U.S. Department of the Interior

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Inventory and Monitoring Program

Trail Monitoring Protocol for the Northern Colorado Plateau Network

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Important Note: This protocol consists of this Protocol Narrative and the following Standard Operating Procedures (SOPs):

SOP 1: Developing a Sampling Plan for Calibration and Counter Data Collection

SOP 2: Calibration

SOP 3: Preparations and Equipment Setup Prior to the Field Season

SOP 4: Installation of Trail Counter and Pressure Mat

SOP 5: Data Retrieval and Management

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Protocol Narrative

Background and Objectives

The NCPN parks (see Table 1) are tasked with developing a monitoring program to assess park natural resources. The NCPN is one of 32 vital signs monitoring networks nationwide in the NPS. The network is comprised of 16 NPS administered units (Figure 1) in the states of Colorado, Utah, Arizona and Wyoming.

As defined by the NPS, vital signs are a subset of physical, chemical, and biological elements and processes of park ecosystems that are selected to represent the overall health or condition of park resources, known or hypothesized effects of stressors, or elements that have important human values. The elements and processes that are monitored are a subset of the total suite of natural resources that park managers are directed to preserve "unimpaired for future generations," including water, air, geological resources, plants and animals, and the various ecological, biological, and physical processes that act on those resources. Vital signs may occur at any level of organization including landscape, community, population, or genetic level, and may be compositional (referring to the variety of elements in the system), structural (referring to the organization or pattern of the system), or functional (referring to ecological processes) (NPS 2006a).

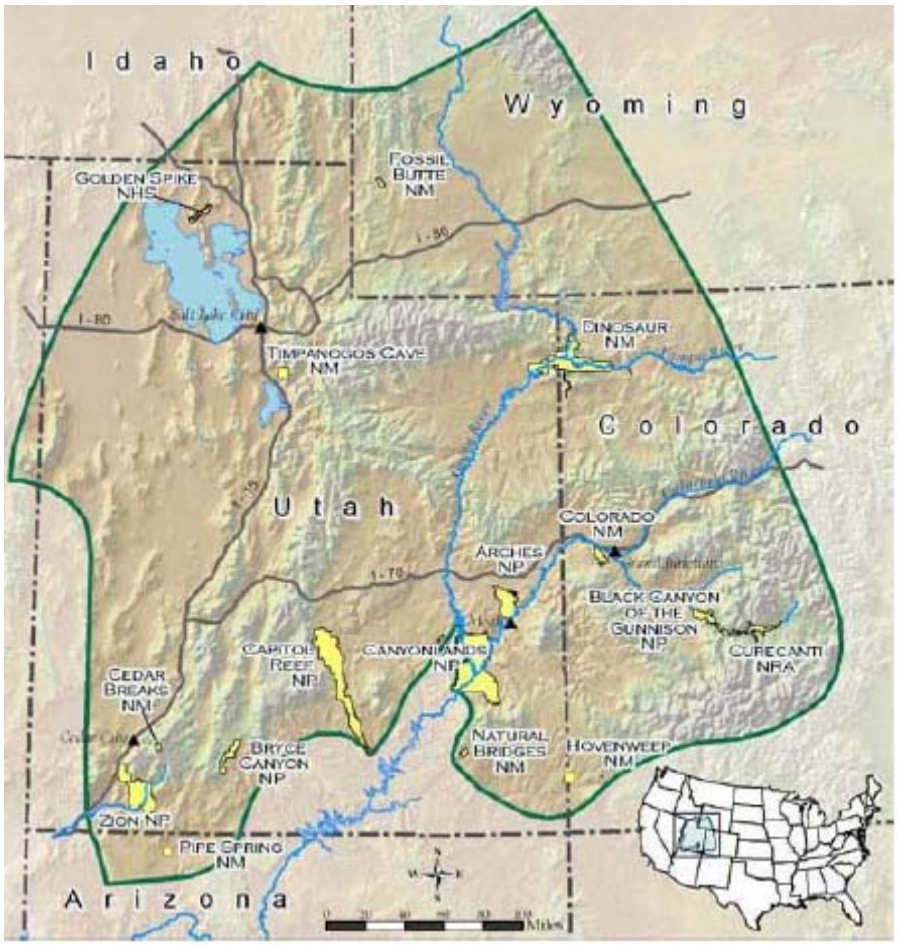
Miller et al. (2003) identified park use by visitors as one of the major stressors to park ecosystems and one of the “high-priority vital signs” in NCPN parks. They noted that understanding the role that human activities play in driving ecosystem processes and changes is vital to managing these resources. Through a Delphi process that involved over 230 scientists and resource-management specialists, measurable ecosystem

