounds Program.

Six locations were monitored in the TWSR corridor: Lembert Dome, Pothole Dome, Tuolumne Meadows Campground, Tuolumne Meadows Grill, Lyell Fork at Rafferty Creek, and Dana Fork on the flanks of Mount Dana. Data was collected from mid-June through early October, although not continuously.

Site Selection: Choosing where to monitor is beyond the scope of a field manual, but is briefly discussed here as background information. Choosing a site depends on the goals of the monitoring. For the acoustic monitoring report, the goal was to develop a “natural ambient” baseline for each of the park’s acoustic zones – accordingly, sites were selected based on the lack of human-caused noise, specifically road noise. Since the goal of the monitoring in the TWSR corridor is to address user capacity in the corridor, locations were selected that represented developed areas, backcountry areas, and transition zones (but not highly remote areas within the corridor like Mt. Lyell, Grand Canyon of the Tuolumne, or Poopenaut Valley).

B.9.3 Field Methods

Before Leaving the Office:

Make sure the low battery light is not lit on the H2. Replace the batteries if necessary.

Make sure the SD card in the H2 is empty. If necessary, transfer the contents of the SD card to the network (described below).

Make sure the date and time is correct on the H2 (page 78 of H2 manual):

1. Bring up the main menu screen by pressing the menu key.
2. Bring up the DATE/TIME screen by repeatedly pressing the REW keys and pressing the REC key (red button).
3. Use the REW/FF keys to move the cursor, REC to change a field, and REW/FF to change values in the field.
4. When finished, use the REW/FF keys to select OK, and press REC (red button)

Note: GPS clocks are highly accurate, as are cell phones

Make sure the H2 settings are as follows:

- REC MODE MP3 64 (REC MODE screen from main menu, p. 35 of H2 manual)
- Surround 2CH (indicated on front display, arrow keys to change)
- Mic Gain M (slider switch on right side of H2)

You should have the following tools/supplies for all site visits:

- Ropes and stakes to secure the tripod
- Extra black and red wire and electrical tape, wire cutter/wire stripper
- Conduit for external cables
- Watch
- Noise-cancelling headphones w/ extra AAA batteries
- Extra AA batteries for H2
- Data sheets
- Compass
- GPS, if needed to map location for initial setup
- Digital camera, if needed for initial setup
- Tools, including small flat-head screwdriver
- Volt meter
- Extra 32GB SD card(s)

And the following equipment (which may already be on site):

- Solar panel
- Ammo box with solar charge controller and 12-volt sealed rechargeable battery
- Tripod with wind screen
- Digital Audio Recorder, model Zoom H2 (including manual)

Initial Setup

A general location for the monitoring should be identified in advance. The specific location will depend on site conditions such as proximity to noise sources, potential for disturbance, sunlight for the solar panel, etc.

When selecting a specific location, avoid sites that might interfere with the operation of the H2, i.e. sites with heavy animal use (e.g. wildlife trails, dens, resting areas), vegetation that might brush against the equipment, windy areas, etc. You should be able to set up the equipment so that it is stable and doesn't blow down, is not in the way of employees, and is somewhat inconspicuous to visitors.

Set up the equipment according to the diagram in Figure 1. The contents of the ammo box should have been configured in the lab. There should be one power cable connecting the solar panel to the ammo box, and one power cable connecting the ammo box to the Zoom H2. *However, do not connect the H2 to external power yet!* The solar panel should be pointing south, and should avoid any shaded areas. The windscreen should be attached to the tripod, and the ¼" diameter hold in the wind screen should be pointing east. The tripod should be staked down if necessary.

