MAPPING RECREATION IMPACTS AT SUNSET CRATER VOLCANO NATIONAL MONUMENT USING A GLOBAL NAVIGATION SATELLITE SYSTEM AND GEOGRAPHIC INFORMATION SYSTEM

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A Practicum

Submitted in Partial Fulfillment

of the Requirements for the Degree of

Master of Science

in Applied Geospatial Sciences

Northern Arizona University

April 2014

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ABSTRACT

The Flagstaff Area National Monuments (FLAG) consist of three co-managed National Park Service (NPS) units in Northern Arizona. One of these units, Sunset Crater Volcano National Monument (SUCR) is largely composed of geologically young terrain resulting from volcanic eruptions. Some types of this volcanic terrain are particularly sensitive to resource impacts from recreation activities. These recreation impacts are dispersed and concentrated at various levels throughout SUCR. Management of primary geologic features and recreation impacts to the resources of SUCR is required under general policies of the NPS and by management documents specific to SUCR.

To provide information for current and future management planning, this project documents the current extent of recreation impacts within SUCR. The title used during the 2013 project is the Recreation Impacts Basemap (RIB). Impacts are documented by developing a data collection plan tailored to the unique character of the SUCR landscape. Geographic Information System (GIS) and Global Navigation Satellite System (GNSS) technology are used to collect and manage the spatial and tabular data used to assess impacts on SUCR resources.

The final product is a comprehensive geodatabase of current recreation impacts and attributes which will be used for data management, analysis, and cartography. A NPS GIS project folder was also developed for documentation of the current project. This data and documentation can be used as a component of understanding the long-term trends of public use and enjoyment activities at SUCR and as a reference for projects in areas with similar natural resources or management objectives.

ACKNOWLEDGEMENTS

I am thankful to the following for their knowledge and support during my coursework at NAU: Dr. Alan Lew and Dr. Pam Foti for channeling my curiosity of geography into a focused graduate program. Dr. Ruihong Huang for his incredible knowledge and dedication to excellence. Mark Manone for his role as a supervisor, advisor, and friend, and for keeping my graduate experience grounded. Special thanks go to Nicole Harris in administration. She’s probably taking care of something I dropping the ball on right now.

My time spent with the Flagstaff Area National Monuments, on this and other GIS projects, has been instrumental to where I am now as a GIS professional. It is a fascinating area, both in resources and management, and I am privileged to have worked there. Mike Jones and Kerry Gaiz are excellent GIS comrades and I hope our paths cross again. The dedication of Paul Whitefield to the responsible management of resources and his example of professionalism will continue to guide me as I continue serving the National Park Service. Lisa Leap, Lisa Baldwin, Kat Eisenman and everyone else at FLAG were a dedicated team, and a model of how an agency can serve the public.

I have never doubted the support of my family, but this project has reaffirmed what true support is. My parents, George and Cyndy Hansen, have always believed in me before I even knew what I was doing. Stacy, Ada and Clara are a welcome sight after a ten hour field day. This project is for us; now let’s go on an adventure.

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CHAPTER ONE

Project Overview

Introduction

The protection of nationally-significant resources from impairment is one of the primary missions of the NPS (National Park Service, 2012 a). This mission also involves a broad spectrum of management activities that must strike balance between natural resource protection and providing interpretive and recreational opportunities of natural resources (National Park Service, 1997). At Sunset Crater National Monument (SUCR), the natural geologic resources of Sunset Crater and the associated volcanic features provides both the motivation for protection, by designation as a National Monument in 1930 (Hoover, 1974), and the motivation for recreation activities (Cooper & Erfurt-Cooper, 2010). Figure 1 displays the general layout of volcanic features at SUCR.

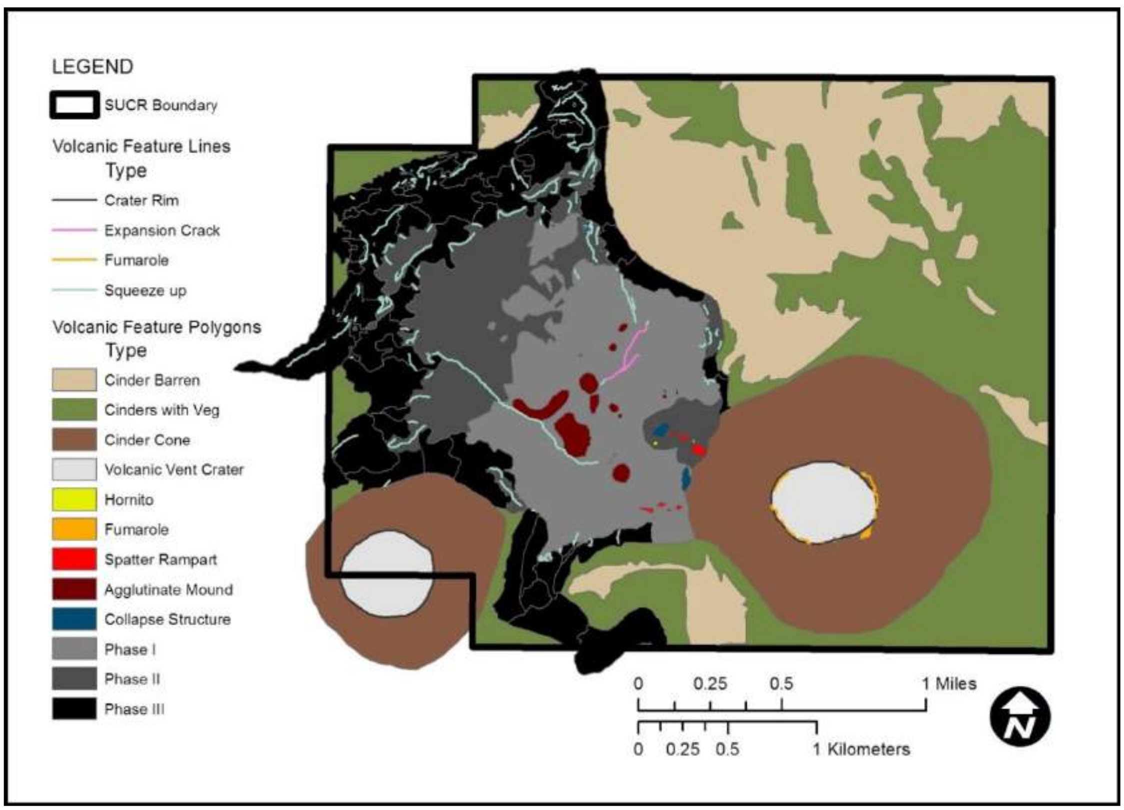

Figure 1 – Volcanic Geologic Features of Sunset Crater Volcano National Monument

The natural erosion rates of surfaces and the potential to change natural erosion rates may vary between geologic resources types (Toy, et al., 2002). Some geologic resources may be considered very stable and have been changing slowly for millennia. Others, such as the unique volcanic features of the most recent eruption at SUCR, are very susceptible to impacts (National Park Service, 2013 b). Natural impact agents, such as wildlife and weather, can cause impacts and erosion of features, but these impacts may be acceptable as part of natural processes (Dunster, 2011). Human recreation impact agents, such as cross-country foot and off-road vehicle (ORV) use, may vary in the amount of impact and erosion caused (Cole, 1989). The acceptability of recreation activities and associated impacts has varied over the human history of SUCR (National Park Service, n.d.a). Some management practices may actively encourage activities that impact resources, or impacts may be incidental or discouraged, but still cumulatively significant.

The recreation activity causing the impact may be acceptable under the current area management plan, but most often impacts are the result of an unauthorized use (National Park Service, 2002). This project is focused on documenting any evidence of recreation activity found outside of a designated recreation facility, under the policies of the current General Management Plan (GMP) (National Park Service, 2002) and recent amendment to the GMP (National Park Service, 2013 b). In SUCR, these impacts of greatest concern fall into two general categories: cumulative impacts on the periphery of designated facilities, and deliberate impacts by recreation users in areas that do not have recreation facilities and have been zoned as closed to general public access. Developed and designated recreation facilities include roads, trails, vehicle pull-offs, rest areas, trailheads and any other planned, constructed and managed facility for recreation use. An impact not within a developed recreation facility may be termed as “off-trail”, “off-road”, “off-highway” or “cross-country” impacts (American Heritage Dictionary, 2011; Nixon, 1972). The term “travel” is often found added to this term as this is the most common and general term for the intention of the recreation use. In this project, “cross-country” is the preferred term to describe an activity taking place outside of a developed recreation facility (American Heritage Dictionary, 2011). Figure 2 is an example of cross-country travel ORV impacts on volcanic cinder terrain detected by remote sensing. The area shown is the US Forest Service managed Cinder Hills OHV area near the southern boundary of SUCR. The image is a high resolution raster derived from the intensity values of an aerial Light Detection and Ranging (LiDAR) dataset. Dark grey areas are cinder; bright white areas are vegetation and medium value linear features are vehicle tracks.

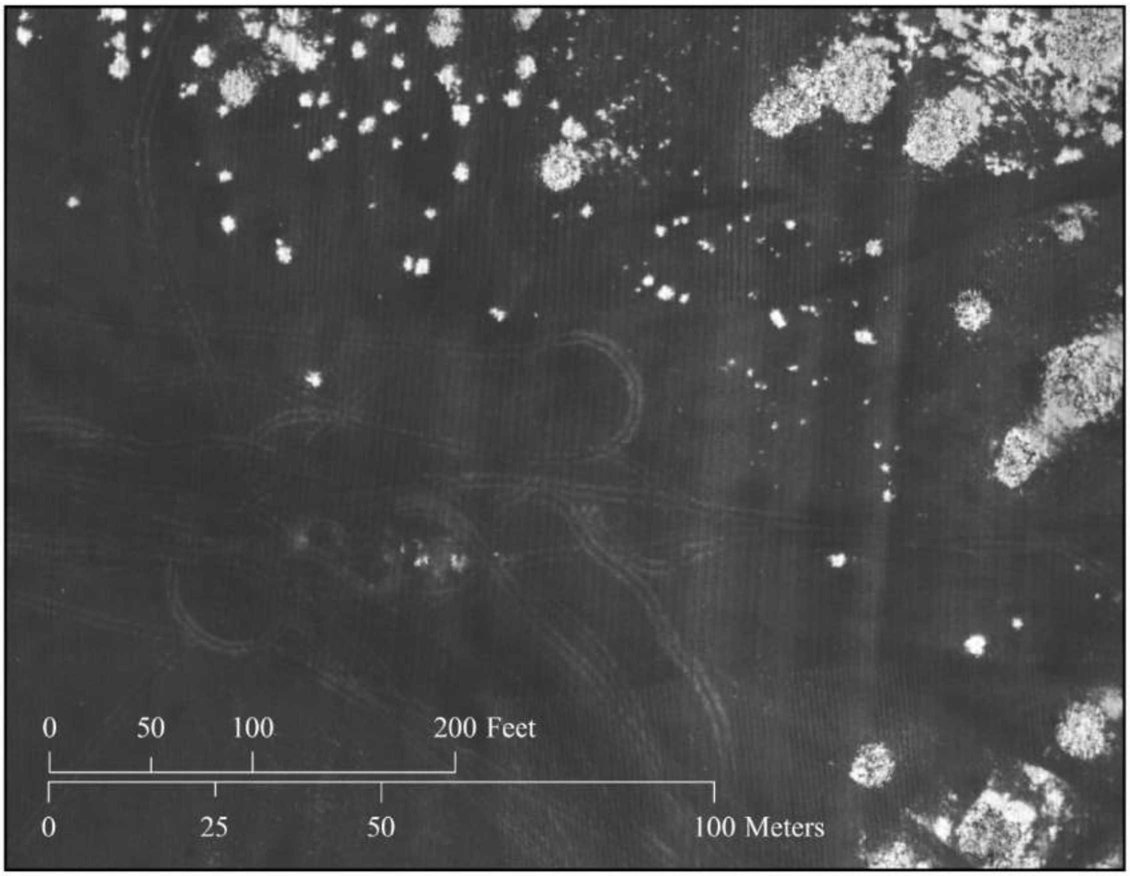

Figure 2 – Cross-Country ORV Impacts on Volcanic Cinder Terrain

The NPS routinely uses GIS as a tool for management planning, resource inventory and monitoring, and facilities projects (National Park Service, n.d. b). A GIS is an effective and efficient way to implement a project where the resource features have spatial characteristics. The Environmental Systems Research Institute (ESRI) software platform ArcGIS for Desktop 10.1 (ESRI, 2013) was used for inspecting existing spatial data, planning and scouting, and collected field data. GNSS hardware and software developed by ESRI and Trimble are a way to further extend the GIS into the field. The ESRI

ArcPad 10 software extensions and mobile applications were used to manage and collect field features and attributes (Environmental Systems Research Institute, n.d. c). Field data collection is further enhanced by using the Trimble Positions software desktop ArcGIS Add-in and ArcPad mobile extensions to allow for nearly seamless integration of GNSS data collection and post-processing (Trimble, 2013 a). The final data deliverables are in a GIS format that uses current industry best practices and meets organizational standards. This data will be the foundation for future spatial analysis, baseline comparisons, and cartographic visualizations, such as maps and animations.

Background

The Natural Resource Program at the Flagstaff Area National Monuments (FLAG) often undertake projects that focus on the primary resource for which SUCR was established to protect, or other identified unique, vulnerable, or sensitive resources. The volcanic landscape of SUCR has had several recent NPS projects focused on its geologic resources, including a Geologic Resources Evaluation (Thornberry-Ehrlich, 2005) and a Volcanic Features Inventory (National Park Service, 2009).

This project is part of a multi-year effort at SUCR to monitor for recreation impacts within volcanic terrain (Sunset Crater Volcano National Monument, 2013). The project funding source is NPS Intermountain Region natural resource project funds obtained through a competitive proposal process. The core project proposal, funding, and performance are managed by the NPS using the Project Management Information System (PMIS) (NPS Focus, n.d.). The initial PMIS proposal was developed in 2004. The first component of the project, an inventory of volcanic feature within SUCR, was completed during 2007 and 2008. The unique features identified are shown in red on the Figure 3 map.

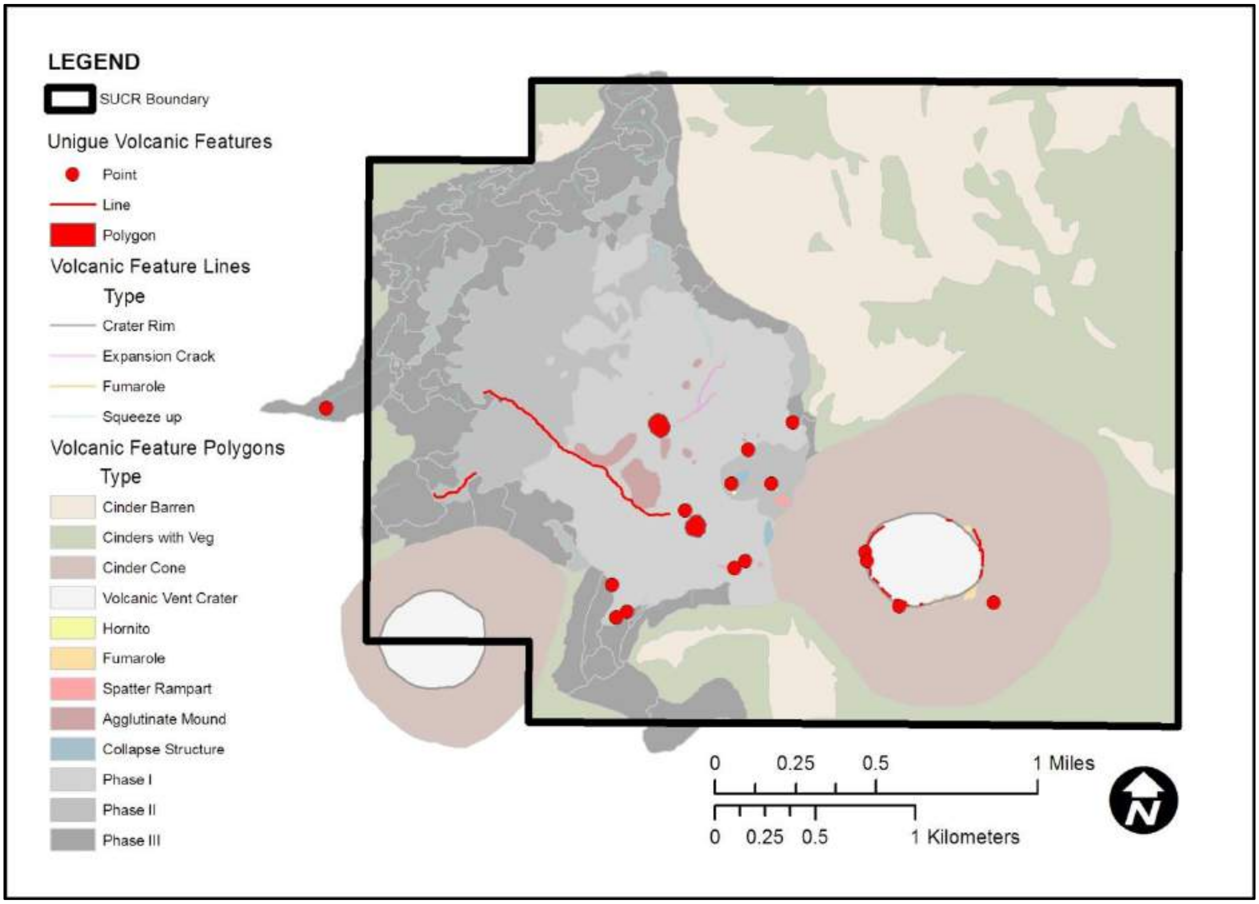

Figure 3 - Unique Volcanic Features within Sunset Crater Volcano National Monument

The second component focuses on a baseline map of recreation activity within the barren volcanic cinder terrain and has two parts. The first is the acquisition of an aerial LiDAR dataset to derive detailed terrain slope models. This part was completed in 2013. The second part of this component is this project which was started in March 2013 and will conclude with the submission of the GIS project folder and documentation to the NPS in May 2014.

Problem Statement

Management planning for NPS natural resources is a complex process that integrates law, regulation, science, expert analysis and public input (National Park Service, n.d. c). It is necessary to understand the impact that monument visitors and associated recreation activities are having on resources, especially resources that require protection under existing management plans. Data on current visitor activity patterns and motivation is also required to develop, update, or amend management plans. An example of this is the SUCR Trail Environmental Assessment (Trails EA) (National Park Service, 2013 b). This project is for the expansion of the formal pedestrian trail system in SUCR. A current basemap of recreation impacts in the affected area is useful to monitor whether the impact and mitigation requirements of the Trails EA are being met over time.

Methods to efficiently and effectively record recreation impact data needed to be developed. Once developed, these methods were used to collect baseline impact data. To organize this project, specific objectives were developed and each objective evaluated for success individually in the project results discussion.

Objectives, Scope and Justification

1. Objective: Create a project plan.

   Scope and Justification: The plan included meeting with NPS resource specialist, scheduling periods of office and field work and gathering relevant documents and tools. A project plan helped ensure the timely and accurate completion of project objectives.

2. Objective: Determine the area where recreation activity and impacts are occurring.

   Scope and Justification: The entire SUCR area was not practical or accessible to inventory, so data collection was limited to areas of interest defined by field scouting and post-field work.

3. Objective: Develop a method to efficiently and accurately record impacts.

   Scope and Justification: Systematic methods were developed to record impact feature geometry. Impact type schema were developed by literature review, field scouting observations and consultation with the natural resource specialist. A well designed method ensured that field work was conducted in a safe and practical manner.

4. Objective: Record impact data using GNSS technology and the project-specific methods.

   Scope and Justification: Used consistent tools and methods, even as the field conditions and impacts encountered changed over the course of the project period due to ongoing use and natural processes. Fieldwork recorded all impacts within areas of interest to complete the basemap data.

5. Objective: Process data.

   Scope and Justification: Processed all scouting, field, editing and final data into formats required for the current project, formats that meets NPS and SUCR data standards and formats that are usable by future GIS and resource specialist. Long term data management and data interoperability are important for NPS management.

6. Objective: Develop project documentation.

   Scope and Justification: Create documentation that met the requirements of the Northern Arizona University (NAU) Applied Geospatial Sciences Master's Program and NPS project.

7. Objective: Present project results.

   Scope and Justification: Results presented to NAU at a combined practicum presentation and oral defense. Present results to the NPS – Flagstaff Area National Monuments at a brown-bag presentation. Presentations are required to meet the author's commitments to NAU and the NPS.

CHAPTER TWO

Literature Review

This literature review will discuss several facets of the natural and human history of Sunset Crater Volcano, and how this area has been affected by human activities. The management of SUCR by the NPS, other projects for NPS management of recreation impacts, and how GIS and GNSS can be a part of resource projects will also be reviewed.

Sunset Crater Volcano Natural History

Sunset Crater Volcano National Monument is located on the eastern side of the San Francisco Volcanic Field and is the youngest volcano in the 6 million year old field (Priest, et al., 2001). The basalt cinder cone and lava flows of Sunset Crater Volcano were formed during a monogenetic eruption event. Archaeological, geologic, and natural history evidence had indicated an eruption date range starting around 1064 and lasting up to 100 years (Hanson, 2009), however, the exact date range is still being refined by research, and is now thought to have a less exact date of onset and much shorter duration (Ort, et al., 2002). The results of the eruption are a large scoria cone, smaller cone structures, fissures, extensive areas of scoria covered terrain, lava flows, and unique volcanic features (Holm & Moore, 1987). Scoria, a loose pyroclastic tephra (United States Geological Survey, 2006), when gravel sized, will generally be referred to as “cinder” in this project and report as the term is more commonly understood. Figure 4 is a photograph of foot impacts in cinder terrain near the Lava Flow Trailhead.

Figure 4 - Overall Trampling Foot Impacts near the Lava Flow Trailhead

The volcanic features of Sunset Crater are important as they provide a detailed scientific insight into volcanic processes that affect this region and similar volcanic regions around the world (Camp, 2006). Volcanic processes of the San Francisco Volcanic Field are also important to understand as this area is inhabited and has the potential for future volcanic activity, although the estimated eruptive interval places any event far into the future (Priest et al., 2001).

Natural weathering and biological processes have been gradually altering the landscape post-eruption (National Park Service, 2013 b). The post-eruption landscape contains many surface types and textures with variable geology, soils, and vegetation cover. Some of these surfaces are considered sensitive to disturbance. Cinder and other loosely welded volcanic products are easily altered by physical disturbance (Camp, 2006). The vegetation of the area is diverse and represents several successional stages (Hansen, et al., 2004). Vegetation succession is also precarious as much of the volcanic substrate is prone to vegetation disrupting physical disturbances and are establishing in relatively nutrient poor soils (Kennedy, 2005). Soil is barely developing in areas of deep cinder deposits, which are largely barren of vegetation. Established trees are more difficult to disturb, but grasses and small woody shrubs are considered vulnerable (Kennedy, 2005).

Sunset Crater Volcano Human History

Human occupation of the area occurred both before and after the eruption. Pre-eruption habitation was by Native American cultures dating back at least 11,000 years (Grahame & Sisk, 2002; Nabhan, et al., 2005). Evidence of their occupation can be found in structures, rockart, and artifacts, but not with significant alterations to natural topography and landscape features. Native Americans witnessed and were directly affected during the recent eruptive period, as recorded in artifacts and the native traditional records (Hanson, 2009). The post-eruption effects on the landscape, in particular aerially dispersed cinder deposits, made the immediate vicinity uninhabitable to farming cultures and displaced the Sinagua Culture. Native Americans, namely the Navajo, began gradually reusing the area for nomadic grazing, but did not establish permanent settlements near Sunset Crater Volcano (Grahame & Sisk, 2002).

Modern human history of the region began with expeditions in the 1850s led by Antoine Leroux (Wikipedia, 2014). Permanent non-native human settlement began in 1876 and was the beginning of many natural resource altering human activities, such as mineral extraction, timber harvest, infrastructure development, travel and recreation (City of Flagstaff, n.d.; Grahame & Sisk, 2002). The current concentration and pattern of human settlement pattern is focused on the Flagstaff, Arizona metropolitan area. There are several outlying unincorporated areas, of which the Wupatki Trails and Bonito Park subdivisions are the closest to Sunset Crater. Sunset Crater Volcano National Monument and adjacent public lands, such as the Coconino National Forest, are primarily managed for human activities but are not available for permanent human settlement.

National Park Service Management

National Park Service management of the SUCR area began with proclamation of the Sunset Crater National Monument by President Hoover in 1930 (Hoover, 1974). Prior to the proclamation, the area was public land managed for multiple uses by the United States Forest Service (USFS), Coconino National Forest. While long considered an important area for native cultures and feature of interest to visitors, no specific protections were in place until a 1929 proposal to dynamite portions of the cinder cone to create special effects for a film production became known (Grahame & Sisk, 2002; KNAU, 2009). This destructive proposal created a strong local movement for protection and rapid action was taken by President Hoover under the authority of the American Antiquities Act of 1906 (Cultural Resources, 2006) to protect the area as a National Monument.

NPS management began an era where preservation of the eruption features was a primary objective. However, the additional NPS objective of visitor enjoyment conflicted with the preservation of features in some areas. For example, an established trail up Sunset Crater and several smaller hill features caused significant erosion (National Park Service, 2013 b). Concerns over the effects of this erosion on natural and visual resources led to the closure and rehabilitation of the Sunset Crater trail in 1973. Further concerns over visitor impacts to Sunset Crater led to emergency closure of the entire cinder cone in 1998. This closure was made permanent and expanded to include most of the monument in a Resource Preservation Zone by the 2002 General Management Plan process (National Park Service, 2002). The 2013 Trail Plan and General Management Plan Amendment is the most recent planning document and will once again change visitor access and activity patterns across the Sunset Crater landscape (National Park Service, 2013 b). Several new trails will be constructed and guided off-trail hikes will be led by the NPS into areas with unique volcanic features.

The resources of SUCR are also affected by recreation on adjacent lands managed by the USFS (National Park Service, 2002). These impacts may have been permissible or the result of inattentive management in the past, however, the current boundary of SUCR is largely fenced and signed. Trespasses do occur and evidence of trespass is most clearly left by cross-country ORV use; several vehicle trespass impacts originating on USFS lands were documented by this project. To better manage travel and ORV use on USFS lands, the adjacent Coconino National Forest completed a Travel Management Plan in 2011 (Coconino National Forest, 2011). This plan formally closed all areas immediately adjacent to SUCR to cross-country ORV use and better defined the Cinder Hills ORV area using practical cultural and physical boundaries.

Recreation and Recreation Impacts in Natural Landscapes

Recreation is "refreshment… through activity that amuses or stimulates" (American Heritage Dictionary, 2011). At Sunset Crater, recreation may be physical by hiking and scrambling in natural areas or cerebral by observing natural and cultural features and learning about natural and cultural process (National Park Service, n.d. d). Recreation in America has always involved indoor and outdoor activities (Rockefeller, 1962), but the need to have special parks and natural reserves protected for recreation activities was not realized until the late 19th century when the effects of industrialization and development were becoming widespread (McLean & Hurd, 2011). Early National Parks were individually created and managed until 1916 when the National Park Service Organic Act formally established a federal agency (National Park Service, 2012 a). Since then, over 400 areas have been designated NPS managed units and these units are a draw for millions of outdoor recreationalist annually (National Park Service, n.d. e), including 184,864 visitors to SUCR during 2013, the year of this project (Public Use Statistics Office, 2014).

The need to methodically inventory and monitor NPS natural resources was recognized by the United States Congress in 1998 with the creation of the Natural Resource Inventory & Monitoring Program (National Park Service, 2013 a). This program studies several resources, including geological resources. The Geological Resources Inventory for SUCR was completed in 2004 (Thornberry-Ehrlich, 2005). The NPS has developed a Geological Monitoring Manual to provide guidance for monitoring projects (Smith, et al., 2009). This manual covers several geologic feature types, but the volcanic section is limited to monitoring current eruptive activity and makes no mention of monitoring post-eruption geologic features, such as those that are at SUCR. The "Cave and Karst" section of the manual has the most practical methods to monitor the condition of static geologic features, but limited usefulness for a survey of recreation impacts such as this.

In the United States, the recognition that outdoor recreation activities may cause impacts to natural resources has been progressing since the 1960s (Monz, et al., 2009) and led to the development of the field of recreation ecology. Most research focuses on the condition of planned recreation facilities, rather than the inventory of unauthorized or informal impacts, and few studies seek to comprehensively inventory all recreation impacts occurring in the study area. Quantitative studies of impacts from recreation on public lands is usually focused on a single recreation activity types, such as ORV, hiking, or horse use and may be even more specific to a sub-categories of a use, for example a trail study may focus on constructed hiking trails, social trails, or cross-country travel (Cole, 2004). Quantitative methods may involve complex experimental design with detailed metric objectives and long term research intervals (Marion, et al., 2006). These detailed methods necessitate a schema to categorize impact types and intensity (Leung & Marion, 1999). The categories may be defined by general activity types or conditions or class breaks from a measured variable. There is not a standard classification system for recreation impacts types for many areas, and the lack of standards is directed as much by differences in management as differences in the actual landscape. Recreation impacts in areas with similar recreation activities or similar natural features may have impact types that, while possibly not enough to develop a broader standard, are useful to compare and contrast the effectiveness of an individual system (Monz, et al., 2009).

Impacts studies specific to volcanic terrain and features are more rare, as this landscape type is less distributed and the terrain characteristics make is less favorable for certain recreation activities (Chhetri & Arrowsmith, 2002). Many pristine volcanic fields and features in the United States are managed by the NPS and a need to develop methods to assess the condition of volcanic features was identified during a workshop in 2000 (Guffanti, et al., 2000). Since then, very little public literature was found on the development of volcanic feature impact research, but it is possible that individual NPS units may have internal projects and reports. A study at Lava Beds National Monument was conducted in 2008 to record social trails using methods from Marion, et al. (2006). This study used focused survey areas, comprehensive inventory, and the use of mobile GNSS to record impact features and attributes (Veal, 2011). However, the study limited feature geometries to lines following social trails and did not record other recreation impact types or geometries, such as trampled area polygons and isolated impact points. The resulting social trail GIS product did create a basemap for any future monitoring limited to social trails.

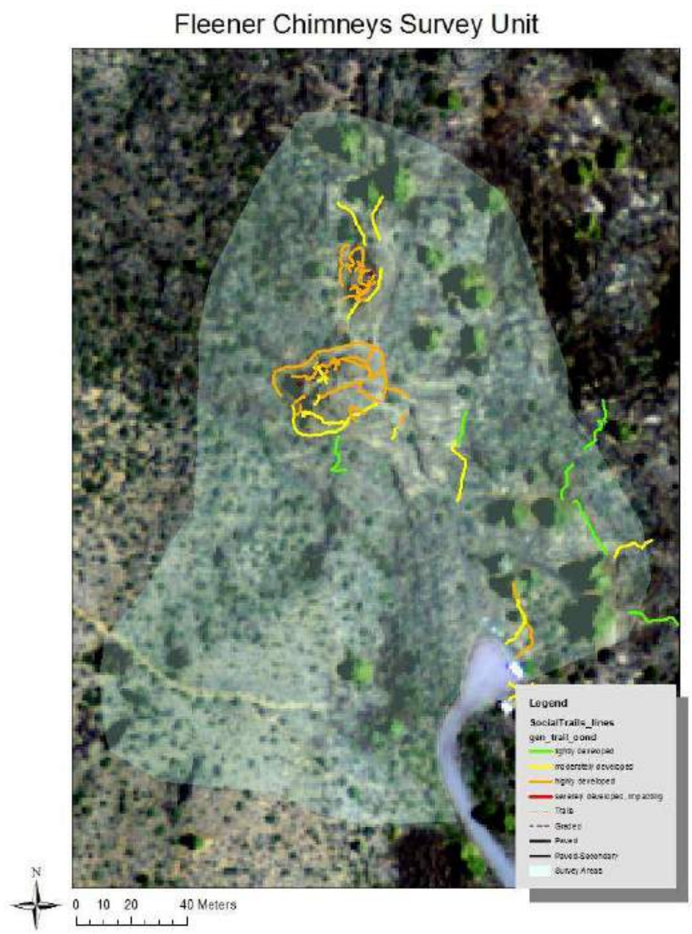

Figure 5 - Social Trails Survey at Lava Beds National Monument (Veal, 2011)

Recreation impact studies have been conducted in other NPS areas. While in a different geologic and natural landscape, several recreation impact assessment projects throughout Yosemite National Park based on the Visitor Experience and Resource Protection (VERP) framework (National Park Service, 1997) have been conducted that can inform planning for this project. While primarily focused on impacts to developed trails and social trails, one study did result in polygon impact features, although these were based on post-field work digitization of the estimated area surrounding a field-collected point feature (Bacon, et al., 2006 a). Another study in Yosemite has conducted over two successive years of social trail impact inventory in a small area (Bacon, et al., 2006 b). The differences in the yearly results have led the authors to question the methods used and suggest that collection inconsistencies and other impact variables are affecting the results, especially when analyzed with strict quantitative tolerances. Overall, the Yosemite projects provide valuable insights into method development and field work planning, but do not provide a template for the project at SUCR. Similar impact assessment work was conducted at Great Falls Park, a NPS managed area, prior to 2008 (Wimpey & Marion, 2011). The spatial data collection and data post-editing methods of this project are the most similar to this project out of any of the studies reviewed, but the focus was limited to linear trail impact features, analysis of the relationship between formal and social trails, and analysis of landscape fragmentation from social trail networks.

Work at Acadia National Park was conducted under the same management need as SUCR to manage recreation impacts (Park, et al., 2008). However, the methods did not involve a baseline spatial inventory of actual resource impacts, rather this study observed the effects of different interpretive strategies on the visitor behavior causing the impacts. This provides little insight into the design of this initial project basemap phase, but could be useful at later phases where NPS actions may be taken to manage impacts at SUCR. A similar active management study was conducted at Bear Island, a unit of the NPS managed C&O Canal National Historic Park (Hockett, et al., 2010; Widman, 2010). This study did include basemap inventory of social trails as an initial phase. While using mapping grade GPS and NPS standard post-processing methods of spatial data in a GIS, the recreation impacts surveyed at Bear Island were limited to linear social trails, and simple trail condition and trail width attributes. A pilot study at Mt. Rainier National Park on social trails included analysis of previous social trial impact inventories and a recent survey (Moskal & Halabisky, 2010). The field survey and impact data GIS processing methods were developed from method used at Yosemite National Park. This study did use polygons, but only from buffers generated from the width attribute of linear features to analyze whether the time consumption of field width measurement was more accurate than applying a generalized buffer to lines to measure the impact area of the trails.

Recording and Managing Resource Information using GNSS and GIS

GIS is a tool to store, manage and visualize spatial data (USGS, 2007). GIS was largely developed around managing resources with human-scale spatial dimensions, such as property and commercial natural resources (Coppock & Rhind, 1991). Software, data models and file formats developed by ESRI have gained a large market share of GIS users and ESRI ArcGIS provides a comprehensive GIS platform with all necessary software application and file formats (Environmental Systems Research Institute, 2013).

An organization can and should adopt a consistent GIS platform (Somers, 1994). While broadly defined as a federal government agency, the NPS can also be thought of as an enterprise organization. The NPS enterprise has largely adopted the ESRI ArcGIS platform by completing Enterprise License Agreements (ELA) (ESRI, 2008) and by actively using the ArcGIS platform for most GIS related work. The NPS has also developed organization wide standards for GIS data collection, data management and metadata (National Park Service, n.d. f).

Using GNSS technology to record the spatial position and attribute for resource grade mapping is an established practice (National Coordination Office for Space-Based Positioning, Navigation, and Timing, 2013; Zimmer, 2001). When used by the NPS, GPS data collection standards as recommended in the “Field Data Collection with Global Positioning Systems Standard Operating Procedures and Guidelines” set a minimum standard (GIS Division, 2004). This document has not been updated to account for advances in the performance of GNSS receivers, and the technical specifications and minimum accuracies recommended in the NPS standard could be considered too coarse for the objectives of this project.

Modern resource mapping grade GNSS receivers are mobile computing devices and have the capability of running office and database software in addition to the GNSS data collection software; they may also sync with other devices using wireless technology (Trimble, 2011). However, the GNSS data collection software may be adequate as the sole software application to record all of the required spatial, tabular and photographic data for a project (Trimble, 2010).

Data Management and Documentation

Data management is process of ensuring that data, whether for a single file, project, or organizations server, is organized, accessible, and integral (Penn State University Libraries, 2013). The outcome of a project, and its usefulness for future projects, can be dependent on how well the project data is managed. Data management of NPS natural resource projects is subject to federal laws, NPS guidelines and industry best practices. Guidelines for implementation of good data management is well described in the Inventory and Monitoring Program "Data Management Guidelines for Inventory and Monitoring Networks" (National Park Service, 2008). There are also data management methods specific to GIS spatial data formats (National Park Service, 2007). An individual Inventory and Monitoring Network or individual NPS units may add to these standards to meet local administrative needs or project needs.

CHAPTER THREE

Project Design

Comprehensive project design contributed to immediate project success by having an project outline and methodology to follow. A good project design was also critical for project documentation and for repeat inventory and monitoring.

Timeline

The timeline in Table 1 combined the estimated time of completion for an objective, any project specific deadlines and any non-project deadlines that effect project activities.

	Month and Year												
Project Objective	April 2013	May 2013	June 2013	July 2013	August 2013	September 2013	October 2013	November 2013	December 2013	January 2014	February 2014	March 2014	April 2014
Objective 1 – Project Plan	X	X											
Objective 2 – Determine Field Area		X	X										
Objective 3 – Develop Methods		X	X										
Objective 4 – Collect Field Data			X	X	X	X	X						
Objective 5 – Process Field Data			X	X	X	X	X	X	X	X	X		
Objective 6 – Project Documentation							X	X	X	X	X	X	X
Objective 7 – Presentation of Results													X

Table 1 - Project Timeline by Objective and Month

Office and Field Hardware

As an NPS employee, the author had access to and was required to use the NPS Information Technology (IT) infrastructure. The NPS IT system uses workstation personal computers. Work accomplished at the NPS workstation computer will generally be referred to using the term “desktop.” Applications and data were stored and managed using internal and wide area NPS networks and servers. An NPS IT team actively manages this system to maintain and update basic operating system (OS) programs and to ensure data integrity by using server replication and periodic backup imaging.

GNSS hardware for the project is manufactured by Trimble Navigation Ltd. Trimble products have proven resource grade mapping capabilities and good data management workflow, and are a preferred GNSS hardware provider for the NPS. The Trimble manufactured device used for this project is the Trimble GeoExplorer 6000 Series GeoXT handheld receiver and will be referred to in this report as the “GeoXT,” “GNSS receiver,” or the “device.” This model is a true GNSS that can use GPS and GLONASS satellite constellations, and real-time correction sources, to provide accurate positions in the field and after post-processing. The primary interface is to use a stylus on a high-resolution adaptive brightness touchscreen. The device can also be configured to communicate with Bluetooth devices and store data from an internal camera. The full technical specifications of the unit are in Appendix A.

Figure 6 - Trimble GeoXT Device and Blocky 'A'a Lava Flow

The ability of the Trimble units to be used for navigation, spatial and tabular data collection, and photo collection made it the only hardware device required for fieldwork. However, it was common to also use printed field maps for navigation and daily field work planning as a large printed map can provide a better sense of orientation and scale. Note-taking materials and a secondary camera are recommended as backup devices and to collect data for any concurrent projects.

Office and Field Software

The desktop computers used during this project were all using the Windows 7 OS. This OS has integrated programs to manage applications, application data, and data files. The GIS platform for this project was the ESRI ArcGIS suite, version 10.1. Administrative tasks and documentation were performed using the Word and Excel programs in the Microsoft Office 2010 suite. The GeoXT device uses the Windows Mobile OS.

Digital directories and files are generally managed using the Windows File Explorer and ArcCatalog applications. Proprietary spatial data file formats must be managed using a program that can properly read the files. ArcCatalog and ArcMap were used to create and manage spatial data. Working project tasks, spatial analysis and cartography are completed using the ArcMap program.

The GNSS software has a combination of desktop and mobile components. Windows ActiveSync, ArcPad Administrator and Positions Administrator were used to manage software installations and licenses. ArcPad was installed in both the desktop version and the mobile version on the GeoXT. Trimble Positions has multiple components that must be installed. The Trimble Positions ArcGIS Desktop Plug-in was installed on the desktop computer and the Trimble Positions ArcPad Mobile Extension was installed on the GeoXT mobile computer.

Resource Data and Spatial Basedata

There is existing basedata for SUCR and surrounding areas that was useful for this project. Datasets could be used for planning, scouting, field collection, post processing, fusion analysis, quality control and cartography. Boundary datasets were useful for properly limiting the extent of scouting and impact survey and were also useful during post-editing of features. Transportation datasets with road and trail information were useful for planning, survey and cartography. Aerial imagery of several time periods was very useful in understanding landscape and possible impact patterns during planning and for field navigation during impact field collection. A map of the major geologic units and unique volcanic features was used to plan for surface types and to properly record impact attributes relevant to unique volcanic features. Point clouds and derived rasters from an aerial LiDAR dataset acquired in 2012 were very useful for several tasks. LiDAR derived digital elevation models (DEM) were used for planning and to define AOIs. The 2012 LiDAR dataset is very accurate relative to the accuracy of the GNSS features collected and was a good tool for quality checking collection methods and results.

Data Management

FLAG has a separate GIS server to accommodate the special IT needs of GIS data, in particular the potential for very large and complex file formats. The GIS server directories are structures to organize data into relevant categories. The major categories at FLAG are the GIS_Data, GIS_Work and the GIS_Info directories. GIS_Data contains the published basedata for the local NPS units and for other relevant organizations and areas. The GIS_Work folder is structured to organize data for individual projects. Typical organization types are by year, NPS unit and NPS program.

A project folder template is used by the FLAG GIS Program to help organization project data in a consistent manner. The template provides many shell directories that attempt to categorize the possible data that will be generated during a project. Most projects do not use more than a few of the possible directories, so the existing template is rarely tested for usefulness in whole. The author viewed this project a good candidate to test a revision of project folder template as many of the categories would be used. A revision of the template was undertaken to meet the needs of this the project, and was used to deliver the final project data. Appendix B details the original and revised templates used for this project.

Spatial data and deliverables were managed according to several standards and best practices. Formatting of spatial data will be informed by the "NPS Layer Naming Conventions" (National Park Service, 2012 b) and the NPS spatial data acquisition handbook (National Park Service, 2007). Field data collection procedures were designed with input from the NPS "Field Data Collection with Global Positioning Systems - Standard Operating Procedures and Guidelines" document (GIS Division, 2004). Metadata was created in the FGDC format using templates and procedures from NPS how-to guide documentation (IMR , 2012). Exceptions to standards were expected, but were minimized and justifiable.

Geodatabase Design

Spatial data storage formats have evolved as the capabilities of GIS programs have evolved. This project primarily uses formats developed by ESRI for ArcGIS. The current spatial data storage formats used by the FLAG GIS Program and NPS involve standalone file formats, such as the shapefile and rasters, and relational database formats such as the geodatabase. The required format for a project with this level of data complexity and for compatibility with the Trimble Positions GNSS software workflows was the ESRI Geodatabase. For this project, a file geodatabase was created rather than a personal geodatabase for better performance and file size capabilities (Childs, 2009).

A Microsoft Excel spreadsheet "[Project]_GDB_Design.xlsx", was developed as a template for geodatabase design, organization and documentation. The excel file format can also be read by ArcGIS programs which allows for the use of certain geodatabase geoprocessing tools. The project template is meant to be copied and renamed when applied to a project.

The geodatabase design process continued into the project implementation phase to allow for continued development and revision. Some of the geodatabase elements, such as the core geodatabase file, feature datasets, and basic feature classes, could be designed immediately. Other geodatabase elements, such as feature class attributes, attribute domains and additional feature classes could not be fully designed until field scouting was underway. Additional revisions were also be made once actual data collection was underway. The additional geodatabase design processes are detailed in the

“Developing Impact Feature Attributes and Domains” section of Chapter 4. There are ten worksheets initially in the workbook template. Each worksheet is in a basic form style with enough formatting information to begin the design and documentation process. The following list describes the individual worksheets. The details and layout of each worksheet are in Appendix C.

A. GDB_Info

Basic information about the geodatabase, such as date created, author, location, and components used. Also includes a basic description of the geodatabase purpose and may include recommendations for use. This was a useful reference for creation of metadata.

B. Feature_Datasets

List and specifications of any feature datasets being used. Small or simple geodatabases may not have feature datasets or feature dataset may be required for certain geodatabase functionality. Raster, terrains and LAS Datasets are not feature datasets and should be described in a separate worksheet.

C. Datasets

A list and specifications of the individual datasets that are within the geodatabase. Individual datasets include feature classes, rasters, and annotation classes. This was a useful worksheet for initial geodatabase design.

D. FC_Template

Copied, pasted, and renamed this template for each feature class that needed detailed design work and documentation. The cell contents and layout mimic the feature class properties windows in ArcGIS, but the contents cannot be used to directly populate the feature class fields. The actual attribute fields were efficiently populated during new feature class creation by importing attributes from a shell feature class created solely as a template.

E. Domains

List and specifications of any domains used in the geodatabase.

F. D_Template

Copied, pasted, and renamed this template for each domain. The cell content format and layout are similar to the domain properties window in ArcGIS. Worksheets with correctly formatted code and description columns were input into the "Table to Domain" geoprocessing tool. This was an efficient tool for initial domain creation and for updating existing domains.

G. Subtypes

Enter the specifications for any subtypes used in the geodatabase. Subtypes were not used in this project for content and technical reasons. The attributes for each impact feature did not have enough consistency between impacts for subtypes to be efficient during feature collection. Very few default values could be identified that would not have to be re-selected. There were no consistent subtypes that could be employed during post-editing. Also, technical limitations of subtypes cause a loss of functionality after data check-out in the ArcPad software and could not be a benefit during field collection.

H. Topologies

Enter the feature classes specifications and rules of any topologies. Topology rules offer many benefits in theory, but in practice the multiple geometries and partial continuous nature of the collected impact features caused the amount of topology errors and exceptions after validation to be excessive and more work than the already required manual geometry shape edits. Some basic topologies were applied to identify minor errors, but marking all exceptions was not practical. Future studies could experiment with more dynamic use of topologies for post-editing.

I. Relationships

Enter the participating feature classes and specifications of the relationship class. There were no relationship classes in the project other than those automatically generated when enabling and creating the attachment tables.

J. Other_Element

Enter a description and specifications of any geodatabase element that is not detailed in an existing worksheet.

CHAPTER FOUR

Project Implementation

Project implementation is placing the objectives and project design into action according to the project schedule. This chapter will discuss the field-based portion of the project and a large part of the project data processing. Some of these procedures were carried out concurrently or revisited during review and troubleshooting, and due to this the order of the following procedures may not exactly match the order that implementation took place.

Project Folder and Geodatabase Creation

A project folder was created in the FLAG "..\GIS_work\2013" GIS server directory and named "SUCR_2013_Recreation_Impacts_Basemap." The project folder was initially in the format used by the FLAG GIS program and then migrated over to the revised project folder template once it was developed. The first geodatabase created for the project was named "SUCR_RIB_2013_Basemaps.gdb." This geodatabase was used for testing the GNSS, some pilot field work, and for storing basemaps used for fieldwork and cartography. The main geodatabase for the project was then created and named "SUCR_Recreation_Impact_Basemap_2013.gdb." The feature classes, attribute tables and domains within this main project geodatabase were designed and implemented using the "[Project]_GDB_Deisgn.xlsx" spreadsheet, renamed to "2013_RIB_GDB_Design.xlsx." After creation, the geodatabase properties and feature class properties were examined in ArcCatalog for errors, functionality, and completeness. The following list summarizes the geodatabase components of this project. Details of each component can be found in the geodatabase design worksheet tables in Appendix D. The ArcGIS Diagrammer Program (ESRI, 2010) was used to generate detailed geodatabase reports using an exported schema .xml file. A schema report is in Appendix E and a data report is in Appendix F.

A. GDB_Info

There are three geodatabases used in this project, one for planning and some initial fieldwork, one for collecting, editing, and publishing the main project data, and a reduced-size version of the main geodatabase for convenient sharing. The information for the main project geodatabase is in Appendix D.

B. Feature_Datasets

The feature datasets used in the main project geodatabase are listed in Appendix D.

C. Datasets

A list and specifications of the individual datasets within the main geodatabase are in Appendix D. "FC" is an abbreviation for "feature class."

D. FC_Template

Completed templates for the original and unique feature class may be found in Appendix D. Feature classes that are copies for editing or scratch do not need a template for design.

E. Domain_Index

Domains are listed in the "Attribute Domains" section on page 57. A detailed discussion of each domain and field identification notes are in the "Detailed Description of Domains" section on page 59 and the "Enter the Feature Attributes" section on page 70. A complete GDB design domain list is in Appendix D.

F. D_Template

Completed templates for each domain may be found in Appendix D. These excel worksheets were the input for the "Table to Domain" tool. "D" is an abbreviation for "domain."

G. Subtypes

No subtypes were implemented for this project.

H. Topologies

The project topologies are listed in Appendix D. Details of the implementation of these are in the "Applying Topology Rules to Validate and Edit Features" section on page 88.

I. Relationships

There are no relationship classes in the project other than those automatically generated when enabling and creating attachment tables in ArcGIS.

J. Other_Element

No other geodatabase elements were implemented in the main project geodatabase.

Enabling the GNSS Components

Several steps were completed to enable the functions of the ArcPad software, the Trimble Positions software, and the GeoXT GNSS receiver. Documentation used to complete these steps was provided by several Trimble Positions Users Guides (Trimble, 2013 b; Trimble, 2013 c; Trimble, 2013 d; Trimble, 2013 e) and by the custom documentation developed for the Cultural Resources Program at FLAG (Gaiz, 2013). Some modification from the documentation was required for this project. The general steps for this project are outlined in the following list:

A. Create a .mxd Document in ArcMap

The project feature classes and other basedata to be used are added to a new ArcMap session. Different maps were created for the testing, AOI delineation, pilot and final collection stages of fieldwork. All maps that are used with GNSS work are saved in the "..\Maps\GNSS" directory.

B. GNSS Enable the Geodatabase and .mxd Document

ESRI ArcPad software was installed on the desktop computer and the extension was activated in ArcGIS desktop. Trimble Positions functions as an ArcGIS Desktop Add-in and

ArcMap desktop toolbar. Once installed, there are two windows used within ArcMap. The "Trimble Positions Desktop Administrator" window was used to complete several required steps as follow:

1. Projects

A Trimble Positions Project is the central organization structure for managing GNSS data collection and processing. Several of the other Trimble Positions Desktop Administrator tasks need to be completed for the project to be functional. All Trimble Positions projects at FLAG share the same office database and are listed in the Projects window. A project named "Hansen_RIB_Field_1" was created and used for all GNSS fieldwork. All required field collection feature classes were added as project layers. A horizontal accuracy threshold of 10 meters, the FLAG GIS Program standard, was applied to all project layers. Accuracy metadata was transferred to the "Horiz_Acc" field and "Ellipsoid_H" fields, if applicable.