indicators were identified. Potential resource impacts associated with visitor-use include trampling effects on soils, vegetation and aquatic resources (Cole 1990; Shakarjian and Stanford 1998), and impacts to wildlife (Swarthout and Steidl 2001). It is therefore critical to identify the relationship between park visitor use and resource and social impacts.

Table 1- NCPN Parks

Park	Code	State	Size (ha)
Arches National Park SEUG	ARCH	UT	30,966
Black Canyon of the Gunnison National Park	BLCA	CO	12,159
Bryce Canyon National Park	BRCA	UT	14,502
Canyonlands National Park SEUG	CANY	UT	136,610
Capitol Reef National Park	CARE	UT	97,895
Cedar Breaks National Monument	CEBR	UT	2,491
Colorado National Monument	COLM	CO	8,310
Curecanti National Recreation Area	CURE	CO	17,433
Dinosaur National Monument	DINO	CO/UT	85,097
Fossil Butte National Monument	FOBU	WY	3,318
Golden Spike National Historic Site	GOSP	UT	1,107
Hovenweep National Monument SEUG	HOVE	CO/UT	318
Natural Bridges National Monument SEUG	NABR	UT	3,009
Pipe Spring National Monument	PISP	AZ	16
Timpanogos Cave National Monument	TICA	UT	101
Zion National Park	ZION	UT	59,900
		TOTAL	474,709

SEUG - Southeast Utah Group



Monitoring visitor use is critical to managing impacts on park resources. Potential resource impacts associated with visitor-use include trampling effects on soils, vegetation and aquatic resources (Leung and Marion, 2000). Impacts to visitor experience visitors might also be widespread. It is therefore critical to identify the relationship between park visitor use and resource and social impacts. The first step in understanding this is to gain information on when and where visitors are going in parks. This requires monitoring of visitor use.

This protocol was part of a three phase project with the purpose of increasing and improving monitoring efforts in the Northern Colorado Plateau Network. The purpose of

the first phase of the project was to inventory current visitor monitoring programs currently in use in the 16 National Park Service units that are included in the Northern Colorado Plateau Inventory and Monitoring Network (NCPN).

A workshop on Monitoring Visitor Use Patterns was held in August, 2005 in Fruita, Colorado. Representatives from the 16 NCPN park units helped identify common visitor information monitoring needs. Prior to the workshop, NCPN park staff responded to a survey eliciting their concerns regarding visitor use monitoring, what additional forms of monitoring data needed to be collected, any additional visitor monitoring needs that are not being met, what more could be done with the existing collected visitor monitoring data, and what barriers keep the data that is collected from being used.

The most commonly identified concern across parks were the impacts to resources from multiple trails or "social trails." The impacts discussed ranged from trampling vegetation, soil erosion, introduction and spreading of exotic plants, litter, graffiti, and impacts to wildlife. Other concerns noted were the impacts of motorized use, impacts to backcountry/wilderness areas, archeological sites and cave resources, and social impacts that include noise impacts on the natural soundscapes and visual impacts to the resources.

An understanding of both the distribution and concentration of visitors was the most commonly cited additional monitoring data needed. Additional staff and expertise to evaluate existing data and to initiate future data collection efforts were the most common additional monitoring resources cited by NCPN staff. Current monitoring data needs to be better organized, made more accessible to users, and needs far more analysis to answer basic visitor monitoring questions.