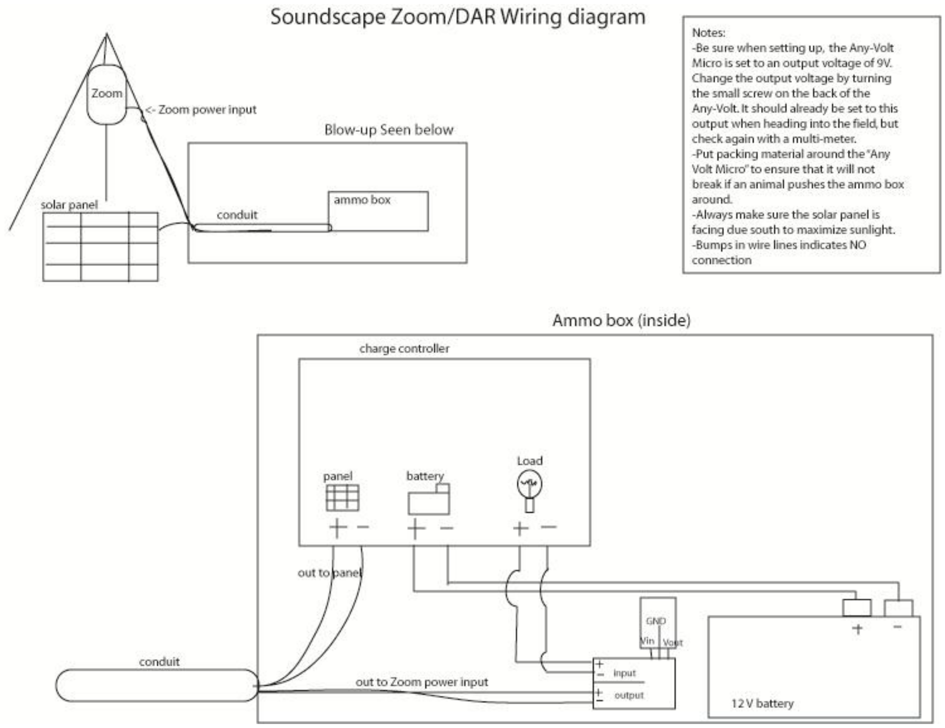

Figure B.9.1 Shows the Soundscapes Equipment Set-up

Operating the Zoom H2 for Initial Setup

1. For each site visit, whether initial setup or maintenance, fill out a data sheet.
2. Unclasp the fur shield so that you can see the screw where the H2 will be mounted. Screw the H2 onto the fur shield casing until the hole in the wind shield lines up with the external power connector on the H2.
3. Connect the H2 to external power through the ~1/4" diameter hole in the wind screen.

4. Using a compass, verify that the front channel of the H2 is facing north.
5. Turn on the H2 using the “slider” power strip on the left side.
6. If you didn’t verify the H2 settings (i.e. date, time, recording interval, etc.) as described in “Before you leave the office” section, now is your last chance to do so!
7. Press the red dot which will put the H2 unit in “standby” mode. The display should say “IIREC” and the H2 is ready to record (but not yet recording).
8. Press the red dot again when the time on your watch indicates “0 seconds”, and the H2 will begin recording. State clearly the date, time, and location.
9. Make a loud noise such as a handclap at a certain time, and state for the recording the exact time of the handclap. Record this time on the data sheet.

Maintaining the H2

Theoretically, the SD Card should hold about 48 days of data using the configuration described in step 2 of “Operating the Zoom H2”. However, we have discovered that the units will stop operating for reasons that we don’t fully understand – could be low power from the solar panels, could be weather conditions, could be curious visitors, could be something else. Ideally, each H2 should be visited once a week, and no less frequent than once every two weeks.

During most visits, the SD Card should be swapped out.

1. For each visit, whether initial setup or maintenance, fill out a data sheet. For maintenance visits, start with location, date and time, and your initials.
2. Carefully noting the time, make a loud handclap next to the H2, and then clearly state exact time of the handclap, the date, and the location.
3. Unclasp the fur protection shield and look at the H2’s display to see if the unit is recording. You should see numbers counting at the top of the screen when the unit is recording.
4. Note the elapsed time on the display, the STE number (which is the name of the file on the SD card), and fill out the remainder of the data sheet.
5. Press the red dot button to stop recording. It makes take a few seconds for the recording to stop. Note: if you turn off the H2 before stopping recording, you will most likely lose data.
6. Turn the unit off.
7. With the volt meter, record the volt readings onto the blank spaces provided in the data form.
8. Verify that the data sheet is completely filled out.
9. If necessary, swap out the SD card by opening the compartment at the bottom of the unit, removing the SD card, and insert in an empty SD card.

B.9.4 Data Management

Transferring the Data from the SD Card to the Network

The job is not done until the data is secure!