2. Devices

Each individual GNSS receiver used with the Trimble Positions Office Database is uniquely identified by an internal serial number that is automatically read by the software. The FLAG GIS Programs had several GeoXT GNSS devises which were usually configured similarly. When using a different device, the preferences were examined and configured, if necessary, to meet the project specifications.

3. Field Configurations

The field configuration for this project, "FLAG Field Settings" was already created for other active GNSS projects at FLAG. The important settings of the primary field configuration used were: SBAS selected for real-time corrections, and GPS+GLONASS base logging with base station distance over 200 km allowed.

4. *Processing Profiles*

The processing profiles used for this project were also already configured by the GIS Program at FLAG for other GNSS projects. Additional processing profiles were investigated as part of initial field testing, but no benefit was identified and the existing and standardized profiles were chosen. The primary processing profile selected was "FLAG Differential Correction 1." This profile used correction files from a Continuously Operating Reference Station (CORS) station that collects both GPS and GLONASS data. The important settings of this profile were: station name "COOP_CORS, MC04, CO" located in Mesa County, CO. Additional processing parameters can be specified during differential correction.

5. *Datum Transformations*

All GNSS positions were calculated and recorded by the GNSS receiver as unprojected geographic coordinates in the WGS 1984 Datum. The NPS and FLAG GIS Program required GIS spatial data to be stored in the UTM Zone 12 North American Datum (NAD) of 1983, a projected coordinate system. This required a datum transformation, and this transformation was applied a part of the data collection and processing workflow. The transformation used to convert GCS WGS 1984 to GCS North American 1983 in this region was "NAD_1983_To_WGS_1984_5."

6. *GNSS Enabling*

GNSS enabling and testing ensured that the ArcMap .mxd document and the geodatabase can successfully transfer data between the desktop file locations and the mobile GNSS equipment, with both systems using the required components of the Trimble Positions software. Enabling the geodatabase created a polygon feature class, attachment table, and an attachment relationship class. These objects hold position data temporarily during the check-in, differential correction, and rebuild processes. Enabling the .mxd document ensured that the implemented versions of ArcGIS and spatial data files are compatible with the installed version of the Trimble Positions software.

Field Session Check-out Procedures

A consistent procedure was developed and followed to prepare and check-out data for fieldwork sessions. The steps were tracked by copying and renaming the "[Project]_GNSS_Log.xlsx" spreadsheet (See Appendix G) and consistently filling out the information for each session. A summary of the steps follows:

1. Start ArcMap and open the .mxd document enabled for the Trimble Positions GNSS workflow. Checked that the ArcPad and Trimble Positions extensions are activated and that the Trimble Positions toolbar is open.
2. Opened the "Trimble Positions Desktop Administration" window and checked that all components are configured, available, and selected for the project. Opened the "Trimble Positions Desktop" window and verified that the "Check Out/In…" button was available. Clicked on this button to launch the "Get Data for ArcPad" wizard window. Followed the steps in the wizard closely:
3. In the "Select Data" window, at a minimum checked-out the geodatabase impact feature classes that were collected in the field. Basedata, such as the SUCR boundary and AOI boundaries, was also checked-out, but not for editing.
4. In the "Select Picture Options" window, selected the "Photo_1" picture field for all of the impact feature classes. Browsed to the copy location and created a new folder labeled with the session begin date, using the "YYYYMMDD" naming convention.
5. The "Select Output Options" window had several areas that were configured. The "Spatial extent:" selected was "The current display extent." The name of the created storage folder was formatted as "RIB_YYYYMDD_Impact" and stored in the "..\GNSS\Check-out" project folder

directory. An .apm map was created for each session and named using the session begin date formatted as “YYYYMMDD.”

6. The “Select Deployment Options” window had the “Create the ArcPad data on this computer now” button selected. After clicking the “Finish” button, the operation report was inspected for completeness.
7. The checked-out data was then inspected in a desktop installation of ArcPad to test that the .apm map would open, the checked out data was present and symbolized correctly, and that the feature attributes entry form windows were functioning.
8. Connected the GNSS device and checked that the internal drive of the device is accessible through the Windows Explorer file management application. The entire session check-out folder was copied and pasted to an ArcPad directory on the GNSS device. The copy operation was verified by comparing the folder properties of the original and copied folders.
9. ArcPad mobile was started on the GNSS device and the .apm map created for the session was opened. The available layers and quick-capture toolbar were inspected for functionality prior to travelling to the day’s collection session fieldwork location.

GNSS Pre-Field Testing

The Trimble Positions workflow was a new procedure for the author. Administrator and user guides developed by a GIS co-worker at FLAG were used to learn this process (Gaiz, 2013). To further understand the process and limitations of the workflow and to ensure effective and efficient field work, several test sessions were conducted at near-office location prior to embarking on field sessions. After several sessions the author was confident in the stability and integrity of the ArcMap, ArcPad and Trimble Positions workflows to collect recreation impact features and data in the field. Session testing questions and results included:

1. Question 1: What is the best possible spatial reference and data transformation that can be selected for the GNSS collected feature classes?

Result: Using the NAD 1983-CORS 96 data transformation to match the 2012 LiDAR data datum realization involved a custom coordinate transformation and did not improve the accuracy of results. The FLAG GIS program standard datum of NAD 1983 (Original) was used.

2. Question 2: What feature class symbology is easy to read in the field and that can allow the display of multiple overlapping layers?

   Result: Overlapping and coincident features could not be seen if solid fill symbology is used on polygons. Selected a hash line or other partial fill symbology for polygon check-out layers. Selected line symbology widths greater than polygon border widths to help differentiate between feature types.

3. Question 3: What should the feature collection GPS Preference settings in ArcPad be, such as point averaging for vertex collection and streaming settings for continuous vertex collection?

   Result: 50 position point and 10 position vertex spacing were reasonable as wait time to acquire positions was less than the time to concurrently record feature attributes. Vertex interval of 0.25 m was in line with the average accuracy of line and polygon vertices and creates feature shapes with few jags and shifts. Position interval of 1 rarely called unless rapidly traverses part of an impact feature. Vertex interval was occasionally raised in poor reception environments, such as blocking terrain or heavy tree canopy.

4. Question 4: What layout of ArcPad attribute collection forms helps collect appropriate data and functions well?

   Result: Field properties and forms allowed for appropriate field data to be entered. Domains were functioning. The nullable properties of each field were functioning.

5. Question 5: How does the spatial feature check-in process perform?

   Result: All field data was successfully checked in using the designed Trimble Positions workflow.

6. Question 6: How do the post-processing profile and feature update tools perform?

   Result: Feature positions were differentially corrected using the recommended GPS/GLONASS correction files from the recommended station and developed Trimble Positions workflow.

7. Question 7: How does photo collection and check-in perform? Must ensure that photos are copied from the unit and that the file path generated in the "photo" field is correct.

   Result: A known software bug in the ArcGIS ArcPad Extension prevented the automatic copying of photos from the GNSS unit to the specified workstation folder location. Photo files were copied manually from the unit to the target folder before data check-in to generate a full file path. If the full file path was not generated, a manual VBA field calculation was used to write the complete path. Once correct, the photo paths allowed hyperlinking and geodatabase attachments.

Location Scouting

It was important to understand the fieldwork location prior to developing many aspects of the geodatabase and the impact collection methods. Location scouting was done in person and remotely using existing spatial datasets.

Remote scouting was completed using many data sources. Web-based mapping services such as Google Earth and Bing Maps provided nearly continuous high-resolution aerial imagery of the project area. Web based services were limited by the fact that it can be difficult to obtain relatively recent imagery and imagery metadata. Aerial imagery datasets such as the NAIP data and terrain datasets such as the National Elevation Dataset (NED) are professionally collected and provided with metadata so that they can be used in spatial analysis (REF). The NAIP program goal is to obtain imagery every three years for the entire US using a rotation of acquisitions (REF). The state of Arizona was scheduled for 2013, but the product was not available in time for scouting, therefore the 2010 data was used.

Terrain data was extremely useful for scouting. The NED data is generally based on elevation data derived from the 7.5' series USGS topographic maps. The NED is accurate enough for general resource mapping, but the minimum available resolution was too coarse to provide detail on smaller geologic features or terrain features and patterns that may affect recreation activity. Very detailed terrain data was available in an aerial LiDAR dataset acquired in 2012. The LiDAR point clouds were used as point vectors or converted into a wide variety of terrain rasters. Figure 7 compares the impact features visible in remotely sensed data and line impact features collected during survey. The aerial imagery (left) shows detailed landscape features and vegetation and changes in soil color and texture. The slope model (right) contrasts topographic slope leveling alterations from social trails against the natural slope gradient.

Figure 7 - Remote Sensing Data and Line Impact Features on an Agglutinate Mound

Field scouting was completed on several occasions. Initial field trips involved a general orientation of the transportation network and facilities of the SUCR area and the types of recreation activities that were occurring. These initial trips were taken with FLAG Natural Resource Specialist who provided in-depth background information on the volcanic resources and various levels of visitor activity within the area, and clearly detailed described the NPS and FLAG objectives of the project. Additional scouting trips were undertaken to get an idea of what the general extent of impact were within SUCR.

Areas of Interest

To better organize fieldwork and to document this project for future monitoring or repeat studies, the broader area of SUCR was subdivided into individual areas, each referred to as an Area of Interest (AOI). These AOI provided a more concise area to target during field work. AOI were delineated based on geographic and human criteria, using such factors as geographic features, facilities, and human activity patterns to define the boundaries. The AOI were also useful to give context to the impacts found as general location was understood.

The process of determining these AOI involved a combination of historical impact review, pilot field surveys, analyzing remote sensing data, and reviewing management plans. Once gathered, this data was processed in a GIS to delineate the AOIs. The following section describes in more detail how each of these information sources was utilized to determine each AOI.

A. Available Information Used to Determine Areas of Interest

1. Historic Impact Data:

The historic recreation use layout plan differs from the current recreation plan and recreation facilities. The historic access road, contact station and trail network all created impacts that may or may not still be apparent. Some of this use, such as the trail leading up Sunset Crater, has been actively rehabilitated and is monitored to prevent any new use and impact. Some impact features of the trail network at the base of the crater are still evident. Historic impacts from off-road vehicle use exist in several areas of the monument adjacent to USFS lands where off-road vehicle use has been prevalent. Historic use areas were determined from literature review, discussions with specialist, and from ground and remote sensing surveys.

2. Pilot Field Data

Foot-based hiking surveys were conducted of historic and contemporary use areas. These foot surveys encompassed any visible recreation impacts. The foot survey were also used to delineate the areas that, while may not have any existing impact, are sensitive to any future recreation impact. Examples of sensitive areas are barren cinder terrain, steep slopes and unique volcanic features. GNSS data was collected while surveying and input into ArcGIS.

3. Remote Sensing Data

Remote sensing data was useful in provided an overview perspective on areas, and was also to model landscape patterns, such as terrain and ground cover, in a different way than field surveys or verbal descriptions could provide. High resolution aerial imagery and aerial LiDAR are available for this area and were used to identify surface types and some recreation impacts.

4. Management Planning Documents

The current GMP provided insight on where recreation activities are allowed, records of use and impacts, and how current recreation impacts are mitigated.

B. Pilot Field Data Collection

While all the detailed sources of information were useful in determining whether an area should be included in an AOI, the data gathered during pilot field data collection work was most directly used to define and draw the actual AOI boundaries. The primary tool used to gather data was the GeoXT GNSS device. The following steps generalize the fieldwork methods specific to AOI survey:

1. Field data collection:

i. Traveled to fieldwork location staging area. Completed necessary safety and equipment checks.

ii. Began walking the edge of possible AOI. Boundaries consisted of human constructed boundary features, such as roads, and natural boundary features such as the distinct transition from a sensitive to a non-sensitive surface, the base of slopes or other distinct topographic features, or across a non-impacted area that functioned as an impact detection transect.

iii. Typically collected line segments using continuously streaming GNSS positions at 0.5 meter spacing or 1 second position intervals.

iv. Regularly finished boundary segments at logical start and end points. Regularly finishing segments was also a good practice to maintaining redundancy of field data.

v. Points were collected to record important field notes. Point were not typically used later to draw the AOI boundary.

vi. Collected boundary segments until a geographically distinct and functional AOI had been delineated.

C. Delineating AOI Boundaries using the Field Data and a GIS

Once all required input data was gathered, the data was processed to create AOI boundaries as polygons in a feature class. This was done using ArcMap. A map visually showing parts of this process is in Appendix H.

1. Delineated the AOI core area:

   i. Created new polygon feature class within the AOI feature dataset. This feature class stores the digitized AOI boundaries.

   ii. Started an editing session and selected the AOI polygon create feature template.

   iii. Began digitizing the polygon boundaries by using the trace editing tool. Traced features included field collected lines, digitized boundary lines and the SUCR boundary shapefile.

   iv. Used the straight segment tool to connect any gaps between traceable features.

   v. Due to the complexity of AOI outlines, the boundaries were often traced in sections and completed. Multiple completed polygon segments could then be merged to create the final polygon.

vi. The reshape tool was used to correct the polygon as necessary. Areas such as small loops, inclusions, and omissions were typically the corrected geometry types.

vii. Used the straight line segment tool to digitize boundaries along road shoulders.

2. Buffered and smoothed the core area:

i. Buffered core AOI areas by 10 meters. This was done to smooth some of the inherent jaggedness of the GNSS data and to ensure that small boundary features that could not be precisely traced in the field were included.

ii. Applied smoothing tool. Used PAEK method with a 10 meter tolerance. Smoothing was used to remove some the "bubbly" appearance from the buffering process and to further generalize the shape.

3. Final area clean-up

i. Clipped AOI polygons to the SUCR boundary. This process removed the areas expanded outside the SUCR boundary by the buffer tool.

ii. Reshaped AOIs edges along coincident boundaries to remove overlapping areas produced by the buffer tool.

iii. Reshaped AOIs along road shoulders of other human-made features. For example, the buffer process expanded boundaries already drawn along road edges. The Reshaping moved the boundaries back to the feature edge.

iv. Visually inspected the AOI boundaries for topological consistency at coincident boundaries.

v. Visually inspected for any other area errors or omissions. Minor omissions were corrected using the reshape tool with adequate vertex spacing setting to maintain the character of the shape.

D. Results and Description of Individual AOIs

Processing field data and delineating the AOI areas was a relatively trouble-free task. The coarseness of the final AOI polygons allowed the acceptance of less-precise field data and also allowed the inclusion of convenient-to-use remote sensing data. The area represented by the AOIs creates a somewhat continuous surface when considering that areas not included in an AOI were omitted either due by inaccessible terrain or a very low probability of recreation activity. The reasoning for each AOI will be discussed to explain its recreational use, general boundary description, and dominant surface components. See Appendix H for a map of the final AOI areas. There are also areas of known recreation impact that did not fit or require a dedicated AOI. These impacts will be recorded individually as needed. The categories for these are:

- Identified During Vegetation Mapping:
- Isolated Impact Incident:
- Other:

1. Bonito Interpretive Area (7.23 acres): This area experiences frequent recreational use. Two small loop trails are being constructed within the area. The northern boundaries are constrained by lava cliffs and the southern boundary falls along the road and developed parking area. The area is primarily composed of a depression or pit in the Phase III lava flow and older cinder covered flows.
2. Cinder Hills Overlook Area (21.82 acres): This area has frequent use in the immediate vicinity of the parking loop and vantage points, and infrequent use beyond the parking loop. The east boundary partially follows the monument boundary, then the 545 road. The boundary then follows cinder patches along the overlook road before following the shallow ridge to the base of Sunset Crater. The crater base is traversed, and then the boundary follows open cinder patches near the top of the slope between the crater and the boundary. The extension to the crater base is to monitor for any crater access made from the overlook parking area. There is somewhat frequent use occurring on the cinder slopes south and east of the overlook. The typical surface type is barren cinder with patchy vegetation.
3. Guided Adventure Zone (306.35 acres): This area has signs of historic use, but is currently closed to general public access. There is unauthorized access occuring. The recreation use of this

area will soon change as ranger-led discovery hikes begin to occur within the GMP amendment established Guided Adventure Zone. The southern boundary follows the 545 road. The western boundary follows the transition between the cinder covered Phase I flow and the rough-surfaced Phase II and Phase III flows. The northern boundaries continue to follow this transition. The eastern boundary follows the steep transition between the Phase I and Phase III flows. The southeast boundary follows the road to encompass several unique volcanic features. The primary surface type is agglutinate mounds, cinder covered Phase I flows and Phase II fissure features at the base of the cone.

4. Lenox Crater Area (78.30 acres): Lenox Crater has an established trail that receives active recreation use. There is also historic off-road vehicle use and evidence of infrequent hiking use off the established trail. The planned trail system expansion would close and rehabilitate the existing steep trail and replace it with a switchback and gradual loop trail. The boundary follows the historic road bed east of the crater between the 545 road and the monument boundary. The southern monument boundary is then followed to the west rim of the crater. The crater rim is then followed until the west end of the proposed trail is reached. The proposed trail was then traversed downslope towards the trailhead. The boundary left the proposed trail corridor and parallels the road once the road was visible from the proposed trail corridor. The surface of the AOI ranges from barren to heavily vegetated cinder.

5. Lava Flow Trail Area (78.33 acres): The Lava Flow Trail area has the highest concentration of recreational use in the Monument. The trail network falls within the Visitor Learning Zone. Off-trail use is not encouraged, but does occur frequently. There are numerous recreation impacts present on the general terrain surface and on unique volcanic features within the area. Planned trail system changes will add to the existing trail network. The northern boundary follows the 545 road. The eastern boundary follows the base of Sunset Crater. The southern boundary traverses a steep cinder slope and follows an old cinder cone rim to the edge of the Phase III flow. The rugged intersection of the Phase I and Phase III flow is then followed until the 545 road is

intersected. The surface of this AOI consists of unique features from Phase III, cinder-covered Phase I and cinder terrain that pre-dates the Sunset Eruption.

6. Monument Trail Area (31.30 acres): This AOI receives use from the SUCR Visitor Center, the USFS Bonito Campground area, and from pullouts along the 545 road. The area is not currently open to public access but does receive active recreational use. The proposed trail system expansion will create several trails in this area. The northern part of the AOI is bounded by the monument boundary and the transition from cinder-covered terrain to Phase III flows. The northern and southern parts are separated where inaccessible Phase III cover the monument boundary. The southern part is also bounded by Phase III to the north and then by the 545 road to the south. The surface is mostly cinder with scattered outcrops of rugged Phase III lava flows.
7. Sunset Scenic Loop Area (42.60 acres): There is historic use of this area and infrequent recent use. The proposed trail system expansion will construct several new trails through this area. The northern boundary follows the rugged edge of the Phase III flow. The eastern boundary follows the base of a remnant cinder cone before cutting across a semi-buried Phase III lobe to the SUCR boundary. The SUCR boundary is then followed until intersecting the historic road grade and the adjacent AOI. The road bed and adjacent boundary are followed until then intersection within the 545 road. The surface is primarily cinder with scattered outcrops of the Phase III flow.

Developing Impact Feature Attributes and Domains

The use of GIS and GNSS devices with mobile computing capabilities allowed for collection of tabular impact data and spatial impact data concurrently. The attribute tables of each spatial feature class were used to store this data. These tables were custom created and formatted to meet the needs of the project. Additional tools, such as attribute domains, were used to make data collection more efficient and to enforce data integrity and logical consistency. When reading description of attribute fields, be aware of the two common uses of the word “field,” one in the sense of attribute tabular data and one in the sense of a non-office or exterior location.

A. Attribute required by GIS and GNSS software and NPS GIS Program Standards

Certain attribute fields are an integral part of the file geodatabase feature class data format, such as Object ID and built-in specifications of the feature geometry. There are also user-creator fields required to record GNSS data and metadata. Some of these fields were also required by the NPS GIS program standard. Additional fields were added to record additional relevant GIS information. Table 2 list the fields, associated feature classes and provides a general description of the field purpose. Exact specifications of each field can be found in the applicable feature class description in Appendix D and E.

General Attribute Fields		
Field Name	**Associated Feature Classes**	**Description**
OBJECTID	Impact_Pnts_Field Impact_Line_Field Impact_Plyg_Field	Unique identifier for each individual feature. Sequential numeric value is generated by ArcGIS software when a new feature is created. Integral field.
SHAPE	Impact_Pnts_Field Impact_Line_Field Impact_Plyg_Field	Integral field with the geometry type and additional spatial reference specification, if applicable, of the feature. Automatically generated by ArcGIS when a new feature is created.
GNSS_Date	Impact_Pnts_Field Impact_Line_Field Impact_Plyg_Field	Date and time that feature geometry collection begins in the field using the GNSS receiver. Must be recorded for every feature.
Photo_1	Impact_Pnts_Field Impact_Line_Field Impact_Plyg_Field	Field to hold the absolute path of the feature photograph. Field is populated when field photo is taken, then updated when field data is imported to ArcGIS.
Review_Notes	Impact_Pnts_Field Impact_Line_Field Impact_Plyg_Field	Text field to hold any notes regarding content review of the feature geometry or attributes.
GIS_Notes	Impact_Pnts_Field Impact_Line_Field Impact_Plyg_Field	Text field to hold any noted regarding GIS processes for the feature. Notes can be from GNSS processing, geometry editing or attribute editing or for future work.
Horiz_Acc	Impact_Pnts_Field Impact_Line_Field Impact_Plyg_Field	Double Float field that stores the estimated horizontal accuracy calculated after the feature is differentially correction. Automatically populated after updating features post-correction.

Ellipsoid_H	Impact_Pnts_Field	Double float field that stores the calculated ellipsoid height of the GNSS receiver during point feature collection. Antenna height adjustment is ignored.
SHAPE_Length	Impact_Line_Field Impact_Plyg_Field	Integral field that records the feature length in the linear units of the feature class. Automatically updated when a feature is created or updated.
SHAPE_Area	Impact_Plyg_Field	Integral field that records the feature area in the units of the feature class. Automatically updated when a feature is created or updates.

Table 2 - General Attributes for Project Feature Classes

B. Attributes to Record Impact Features

Certain attributes were developed to record project specific data. Many of these are domain controlled for convenience and consistency. The exact feature class specifications are in Appendix D and E. Table 3 list the attributes developed specifically for the RIB project.

Recreation Impact Basemap Attribute Fields		
Field Name	**Associated Feature Classes**	**Description**
Impact_ID	Impact_Pnts_Field Impact_Line_Field Impact_Plyg_Field	Text field creating a unique ID for each feature based on concatenated data specific to each feature. Format is AOI Code + Impact Type Code + OID + Date YYYYMMDD. This creates a 18-21 character ID. Calculated during post editing.
AOI	Impact_Pnts_Field Impact_Line_Field Impact_Plyg_Field	Text field recording the Area of Interest that the impact occurs within. Entered at time of feature collection.
Impact_Type	Impact_Pnts_Field Impact_Line_Field Impact_Plyg_Field	Text field of the type of impact being recorded. Entered at time of feature collection.
Field_Notes	Impact_Pnts_Field Impact_Line_Field Impact_Plyg_Field	Text field to record any notes from the field. Some examples of notes are: relationship to unique volcanic features, sensitive resource details or editing notes.
Confidence	Impact_Pnts_Field Impact_Line_Field Impact_Plyg_Field	Text field to record the field collector's level of confidence in the impact feature geometry and attributes. Entered at time of feature collection.

Table 3 - Specific Attributes for Recreation Impact Basemap

C. Supplemental Attributes

The basic goal of the project was to collect the type and extent of recreation impacts. Trying to further understand and manage impacts by describing the motivation and trend of the impact is difficult to describe exactly, but these can be inferred by the immediate and surrounding context of the impact and by interpreting the impact character. As this information is not required by this project and will not be analyzed at this time, this data is considered supplemental information. Collecting this supplemental information in the field did not add any significant amount of time to the feature collection process. Analysis of this data, such as spatial patterns of impact motivation or ranking motivation or areas of changing impact trends, could be completed at a later time. The supplemental attributes are detailed in Table 4, with additional specifications in Appendix D and E.

Supplemental Attribute Fields		
Field Name	**Associated Feature Classes**	**Description**
Motive_1	Impact_Pnts_Field Impact_Line_Field Impact_Plyg_Field	Text field that records the motive behind the recreation activity that is causing the impact. The Motive_1 field may be the only motive found or the primary motive if more than one motive is determined. Entered at time of feature collection.
Motive_2	Impact_Pnts_Field Impact_Line_Field Impact_Plyg_Field	Text field to record a secondary motive behind the recreation activity. Secondary motive may or may not be determined. Entered at time of feature collection.
Trend	Impact_Pnts_Field Impact_Line_Field Impact_Plyg_Field	Any trend in activity level that can be described by the character of the impact feature. Entered at time of feature collection.

Table 4 - Supplemental Attributes for Impact Features

D. Attribute Domains

Many impact types were identified during planning and field scouting. Some of these impact types were unique to the feature geometry type, but many can occur in the form of points, lines or polygons. The domain created for each feature class and impact type was overall unique, but common domain codes were used for related impact types. This helped keep impact type development and recording consistent between the different geometry types. Attribute domains help maintain attribute consistency and ease of data entry in the field. All domains created are listed in Table 5. The domain name is the exact name used to create the domain in the geodatabase and to implement the domain on an individual field. The associated feature classes are the feature classes with fields having the applied domain.

Attribute Domains		
Domain Name	**Associated Field, Associated Feature Classes**	**Description**
RIB_AOI	RIB, Impact_Pnts_Field RIB, Impact_Line_Field RIB, Impact_Plyg_Field	The name of the Area of Interest that the impact is being recorded in.
Impact_Line	Impact_Type, Impact_Line_Field	Impact types that are recorded as lines.
Impact_Plyg	Impact_Type, Impact_Plyg_Field	Impact types that are recorded as polygons.
Impact_Pnts	Impact_Type, Impact_Pnts_Field	Impact types that are recorded as points.
Confidence	Confidence, Impact_Pnts_Field Confidence, Impact_Line_Field Confidence, Impact_Plyg_Field	Ordinal ranking of confidence in the feature geometry and attribute accuracy.
Motive	Motive_1 and Motive_2, Impact_Pnts_Field Motive_1 and Motive_2, Impact_Line_Field Motive_1 and Motive_2, Impact_Plyg_Field	List of the possible motives behind the recreation activity that is causing the recreation impact.
Trend	Impact_Pnts_Field Impact_Line_Field Impact_Plyg_Field	List of trend directions that can be described for the impact feature.
Edit_Status	Edit_Check_Fishnet	Status of desktop edits from manual checks of individual fishnet cells.

Table 5 - Project Attribute Domains

E. Detailed Descriptions of Domains

Some of the domains record simple information, such as the name of an area or a relative ranking. Some of the domains control important information about the impacts and are considered to be the classification schema for the impact types recorded during this project. Some impact classifications were grouped by terrain types with different levels of intensity and severity. The impact type classes were somewhat generalized to tolerate a certain amount of overlap. The intention of this was to ensure that the impact type decision made in the field will definitely capture the fundamental impact type, but not create too much dependence on classify the impact exactly, especially as no actual measurement is made other than an informed observation. This method also allowed for variance due to time of day, season, weather and personnel.

The "Code" column is the coded value assigned to each type within the domain. The code was usually derived from the initials or first few letters of the description. Codes of the same impact description that were applicable to more than one feature geometry type have been standardized. The "Geodatabase Description" column is the descriptive name displayed by the software, while the code is used to link the information in the application background. "Description" is the description of the domain type for use in this document and is more detailed than the geodatabase description. Further discussion of how to select the domain value for a feature during fieldwork is in the "Collection of Impact Features" section beginning on page 66. The following tables describe each domain:

1. RIB_AOI

Code	Geodatabase Description	Description
LFT	Lava Flow Trail Area	Area near the Lava Flow Trail and main monument road that receives frequent recreation activity. A high variety of surface materials are present, including several unique volcanic features.

GAZ	Guided Adventure Zone	Relatively large area north of the main monument road. Closed to recreation use, but is still impacted by current and historic recreation. Diverse surface types and the largest collection of unique volcanic features.
LCA	Lenox Crater Area	The cinder slopes and crater of Lenox Crater. Large variety of vegetation communities. Frequent recreation activity on established trail and off trail.
BIA	Bonito Interpretive Area	Lava pit and cinder slopes at the base of Lenox Crater. Very frequent recreation activity. Additional trail facilities planned for area.
SSL	Sunset Scenic Loop Area	Area between the Lava Flow Trail and Lenox Crater. Cinder and lava terrain that receives foot impacts from NPS areas and vehicle impacts from adjacent Forest Service off-road vehicle areas.
MTA	Monument Trail Area	Area between main monument road and lava flows. Impacts primarily on cinder terrain. Current and historic recreation use in area is common. Additional trail facilities planned for area.
CHO	Cinder Hills Overlook Area	Area from overlook parking area to the base of Sunset Crater. No trails or off-road facilities. Impacts on vegetated cinder terrain.
IVM	Identified during 2004 Vegetation Mapping	Non-continuous and widely scattered areas identified as having off-road vehicle impacts. Impacts documented while classifying vegetation cover using aerial imagery.
III	Isolated Impact Incident	Recreation impact feature that is within the boundary of SUCR, but does not fall into one of the defined AOI areas.
OTH	Other	Any area that is outside of an AOI and does not meet the criteria of vegetation mapping area or an isolated impact incident. Also used to satisfy no null requirement of field if feature is being collected for other purposes.

Table 6 - Recreation Impact Basemap Area of Interest Domain

2. *Impact_Pnts*

Code	Geodatabase Description	Description
VRC	veg - roots/crown	Damage, such as bark removal, root exposure or trauma, to the base and surrounding structures of trees and woody shrubs.
VBT	veg - breakage/trampling	Broken branches of trees and shrubs. Trampled saplings, shrubs, herbaceous plants, and grasses.
VGT	veg - other	Any impact to vegetation that is not described in another vegetation impact class.
GBR	geologic - breakage	Solid substrate materials, such as basalt blocks, agglutinate, or welded spatter that have been broken or displaced and physically change the structure of the feature.
GDE	geologic - defaced	Surface of the geological substrate has been altered from natural surface type. Site is not physically altered.

GOT	geologic - other	Any impact to a geologic feature that is not described in another geologic impact class.
GRA	graffiti	Human made writing, drawings, or other visible expression created on a surface.
LIC	litter concentration	Area where litter is being deposited and is accumulating.
SRN	sensitive resource notes	Feature and notes to describe a sensitive resource. Not an impact feature, but has a direct connection to recreation impacts based on proximity or related attributes.
ARE	active restoration	Area that has undergone or is undergoing active restoration.
OTH	other - see field notes	Any impact or other point feature that is not described in another class.
GIS	GIS processing	Feature recorded for use in GIS processing.

Table 7 - Recreation Impact Type for Point Features Domain

3. Impact_Line

Code	Geodatabase Description	Description
FST	foot - single traverse	A single traverse or track way visible on the terrain surface caused by human foot travel.
FMT	foot - multiple traverses	Multiple traverses or track ways visible on the terrain surface caused by human foot travel.
FOT	foot - other	Any impact caused by human foot travel that is not described in another foot impact class.
SCI	social trail - cinder, infrequent	A social trail impact on cinder substrate. Infrequent use estimate based on stable or decreasing extent of impact and no evidence of recent use.
SCF	social trail - cinder, frequent	A social trail impact on cinder substrate. Frequent use estimate based on stable or increasing extent of impact and evidence of recent use.
SAI	social trail - agglutinate, infrequent	A social trail impact on agglutinate substrate. Infrequent use estimate based on stable or decreasing extent of impact and no evidence of recent use.
SAF	social trail - agglutinate, frequent	A social trail impact on agglutinate substrate. Frequent use estimate based on stable or increasing extent of impact and evidence of recent use.
SSI	social trail - spatter, infrequent	A social trail impact on lava spatter substrate. Infrequent use estimate based on stable or decreasing extent of impact and no evidence of recent use.
SSF	social trail - spatter, frequent	A social trail impact on lava spatter substrate. Frequent use estimate based on stable or increasing extent of impact and evidence of recent use.
SLI	social trail - lava flow, infrequent	A social trail impact on consolidated lava flow substrate. Infrequent use estimate based on stable or decreasing extent of impact and no evidence of recent use.

SLF	social trail - lava flow, frequent	A social trail impact on consolidated lava flow substrate. Frequent use estimate based on stable or increasing extent of impact and evidence of recent use.
STO	social trail - other	Any social trail impact that is not described in another social trail class.
VRC	veg - roots/crown	Damage, such as bark removal, root exposure or trauma, to the base and surrounding structures of trees and woody shrubs.
VBT	veg - breakage/trampling	Broken branches of trees and shrubs. Trampled saplings, shrubs, herbaceous plants and grasses.
VGT	veg - other	Any impact to vegetation that is not described in another vegetation impact class.
VST	vehicle - single traverse	A single traverse or track way visible on the terrain surface caused by mechanized vehicle travel.
VMD	vehicle - multiple traverses	Multiple traverses or track ways visible on the terrain surface caused by mechanized vehicle travel.
VOT	vehicle - other	Any impact caused by mechanized vehicle travel that is not described in another vehicle impact class.
GBR	geologic - breakage	Solid substrate materials, such as basalt, agglutinate or welded spatter that have been broken or displaced and physically change the structure of the feature.
GDE	geologic - defaced	Surface of the geological substrate has been altered from natural surface type. Site is not physically altered.
GOT	geologic - other	Any impact to a geologic feature that is not described in another geologic impact class.
SRN	sensitive resource notes	Feature and notes to describe a sensitive resource. Not an impact feature, but has a direct connection to recreation impacts based on proximity or related attributes.
ARE	active restoration	Area that has undergone or is undergoing active restoration.
OTH	other - see field notes	Any impact or other line feature that is not described in another class.
GIS	GIS processing	clip, boundary, edge, etc…

Table 8 - Recreation Impact Type for Line Features Domain

4. Impact_Plyg

Code	Geodatabase Description	Description
FDM	foot - distinct route, multiple traverses	Multiple traverses or track ways visible on the terrain surface caused by human foot travel. Impact concentrated along a distinct route.
FIM	foot - indeterminate route, multiple traverses	Multiple traverses or track ways visible on the terrain surface caused by human foot travel. Distinct individual traverses, but no distinct overall route.
FTR	foot - overall trampled	Surface impacted by dense or continuous human foot travel. Individual foot impression density level high enough that individual traverses or overall route cannot be distinguished.

FOT	foot - other	Any impact caused by human foot travel that is not described in another foot impact class.
VDM	vehicle - distinct route, multiple traverses	Multiple traverses or track ways visible on the terrain surface caused by vehicle travel. Impact concentrated along a distinct route.
VIM	vehicle - indeterminate route, multiple traverses	Multiple traverses or track ways visible on the terrain surface caused by vehicle foot travel. Distinct individual traverses, but no distinct overall route.
VTR	vehicle - overall trampled	Surface impacted by dense or continuous vehicle travel. Individual vehicle impression density level high enough that individual traverses or overall route cannot be distinguished.
VOT	vehicle - other	Any impact caused by vehicle travel that is not described in another vehicle impact class.
GBR	geologic - breakage	Solid substrate materials, such as basalt, agglutinate or welded spatter that have been broken or displaced and physically change the structure of the feature.
GDE	geologic - defaced	Surface of the geological substrate has been altered from natural surface type. Site is not physically altered.
GOT	geologic - other	Any impact to a geologic feature that is not described in another geologic impact class.
VRC	veg - roots/crown	Damage, such as bark removal, root exposure or trauma, to the base and surrounding structures of trees and woody shrubs.
VBT	veg - breakage/trampling	Broken branches of trees and shrubs. Trampled saplings, shrubs, herbaceous plants and grasses.
VGT	veg - other	Any impact to vegetation that is not described in another vegetation impact class.
TWC	trail - widening beyond core	Impacted area adjacent to the constructed trail corridor core caused by encroaching trail use.
SRN	sensitive resource notes	Feature and notes to describe a sensitive resource. Not an impact feature, but has a direct connection to recreation impacts based on proximity or related attributes.
ARE	active restoration	Area that has undergone or is undergoing active restoration.
OTH	other - see field notes	Any impact or other polygon feature that is not described in another class.
GIS	GIS processing	clip, boundary, edge, etc…

Table 9 - Recreation Impact Type for Polygon Features Domain

5. Motive

Code	Geodatabase Description	Description
OTE	off-trail exploration	Impact from cross-country travel that does not serve a specific purpose.
AGF	access - geologic feature	Impact caused by user accessing a geologic feature.
AVF	access - vegetation feature	Impact caused by user accessing a vegetation feature.

ALF	access - lava flow	Impact caused by user accessing a lava flow feature.
AAP	access - passageway	Impact caused by user accessing a passageway feature.
AOT	access - other	Any impact caused by user access that is not described in another access impact class.
VBV	viewpoint - break in vegetation/terrain	Impact caused by user travelling to or presence at a viewpoint provided by a break in vegetation cover or terrain.
VEL	viewpoint - elevated vantage point	Impact caused by user travelling to or presence at a viewpoint provided by an elevated vantage point.
VBL	viewpoint - broad landscape overview	Impact caused by user travelling to or presence at a broad landscape overview viewpoint.
SFF	shortcut - facility to facility	Impact caused by user travelling cross-country between established facilities in a way that creates a shortcut.
STF	shortcut - trail to facility	Impact caused by user travelling cross-country between established trails and facilities in a way that creates a shortcut.
STT	shortcut - trail to trail	Impact caused by user travelling cross-country between established trails in a way that creates a shortcut.
SOT	shortcut - other	Any impact caused by a user shortcut that is not described in an existing shortcut impact class.
SAR	social area - rest	Undeveloped area being used as an area for rest.
SAS	social area – shelter	Undeveloped area being used as an area for shelter.
SAP	social area - picnic	Undeveloped area being used as an area for picnicking.
SAT	social area - toilet	Undeveloped area being used as an area for toileting.
SAO	social area - other	Any undeveloped area being using in a way not described in an existing social area class.
ATR	ambiguous trail routing	Impact caused by off-trail use from user by receiving incorrect or inadequate trail routing.
OTH	other - see field notes	Any motive that is not described in another class.

Table 10 - Motive for Recreation Activity Domain

6. Trend

Code	Geodatabase Description	Description
DEC	decreasing	The extent and/or severity of the impact appear to be decreasing.
STE	steady	The extent and/or severity of the impact appear to be steady.
INC	increasing	The extent and/or severity of the impact appear to be increasing.
IND	indeterminate	The extent and/or severity of the impact cannot be determined.
OTH	other - see field notes	The extent and/or severity of the impact is not described in another class.

Table 11 - Trend of Impact Domain

7. *Confidence*

Code	Geodatabase Description	Description
HIG	high	Definitely a recreation impact, precise feature geometry collected and accurate attributes recorded.
MED	medium	Likely a recreation impact, precise feature geometry recorded and attribute recorded likely accurate.
LOW	low	Not certain if a recreation impact, imprecise feature geometry and inaccurate attributes recorded.
IND	indeterminate	Confidence of impact status, feature geometry and attributes cannot be determined
OTH	other - see field notes	Confidence of the impact is not described in another class.

Table 12 - Confidence in Recording of Impact Feature Domain

8. *Edit_Status*

Code	Geodatabase Description	Description
NC	not checked	Fishnet cell has not been inspected manually for errors.
CN	checked – needs editing	Cell has been inspected and has errors that need editing.
CC	checked – edits complete	Cell has been inspected and does not appear to have any errors.
CX	checked – no features in cell	No features to be inspected fall within the cell.

Table 13 - Status of Impact Feature Post-editing Inspection

Pilot Collection of Impact Features

Some areas near recreation facilities had very dense or continuous impacts, and a methodical search was not required to inventory all of the impacts present. Other areas where impacts were more dispersed did require a methodical search. It was originally thought that some sort of gridded or buffered track search method would have to be developed to search for impacts, but it became apparent after a few pilot collection session and after viewed the pilot data in a GIS that impacts followed network topology rules, and that grid searching or randomly searching could actually lead to a less accurate survey as the actual feature patterns would have to be ignored in order to maintain the search method integrity. Gridded or controlled buffer searches would also cause more collateral impacts during fieldwork, while following the impact networks limited new impacts caused by the field personnel to mostly overlap existing impacts.

Design Revisions

Based on pilot fieldwork sessions, certain elements of the attribute table fields and domains were revised. The major revisions are detailed in the following list:

1. The domain for line feature impact types was expanded. Two frequency levels for social trail impacts on the major geologic substrate types were developed. This recorded useful data on the substrate that could not be obtained from any current geologic basemaps.
2. Matched impact type domain codes across feature classes and changed any duplicate codes.
3. Deleted the Photo_2 attribute field, a field to record pathnames for a second field photo. Pilot impact features photos did not capture the details of impacts or complex features well, but did serve as a good reference image. A second photo did not contribute to further detailing or referencing the impacts, so the option to record a second photo was removed. It was also impractical to move to a second photo location during the field collection workflow and created unnecessary field impacts.

Collection of Impact Features

Pilot fieldwork determined that most recreation impact features have a distinct point or origin and predictable network interconnections. Dangling or floating features were encountered, but were a minor exception and could usually be explained by differences in the land surface type. Trying to determine and record impact motivation did help with successfully identifying and recording impacts by better delineating individual impacts and by helping to understand the impact's network connections. Figure 8 illustrates the formation of an impact network by collection impact features in a small example area.

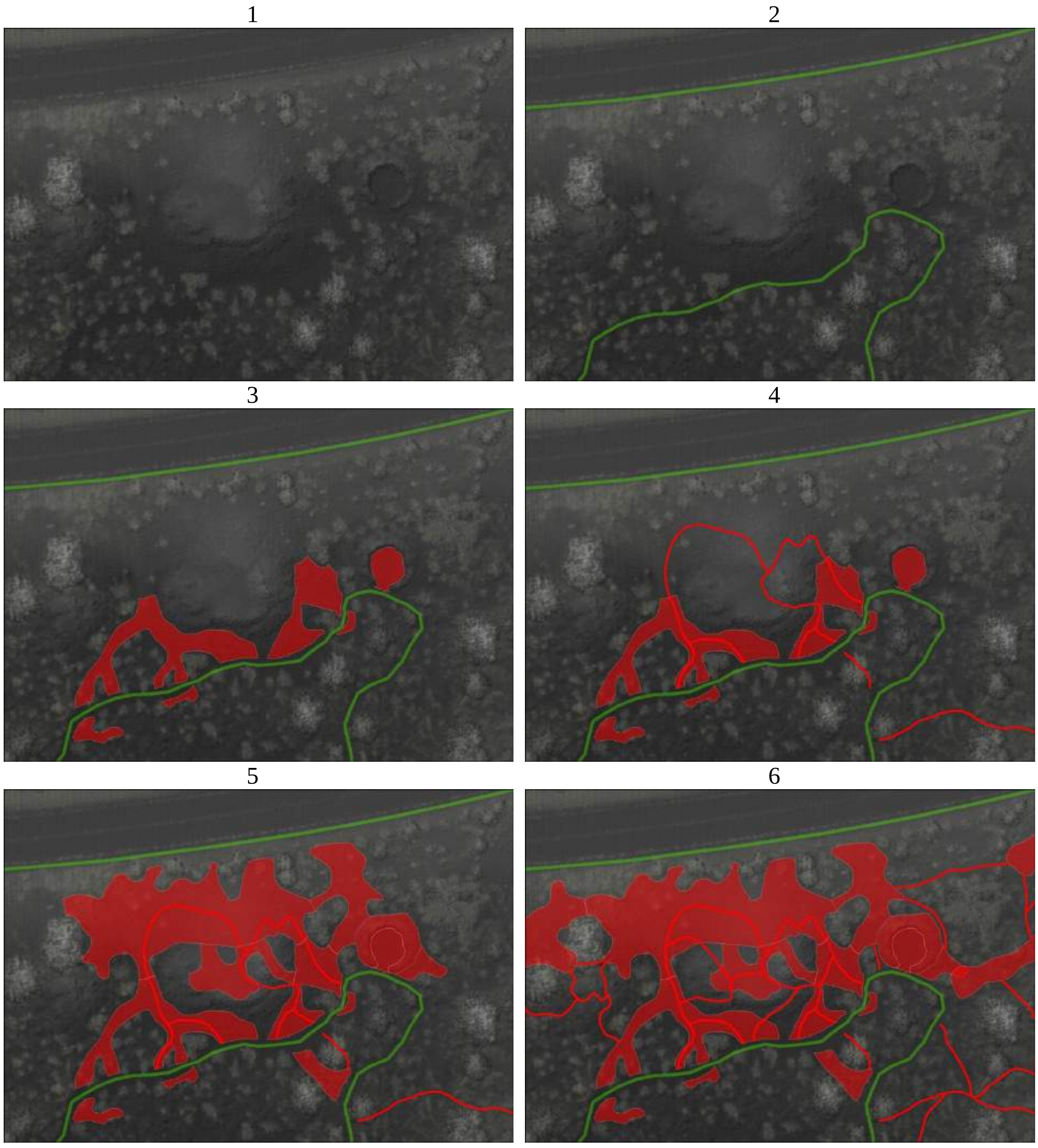

Figure 8 - Impact Feature Collection Series Demonstrating Network Characteristics

To collect impact features, a fieldwork session was conducted. After arriving at the fieldwork staging location, the GeoXT device was turned on and the ArcPad application started. The .apm map created during the check-out procedure for the session was opened and the GNSS receiver turned on and connected to ArcPad. Guides for using ArcPad are available from ESRI, Trimble, reports, online education sites and community resources, and documentation prepared by the NPS and the GIS Program at FLAG. The documentation for this project will not include the details of these extensive resources and procedures for the basic operation of ArcPad.

A. Estimate the Extent of the Impact Feature

Identify an impact and make a preliminary mental estimate of the extent. Details on how to identify a recreation impact are in the Impact_Type tables beginning on page 70. The extent could be the absolute bounds of the impact or the practical extent of the collection of the feature part. Very large or complex impact areas were be subdivided for several reasons. It was easier to perform the GNSS work on a smaller feature, and the risk value of any data loss or error is divided into smaller individual feature parts rather than a large complex feature. Subdividing feature also allowed better description of any feature attribute that change in value across the extent.

B. Identify a Point of Origin

Recreation impacts often have a point of origin, and all geometric features have a technical point of origin where vertex collection begins. The original user point of origin sites at SUCR included trailheads, road pull-offs, picnic area, campgrounds, and other facilities. Impact features not connected to the original point of origin or a facility typically originated from another recreation impact. There are exceptions where impacts appeared to be floating or dangling with no point of origin. However, this disconnect was from a lack of connection evidence, not an actual disconnect from the impact network. All impact features found were collected, even if the network was not entirely clear. The point of origin simply helped with the identification and organization of the features for collection.

C. Collect the Feature Geometry

Polygons and lines were usually collected using continuously streaming vertex collection, but individual vertices could be collected if the situation required. Points were always collected while remaining stationary. The three basic geometry types and feature classes used to collect each geometry type were:

1. Point – Impact_Pnts_Field

Points are defined as a location without dimension, but are often used in a geographic context to represent a larger feature. For this project, points could represent dimensionless impact occurrences or impacts that are smaller than the minimum feature dimension that can be collected with the GNSS receiver. The minimum feature dimension to record a polygon, based on the mean horizontal of feature GNSS positions collected during pilot surveys, is 0.6 meters. GPS Preferences in ArcPad were usually set to collect point features using 50 position point averaging.

2. Line – Impact_Line_Field

Any linear feature with a width greater than 0.6 meters was eligible to be recorded as a polygon feature, although this is not an exact threshold. It was recommended that any linear impact feature with a width dimension greater than 1 meter be recorded as a polygon. A new feature was created if there were significant changes in any feature attribute, in particular for the social trail categories when the geologic substrate changed, or the use frequency changed. Features over mixed surfaces where it was not practical to collect a new feature for each feature change were recorded using the primary or dominant impact type, if present, or the other class. Any notes on the feature were recorded in the Field_Notes field.

GPS Preferences to record line features were set to a position interval of 1 and distance interval of 0.25 m under normal GNSS receiver operating conditions. If real-time GNSS receiver performance and expected post-processing accuracy were lower due to canopy cover, terrain or satellite constellation, the position interval and distance interval was increased to a maximum position interval of 3 and maximum distance interval of 1.0 meter.

3. Polygon – Impact_Plyg_Field

An impact with any dimension greater than 0.6 meters could be accurately recorded as a polygon. Any impact with any two dimension over 1 meter, or generally larger than 1 square meter, was typically recorded as a polygon. GNSS position collection was started at a distinctive location along the polygon edge to make endpoint location and completion of the feature geometry capture easier. If the impact geometry was too complex for capture as a single polygon, the area was subdivided and collected using multiple features. Interior rings or islands were collected by either tracking into the area, traversing the area to be excluded, then exiting along the same path to continue collection the impact boundary or by collecting a separate polygon of the area to be excluded and entering attributes that will select the feature for clipping during post-editing. A new feature was created if there were significant changes in any feature attribute, in particular for when track density changed from overall trampled to indistinct routes, changed between distinct routes and other classes, and when the geologic substrate changed. Features over mixed surfaces where it was not practical to collect an additional feature for each feature change were recorded using the primary or dominant impact type, if present, or the “other” class. Any notes on the feature were entered in the Field_Notes field.

GPS Preferences to record polygon features were a position interval of 1 and distance interval of 0.25 m under normal GNSS receiver conditions. If real-time GNSS receiver performance and expected post-processing accuracy was lower due to canopy cover, terrain or satellite constellation, the position interval and distance interval were increased to a maximum position interval of 3 and maximum distance interval of 1.0 meter.

D. Enter the Feature Attributes

All feature attribute, even those not entered during fieldwork, were visible on the attribute capture forms in ArcPad when using the non-custom check-out and data collection methods of this project. Attributes not collected in the field will not be included in the following descriptions. The following attribute are common to all feature classes, with the exception of impact type which is specific to the geometry type of the feature class.

1. AOI

Selected the AOI that the feature is located in.

2. Impact_Type

Selected an impact type. The choices and identification notes detailed in the following tables are specific to each feature geometry type:

i. Impact_Pnts_Field

Code	Geodatabase Description	Field Identification Notes
VRC	veg - roots/crown	Look for newly exposed inner bark, fresh sap flow and pulverized organic debris at impact. Impact to base of trees and shrubs usually represented as a point, If any dimension larger than 1 meter, use line or polygon.
VBT	veg - breakage/trampling	Look for broken branches and severed material at impact site. Trampling may be on old dead or new growth. Look for evidence that impact is human caused and not caused by wildlife, a weather event or other natural process.
VGT	veg - other	Use only if impact does not fit an existing vegetation class. Provide description of impact type in Field_Notes field.
GBR	geologic - breakage	Broken rocks can be identified by the contrast of fresh broken faces to surrounding surfaces, matching displaced or broken material to shapes on the substrate and unnatural placement of disturbed materials around impact site.