Resources such as time, money, and expertise were the most commonly cited reasons for not using currently collected data. The workshop participants identified social science data as their most important data need. These focused on educating visitors and communities so they understand the natural resources of parks, how visitor use impacts the resources, how to change visitor behavior to mitigate the impacts of visitor use so that visitors can advocate for the protection of Park resources. Implicit in this is not only having good visitor counts, but to be better able to understand visitor spatial and temporal distribution within parks, and to then relate these variables to resource impacts. But while mangers and park staff have some information about overall visitor numbers, there is a dearth of data on the number and behaviors of visitors once they are in the parks and how these relate to resource impacts

This protocol is designed to help managers with visitor monitoring on trails. The use of trail counters provides a reliable estimate of actual trail use. The placement of trail counters on a trail network can give very accurate counts of the number of people on each section of the trail. Trail counters function similarly to vehicle counters and are typically photo-electric or infra-red beam, loop-type counters or seismic counters. The cost of acquiring the counters is similar to vehicle counters but the costs to calibrate can be much higher (Watson et al., 2000).

This protocol has been developed to aid NCPN parks in expanding and improving the monitoring of visitor use patterns through the use of mechanical trail counters.

Objectives

The primary objectives for the monitoring described in this protocol are to:

1. Determine status and trends in numbers, and spatial and temporal distribution of visitors in selected NCPN parks.

2. Provide spatial and temporal visitor use data to enhance understanding of the relationship between visitor use and resource impacts.

Sampling Design

The system described in this protocol will enable a manager to obtain visit counts on a particular trail segment or system. Mechanical trail counters are set up to count visitors on the trail. Simultaneous observations are conducted to assess the reliability of the data from the counter. The observation portion of the system is crucial as it serves as the calibration for the counters (Watson et al., 2000).

Site Selection

The use of trail counters provides a reliable estimate of actual trail use. The placement of trail counters on a trail network can give very accurate counts of the number of people on each section of the trail. In situations where one trail provides access to an area, trail counters can be left permanently in one location. This will provide counts of visitors using that trail to access the areas that the trail bisects. In areas where there are several trails that provide access to an area or where one trail provides access to many areas (e.g., the main trail splits into two or more trails), the trail counter can be moved around to provide sample estimates of use for each trail and can illustrate trail use patterns.. Sampling at a variety of locations can reduce equipment costs, but generally increases the cost of installation, calibration, and the statistical procedures to estimate overall trail system use.

In general, trail counters should be placed some distance away from trailheads to ensure that only visitors who are actually using the trail will be counted. This tends to reduce the overestimation of visitor use by excluding visitors that might only walk the

first few yards of a trail for sightseeing for example. Trail counters should be placed before trail intersections if counts for the entire area are desired. However, the counters should not be placed so far from the trailhead that personnel will have to dedicate a great amount of time reaching them to calibrate and download data. The trail counter should not be located in an area where visitors may linger (e.g., trail intersections, obvious lunch or picnic spots, or at attraction sites) as this will decrease accuracy. In addition, areas where wildlife trails intersect the main trails should also be avoided to reduce the likelihood of counting wildlife.

The unit should be obscured in a location where disturbance will be minimized. The dust cover which fits over the liquid-crystal display of the counter may be camouflaged with dirt and plant material (Watson et al., 2000). Connecting wires (available in lengths up to 50 feet) must also be buried for concealment.

Please see SOP 1 for installation procedures.

Sampling Plan for Data Retrieval and Calibration

Calibration is the procedure for assessing the reliability of the counting device by comparing its output to some alternative method of known accuracy (Watson et al. 2000). Data from the trail counters should be collected on the days that calibration is performed. Calibration is performed by recording the number of individuals or groups passing the mechanical counter during a specified observation period. Observations must be recorded in a standardized format (see Appendix B). During the sample period the observer records the number of individuals passing the counter, their direction of travel, and the time of the day that they pass.

There are two potential sources of error with the use of trail counters. Counter output may show either overestimation bias**,** where the counter registers something it should not, or underestimation bias where the counter does not count something that it should. The calibration technique chosen should provide an accurate measure of one or both types of bias if possible and should provide feedback as to how to avoid the type of bias encountered. Trail counter errors typically occur due to poor site placement or to errors due to environmental conditions (animals, etc.).