SD card readers are Inexpensive and can used on any computer with a USB port. The data is organized by year, sampling location, and sampling dates. Since the H2s automatically generates file names, and uses or reuses the same file names, it is imperative that the data be placed in the correct directory.

B.9.5 Personnel Requirements and Training

Roles and Responsibilities (tasks and time commitments):

Yosemite National Park, through the Division of Resource Management and Science will be responsible for the administration of this monitoring plan. Management of this project will be conducted by the Branch Chief of Physical Sciences and Landscape Ecology within the division of Resources Management and Science. Responsibilities are:

- Preparation of an annual implementation plan and budget
- Training of field personnel
- Purchase and maintenance of field equipment
- Review of data and procedures
- Maintenance of data, field forms, equipment repair and maintenance logs, and updating protocols

Preparation of an Annual Implementation Plan and Budget:

The annual plan and budget should include a sampling schedule, anticipated personnel needs, comprehensive list of equipment, and repair or calibration needs.

As each new or returning technician enters on duty, they should receive comprehensive training on field and office water sampling procedures. The project manager should document this training for each technician for each season.

All field data forms should be photocopied and stored as office copies or archive copies. Office copies are photocopies of the originals and are intended as an operational reference.

Training procedures:

Each technician collecting field data associated with this project must have demonstrated the following:

- The ability to set up and maintain sound monitoring equipment
- A safety conscious approach to field work in backcountry areas
- Knowledge of proper documentation procedures.

These skills may be verified through assisting a qualified technician or by a means deemed satisfactory to the Branch Chief for Physical Sciences and Landscape Ecology. This training should be documented at least once a year for each technician.

B.9.6 Operational Requirements

Safety:

A job hazard analysis (JHA) has been completed. See job hazard analysis table below (Table B.9.5).

Table B.9.1 Job Hazard Analysis for Soundscapes Data Collection.

United States Department of Interior NATIONAL PARK SERVICE	1. WORK PROJECT/ACTIVITY	2. LOCATION	
	Soundscapes monitoring	Primarily Tuolumne River corridor near Tuolumne Meadows	
Job Hazard Analysis (JHA)	3. NAME OF ANALYST	4. JOB TITLE	5. DATE PREPARED
	Joe Meyer	Technician	January, 2010
6. TASKS/PROCEDURES	7. HAZARDS	8. ABATEMENTS ACTIONS ENGINEERING CONTROLS – SUBSTITUTION – ADMINISTRATIVE CONTROLS – PPE	
a. Driving to, from, and around sampling sites.	a. Collision resulting in damage, injury, or death.	a. Drive defensively, obey traffic laws, lights on, seatbelt on, be alert for pedestrians, wildlife, and distracted drivers. Know procedures for installing snow chains. Always carry and know how to use a Park radio.	
b. Walking to, from, and around sampling sites	b. Getting lost, tripping.	b. Know the location of and the route to the sampling site, take map and radio. Walk carefully, don't rush, avoid steep terrain.	
c. Working and walking along riverbanks.	c. Tripping and/or falling due to wet and slippery rocks or sloping ground surfaces, contact with poison oak, etc.	c. Watch footing, walk carefully.	
d. Working outdoors in cold and/or wet weather.	d. Hypothermia, reduced resistance to illness.	d. Stay dry. Use rubberized raingear if possible. Stay hydrated preferably with warm liquids. Stop work to warm up if necessary. Snack often.	

e. Working outdoors when lightning is possible.	e. Lightning strike, particularly in high elevation areas such as Tuolumne Meadows.	e. Consult weather forecast in advance, and monitor forecast on park radio. Avoid outdoor work when lightning is present or imminent. If unable to avoid lightning, avoid lightning-prone areas such as ridge tops.
f. Carrying equipment	f. For heavy loads, muscle strain or tripping	f. Avoid heavy loads. If necessary, ensure there are people to help carry equipment.
10. SUPERVISORS SIGNATURE	11. TITLE	12. DATE

Equipment and materials:

All equipment and materials are stored with the Branch of Physical Sciences and GIS. The lead technician and the park hydrologist are responsible for making sure that adequate supplies are available and in working order prior to each sample event.