GDE	geologic - defaced	Look for contrast between natural and impacted surface properties. Lichens, patina or other natural surfaces may be defaced. Imported material, such as trapped soil, cinder or rubber markings from footwear, may alter surface. Feature may be spattered or covered with charcoal, mud, cinders or other loose material.
GOT	geologic - other	Use only if impact does not fit an existing class. Provide description of impact type in Field_Notes field.
GRA	graffiti	Graffiti may be destructive, such as scratching, engraving and pecking, or additive, such as drawing and painting with mud, charcoal or human-made materials. A graffiti impact could also be classified as a vegetation or geologic impact, but should be primarily be recorded as a graffiti impact as this is of greater management concern.
LIC	litter concentration	Area with litter accumulation. Accumulation may be from a single large littering event or from the gradual accumulation of individual pieces. Litter may be artificial litter such as food wrappers, organic litter such as food scraps and human waste litter and toilet paper. Provide details in Field_Notes field.
SRN	sensitive resource notes	A sensitive resource could be a cultural site or sensitive vegetation. A sensitive resource could also be an infrastructure of facilities feature that is being impacted. Provide details in the Field_Notes field.
ARE	active restoration	Active restoration sites may be established around facility developments or for recreation impacts. Although undergoing restoration, area may still show evidence of past impacts or may be experiencing new impacts. The transition from restoration areas, non-restoration areas and impacts may be imprecise. A priority should be placed on documenting any impact features or both impact and restoration features can be collected using overlap.
OTH	other - see field notes	Use only if impact does not fit an existing class. Provide description of impact type in Field_Notes field.
GIS	GIS processing	Feature recorded to aid in a GIS process, such as GNSS post-processing, feature geometry editing, feature attribute editing, spatial analysis or cartography. Provide details in Field_Notes field.

Table 14 - Identifying a Point Feature Impact Type

ii. *Impact_Line_Field*

Code	Geodatabase Description	Field Identification Notes
FST	foot - single traverse	There should not be any significant alteration of the substrate or changes in surface topography that indicate a social trail. A single set of recent tracks on an established social trail should be recorded as a social trail. A single traverse usually does not have enough dimension to be recorded as a polygon. Foot impacts typically confined to unconsolidated substrates.
FMT	foot - multiple traverses	There should not be any significant alteration of the substrate or changes in surface topography that form a social trail. Multiple sets of recent tracks on an established social trail should be recorded as a social trail. A single traverse usually does not have enough dimension to be recorded as a polygon. Foot impacts typically confined to unconsolidated substrates.
FOT	foot - other	Use only if impact does not fit an existing class. Provide description of foot impact in Field_Notes field.
SCI	social trail - cinder, infrequent	Social trail causing alteration of substrate and changes to surface topography. Primary substrate volcanic cinders. Vegetation cover may range from completely barren to dense vegetation surrounding impact. Infrequent use indicated by stable or decreasing extent of impact. Extent indicators may be new vegetation growth or organic litter deposits in impact, heavily weathered foot tracks or a complete lack of any individual track impressions and erosion of substrate in natural topographic patterns.
SCF	social trail - cinder, frequent	Social trail causing alteration of substrate and changes to surface topography. Primary substrate volcanic cinders. Vegetation cover may range from completely barren to dense vegetation surrounding impact. Frequent use indicated by stable or increasing extent of impact. Extent indicators may be broken or trampled vegetation, distinct foot impressions and impression with visible sole lug patterns, color and texture contrast surrounding impact and unnatural topographic patterns such as slumps, cut faces and gullies.
SAI	social trail - agglutinate, infrequent	Social trail causing alteration of substrate and changes to surface topography. Primary substrate agglutinate. An impact on agglutinate is likely on an agglutinate mound unique volcanic feature. Record any unique volcanic features details in the Field_Notes field. Infrequent use indicated by stable or decreasing extent of impact. Extent indicators may be deposits of organic litter in impact, heavily weathered foot tracks or a complete lack of any individual track impressions and erosion of substrate in natural topographic patterns.

SAF	social trail - agglutinate, frequent	Social trail causing alteration of substrate and changes to surface topography. Primary substrate agglutinate. An impact on agglutinate is likely on an agglutinate mound unique volcanic feature. Record any unique volcanic features details in the Field_Notes field. Frequent use indicated by stable or increasing extent of impact. Extent indicators may be distinct foot impressions, deep foot impressions and trail troughs, color and texture contrast surrounding impact and unnatural topographic patterns such as slumps, cut faces and gullies.
SSI	social trail - spatter, infrequent	Social trail causing alteration of substrate and changes to surface topography. Primary substrate lava spatter. An impact on spatter is likely on a spatter unique volcanic feature. Record any unique volcanic features details in the Field_Notes field. Infrequent use indicated by stable or decreasing extent of impact. Extent indicators may be deposits of organic litter in impact, lack of recently disturbed spatter pieces, little contrast between color of spatter and any surface patina surrounding impact, no damage and possible increase in any vegetation and lichen coverage and erosion of substrate in natural topographic patterns.
SSF	social trail - spatter, frequent	Social trail causing alteration of substrate and changes to surface topography. Primary substrate lava spatter. An impact on spatter is likely on a spatter unique volcanic feature. Record any unique volcanic features details in the Field_Notes field. Frequent use indicated by stable or increasing extent of impact. Extent indicators may be individual foot impressions, recently disturbed spatter pieces, contrast between color of spatter and any surface patina surrounding impact, damage to any vegetation and lichen coverage and unnatural topographic patterns such as slumps and cut faces.
SLI	social trail - lava flow, infrequent	Social trail causing alteration of substrate and changes to surface topography. Primary substrate consolidated lava flow. Infrequent use indicated by stable or decreasing extent of impact. Extent and use indicators may be no recent breakage of lava, new vegetation growth or organic litter deposits in impact, contrast in color of substrate and contrast of any patina on substrate and use level of adjacent impacts with more exact use indicators.
SLF	social trail - lava flow, frequent	Social trail causing alteration of substrate and changes to surface topography. Primary substrate consolidated lava flow. Frequent use indicated by stable or increasing extent of impact. Extent and use indicators may be recent breakage or crumbling of lava, soil and cinder deposits tracked in by footwear, contrast in color of substrate and contrast of any patina on substrate and use level of adjacent impacts with more exact use indicators.

STO	social trail - other	Use only if impact does not fit an existing class. Use where surface substrate changes frequently and does not have a dominant substrate type. Provide description of impact in Field_Notes field.
VRC	veg - roots/crown	Look for newly exposed inner bark, fresh sap flow and pulverized organic debris at impact. Roots may be exposed naturally, survey for adjacent recreation impact if cause of root exposure is unsure. Impact to roots usually recorded as a line. If length and width exceed 1 meter, consider recording as a polygon.
VBT	veg - breakage/trampling	Look for broken branches and severed material at impact site. Trampling may be on old dead or new growth. Look for evidence that impact is human caused and not caused by wildlife, a weather event or other natural process.
VGT	veg - other	Use only if impact does not fit an existing vegetation class. Provide description of impact type in Field_Notes field.
VST	vehicle - single traverse	Source vehicle may be a bicycle, motorcycle, all-terrain vehicle, side-by-side or full-size vehicle. Note source vehicle in Field_Notes field. Single traverses may technically be wide enough to record as a polygon, but are usually represented by a line.
VMD	vehicle - multiple traverses	Source vehicle may be a bicycle, motorcycle, all-terrain vehicle, side-by-side or full-size vehicle. Note source vehicle in Field_Notes field. To be recorded as a line, multiple travel routes should closely overlap and not cause a widely scattered impact, otherwise a polygon should be used.
VOT	vehicle - other	Use only if impact does not fit an existing vehicle class. Provide description of impact type in Field_Notes field.
GBR	geologic - breakage	Broken rocks can be identified by the contrast of fresh broken faces to surrounding surfaces, matching displaced or broken material to shapes on the substrate and unnatural placement of disturbed materials around impact site. Breakage may be incidental from travel or deliberate from vandalism or mineral specimen collection.
GDE	geologic - defaced	Look for contrast between natural and impacted surface characteristics. Lichens, patina or other natural surfaces may be defaced. Imported material, such as trapped soil, cinder or rubber markings from footwear, may alter surface. Feature may be spattered or covered with charcoal, mud, cinders or other loose material.
GOT	geologic - other	Use only if impact does not fit an existing geologic class. Provide description of impact type in Field_Notes field.

SRN	sensitive resource notes	A sensitive resource could be a cultural site or sensitive vegetation. A sensitive resource could also be an infrastructure of facilities feature that is being impacted. Provide details in the Field_Notes field.
ARE	active restoration	Active restoration sites may be established around facility developments or for recreation impacts. Although undergoing restoration, area may still show evidence of past impacts or may be experiencing new impacts. The transition from restoration areas, non-restoration areas and impacts may be imprecise. A priority should be placed on documenting any impact features or both impact and restoration features can be collected using overlap.
OTH	other - see field notes	Use only if impact does not fit an existing class. Provide description of impact type in Field_Notes field.
GIS	GIS processing	Feature recorded to aid in a GIS process, such as GNSS post-processing, feature geometry editing, feature attribute editing, spatial analysis or cartography. Provide details in Field_Notes field.

Table 15 - Identifying a Line Feature Impact Type

iii. Impact_Plyg_Field

Code	Geodatabase Description	Field Identification Notes
FDM	foot - distinct route, multiple traverses	Multiple traverses accumulate to form a distinct route. The distinct route is usually has specific motive factors. Impact is visible from accumulated tracks, but it not causing topographic changes that would indicate a social trail. Typically limited to unconsolidated terrain, such as cinder. If a single traverse, record as a line feature. Apparent age of impact may vary and include multiple ages.
FIM	foot - indeterminate route, multiple traverses	Area with multiple traverses, but not in a pattern that indicates a distinct route and not at an accumulation level that obscures individual traverses. There may not be any specific motive factors. Useful for recording areas where the impact is not overall trampled, but recording individual traverses as lines would not be practical. Typically limited to unconsolidated terrain, such as cinder. Apparent age of impact may vary and include multiple ages.
FTR	foot - overall trampled	Area has foot impression at a density level that prevents identification of individual traverses or is continuous in coverage. No distinct overall route in impact. Motive factors may be specific or general. Adjacent surfaces or interior pockets contrast impacted surface. Typically limited to unconsolidated terrain, such as cinder. Apparent age of impact may vary and include multiple ages.

FOT	foot - other	Use only if impact does not fit an existing class. Provide description of foot impact in Field_Notes field.
VDM	vehicle - distinct route, multiple traverses	Multiple traverses accumulate to form a distinct route. The distinct route usually has specific motive factors. Typically limited to unconsolidated terrain, such as cinder. If a single traverse, record as a line feature. Apparent age of impact may vary and include multiple ages.
VIM	vehicle - indeterminate route, multiple traverses	Area with multiple traverses, but not in a pattern that indicates a distinct route and not at an accumulation level that obscures individual traverses. There may not be any specific motive factors. Useful for recording areas where the impact is not overall trampled, but recording individual traverses as lines would not be practical. Typically limited to unconsolidated terrain, such as cinder. Apparent age of impact may vary and include multiple ages.
VTR	vehicle - overall trampled	Area has vehicle tracks at a density level that prevents identification of individual traverses or is continuous in coverage. No distinct overall route in impact. Motive factors may be specific or general. Adjacent surfaces or interior pockets contrast impacted surface. Typically limited to unconsolidated terrain, such as cinder. Apparent age of impact may vary and include multiple ages.
VOT	vehicle - other	Use only if impact does not fit an existing class. Provide description of vehicle impact in Field_Notes field. May include vehicle staging or parking areas.
GBR	geologic - breakage	Broken rocks can be identified by the contrast of fresh broken faces to surrounding surfaces, matching displaced or broken material to shapes on the substrate and unnatural placement of disturbed materials around impact site. Breakage may be incidental from travel or deliberate from vandalism or mineral specimen collection.
GDE	geologic - defaced	Look for contrast between natural and impacted surface characteristics. Lichens, patina or other natural surfaces may be defaced. Imported material, such as trapped soil, cinder or rubber markings from footwear, may alter surface. Feature may be spattered or covered with charcoal, mud, cinders or other loose material.
GOT	geologic - other	Use only if impact does not fit an existing geologic class. Provide description of impact type in Field_Notes field.

VRC	veg - roots/crown	Look for newly exposed inner bark, fresh sap flow and pulverized organic debris at impact. Roots may be exposed naturally, survey for adjacent recreation impact if cause of root exposure is unsure. Impact to roots usually recorded as a line. Consider canopy effects on GNSS when recording a polygon, a point may be more accurate in dense canopy.
VBT	veg - breakage/trampling	Look for broken branches and severed material at impact site. Trampling may be on old dead or new growth. Look for evidence that impact is human caused and not caused by wildlife, a weather event or other natural process.
VGT	veg - other	Use only if impact does not fit an existing vegetation class. Provide description of impact type in Field_Notes field.
TWC	trail - widening beyond core	Widening of trail tread surface onto adjacent natural surfaces beyond the constructed trail core. If there is not a distinct construction core, the core is determined by the minimum area required to provide for a reasonable trail corridor and the area that is most frequently used by trail traffic. Widening is caused by the gradual encroachment on on-trail use impacts, not deliberate off-trail use. Widening must be significant enough to be accurately recorded as a polygon feature.
SRN	sensitive resource notes	A sensitive resource could be a cultural site or sensitive vegetation. A sensitive resource could also be an infrastructure of facilities feature that is being impacted. Provide details in the Field_Notes field.
ARE	active restoration	Active restoration sites may be established around facility developments or for recreation impacts. Although undergoing restoration, area may still show evidence of past impacts or may be experiencing new impacts. The transition from restoration areas, non-restoration areas and impacts may be imprecise. A priority should be placed on documenting any impact features or both impact and restoration features can be collected using overlap.
OTH	other - see field notes	Use only if impact does not fit an existing class. Provide description of impact type in Field_Notes field.
GIS	GIS processing	Feature recorded to aid in a GIS process, such as GNSS post-processing, feature geometry editing, feature attribute editing, spatial analysis or cartography. Provide details in Field_Notes field.

Table 16 - Identifying a Polygon Feature Impact Type

3. GNSS_Date

Checked to box to record the date and time of the impact feature collection as the current time set on the GNSS device. Date and time were the local Mountain Time Zone (UTC-07:00).

4. Field_Notes

Recorded any relevant field notes. Field may be left blank. The selection of certain impact types, such as any of the "other" classes or "GIS processing" required that field notes be entered here to provide details on the impact type.

5. Motive_1

Selected a motive. Motive_1 recorded either the sole motive determined to be driving an impact or the primary motive if more than one motive is identified. If more than two motives were identified, the two motives that best represent the impact and provide the most specific detail were selected. This field may be left "null."

Code	Geodatabase Description	Field Identification Notes
OTE	off-trail exploration	General motive class for cross-country impacts. A more specific motive may not exist, be difficult to identify or may exist in addition to this motive.
AGF	access - geologic feature	Geologic features are exact features and often classified as unique volcanic features. Attractive features include mounds, hornitos, fissures, caves, depressions, pinnacles, arches and smooth slopes. Impacts may be in the general vicinity or lead directly to the geologic feature. Provide details of geologic feature type in Field_Notes field.
AVF	access - vegetation feature	Attractive vegetation features include shade trees, large snags and downed trees, root balls, currently blooming plants and unique plants. Impacts may be in the general vicinity or lead directly to the vegetation feature. Provide details of vegetation feature type in Field_Notes field.
ALF	access - lava flow	General motive class for lava flow areas. Lava flows are the various textured consolidated basalts. A lava flow may be a generalized area that has specific geologic feature within. If attractive geologic feature occurs within a lava flow, either record both motives or give preference to the more specific geologic feature class.

AAP	access - passageway	Attractive passageways include passes, navigable fissures, cliff gaps, gullies, corridors clear of vegetation and corridors without rugged terrain. Impacts may be in the general vicinity or lead directly to the passageway feature. Provide details of vegetation feature type in Field_Notes field.
AOT	access - other	Use only if access motive does not fit an existing class. Provide description of motive in Field_Notes field.
VBV	viewpoint - break in vegetation/terrain	Break in vegetation cover or terrain creates an attractive viewpoint. Very heavy impact may be observed at preferred viewing spots within viewpoint. Impacts may be in the general vicinity or lead directly to the viewpoint area.
VEL	viewpoint - elevated vantage point	Elevated vantage point, such as a hill, mound, cliff edge or pinnacle that provides an attractive viewpoint. Very heavy impact may be observed at preferred viewing spots within viewpoint. Impacts may be in the general vicinity or lead directly to the viewpoint area.
VBL	viewpoint - broad landscape overview	General viewpoint category where a specific break in vegetation/terrain or elevated area are not present, but a broad overview is provided. Very heavy impact may be observed at preferred viewing spots within viewpoint. Impacts may be in the general vicinity or lead directly to the viewpoint area.
SFF	shortcut - facility to facility	Facility to facility shortcuts often found near road pull offs and trailhead facilities. Usually additional motives for associated impact.
STF	shortcut - trail to facility	Trail to facility shortcuts often located where trailhead facilities are visible from the trail and a shortcut appears possible. Usually additional motives for associated impact.
STT	shortcut - trail to trail	Common trail to trail shortcuts found at switchbacks and areas where distant trails can be seen. Usually additional motives for associated impact.
SOT	shortcut - other	Use only if shortcut motive does not fit an existing class. Provide description of motive in Field_Notes field.
SAR	social area - rest	Area being impacted has not been specifically developed for social area use. May be in proximity of a strenuous or exposed section of trail, or near an overlook. May be in locations relatively far from trailheads or other facilities.
SAS	social area - shelter	Area being impacted has not been specifically developed for social area use. Shelter from sun, wind, precipitation or public view may be provided by vegetation or geologic structures.
SAP	social area - picnic	Area being impacted has not been specifically developed for social area use. Must be specific evidence of picnic use, such as food preparation and staging area, food waste and litter. Otherwise, another social area class should be selected.

SAT	social area - toilet	Area being impacted has not been specifically developed for social area use. Must be specific evidence of toilet activities, such as human waste or toileting litter. Otherwise, another social area class should be selected.
SAO	social area - other	Use only if social area motive does not fit an existing class. Provide description of motive in Field_Notes field.
ATR	ambiguous trail routing	For an impact to have a secondary motive in addition to ambiguous routing, any secondary motive would be removed if the ambiguity was resolved. An ambiguous routing can be from inadequate or missing signage or a lack of directive trail infrastructure, such as trail edging material or fencing.
OTH	other - see field notes	Use only if motive does not fit an existing class. Provide description of motive type in Field_Notes field.

Table 17 - Identifying a Primary Motive of an Impact Feature

6. Motive_2

Selected a secondary motive, if any. Field may be left "null." The Motive_1 field must have had a selection in order to select a motive in Motive_2. Used the same field identification note table as the Motive_1 field – Table 17.

7. Trend

Selected a trend in the impact extent. This was a relative measure based on the immediate assessment of the field collector. Field may be left "null."

Code	Geodatabase Description	Field Identification Notes
DEC	decreasing	Decreasing use indicated by decreasing extent and/or severity of impact. Trend indicators may be deposits of organic litter in impact, lack of recently disturbed rocks , little contrast between color of surface and any surface patina surrounding impact, new vegetation establishment and growth of existing vegetation and erosion of substrate in natural topographic patterns. No fresh tracks having individual lug definition.
STE	steady	Steady use indicated by no significant changes to extent and/or severity of impact. Fresh tracks may be present. This is the reference class and the most likely class to be determined.

INC	increasing	Increasing use indicated by increasing extent and/or severity of impact. Trend indicators may be fresh tracks with detailed lug patterns intact, recently disturbed rocks, contrast between color of surface and any surface patina surrounding impact, recent damage to any vegetation and lichen coverage and development of unnatural topographic patterns such as slumps, cut faces and gullies.
IND	indeterminate	Trend in impact extent and/or severity cannot be determined by project field observation techniques. If no trend evaluation was made, field should be left as "null" and not as "indeterminate" or "other".
OTH	other - see field notes	Use only if trend does not fit an existing class. Provide description of trend type in Field_Notes field.

Table 18 - Identifying the Trend of an Impact Feature

8. Confidence

Selected the confidence level in the collection of the impact feature geometry and attributes. Field may be left "null."

Code	Geodatabase Description	Field Identification Notes
HIG	high	Definitely a recreation impact based on field observations. Precise feature geometry collected due to good GNSS receiver conditions and inerrant ArcPad form processing. Complete and accurate attributes able to be recorded.
MED	medium	Likely a recreation impact based on field observations, but extent may be ambiguous due to low use levels, difficult to observe substrate or recreation impacts mixing with wildlife impacts. Precise feature geometry collected due to good GNSS receiver conditions. ArcPad forms and attribute recorded likely accurate, but some field may be omitted or indeterminate.
LOW	low	Not certain if a recreation impact based on field observations. Extent may be ambiguous due to low use levels, difficult to observe substrate or frequent mixing of recreation impacts and wildlife impacts. GNSS receiver conditions may cause poor feature geometry. ArcPad forms and attributes may be incomplete or there may low confidence in selected attributes. Area may have significant exposure to weathering factors that can quickly alter impacts.

IND	indeterminate	Confidence of impact status, feature geometry and attributes cannot be determined from field observations. Only select indeterminate is confidence evaluation was made. Otherwise, leave field as "null."
OTH	other - see field notes	Use only if confidence does not fit an existing class. Provide description of confidence level in Field_Notes field.

Table 19 - Identifying the Confidence of an Impact Feature

9. Photo_1

A photo of the impact feature was taken and the photo file name recorded. The photo was representative of the impact. Attempted to provide a broad view of the impact so the areas adjacent to the impact could be used to relocate the impact, and for visual analysis of any changes in impact extent that can be seen using photography. If using an external camera that is not synced using Bluetooth, manually record the photograph file name in the field. If using an automatic photo syncing method, follow the method instructions. Photo syncing was not used in this project.

The author used photo capture methods for the GeoXT internal camera and the Trimble Positions ArcGIS workflow, and followed the recommended steps to capture and transfer photographs. While taking the image, the camera position was kept horizontal to frame the picture in landscape format. The collector remained still between tapping the capture button to when the image thumbnail appears. The shutter on the internal camera is very slow and does not activate immediately after tapping capture. The photograph was previewed and retaken if necessary.

E. Determine the Next Action

The next action taken after finishing collecting the impact feature varied. The next action taken could be further scouting to estimate the extent of additional impacts. It could be the collection of other parts of a subdivided feature or the collection of adjacent or connected features with different attributes or a different geometry type. The sequence of actions chosen was planned to be efficient, systematic and thorough.

F. Check for Accuracy and Completeness

An estimate of what could be recorded during each daily collection session was made to avoid omitting impacts and to make additional collection session easier. The collected features were visually inspected often to check for missed areas or incomplete feature. Notes were taken on dangling or isolated features so that their effect on the impact network was understood.

Field Data Check-in and Processing Procedures

Several post-processing steps were completed after collecting the raw field data.   This processing ensured that the accuracy, formatting, and data integrity objectives were met. It also ensured that the data was functional in the GIS. In addition to the technical steps, processing transformed the data into information that is useful for resource specialist and managers.

A. Check-in and Post-Processing of Field Data

Checking-in and differentially correcting GNSS data is referred to as post-processing. The field session data was copied from the GeoXT device to the GIS server using the desktop computer. Several semi-automated steps were required for complete and accurate transfer of field data to desktop storage folders and the project geodatabase. The steps were tracked by continuing the record started on the “[Project]GNSS__Log.xlsx” spreadsheet (See Appendix G). Details of these steps are in separate the Trimble Positions and FLAG GIS documentation. A summary of the steps follows:

1. Copied the entire collection session folder from the GNSS device to the “Check-in” server folder and the “Backup” folder created for the project. The copy operations were verified by comparing the folder properties of the original and copied folders.

2. Selected, copied, and pasted all field photographs from the “Check-in” folder to the folder specified as the photograph location during the Check-out process. This operation was verified by noting and comparing the number of photograph in the session.
3. Opened ArcMap and opened the .mxd that had been enabled for the Trimble Positions workflow; opened the Trimble Positions Desktop Window.
4. Performed check-in of the field session by following the wizard windows and selecting .axf data for the session being checked-in. Any inconsistencies in check-in were noted in the GNSS log and, if appropriate, the “GIS_notes” field of the affected features.
5. Differentially corrected the session using the preferred GLONASS-enabled processing profile. Ensured that all correction files were successfully downloaded and that 100% of eligible positions were differentially corrected. Any inconsistencies or failures in the differential correction of a feature were recorded in the GIS_notes field. Repeat attempts were made to correct the session if any processing errors were encountered. Repeat attempts usually found the previously unavailable correction files, if not then a different processing profile was used. Features without ideal differential correction and accuracies beyond the established thresholds were still used, but were marked or noted and required more extensive geometry post editing.
6. Updated the checked in features. This rebuilt the feature geometries by moving the vertices to the corrected positions. Entire features or individual positions could be unlinked and the feature rebuilt without correction. This process can be tedious and only allows feature positions to return to the uncorrected position. Manual editing of features was a good solution when the exact GNSS positional data was not required, and the editing improved the usefulness of the feature.

B. Post-Editing Feature Geometry

The scale of viewing and interpreting the collected recreation impact data can approach 1:100 or larger. At this scale, the feature geometries are still accurate, but some inconsistencies become apparent such as: coincident boundary overlap, dangling lines, and jags from adjacent vertexes that had slightly different GNSS satellite constellation fixes. To provide for better data analysis and visualization, additional post-fieldwork editing was completed on the features. This process is generally referred to as “post-editing” and was largely carried out manually rather than with automated software processes.

Differential correction rebuilds feature vertexes and provides an estimated horizontal accuracy. Most collected impact feature resulted in sub-meter horizontal accuracies, with the greatest number falling in the 30-50cm range. Features were rarely over 1 meter estimated error and no positions from this project exceeded the project accuracy threshold of 10 meters estimated horizontal accuracy. This horizontal accuracy value can be interpreted as the potential area where the position actually occurs, therefore the vertex representing this position can be placed anywhere within this estimated area, although the position determined during post-processing often appeared to be more accurate than the estimate based on the logical layout and shape consistency with adjacent features. In theory and practice, moved and reshaped feature vertices should be moved no further than half the distance of the estimated horizontal accuracy. In the few areas where this was examined in detail, this distance was not being exceeded, and if it were, the benefits to the presentation of the feature by exempting the accuracy would be considered.

Manually moving a features vertex position technically removes it from the GNSS metadata. To preserve the raw datasets, copies of the field feature classes are made for further post-editing the feature classes. When a feature class is duplicated before field collection is finished, any new features collected are not automatically duplicated during check-in and post-processing. The new features collected were duplicated in the edit feature class by using the append tool in ArcGIS.

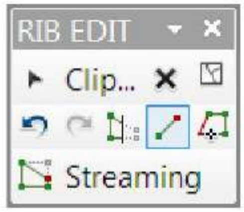

Figure 9 - Custom ArcMap Toolbar for Editing Impact Features

Several thousand features with tens of thousands of vertexes were candidates for editing. A custom toolbar, shown in Figure 9, was developed to arrange the commonly used tools for some of the particular editing tasks. A fishnet feature class was created so that a gridded search method could be used and that edit inspection results could be recorded as attributes for tracking.

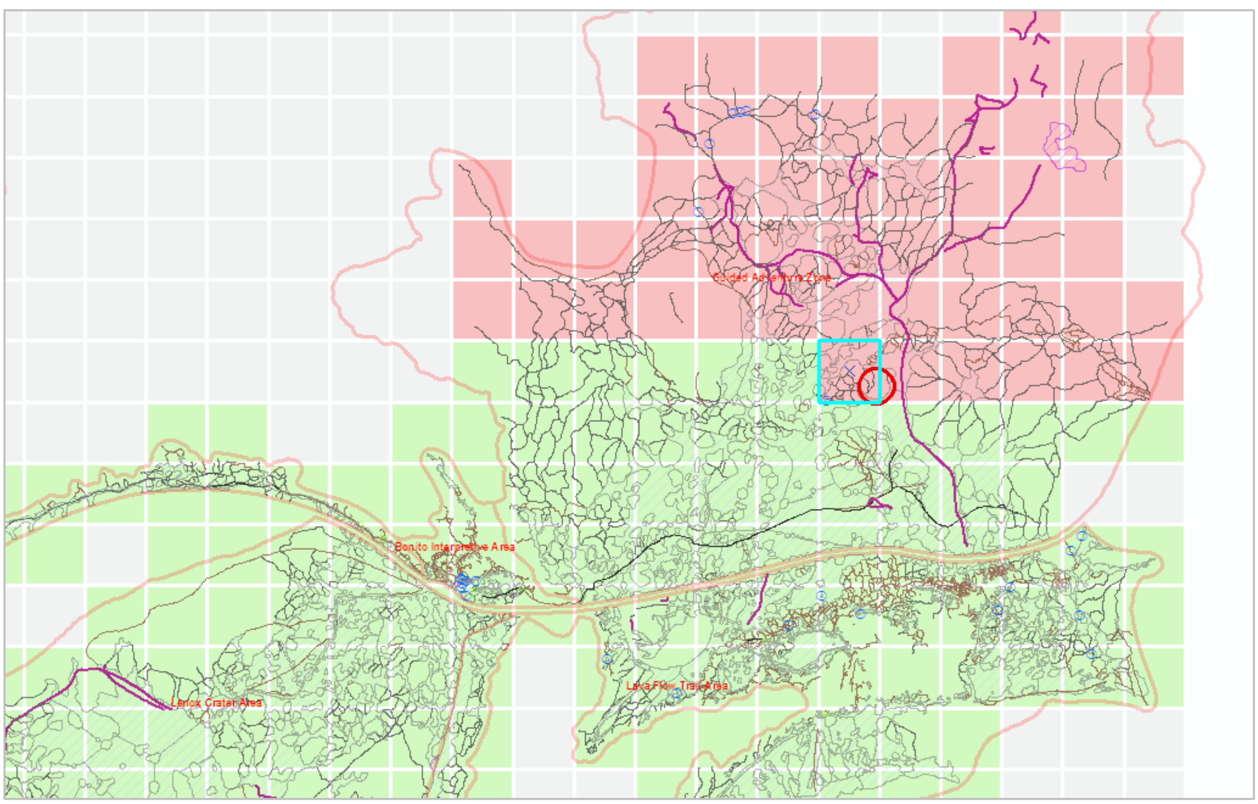

Figure 10 - Fishnet and Cells for Edit Inspection

The layout of this fishnet in relation to the project area is shown in Figure 10. This figure was a screen capture taken during the fishnet cell inspection process. Manual post-editing followed this general procedure:

1. Editing started with polygon features. If the polygon shared a co-incident boundary with another feature, reshaped and traced the features along a simplified dividing line. After creating the clean co-incident boundary, inspected the shape of the polygon boundary near the intersection for consistency between the component features. Reshaped or more vertices added as necessary. If polygons truly overlap, ensured that each feature boundary shape is distinct and avoids wandering, especially if the relative overlap length is small.
2. Inspected the rest of the polygon edges. Moved or deleted vertices to improve individual jags or reshape entire jaggy areas. Inspected areas where polygons transition to line features and reshaped these areas as necessary to represent this transition. Compared the polygons to basedata imagery or LiDAR products if a questionable area was found. Used the attributes of the selected feature and adjacent features to resolve questionable areas.
3. Edited internal rings. Two methods worked rapidly and reliably: merging in-and-out rings using a scratch polygon or clipping the impact polygon using a non-impact polygon collected specifically for use as a clip template. All edits to the original polygon were inspected to ensure preservation of the original feature attributes.
4. Clipped or traced any polygons that overlap the SUCR boundary feature class. This removed any impacts collected outside of the NPS jurisdiction. Any polygons with segments that followed field-marked boundaries falling inside the actual SUCR boundary feature class were not edited to trace the SUCR boundary feature class, unless the distance between the SUCR boundary feature class and the feature in question was less than the estimated horizontal accuracy of the feature.
5. After the polygons were satisfactory, line features were edited. Truly dangling lines occurred where impacts terminate or fade, or where the line is entirely disconnected from the impact

network. Lines that are not true dangles were edited to connect to the impact network by moving vertices and using snapping tools. Line features that originated or connected to a polygon had their endpoint snapped to the polygon edge. If a line feature overlapped a polygon, snapping was not required, but the feature was inspected to ensure that the overlap appears clearly as a true overlap, and not a network error. Line features that cross did not need snapping or editing at the intersection. Lines that intersected either at two endpoints or where an endpoint intersects an edge were snapped, but individual line features were not merged.

6. Reshaped the lines where appropriate. Jags commonly occurred where GNSS positions were collected under relatively heavy tree canopy, where topography blocked satellite views, or when the collector was roving relatively slowly when compared to the position collection rate preferences set on the GNSS receiver. These jags were improved by moving or deleting individual vertices or by reshaping sections of the line. Multiple linear features, or adjacent polygon features, that were truly parallel on the ground, but not overlapping, may appear to overlap or meander depending on the collector behavior and accuracy performance when the features were collected. Lines with visually conflicting meandering or overlap were moved or reshaped.
7. Points need minimal post-editing. There are not any theoretical conflicts by having points overlap other features, or a need for points to snap directly to adjacent network features. Point locations were inspected and no post-edits to point geometry were required.

C. Applying Topology Rules to Validate and Edit Features

Automated topology tools could theoretically be applied in a feature class editing situation such as this, but the non-continuous nature of the recreation impact network and the variety of geometry types and impact network relationships made this difficult from both a technical and practical perspectives. Some rules that could be applied in theory, such as “line endpoint must be covered by polygon boundaries", do not exist in ArcGIS. Some rules, such as "lines endpoints must not dangle," worked when identifying dangles that should be fixed, but also marked hundreds of dangles that are acceptable, and marking these as exceptions is not practical or useful for identify true errors. Figure 10 demonstrates the extensive nature of the line dangle exceptions:

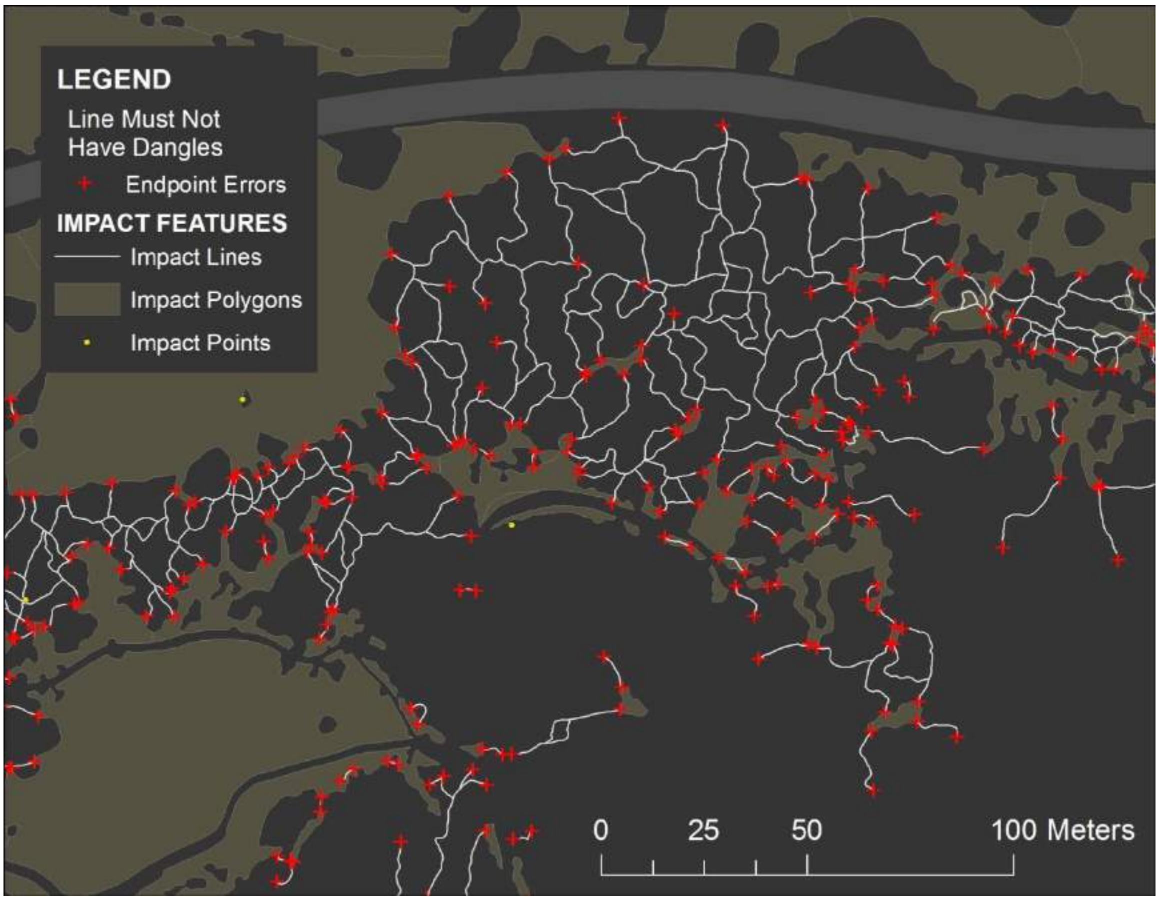

Figure 11 - Line Endpoint Topology Errors

Topology rules that are obviously not being violated by the inherent nature of the features, field collection methods, or feature layout, should not be and were not applied. For example, if the rule that AOIs must be inside the SUCR boundary is valid and the rule that impacts must be inside AOIs is valid, then the rule that impact features must be inside the SUCR boundary would be redundant. These unnecessary rules are confusing and create clutter in the geodatabase. Some topology rules were applied after, instead of during the majority of manual editing, for some basic quality control checks. A list of the exact rules in the format of the geodatabase design worksheet is in Appendix D. Descriptions of the basic rule theories applied follow:

1. ***AOI Polygons Must Be Covered By SUCR Boundary Polygon***

The project area is restricted to the area managed as SUCR by the NPS. This boundary was not always exact in the field, but the "polygon must be covered by polygon feature class of" rule was used to validate that the AOI areas were within the SUCR spatial data boundary.

2. ***AOI Polygons Must Not Overlap***

The AOIs created for the project are not continuous throughout SUCR, but there are areas where the AOI boundaries are coincident and the "polygon must not overlap" rule was used to validate that the AOI areas did not overlap.

3. ***All Impact Features Must Fall Within AOI Polygons***

All impact features should fall within the AOI boundary polygons. The "point must be properly inside polygon" rule was used to validate that all point were within the project area. The "line must be inside polygon" rule was used to validate that all lines were within the AOI areas. Five line errors were returned where lines crossed AOI boundaries for brief distances. These errors were marked as exceptions. The "polygon must be covered by polygon feature class of" rule was used to validate that all impact polygons fell within the AOI areas; no errors were found.

4. Impact Polygons Must Not Overlap and Must Not Have Gaps

Manual editing procedures were carefully followed to create co-incident boundaries between adjacent polygons by using snapping and trace tools. The “polygon must not overlap” rule was used to validate polygon impacts. Nearly forty errors were returned. Some of these were true overlaps where multiple impacts were occurring and were marked as exceptions. Some of there were editing errors where boundaries that should be coincident were overlapping. These overlaps were edited and validated.

Minor gaps could also occur along these coincident boundaries. The “polygon must not have gaps” could not be used to validate for gaps over the entire feature class as the non-continuous nature of the polygon returned nearly 800 errors when validated, with most representing true edges of polygons. However, the errors were symbolized using a high contrast style and visually inspected to locate and correct very small true gaps.

5. Impact Line Endpoints Must Not Dangle

The “line must not have dangles” rule was used to find errors at line to line network connections. Validating this rule returned over 2000 errors, the majority of which were acceptable dangles where lines ended on polygon edges. No automated methods exist to separate these error types and they must be visually inspected. Visual inspection was enhanced by using symbology that made identifying actual errors more visible. All line to line dangles were removed. The numerous non-error areas were not marked as exceptions.

D. Editing Feature Attributes

The feature attributes were inspected for errors, completeness, and accuracy. Each feature class attribute table was opened and inspected field by field. The initial check was for completeness by sorting records to search for null values. If a null value was found in a non-nullable record, a value was determined by inspecting other attributes of the record or attributes records from the same collections session or area. If the exact value could not be determined, an appropriate “other” value and notes were entered. One common error encountered was incomplete photo location paths in the Photo_1 field. These were repaired using the field calculator. Another common error was unmatched domain codes created after a domain was updated early in the project. These were fixed manually or by using the field calculator. Overall, relatively few edits to attributes had to be made as the non-nullable and domain functions of the field data collection worked well.

An Impact_ID field was created to store a primary key for each feature. The Impact_ID is a concatenation of several feature attributes (AOI, OID, Impact_Type, and YYYYMMDD GNSS_Date) that create a descriptive and unique identifier for each feature. This is intended to be the permanent ID for this collection of recreation impact and for future collections. The unique value was calculated using the field calculator tool and a custom developed VB Script. The VB script was required to extract the date information into the necessary format of the Impact ID. This script is detailed in Appendix I.

E. Quality Control Checks

Final quality control of the feature geometries and attributes was completed in ArcMap. The post-editing procedures and attribute table inspections remedied most errors, but a final visual inspection of all the data was considered important. The fishnet feature class was again used to systematically review the entire project. The layers were symbolized using various combinations of attribute which allowed for visual inspection of any attribute inaccuracies and for attribute consistency.

F. Management of the Geodatabase

1. Creating Final Feature Classes

The post-editing feature classes were copied and renamed to create final impact feature classes. This allowed for a slight reduction in the attribute table size as some now-unnecessary field were deleted. The final feature classes were also used for any feature-linked annotation classes and for creating attachments, as was done with the feature photographs.

2. Attaching Impact Feature Photos

Maintaining the link between spatial features and digital photographs is an ongoing data management concern in the NPS. It is not uncommon for staff turnover, server management, and file or directory renaming to cause a loss of integrity when using absolute paths to link features and photographs. The file geodatabase has a permanent attachment functionality that directly stores the photographs in the same geodatabase as the features and maintains a dedicated relationship class. This relationship cannot be corrupted as long as standard data management practices are followed in ArcGIS. It takes deliberate action or neglect to remove the attachments. This does permanently increase the size of the individual geodatabase, but not the overall size of the combined spatial and photographic data.

Field photographs had paths written to the Photo_1 field. Attachments were enabled for the geodatabase and then the "Add Attachments" tool was used to populate the attachment table records. The Photo_1 paths were used to find the .jpeg image files and copy them into the file blob field of the attachment table. In this project, attachments were added as one of the final steps as there were several working versions of the feature classes and the large attachments sizes would be unwieldy to move frequently. After being used for the attachments, the Photo_1 paths were converted to relative paths.

3. Creating Templates for Future Collection

One of the few tangible things that can be done now to plan for future impact monitoring is to prepare planning and collection templates and shell feature classes. A new feature dataset was created and all of the relevant impact feature classes were imported. The impact feature classes had all of the features selected and deleted while leaving all of the domains and table structures intact. The imported and emptied feature classes were renamed using "[feature_class]_SHELL" as a placeholder names that clearly describe their function as shells. Ideally these shells will remain compatible through several software and personnel cycles, but there may need to be upgrades made if there are significant changes to ArcGIS, or any of the file formats, before the templates are used.

4. Metadata

Metadata was created for the significant planning and fieldwork datasets and for all final datasets. Scratch, temporary and certain non-published datasets were part of the project, but did not need to be archived or have metadata completed for the project methods to be documented completely. Metadata was created in the in the Federal Geographic Data Committee (FGDC) format and conforms to the FGDC standards and NPS metadata standards (National Park Service, n.d. f). Guides published by the NPS (IMR , 2012) were used to begin the metadata process and templates were used to efficiently copy common information between multiple objects metadata.

5. Final Inspection, Clean-up and Compaction of the Geodatabase

After all processing, post-edits, and datasets copying tasks were completed, the geodatabase was inspected for errors, omission and consistency. The geodatabase, feature dataset, and feature class properties for all components were examined. The file names used were reviewed and renamed if necessary to be standardized and understandable. A final tasks was using the compaction tool to defragment and possible decrease the size of the geodatabase, although the size reduction was minor as a large portion of the geodatabase data is attachment images already compressed in the .jpeg format and stored as blobs within the geodatabase attachment table. Geodatabase compression tools could theoretically be applied, but were not as the geodatabase will be edited in the future, and the use of geodatabase compression is not common in the NPS GIS program for archiving. The main geodatabase was also copied and renamed “SUCR_2013_Recreation_Impacts_Basemap_LITE.gdb.” This geodatabase contains the AOI feature class and all three final impact feature classes, but no attachment tables, basedata, or scratch data and is meant to be small in size for general distribution.

Final Management of the GIS Project Folder

The “SUCR_2013_Recreation_Impact_Basemap.gdb” is the most significant file of this project and the “SUCR_2013_Recreation_Impacts_Basemap” GIS project folder is the central object to store all data and documentation relating to the project. All of the project folder directories and files were inspected for storage location consistency and appropriate file naming. Any GIS data stored in other directories or servers, any separately stored communications, literature and reference documents, and any other miscellaneous files were compiled and placed within the project folder. A brief “README.txt” was written and placed in the root project folder directory. The general contents of the GIS project folder are listed in Appendix N.

CHAPTER FIVE

Project Results and Discussion

The results of this project will be discussed in relation to each objective and by simple summary statistical analysis of the data collected.

In Reference to Objectives

1. Objective: Create a project plan.

   Result: A singular project plan was not successfully created, but smaller or related plans were used. Project work was planned and scheduled as part of the broader planning of duties of the author as a Cartographic Technician for the NPS. Focused work plans were developed and followed on a weekly and daily basis for the development of specific project tasks and for fieldwork sessions. Factors leading to the lack of a single formal plan were communication, difficulties and adjustments encountered during project design and pilot fieldwork, unpredictable field work scheduling both from weather and scheduling uncertainties due to length of job appointment limitations and the forced halt to fieldwork during the October 2013 Federal Government Shutdown. It is recommended that future recreation impact monitoring projects, or similar field-based projects, use the results of this project to develop more successful central workplans, in particular for planning the amount of time spent on detailed GNSS fieldwork.

2. Objective: Determine the area where recreation impacts are occurring.

   Result: Field scouting successfully identified the concentrated areas with recreation impacts. Areas of interest with practical recreation and geographic boundaries were delineated and only minor adjustments were needed over the course of the project. AOI boundaries were expanded when impacts were found beyond the scouting area. There were no major collection conflicts, such as impact overlapping two AOIs, along coincident boundaries. Dispersed impacts are known to exist outside of the AOIs, but not in enough concentration to develop additional focused AOIs.

3. Objective: Develop a method to efficiently and accurately record impacts.

   Result: Methods developed required one major revision of feature attributes and domain description after pilot collection, and minor technical revision early on during field collection. Method development was documented using a geodatabase spreadsheet template and internal ArcGIS geodatabase documentation.

4. Objective: Record impact data using GNSS technology and the project-specific methods.

   Result: Method developed allowed a daily cycle of field data collection sessions and post-processing to occur. High precision GPS preferences were used for the majority of features. Use of network theory was successful in searching for and recording impact features. A review of collected features, both in the field and visually using the desktop, found few exceptions to basic geometric network rules. Most exceptions were determined to be true exceptions, not errors or feature types that the project design could not accommodate. The project field data transfer success rate was 100% - no field collected feature geometry, attributes or photographs were lost or corrupted. The required attributes were recorded for all features with minimal use of "other" or "null" types, and most features had complete supplemental attributes collected.

5. Objective: Process data.

   Result: All GNSS position data was differentially corrected, and all but one session was processed using the primary Trimble Positions processing profile. All feature geometries were updated with corrected positions, and very few (less than one percent) were rebuilt where the real-time corrected positions had better accuracy. All areas and features were inspected for post-editing needs. Any required post-edits were conducted, and all features displayed shape consistency while meeting the topology rules and guidelines specified for the project. The GIS and geodatabase contents were prepared for immediate use, distribution, archiving, and for future uses.

6. Objective: Develop project documentation.

   Result: A detailed practicum report was delivered to NAU and NPS. The comprehensive GIS Project data folder was finalized and distributed to the NPS FLAG servers and in hardcopy digital formats.

7. Objective: Present project results.

   Results: Project results were presented to the author's committee, faculty, students and general public at NAU during a combined practicum presentation and oral defense on April 29, 2014. A brown-bag presentation was delivered at the NPS FLAG Headquarter office on April 30, 2014.

Project Summary Statistics

The amount of time spent in the field on design and impact collection is important for understanding the value of this project and for planning future monitoring. Table 20 is a summary of fieldwork grouped by planning and design tasks and by AOI.

Fieldwork Summary	**Sunset Crater Volcano National Monument - 2013 Recreation Impacts Basemap**					
Fieldwork Component	Days	Features Collected				
		Points	Lines		Polygons	
		Count	Count	Length Meters	Count	Area Acres
Project Planning and Design						
GNSS and Geodatabase Testing	6	44	46	-	80	-
Impact and AOI Scouting	3	-	-	-	-	-
AOI Delineation	5	31	107	26388	-	-
Planning Sub-totals						
Sum of Days and Features	14	75	153	26388	80	-
Impact Feature Collection						
LFT - Lava Flow Trail Area	11	11	633	10266	329	25.88
GAZ - Guided Adventure Zone	7	7	539	27017	89	42.60
LCA - Lenox Crater Area	5	0	199	6712	87	29.18
BIA - Bonito Interpretive Area	4	7	142	1931	48	1.20
MTA - Monument Trail Area - Surveyed	2	0	111	3194	30	2.96
SSL - Sunset Scenic Loop Area	1	0	80	4631	10	4.11
Impact Feature Sub-totals						
Sum of Days and Features	30	25	1704	53751	593	105.93
Totals						
Sum of Days and Features	44	100	1857	80139	673	105.93

Table 20 - Summary of Fieldwork Days and Features Collected

Summary statistics can be calculated without exporting data from attribute tables by using the selection, statistics, and summary tools built into ArcGIS. Several tables were exported and formatted for initial data analysis, reporting, and distribution of preliminary results. General summary statistics of impact features, motive, and for individual AOIs are in Appendix J. Ready-for-use formatted tables for the Natural Resources program at FLAG are in Appendix K. More detailed statistical analysis, using both tabular and spatial data, can be performed to answer additional research or management questions.

Maps of Recreation Impact Features

The basemap product of this project is best represented as the digital spatial data in a GIS. In this desktop environment, queries, analysis, and visualization can be conducted utilizing all of the varied attributes and software tools. A single flat map cannot clearly or accurately display all of the attributes and possible attribute combinations that the impact data contain. Some static maps have been created for basic interpretation of the project results. An overall impact map of SUCR and focus maps on each AOI are in Appendix L.

Problems – Known and Potential

Time constraints caused one AOI, the Monument Trail Area, to be only partially completed and another AOI, the Cinder Hills Overlook, to not be surveyed for impacts at all. These two areas are isolated from the AOI areas that were completed and all local areas within the AOIs were completed. Areas outside of the AOIs, two types of general areas - the Isolated Impact Incident or Other areas - were not surveyed. These omissions do not affect the quality of the data that was collected, and the majority of the impacted area at SUCR was successfully mapped.

The identification and description of impact types is acknowledged to be difficult and somewhat subjective. The impact type classification system was designed to have enough class types and enough transitional variety that a certain amount of class type overlap would account for collection ambiguity, with the overall description created being accurate. More quantitative type description methods, and the possible use of actual metrics, could lead to more accurate impact type selection, but may greatly increase the collection method time and make a comprehensive survey, such as this project was, even more time and processing intensive. A review of the use frequency of certain impact types could lead to the removal of certain classes in future studies, but some of these classes are important indicators regardless of whether or not a certain recreation impact is occurring. It is an important statistic if an impact type has the potential to occur, but is not occurring in an area.