Two methods of calibration that can be used are camera calibration or observer calibration. Camera calibration involves installing a camera system where the counter is installed and all traffic during a set period of time is photographed. This allows direct comparison with the counter read out. The second type of calibration is more labor intensive but potentially more accurate. In this method, observers are stationed near the counter and they physically count the people that cross the area covered by the trail counter. The observation data is then compared with the counter data. Adjustments are then made to the counter setup if needed (e.g. if the trail counter is recording data other than people) or the calibration data can be used to adjust the counter data.

Whichever method is chosen, the counters need to be calibrated at least twice a month according to a sampling plan. The process will be more accurate, time efficient, and will involve less bias with the use of statistical sampling as opposed to convenience sampling. The days chosen to calibrate and collect data from the counter should be randomly chosen. (See SOP 1 for details on how to choose days for calibration and data collection based on a systematic sampling design.)

Data Retrieval and Management

After each sample day, the data from the field data management sheet should be recorded in a spreadsheet. The hard copy of the sheets should also be filed. There should be two separate spreadsheets. The first should include the data from the counter only. This spreadsheet will have fields for name, date, and initial counter reading. The second spreadsheet should include fields for the information on the calibration data sheet including: name, sampling location, date, time of start, initial reading of counter, end time, and final reading of counter.

Data Analysis

Estimating Use

Using both the observed data during calibration and the mechanical counts during the same period, a rough estimate of the counter bias can be developed. Table 2 shows how this data can be viewed.

Day	Mechanical counts (X)	Visitors observed (Y)
Friday	**132**	**119**
Saturday	**514**	**408**
Sunday	**604**	**556**
Wednesday	**107**	**119**
Thursday	**74**	**74**

An estimate of counter bias could be given by the ratio of the average number of counts by the counter and the average number of counts observed. For example: if in a sample of 15 days, the counter counted an average of 280 people and the observer counted 250 people the ratio would be 250/280= 0.89 or 89 percent of counts registered by the mechanical counter can be attributed to actual visitor traffic while the remaining 11 percent is due to other causes. In this case, if there were no obvious reasons for the discrepancy (e.g. animals setting off the counter or if the counter location is where people

congregate resulting in multiple counts) subsequent counter readings can be adjusted down to reflect the calibration results.

Operational Requirements

Management costs are high when working with mechanical trail counters. Initial equipment procurement can be expensive as well as the associated personnel costs that come with the installation, maintenance, and calibration of the counters. These costs can be minimized in cases where access points that managers want to monitor are few. However, in areas where there are multiple access points, the installation and maintenance costs will be higher. Also, in order to ensure accuracy, the counters need to be calibrated on a regular basis which will be costly in terms of personnel. If counters are concealed properly the chances of vandalism should be low thus minimizing the chances of having to replace equipment.

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Standard Operating Procedure (SOP) # 1
Developing a Sampling Plan for Calibration and Counter Data Collection

This standard operating procedure details the procedures that should be followed to design a sampling plan to schedule days in the month when calibration and counter data collection should occur. This procedure follows a systematic sampling design where the sample (or days in the month) is obtained by randomly selecting the first item or day: the remaining items are selected by systematic selection of each item at some predetermined sample.

Procedure:

1. Obtain a calendar for the current year. Determine how many days are in the first month when sampling will occur. This is the population size N. Determine the number of times a month that sampling can occur (≥ 2). This is the sample size n.
2. Determine the sampling interval k between selected items; k is calculated as the ratio N/n. This ratio is then rounded off to the nearest whole number.
3. Using a random number table, or by generating a random number in Microsoft Excel, select some number i between 1 and k. This number will correspond with the first day of the month that you will sample.
4. Sample the rest of the days of the month identified by the following sequence of numbers: i, i + k, i + 2k, i + 3k…, and so forth
5. Mark the days on the calendar that were identified in the process.
6. Calibrate the counters and read the counters on these days.

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Standard Operating Procedure (SOP) # 2
Calibration

This SOP details the procedures that should be followed to prepare for the calibration of a Diamond Traffic TT-3 counter.