SECTION C: References

C.1 REFERENCES BY DOCUMENT SECTION

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SECTION D: Appendices

National Park Service
U.S. Department of the Interior

D.1 APPENDIX A: GLOSSARY OF TERMS AND ACRONYMS

D.1.1 TERMS

Azimuth: This is the direction of a celestial object, measured clockwise around the observer's horizon from north. So an object due north has an azimuth of 0°, one due east 90°, south 180° and west 270°. Azimuth and altitude are usually used together to give the direction of an object in the topocentric coordinate system.

Carrying Capacity: As it applies to parks, carrying capacity is the type and level of visitor use that can be accommodated while sustaining the desired resource and social conditions that complement the purpose of a park unit and its management objectives.

Geographic Information System (GIS): A computer system for capturing, storing, checking, integrating, manipulating, analyzing and displaying data related to positions on the Earth's surface. Typically, a Geographical Information System (or Spatial Information System) is used for handling maps of one kind or another. These might be represented as several different layers where each layer holds data about a particular kind of feature. Each feature is linked to a position on the graphical image of a map.

Global Positioning System (GPS): The Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense. GPS was originally intended for military applications, but in the 1980s, the government made the system available for civilian use. GPS works in any weather conditions, anywhere in the world, 24 hours a day. There are no subscription fees or setup charges to use GPS.

Indicator: Indicators are specific, measurable physical, ecological, or social variables that reflect the overall condition of a management zone. Resource indicators measure visitor impacts on the biological, physical, and/or cultural resources of a park; social indicators measure visitor impacts on the park visitor experience.

Management zone (zone): A geographical area for which management directions or prescriptions have been developed to determine what can and cannot occur in terms of resource management, visitor use, access, facilities or development, and park operations.

Outstandingly Remarkable Values (ORVs): Those resources in the corridor of a Wild and Scenic River that are of special value and warrant protection. ORVs are the “scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values…that shall be protected for the benefit and enjoyment of present and future generations” (16 USC 1272).

River corridor: The area within the boundaries of a Wild and Scenic River (e.g., the Merced River corridor).

Standard: Standards define the desired condition of each indicator variable. A standard does not define an intolerable condition, but rather the minimum acceptable condition.

User capacity: As it applies to parks, user capacity is the type and level of visitor use that can be accommodated while sustaining the desired resource and social conditions based on the purpose and objectives of a park unit.

Visitor experience: The perceptions, feelings, and reactions a park visitor has in relationship with the surrounding environment.

Wetland: Wetlands are defined by the U.S. Army Corps of Engineers (CFR, Section 328.3[b], 1986) as those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Wild and Scenic Rivers: Those rivers receiving special protection under the Wild and Scenic Rivers Act.

Wilderness: Those areas protected by the provisions of the 1964 Wilderness Act. These areas are characterized by a lack of human interference in natural processes.

Wilderness Impact Monitoring System (WIMS): An inventory process that monitors campsite and trail conditions in Yosemite National Park backcountry and Wilderness.

D.1.2 Acronyms

C	Centigrade
CA	California
CCC	Continuing Calibration Check
CD	Compact Disc
cfs	cubic feet per second
cm	centimeter
CMP	Comprehensive Management Plan
DH-81	Standard USGS wading sediment / water sampling device
DH-95	Standard USGS suspended sediment / water sampling device
DO	Dissolved Oxygen
DI	Deionized Water
DOQs	Digital Orthophotos
EPA	Environmental Protection Agency
EDI	Equal Discharge Increment
EWI	Equal Width Interval
GIS	Geographic Information System
GPS	Global Positioning System
HCl	Hydrochloric Acid
Hg	Mercury
ICC	Initial Calibration Check
KCl	Potassium Chloride
L	Liter
mg/l	Milligram per Liter
ml	Milliliter

MDL	Method Detection Limit
mm	Millimeter
MPN	Most Probable Number
NAD27	North American Datum 27
NAD83	North American Datum 83
NELAP	National Environmental Laboratory Accreditation Program
NFM	National Field Manual
NIST	National Institute of Standards and Technology
NPS	National Park Service
PDA	Personal Data Assistant
pH	Potential Hydrogen
QAPP	Quality Assurance Project Plan
QC	Quality Control
SOP	Standard Operating Procedure
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
µS	Micro-Siemens (a measure of electrical conductivity)
µmhos	Micro-mhos (inverse of micro-ohms, a measure of electrical resistance)
WIMS	Wilderness Impacts Monitoring System

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