The ambiguity of impact types is further complicated by daily and seasonal variances in the visibility of impacts. The immediate light conditions and collector perspective play a role in the visibility of impacts on many surface types, especially cinder terrain. Snow and seasonal vegetation can obscure impacts, and rain can cause the appearance of impacts and the susceptibility of terrain to impact to vary. Human caused impacts may be confused with wildlife impacts, especially in older areas or near the edges It is likely that snowpack, freeze-thaw cycling, seasonal wind patterns, and the absence of visitor use cause a continual amount of weathering and natural restoration to impacts while new impacts are simultaneously being created by recreation activity.

With all of these variables considered, many of which are difficult to measure and describe, it was determined that this survey would not focus on describing the heritage or precise intensity metrics of impacts, but would rather focus on recording impacts as they can presently be identified, assuming that the general pattern of uses can be captured at any time by following simplified impact description methods.

The skill and experience level of personnel conducting the survey is also important to consider. The author has experience identifying recreation impacts in semi-arid landscapes for nearly 15 years, while a future collector may just be learning about recreation impact types. The already discussed ambiguity of the impact types combined with different skill levels should be addressed. Training, practice and pilot fieldwork are essential tasks for individuals conducting future monitoring. The GNSS operation and GIS editing require a minimum level of advanced skills. There is a certain amount of aesthetic decision making involved during post-editing as some of the process undertaken are for improving the visual interpretation qualities of the data.

Future Work

Features collected as line may be appropriate to collect as polygon as GNSS technology become more precise. Alternatively, a more rapid assessment may consider using lines to record the impact network rather than the more intensive polygon and line delineation methods. The point impact feature class was underutilized, partially from the use of the network feature collection methods, as it was uncommon to visit the internal area of a polygon, stop mid-feature to collect a different feature, or re-visit an area already covered by a polygon or line edge. Remote sensing methods, such as higher resolution aerial LiDAR and imagery may also be developed that can record certain impacts. Measurement based methods rather than an observation based method could be developed to classify the impact types and severity in exact detail. This would likely be impractical for the entire monument, but may be appropriate in selected area with active management or mitigation of impacts.

Impacts that affect sensitive or management priority resources should be shared with the appropriate NPS resource program. Hundreds of impacts were found affecting unique volcanic features. Impacts that might have historic significance as cultural site were documented. Prehistoric and historic cultural resources and sensitive vegetation may be receiving impacts.

Analysis of supplemental data, such as spatial patterns of impact motivation, or ranking motivation or impact areas by impact trends, could have several benefits. Results of motivation analysis could prove useful for management planning. The motive attributes could be used to develop NPS facilities that either protect an area from a motive or mitigate a motive by providing satisfying visitor activities. Unique volcanic features with research value can be analyzed to see the extent and type of recreation impacts affecting them. The effectiveness of existing facilities on impacts can be investigated by analyzing the intensity of impacts relative to interpretative signing or structures that discouraging cross-country use.

Any future use of these methods will take time and detailed planning. While much of the technical details of mapping recreation impact features have been provided, any personnel will need to become familiar with the basic GIS and GNSS methods required, the landscape of SUCR, and the identification and recording of recreation impact features. It is recommended that a generous amount of time is dedicated to orientation of the area and re-testing the methods. Testing the results of different personnel collecting features in the same area under similar conditions would be informative. It is unlikely that the efficiency of these method could be improved by using a fieldwork collection team, and the increase of collateral impacts would likely be unacceptable. An approach using multiple collectors working individually in separate areas could improve the efficiency of a future project.

Conclusion

This project successfully created a detailed recreation impacts basemap for the majority of the SUCR area. Areas that were not visited are clearly known and no partially surveyed local areas exist. The areas that were mapped are the focus of recreation and management activity at SUCR, and the products of this product are ready for use in planning and operations.

The fieldwork components of the project were very successful. Efficient and accurate GNSS methods were implemented. The precision of the features collected is appropriate for the human and landscape scale of SUCR. The technical procedures were very efficient and robust with thousands of pieces of data being collected in each session with no data loss. There were no injuries and only minor weather-related downtime considering the very active summer monsoon storm pattern.

The initial project planning and kick-off, post-editing, and project documentation did take longer than planned. These delays did not affect any other projects or management actions. Related projects in the future should have more rapid start-up and processing timeframes.

This project met the author’s personal and professional objectives to become an efficient user of GIS and GNSS equipment for field and desktop projects. The post-editing process was an exercise in detailed exactness. The extensive editing tasks provided good motivation to develop efficient editing techniques. The scale and complexity of the resulting data provided several opportunities for data synthesis with other detailed basedata, visualizations, and cartography. This project was an overall satisfying experience with a good balance of technical planning, interesting and challenging fieldwork, careful processing, and management-focused reporting.

CHAPTER SIX

Project Documentation

Documentation helps ensure smooth project implementation, and is a requirement of the organizations involved. NAU requires documentation to fulfill the degree requirements. The NPS requires documentation as part of project funding reporting, to describe and distribute the project data and for future resource monitoring and management planning projects.

Northern Arizona University Documentation

A practicum report is required for the Applied Geospatial Sciences degree. This report will be published in hard copy and digitally as a PDF. A presentation will also be created for use during the practicum presentation and oral defense. The presentation is attached in Appendix M.

National Park Service Deliverables

Several documents and data deliverables will be prepared for FLAG. All data will be delivered digitally and stored in the appropriate location on the FLAG network. The deliverables will also contain hardcopy digital media and copies of any printable documents. The contents of the GIS project folder can change as additional work, such as analysis, cartography, or fieldwork, are completed. The structure of the “SUCR_2013_Recreation_Impacts_Basemap” folder at the end of the 2013 project is outlined in Appendix N.

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APPENDICES

Appendix A: Equipment Specifications

Trimble GeoExplorer 6000 Series GeoXT Handheld Computer with GNSS

GEOEXPLORER 6000 SERIES GEOXT HANDHELD

SYSTEM SUMMARY

- Single-frequency GNSS receiver and antenna with Everest™ multipath rejection technology and optional Trimble Floodlight satellite shadow reduction technology
- Sunlight readable 4.2" polarized screen
- Optional integrated 3.5G cellular modem
- Integrated Wi-Fi and Bluetooth wireless technology
- 5 megapixel autofocus camera
- Windows Mobile® 6.5 (Professional edition)
- Rugged and water-resistant design

SIZE AND WEIGHT

Height . . . . 234 mm (9.2 in)
Width . . . . 99 mm (3.9 in)
Depth . . . . 56 mm (2.2 in)
Weight (inc. battery) . . . . 925 g (2.0 lb)

GNSS

Receiver . . . . . . Trimble Maxwell™ 6 GNSS chipset
Channels . . . . 220 channels
Systems . . . . GPS, GLONASS[1], SBAS
GPS L1C/A
GLONASS[1] L1C/A, L1P
SBAS[2] . . . . WAAS/EGNOS/MSAS
Update rate . . . . 1 Hz
Time to first fix . . . . 45 s (typical)
NMEA-0183 support . . . . Optional
RTCM support RTCM2.x/RTCM3.x
CMR support . . . . CMR/CMR+/CMRx

GNSS ACCURACY (HRMS) AFTER CORRECTION[3]

Real-time code corrected
VRS or local base . . . . 75 cm + 1 ppm
SBAS (WAAS/MSAS/EGNOS) . . . . < 1 m
Code postprocessed . . . . 50 cm + 1 ppm
Carrier postprocessed[3]
After 10 minutes . . . . 20 cm + 2 ppm
After 20 minutes . . . . 10 cm + 2 ppm
After 45 minutes . . . . 1 cm + 2 ppm

TEMPERATURE

Operation . . . . . –20 °C to +50 °C (–4 °F to 122 °F)
Storage . . . . –30 °C to +70 °C (–22 °F to 158 °F)
Charging . . . . 0 °C to +45 °C (32 °F to 113 °F)

MECHANICAL SHOCK

Drop . . . . 1.2 m (4 ft) concrete under plywood
Vibration . . . . Method 514.5

ALTITUDE & HUMIDITY RATINGS

Relative humidity . . . . 95% non-condensing
Maximum operating altitude . . 3,658 m (12,000 ft)
Maximum storage altitude . . . . 5,000 m (16,400 ft)

INGRESS PROTECTION

Water/Dust IP65

BATTERY

Type . . . . Rechargeable, removable Li-Ion
Capacity . . . . 11.1V 2.5 AH
Charge time . . . . 4 hours (typical)

BATTERY RUN TIME[4]

GNSS only . . . . 11.5 hours
GNSS & VRS over BT . . . . 11 hours
GNSS & VRS over Wi-Fi . . . . 10 hours
GNSS & VRS over Cellular modem . . . . . . 8.5 hours
Standby time . . . . 50 days

BUTTONS & CONTROLS

- Power key
- Left & right application keys
- Camera key

CONNECTORS & INPUTS

- Internal microphone and speaker
- Mini USB connector
- DE-9 serial via optional USB to serial converter
- External power connector
- SIM socket
- SDHC socket

CAMERA

Still mode . . . . Autofocus 5 MP
Still image format . . . . JPG
Video mode . . . . Up to VGA resolution
Video file format . . . . WMV with audio

CELLULAR[5] & WIRELESS[6]

UMTS/HSDPA . . . . 850/900/2100 MHz
GPRS/EDGE . . . . 850/900/1800/1900 MHz
Wi-Fi . . . . 802.11 b/g
Bluetooth . . . . Version 2.1 + EDR

DISPLAY

Type . . . . Transflective LED-backlit LCD
Size . . . . 4.2" (diagonal)
Resolution 480x640
Luminance . . . . 280 cd/m^2

HARDWARE

Processor . . . . TI OMAP 3503
RAM . . . . 256 MB
Flash . . . . 2 GB
External storage . . . . SD/SDHC up to 32 GB

LANGUAGES

- English (US), Spanish, French, German, Italian, Portuguese (Brazilian), Chinese (Simplified), Korean, Japanese, Russian

IN THE BOX

- GeoExplorer 6000 series handheld
- Pouch
- Hand strap
- USB data cable
- Rechargeable battery pack
- AC Power adaptor
- Screen protector kit
- Spare stylus & tether
- Documentation

OPTIONAL ACCESSORIES

- Tempest™ external GNSS antenna
- 1.5 m & 5 m external antenna cable
- Range pole kit for external antenna
- Backpack kit for external antenna
- Vehicle mount
- Hard carry case
- TDL 3G cellular modem
- GeoBeacon receiver
- Null modem cable
- USB to serial converter cable

SOFTWARE COMPATIBILITY

- TerraSync™ software
- Trimble GPScorrect™ extension for Esri ArcPad software
- Trimble GPS Controller software
- GNSS Connector software
- GPS Pathfinder® Office software
- Trimble GPS Analyst™ extension for Esri ArcGIS Desktop software
- Third party NMEA-based applications[7]

1 GLONASS tracking is available only if the Trimble Floodlight satellite shadow reduction option is activated.
2 SBAS (Satellite Based Augmentation System). Includes WAAS available in North America only, EGNOS available in Europe only, and MSAS available in Japan only.
3 HRMS refers to Horizontal Root Mean Squared accuracy, 1-sigma (68%). Except in conditions where most GNSS signals are affected by trees, or buildings, or other objects. 45 minute carrier postprocessed accuracy is limited to data collected within 10 km of the base station. Except when using VRS corrections, accuracy varies with proximity to base station by +1 ppm for code postprocessing and real-time. Carrier postprocessed accuracy varies with proximity to base station by +2 ppm.
4 Tested by Trimble with default system settings at 21°C ambient. Actual run time will vary with conditions of use
5 3.5G edition handhelds only. The GeoXT 3.5G edition handheld is PTCRB certified and can operate on supported networks that do not require carrier certification. Consult with your local reseller for more information.
6 Bluetooth and Wi-Fi type approvals are country specific. GeoExplorer 6000 series handhelds have Bluetooth and Wi-Fi approval in the U.S. and in most European countries. For further information please consult your local reseller.
7 NMEA output is an optional upgrade.

Specifications subject to change without notice.

Wi-Fi CERTIFIED

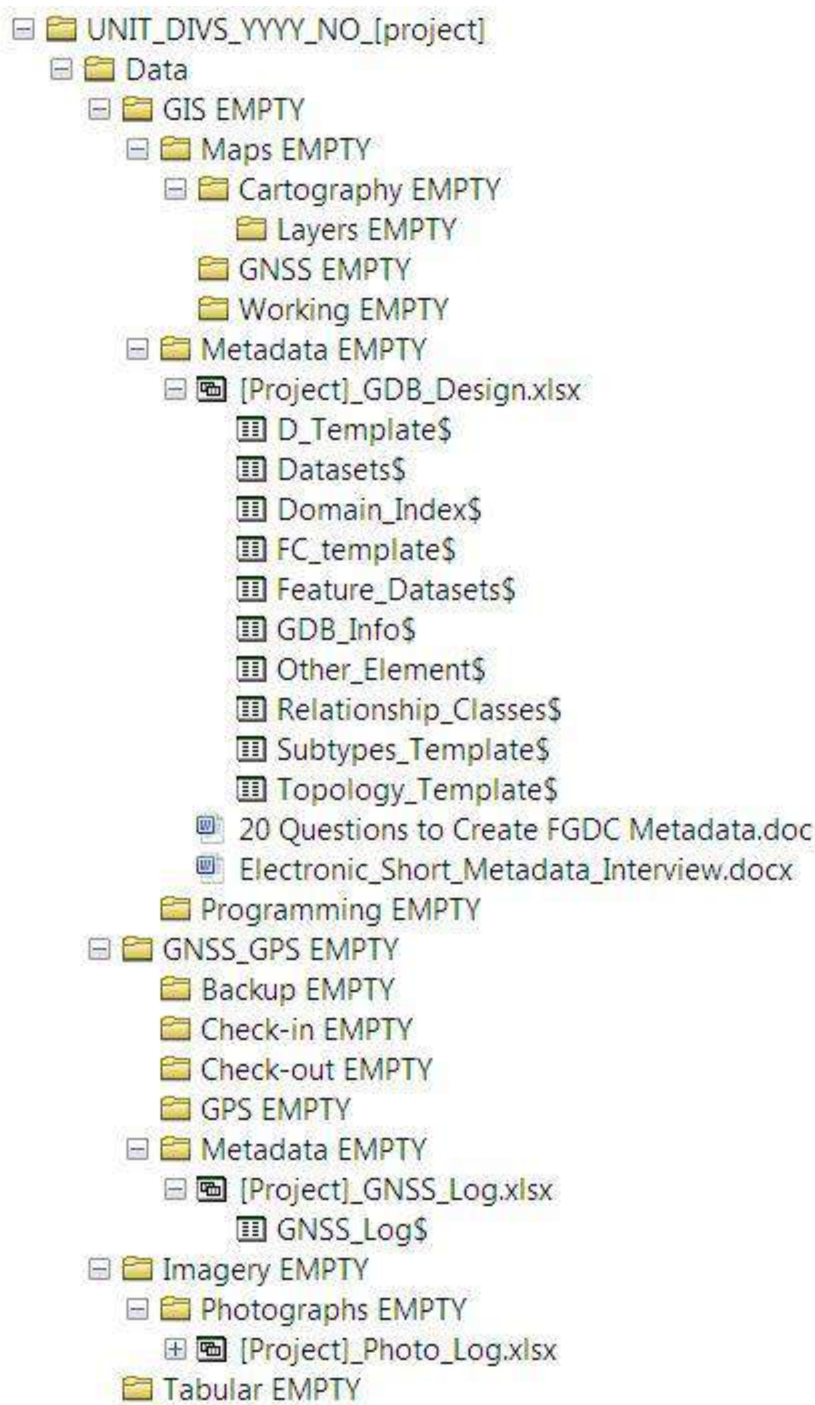
Bluetooth®

Appendix B: GIS Project Folder Design

Original Folder Design

- Project_YYYY
  - Analysis
  - Data
  - Documents
    - Admin
    - Correspondences
    - Outreach
    - ProjectLog
  - GIS
  - GPS
    - Base
    - Check-in
    - Check-out
    - Export
    - GPS_Data_Backup
  - Images
  - Maps
  - Protocol
    - DataProcessingProtocol
    - EquipmentProtocol
    - FieldProtocol
    - Historical
    - Images
    - SafetyProtocol
    - StudyPlan
  - Reports
  - 20 Questions to Create FGDC Metadata.doc
  - Electronic_Short_Metadata_Interview.docx
  - Project_Index.doc

New Folder Design



(continued from previous page)

- Documentation
  - Admin EMPTY
    - Planning EMPTY
    - Proposal EMPTY
  - Communication EMPTY
    - Email EMPTY
    - Meetings EMPTY
    - Outreach EMPTY
    - Paper EMPTY
  - Graphic EMPTY
    - Figures EMPTY
    - Imagery EMPTY
    - Maps EMPTY
  - Protocols_SOPs EMPTY
    - Analysis EMPTY
    - Equipment EMPTY
    - Field EMPTY
    - Legacy EMPTY
    - Office EMPTY
    - Reporting EMPTY
    - Safety EMPTY
  - References_Literature EMPTY
  - Reports EMPTY
    - Drafts EMPTY
    - Final EMPTY
- README.txt

Appendix C: Geodatabase Design Worksheet Templates

Individual Worksheets within the [Project]_GDB_Design.xlsx Workbook

Name:	
Project Folder Relative Path:	
Created By:	
Date Initiated:	
Description:	

	Specification	Details
Geodatabase Type:	File/Personal	ArcGIS Version
Feature Datasets:	Yes/No	Number
Domains:	Yes/No	Number
Subtypes:	Yes/No	
Topology:	Yes/No	Number
Relationship Classes:	Yes/No	Number
Attachments:	Yes/No	
External Links:	Yes/No	
Other Elements:	Yes/No	
GNSS Enabled:	Yes/No	Protocol

Notes:	

GEODATABASE INFORMATION

Feature Dataset Name:	spatial reference - horizontal	spatial reference - vertical	resolution	tolerances	notes

FEATURE DATASETS

Parent Dataset	Feature Class or Dataset Name	Description	Date Created	Date of Initial Data Collection	Date of Last Data Collection	Date last Modified	Metadata Y/N/Partial	Complete Y/N/Partial
(Geodtabase Root)								
(Feature Dataset)								

DATASETS

name:	TEMPLATE
alias:	
feature type:	
z-values:	Yes/No
configuration default:	

Field Name	Data Type	Alias	Allow NULL	Default	Domain	Properties	other	notes

FEATURE CLASS TEMPLATE

Name	Description	Associated Feature Classes	Created/Modified

DOMAIN INDEX

Code	Description	Notes		Properties
			domain name:	
			field type (prop):	
			domain type:	
			split policy:	
			merge policy:	

DOMAIN TEMPLATE

Subtypes Description:	
Subtype Field:	
Default Subtype:	

Subtypes:

Code	**Descrition**

Default Values and Domains:

Field Name	**Default Value**	**Domain**

SUBTYPES TEMPLATE

Topology Name:	
Cluster Tolerance:	
Location:	

Participating Feature Classes	
Feature Class	Rank

Topology Rules		
Feature Class	Rule	Feature Class

TOPOLOGY TEMPLATE

			Origin Table/Feature Class			Destination T/FC	Labels		Rules
Name	Type	Cardinality	Name	Primary Key	Foreign Key	Name	Forward	Backward	Yes/No

RELATIONSHIP CLASSES

Element Type	Name	Location	Description

OTHER ELEMENTS

Appendix D: 2013 RIB Geodatabase Design Worksheets

Individual Worksheets within the 2013_RIB_GDB_Design.xlsx Workbook

Name:	SUCR_2013_Recreation_Impacts_Basemap.gdb
Project Folder Relative Path:	..\SUCR_2013_Recreation_Impacts_Basemap\Data \GIS\SUCR_2013_Recreation_Impacts_Basemap.gdb
Created By:	Sunset Crater Volcano National Monument, Natural Resources and GIS Programs. Paul Whitefield, supervising Natural Resource Specialist; Bryan Hansen, GIS and field data collection, processing, and analysis; Michael Jones, GIS supervisor.
Date Initiated:	April, 2013
Description:	Geodatabase to organize and enable spatial data for the 2013 recreation impacts basemap surveys at Sunset Crater. Used for GNSS testing, field scouting, AOI delineation, impact feature collection, post-processing and post-editing, analysis and summary statistics, and cartography. Sixe largely due to attachment tables containing over 2000 photographs, also include relative paths to external photo location.

	Description	Details
Type:	File	ArcGIS 10.2
Feature Datasets:	Yes	4
Domains:	Yes	8
Subtypes:	No	-
Topology:	Yes	1, impact feature editing
Relationship Classes:	Yes	4, all for attachment tables
Attachments:	Yes	4 tables, 3 for photographs
External Links:	Yes	relative paths to photographs
Other Elements:	No	-
GNSS Enabled:	Yes	Trimble Positions

Notes:	Final version of GDB prepared in April 2014 during preparation of GIS project folder. Prepared from working GDB used during 2013 project design and field data collection and 2014 data processing. Some paths may be broken due to movement of files between different drives, but all files and GIS objects are intact.

GEODATABASE INFORMATION

Feature Dataset Name:	spatial reference - horizontal	spatial reference - vertical	resolution	tolerances	notes
AOI_Development_NAD83HARN	NAD_1983_HARN_UTM_Zone_12N	NAVD_1988	0.0001	0.001	Initially develped using HARN to match LiDAR CORS data, but GNSS data transformations were troublesome and no perfomance benefits was achieved. Results projected to original realization and exported to other feature datasets for analysis and topology.
RI_Future_Monitoring_SHELLS	NAD_1983_UTM_Zone_12N	NAVD_1988	0.0001	0.001	Contains copies of the field data collection feature classes with all fields and domains intact, but all features removed. Rename or copy for future monitoring work.
RIB_2013_Analysis	NAD_1983_UTM_Zone_12N	NAVD_1988	0.0001	0.001	Contains scratch and custom datasets used for editing and QA/QC
RIB_2013_Impacts	NAD_1983_UTM_Zone_12N	NAVD_1988	0.0001	0.001	Certain basemap FC inported to perform topology analysis.

FEATURE DATASETS

Parent Dataset	Feature Class or Dataset Name	Description	Date Created	Date of Initial Data Collection	Date of Last Data Collection	Date last Modified	Metadata Y/N/Partial	Complete Y/N/Partial
AOI_Development_NAD83HARN	AOI_Edit_Plyg_2	additional edits to AOI to refine divisions and expand for additonal impact features						
	AOI_Edits_B1_S3_Clip_C1	clipped to monument boundary						
	AOI_Edits_B1_Smooth_PAEK10m_S3	Smoothing algorithm applied to buffer						
	AOI_Edits_Buff_10m_1	10 meter buffer made to AOI_Edits_Plyg						
	AOI_Edits_Plyg	desktop edits and additonal digitizations made to copy of field-collected features. Primarily traced AOI_field_lines and cut along boundaries						
	AOI_Field_Line	surface features collected by GNSS and ArcPad in the field						
	AOI_Field_Plyg	surface features collected by GNSS and ArcPad in the field						
	AOI_Field_Pnts	surface features collected by GNSS and ArcPad in the field - not used in field						
	AOI_Plyg_FINAL	final AOI polygon feature class. Additonal fields to calculate area						
RI_Future_Monitoring_SHELLS	Impact_Line_Field_SHELL	shell feature class with fields and domains for collecting impact features						
	Impact_Plyg_Field_SHELL	shell feature class with fields and domains for collecting impact features						
	Impact_Pnts_Field_SHELL	shell feature class with fields and domains for collecting impact features						
RIB_2013_Analysis	Edit_Check_Fishnet	100m x 100m fishnet grid for manual QA/QC						
	Impact_Edit_Plyg_SCRATCH	scratch polygon feature class used for post-editing merges, reshaping and tracing						
	plyg_to_line_20140426	all polygons converted to lines to determine linear area survey to create polygons						
	RIB_Desktop_Edit_Scratch	scratch line feature class used for post-editing merges, reshaping and tracing						
RIB_2013_Impacts	AOI_Plyg	Exported from AOI FD for use in topology						
	Impact_Line	Final feature class copied from _Edit feature class. Complete post-edited geometry, attributes, relative paths, attachments and additonal calculated geometry fields. Used for statistics, cartography, LITE exports, SHELLS and other final project products.						
	Impact_Line_Edit	Copied from _Field feature class. Used for editing of geometries, attributes, and topology.						
	Impact_Line_Field	Original impact feature class. Used to create fields, implement domains and collect GNSS impact feature data. All features differentially corrected and rebuilt.						
	Impact_Plyg	Final feature class copied from _Edit feature class. Complete post-edited geometry, attributes, relative paths, attachments and additonal calculated geometry fields. Used for statistics, cartography, LITE exports, SHELLS and other final project products.						
	Impact_Plyg_Edit	Copied from _Field feature class. Used for editing of geometries, attributes, and topology.						
	Impact_Plyg_Field	Original impact feature class. Used to create fields, implement domains and collect GNSS impact feature data. All features differentially corrected and rebuilt.						
	Impact_Pnts	Final feature class copied from _Edit feature class. Complete post-edited geometry, attributes, relative paths, attachments and additonal calculated geometry fields. Used for statistics, cartography, LITE exports, SHELLS and other final project products.						
	Impact_Pnts_Edit	Copied from _Field feature class. Used for editing of geometries, attributes, and topology.						
	Impact_Pnts_Field	Original impact feature class. Used to create fields, implement domains and collect GNSS impact feature data. All features differentially corrected and rebuilt.						
	RIB_2013_Impacts_Topology	Topology used for post-editing						
	SUCR_Boundary	Imported for use in topology						
Geodatabase Root	Impact_Line_ATTACH	file geodatabase table to store attachment files as blobs, contains image .jpegs						
	Impact_Line_ATTACHREL	relationship class between feature class and attachment table						
	Impact_Plyg_ATTACH	file geodatabase table to store attachment files as blobs, contains image .jpegs						
	Impact_Plyg_ATTACHREL	relationship class between feature class and attachment table						
	Impact_Pnts_ATTACH	file geodatabase table to store attachment files as blobs, contains image .jpegs						
	Impact_Pnts_ATTACHREL	relationship class between feature class and attachment table						
	TrimbleSessions	feature class to enable geodatabase data .apx check-out and .apx and .ssf check-in						
	TrimbleSessions_ATTACH	file geodatabase table to temporarily store check-out and check-in data						
	TrimbleSessions_ATTACHREL	relationship class between feature class and attachment table						

DATASETS

name:	AOI_Plyg
alias:	-
feature type:	Polygon
z-values:	No
configuration default:	-

Field Name	Data Type	Alias	Allow NULL values	Default Value	Domain	Properties	other	notes
AOI	Text	-	Yes	-	RIB_AOI	50		
GIS_notes	Text	-	Yes	-	-	100		
SHAPE_Length	Double	-	Yes	-	-	-		GDB FC internal field
SHAPE_Area	Double	-	Yes	-	-	-		GDB FC internal field
Area_Acres	Double	-	Yes	-	-	-		from calculate geometry - area
Area_Hectares	Double	-	Yes	-	-	-		from calculate geometry - area
Perim_Miles	Double	-	Yes	-	-	-		from calculate geometry - area
Perim_Km	Double	-	Yes	-	-	-		from calculate geometry - area

FEATURE CLASS

name:	Impact_Line_Field
alias:	-
feature type:	Line
z-values:	Yes
configuration default:	-

Field Name	Data Type	Alias	Allow NULL values	Default Value	Domain	Properties	other	notes
Impact_ID	Text	-	Yes (post-edit)	-	-	21		concat AOI_Type_OID_date, 3_3_3_8
AOI	Text	-	No	-	RIB_AOI	3		
Impact_Type	Text	-	No	-	Impact_Line	3		
GNSS_Date	Date	-	No	-	-	-		
Field_Notes	Text	-	Yes	-	-	80		
Motive_1	Text	-	Yes (supplemental)	-	Motive	3		experimental
Motive_2	Text	-	Yes (supplemental)	-	Motive	3		experimental, may be redundant
Trend	Text	-	Yes (supplemental)	-	Trend	3		experimental
Confidence	Text	-	Yes (supplemental)	-	Confidence	3		experimental
Photo_1	Text	-	Yes (supplemental)	-	-	160		hide unless used, hyperlink enable
Review_Notes	Text	-	Yes	-	-	80		
GIS_Notes	Text	-	Yes	-	-	80		
Horiz_Acc	Double	-	Yes (post-process)	-	-	-		completed during post-processing

FEATURE CLASS

name:	Impact_Plyg_Field
alias:	-
feature type:	Polygon
z-values:	Yes
configuration default:	-

Field Name	Data Type	Alias	Allow NULL values	Default Value	Domain	Properties	other	notes
Impact_ID	Text	-	Yes (post-edit)	-	-	21		concat AOI_Type_OID_date, 3_3_3_8
AOI	Text	-	No	-	RIB_AOI	3		
Impact_Type	Text	-	No	-	Impact_Plyg	3		
GNSS_Date	Date	-	No	-	-	-		
Field_Notes	Text	-	Yes	-	-	80		
Motive_1	Text	-	Yes (supplemental)	-	Motive	3		experimental
Motive_2	Text	-	Yes (supplemental)	-	Motive	3		experimental, may be redundant
Trend	Text	-	Yes (supplemental)	-	Trend	3		experimental
Confidence	Text	-	Yes (supplemental)	-	Confidence	3		experimental
Photo_1	Text	-	Yes (supplemental)	-	-	160		hide unless used, hyperlink enable
Review_Notes	Text	-	Yes	-	-	80		
GIS_Notes	Text	-	Yes	-	-	80		
Horiz_Acc	Double	-	Yes (post-process)	-	-	-		completed during post-processing

FEATURE CLASS

name:	Impact_Pnts_Field
alias:	-
feature type:	Point
z-values:	Yes
configuration default:	-

Field Name	Data Type	Alias	Allow NULL values	Default Value	Domain	Properties	other	notes
Impact_ID	Text	-	Yes (post-edit)	-	-	21		concat AOI_Type_OID_date, 3_3_3_8
AOI	Text	-	No	-	RIB_AOI	3		
Impact_Type	Text	-	No	-	Impact_Pnts	3		
GNSS_Date	Date	-	No	-	-	-		
Field_Notes	Text	-	Yes	-	-	80		
Motive_1	Text	-	Yes (supplemental)	-	Motive	3		experimental
Motive_2	Text	-	Yes (supplemental)	-	Motive	3		experimental, may be redundant
Trend	Text	-	Yes (supplemental)	-	Trend	3		experimental
Confidence	Text	-	Yes (supplemental)	-	Confidence	3		experimental
Photo_1	Text	-	Yes (supplemental)	-	-	160		hide unless used, hyperlink enable
Review_Notes	Text	-	Yes	-	-	80		
GIS_Notes	Text	-	Yes	-	-	80		
Horiz_Acc	Double	-	Yes (post-process)	-	-	-		completed during post-processing
Ellipsoid_H	Double	-	Yes (post-process)	-	-	-		completed during post-processing

FEATURE CLASS

name:	Impact_Line
alias:	-
feature type:	Line
z-values:	Yes
configuration default:	-

Field Name	Data Type	Alias	Allow NULL values	Default Value	Domain	Properties	other	notes
Impact_ID	Text	-	Yes (post-edit)	-	-	21		concat AOI_Type_OID_date, from VB expression
AOI	Text	-	No	-	RIB_AOI	3		
Impact_Type	Text	-	No	-	Impact_Line	3		
GNSS_Date	Date	-	No	-	-	-		
Field_Notes	Text	-	Yes	-	-	80		
Motive_1	Text	-	Yes (supplemental)	-	Motive	3		
Motive_2	Text	-	Yes (supplemental)	-	Motive	3		
Trend	Text	-	Yes (supplemental)	-	Trend	3		
Confidence	Text	-	Yes (supplemental)	-	Confidence	3		
Photo_1	Text	-	Yes (supplemental)	-	-	160		converted to relative path
Review_Notes	Text	-	Yes	-	-	80		
GIS_Notes	Text	-	Yes	-	-	80		
Horiz_Acc	Double	-	Yes (post-process)	-	-	-		
Length_Meters	Double	-	Yes	-	-	-		from calculate geometry - length
Length_Km	Double	-	Yes	-	-	-		from calculate geometry - length
Length_Feet	Double	-	Yes	-	-	-		from calculate geometry - length
Length_Miles	Double	-	Yes	-	-	-		from calculate geometry - length

FEATURE CLASS

name:	Impact_Plyg
alias:	-
feature type:	Polygon
z-values:	Yes
configuration default:	-

Field Name	Data Type	Alias	Allow NULL values	Default Value	Domain	Properties	other	notes
Impact_ID	Text	-	Yes (post-edit)	-	-	21		concat AOI_Type_OID_date, from VB expression
AOI	Text	-	No	-	RIB_AOI	3		
Impact_Type	Text	-	No	-	Impact_Plyg	3		
GNSS_Date	Date	-	No	-	-	-		
Field_Notes	Text	-	Yes	-	-	80		
Motive_1	Text	-	Yes (supplemental)	-	Motive	3		
Motive_2	Text	-	Yes (supplemental)	-	Motive	3		
Trend	Text	-	Yes (supplemental)	-	Trend	3		
Confidence	Text	-	Yes (supplemental)	-	Confidence	3		
Photo_1	Text	-	Yes (supplemental)	-	-	160		converted to relative path
Review_Notes	Text	-	Yes	-	-	80		
GIS_Notes	Text	-	Yes	-	-	80		
Horiz_Acc	Double	-	Yes (post-process)	-	-	-		
Area_Meters	Double	-	Yes	-	-	-		from calculate geometry - area
Area_Hectares	Double	-	Yes	-	-	-		from calculate geometry - area
Area_Feet	Double	-	Yes	-	-	-		from calculate geometry - area
Area_Acres	Double	-	Yes	-	-	-		from calculate geometry - area

FEATURE CLASS

name:	Impact_Pnts_Field
alias:	-
feature type:	Point
z-values:	Yes
configuration default:	-

Field Name	Data Type	Alias	Allow NULL values	Default Value	Domain	Properties	other	notes
Impact_ID	Text	-	Yes (post-edit)	-	-	21		concat AOI_Type_OID_date, from VB expression
AOI	Text	-	No	-	RIB_AOI	3		
Impact_Type	Text	-	No	-	Impact_Pnts	3		
GNSS_Date	Date	-	No	-	-	-		
Field_Notes	Text	-	Yes	-	-	80		
Motive_1	Text	-	Yes (supplemental)	-	Motive	3		
Motive_2	Text	-	Yes (supplemental)	-	Motive	3		
Trend	Text	-	Yes (supplemental)	-	Trend	3		
Confidence	Text	-	Yes (supplemental)	-	Confidence	3		
Photo_1	Text	-	Yes (supplemental)	-	-	160		converted to relative path
Review_Notes	Text	-	Yes	-	-	80		
GIS_Notes	Text	-	Yes	-	-	80		
Horiz_Acc	Double	-	Yes (post-process)	-	-	-		
Ellipsoid_H	Double	-	Yes (post-process)	-	-	-		

FEATURE CLASS

name:	Edit_Check_Fishnet
alias:	-
feature type:	Polygon
z-values:	No
configuration default:	-

Field Name	Data Type	Alias	Allow NULL values	Default Value	Domain	Properties	other	notes
Edit_Status	Text	-	Yes	NC	Edit_Status	2		for manual QA/QC during desktop editing

FEATURE CLASS

Name	Description	Associated Feature Classes	Created/Modified
RIB_AOI	SUCR Recreation Impact Basemap 2013 - Area of Interest (AOI) names	all AOI development, all impact, all SHELLS	201306
Impact_Pnts	Impact types that can be recorded as points.	all impact and impact SHELLS	201307
Impact_Line	Impact types that can be recorded as lines.	all impact and impact SHELLS	201307
Impact_Plyg	Impact types that can be recorded as polygons.	all impact and impact SHELLS	201307
Motive	Possible reason motivating recreation activity.	all impact and impact SHELLS	201307
Trend	Observed trend in impact extent.	all impact and impact SHELLS	201307
Confidence	General confidence of impact observation and classification.	all impact and impact SHELLS	201307
Edit_Status	Status of desktop edits from manual check.	Edit_Check_Fishnet	201402

DOMAIN INDEX

Code	Description	Notes		Properties
LFT	Lava Flow Trail Area		domain name:	RIB_AOI
GAZ	Guided Adventure Zone		field type (prop):	Text (3)
LCA	Lenox Crater Area		domain type:	Coded Values
BIA	Bonito Interpretive Area	split from Lennox Crater Area	split policy:	Duplicate
SSL	Sunset Scenic Loop Area	Cut from LFT and LCA	merge policy:	Default Values
MTA	Monument Trail Area			
CHO	Cinder Hills Overlook Area			
IVM	Identified during 2004 Vegetation Mapping			
III	Isolated Impact Incident			
OTH	Other			

DOMAIN

Code	Description	Notes		Properties
VRC	veg - roots/crown		domain name:	Impact_Pnts
VBT	veg - breakage/trampling		field type (prop):	Text (3)
VGT	veg - other		domain type:	Coded
GBR	geologic - breakage		split policy:	Duplicate
GDE	geologic - defaced		merge policy:	Default
GOT	geologic - other			
GRA	graffiti			
LIC	litter concentration			
SRN	sensitive resource notes			
ARE	active restoration			
OTH	other - see field notes			
GIS	GIS processing	clip, boundary, edge, etc...		

DOMAIN

Code	Description	Notes		Properties
FST	foot - single traverse		domain name:	Impact_Line
FMT	foot - multiple traverses		field type (prop):	Text (3)
FOT	foot - other		domain type:	Coded
SCI	social trail - cinder, infrequent		split policy:	Duplicate
SCF	social trail - cinder, frequent		merge policy:	Default
SAI	social trail - agglutinate, infrequent			
SAF	social trail - agglutinate, frequent			
SSI	social trail - spatter, infrequent			
SSF	social trail - spatter, frequent			
SLI	social trail - lava flow, infrequent			
SLF	social trail - lava flow, frequent			
STO	social trail - other			
VRC	veg - roots/crown			
VBT	veg - breakage/trampling			
VGT	veg - other			
VST	vehicle - single traverse			
VMD	vehicle - multiple traverses			
VOT	vehicle - other			
GBR	geologic - breakage			
GDE	geologic - defaced			

DOMAIN

Code	Description	Notes		Properties
FDM	foot - distinct route, multiple traverses		domain name:	Impact_Plyg
FIM	foot - indeterminate route, multiple traverses		field type (prop):	Text (3)
FTR	foot - overall trampled		domain type:	Coded
FOT	foot - other		split policy:	Duplicate
VDM	vehicle - distinct route, multiple traverses		merge policy:	Default
VIM	vehicle - indeterminate route, multiple traverses			
VTR	vehicle - overall trampled			
VOT	vehicle - other	staging, break area		
GBR	geologic - breakage			
GDE	geologic - defaced			
GOT	geologic - other			
VRC	veg - roots/crown			
VBT	veg - breakage/trampling			
VGT	veg - other			
TWC	trail - widening beyond core			
SRN	sensitive resource notes			
ARE	active restoration			
OTH	other - see field notes			
GIS	GIS processing	clip, boundary, edge, etc...		

DOMAIN

Code	Description	Notes	Properties	
OTE	off-trail exploration		domain name:	Motive
AGF	access - geologic feature		field type (prop):	Text (3)
AVF	access - vegetation feature		domain type:	Coded
ALF	access - lava flow		split policy:	Duplicate
AAP	access - passageway		merge policy:	Default
AOT	access - other			
VBV	viewpoint - break in vegetation/terrain			
VEL	viewpoint - elevated vantage point			
VBL	viewpoint - broad landscape overview			
SFF	shortcut - facility to facility			
STF	shortcut - trail to facility			
STT	shortcut - trail to trail			
SOT	shortcut - other			
SAR	social area - rest			
SAS	social area - shelter			
SAP	social area - picnic			
SAT	social area - toilet			
SAO	social area - other			
ATR	ambiguous trail routing			
OTH	other - see field notes			

DOMAIN

Code	Description	Notes	Properties	
DEC	decreasing		domain name:	Trend
STE	steady		field type (prop):	Text (3)
INC	increasing		domain type:	Coded
IND	indeterminate		split policy:	Duplicate
OTH	other - see field notes		merge policy:	Default

DOMAIN

Code	Description	Notes	Properties	
HIG	high	high - definitely a recreation impact	domain name:	Confidence
MED	medium	medium - likely a recreation impact	field type (prop):	Text
LOW	low	low - not certain if a recreation impact	domain type:	Coded
IND	indeterminate	confidence cannot be determined	split policy:	Duplicate
OTH	other - see field notes		merge policy:	Default

DOMAIN

Code	Description	Notes		Properties
NC	not checked		domain name:	Edit_Status
CN	checked - needs editing		field type (prop):	Text (2)
CC	checked - edits complete		domain type:	Coded Values
CX	checked - no features in cell		split policy:	Default Value
			merge policy:	Default Value

DOMAIN

Topology Name:	RIB_2013_Impacts_Topology
Cluster Tolerance:	0.001 Meters
Location:	RIB_2013_Impacts Feature Dataset

Participating Feature Classes

Feature Class	Rank
SUCR_Boundary	1
AOI_Plyg	2
Impact_Plyg_Edit	3
Impact_Line_Edit	4
Impact_Pnts_Edit	5

Topology Rules

Feature Class	Rule	Feature Class
AOI_Plyg	Must Be Covered By	SUCR_Boundary
AOI_Plyg	Must Not Overlap	-
AOI_Plyg	Must Not Have Gaps	-
Impact_Line_Edit	Must Be Inside	AOI_Plyg
Impact_Pnts_Edit	Must Be Properly Inside	AOI_Plyg
Impact_Plyg_Edit	Must Be Covered By	AOI_Plyg
Impact_Plyg_Edit	Must Not Overlap	-
Impact_Line_Edit	Must Not Have Dangles	-
Impact_Plyg_Edit	Must Not Have Gaps	-

Appendix E: Geodatabase Schema Report Using ArcGIS Diagrammer

SUCR_2013_Recreation_Impacts_Basemap.gdb

ArcGIS Diagrammer

Report Creation	
Date	Sunday, May 11, 2014
Author	
System Information	
Operating System	Microsoft Windows NT 6.1.7601 Service Pack 1
.Net Framework	2.0.50727.5477
Diagrammer	10.0.1.0
Geodatabase	
Workspace Type	Personal Geodatabase
File	..\SUCR_2013_Recreation_Impacts_Basemap\Data\GIS\Metadata\SUCR_2013_Recreation_Impacts_Basemap_SCHEMA.xml

Table Of Contents

Domains

Domain Name	Owner	Domain Type
Confidence		Coded Value
Edit_Status		Coded Value
Impact_Line		Coded Value
Impact_Plyg		Coded Value
Impact_Pnts		Coded Value
Motive		Coded Value
RIB_AOI		Coded Value
Trend		Coded Value

Confidence

Owner	
Description	General confidence of impact observation and classification.
Domain Type	Coded Value
Field Type	String
Merge Policy	Default Value
Split Policy	Default Value
Domain Members	
Name	**Value**
high	HIG
medium	MED
low	LOW
indeterminate	IND

other - see field notes	OTH

Edit_Status

Owner	
Description	Status of desktop edits from manual check.
Domain Type	Coded Value
Field Type	String
Merge Policy	Default Value
Split Policy	Default Value
Domain Members	
Name	**Value**
not checked	NC
checked - needs editing	CN
checked - edits complete	CC
checked - no features in cell	CX

Impact_Line

Owner	
Description	Impact types that can be recorded as lines.
Domain Type	Coded Value
Field Type	String
Merge Policy	Default Value
Split Policy	Default Value
Domain Members	
Name	**Value**
foot - single traverse	FST
foot - multiple traverses	FMT
foot - other	FOT
social trail - cinder, infrequent	SCI
social trail - cinder, frequent	SCF
social trail - agglutinate, infrequent	SAI
social trail - agglutinate, frequent	SAF
social trail - spatter, infrequent	SSI
social trail - spatter, frequent	SSF
social trail - lava flow, infrequent	SLI
social trail - lava flow, frequent	SLF
social trail - other	STO
veg - roots/crown	VRC
veg - breakage/trampling	VBT
veg - other	VGT
vehicle - single traverse	VST

vehicle - multiple traverses	VMD
vehicle - other	VOT
geologic - breakage	GBR
geologic - defaced	GDE
geologic - other	GOT
sensitive resource notes	SRN
active restoration	ARE
other - see field notes	OTH
GIS processing	GIS

Impact_Plyg

Owner	
Description	Impact types that can be recorded as polygons.
Domain Type	Coded Value
Field Type	String
Merge Policy	Default Value
Split Policy	Default Value
Domain Members	
Name	**Value**
foot - distinct route, multiple traverses	FDM
foot - indeterminate route, multiple traverses	FIM
foot - overall trampled	FTR
foot - other	FOT
vehicle - distinct route, multiple traverses	VDM
vehicle - indeterminate route, multiple traverses	VIM
vehicle - overall trampled	VTR
vehicle - other	VOT
geologic - breakage	GBR
geologic - defaced	GDE
geologic - other	GOT
veg - roots/crown	VRC
veg - breakage/trampling	VBT
veg - other	VGT
trail - widening beyond core	TWC
sensitive resource notes	SRN
active restoration	ARE
other - see field notes	OTH
GIS processing	GIS

Impact_Pnts

Owner	
Description	Impact types that can be recorded as points.
Domain Type	Coded Value
Field Type	String

Merge Policy	Default Value
Split Policy	Default Value
Domain Members	
Name	**Value**
veg - roots/crown	VRC
veg - breakage/trampling	VBT
veg - other	VGT
geologic - breakage	GBR
geologic - defaced	GDE
geologic - other	GOT
graffiti	GRA
litter concentration	LIC
sensitive resource notes	SRN
active restoration	ARE
other - see field notes	OTH
GIS processing	GIS

Motive

Owner	
Description	Possible reason motivating recreation activity.
Domain Type	Coded Value
Field Type	String
Merge Policy	Default Value
Split Policy	Default Value
Domain Members	
Name	**Value**
off-trail exploration	OTE
access - geologic feature	AGF
access - vegetation feature	AVF
access - lava flow	ALF
access - passageway	AAP
access - other	AOT
viewpoint - break in vegetation/terrain	VBV
viewpoint - broad landscape overview	VBL
shortcut - facility to facility	SFF
shortcut - trail to facility	STF
shortcut - trail to trail	STT
shortcut - other	SOT
social area - rest	SAR
social area - shelter	SAS
social area - picnic	SAP
social area - toilet	SAT
social area - other	SAO
ambiguous trail routing	ATR
other - see field notes	OTH
viewpoint - elevated vantage point	VEL

RIB_AOI

Owner	
Description	SUCR Recreation Impact Basemap 2013 - Area of Interest (AOI) names
Domain Type	Coded Value
Field Type	String
Merge Policy	Default Value
Split Policy	Duplicate
Domain Members	
Name	**Value**
Lava Flow Trail Area	LFT
Guided Adventure Zone	GAZ
Lenox Crater Area	LCA
Bonito Interpretive Area	BIA
Sunset Scenic Loop Area	SSL
Monument Trail Area	MTA
Cinder Hills Overlook Area	CHO
Isolated Impact Incident	III
Other	OTH
Identified during 2004 Vegetation Mapping	IVM

Trend

Owner	
Description	Observed trend in impact extent.
Domain Type	Coded Value
Field Type	String
Merge Policy	Default Value
Split Policy	Duplicate
Domain Members	
Name	**Value**
decreasing	DEC
steady	STE
increasing	INC
indeterminate	IND
other - see field notes	OTH

ObjectClasses

ObjectClass Name	**Type**	**Geometry**	**Subtype**
AOI_Development_NAD83HARN			SR
AOI_Edit_Plyg_2	Simple FeatureClass	Polygon	-
AOI_Edits_B1_S3_Clip_C1	Simple FeatureClass	Polygon	-
AOI_Edits_B1_Smooth_PAEK10m_S3	Simple FeatureClass	Polygon	-
AOI_Edits_Buff_10m_1	Simple FeatureClass	Polygon	-
AOI_Edits_Plyg	Simple FeatureClass	Polygon	-
AOI_Field_Line	Simple FeatureClass	Polyline	-
AOI_Field_Plyg	Simple FeatureClass	Polygon	-
AOI_Field_Pnts	Simple FeatureClass	Point	-

AOI_Plyg_FINAL	Simple FeatureClass	Polygon	-	
RI_Future_Monitoring_SHELLS				SR
Impact_Line_Field_SHELL	Simple FeatureClass	Polyline	-	
Impact_Plyg_Field_SHELL	Simple FeatureClass	Polygon	-	
Impact_Pnts_Field_SHELL	Simple FeatureClass	Point	-	
RIB_2013_Analysis				SR
Edit_Check_Fishnet	Simple FeatureClass	Polygon	-	
Impact_Edit_Plyg_SCRATCH	Simple FeatureClass	Polygon	-	
plyg_to_line_20140426	Simple FeatureClass	Polyline	-	
RIB_Desktop_Edit_Scratch	Simple FeatureClass	Polyline	-	
RIB_2013_Impacts				SR
AOI_Plyg	Simple FeatureClass	Polygon	-	
Impact_Line	Simple FeatureClass	Polyline	-	
Impact_Line_Edit	Simple FeatureClass	Polyline	-	
Impact_Line_Field	Simple FeatureClass	Polyline	-	
Impact_Plyg	Simple FeatureClass	Polygon	-	
Impact_Plyg_Edit	Simple FeatureClass	Polygon	-	
Impact_Plyg_Field	Simple FeatureClass	Polygon	-	
Impact_Pnts	Simple FeatureClass	Point	-	
Impact_Pnts_Edit	Simple FeatureClass	Point	-	
Impact_Pnts_Field	Simple FeatureClass	Point	-	
SUCR_Boundary	Simple FeatureClass	Polygon	-	
Stand Alone ObjectClass(s)				
Impact_Line__ATTACH	Table	-	-	
Impact_Plyg__ATTACH	Table	-	-	
Impact_Pnts__ATTACH	Table	-	-	
TrimbleSessions	Simple FeatureClass	Polygon	-	SR
TrimbleSessions__ATTACH	Table	-	-	

AOI_Edit_Plyg_2

Alias	AOI_Edit_Plyg_2	**Geometry:**Polygon
Dataset Type	FeatureClass	**Average Number of Points:**0
FeatureType	Simple	**Has M:**No **Has Z:**No **Grid Size:**1500

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
AOI	AOI	AOI	String	0	0	50	Yes
GIS_notes	GIS_notes	GIS_notes	String	0	0	100	Yes
BUFF_DIST	BUFF_DIST	BUFF_DIST	Double	0	0	8	Yes
area_acres	area_acres	area_acres	Double	0	0	8	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes
SHAPE_Area	SHAPE_Area	SHAPE_Area	Double	0	0	8	Yes

Subtype Name	Default Value	Domain
ObjectClass		
AOI		RIB_AOI

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

AOI_Edits_B1_S3_Clip_C1

Alias	AOI_Edits_B1_S3_Clip_C1	**Geometry:**Polygon
Dataset Type	FeatureClass	**Average Number of Points:**0
FeatureType	Simple	**Has M:**No **Has Z:**No **Grid Size:**1500