Procedures:

1. A sampling strategy must be developed for calibration (see SOP 1)
2. Equipment needed is: pencil, calibration data sheets.
3. Observation should take place from a location near the counter where the trail is clearly visible. Observers should be in appropriate uniform and possess necessary communication and safety equipment
4. Record your name, the sampling location, the date, the start time, the initial counter reading, and the end counter reading on the calibration data sheet.
5. Count each individual that passes the trail counter. Record the number, their direction of travel, and the time.

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Standard Operating Procedure (SOP) # 3

Preparations and Equipment Setup

This SOP details the procedures that should be followed to prepare for the installation of a Diamond Traffic TT-3 trail counter and corresponding pressure mat. All of the equipment and supplies listed in this SOP should be organized and made ready for the field season, and copies of the field data forms in Appendix A should be made.

General Preparation

Procedures:

1. A location for the counter and pressure mat should be determined. The counter should be located in an area where resource managers need to determine trail use. The counter and mat should be installed in an area that has been approved by resource managers and other park authorities. Ideal conditions for installation are dirt or gravel hiking trails.
2. To prepare the counter and mat for installation, ensure that the battery in the unit has not expired. For use with the trail mat, the battery life of the TT-3 is seven years. If/when the battery needs to be replaced, it is recommended that the unit be sent back to Diamond Traffic for replacement of the battery to ensure that the water-tight seal is maintained.
3. Equipment needed for installation includes: a shovel, a pick, a small flat bladed screw driver, and the magnet reset marker that came with the counter.

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Standard Operating Procedure (SOP) # 4

Installation of Trail Counter and Pressure Mat

This SOP details the procedures that should be followed to install a Diamond Traffic TT-3 trail counter and corresponding pressure mat. The time required to install the counter will vary depending on distance from the trailhead and the medium in which the counter is being placed. It is recommended that at least an hour be reserved for installation.

Installation

Procedures:

1. Dig a trench across the trail about 4 feet wide, 4-6 inches deep, and 6 inches longer than the pressure mat. Remove all rocks and roots so the trench bottom is a fine soil or sand bed. Lay the pressure mat in the trench and cover with soil or trail material.
2. Dig a 9 foot trench from the mat area to the specified counter location. The location of the counter should be concealed by brush. Attach the 5-pin connector cable end to the TT-3 counter input. Using the screw driver, adjust the sensitivity to the 12:00 position, or straight up. Set the delay to the quarter till position, or pointing to the left. Walk on the mat to ensure that you get a count before you bury the mat. If the counter does not count, turn the sensitivity up. If the counter double counts, turn the delay up further. Once you have adjusted the counter, bury the mat and the cable leading up to the counter. Reset the counter to zero by placing the magnet over the space marked “reset” on the counter face.
3. After the equipment has been installed, observe conditions for a short time to make certain that the counter is functioning correctly and that any camouflage is not obscuring or tripping the counter continuously.

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Standard Operating Procedure (SOP) # 5

Data Retrieval and Management

This SOP details the procedures that should be followed to retrieve data from the Diamond Traffic TT-3 trail counter and corresponding pressure mat. The data should be retrieved on a monthly basis and recorded on a field sheet and then transferred to a spread sheet that is saved on a secure computer.

Data Retrieval

Procedures:

1. The trail counter should be read every thirty days. It is important to ensure that the time interval between readings is the same so that comparisons can be made.
2. Print out a data management sheet to take into the field and record the data (Appendix 1). To retrieve the data, go to the counter and read the LCD display. Record the location, the date, the count, the name of the person counting and any comments the reader may have on the data management sheet. Comments may be damage to the counter, unusual numbers, or other important events.
3. After retrieving the data, reset the counter to zero by placing the magnet over the space marked “reset” on the face of the counter.

Data Management

Procedures:

1. The data retrieved should be transferred from the field sheet to the spreadsheet as soon as the reader returns from the field.
2. The data should be entered into the spreadsheet and the file should be saved and backed up.

Appendix A- Trail Counter Data Management Sheet

Counter Location	Date	Count	Reporting Personnel	Comments

Appendix B- Calibration Data Sheet

Name:	Sampling Location:	Date:	Start Time:
Initial Reading	Final Reading:	End Time:	
Direction of Travel	Number of people	Time	Comments