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
AOI	AOI	AOI	String	0	0	50	Yes
GIS_notes	GIS_notes	GIS_notes	String	0	0	100	Yes
BUFF_DIST	BUFF_DIST	BUFF_DIST	Double	0	0	8	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes
SHAPE_Area	SHAPE_Area	SHAPE_Area	Double	0	0	8	Yes

Subtype Name	Default Value	Domain
ObjectClass		
AOI		RIB_AOI

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

AOI_Edits_B1_Smooth_PAEK10m_S3

Alias	AOI_Edits_B1_Smooth_PAEK10m_S3	**Geometry:**Polygon
Dataset Type	FeatureClass	**Average Number of Points:**0
FeatureType	Simple	**Has M:**No **Has Z:**No **Grid Size:**1500

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
AOI	AOI	AOI	String	0	0	50	Yes
GIS_notes	GIS_notes	GIS_notes	String	0	0	100	Yes
BUFF_DIST	BUFF_DIST	BUFF_DIST	Double	0	0	8	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes
SHAPE_Area	SHAPE_Area	SHAPE_Area	Double	0	0	8	Yes

Subtype Name	Default Value	Domain
ObjectClass		
AOI		RIB_AOI

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

AOI_Edits_Buff_10m_1

Alias	AOI_Edits_Buff_10m_1	**Geometry:**Polygon
Dataset Type	FeatureClass	**Average Number of Points:**0
FeatureType	Simple	**Has M:**No **Has Z:**No **Grid Size:**1500

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
AOI	AOI	AOI	String	0	0	50	Yes
GIS_notes	GIS_notes	GIS_notes	String	0	0	100	Yes
BUFF_DIST	BUFF_DIST	BUFF_DIST	Double	0	0	8	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes
SHAPE_Area	SHAPE_Area	SHAPE_Area	Double	0	0	8	Yes

Subtype Name	Default Value	Domain
ObjectClass		
AOI		RIB_AOI

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

AOI_Edits_Plyg

Alias	AOI_Edits_Plyg	**Geometry:**Polygon
Dataset Type	FeatureClass	**Average Number of Points:**0
		Has M: No
FeatureType	Simple	**Has Z:**Yes
		Grid Size:1000

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
AOI	AOI	AOI	String	0	0	50	Yes
GIS_notes	GIS_notes	GIS_notes	String	0	0	100	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes
SHAPE_Area	SHAPE_Area	SHAPE_Area	Double	0	0	8	Yes

Subtype Name	Default Value	Domain
ObjectClass		
AOI		RIB_AOI

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

AOI_Field_Line

Alias	AOI_Field_Line	**Geometry:**Polyline
Dataset Type	FeatureClass	**Average Number of Points:**0
		Has M: No
FeatureType	Simple	**Has Z:**Yes
		Grid Size:560

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
AOI	AOI	AOI	String	0	0	50	Yes
field_notes	field_notes	field_notes	String	0	0	100	Yes
photo_1	photo_1	photo_1	String	0	0	150	Yes
GPS_date	GPS_date	GPS_date	Date	0	0	8	Yes
horiz_acc	horiz_acc	horiz_acc	Double	0	0	8	Yes
GIS_notes	GIS_notes	GIS_notes	String	0	0	100	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes

Subtype Name	Default Value	Domain
ObjectClass		
AOI		RIB_AOI

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

AOI_Field_Plyg

Alias	AOI_Field_Plyg	**Geometry:**Polygon
Dataset Type	FeatureClass	**Average Number of Points:**0
		Has M: No
FeatureType	Simple	**Has Z:**Yes
		Grid Size:0

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
AOI	AOI	AOI	String	0	0	50	Yes
field_notes	field_notes	field_notes	String	0	0	100	Yes
photo_1	photo_1	photo_1	String	0	0	150	Yes
GPS_date	GPS_date	GPS_date	Date	0	0	8	Yes
horiz_acc	horiz_acc	horiz_acc	Double	0	0	8	Yes
GIS_notes	GIS_notes	GIS_notes	String	0	0	100	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes
SHAPE_Area	SHAPE_Area	SHAPE_Area	Double	0	0	8	Yes

Subtype Name	Default Value	Domain
ObjectClass		
AOI		RIB_AOI

Index Name	Ascending	Unique	Fields

FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

AOI_Field_Pnts

Alias	AOI_Field_Pnts	**Geometry:**Point
Dataset Type	FeatureClass	**Average Number of Points:**0 **Has M:**No
FeatureType	Simple	**Has Z:**Yes **Grid Size:**474.52610277819008

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
AOI	AOI	AOI	String	0	0	50	Yes
field_notes	field_notes	field_notes	String	0	0	100	Yes
photo_1	photo_1	photo_1	String	0	0	150	Yes
GPS_date	GPS_date	GPS_date	Date	0	0	8	Yes
horiz_acc	horiz_acc	horiz_acc	Double	0	0	8	Yes
spheroid_h	spheroid_h	spheroid_h	Double	0	0	8	Yes
GIS_notes	GIS_notes	GIS_notes	String	0	0	100	Yes
DEM_val	DEM_val	DEM_val	Single	0	0	4	Yes
elev_diff	elev_diff	elev_diff	Double	0	0	8	Yes

Subtype Name	Default Value	Domain
ObjectClass		
AOI		RIB_AOI

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

AOI_Plyg

Alias	AOI_Plyg	**Geometry:**Polygon
Dataset Type	FeatureClass	**Average Number of Points:**0 **Has M:**No
FeatureType	Simple	**Has Z:**No **Grid Size:**1500

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
AOI	AOI	AOI	String	0	0	50	Yes
GIS_notes	GIS_notes	GIS_notes	String	0	0	100	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes
SHAPE_Area	SHAPE_Area	SHAPE_Area	Double	0	0	8	Yes
Area_Acres	Area_Acres	Area_Acres	Double	0	0	8	Yes
Area_Hectares	Area_Hectares	Area_Hectares	Double	0	0	8	Yes
Perim_Miles	Perim_Miles	Perim_Miles	Double	0	0	8	Yes
Perim_Km	Perim_Km	Perim_Km	Double	0	0	8	Yes

Subtype Name	Default Value	Domain
ObjectClass		
AOI		RIB_AOI

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

AOI_Plyg_FINAL

Alias	AOI_Plyg_FINAL	**Geometry:**Polygon
Dataset Type	FeatureClass	**Average Number of Points:**0 **Has M:**No
FeatureType	Simple	**Has Z:**No **Grid Size:**1500

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
Shape	Shape	Shape	Geometry	0	0	0	Yes
AOI	AOI	AOI	String	0	0	50	Yes
GIS_notes	GIS_notes	GIS_notes	String	0	0	100	Yes

BUFF_DIST	BUFF_DIST	BUFF_DIST	Double	0	0	8	Yes
area_acres	area_acres	area_acres	Double	0	0	8	Yes
Shape_Length	Shape_Length	Shape_Length	Double	0	0	8	Yes
Shape_Area	Shape_Area	Shape_Area	Double	0	0	8	Yes

Subtype Name	**Default Value**	**Domain**
ObjectClass		
AOI		RIB_AOI

Index Name	**Ascending**	**Unique**	**Fields**
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_Shape	Yes	No	Shape

Edit_Check_Fishnet

Alias	Edit_Check_Fishnet	**Geometry:**Polygon
Dataset Type	FeatureClass	**Average Number of Points:**0
		Has M: No
FeatureType	Simple	**Has Z:**No
		Grid Size:100

Field Name	**Alias Name**	**Model Name**	**Type**	**Precn.**	**Scale**	**Length**	**Null**
OID	OID	OID	OID	0	0	4	No
Shape	Shape	Shape	Geometry	0	0	0	Yes
Shape_Length	Shape_Length	Shape_Length	Double	0	0	8	Yes
Shape_Area	Shape_Area	Shape_Area	Double	0	0	8	Yes
Edit_Status	Edit_Status	Edit_Status	String	0	0	2	Yes

Subtype Name	**Default Value**	**Domain**
ObjectClass		
Edit_Status	NC	Edit_Status

Index Name	**Ascending**	**Unique**	**Fields**
FDO_OID	Yes	Yes	OID
FDO_Shape	Yes	No	Shape

Impact_Edit_Plyg_SCRATCH

Alias	Impact_Edit_Plyg_SCRATCH	**Geometry:**Polygon
Dataset Type	FeatureClass	**Average Number of Points:**0
		Has M: No
FeatureType	Simple	**Has Z:**Yes
		Grid Size:75

Field Name	**Alias Name**	**Model Name**	**Type**	**Precn.**	**Scale**	**Length**	**Null**
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
Impact_ID	Impact_ID	Impact_ID	String	0	0	20	Yes
AOI	AOI	AOI	String	0	0	3	No
Impact_Type	Impact_Type	Impact_Type	String	0	0	3	No
GNSS_Date	GNSS_Date	GNSS_Date	Date	0	0	8	No
Field_Notes	Field_Notes	Field_Notes	String	0	0	80	Yes
Motive_1	Motive_1	Motive_1	String	0	0	3	Yes
Motive_2	Motive_2	Motive_2	String	0	0	3	Yes
Trend	Trend	Trend	String	0	0	3	Yes
Confidence	Confidence	Confidence	String	0	0	3	Yes
Photo_1	Photo_1	Photo_1	String	0	0	160	Yes
Review_Notes	Review_Notes	Review_Notes	String	0	0	80	Yes
GIS_Notes	GIS_Notes	GIS_Notes	String	0	0	80	Yes
Horiz_Acc	Horiz_Acc	Horiz_Acc	Double	0	0	8	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes
SHAPE_Area	SHAPE_Area	SHAPE_Area	Double	0	0	8	Yes

Subtype Name	**Default Value**	**Domain**
ObjectClass		
AOI		RIB_AOI
Impact_Type		Impact_Plyg
Motive_1		Motive
Motive_2		Motive
Trend		Trend
Confidence		Confidence

Index Name	**Ascending**	**Unique**	**Fields**
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

Impact_Line

Alias	Impact_Line	**Geometry:**Polyline	
Dataset Type	FeatureClass	**Average Number of Points:**0	
		Has M: No	
FeatureType	Simple	**Has Z:**Yes	
		Grid Size:34	

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
Impact_ID	Impact_ID	Impact_ID	String	0	0	21	Yes
AOI	AOI	AOI	String	0	0	3	No
Impact_Type	Impact_Type	Impact_Type	String	0	0	3	No
GNSS_Date	GNSS_Date	GNSS_Date	Date	0	0	8	No
Field_Notes	Field_Notes	Field_Notes	String	0	0	80	Yes
Motive_1	Motive_1	Motive_1	String	0	0	3	Yes
Motive_2	Motive_2	Motive_2	String	0	0	3	Yes
Trend	Trend	Trend	String	0	0	3	Yes
Confidence	Confidence	Confidence	String	0	0	3	Yes
Photo_1	Photo_1	Photo_1	String	0	0	160	Yes
Review_Notes	Review_Notes	Review_Notes	String	0	0	80	Yes
GIS_Notes	GIS_Notes	GIS_Notes	String	0	0	80	Yes
Horiz_Acc	Horiz_Acc	Horiz_Acc	Double	0	0	8	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes
Length_Meters	Length_Meters	Length_Meters	Double	0	0	8	Yes
Length_Km	Length_Km	Length_Km	Double	0	0	8	Yes
Length_Feet	Length_Feet	Length_Feet	Double	0	0	8	Yes
Length_Miles	Length_Miles	Length_Miles	Double	0	0	8	Yes

Subtype Name	Default Value	Domain
ObjectClass		
AOI		RIB_AOI
Impact_Type		Impact_Line
Motive_1		Motive
Motive_2		Motive
Trend		Trend
Confidence		Confidence

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

Impact_Line__ATTACH

Alias	Impact_Line__ATTACH
Dataset Type	Table
FeatureType	

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
ATTACHMENTID	ATTACHMENTID	ATTACHMENTID	OID	0	0	4	No
REL_OBJECTID	REL_OBJECTID	REL_OBJECTID	Integer	0	0	4	No
CONTENT_TYPE	CONTENT_TYPE	CONTENT_TYPE	String	0	0	150	No
ATT_NAME	ATT_NAME	ATT_NAME	String	0	0	250	No
DATA_SIZE	DATA_SIZE	DATA_SIZE	Integer	0	0	4	No
DATA	DATA	DATA	Blob	0	0	0	Yes

Subtype Name	Default Value	Domain

Index Name	Ascending	Unique	Fields
FDO_ATTACHMENTID	Yes	Yes	ATTACHMENTID
GDB_87_REL_OBJECTID	Yes	No	REL_OBJECTID

Impact_Line_Edit

Alias	Impact_Line_Edit	**Geometry:**Polyline	
Dataset Type	FeatureClass	**Average Number of Points:**0	
		Has M: No	
FeatureType	Simple	**Has Z:**Yes	
		Grid Size:34	

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No

SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
Impact_ID	Impact_ID	Impact_ID	String	0	0	21	Yes
AOI	AOI	AOI	String	0	0	3	No
Impact_Type	Impact_Type	Impact_Type	String	0	0	3	No
GNSS_Date	GNSS_Date	GNSS_Date	Date	0	0	8	No
Field_Notes	Field_Notes	Field_Notes	String	0	0	80	Yes
Motive_1	Motive_1	Motive_1	String	0	0	3	Yes
Motive_2	Motive_2	Motive_2	String	0	0	3	Yes
Trend	Trend	Trend	String	0	0	3	Yes
Confidence	Confidence	Confidence	String	0	0	3	Yes
Photo_1	Photo_1	Photo_1	String	0	0	160	Yes
Review_Notes	Review_Notes	Review_Notes	String	0	0	80	Yes
GIS_Notes	GIS_Notes	GIS_Notes	String	0	0	80	Yes
Horiz_Acc	Horiz_Acc	Horiz_Acc	Double	0	0	8	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes

Subtype Name	**Default Value**	**Domain**
ObjectClass		
AOI		RIB_AOI
Impact_Type		Impact_Line
Motive_1		Motive
Motive_2		Motive
Trend		Trend
Confidence		Confidence

Index Name	**Ascending**	**Unique**	**Fields**
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

Impact_Line_Field

Alias	Impact_Line_Field	**Geometry:**Polyline	
Dataset Type	FeatureClass	**Average Number of Points:**0	
		Has M: No	
FeatureType	Simple	**Has Z:**Yes	
		Grid Size:34	

Field Name	**Alias Name**	**Model Name**	**Type**	**Precn.**	**Scale**	**Length**	**Null**
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
Impact_ID	Impact_ID	Impact_ID	String	0	0	21	Yes
AOI	AOI	AOI	String	0	0	3	No
Impact_Type	Impact_Type	Impact_Type	String	0	0	3	No
GNSS_Date	GNSS_Date	GNSS_Date	Date	0	0	8	No
Field_Notes	Field_Notes	Field_Notes	String	0	0	80	Yes
Motive_1	Motive_1	Motive_1	String	0	0	3	Yes
Motive_2	Motive_2	Motive_2	String	0	0	3	Yes
Trend	Trend	Trend	String	0	0	3	Yes
Confidence	Confidence	Confidence	String	0	0	3	Yes
Photo_1	Photo_1	Photo_1	String	0	0	160	Yes
Review_Notes	Review_Notes	Review_Notes	String	0	0	80	Yes
GIS_Notes	GIS_Notes	GIS_Notes	String	0	0	80	Yes
Horiz_Acc	Horiz_Acc	Horiz_Acc	Double	0	0	8	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes

Subtype Name	**Default Value**	**Domain**
ObjectClass		
AOI		RIB_AOI
Impact_Type		Impact_Line
Motive_1		Motive
Motive_2		Motive
Trend		Trend
Confidence		Confidence

Index Name	**Ascending**	**Unique**	**Fields**
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

Impact_Line_Field_SHELL

Alias	Impact_Line_Field_SHELL	**Geometry:**Polyline	
Dataset Type	FeatureClass	**Average Number of Points:**0	

FeatureType	Simple		**Has M:**No **Has Z:**Yes **Grid Size:**34				

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
Impact_ID	Impact_ID	Impact_ID	String	0	0	20	Yes
AOI	AOI	AOI	String	0	0	3	No
Impact_Type	Impact_Type	Impact_Type	String	0	0	3	No
GNSS_Date	GNSS_Date	GNSS_Date	Date	0	0	8	No
Field_Notes	Field_Notes	Field_Notes	String	0	0	80	Yes
Motive_1	Motive_1	Motive_1	String	0	0	3	Yes
Motive_2	Motive_2	Motive_2	String	0	0	3	Yes
Trend	Trend	Trend	String	0	0	3	Yes
Confidence	Confidence	Confidence	String	0	0	3	Yes
Photo_1	Photo_1	Photo_1	String	0	0	160	Yes
Review_Notes	Review_Notes	Review_Notes	String	0	0	80	Yes
GIS_Notes	GIS_Notes	GIS_Notes	String	0	0	80	Yes
Horiz_Acc	Horiz_Acc	Horiz_Acc	Double	0	0	8	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes

Subtype Name	Default Value	Domain
ObjectClass		
AOI		RIB_AOI
Impact_Type		Impact_Line
Motive_1		Motive
Motive_2		Motive
Trend		Trend
Confidence		Confidence

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

Impact_Plyg

Alias	Impact_Plyg	**Geometry:**Polygon **Average Number of Points:**0
Dataset Type	FeatureClass	**Has M:**No
FeatureType	Simple	**Has Z:**Yes **Grid Size:**75

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
Impact_ID	Impact_ID	Impact_ID	String	0	0	21	Yes
AOI	AOI	AOI	String	0	0	3	No
Impact_Type	Impact_Type	Impact_Type	String	0	0	3	No
GNSS_Date	GNSS_Date	GNSS_Date	Date	0	0	8	No
Field_Notes	Field_Notes	Field_Notes	String	0	0	80	Yes
Motive_1	Motive_1	Motive_1	String	0	0	3	Yes
Motive_2	Motive_2	Motive_2	String	0	0	3	Yes
Trend	Trend	Trend	String	0	0	3	Yes
Confidence	Confidence	Confidence	String	0	0	3	Yes
Photo_1	Photo_1	Photo_1	String	0	0	160	Yes
Review_Notes	Review_Notes	Review_Notes	String	0	0	80	Yes
GIS_Notes	GIS_Notes	GIS_Notes	String	0	0	80	Yes
Horiz_Acc	Horiz_Acc	Horiz_Acc	Double	0	0	8	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes
SHAPE_Area	SHAPE_Area	SHAPE_Area	Double	0	0	8	Yes
Area_Meters	Area_Meters	Area_Meters	Double	0	0	8	Yes
Area_Hectares	Area_Hectares	Area_Hectares	Double	0	0	8	Yes
Area_Feet	Area_Feet	Area_Feet	Double	0	0	8	Yes
Area_Acres	Area_Acres	Area_Acres	Double	0	0	8	Yes

Subtype Name	Default Value	Domain
ObjectClass		
AOI		RIB_AOI
Impact_Type		Impact_Plyg
Motive_1		Motive
Motive_2		Motive
Trend		Trend
Confidence		Confidence

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

Impact_Plyg__ATTACH

Alias	Impact_Plyg__ATTACH
Dataset Type	Table
FeatureType	

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
ATTACHMENTID	ATTACHMENTID	ATTACHMENTID	OID	0	0	4	No
REL_OBJECTID	REL_OBJECTID	REL_OBJECTID	Integer	0	0	4	No
CONTENT_TYPE	CONTENT_TYPE	CONTENT_TYPE	String	0	0	150	No
ATT_NAME	ATT_NAME	ATT_NAME	String	0	0	250	No
DATA_SIZE	DATA_SIZE	DATA_SIZE	Integer	0	0	4	No
DATA	DATA	DATA	Blob	0	0	0	Yes

Subtype Name	Default Value	Domain

Index Name	Ascending	Unique	Fields
FDO_ATTACHMENTID	Yes	Yes	ATTACHMENTID
GDB_85_REL_OBJECTID	Yes	No	REL_OBJECTID

Impact_Plyg_Edit

Alias	Impact_Plyg_Edit	**Geometry:**Polygon **Average Number of Points:**0
Dataset Type	FeatureClass	**Has M:**No
FeatureType	Simple	**Has Z:**Yes **Grid Size:**75

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
Impact_ID	Impact_ID	Impact_ID	String	0	0	21	Yes
AOI	AOI	AOI	String	0	0	3	No
Impact_Type	Impact_Type	Impact_Type	String	0	0	3	No
GNSS_Date	GNSS_Date	GNSS_Date	Date	0	0	8	No
Field_Notes	Field_Notes	Field_Notes	String	0	0	80	Yes
Motive_1	Motive_1	Motive_1	String	0	0	3	Yes
Motive_2	Motive_2	Motive_2	String	0	0	3	Yes
Trend	Trend	Trend	String	0	0	3	Yes
Confidence	Confidence	Confidence	String	0	0	3	Yes
Photo_1	Photo_1	Photo_1	String	0	0	160	Yes
Review_Notes	Review_Notes	Review_Notes	String	0	0	80	Yes
GIS_Notes	GIS_Notes	GIS_Notes	String	0	0	80	Yes
Horiz_Acc	Horiz_Acc	Horiz_Acc	Double	0	0	8	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes
SHAPE_Area	SHAPE_Area	SHAPE_Area	Double	0	0	8	Yes

Subtype Name	Default Value	Domain
ObjectClass		
AOI		RIB_AOI
Impact_Type		Impact_Plyg
Motive_1		Motive
Motive_2		Motive
Trend		Trend
Confidence		Confidence

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

Impact_Plyg_Field

Alias	Impact_Plyg_Field	**Geometry:**Polygon **Average Number of Points:**0
Dataset Type	FeatureClass	**Has M:**No
FeatureType	Simple	**Has Z:**Yes **Grid Size:**75

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
Impact_ID	Impact_ID	Impact_ID	String	0	0	21	Yes
AOI	AOI	AOI	String	0	0	3	No
Impact_Type	Impact_Type	Impact_Type	String	0	0	3	No
GNSS_Date	GNSS_Date	GNSS_Date	Date	0	0	8	No
Field_Notes	Field_Notes	Field_Notes	String	0	0	80	Yes
Motive_1	Motive_1	Motive_1	String	0	0	3	Yes
Motive_2	Motive_2	Motive_2	String	0	0	3	Yes
Trend	Trend	Trend	String	0	0	3	Yes
Confidence	Confidence	Confidence	String	0	0	3	Yes
Photo_1	Photo_1	Photo_1	String	0	0	160	Yes
Review_Notes	Review_Notes	Review_Notes	String	0	0	80	Yes
GIS_Notes	GIS_Notes	GIS_Notes	String	0	0	80	Yes
Horiz_Acc	Horiz_Acc	Horiz_Acc	Double	0	0	8	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes
SHAPE_Area	SHAPE_Area	SHAPE_Area	Double	0	0	8	Yes
acres	acres	acres	Double	0	0	8	Yes

Subtype Name	Default Value	Domain
ObjectClass		
AOI		RIB_AOI
Impact_Type		Impact_Plyg
Motive_1		Motive
Motive_2		Motive
Trend		Trend
Confidence		Confidence

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

Impact_Plyg_Field_SHELL

Alias	Impact_Plyg_Field_SHELL	**Geometry:**Polygon
Dataset Type	FeatureClass	**Average Number of Points:**0
		Has M: No
FeatureType	Simple	**Has Z:**Yes
		Grid Size:75

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
Impact_ID	Impact_ID	Impact_ID	String	0	0	20	Yes
AOI	AOI	AOI	String	0	0	3	No
Impact_Type	Impact_Type	Impact_Type	String	0	0	3	No
GNSS_Date	GNSS_Date	GNSS_Date	Date	0	0	8	No
Field_Notes	Field_Notes	Field_Notes	String	0	0	80	Yes
Motive_1	Motive_1	Motive_1	String	0	0	3	Yes
Motive_2	Motive_2	Motive_2	String	0	0	3	Yes
Trend	Trend	Trend	String	0	0	3	Yes
Confidence	Confidence	Confidence	String	0	0	3	Yes
Photo_1	Photo_1	Photo_1	String	0	0	160	Yes
Review_Notes	Review_Notes	Review_Notes	String	0	0	80	Yes
GIS_Notes	GIS_Notes	GIS_Notes	String	0	0	80	Yes
Horiz_Acc	Horiz_Acc	Horiz_Acc	Double	0	0	8	Yes
acres	acres	acres	Double	0	0	8	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes
SHAPE_Area	SHAPE_Area	SHAPE_Area	Double	0	0	8	Yes

Subtype Name	Default Value	Domain
ObjectClass		
AOI		RIB_AOI
Impact_Type		Impact_Plyg
Motive_1		Motive
Motive_2		Motive
Trend		Trend
Confidence		Confidence

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

Impact_Pnts

Alias	Impact_Pnts	**Geometry:**Point **Average Number of Points:**0
Dataset Type	FeatureClass	**Has M:**No **Has Z:**Yes
FeatureType	Simple	**Grid Size:**56.163258109009213

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
Impact_ID	Impact_ID	Impact_ID	String	0	0	21	Yes
AOI	AOI	AOI	String	0	0	3	No
Impact_Type	Impact_Type	Impact_Type	String	0	0	3	No
GNSS_Date	GNSS_Date	GNSS_Date	Date	0	0	8	No
Field_Notes	Field_Notes	Field_Notes	String	0	0	80	Yes
Motive_1	Motive_1	Motive_1	String	0	0	3	Yes
Motive_2	Motive_2	Motive_2	String	0	0	3	Yes
Trend	Trend	Trend	String	0	0	3	Yes
Confidence	Confidence	Confidence	String	0	0	3	Yes
Photo_1	Photo_1	Photo_1	String	0	0	160	Yes
Review_Notes	Review_Notes	Review_Notes	String	0	0	80	Yes
GIS_Notes	GIS_Notes	GIS_Notes	String	0	0	80	Yes
Horiz_Acc	Horiz_Acc	Horiz_Acc	Double	0	0	8	Yes
Ellipsoid_H	Ellipsoid_H	Ellipsoid_H	Double	0	0	8	Yes

Subtype Name	Default Value	Domain
ObjectClass		
AOI		RIB_AOI
Impact_Type		Impact_Pnts
Motive_1		Motive
Motive_2		Motive
Trend		Trend
Confidence		Confidence

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

Impact_Pnts__ATTACH

Alias	Impact_Pnts__ATTACH
Dataset Type	Table
FeatureType	

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
ATTACHMENTID	ATTACHMENTID	ATTACHMENTID	OID	0	0	4	No
REL_OBJECTID	REL_OBJECTID	REL_OBJECTID	Integer	0	0	4	No
CONTENT_TYPE	CONTENT_TYPE	CONTENT_TYPE	String	0	0	150	No
ATT_NAME	ATT_NAME	ATT_NAME	String	0	0	250	No
DATA_SIZE	DATA_SIZE	DATA_SIZE	Integer	0	0	4	No
DATA	DATA	DATA	Blob	0	0	0	Yes

Subtype Name	Default Value	Domain

Index Name	Ascending	Unique	Fields
FDO_ATTACHMENTID	Yes	Yes	ATTACHMENTID
GDB_83_REL_OBJECTID	Yes	No	REL_OBJECTID

Impact_Pnts_Edit

Alias	Impact_Pnts_Edit	**Geometry:**Point **Average Number of Points:**0
Dataset Type	FeatureClass	**Has M:**No **Has Z:**Yes
FeatureType	Simple	**Grid Size:**56.163258109009213

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
Impact_ID	Impact_ID	Impact_ID	String	0	0	21	Yes
AOI	AOI	AOI	String	0	0	3	No
Impact_Type	Impact_Type	Impact_Type	String	0	0	3	No

GNSS_Date	GNSS_Date	GNSS_Date	Date	0	0	8	No
Field_Notes	Field_Notes	Field_Notes	String	0	0	80	Yes
Motive_1	Motive_1	Motive_1	String	0	0	3	Yes
Motive_2	Motive_2	Motive_2	String	0	0	3	Yes
Trend	Trend	Trend	String	0	0	3	Yes
Confidence	Confidence	Confidence	String	0	0	3	Yes
Photo_1	Photo_1	Photo_1	String	0	0	160	Yes
Review_Notes	Review_Notes	Review_Notes	String	0	0	80	Yes
GIS_Notes	GIS_Notes	GIS_Notes	String	0	0	80	Yes
Horiz_Acc	Horiz_Acc	Horiz_Acc	Double	0	0	8	Yes
Ellipsoid_H	Ellipsoid_H	Ellipsoid_H	Double	0	0	8	Yes

Subtype Name	**Default Value**	**Domain**
ObjectClass		
AOI		RIB_AOI
Impact_Type		Impact_Pnts
Motive_1		Motive
Motive_2		Motive
Trend		Trend
Confidence		Confidence

Index Name	**Ascending**	**Unique**	**Fields**
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

Impact_Pnts_Field

Alias	Impact_Pnts_Field	**Geometry:**Point **Average Number of Points:**0
Dataset Type	FeatureClass	**Has M:**No
FeatureType	Simple	**Has Z:**Yes **Grid Size:**56.163258109009213

Field Name	**Alias Name**	**Model Name**	**Type**	**Precn.**	**Scale**	**Length**	**Null**
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
Impact_ID	Impact_ID	Impact_ID	String	0	0	21	Yes
AOI	AOI	AOI	String	0	0	3	No
Impact_Type	Impact_Type	Impact_Type	String	0	0	3	No
GNSS_Date	GNSS_Date	GNSS_Date	Date	0	0	8	No
Field_Notes	Field_Notes	Field_Notes	String	0	0	80	Yes
Motive_1	Motive_1	Motive_1	String	0	0	3	Yes
Motive_2	Motive_2	Motive_2	String	0	0	3	Yes
Trend	Trend	Trend	String	0	0	3	Yes
Confidence	Confidence	Confidence	String	0	0	3	Yes
Photo_1	Photo_1	Photo_1	String	0	0	160	Yes
Review_Notes	Review_Notes	Review_Notes	String	0	0	80	Yes
GIS_Notes	GIS_Notes	GIS_Notes	String	0	0	80	Yes
Horiz_Acc	Horiz_Acc	Horiz_Acc	Double	0	0	8	Yes
Ellipsoid_H	Ellipsoid_H	Ellipsoid_H	Double	0	0	8	Yes

Subtype Name	**Default Value**	**Domain**
ObjectClass		
AOI		RIB_AOI
Impact_Type		Impact_Pnts
Motive_1		Motive
Motive_2		Motive
Trend		Trend
Confidence		Confidence

Index Name	**Ascending**	**Unique**	**Fields**
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

Impact_Pnts_Field_SHELL

Alias	Impact_Pnts_Field_SHELL	**Geometry:**Point **Average Number of Points:**0
Dataset Type	FeatureClass	**Has M:**No
FeatureType	Simple	**Has Z:**Yes **Grid Size:**56.163258109009213

Field Name	**Alias Name**	**Model Name**	**Type**	**Precn.**	**Scale**	**Length**	**Null**
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No

SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
Impact_ID	Impact_ID	Impact_ID	String	0	0	20	Yes
AOI	AOI	AOI	String	0	0	3	No
Impact_Type	Impact_Type	Impact_Type	String	0	0	3	No
GNSS_Date	GNSS_Date	GNSS_Date	Date	0	0	8	No
Field_Notes	Field_Notes	Field_Notes	String	0	0	80	Yes
Motive_1	Motive_1	Motive_1	String	0	0	3	Yes
Motive_2	Motive_2	Motive_2	String	0	0	3	Yes
Trend	Trend	Trend	String	0	0	3	Yes
Confidence	Confidence	Confidence	String	0	0	3	Yes
Photo_1	Photo_1	Photo_1	String	0	0	160	Yes
Review_Notes	Review_Notes	Review_Notes	String	0	0	80	Yes
GIS_Notes	GIS_Notes	GIS_Notes	String	0	0	80	Yes
Horiz_Acc	Horiz_Acc	Horiz_Acc	Double	0	0	8	Yes
Ellipsoid_H	Ellipsoid_H	Ellipsoid_H	Double	0	0	8	Yes

Subtype Name	**Default Value**	**Domain**
ObjectClass		
AOI		RIB_AOI
Impact_Type		Impact_Pnts
Motive_1		Motive
Motive_2		Motive
Trend		Trend
Confidence		Confidence

Index Name	**Ascending**	**Unique**	**Fields**
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

plyg_to_line_20140426

Alias	plyg_to_line_20140426	**Geometry:**Polyline **Average Number of Points:**0	
Dataset Type	FeatureClass	**Has M:**No **Has Z:**Yes	
FeatureType	Simple	**Grid Size:**140	

Field Name	**Alias Name**	**Model Name**	**Type**	**Precn.**	**Scale**	**Length**	**Null**
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
Impact_ID	Impact_ID	Impact_ID	String	0	0	20	Yes
AOI	AOI	AOI	String	0	0	3	No
Impact_Type	Impact_Type	Impact_Type	String	0	0	3	No
GNSS_Date	GNSS_Date	GNSS_Date	Date	0	0	8	No
Field_Notes	Field_Notes	Field_Notes	String	0	0	80	Yes
Motive_1	Motive_1	Motive_1	String	0	0	3	Yes
Motive_2	Motive_2	Motive_2	String	0	0	3	Yes
Trend	Trend	Trend	String	0	0	3	Yes
Confidence	Confidence	Confidence	String	0	0	3	Yes
Photo_1	Photo_1	Photo_1	String	0	0	160	Yes
Review_Notes	Review_Notes	Review_Notes	String	0	0	80	Yes
GIS_Notes	GIS_Notes	GIS_Notes	String	0	0	80	Yes
Horiz_Acc	Horiz_Acc	Horiz_Acc	Double	0	0	8	Yes
ORIG_FID	ORIG_FID	ORIG_FID	Integer	0	0	4	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes

Subtype Name	**Default Value**	**Domain**
ObjectClass		
AOI		RIB_AOI
Impact_Type		Impact_Plyg
Motive_1		Motive
Motive_2		Motive
Trend		Trend
Confidence		Confidence

Index Name	**Ascending**	**Unique**	**Fields**
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

RIB_Desktop_Edit_Scratch

Alias	RIB_Desktop_Edit_Scratch	**Geometry:**Polyline

Dataset Type	FeatureClass	**Average Number of Points:**0 **Has M:**No	
FeatureType	Simple	**Has Z:**Yes **Grid Size:**190	

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
GIS_Notes	GIS_Notes	GIS_Notes	String	0	0	80	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes

Subtype Name	Default Value	Domain

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

SUCR_Boundary

Alias	SUCR_Boundary	**Geometry:**Polygon	
Dataset Type	FeatureClass	**Average Number of Points:**0 **Has M:**No	
FeatureType	Simple	**Has Z:**No **Grid Size:**4100	

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
Shape	Shape	Shape	Geometry	0	0	0	Yes
UNIT_TYPE	UNIT_TYPE	UNIT_TYPE	String	0	0	50	Yes
STATE	STATE	STATE	String	0	0	2	Yes
REGION	REGION	REGION	String	0	0	2	Yes
UNIT_CODE	UNIT_CODE	UNIT_CODE	String	0	0	16	Yes
UNIT_NAME	UNIT_NAME	UNIT_NAME	String	0	0	254	Yes
DATE_EDIT	DATE_EDIT	DATE_EDIT	Date	0	0	8	Yes
GIS_NOTES	GIS_NOTES	GIS_NOTES	String	0	0	254	Yes
CREATED_BY	CREATED_BY	CREATED_BY	String	0	0	10	Yes
METADATA	METADATA	METADATA	String	0	0	100	Yes
PARKNAME	PARKNAME	PARKNAME	String	0	0	254	Yes
GNIS_ID	GNIS_ID	GNIS_ID	String	0	0	16	Yes
Shape_Length	Shape_Length	Shape_Length	Double	0	0	8	Yes
Shape_Area	Shape_Area	Shape_Area	Double	0	0	8	Yes
Area_Acres	Area_Acres	Area_Acres	Double	0	0	8	Yes

Subtype Name	Default Value	Domain

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_Shape	Yes	No	Shape

TrimbleSessions

Alias	TrimbleSessions	**Geometry:**Polygon	
Dataset Type	FeatureClass	**Average Number of Points:**0 **Has M:**No	
FeatureType	Simple	**Has Z:**No **Grid Size:**0	

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
SessionID	SessionID	SessionID	GUID	0	0	38	No
ProjectID	ProjectID	ProjectID	GUID	0	0	38	No
DeviceID	DeviceID	DeviceID	String	0	0	50	No
DeviceSerialNumber	DeviceSerialNumber	DeviceSerialNumber	String	0	0	100	No
StartTime	StartTime	StartTime	Date	0	0	8	No
EndTime	EndTime	EndTime	Date	0	0	8	No
Note	Note	Note	String	0	0	250	Yes
ConstructionData	ConstructionData	ConstructionData	Blob	0	0	0	Yes
GnssData	GnssData	GnssData	Blob	0	0	0	Yes
Shape	Shape	Shape	Geometry	0	0	0	Yes
Shape_Length	Shape_Length	Shape_Length	Double	0	0	8	Yes
Shape_Area	Shape_Area	Shape_Area	Double	0	0	8	Yes
GlobalID	GlobalID	GlobalID	Global ID	0	0	38	No

Subtype Name	Default Value	Domain

Index Name	Ascending	Unique	Fields
FDO_GlobalID	Yes	No	GlobalID

FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_Shape	Yes	No	Shape

TrimbleSessions__ATTACH

Alias	TrimbleSessions__ATTACH
Dataset Type	Table
FeatureType	

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
ATTACHMENTID	ATTACHMENTID	ATTACHMENTID	OID	0	0	4	No
REL_GLOBALID	REL_GLOBALID	REL_GLOBALID	GUID	0	0	38	No
CONTENT_TYPE	CONTENT_TYPE	CONTENT_TYPE	String	0	0	150	No
ATT_NAME	ATT_NAME	ATT_NAME	String	0	0	250	No
DATA_SIZE	DATA_SIZE	DATA_SIZE	Integer	0	0	4	No
DATA	DATA	DATA	Blob	0	0	0	Yes
GLOBALID	GLOBALID	GLOBALID	Global ID	0	0	38	No

Subtype Name	Default Value	Domain

Index Name	Ascending	Unique	Fields
FDO_ATTACHMENTID	Yes	Yes	ATTACHMENTID
FDO_GLOBALID	Yes	No	GLOBALID
GDB_15_REL_GLOBALID	Yes	No	REL_GLOBALID

Relationships

Name	Origin	Destination	Attributed	Composite	Rules
Impact_Line__ATTACHREL	Impact_Line	Impact_Line__ATTACH	No	Yes	No
Impact_Plyg__ATTACHREL	Impact_Plyg	Impact_Plyg__ATTACH	No	Yes	No
Impact_Pnts__ATTACHREL	Impact_Pnts	Impact_Pnts__ATTACH	No	Yes	No
TrimbleSessions__ATTACHREL	TrimbleSessions	TrimbleSessions__ATTACH	No	Yes	No

Impact_Line__ATTACHREL

Composite	Yes	
Cardinality	One To Many	
Notification	None	
Attributed	No	
	Origin	**Destination**
ObjectClass	Impact_Line	Impact_Line__ATTACH
Key	OBJECTID (*Origin Primary Key*)	REL_OBJECTID (*Origin Foreign Key*)
Labels	object	attachment

Impact_Plyg__ATTACHREL

Composite	Yes	
Cardinality	One To Many	
Notification	None	
Attributed	No	
	Origin	**Destination**
ObjectClass	Impact_Plyg	Impact_Plyg__ATTACH
Key	OBJECTID (*Origin Primary Key*)	REL_OBJECTID (*Origin Foreign Key*)
Labels	object	attachment

Impact_Pnts__ATTACHREL

Composite	Yes	
Cardinality	One To Many	
Notification	None	
Attributed	No	
	Origin	**Destination**
ObjectClass	Impact_Pnts	Impact_Pnts__ATTACH

Key	OBJECTID (*Origin Primary Key*)	REL_OBJECTID (*Origin Foreign Key*)
Labels	object	attachment

TrimbleSessions__ATTACHREL

Composite	Yes	
Cardinality	One To Many	
Notification	None	
Attributed	No	
	Origin	**Destination**
ObjectClass	TrimbleSessions	TrimbleSessions__ATTACH
Key	GlobalID (*Origin Primary Key*)	REL_GLOBALID (*Origin Foreign Key*)
Labels	object	attachment

Topologies

Name: RIB_2013_Impacts_Topology

Cluster Tolerance: 0.001
Maximum Generated Error Count: Undefined

Feature Class	Weight	XY Rank	Z Rank	Event Notification
AOI_Plyg	1	2	1	No
Impact_Line_Edit	1	4	1	No
Impact_Plyg_Edit	1	3	1	No
Impact_Pnts_Edit	1	5	1	No
SUCR_Boundary	1	1	1	No

Topology Rules

Name	Origin (*FeatureClass::Subtype*)	Rule Type	Destination (*FeatureClass::Subtype*)	Trigger Events
	AOI_Plyg:: All Subtypes	Must be covered by	SUCR_Boundary:: All Subtypes	No
	AOI_Plyg:: All Subtypes	Must not have overlaps	AOI_Plyg:: All Subtypes	No
	AOI_Plyg:: All Subtypes	Must not have gaps	AOI_Plyg:: All Subtypes	No
	Impact_Line_Edit:: All Subtypes	-	AOI_Plyg:: All Subtypes	No
	Impact_Pnts_Edit:: All Subtypes	Must be properly inside polygons	AOI_Plyg:: All Subtypes	No
	Impact_Plyg_Edit:: All Subtypes	Must be covered by	AOI_Plyg:: All Subtypes	No
	Impact_Plyg_Edit:: All Subtypes	Must not have overlaps	Impact_Plyg_Edit:: All Subtypes	No
	Impact_Line_Edit:: All Subtypes	Must not have dangles	Impact_Line_Edit:: All Subtypes	No
	Impact_Plyg_Edit:: All Subtypes	Must not have gaps	Impact_Plyg_Edit:: All Subtypes	No

Spatial References

Dimension	Minimum	Precision
AOI_Development_NAD83HARN		
X	-5120900	10000
Y	-9998100	
M	-100000	10000
Z	-100000	10000
Coordinate System Description PROJCS["NAD_1983_HARN_UTM_Zone_12N",GEOGCS["GCS_North_American_1983_HARN",DATUM["D_North_American_1983_HARN",SPHEROID["GRS_1980",6378137.0,298.257222101]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Transverse_Mercator"],PARAMETER["False_Easting",500000.0],PARAMETER["False_Northing",0.0],PARAMETER["Central_Meridian",-111.0],PARAMETER["Scale_Factor",0.9996],PARAMETER["Latitude_Of_Origin",0.0],UNIT["Meter",1.0],AUTHORITY["EPSG",3742]],VERTCS["NAVD_1988",VDATUM["North_American_Vertical_Datum_1988"],PARAMETER["Vertical_Shift",0.0],PARAMETER["Direction",1.0],UNIT["Meter",1.0],AUTHORITY["EPSG",5703]]		
RI_Future_Monitoring_SHELLS		
X	-5120900	10000
Y	-9998100	
M	-100000	10000

Z	-100000	10000

Coordinate System Description
PROJCS["NAD_1983_UTM_Zone_12N",GEOGCS["GCS_North_American_1983",DATUM["D_North_American_1983",SPHEROID["GRS_1980",6378137.0,298.257222101]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Transverse_Mercator"],PARAMETER["False_Easting",500000.0],PARAMETER["False_Northing",0.0],PARAMETER["Central_Meridian",-111.0],PARAMETER["Scale_Factor",0.9996],PARAMETER["Latitude_Of_Origin",0.0],UNIT["Meter",1.0],AUTHORITY["EPSG",26912]],VERTCS["NAVD_1988",VDATUM["North_American_Vertical_Datum_1988"],PARAMETER["Vertical_Shift",0.0],PARAMETER["Direction",1.0],UNIT["Meter",1.0],AUTHORITY["EPSG",5703]]

RIB_2013_Analysis

X	-5120900	10000
Y	-9998100	
M	-100000	10000
Z	-100000	10000

Coordinate System Description
PROJCS["NAD_1983_UTM_Zone_12N",GEOGCS["GCS_North_American_1983",DATUM["D_North_American_1983",SPHEROID["GRS_1980",6378137.0,298.257222101]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Transverse_Mercator"],PARAMETER["False_Easting",500000.0],PARAMETER["False_Northing",0.0],PARAMETER["Central_Meridian",-111.0],PARAMETER["Scale_Factor",0.9996],PARAMETER["Latitude_Of_Origin",0.0],UNIT["Meter",1.0],AUTHORITY["EPSG",26912]],VERTCS["NAVD_1988",VDATUM["North_American_Vertical_Datum_1988"],PARAMETER["Vertical_Shift",0.0],PARAMETER["Direction",1.0],UNIT["Meter",1.0],AUTHORITY["EPSG",5703]]

RIB_2013_Impacts

X	-5120900	10000
Y	-9998100	
M	-100000	10000
Z	-100000	10000

Coordinate System Description
PROJCS["NAD_1983_UTM_Zone_12N",GEOGCS["GCS_North_American_1983",DATUM["D_North_American_1983",SPHEROID["GRS_1980",6378137.0,298.257222101]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Transverse_Mercator"],PARAMETER["False_Easting",500000.0],PARAMETER["False_Northing",0.0],PARAMETER["Central_Meridian",-111.0],PARAMETER["Scale_Factor",0.9996],PARAMETER["Latitude_Of_Origin",0.0],UNIT["Meter",1.0],AUTHORITY["EPSG",26912]],VERTCS["NAVD_1988",VDATUM["North_American_Vertical_Datum_1988"],PARAMETER["Vertical_Shift",0.0],PARAMETER["Direction",1.0],UNIT["Meter",1.0],AUTHORITY["EPSG",5703]]

TrimbleSessions

X	-400	999999999.99999988
Y	-400	
M	-	-
Z	-	-

Coordinate System Description
GEOGCS["GCS_WGS_1984",DATUM["D_WGS_1984",SPHEROID["WGS_1984",6378137.0,298.257223563]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433],AUTHORITY["EPSG",4326]]

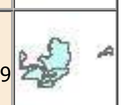
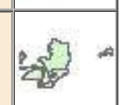
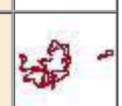
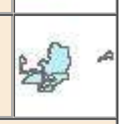
Appendix F: Geodatabase Data Report Using ArcGIS Diagrammer

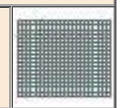
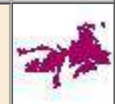
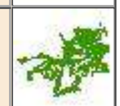
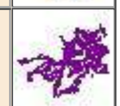
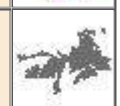
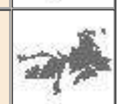
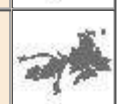
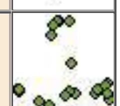
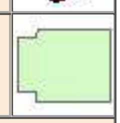
SUCR_2013_Recreation_Impacts_Basemap.gdb

ArcGIS Diagrammer

Report Creation	
Date	Sunday, May 11, 2014
Author	
System Information	
Operating System	Microsoft Windows NT 6.1.7601 Service Pack 1
.Net Framework	2.0.50727.5477
Diagrammer	10.0.1.0
Geodatabase	
Workspace Type	File Geodatabase
File	..\SUCR_2013_Recreation_Impacts_Basemap\ Data\GIS\SUCR_2013_Recreation_Impacts_Basemap.gdb

Data Report

ObjectClass Name	Type	Geometry	Subtype	Total	Extent	Snapshot
AOI_Development_NAD83HARN						
AOI_Edit_Plyg_2	Feature Class	Polygon	-	7	451524.9386 455575.3825 3912727.2116 3914907.9539	
AOI_Edits_B1_S3_Clip_C1	Feature Class	Polygon	-	7	451524.9613 455575.3825 3912727.2116 3914907.9539	
AOI_Edits_B1_Smooth_PAEK10m_S3	Feature Class	Polygon	-	7	451514.9931 455585.4766 3912717.1857 3914907.9539	
AOI_Edits_Buff_10m_1	Feature Class	Polygon	-	7	451515.0066 455585.3796 3912717.25427159 3914908.1567	
AOI_Edits_Plyg	Feature Class	Polygon	-	7	451525.0066 455575.3796 3912727.2542 3914898.1567	
AOI_Field_Line	Feature Class	Polyline	-	107	451480.5187 455586.4533 3912727.2542 3914898.1567	
AOI_Field_Plyg	Feature Class	Polygon	-	0	No Extent	-
AOI_Field_Pnts	Feature Class	Point	-	31	451520.9242 455578.3133 3913000.8667 3914480.7061	
AOI_Plyg_FINAL	Feature Class	Polygon	-	7	451524.9739 455575.4181 3912727.0732 3914907.8241	
RI_Future_Monitoring_SHELLS						
Impact_Line_Field_SHELL	Feature Class	Polyline	-	0	No Extent	-
Impact_Plyg_Field_SHELL	Feature Class	Polygon	-	0	No Extent	-
Impact_Pnts_Field_SHELL	Feature	Point	-	0	No Extent	-

	Class						
RIB_2013_Analysis							
Edit_Check_Fishnet	Feature Class	Polygon	-	396	451500 453700 3912700 3914500		
Impact_Edit_Plyg_SCRATCH	Feature Class	Polygon	-	424	451525.3046 453650.6552 3912745.5177 3914257.532		
plyg_to_line_20140426	Feature Class	Polyline	-	424	451525.3045 453650.6552 3912745.5177 3914257.532		
RIB_Desktop_Edit_Scratch	Feature Class	Polyline	-	5	452311.7979 453488.2685 3912837.6665 3913665.1599		
RIB_2013_Impacts							
AOI_Plyg	Feature Class	Polygon	-	8	451524.9739 455575.4181 3912727.0732 3914907.8241		
Impact_Line	Feature Class	Polyline	-	1687	451525.3662 453670.164 3912752.8056 3914443.7434		
Impact_Line_Edit	Feature Class	Polyline	-	1687	451525.3662 453670.164 3912752.8056 3914443.7434		
Impact_Line_Field	Feature Class	Polyline	-	1704	451520.5061 453691.4023 3912752.76 3914444.2165		
Impact_Plyg	Feature Class	Polygon	-	424	451525.3045 453650.6552 3912745.5177 3914257.532		
Impact_Plyg_Edit	Feature Class	Polygon	-	424	451525.3045 453650.6552 3912745.5177 3914257.532		
Impact_Plyg_Field	Feature Class	Polygon	-	593	451517.5908 453651.2939 3912745.4191 3914260.4611		
Impact_Pnts	Feature Class	Point	-	25	452515.1133 453546.5037 3913323.6715 3914275.9706		
Impact_Pnts_Edit	Feature Class	Point	-	25	452515.1133 453546.5037 3913323.6715 3914275.9706		
Impact_Pnts_Field	Feature Class	Point	-	136	451645.2706 453546.7494 3912782.0458 3914275.9706		
SUCR_Boundary	Feature Class	Polygon	-	1	451522.9029 455577.4815 3912708.4085 3915926.8594		

Stand Alone ObjectClass(s)						
Impact_Line__ATTACH	Table	-	-	1656	No Extent	-
Impact_Plyg__ATTACH	Table	-	-	419	No Extent	-
Impact_Pnts__ATTACH	Table	-	-	25	No Extent	-
TrimbleSessions	Feature Class	Polygon	-	0	No Extent	-
TrimbleSessions__ATTACH	Table	-	-	0	No Extent	-

Appendix G: [Project]_GNSS_Log.xlsx Template

Project	Checkout Date	Collection Start Date	Collection End Date	Location	Objective	Checkout map .mxd	ArcPad Map .apm	Check-out Folder	Photo Folder	Checkout Data	Transfer to Unit	Test on Unit	Collection Notes	Checkin Transfer	Checkin Backup	Copy Photos	Positions Checkin	Differential Correction	Update Features	Session Complete
										☐ OK	☐ OK	☐ OK		☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK
										☐ OK	☐ OK	☐ OK		☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK
										☐ OK	☐ OK	☐ OK		☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK
										☐ OK	☐ OK	☐ OK		☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK
										☐ OK	☐ OK	☐ OK		☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK
										☐ OK	☐ OK	☐ OK		☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK
										☐ OK	☐ OK	☐ OK		☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK
										☐ OK	☐ OK	☐ OK		☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK
										☐ OK	☐ OK	☐ OK		☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK
										☐ OK	☐ OK	☐ OK		☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK	☐ OK

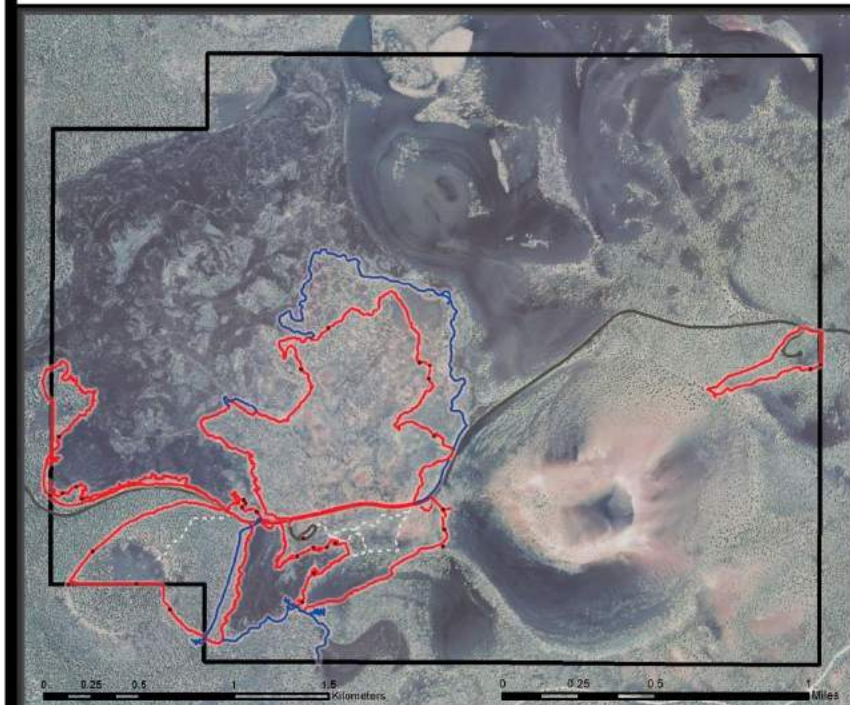
Appendix H: Map and Methods for Defining Areas of Interest

Sunset Crater Volcano National Monument
Arizona

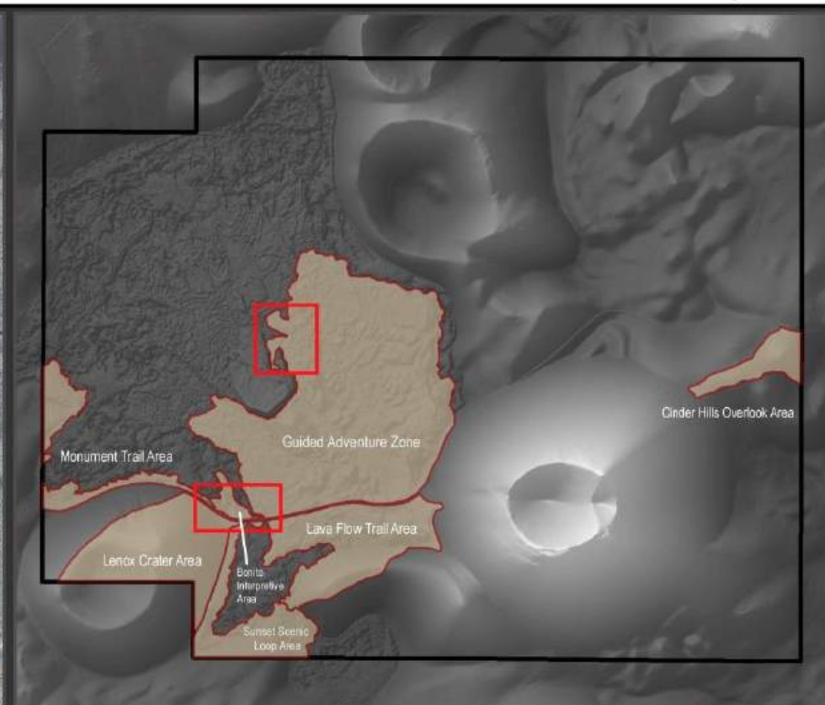
National Park Service
U.S. Department of the Interior

2013 Recreation Impacts Basemap

Areas of Interest (AOIs)



Lines and points from AOI field surveys. Surveys records extent of impact sensitive substrate and existing impacts. Certain segments desktop edited to further delinieate areas and to correct omissions in the field data. 2010 NAIP Basemap.



Final AOI boundaries and names. Post-editing process traces field survey lines, buffers AOIs, manually corrects errors and omissions, removes overlap between coincident boundaries and clips to Monument boundary. 2012 LiDAR Basemap.

The Recreation Impacts Basemap Study is being conducted by the National Park Service at Sunset Crater National Monument. The Natural Resource Program designed this study to gather baseline recreation impact data for planning and management needs.

Field data collection and post-editing completed June 2013. Field data collected with Trimble GeoExplorer 6000 series GeoXT GNSS receiver using ArcPad 10 and the Trimble Positions extension. GNSS data post-processed using Trimble Positions ArcGIS Add-in. Mean horizontal accuracy 30-50 cm. Additonal post-processing, editing and cartography completed using ArcMap 10.1. 2010 NAIP, 2010 ArcGIS World Imagery and 2012 LiDAR products used to enhance and verify field and desktop products.

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Natural Resource Specialist - Flagstaff Area National Monuments
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Coordinate System:
NAD 1983 HARN UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983 HARN
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -111.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

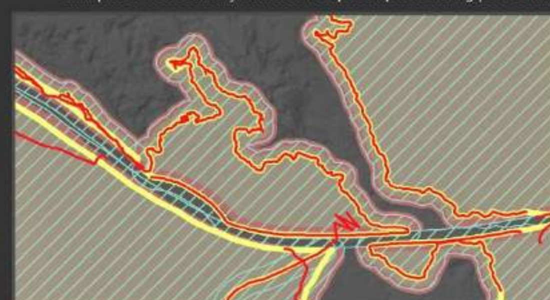
UPPER MAPS LEGEND

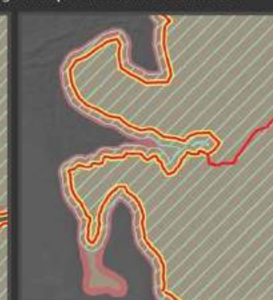
Monument Boundary
Paved Road
Trail
Field Collected Lines
Desktop Digitized Lines
Field Points
Final AOI Boundary

DETAIL MAPS LEGEND

Field and Desktop Survey
Initial Desktop Edits
Buffer - 10 Meters
Final AOI Boundary

Examples of AOI boundary delineation steps completed during post-editing. Example extents indicated above.





Appendix I: VB Script to Calculate Impact_ID Field

Instructions for populating the Impact_ID concatenated unique identifier using the Field Calculator in ArcGIS

1. Open ArcMap and add the target feature class. This calculation was scripted, tested, and used in 2014 with ArcGIS 10.2 and file geodatabase feature classes.
2. Start editing to allow for calculations to be undone if there is any error.
3. Right-click on the **[Impact_ID]** field header, select **Field Calculator…**
4. Parser radio button: **VB Script** selected
5. **Show Codeblock** check-box selected
6. To properly concatenate the Impact_ID using multiple fields, including the GNSS_Date field, the length of the day and month string must be two characters. To format this date part, enter the following code into the **Pre-Logic Script Code** window:

```
If DatePart ("d", [GNSS_Date] ) < 10 Then
dateday = "0" & DatePart ("d", [GNSS_Date] )
Else
dateday = DatePart ("d", [GNSS_Date] )
End If

If DatePart ("m", [GNSS_Date] ) < 10 Then
datemon = "0" & DatePart ("m", [GNSS_Date] )
Else
datemon = DatePart ("m", [GNSS_Date] )
End If
```

7. Enter the following code into the **Impact_ID =** expression window:

```
[AOI] & "_" & [Impact_Type] & "_" & [OBJECTID] & "_" & DatePart("yyyy",
[GNSS_Date]) & datemon & dateday
```

8. Click OK to populate the Impact_ID field with the concatenated unique identifier.
9. Save edits and stop editing.

Appendix J: Recreation Impact Summary Statistics Tables

AOI - Areas of Interest

Source: AOI_Plyg, Impact_Pnts, Impact_Line, Impact_Plyg

Code	Name	Area Acres	Area Hectares	Perimeter Miles	Perimeter Kilometers	Count Impact Points	Count Impact Lines	Count Impact Polygons	Count All Features	Impact Area Acres	% of AOI with Polygon Impact
III	Isolated Impact Incident	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
IVM	Identified during 2004 Vegetation Mapping	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
OTH	Other	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
MTA	Monument Trail Area - Entire AOI	(31.30)	(12.66)	(2.42)	(3.90)	<null>	<null>	<null>	<null>	<null>	<null>
CHO	Cinder Hills Overlook Area	(21.82)	(8.83)	(1.05)	(1.69)	<null>	<null>	<null>	<null>	<null>	<null>
GAZ	Guided Adventure Zone	306.35	123.97	3.66	5.89	7	535	65	607	39.8485	13.01%
LFT	Lava Flow Trail Area	78.33	31.70	2.31	3.72	11	625	220	856	23.8951	30.51%
LCA	Lenox Crater Area	78.30	31.69	1.81	2.91	0	196	74	270	27.6297	35.29%
SSL	Sunset Scenic Loop Area	42.60	17.24	1.87	3.01	0	80	8	88	4.0103	9.41%
MTA	Monument Trail Area - Surveyed	14.75	5.97	1.51	2.43	0	111	28	139	2.9279	19.85%
BIA	Bonito Interpretive Area	7.23	2.93	0.61	0.98	7	140	29	176	1.0711	14.81%
Total	11	527.56	213.50	11.77	18.94	25	1687	424	2136	99.3826	18.84%

RIB Point Features - All Areas

Source Feature Class: Impact_Pnts

CODE	Impact Type	Count	Average Horizontal Accuracy
OTH	other - see field notes	12	0.453
GRA	graffiti	5	0.448
VRC	veg - roots/crown	4	0.405
GOT	geologic - other	2	0.453
GBR	geologic - breakage	1	0.618
LIC	litter concentration	1	0.368
ARE	active restoration	0	<null>
GDE	geologic - defaced	0	<null>
GIS	GIS processing	0	<null>
SRN	sensitive resource notes	0	<null>
VBT	veg - breakage/trampling	0	<null>
VGT	veg - other	0	<null>
Total	12	25	0.457

RIB Line Features - All Areas

Source Feature Class: Impact_Line

CODE	Impact Type	Count	Average Horizontal Accuracy	Minimum Length Meters	Maximum Length Meters	Average Length Meters	Sum Length Meters	Sum Length Kilometers	Sum Length Feet	Sum Length Miles
FMT	foot - multiple traverses	873	0.70	1.5	352.0	37.8	33004.3	33.00	108282	20.51
SLI	social trail - lava flow, infrequent	252	0.55	1.9	72.2	13.2	3338.4	3.34	10953	2.07
STO	social trail - other	166	0.62	2.2	653.1	25.0	4149.9	4.15	13615	2.58
SCI	social trail - cinder, infrequent	89	0.59	1.6	182.5	22.1	1963.5	1.96	6442	1.22
SSI	social trail - spatter, infrequent	82	0.52	2.4	62.6	15.0	1226.6	1.23	4024	0.76
FST	foot - single traverse	37	0.59	5.4	199.5	27.6	1020.1	1.02	3347	0.63
SCF	social trail - cinder, frequent	34	0.64	1.8	353.7	44.1	1501.1	1.50	4925	0.93
SLF	social trail - lava flow, frequent	33	0.62	1.0	51.6	14.0	463.2	0.46	1520	0.29
VST	vehicle - single traverse	29	0.57	15.1	230.4	91.6	2656.5	2.66	8715	1.65
SAI	social trail - agglutinate, infrequent	23	0.58	6.0	49.8	21.1	484.7	0.48	1590	0.30
VRC	veg - roots/crown	21	0.56	2.6	11.6	5.9	123.1	0.12	404	0.08
SSF	social trail - spatter, frequent	18	0.55	5.7	42.1	16.1	289.4	0.29	949	0.18
OTH	other - see field notes	11	0.62	10.7	259.7	100.7	1107.9	1.11	3635	0.69
VMD	vehicle - multiple traverses	11	0.91	46.6	297.2	148.0	1627.5	1.63	5340	1.01
SAF	social trail - agglutinate, frequent	6	0.53	15.1	68.1	41.0	245.9	0.25	807	0.15
GDE	geologic - defaced	1	0.36	6.3	6.3	6.3	6.3	0.01	21	0.00
VGT	veg - other	1	0.46	121.1	121.1	121.1	121.1	0.12	397	0.08
ARE	active restoration	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
FOT	foot - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GBR	geologic - breakage	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GOT	geologic - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GIS	GIS processing	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SRN	sensitive resource notes	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VBT	veg - breakage/trampling	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VOT	vehicle - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
Total	25	1687	0.59	1.0	653.1	44.1	53329.4	53.33	174965	33.14

RIB Polygon Features - All Areas

Source Feature Class: Impact_Plyg

CODE	Impact Type	Count	Average Horizontal Accuracy	Minimum Area - Meters	Maximum Area - Meters	Average Area - Meters	Sum Area - Meters	Sum Area - Hectares	Sum Area - Feet	Sum Area - Acres
FTR	foot - overall trampled	214	0.83	6.22	12601.91	845.32	180898.62	18.09	1947169	44.70
FIM	foot - indeterminate route, multiple traverses	106	0.94	20.84	11582.39	1861.30	197297.61	19.73	2123685	48.75
GBR	geologic - breakage	39	0.54	8.74	181.54	52.65	2053.40	0.21	22103	0.51
FDM	foot - distinct route, multiple traverses	37	0.80	13.60	2648.75	407.33	15071.27	1.51	162225	3.72
OTH	other - see field notes	10	0.77	15.46	1563.05	285.45	2854.50	0.29	30725	0.71
TWC	trail - widening beyond core	8	0.68	3.92	45.22	15.26	122.06	0.01	1314	0.03
VIM	vehicle - indeterminate route, multiple traverses	3	0.68	85.78	2732.35	984.85	2954.54	0.30	31802	0.73
GDE	geologic - defaced	2	0.46	12.43	44.00	28.22	56.43	0.01	607	0.01
VBT	veg - breakage/trampling	2	0.90	59.28	73.33	66.31	132.61	0.01	1427	0.03
VGT	veg - other	2	0.51	57.60	93.73	75.67	151.33	0.02	1629	0.04
VDM	vehicle - distinct route, multiple traverses	1	0.60	595.02	595.02	595.02	595.02	0.06	6405	0.15
ARE	active restoration	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
FOT	foot - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GIS	GIS processing	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GOT	geologic - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SRN	sensitive resource notes	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VOT	vehicle - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VRC	veg - roots/crown	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VTR	vehicle - overall trampled	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
Total	19	424	0.70	3.92	12601.91	474.31	402187.40	40.22	4329092	99.38

RIB Point Features - All Areas

Source Feature Class: Impact_Pnts

Code	Motive	Count Motive_1	Count Motive_2	Sum Motive_1 and Motive_2
OTH	other - see field notes	14	6	20
SAO	social area - other	5	0	5
OTE	off-trail exploration	2	2	4
AGF	access - geologic feature	1	1	2
ALF	access - lava flow	1	0	1
SAS	social area - shelter	1	0	1
VEL	viewpoint - elevated vantage point	0	1	1
AAP	access - passageway	0	0	0
AOT	access - other	0	0	0
ATR	ambiguous trail routing	0	0	0
AVF	access - vegetation feature	0	0	0
SAP	social area - picnic	0	0	0
SAR	social area - rest	0	0	0
SAT	social area - toilet	0	0	0
SFF	shortcut - facility to facility	0	0	0
SOT	shortcut - other	0	0	0
STF	shortcut - trail to facility	0	0	0
STT	shortcut - trail to trail	0	0	0
VBL	viewpoint - broad landscape overview	0	0	0
VBV	viewpoint - break in vegetation/terrain	0	0	0
Total	20	24	10	34

RIB Line Features - All Areas

Source Feature Class: Impact_Line

Code	Motive	Count Motive_1	Count Motive_2	Sum Motive_1 and Motive_2	Minimum Length Meters Motive_1	Maximum Length Meters Motive_1	Average Length Meters Motive_1	Sum Length Meters Motive_1	Sum Length Kilometers Motive_1	Sum Length Feet Motive_1	Sum Length Miles Motive_1
AGF	access - geologic feature	599	328	927	1.9	225.5	24.8	14855.4	14.86	48738	9.23
OTE	off-trail exploration	534	662	1196	1.0	352.0	42.5	22713.1	22.71	74518	14.11
ALF	access - lava flow	439	56	495	1.6	353.7	24.7	10861.8	10.86	35636	6.75
STT	shortcut - trail to trail	32	120	152	2.3	31.7	8.5	270.6	0.27	888	0.17
AAP	access - passageway	27	52	79	4.1	182.5	61.8	1669.6	1.67	5478	1.04
OTH	other - see field notes	18	22	40	9.1	653.1	132.7	2388.8	2.39	7837	1.48
STF	shortcut - trail to facility	10	107	117	3.2	34.8	15.4	153.8	0.15	505	0.10
AVF	access - vegetation feature	8	22	30	7.5	14.5	10.9	86.9	0.09	285	0.05
VBL	viewpoint - broad landscape overview	5	66	71	11.2	43.6	23.6	117.8	0.12	387	0.07
VEL	viewpoint - elevated vantage point	4	125	129	4.3	10.7	6.4	25.4	0.03	83	0.02
SOT	shortcut - other	3	4	7	6.3	8.7	7.8	23.4	0.02	77	0.01
SAS	social area - shelter	2	13	15	5.7	8.5	7.1	14.2	0.01	46	0.01
ATR	ambiguous trail routing	2	1	3	41.6	50.5	46.0	92.1	0.09	302	0.06
AOT	access - other	2	0	2	11.8	14.4	13.1	26.1	0.03	86	0.02
SFF	shortcut - facility to facility	1	4	5	14.6	14.6	14.6	14.6	0.01	48	0.01
SAO	social area - other	1	2	3	15.9	15.9	15.9	15.9	0.02	52	0.01
SAR	social area - rest	0	2	2	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SAP	social area - picnic	0	0	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SAT	social area - toilet	0	0	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VBV	viewpoint - break in vegetation/terrain	0	0	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>
Total	20	1687	1586	3273	<null>	<null>	<null>	<null>	<null>	<null>	<null>

Count Motives - All Feature Types

Source Feature Class: Impact_Pnts, Impact_Line, Impact_Plyg

Code	Motive	Count All Features and Motives
OTE	off-trail exploration	1531
AGF	access - geologic feature	1120
ALF	access - lava flow	618
STT	shortcut - trail to trail	171
VEL	viewpoint - elevated vantage point	169
STF	shortcut - trail to facility	159
VBL	viewpoint - broad landscape overview	96
AAP	access - passageway	80
OTH	other - see field notes	74
AVF	access - vegetation feature	46
SAS	social area - shelter	26
SOT	shortcut - other	12
SAO	social area - other	10
SFF	shortcut - facility to facility	6
AOT	access - other	4
ATR	ambiguous trail routing	4
SAR	social area - rest	3
SAP	social area - picnic	0
SAT	social area - toilet	0
VBV	viewpoint - break in vegetation/terrain	0
Total		4129

RIB Polygon Features - All Areas

Source Feature Class: Impact_Plyg

Code	Motive	Count Motive_1	Count Motive_2	Sum Motive_1 and Motive_2	Minimum Area Meters Motive_1	Maximum Area Meters Motive_1	Average Area Meters Motive_1	Sum Area Meters Motive_1	Sum Area Hectares Motive_1	Sum Area Feet Motive_1	Sum Area Acres Motive_1
OTE	off-trail exploration	174	157	331	3.9	12601.9	1413.9	246013.3	24.60	2648054	60.79
AGF	access - geologic feature	127	64	191	8.5	11415.7	833.6	105868.6	10.59	1139555	26.16
ALF	access - lava flow	93	29	122	5.6	3606.6	372.7	34659.8	3.47	373074	8.56
OTH	other - see field notes	7	7	14	15.5	214.3	104.3	729.8	0.07	7856	0.18
VBL	viewpoint - broad landscape overview	6	19	25	21.8	1150.5	390.6	2343.8	0.23	25229	0.58
AVF	access - vegetation feature	5	11	16	22.7	364.3	122.7	613.3	0.06	6601	0.15
STF	shortcut - trail to facility	4	38	42	190.2	3702.4	2113.1	8452.4	0.85	90980	2.09
SOT	shortcut - other	3	2	5	88.7	572.1	290.5	871.5	0.09	9381	0.22
STT	shortcut - trail to trail	3	16	19	23.3	2110.0	759.6	2278.9	0.23	24530	0.56
AAP	access - passageway	1	0	1	17.8	17.8	17.8	17.8	0.00	192	0.00
AOT	access - other	1	1	2	338.1	338.1	338.1	338.1	0.03	3640	0.08
ATR	ambiguous trail routing	0	1	1	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SAO	social area - other	0	2	2	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SAP	social area - picnic	0	0	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SAR	social area - rest	0	1	1	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SAS	social area - shelter	0	10	10	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SAT	social area - toilet	0	0	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SFF	shortcut - facility to facility	0	1	1	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VBV	viewpoint - break in vegetation/terrain	0	0	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VEL	viewpoint - elevated vantage point	0	39	39	<null>	<null>	<null>	<null>	<null>	<null>	<null>
Total	20	424	398	822	<null>	<null>	<null>	<null>	<null>	<null>	<null>

BIA - Bonito Interpretive Area

Impact_Pnts - Points

Code	Impact Type	Count
GRA	graffiti	5
VRC	veg - roots/crown	2
ARE	active restoration	0
GBR	geologic - breakage	0
GDE	geologic - defaced	0
GIS	GIS processing	0
GOT	geologic - other	0
LIC	litter concentration	0
OTH	other - see field notes	0
SRN	sensitive resource notes	0
VBT	veg - breakage/trampling	0
VGT	veg - other	0
Total	2	7

Impact_Line - Lines

Code	Impact Type	Count	Average Horizontal Accuracy	Minimum Length Meters	Maximum Length Meters	Average Length Meters	Sum Length Meters	Sum Length Km	Sum Length Feet	Sum Length Miles
SLI	social trail - lava flow, infrequent	70	0.58	1.9	72.2	12.0	837.6	0.84	2748	0.52
SLF	social trail - lava flow, frequent	22	0.64	1.0	51.6	15.7	344.4	0.34	1130	0.21
VRC	veg - roots/crown	16	0.52	2.6	11.6	5.8	92.5	0.09	304	0.06
SCI	social trail - cinder, infrequent	9	0.53	3.1	18.0	8.6	77.8	0.08	255	0.05
FMT	foot - multiple traverses	8	0.55	5.4	17.0	9.9	79.0	0.08	259	0.05
SCF	social trail - cinder, frequent	8	0.53	1.8	26.1	7.1	57.0	0.06	187	0.04
STO	social trail - other	4	0.52	19.4	47.4	33.3	133.2	0.13	437	0.08
OTH	other - see field notes	3	0.47	14.0	29.9	21.5	64.5	0.06	212	0.04
FST	foot - single traverse	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SAI	social trail - agglutinate, infrequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SAF	social trail - agglutinate, frequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SSI	social trail - spatter, infrequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SSF	social trail - spatter, frequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
ARE	active restoration	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
FOT	foot - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GBR	geologic - breakage	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GDE	geologic - defaced	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GOT	geologic - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GIS	GIS processing	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SRN	sensitive resource notes	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VBT	veg - breakage/trampling	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VGT	veg - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VMD	vehicle - multiple traverses	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VOT	vehicle - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VST	vehicle - single traverse	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
Total	8	140	0.54	<null>	<null>	14.2	1686.0	1.69	5532	1.05

Impact_Plyg - Polygons

7.2322 acres

Code	Impact Type	Count	Average Horizontal Accuracy	Minimum Area Meters	Maximum Area Meters	Average Area Meters	Sum Area Meters	Sum Area Hectares	Sum Area Feet	Sum Area Acres	Percent of Total AOI Area
GBR	geologic - breakage	11	0.66	10.2	181.5	57.4	631.9	0.06	6801	0.16	2.16%
FTR	foot - overall trampled	10	0.79	17.2	1168.8	288.8	2888.4	0.29	31090	0.71	9.87%
FDM	foot - distinct route, multiple traverses	4	0.62	29.0	170.5	85.7	342.7	0.03	3689	0.08	1.17%
FIM	foot - indeterminate route, multiple traverses	3	0.46	30.9	364.5	142.6	427.7	0.04	4603	0.11	1.46%
GDE	geologic - defaced	1	0.54	44.0	44.0	44.0	44.0	0.00	474	0.01	0.15%
ARE	active restoration	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
FOT	foot - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GIS	GIS processing	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GOT	geologic - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
OTH	other - see field notes	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SRN	sensitive resource notes	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
TWC	trail - widening beyond core	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VBT	veg - breakage/trampling	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VDM	vehicle - distinct route, multiple traverses	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VGT	veg - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VIM	vehicle - indeterminate route, multiple traverses	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VOT	vehicle - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VRC	veg - roots/crown	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VTR	vehicle - overall trampled	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
Total	5	29	0.61	<null>	<null>	123.7	4334.6	0.43	46657	1.07	14.81%

GAZ - Guided Adventure Zone

Impact_Pnts - Points

Code	Impact Type	Count
OTH	other - see field notes	6
GOT	geologic - other	1
ARE	active restoration	0
GBR	geologic - breakage	0
GDE	geologic - defaced	0
GIS	GIS processing	0
GRA	graffiti	0
LIC	litter concentration	0
SRN	sensitive resource notes	0
VBT	veg - breakage/trampling	0
VGT	veg - other	0
VRC	veg - roots/crown	0
Total	2	7

Impact_Line - Lines

Code	Impact Type	Count	Average Horizontal Accuracy	Minimum Length Meters	Maximum Length Meters	Average Length Meters	Sum Length Meters	Sum Length Km	Sum Length Feet	Sum Length Miles
FMT	foot - multiple traverses	396	0.63	2.6	352.0	50.1	19847.3	19.85	65116	12.33
SSI	social trail - spatter, infrequent	32	0.58	3.9	62.6	23.4	749.5	0.75	2459	0.47
STO	social trail - other	32	0.74	4.4	151.7	43.2	1383.7	1.38	4540	0.86
SAI	social trail - agglutinate, infrequent	22	0.59	6.0	49.8	21.7	477.7	0.48	1567	0.30
VST	vehicle - single traverse	20	0.59	41.4	230.4	102.9	2057.3	2.06	6750	1.28
SCI	social trail - cinder, infrequent	8	0.75	8.7	182.5	60.1	480.4	0.48	1576	0.30
SLI	social trail - lava flow, infrequent	6	0.48	4.6	29.7	12.1	72.7	0.07	238	0.05
SAF	social trail - agglutinate, frequent	5	0.46	15.1	68.1	45.3	226.6	0.23	743	0.14
VMD	vehicle - multiple traverses	5	0.60	46.6	297.2	125.8	628.9	0.63	2063	0.39
OTH	other - see field notes	4	0.72	204.0	259.7	229.5	918.0	0.92	3012	0.57
FST	foot - single traverse	3	0.80	37.0	199.5	98.6	295.8	0.30	970	0.18
SSF	social trail - spatter, frequent	1	0.43	23.0	23.0	23.0	23.0	0.02	76	0.01
VOT	vehicle - other	1	0.46	121.1	121.1	121.1	121.1	0.12	397	0.08
SCF	social trail - cinder, frequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SLF	social trail - lava flow, frequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
ARE	active restoration	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
FOT	foot - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GBR	geologic - breakage	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GDE	geologic - defaced	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GOT	geologic - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GIS	GIS processing	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SRN	sensitive resource notes	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VBT	veg - breakage/trampling	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VGT	veg - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VRC	veg - roots/crown	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
Total	13	535	0.60	<null>	<null>	73.6	27282.1	27.28	89508	16.95

Impact_Plyg - Polygons

303.3474 acres

Code	Impact Type	Count	Average Horizontal Accuracy	Minimum Area Meters	Maximum Area Meters	Average Area Meters	Sum Area Meters	Sum Area Hectares	Sum Area Feet	Sum Area Acres	Percent of Total AOI Area
FIM	foot - indeterminate route, multiple traverses	38	0.88	123.2	11582.4	2979.1	113205.3	11.32	1218527	27.97	9.22%
FTR	foot - overall trampled	19	0.81	30.2	12601.9	2221.9	42215.9	4.22	454406	10.43	3.44%
FDM	foot - distinct route, multiple traverses	3	1.04	368.7	1513.5	817.5	2452.4	0.25	26397	0.61	0.20%
GBR	geologic - breakage	2	0.43	34.5	68.4	51.4	102.9	0.01	1107	0.03	0.01%
OTH	other - see field notes	2	0.81	214.3	338.1	276.2	552.5	0.06	5947	0.14	0.05%
VIM	vehicle - indeterminate route, multiple traverses	1	0.92	2732.4	2732.4	2732.4	2732.4	0.27	29411	0.68	0.22%
ARE	active restoration	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
FOT	foot - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GDE	geologic - defaced	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GIS	GIS processing	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GOT	geologic - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SRN	sensitive resource notes	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
TWC	trail - widening beyond core	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VBT	veg - breakage/trampling	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VDM	vehicle - distinct route, multiple traverses	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VGT	veg - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VOT	vehicle - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VRC	veg - roots/crown	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VTR	vehicle - overall trampled	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
Total	6	65	0.81	<null>	<null>	1513.1	161261.2	16.13	1735794	39.8485	13.14%

LCA - Lenox Crater Area

Impact_Pnts - Points

Code	Impact Type	Count
ARE	active restoration	0
GBR	geologic - breakage	0
GDE	geologic - defaced	0
GIS	GIS processing	0
GOT	geologic - other	0
GRA	graffiti	0
LIC	litter concentration	0
OTH	other - see field notes	0
SRN	sensitive resource notes	0
VBT	veg - breakage/trampling	0
VGT	veg - other	0
VRC	veg - roots/crown	0
Total	0	0

Impact_Line - Lines

Code	Impact Type	Count	Average Horizontal Accuracy	Minimum Length Meters	Maximum Length Meters	Average Length Meters	Sum Length Meters	Sum Length Km	Sum Length Feet	Sum Length Miles
FMT	foot - multiple traverses	170	0.97	2.2	211.3	27.1	4598.6	4.60	15087	2.86
SCF	social trail - cinder, frequent	10	0.68	5.2	50.5	18.9	189.3	0.19	621	0.12
SCI	social trail - cinder, infrequent	6	0.99	7.8	164.4	68.1	408.8	0.41	1341	0.25
FST	foot - single traverse	3	0.51	10.6	30.9	17.6	52.8	0.05	173	0.03
VST	vehicle - single traverse	3	0.56	16.6	128.6	58.5	175.5	0.18	576	0.11
STO	social trail - other	2	1.08	11.0	653.1	332.1	664.1	0.66	2179	0.41
VMD	vehicle - multiple traverses	2	1.42	215.3	255.2	235.3	470.5	0.47	1544	0.29
SAI	social trail - agglutinate, infrequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SAF	social trail - agglutinate, frequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SSI	social trail - spatter, infrequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SSF	social trail - spatter, frequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SLI	social trail - lava flow, infrequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SLF	social trail - lava flow, frequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
OTH	other - see field notes	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
ARE	active restoration	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
FOT	foot - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GBR	geologic - breakage	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GDE	geologic - defaced	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GOT	geologic - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GIS	GIS processing	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SRN	sensitive resource notes	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VBT	veg - breakage/trampling	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VGT	veg - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VRC	veg - roots/crown	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VOT	vehicle - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
Total	7	196	0.89	<null>	<null>	108.2	6559.5	6.56	21521	4.08

Impact_Plyg - Polygons

78.3034 acres

Code	Impact Type	Count	Average Horizontal Accuracy	Minimum Area Meters	Maximum Area Meters	Average Area Meters	Sum Area Meters	Sum Area Hectares	Sum Area Feet	Sum Area Acres	Percent of Total AOI Area
FTR	foot - overall trampled	37	1.27	121.3	12061.9	1932.5	71502.9	7.15	769648	17.67	22.56%
FIM	foot - indeterminate route, multiple traverses	27	1.22	104.7	5613.8	1349.1	36426.5	3.64	392090	9.00	11.50%
FDM	foot - distinct route, multiple traverses	6	1.01	13.6	866.6	312.6	1875.3	0.19	20186	0.46	0.59%
OTH	other - see field notes	2	1.20	223.4	1563.1	893.2	1786.5	0.18	19230	0.44	0.56%
VIM	vehicle - indeterminate route, multiple traverses	2	0.56	85.8	136.4	111.1	222.2	0.02	2392	0.05	0.07%
FOT	foot - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
ARE	active restoration	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GBR	geologic - breakage	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GDE	geologic - defaced	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GIS	GIS processing	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GOT	geologic - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SRN	sensitive resource notes	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
TWC	trail - widening beyond core	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VBT	veg - breakage/trampling	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VDM	vehicle - distinct route, multiple traverses	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VGT	veg - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VOT	vehicle - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VRC	veg - roots/crown	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VTR	vehicle - overall trampled	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
Total	5	74	1.05	<null>	<null>	919.7	111813.4	11.18	1203544	27.63	35.29%

LFT - Lava Flow Trail

Impact_Pnts - Points

Code	Impact Type	Count
OTH	other - see field notes	6
VRC	veg - roots/crown	2
GBR	geologic - breakage	1
GOT	geologic - other	1
LIC	litter concentration	1
ARE	active restoration	0
GDE	geologic - defaced	0
GIS	GIS processing	0
GRA	graffiti	0
SRN	sensitive resource notes	0
VBT	veg - breakage/trampling	0
VGT	veg - other	0
Total	5	11

Impact_Line - Lines

Code	Impact Type	Count	Average Horizontal Accuracy	Minimum Length Meters	Maximum Length Meters	Average Length Meters	Sum Length Meters	Sum Length Km	Sum Length Feet	Sum Length Miles
SLI	social trail - lava flow, infrequent	161	0.54	2.7	53.7	13.3	2142.1	2.14	7028	1.33
FMT	foot - multiple traverses	151	0.56	1.5	112.3	20.3	3065.0	3.06	10056	1.90
STO	social trail - other	114	0.58	2.2	59.7	13.5	1543.3	1.54	5063	0.96
SCI	social trail - cinder, infrequent	66	0.54	1.6	125.3	15.1	996.5	1.00	3269	0.62
SSI	social trail - spatter, infrequent	50	0.49	2.4	23.1	9.5	477.1	0.48	1565	0.30
FST	foot - single traverse	31	0.58	5.4	67.8	21.7	671.6	0.67	2203	0.42
SSF	social trail - spatter, frequent	17	0.55	5.7	42.1	15.7	266.4	0.27	874	0.17
SCF	social trail - cinder, frequent	11	0.59	3.2	204.4	37.2	409.4	0.41	1343	0.25
SLF	social trail - lava flow, frequent	11	0.58	5.8	37.9	10.8	118.8	0.12	390	0.07
VRC	veg - roots/crown	5	0.68	2.6	9.1	6.1	30.6	0.03	100	0.02
VST	vehicle - single traverse	4	0.49	15.1	90.7	44.2	176.7	0.18	580	0.11
SAI	social trail - agglutinate, infrequent	1	0.46	6.9	6.9	6.9	6.9	0.01	23	0.00
SAF	social trail - agglutinate, frequent	1	0.87	19.3	19.3	19.3	19.3	0.02	63	0.01
OTH	other - see field notes	1	0.52	26.3	26.3	26.3	26.3	0.03	86	0.02
GDE	geologic - defaced	1	0.36	6.3	6.3	6.3	6.3	0.01	21	0.00
ARE	active restoration	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
FOT	foot - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GBR	geologic - breakage	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GOT	geologic - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GIS	GIS processing	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SRN	sensitive resource notes	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VBT	veg - breakage/trampling	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VGT	veg - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VMD	vehicle - multiple traverses	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VOT	vehicle - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
Total	15	625	0.56	<null>	<null>	17.7	9956.1	9.96	32664	6.19

Impact_Plyg - Polygons

78.3250 acres

Code	Impact Type	Count	Average Horizontal Accuracy	Minimum Area Meters	Maximum Area Meters	Average Area Meters	Sum Area Meters	Sum Area Hectares	Sum Area Feet	Sum Area Acres	Percent of Total AOI Area
FTR	foot - overall trampled	134	0.73	6.2	5083.3	428.5	57415.9	5.74	618017	14.19	18.11%
FIM	foot - indeterminate route, multiple traverses	28	0.80	20.8	5604.9	1046.0	29287.9	2.93	315251	7.24	9.24%
GBR	geologic - breakage	26	0.49	8.7	120.0	50.7	1318.7	0.13	14194	0.33	0.42%
FDM	foot - distinct route, multiple traverses	18	0.68	17.7	2648.8	452.2	8139.4	0.81	87611	2.01	2.57%
TWC	trail - widening beyond core	8	0.68	3.9	45.2	15.3	122.1	0.01	1314	0.03	0.04%
OTH	other - see field notes	3	0.62	15.5	172.9	90.4	271.2	0.03	2919	0.07	0.09%
VBT	veg - breakage/trampling	2	0.90	59.3	73.3	66.3	132.6	0.01	1427	0.03	0.04%
GDE	geologic - defaced	1	0.38	12.4	12.4	12.4	12.4	0.00	134	0.00	0.00%
ARE	active restoration	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
FOT	foot - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GIS	GIS processing	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GOT	geologic - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SRN	sensitive resource notes	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VDM	vehicle - distinct route, multiple traverses	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VGT	veg - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VIM	vehicle - indeterminate route, multiple traverses	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VOT	vehicle - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VRC	veg - roots/crown	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VTR	vehicle - overall trampled	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
Total	8	220	0.66	<null>	<null>	270.2	96700.1	9.67	1040868	23.90	30.51%

MTA - Monument Trail Area

Impact_Pnts - Points

Code	Impact Type	Count
ARE	active restoration	0
GBR	geologic - breakage	0
GDE	geologic - defaced	0
GIS	GIS processing	0
GOT	geologic - other	0
GRA	graffiti	0
LIC	litter concentration	0
OTH	other - see field notes	0
SRN	sensitive resource notes	0
VBT	veg - breakage/trampling	0
VGT	veg - other	0
VRC	veg - roots/crown	0
Total	0	0

Impact_Line - Lines

Code	Impact Type	Count	Average Horizontal Accuracy	Minimum Length Meters	Maximum Length Meters	Average Length Meters	Sum Length Meters	Sum Length Km	Sum Length Feet	Sum Length Miles
FMT	foot - multiple traverses	75	0.80	3.3	107.2	20.3	1523.8	1.52	4999	0.95
SLI	social trail - lava flow, infrequent	14	0.60	5.3	37.8	18.4	257.0	0.26	843	0.16
STO	social trail - other	14	0.63	5.7	111.8	30.4	425.5	0.43	1396	0.26
SCF	social trail - cinder, frequent	5	0.85	8.2	353.7	169.1	845.3	0.85	2773	0.53
OTH	other - see field notes	3	0.66	10.7	68.8	33.1	99.2	0.10	325	0.06
FST	foot - single traverse	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SCI	social trail - cinder, infrequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SAI	social trail - agglutinate, infrequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SAF	social trail - agglutinate, frequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SSI	social trail - spatter, infrequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SSF	social trail - spatter, frequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SLF	social trail - lava flow, frequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
ARE	active restoration	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
FOT	foot - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GBR	geologic - breakage	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GDE	geologic - defaced	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GOT	geologic - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GIS	GIS processing	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SRN	sensitive resource notes	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VBT	veg - breakage/trampling	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VGT	veg - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VRC	veg - roots/crown	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VMD	vehicle - multiple traverses	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VOT	vehicle - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VST	vehicle - single traverse	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
Total	5	111	0.71	<null>	<null>	54.2	3150.8	3.15	10337	1.96

Impact_Plyg - Polygons

14.7496 acres

Code	Impact Type	Count	Average Horizontal Accuracy	Minimum Area Meters	Maximum Area Meters	Average Area Meters	Sum Area Meters	Sum Area Hectares	Sum Area Feet	Sum Area Acres	Percent of Total AOI Area
FTR	foot - overall trampled	14	0.71	23.7	3516.1	491.1	6875.5	0.69	74007	1.70	11.52%
FDM	foot - distinct route, multiple traverses	6	0.94	40.3	968.3	376.9	2261.5	0.23	24343	0.56	3.79%
FIM	foot - indeterminate route, multiple traverses	3	0.90	98.9	1583.6	772.1	2316.2	0.23	24931	0.57	3.88%
OTH	other - see field notes	3	0.59	28.0	166.3	81.4	244.3	0.02	2630	0.06	0.41%
VGT	veg - other	2	0.51	57.6	93.7	75.7	151.3	0.02	1629	0.04	0.25%
ARE	active restoration	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
FOT	foot - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GBR	geologic - breakage	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GDE	geologic - defaced	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GIS	GIS processing	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GOT	geologic - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SRN	sensitive resource notes	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
TWC	trail - widening beyond core	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VBT	veg - breakage/trampling	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VDM	vehicle - distinct route, multiple traverses	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VIM	vehicle - indeterminate route, multiple traverses	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VOT	vehicle - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VRC	veg - roots/crown	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VTR	vehicle - overall trampled	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
Total	5	28	0.73	<null>	<null>	359.4	11848.9	1.18	127540	2.93	19.85%

SSL - Sunset Scenic Loop

Impact_Pnts - Points

Code	Impact Type	Count
ARE	active restoration	0
GBR	geologic - breakage	0
GDE	geologic - defaced	0
GIS	GIS processing	0
GOT	geologic - other	0
GRA	graffiti	0
LIC	litter concentration	0
OTH	other - see field notes	0
SRN	sensitive resource notes	0
VBT	veg - breakage/trampling	0
VGT	veg - other	0
VRC	veg - roots/crown	0
Total	0	0

Impact_Line - Lines

Code	Impact Type	Count	Average Horizontal Accuracy	Minimum Length Meters	Maximum Length Meters	Average Length Meters	Sum Length Meters	Sum Length Km	Sum Length Feet	Sum Length Miles
FMT	foot - multiple traverses	73	0.70	4.4	342.6	53.3	3890.7	3.89	12765	2.42
VMD	vehicle - multiple traverses	4	1.04	94.5	211.0	132.0	528.1	0.53	1732	0.33
VST	vehicle - single traverse	2	0.60	61.6	185.5	123.5	247.1	0.25	811	0.15
SLI	social trail - lava flow, infrequent	1	0.49	29.1	29.1	29.1	29.1	0.03	95	0.02
FST	foot - single traverse	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SCI	social trail - cinder, infrequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SCF	social trail - cinder, frequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SAI	social trail - agglutinate, infrequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SAF	social trail - agglutinate, frequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SSI	social trail - spatter, infrequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SSF	social trail - spatter, frequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SLF	social trail - lava flow, frequent	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
STO	social trail - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
OTH	other - see field notes	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
ARE	active restoration	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
FOT	foot - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GBR	geologic - breakage	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GDE	geologic - defaced	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GOT	geologic - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GIS	GIS processing	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SRN	sensitive resource notes	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VBT	veg - breakage/trampling	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VGT	veg - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VRC	veg - roots/crown	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VOT	vehicle - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
Total	4	80	0.71	<null>	<null>	84.5	4694.9	4.69	15403	2.92

Impact_Plyg - Polygons

42.6020 acres

Code	Impact Type	Count	Average Horizontal Accuracy	Minimum Area Meters	Maximum Area Meters	Average Area Meters	Sum Area Meters	Sum Area Hectares	Sum Area Feet	Sum Area Acres	Percent of Total AOI Area
FIM	foot - indeterminate route, multiple traverses	7	1.02	686.1	3606.6	2233.5	15634.2	1.56	168284	3.86	9.07%
VDM	vehicle - distinct route, multiple traverses	1	0.60	595.0	595.0	595.0	595.0	0.06	6405	0.15	0.35%
ARE	active restoration	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
FDM	foot - distinct route, multiple traverses	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
FOT	foot - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
FTR	foot - overall trampled	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GBR	geologic - breakage	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GDE	geologic - defaced	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GIS	GIS processing	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
GOT	geologic - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
OTH	other - see field notes	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
SRN	sensitive resource notes	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
TWC	trail - widening beyond core	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VBT	veg - breakage/trampling	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VGT	veg - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VIM	vehicle - indeterminate route, multiple traverses	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VOT	vehicle - other	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VRC	veg - roots/crown	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
VTR	vehicle - overall trampled	0	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
Total	2	8	0.81	<null>	<null>	1414.2	16229.2	1.62	174689	4.01	9.41%

Appendix K: Tables Formatted for FLAG Natural Resources Program

Area and Relative Percentage of Primary Impact Types of the Impact Polygon Feature Class — **Sunset Crater Volcano National Monument - 2013 Recreation Impacts Basemap**

	AOI - Area of Interest												Overall Areas			
	LFT - Lava Flow Trail		GAZ - Guided Adventure Zone		LCA - Lenox Crater Area		BIA - Bonito Interpretive Area		SSL - Sunset Scenic Loop		MTA - Monument Trail Area[1]		All Areas of Interest		Sunset Crater Volcano NM	
	acres	% total	acres	% total	acres	% total	acres	% total	acres	% total	acres	% total	acres	% total	acres	% total
Total Area																
Acres	78.33	100%	306.35	100%	78.30	100%	7.23	100%	42.60	100%	14.75	100%	527.56	100%	3037.00	100%
Primary Impact Types[2]																
FDM, foot - distinct route, multiple traverses	2.01	2.57%	0.61	0.20%	0.46	0.59%	0.08	1.11%	-	-	0.56	3.80%	3.72	0.71%	3.72	0.12%
FIM, foot - indeterminate route, multiple traverses	7.24	9.24%	27.97	9.13%	9.00	11.49%	0.11	1.52%	3.86	9.06%	0.57	3.86%	48.75	9.24%	48.75	1.61%
FTR, foot - overall trampled	14.19	18.12%	10.43	3.40%	17.67	22.57%	0.71	9.82%	-	-	1.70	11.53%	44.70	8.47%	44.70	1.47%
OTH, other - see field notes[3]	0.07	0.09%	0.14	0.05%	0.44	0.56%	-	-	-	-	0.06	0.41%	0.71	0.13%	0.71	0.02%
GBR, geologic - breakage	0.33	0.42%	0.03	0.01%	-	-	0.16	2.21%	-	-	-	-	0.52	0.10%	0.52	0.02%
Total Primary Impact Types																
Sum Impact Acres	23.84	30.44%	39.18	12.79%	27.57	35.21%	1.06	14.66%	3.86	9.06%	2.89	19.59%	98.40	18.65%	98.40	3.24%

[1] Area is actual surveyed area, excludes portion of AOI not surveyed.

[2] The five impact types most commonly recorded across the study area; out of nineteen possible polygon impact types.

[3] Field notes are an attribute field of the impact polygon GIS feature class.

Length of Primary Impact Types of the Impact Line Feature Class — **Sunset Crater Volcano National Monument - 2013 Recreation Impacts Basemap**

	AOI - Area of Interest												Overall Area	
	LFT - Lava Flow Trail		GAZ - Guided Adventure Zone		LCA - Lenox Crater Area		BIA - Bonito Interpretive Area		SSL - Sunset Scenic Loop		MTA - Monument Trail Area[1]		All Areas of Interest	
	meters	miles	meters	miles	meters	miles	meters	miles	meters	miles	meters	miles	meters	miles
Primary Impact Types[2]														
FST, foot - single traverse	672	0.42	296	0.18	53	0.03	-	-	-	-	-	-	1020	0.63
FMT, foot - multiple traverses	3065	1.90	19847	12.33	4599	2.86	79	0.05	3891	2.42	1524	0.95	33004	20.51
SCI, social trail - cinder, infrequent	996	0.62	480	0.30	409	0.25	78	0.05	-	-	-	-	1964	1.22
SCF, social trail - cinder, frequent	409	0.25	-	-	189	0.12	57	0.04	-	-	845	0.53	1501	0.93
SAI, social trail - agglutinate, infrequent	7	0.004	478	0.30	-	-	-	-	-	-	-	-	485	0.30
SAF, social trail - agglutinate, frequent	19	0.01	227	0.14	-	-	-	-	-	-	-	-	246	0.15
SSI, social trail - spatter, infrequent	477	0.30	750	0.47	-	-	-	-	-	-	-	-	1227	0.76
SSF, social trail - spatter, frequent	266	0.17	23	0.01	-	-	-	-	-	-	-	-	289	0.18
SLI, social trail - lava flow, infrequent	2142	1.33	73	0.05	-	-	838	0.52	29	0.02	257	0.16	3338	2.07
SLF, social trail - lava flow, frequent	119	0.07	-	-	-	-	344	0.21	-	-	-	-	463	0.29
STO, social trail - other	1543	0.96	1384	0.86	664	0.41	133	0.08	-	-	426	0.26	4150	2.58
OTH, other - see field notes[3]	26	0.02	918	0.57	-	-	64	0.04	-	-	99	0.06	1108	0.69
Total Primary Impact Types														
Sum Impact Length	9743	6.05	24475	15.21	5914	3.67	1594	0.99	3920	2.44	3151	1.96	48795	30.32

[1] Area is actual surveyed area, excludes portion of AOI not surveyed.

[2] The twelve impact types most commonly recorded across the study area; out of twenty-five possible line impact types.

[3] Field notes are an attribute field of the impact polygon GIS feature class.

Count of Primary Impact Types of the Impact Points Feature Class — **Sunset Crater Volcano National Monument - 2013 Recreation Impacts**

	AOI - Area of Interest						Overall Area
	LFT - Lava Flow Trail	GAZ - Guided Adventure Zone	LCA - Lenox Crater Area	BIA - Bonito Interpretive Area	SSL - Sunset Scenic Loop	MTA - Monument Trail Area[1]	All Areas of Interest
Primary Impact Types[2]							
VRC, veg - roots/crown	2	-	-	2	-	-	4
VBT, veg - breakage/tramplin	-	-	-	-	-	-	-
GBR, geologic - breakage	1	-	-	-	-	-	1
GDE, geologic - defaced	-	-	-	-	-	-	-
GOT, geologic - other	1	1	-	-	-	-	2
GRA, graffiti	-	-	-	5	-	-	5
LIC, litter concentration	1	-	-	-	-	-	1
OTH - see field notes	6	6	-	-	-	-	12
Total Primary Impact Types							
Sum Impact Count	11	7	-	7	-	-	25

[1] Area is actual surveyed area, excludes portion of AOI not surveyed.

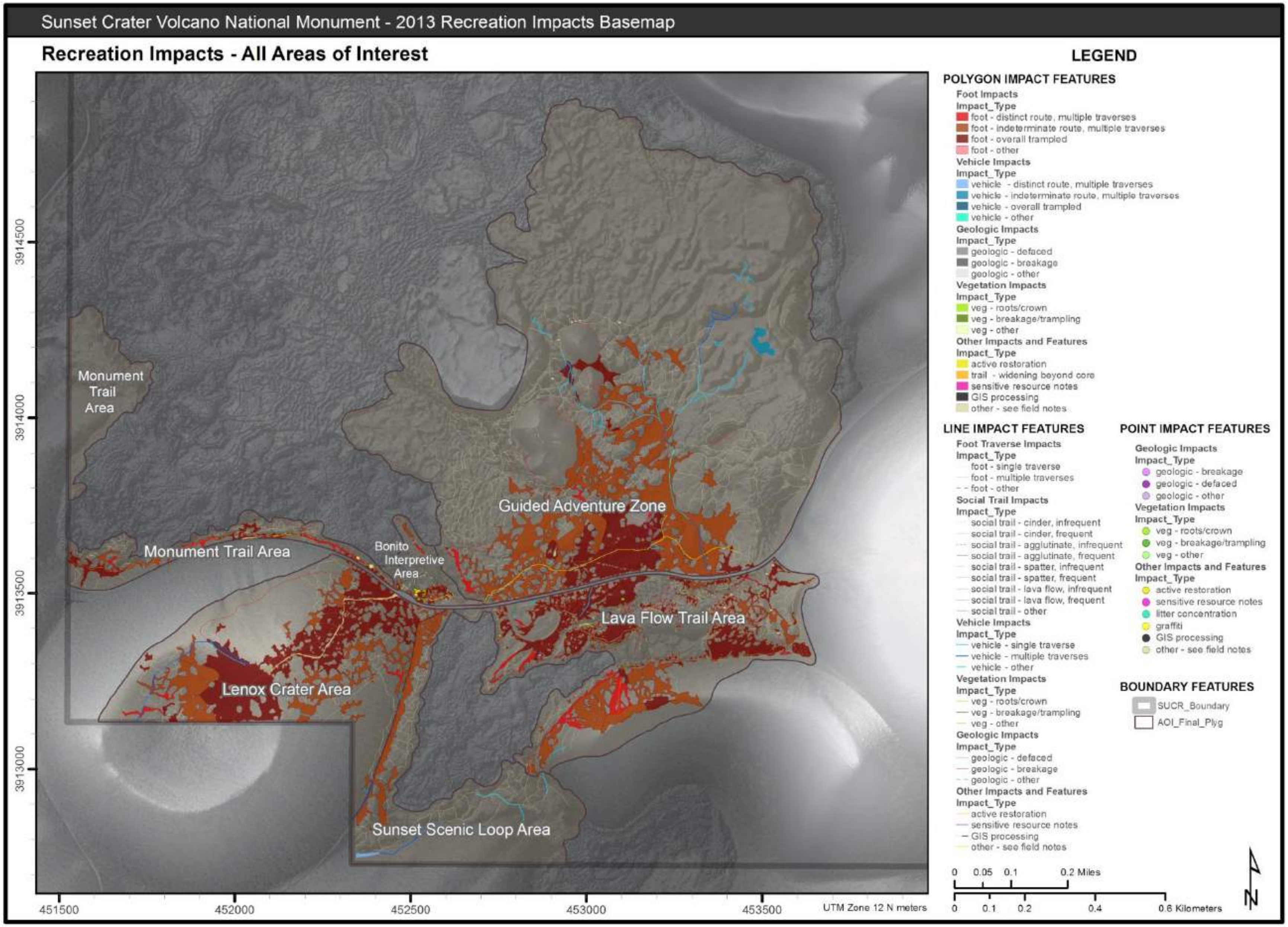
[2] The eight impact types most commonly recorded across the study area; out of twelve possible point impact types.

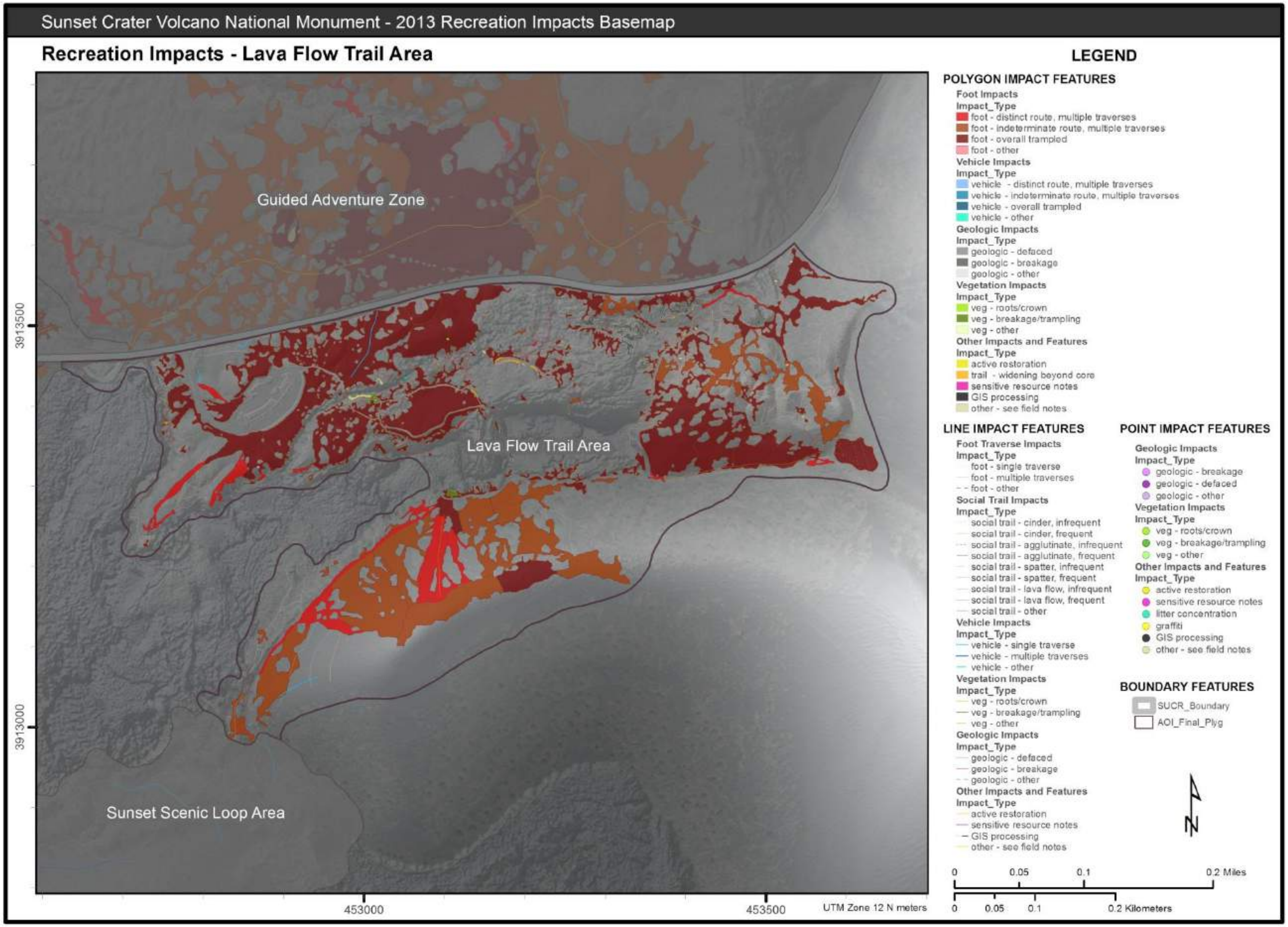
[3] Field notes are an attribute field of the impact polygon GIS feature class.

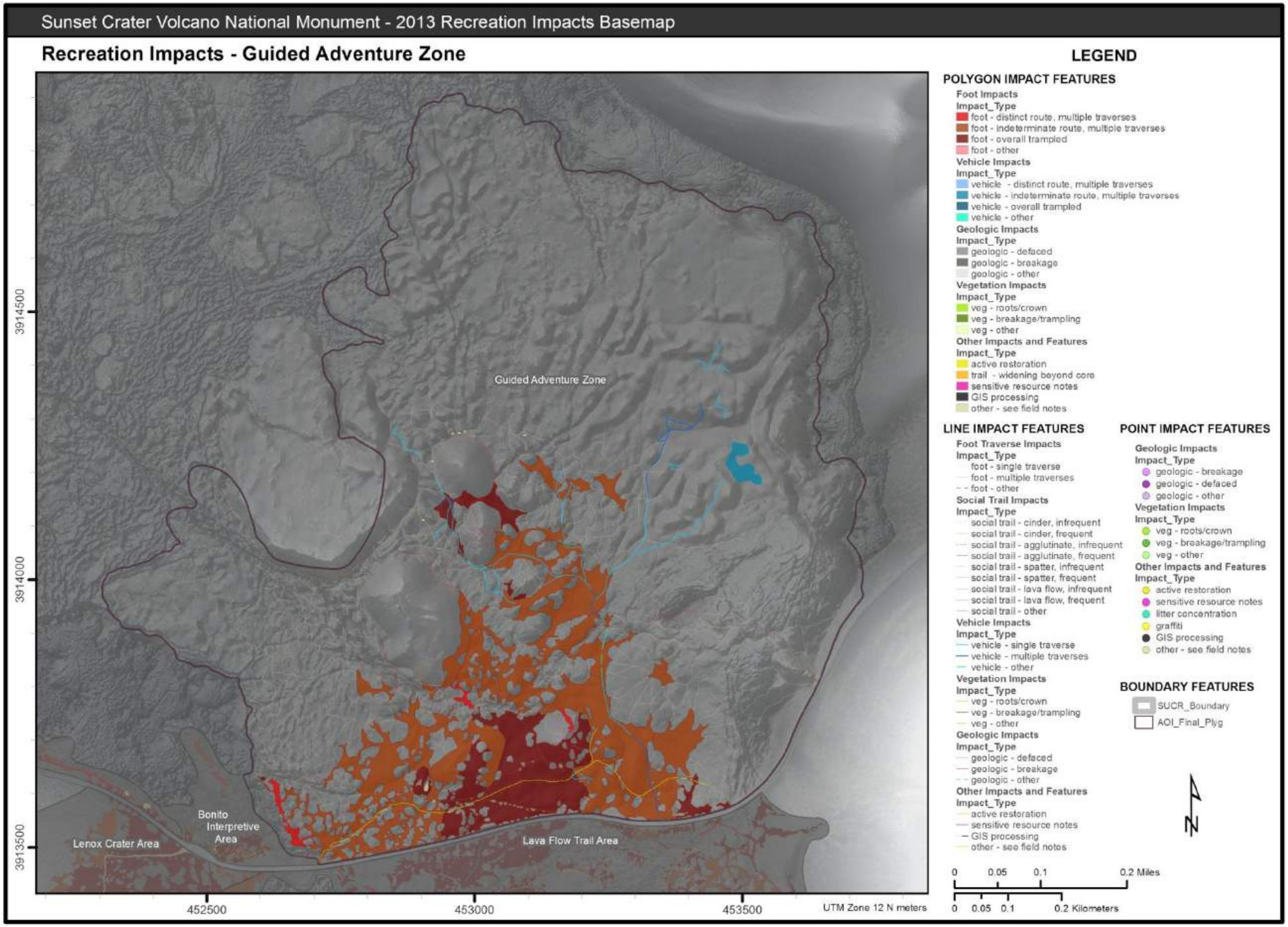
Fieldwork Summary **Sunset Crater Volcano National Monument - 2013 Recreation Impacts Basemap**

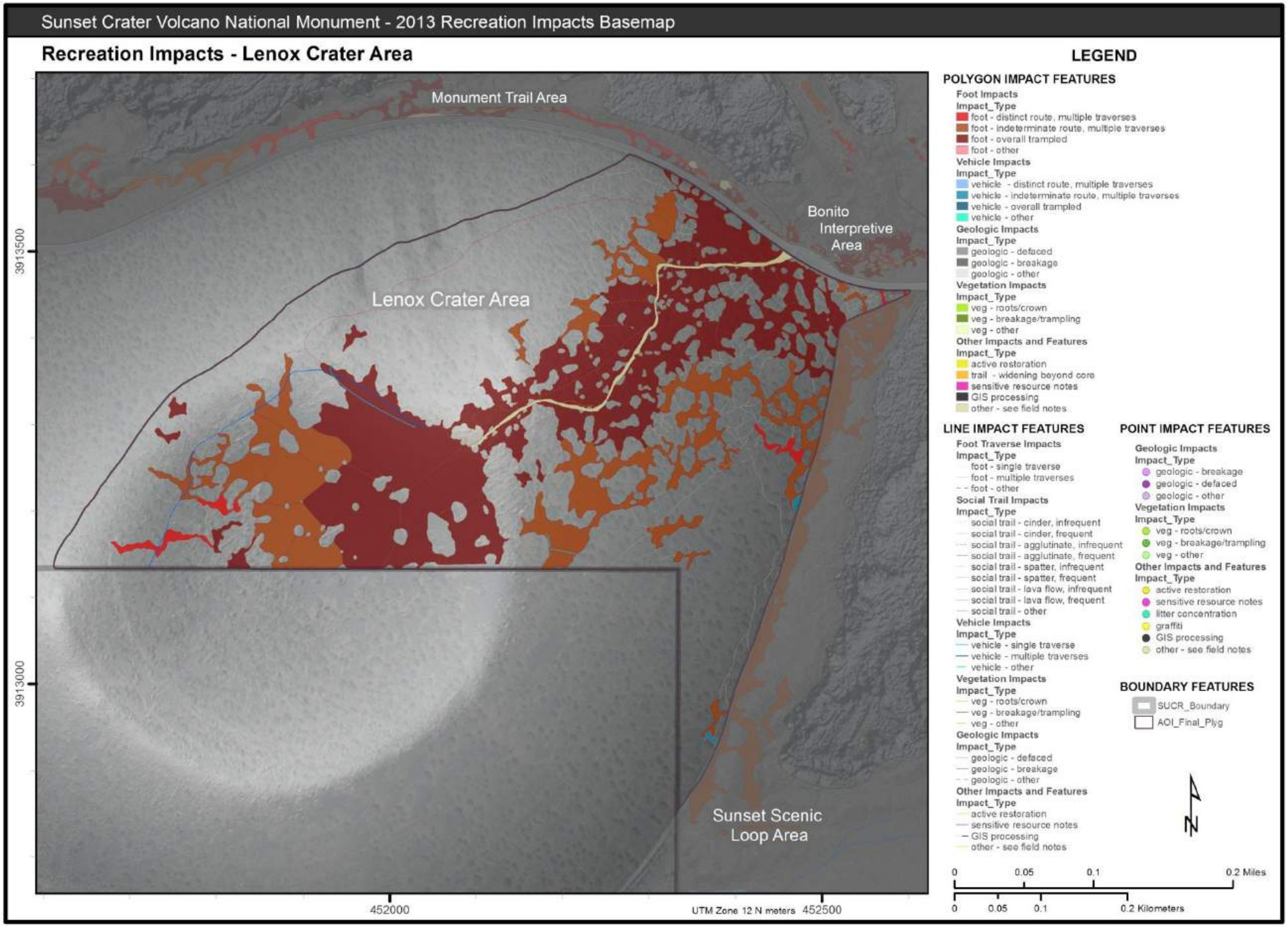
Fieldwork Component	Days	Features Collected				
		Points	Lines		Polygons	
		Count	Count	Length Meters	Count	Area Acres
Project Planning and Design						
GNSS and Geodatabase Testing	6	44	46	-	80	-
Impact and AOI Scouting	3	-	-	-	-	-
AOI Delineation	5	31	107	26388	-	-
Planning Sub-totals						
Sum of Days and Features	14	75	153	26388	80	-
Impact Feature Collection						
LFT - Lava Flow Trail Area	11	11	633	10266	329	25.88
GAZ - Guided Adventure Zone	7	7	539	27017	89	42.60
LCA - Lenox Crater Area	5	0	199	6712	87	29.18
BIA - Bonito Interpretive Area	4	7	142	1931	48	1.20
MTA - Monument Trail Area - Surveyed	2	0	111	3194	30	2.96
SSL - Sunset Scenic Loop Area	1	0	80	4631	10	4.11
Impact Feature Sub-totals						
Sum of Days and Features	30	25	1704	53751	593	105.93
Totals						
Sum of Days and Features	44	100	1857	80139	673	105.93

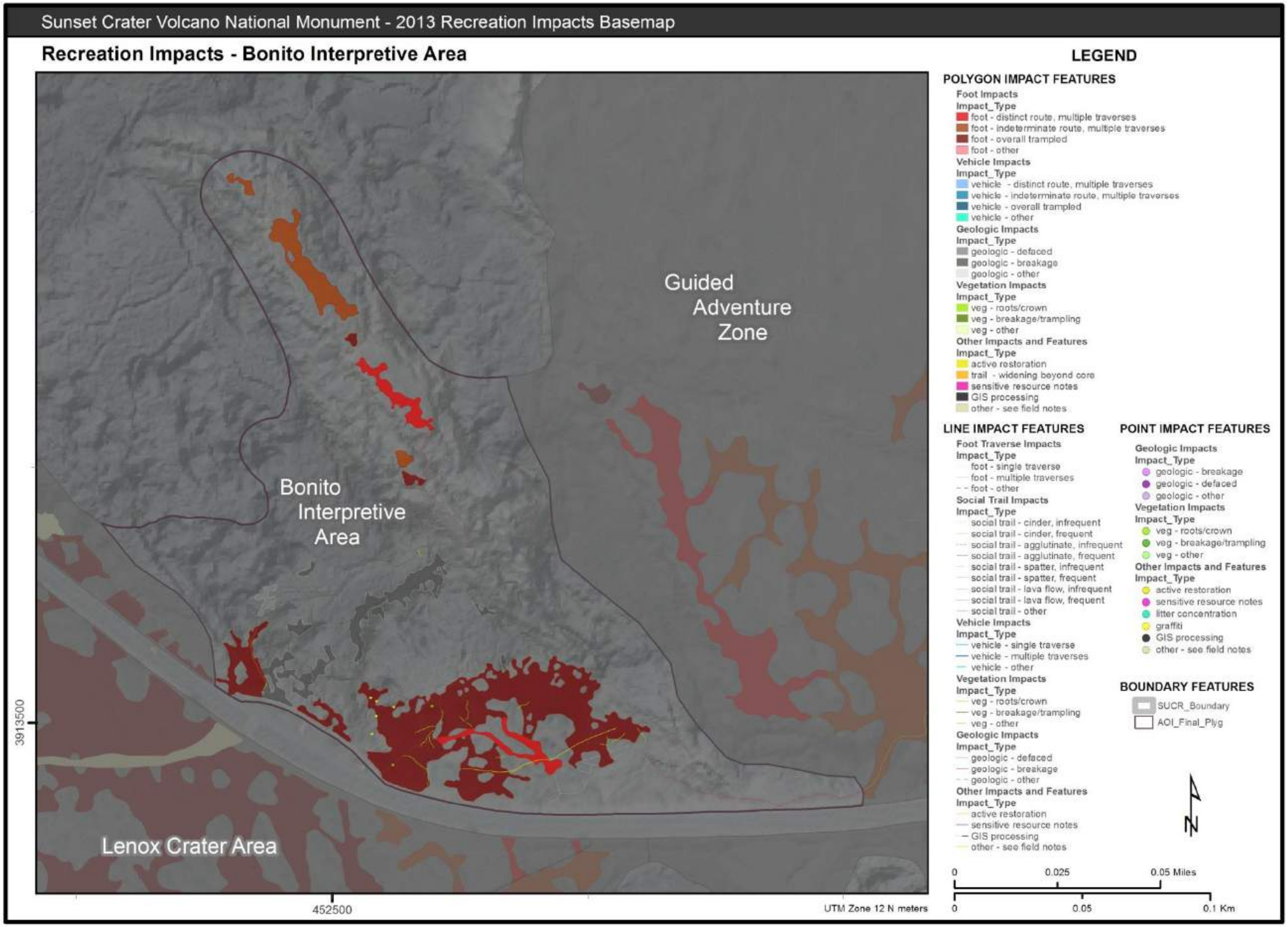
Appendix L: Recreation Impact Maps

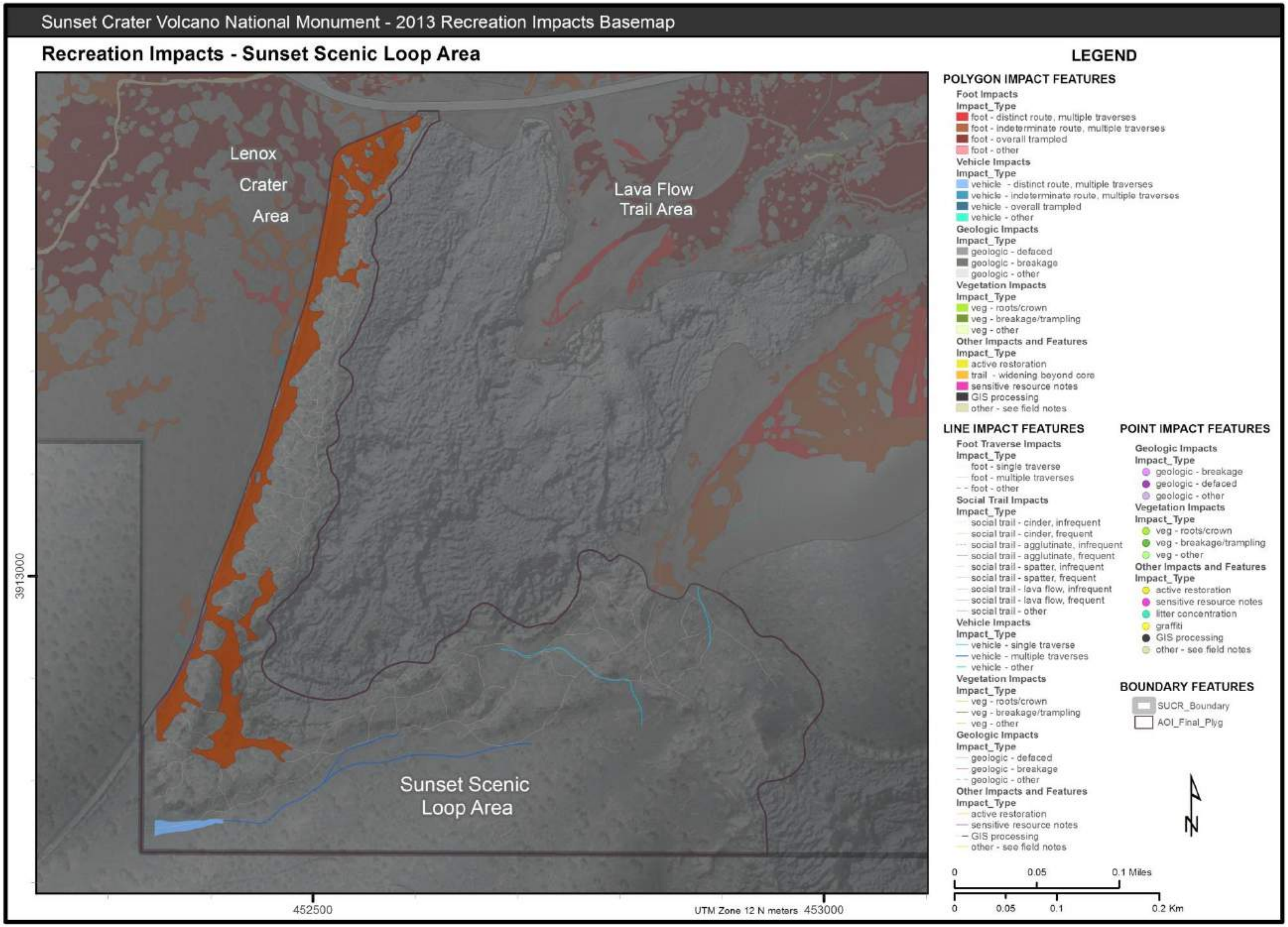

Sunset Crater Volcano National Monument - 2013 Recreation Impacts Basemap
Recreation Impacts - All Areas of Interest
Monument Trail Area
Monument Trail Area
Bonito Interpretive Area
Guided Adventure Zone
Lava Flow Trail Area
Lenox Crater Area
Sunset Scenic Loop Area
3914500
3914000
3913500
3913000
451500
452000
452500
453000
453500
UTM Zone 12 N meters
LEGEND
POLYGON IMPACT FEATURES
Foot Impacts
Impact_Type
foot - distinct route, multiple traverses
foot - indeterminate route, multiple traverses
foot - overall trampled
foot - other
Vehicle Impacts
Impact_Type
vehicle - distinct route, multiple traverses
vehicle - indeterminate route, multiple traverses
vehicle - overall trampled
vehicle - other
Geologic Impacts
Impact_Type
geologic - defaced
geologic - breakage
geologic - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Other Impacts and Features
Impact_Type
active restoration
trail - widening beyond core
sensitive resource notes
GIS processing
other - see field notes
LINE IMPACT FEATURES
Foot Traverse Impacts
Impact_Type
foot - single traverse
foot - multiple traverses
foot - other
Social Trail Impacts
Impact_Type
social trail - cinder, infrequent
social trail - cinder, frequent
social trail - agglutinate, infrequent
social trail - agglutinate, frequent
social trail - spatter, infrequent
social trail - spatter, frequent
social trail - lava flow, infrequent
social trail - lava flow, frequent
social trail - other
Vehicle Impacts
Impact_Type
vehicle - single traverse
vehicle - multiple traverses
vehicle - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Geologic Impacts
Impact_Type
geologic - defaced
geologic - breakage
geologic - other
Other Impacts and Features
Impact_Type
active restoration
sensitive resource notes
GIS processing
other - see field notes
POINT IMPACT FEATURES
Geologic Impacts
Impact_Type
geologic - breakage
geologic - defaced
geologic - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Other Impacts and Features
Impact_Type
active restoration
sensitive resource notes
litter concentration
graffiti
GIS processing
other - see field notes
BOUNDARY FEATURES
SUCR_Boundary
AOI_Final_Plyg
0 0.05 0.1 0.2 Miles
0 0.1 0.2 0.4 0.6 Kilometers
N

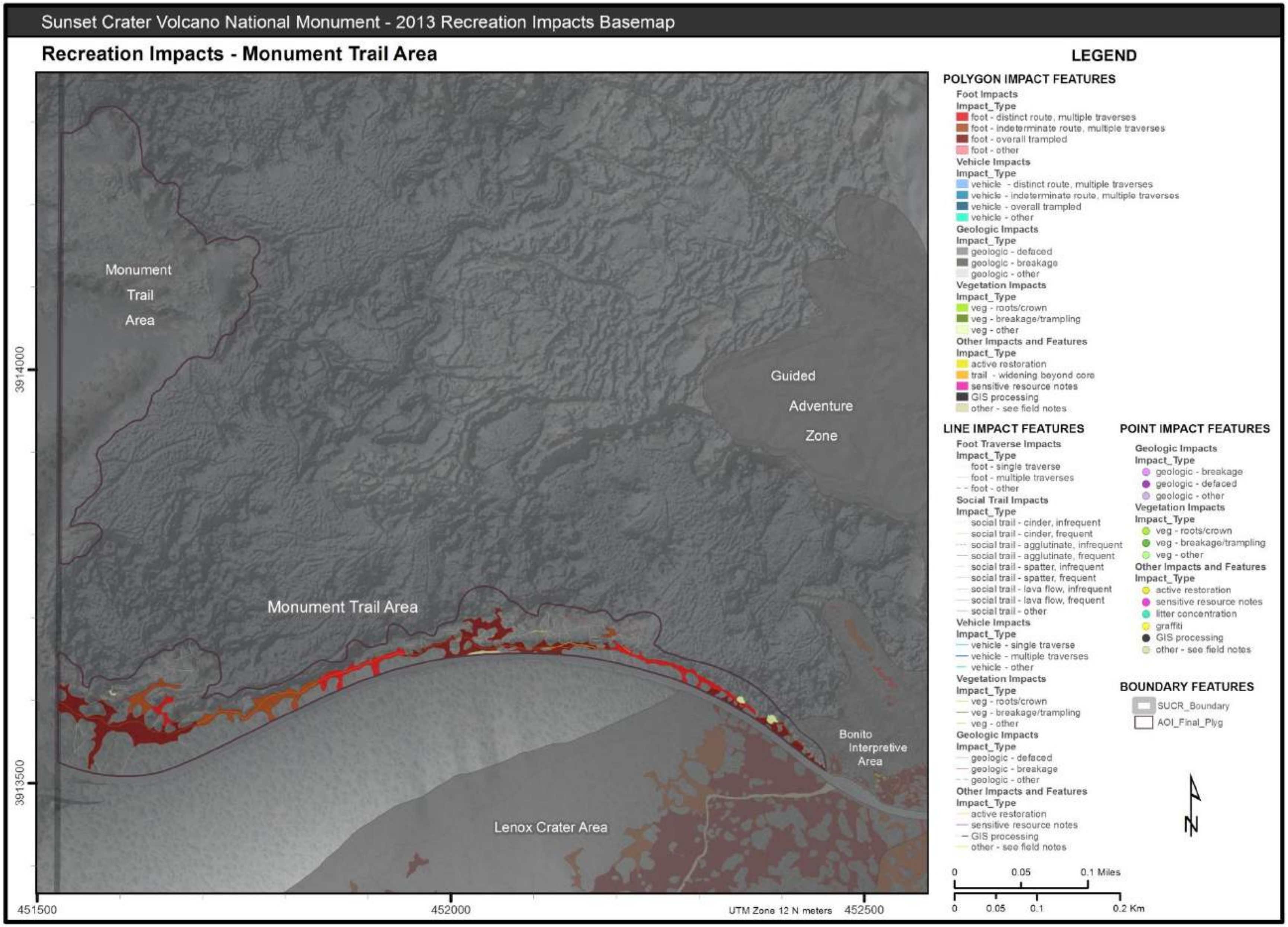

Sunset Crater Volcano National Monument - 2013 Recreation Impacts Basemap
Recreation Impacts - Lava Flow Trail Area
Guided Adventure Zone
Lava Flow Trail Area
Sunset Scenic Loop Area
3913500
3913000
453000
453500
UTM Zone 12 N meters
LEGEND
POLYGON IMPACT FEATURES
Foot Impacts
Impact_Type
foot - distinct route, multiple traverses
foot - indeterminate route, multiple traverses
foot - overall trampled
foot - other
Vehicle Impacts
Impact_Type
vehicle - distinct route, multiple traverses
vehicle - indeterminate route, multiple traverses
vehicle - overall trampled
vehicle - other
Geologic Impacts
Impact_Type
geologic - defaced
geologic - breakage
geologic - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Other Impacts and Features
Impact_Type
active restoration
trail - widening beyond core
sensitive resource notes
GIS processing
other - see field notes
LINE IMPACT FEATURES
Foot Traverse Impacts
Impact_Type
foot - single traverse
foot - multiple traverses
foot - other
Social Trail Impacts
Impact_Type
social trail - cinder, infrequent
social trail - cinder, frequent
social trail - agglutinate, infrequent
social trail - agglutinate, frequent
social trail - spatter, infrequent
social trail - spatter, frequent
social trail - lava flow, infrequent
social trail - lava flow, frequent
social trail - other
Vehicle Impacts
Impact_Type
vehicle - single traverse
vehicle - multiple traverses
vehicle - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Geologic Impacts
Impact_Type
geologic - defaced
geologic - breakage
geologic - other
Other Impacts and Features
Impact_Type
active restoration
sensitive resource notes
GIS processing
other - see field notes
POINT IMPACT FEATURES
Geologic Impacts
Impact_Type
geologic - breakage
geologic - defaced
geologic - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Other Impacts and Features
Impact_Type
active restoration
sensitive resource notes
litter concentration
graffiti
GIS processing
other - see field notes
BOUNDARY FEATURES
SUCR_Boundary
AOI_Final_Plyg
N
0
0.05
0.1
0.2 Miles
0
0.05
0.1
0.2 Kilometers


Sunset Crater Volcano National Monument - 2013 Recreation Impacts Basemap
Recreation Impacts - Guided Adventure Zone
Guided Adventure Zone
Bonito
Interpretive
Area
Lenox Crater Area
Lava Flow Trail Area
3914500
3914000
3913500
452500
453000
453500
UTM Zone 12 N meters
LEGEND
POLYGON IMPACT FEATURES
Foot Impacts
Impact_Type
foot - distinct route, multiple traverses
foot - indeterminate route, multiple traverses
foot - overall trampled
foot - other
Vehicle Impacts
Impact_Type
vehicle - distinct route, multiple traverses
vehicle - indeterminate route, multiple traverses
vehicle - overall trampled
vehicle - other
Geologic Impacts
Impact_Type
geologic - defaced
geologic - breakage
geologic - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Other Impacts and Features
Impact_Type
active restoration
trail - widening beyond core
sensitive resource notes
GIS processing
other - see field notes
LINE IMPACT FEATURES
Foot Traverse Impacts
Impact_Type
foot - single traverse
foot - multiple traverses
foot - other
Social Trail Impacts
Impact_Type
social trail - cinder, infrequent
social trail - cinder, frequent
social trail - agglutinate, infrequent
social trail - agglutinate, frequent
social trail - spatter, infrequent
social trail - spatter, frequent
social trail - lava flow, infrequent
social trail - lava flow, frequent
social trail - other
Vehicle Impacts
Impact_Type
vehicle - single traverse
vehicle - multiple traverses
vehicle - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Geologic Impacts
Impact_Type
geologic - defaced
geologic - breakage
geologic - other
Other Impacts and Features
Impact_Type
active restoration
sensitive resource notes
GIS processing
other - see field notes
POINT IMPACT FEATURES
Geologic Impacts
Impact_Type
geologic - breakage
geologic - defaced
geologic - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Other Impacts and Features
Impact_Type
active restoration
sensitive resource notes
litter concentration
graffiti
GIS processing
other - see field notes
BOUNDARY FEATURES
SUCR_Boundary
AOI_Final_Plyg
N
0 0.05 0.1 0.2 Miles
0 0.05 0.1 0.2 Kilometers

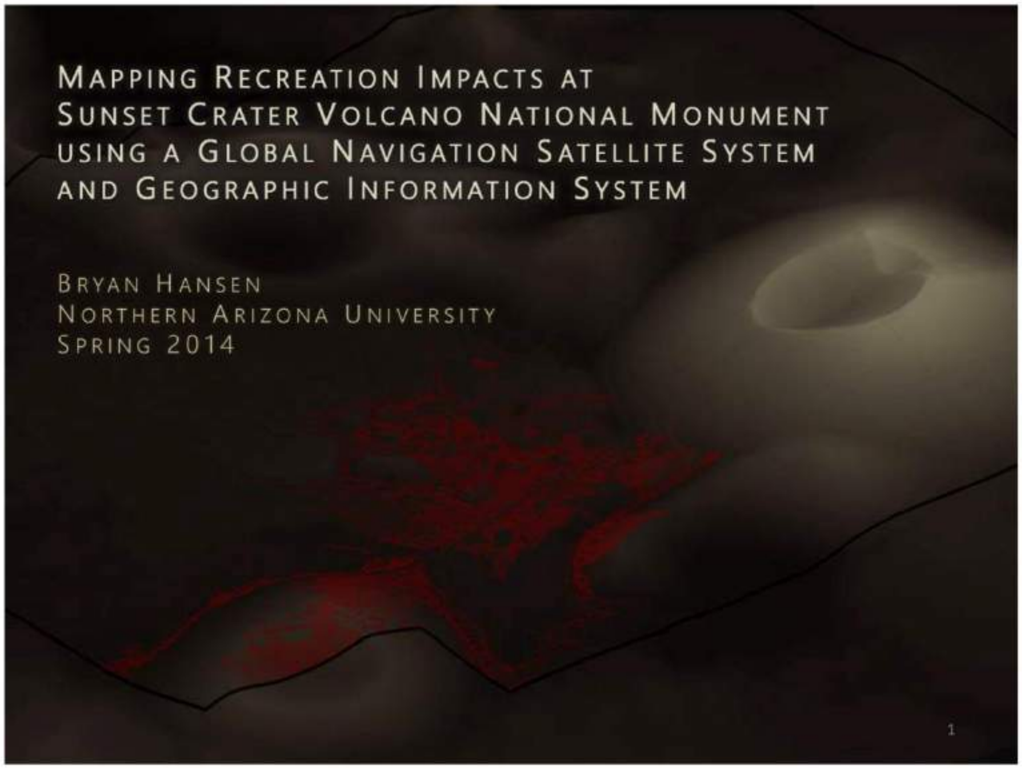

Sunset Crater Volcano National Monument - 2013 Recreation Impacts Basemap
Recreation Impacts - Lenox Crater Area
Monument Trail Area
Bonito Interpretive Area
Lenox Crater Area
Sunset Scenic Loop Area
3913500
3913000
452000
UTM Zone 12 N meters 452500
LEGEND
POLYGON IMPACT FEATURES
Foot Impacts
Impact_Type
foot - distinct route, multiple traverses
foot - indeterminate route, multiple traverses
foot - overall trampled
foot - other
Vehicle Impacts
Impact_Type
vehicle - distinct route, multiple traverses
vehicle - indeterminate route, multiple traverses
vehicle - overall trampled
vehicle - other
Geologic Impacts
Impact_Type
geologic - defaced
geologic - breakage
geologic - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Other Impacts and Features
Impact_Type
active restoration
trail - widening beyond core
sensitive resource notes
GIS processing
other - see field notes
LINE IMPACT FEATURES
Foot Traverse Impacts
Impact_Type
foot - single traverse
foot - multiple traverses
foot - other
Social Trail Impacts
Impact_Type
social trail - cinder, infrequent
social trail - cinder, frequent
social trail - agglutinate, infrequent
social trail - agglutinate, frequent
social trail - spatter, infrequent
social trail - spatter, frequent
social trail - lava flow, infrequent
social trail - lava flow, frequent
social trail - other
Vehicle Impacts
Impact_Type
vehicle - single traverse
vehicle - multiple traverses
vehicle - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Geologic Impacts
Impact_Type
geologic - defaced
geologic - breakage
geologic - other
Other Impacts and Features
Impact_Type
active restoration
sensitive resource notes
GIS processing
other - see field notes
POINT IMPACT FEATURES
Geologic Impacts
Impact_Type
geologic - breakage
geologic - defaced
geologic - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Other Impacts and Features
Impact_Type
active restoration
sensitive resource notes
litter concentration
graffiti
GIS processing
other - see field notes
BOUNDARY FEATURES
SUCR_Boundary
AOI_Final_Plyg
N
0 0.05 0.1 0.2 Miles
0 0.05 0.1 0.2 Kilometers


Sunset Crater Volcano National Monument - 2013 Recreation Impacts Basemap
Recreation Impacts - Bonito Interpretive Area
Guided Adventure Zone
Bonito Interpretive Area
Lenox Crater Area
3913500
452500
UTM Zone 12 N meters
LEGEND
POLYGON IMPACT FEATURES
Foot Impacts
Impact_Type
foot - distinct route, multiple traverses
foot - indeterminate route, multiple traverses
foot - overall trampled
foot - other
Vehicle Impacts
Impact_Type
vehicle - distinct route, multiple traverses
vehicle - indeterminate route, multiple traverses
vehicle - overall trampled
vehicle - other
Geologic Impacts
Impact_Type
geologic - defaced
geologic - breakage
geologic - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Other Impacts and Features
Impact_Type
active restoration
trail - widening beyond core
sensitive resource notes
GIS processing
other - see field notes
LINE IMPACT FEATURES
Foot Traverse Impacts
Impact_Type
foot - single traverse
foot - multiple traverses
foot - other
Social Trail Impacts
Impact_Type
social trail - cinder, infrequent
social trail - cinder, frequent
social trail - agglutinate, infrequent
social trail - agglutinate, frequent
social trail - spatter, infrequent
social trail - spatter, frequent
social trail - lava flow, infrequent
social trail - lava flow, frequent
social trail - other
Vehicle Impacts
Impact_Type
vehicle - single traverse
vehicle - multiple traverses
vehicle - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Geologic Impacts
Impact_Type
geologic - defaced
geologic - breakage
geologic - other
Other Impacts and Features
Impact_Type
active restoration
sensitive resource notes
GIS processing
other - see field notes
POINT IMPACT FEATURES
Geologic Impacts
Impact_Type
geologic - breakage
geologic - defaced
geologic - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Other Impacts and Features
Impact_Type
active restoration
sensitive resource notes
litter concentration
graffiti
GIS processing
other - see field notes
BOUNDARY FEATURES
SUCR_Boundary
AOI_Final_Plyg
N
0
0.025
0.05 Miles
0
0.05
0.1 Km


Sunset Crater Volcano National Monument - 2013 Recreation Impacts Basemap
Recreation Impacts - Sunset Scenic Loop Area
Lenox Crater Area
Lava Flow Trail Area
Sunset Scenic Loop Area
LEGEND
POLYGON IMPACT FEATURES
Foot Impacts
Impact_Type
foot - distinct route, multiple traverses
foot - indeterminate route, multiple traverses
foot - overall trampled
foot - other
Vehicle Impacts
Impact_Type
vehicle - distinct route, multiple traverses
vehicle - indeterminate route, multiple traverses
vehicle - overall trampled
vehicle - other
Geologic Impacts
Impact_Type
geologic - defaced
geologic - breakage
geologic - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Other Impacts and Features
Impact_Type
active restoration
trail - widening beyond core
sensitive resource notes
GIS processing
other - see field notes
LINE IMPACT FEATURES
Foot Traverse Impacts
Impact_Type
foot - single traverse
foot - multiple traverses
foot - other
Social Trail Impacts
Impact_Type
social trail - cinder, infrequent
social trail - cinder, frequent
social trail - agglutinate, infrequent
social trail - agglutinate, frequent
social trail - spatter, infrequent
social trail - spatter, frequent
social trail - lava flow, infrequent
social trail - lava flow, frequent
social trail - other
Vehicle Impacts
Impact_Type
vehicle - single traverse
vehicle - multiple traverses
vehicle - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Geologic Impacts
Impact_Type
geologic - defaced
geologic - breakage
geologic - other
Other Impacts and Features
Impact_Type
active restoration
sensitive resource notes
GIS processing
other - see field notes
POINT IMPACT FEATURES
Geologic Impacts
Impact_Type
geologic - breakage
geologic - defaced
geologic - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Other Impacts and Features
Impact_Type
active restoration
sensitive resource notes
litter concentration
graffiti
GIS processing
other - see field notes
BOUNDARY FEATURES
SUCR_Boundary
AOI_Final_Plyg
N
0 0.05 0.1 Miles
0 0.05 0.1 0.2 Km
3913000
452500
UTM Zone 12 N meters 453000

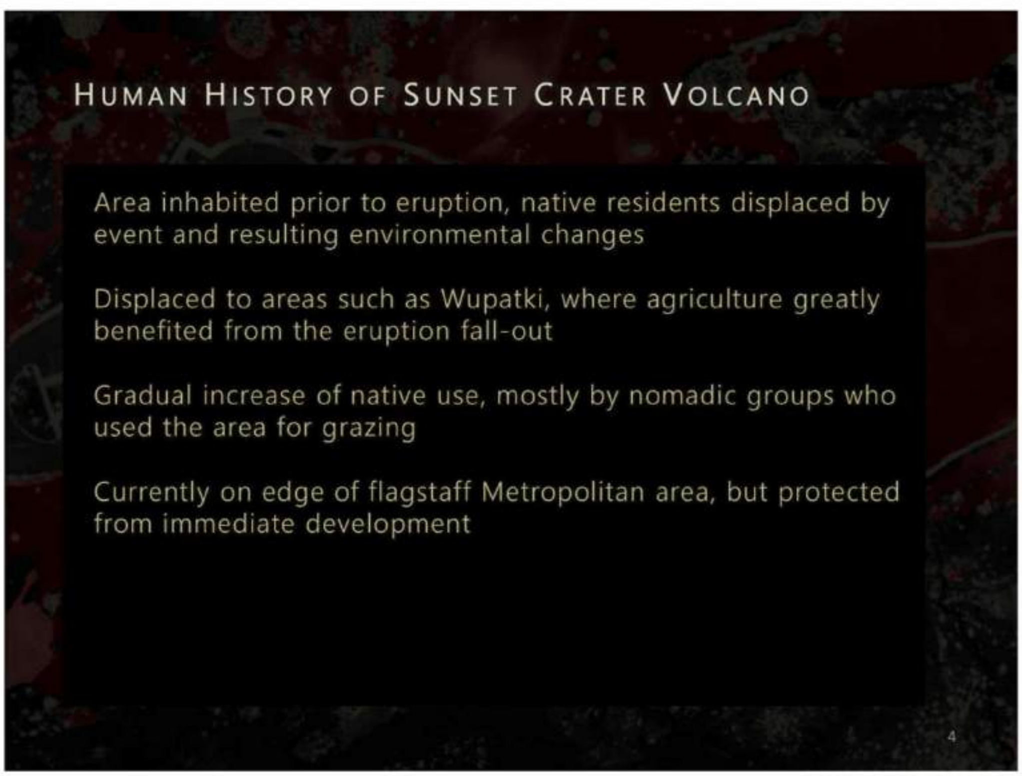

Sunset Crater Volcano National Monument - 2013 Recreation Impacts Basemap
Recreation Impacts - Monument Trail Area
Monument Trail Area
Monument Trail Area
Guided Adventure Zone
Bonito Interpretive Area
Lenox Crater Area
3914000
3913500
451500
452000
452500
UTM Zone 12 N meters
LEGEND
POLYGON IMPACT FEATURES
Foot Impacts
Impact_Type
foot - distinct route, multiple traverses
foot - indeterminate route, multiple traverses
foot - overall trampled
foot - other
Vehicle Impacts
Impact_Type
vehicle - distinct route, multiple traverses
vehicle - indeterminate route, multiple traverses
vehicle - overall trampled
vehicle - other
Geologic Impacts
Impact_Type
geologic - defaced
geologic - breakage
geologic - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Other Impacts and Features
Impact_Type
active restoration
trail - widening beyond core
sensitive resource notes
GIS processing
other - see field notes
LINE IMPACT FEATURES
Foot Traverse Impacts
Impact_Type
foot - single traverse
foot - multiple traverses
foot - other
Social Trail Impacts
Impact_Type
social trail - cinder, infrequent
social trail - cinder, frequent
social trail - agglutinate, infrequent
social trail - agglutinate, frequent
social trail - spatter, infrequent
social trail - spatter, frequent
social trail - lava flow, infrequent
social trail - lava flow, frequent
social trail - other
Vehicle Impacts
Impact_Type
vehicle - single traverse
vehicle - multiple traverses
vehicle - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Geologic Impacts
Impact_Type
geologic - defaced
geologic - breakage
geologic - other
Other Impacts and Features
Impact_Type
active restoration
sensitive resource notes
GIS processing
other - see field notes
POINT IMPACT FEATURES
Geologic Impacts
Impact_Type
geologic - breakage
geologic - defaced
geologic - other
Vegetation Impacts
Impact_Type
veg - roots/crown
veg - breakage/trampling
veg - other
Other Impacts and Features
Impact_Type
active restoration
sensitive resource notes
litter concentration
graffiti
GIS processing
other - see field notes
BOUNDARY FEATURES
SUCR_Boundary
AOI_Final_Plyg
N
0 0.05 0.1 Miles
0 0.05 0.1 0.2 Km

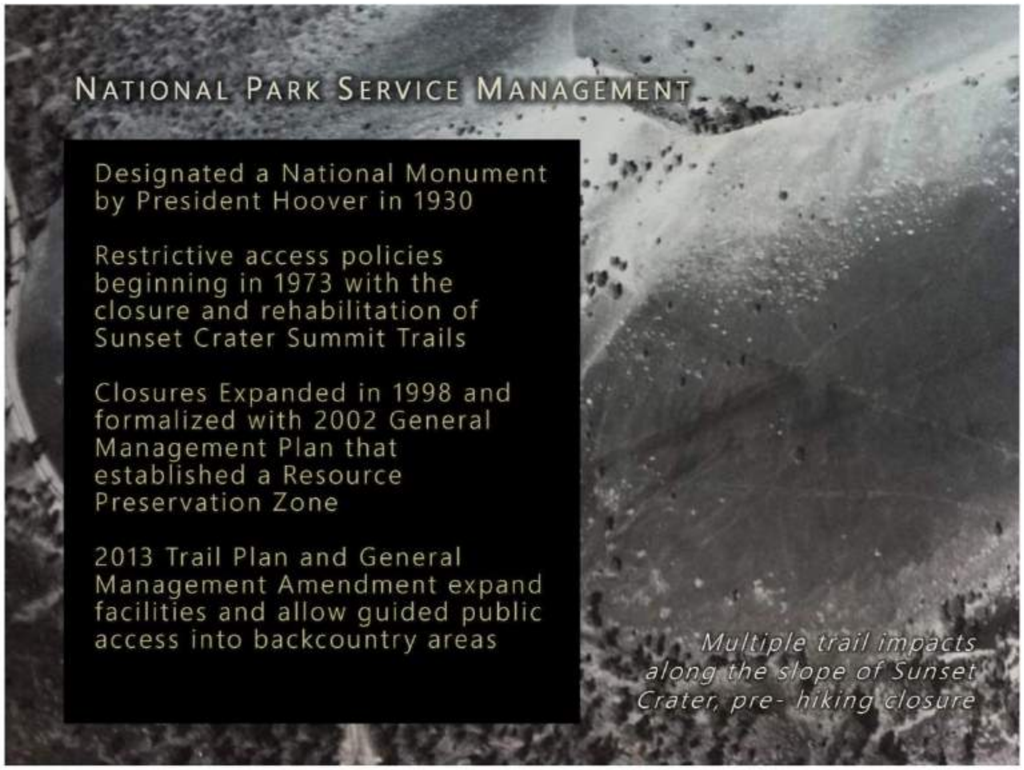
Appendix M: Recreation Impacts Project PowerPoint Presentation

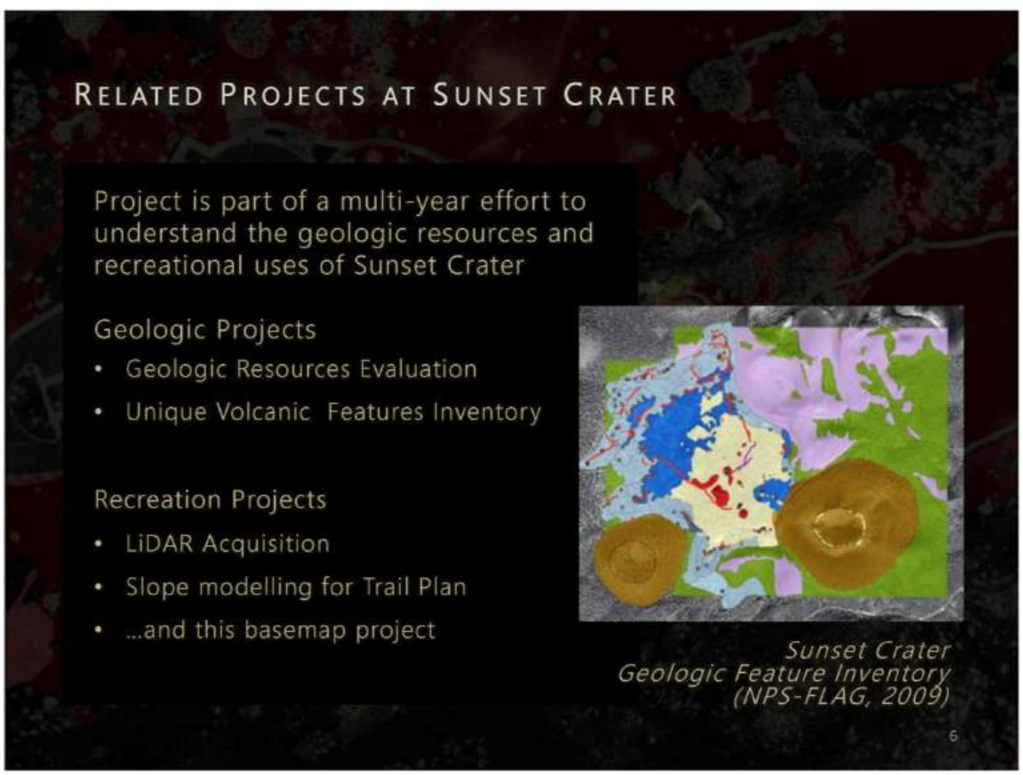

MAPPING RECREATION IMPACTS AT
SUNSET CRATER VOLCANO NATIONAL MONUMENT
USING A GLOBAL NAVIGATION SATELLITE SYSTEM
AND GEOGRAPHIC INFORMATION SYSTEM
BRYAN HANSEN
NORTHERN ARIZONA UNIVERSITY
SPRING 2014
1


INTRODUCTION
Spatter mound with extensive impacts from foot travel
2


NATURAL HISTORY OF SUNSET CRATER VOLCANO
Young eruption event, Occurred within 50 years of AD 1100 and may have lasted for months or decades
Formed several unique volcanic features, including:
• Squeeze-ups
• Rafted Agglutinate Mounds
• Spatter Features
• Xenoliths
Post-eruption landscape is still undergoing primary ecological succession
Xenolith in Phase III Flow:
Background: Mid-section of the "Mother of All Squeeze-ups"
3


HUMAN HISTORY OF SUNSET CRATER VOLCANO
Area inhabited prior to eruption, native residents displaced by event and resulting environmental changes
Displaced to areas such as Wupatki, where agriculture greatly benefited from the eruption fall-out
Gradual increase of native use, mostly by nomadic groups who used the area for grazing
Currently on edge of flagstaff Metropolitan area, but protected from immediate development
4


NATIONAL PARK SERVICE MANAGEMENT
Designated a National Monument by President Hoover in 1930
Restrictive access policies beginning in 1973 with the closure and rehabilitation of Sunset Crater Summit Trails
Closures Expanded in 1998 and formalized with 2002 General Management Plan that established a Resource Preservation Zone
2013 Trail Plan and General Management Amendment expand facilities and allow guided public access into backcountry areas
Multiple trail impacts along the slope of Sunset Crater, pre- hiking closure


RELATED PROJECTS AT SUNSET CRATER
Project is part of a multi-year effort to understand the geologic resources and recreational uses of Sunset Crater
Geologic Projects
• Geologic Resources Evaluation
• Unique Volcanic Features Inventory
Recreation Projects
• LiDAR Acquisition
• Slope modelling for Trail Plan
• ...and this basemap project
Sunset Crater Geologic Feature Inventory (NPS-FLAG, 2009)
6

Mapping Recreation Impacts – Where to Start?

Overall trampled cinder near the Lava Flow Trailhead

7

What methods are available?

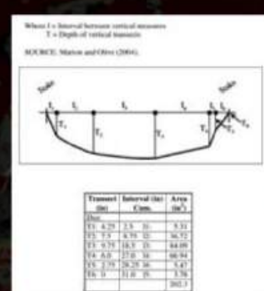
Recreation impact studies fit into the broader field of Recreation Ecology

Methods are typically very quantitative

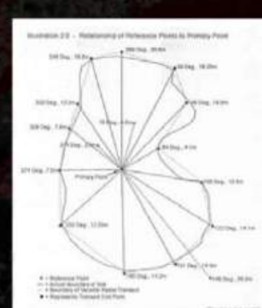
- Cross-section metrics
- Variable radial transects
- Quadrats

These methods work very well to record a known site for monitoring

Methods are not rapid and involve disjoint steps to represent true spatial information in a modern GIS



Cross-section method



Variable radial transect method

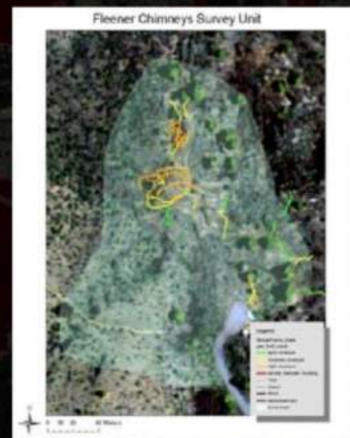
8

How has the National Park Service mapped Recreation Impacts in other Areas?

Numerous examples exist:

- Multiple projects in Yosemite National Park
- C&O Canal National Historic Park
- Great Falls Park
- Mt. Rainer National Park
- Lava Beds National Monument

Many of these studies focus on the condition of existing trails, or the recording of social trails as line features



Social trail survey at Lava Beds National Monument (Veal, 2011)

9

What Methods and Standards Should This Project Follow?

Conducted field scouting at Sunset Crater to understand the type of impacts present and the extent of impacts

Based on information from scouting and the literature:

- Impacts at Sunset Crater are widespread and variable
- Few studies or methods directly relate to these impact types
- Do not have the resources to perform individual impact metrics
- A complete basemap is desirable for management

Decided to create a method that met the time and personnel restrictions, best leveraged GIS Program capabilities, and best captured the recreation impact types unique to the Sunset Crater area

10

Implementing the Method

Social trails on Lenox Crater

11

Data Management and Spatial Data Types

Used a GIS Project Folder – A directory template to organize project data and documentation

Spatial data types compatible with ArcGIS platform and extensions

- ESRI File Geodatabase
- Feature datasets and feature classes
- Additional geodatabase functionalities
- LAS datasets, rasters, scripts
- Cartographic output

Be consistent and redundant!

GIS project folder template

12

GNSS Integration

Used a robust commercial Global Navigation Satellite System (GNSS)

System used was by Trimble Navigation

- Compatible hardware and software
- Excellent field performance
- Efficient workflows
- High quality processing
- Meets metadata needs and requirements

GeoXT and 'a'a lava

13

Applicable Guidelines and Standards

Several published documents exist:

- Field Data Collection with GPS (NPS)
- Interagency Data Delivery Standards and Specifications Template (USGS)
- GIS Data Layer Standards (NPS)
- I&M Program Data Management Plan (NPS)
- The current FGDC compliant NPS metadata standard
- ArcGIS and Trimble procedures and best practices

All have useful parts and parts that are outdated. This is expected with a constantly evolving technology

14

Mapping Recreation Impacts

Impacts on cinder mounds from multiple foot traverses

15

Preparing for Field Collection

Made daily objective based on current needs and expected productivity

Prepare the GNSS equipment by performing a data check-out

Get geared up:

- Equipment to accomplish tasks
- Equipment to work comfortably
- Equipment to work safely

Check expected field conditions daily

16

Identifying Impact Features

Impact features vary greatly based on:

- The recreation activity type
- When did the activity occur
- The substrate and ground cover
- Any restoration factors

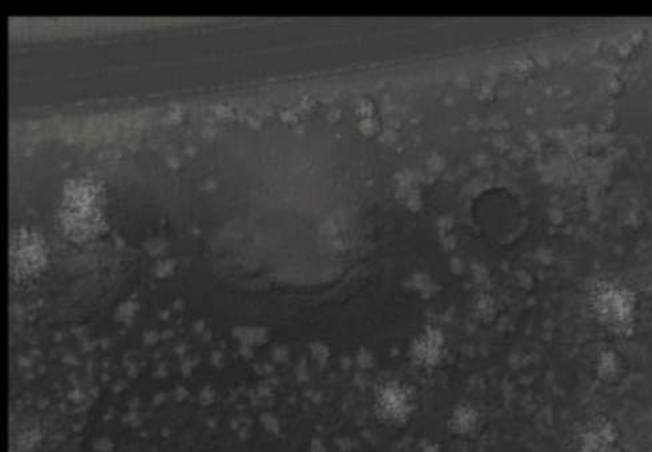
This method did not limit impacts by age, severity, or cause. If there was any evidence at all that an impact was caused by human recreation, it was recorded

Impact feature attributes

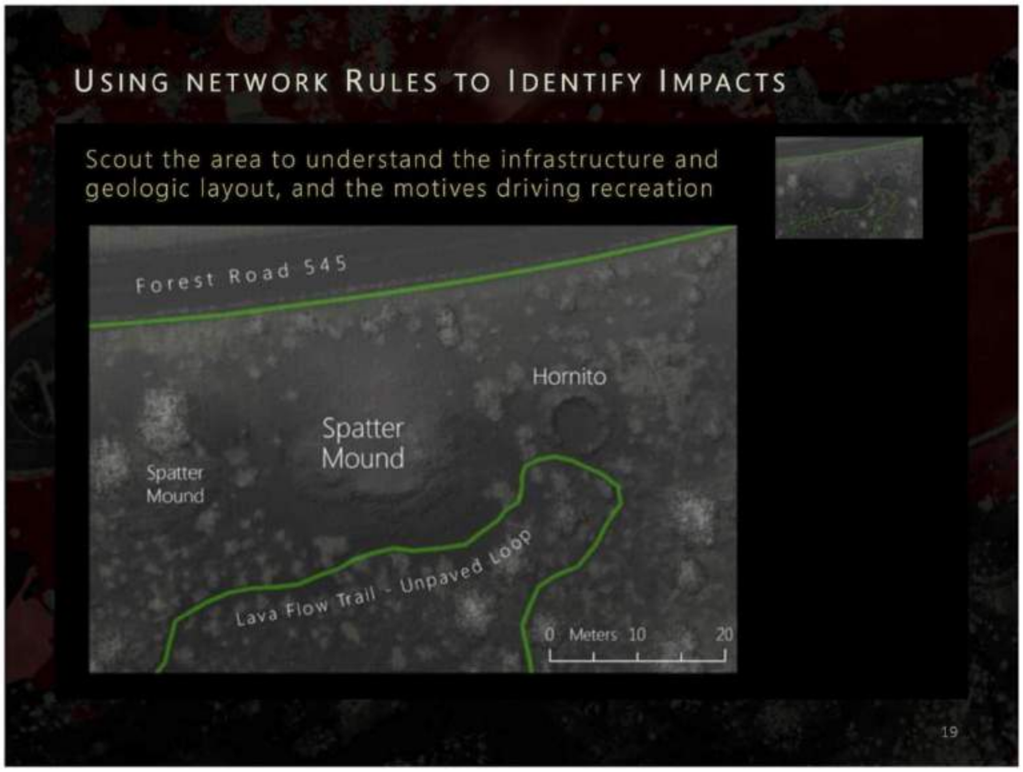
17

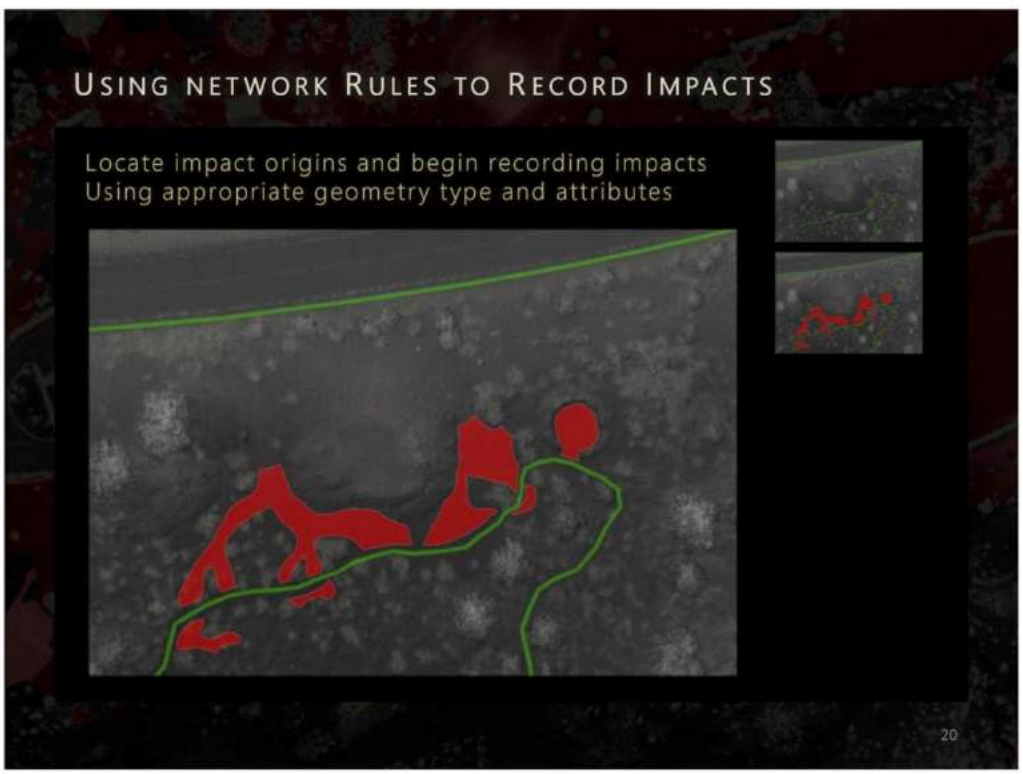
Using network Rules to Identify Impacts

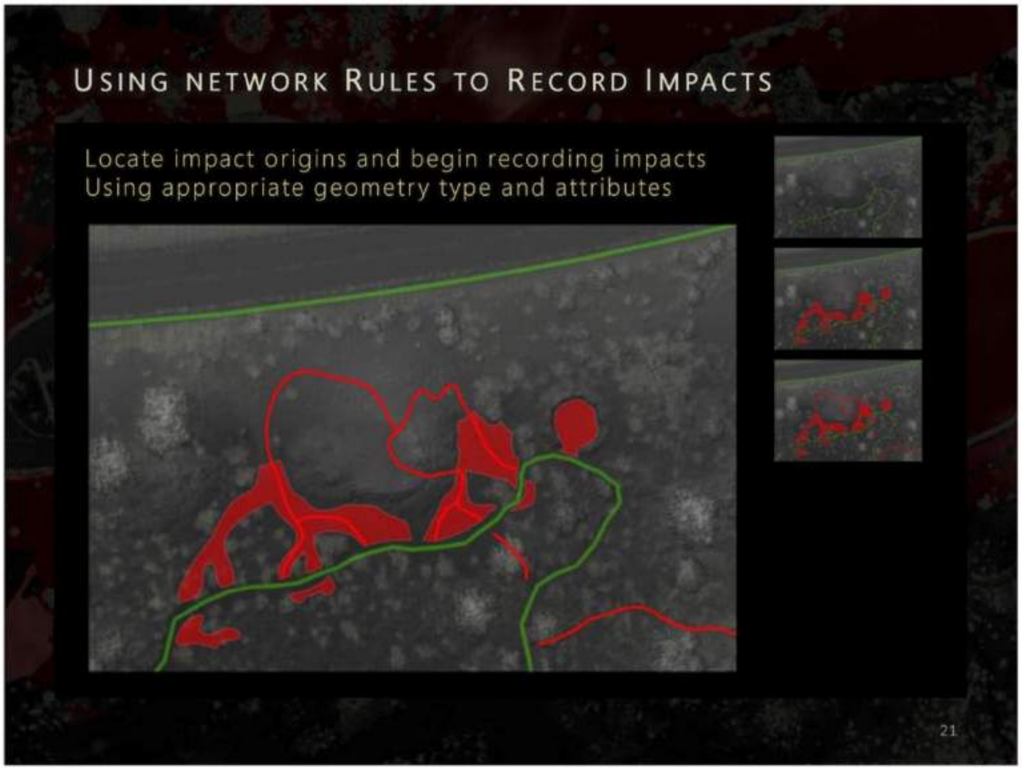
Human caused impacts tend to form networks and follow some general network and topology rules



18

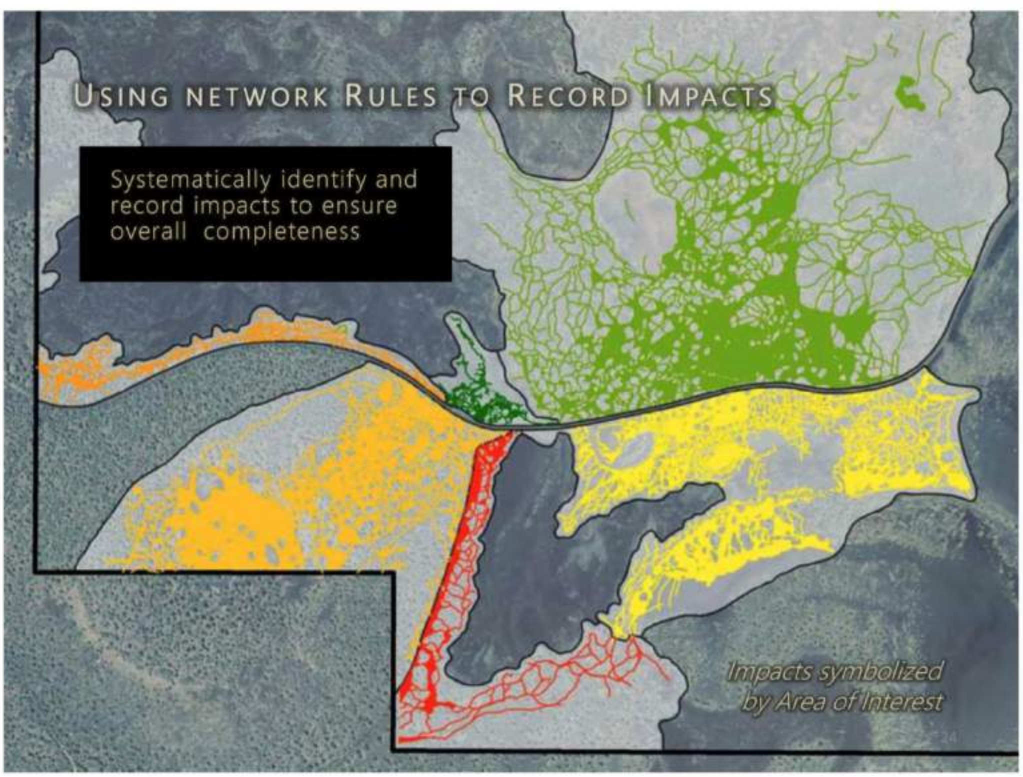

USING NETWORK RULES TO IDENTIFY IMPACTS
Scout the area to understand the infrastructure and geologic layout, and the motives driving recreation
Forest Road 545
Hornito
Spatter Mound
Spatter Mound
Lava Flow Trail - Unpaved Loop
0 Meters 10 20
19


USING NETWORK RULES TO RECORD IMPACTS
Locate impact origins and begin recording impacts Using appropriate geometry type and attributes
20

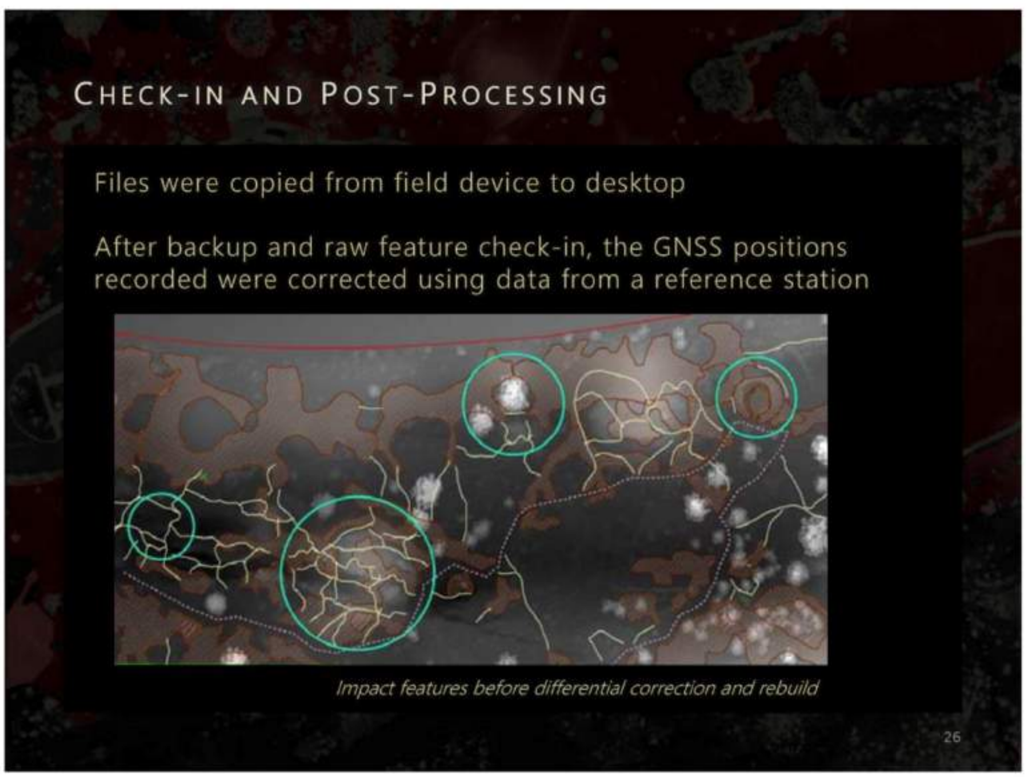

USING NETWORK RULES TO RECORD IMPACTS
Locate impact origins and begin recording impacts
Using appropriate geometry type and attributes
21

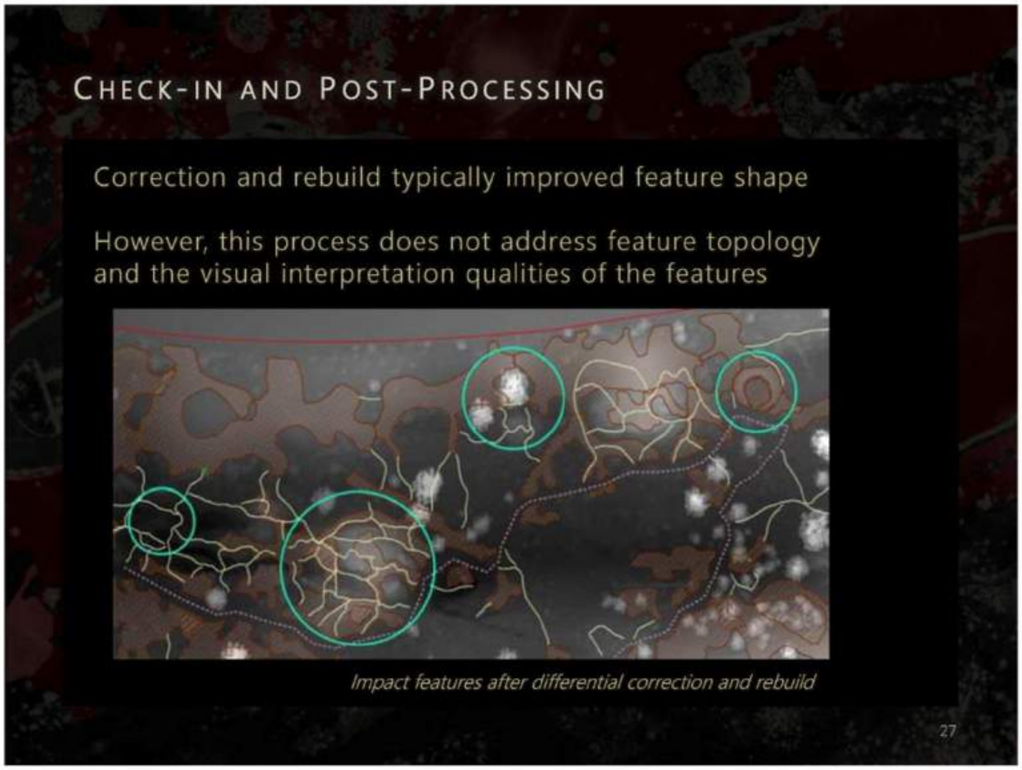

USING NETWORK RULES TO RECORD IMPACTS
Finish subdivided features and continue collecting
adjoining features until impact network is complete
22


USING NETWORK RULES TO RECORD IMPACTS
Finish subdivided features and continue collecting adjoining features until impact network is complete
23

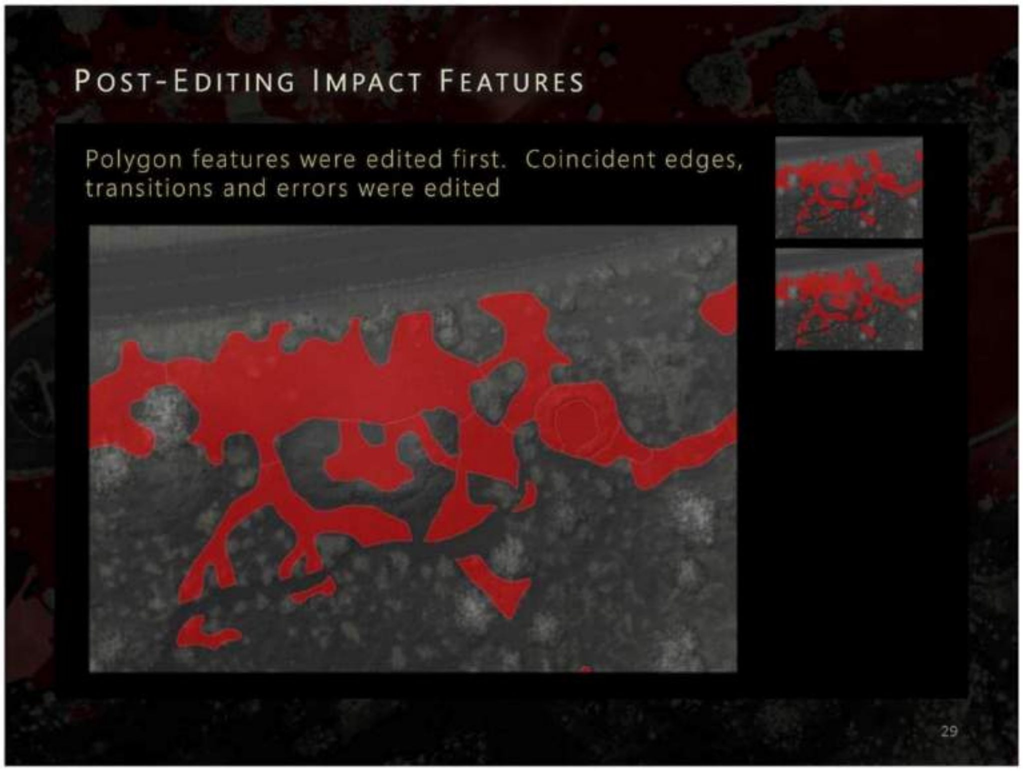

USING NETWORK RULES TO RECORD IMPACTS
Systematically identify and record impacts to ensure overall completeness
Impacts symbolized by Area of Interest


PROCESSING IMPACT FEATURE DATA
Defaced hornito with extensive geologic breakage
25


CHECK-IN AND POST-PROCESSING
Files were copied from field device to desktop
After backup and raw feature check-in, the GNSS positions recorded were corrected using data from a reference station
Impact features before differential correction and rebuild
26

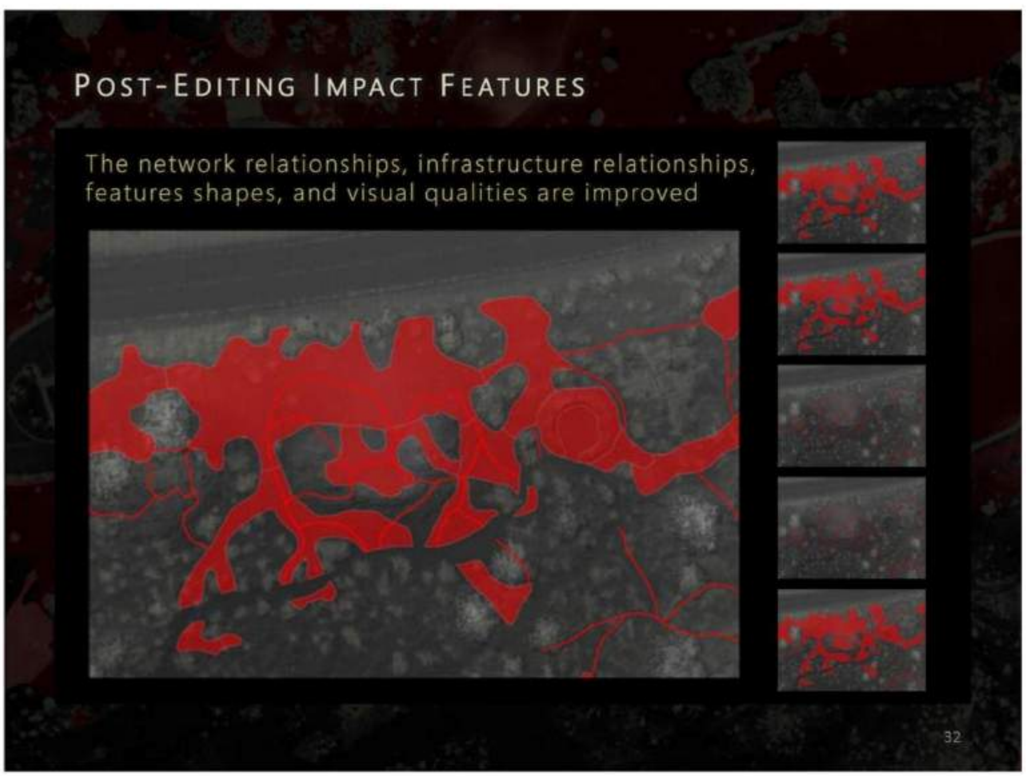

CHECK-IN AND POST-PROCESSING
Correction and rebuild typically improved feature shape
However, this process does not address feature topology and the visual interpretation qualities of the features
Impact features after differential correction and rebuild
27

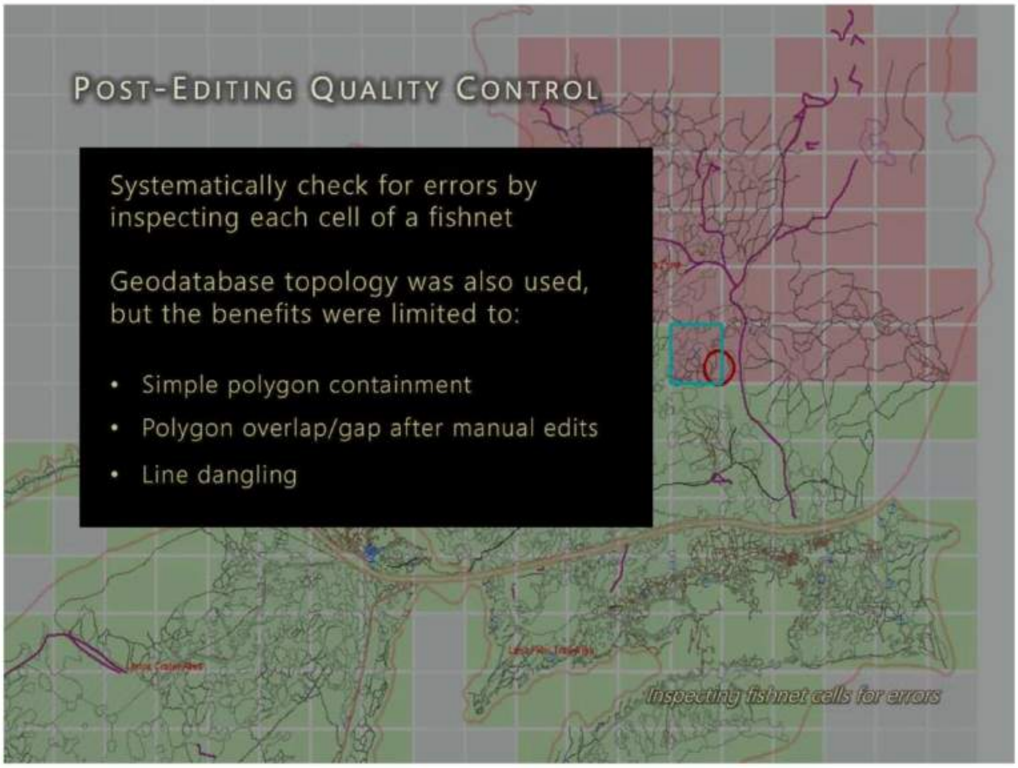

POST-EDITING IMPACT FEATURES
Polygon features were edited first. Coincident edges, transitions and errors were edited
28


POST-EDITING IMPACT FEATURES
Polygon features were edited first. Coincident edges, transitions and errors were edited
29


POST-EDITING IMPACT FEATURES
Line features were then edited. Endpoints, junctions and errors were edited
30

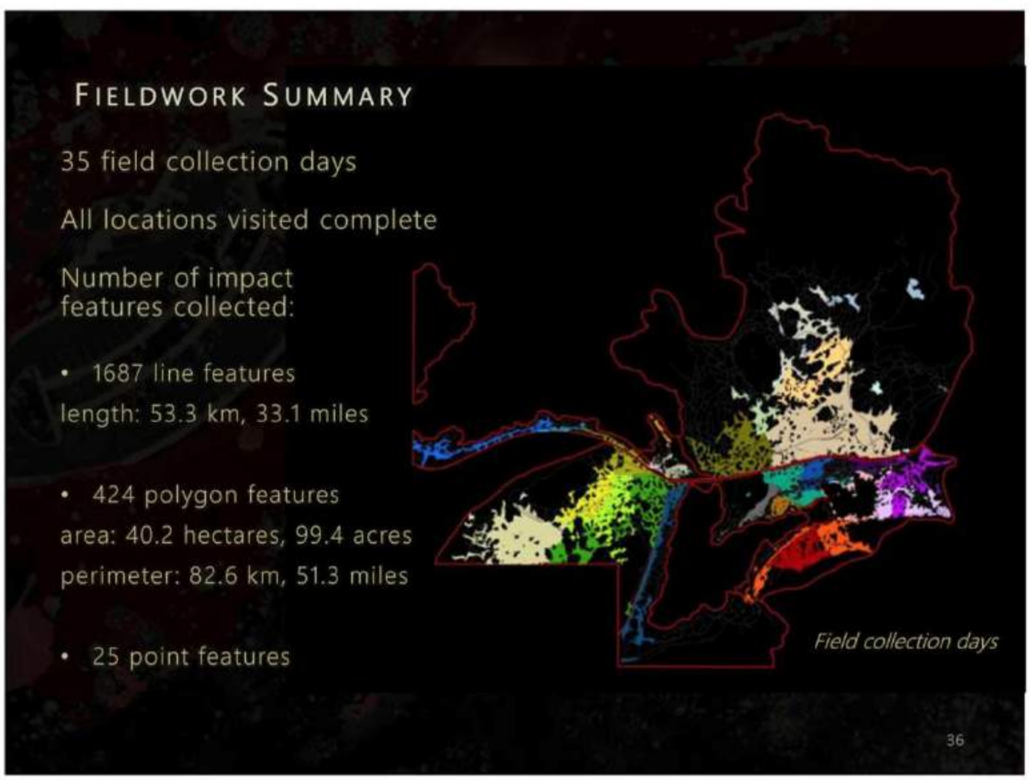

POST-EDITING IMPACT FEATURES
Line features were then edited. Endpoints, junctions and errors were edited
31


POST-EDITING IMPACT FEATURES
The network relationships, infrastructure relationships, features shapes, and visual qualities are improved
32


POST-EDITING QUALITY CONTROL
Systematically check for errors by inspecting each cell of a fishnet
Geodatabase topology was also used, but the benefits were limited to:
• Simple polygon containment
• Polygon overlap/gap after manual edits
• Line dangling
Inspecting fishnet cells for errors


FINAL DATA MANAGEMENT
Several steps to prepare project data for other users
• Inspect attributes for completeness and errors
• Create final impact feature classes and attach files
• Create templates and feature shells for future projects
• Create metadata for datasets
• Organize and distribute GIS project folder
34


RESULTS
Graffiti in aspen stand near Bonito Interpretative Area
35


FIELDWORK SUMMARY
35 field collection days
All locations visited complete
Number of impact features collected:
• 1687 line features
length: 53.3 km, 33.1 miles
• 424 polygon features
area: 40.2 hectares, 99.4 acres
perimeter: 82.6 km, 51.3 miles
• 25 point features
Field collection days
36

Processing and Attribute summary

Processing on-the-go, additional 15 post-edit and writing days

No field collected data lost or corrupted

100% of features differentially-corrected and rebuilt

Mean horizontal accuracies:

- Lines: 0.64 meters
- Polygons: 0.82 meters
- Points: 0.45 meters

Required attributes collected for all features

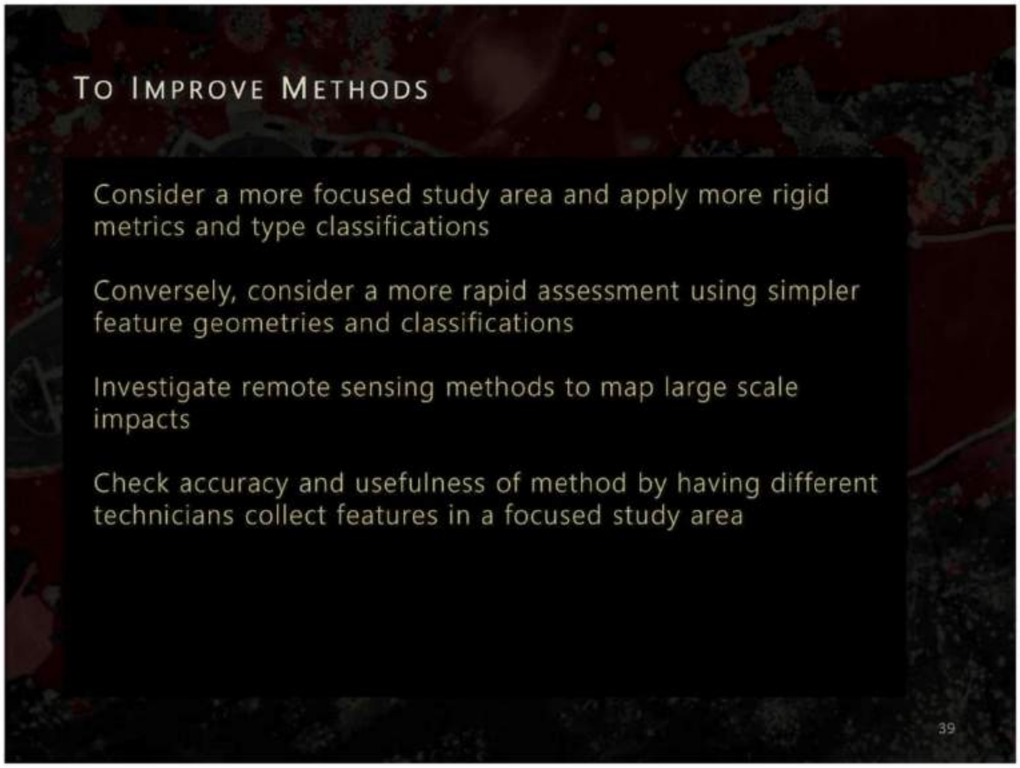
Photographs and supplemental attributes collected

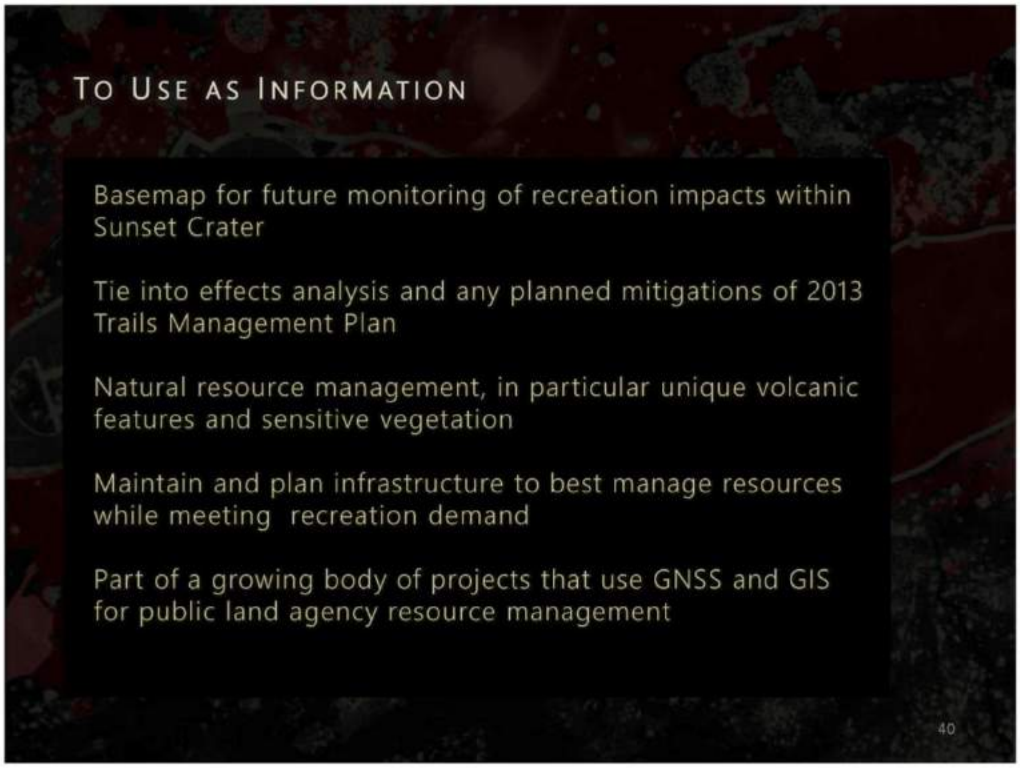
37

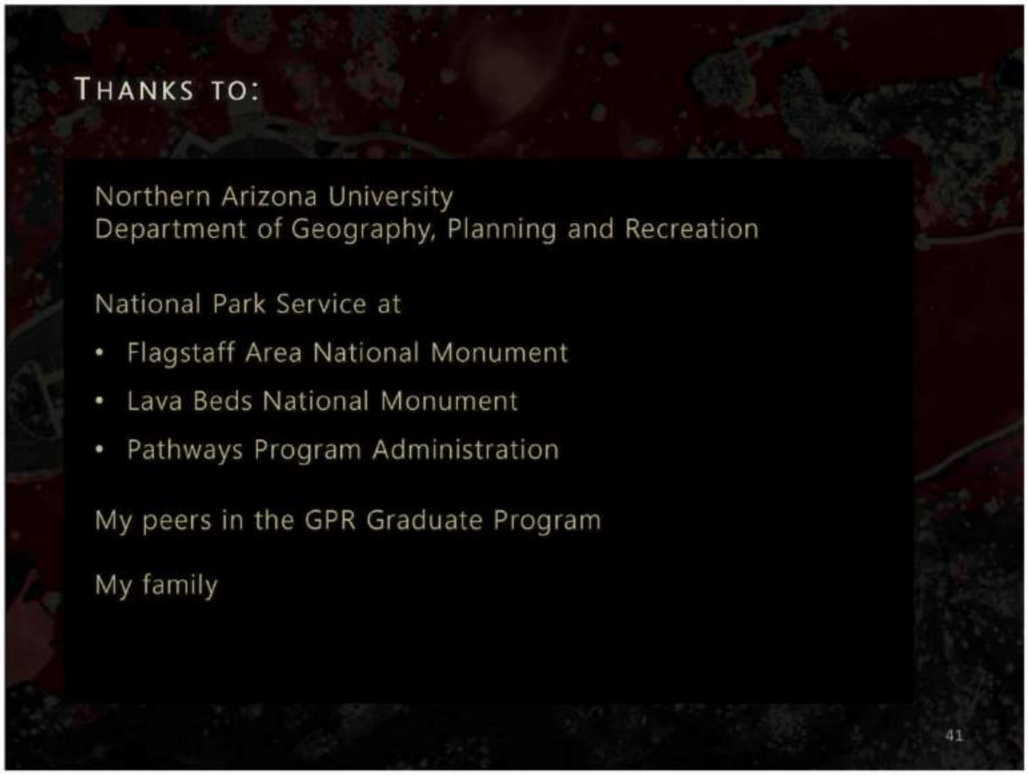
Future Work

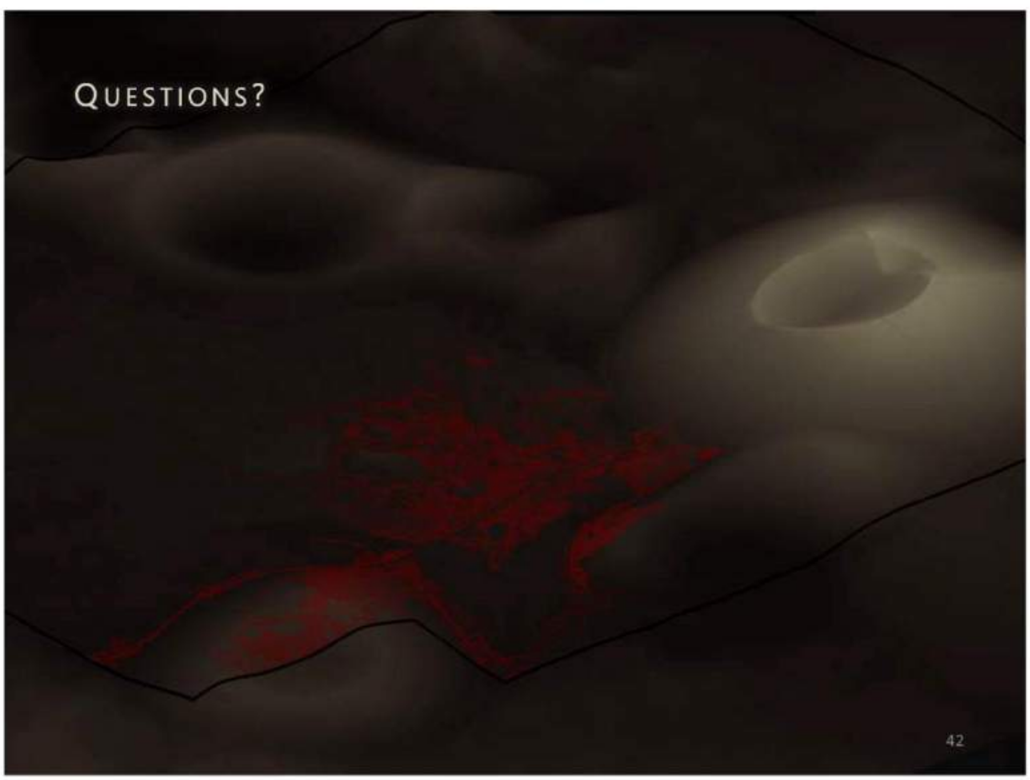
Vehicle and foot impacts near cinder subsidence features

38


To Improve Methods
Consider a more focused study area and apply more rigid metrics and type classifications
Conversely, consider a more rapid assessment using simpler feature geometries and classifications
Investigate remote sensing methods to map large scale impacts
Check accuracy and usefulness of method by having different technicians collect features in a focused study area
39


To Use as Information
Basemap for future monitoring of recreation impacts within Sunset Crater
Tie into effects analysis and any planned mitigations of 2013 Trails Management Plan
Natural resource management, in particular unique volcanic features and sensitive vegetation
Maintain and plan infrastructure to best manage resources while meeting recreation demand
Part of a growing body of projects that use GNSS and GIS for public land agency resource management
40


THANKS TO:
Northern Arizona University
Department of Geography, Planning and Recreation
National Park Service at
• Flagstaff Area National Monument
• Lava Beds National Monument
• Pathways Program Administration
My peers in the GPR Graduate Program
My family
41


QUESTIONS?
42

Appendix N: SUCR_2013_Recreation_Impacts_Basemap Project Folder Structure

- SUCR_2013_Recreation_Impacts_Basemap
  - Data
    - GIS
      - GNSS_testing
        - FLAG_HQ_testing.gdb
          - HQ_basemap_CORS96
          - HQ_aerial_1to1000_200dpi
          - HQ_basemap_HARN
          - TrimbleSessions
          - TrimbleSessions__ATTACH
          - TrimbleSessions__ATTACHREL
        - SUCR_2013_RIB_GNSS_testing.gdb
          - GNSS_Testing_NAD83HARN
          - GNSS_Testing_NAD83orig
          - GNSS_Testing_WGS_84
          - NAD83orig_digit_plyg_test1
          - NAD83orig_digit_plyg_test1_1
          - NAD83orig_digit_plyg_test1_prjtoHARN
          - TestPolygons_WGS84_to_83CORS96
          - TrimbleSessions
          - TrimbleSessions__ATTACH
          - TrimbleSessions__ATTACHREL
      - Maps
        - Cartography
          - Layers
          - LFT_visualizations_1.sxd
          - Report_Figures_SCRATCH.mxd
          - report_figures_scratch.xml
          - RIB_AOIs_1.mxd
          - RIB_field_days.mxd
          - rib_field_days.xml
          - RIB_Impact_Layers.mxd
          - RIB_overview.sxd
        - GNSS
          - Testing
          - RIB_2013_Field_AOI_HARN_1.mxd
          - RIB_2013_Impact_Field_83Orig_1.mxd
          - RIB_2013_Impact_Field_83Orig_2.mxd
        - Working
          - RIB_2013_Impact_Field_Status_1.mxd
          - RIB_AOI_PostEdits_1.mxd
          - RIB_Desktop_Edits.mxd
          - rib_desktop_edits.xml
          - RIB_Topology_1.mxd
          - rib_topology_1.xml
      - Metadata
        - 2013_RIB_ArcGIS_Diagrammer_DR_files
        - 2013_RIB_ArcGIS_Diagrammer_SR_files
          - colorschememapping.xml
          - filelist.xml
        - 2013_RIB_GDB_Design_Figures

- GDB_Design_TEMPLATES
  - (Project)_GDB_Design.pdf
  - (Project)_GDB_Design_Page_01.jpg
  - (Project)_GDB_Design_Page_02.jpg
  - (Project)_GDB_Design_Page_03.jpg
  - (Project)_GDB_Design_Page_04.jpg
  - (Project)_GDB_Design_Page_05.jpg
  - (Project)_GDB_Design_Page_06.jpg
  - (Project)_GDB_Design_Page_07.jpg
  - (Project)_GDB_Design_Page_08.jpg
  - (Project)_GDB_Design_Page_09.jpg
  - (Project)_GDB_Design_Page_10.jpg
  - [Project]_GDB_Design.xlsx
    - D_Template$
    - Datasets$
    - Domain_Index$
    - FC_template$
    - Feature_Datasets$
    - GDB_Info$
    - Other_Element$
    - Relationship_Classes$
    - Subtypes_Template$
    - Topology_Template$
  - 2013_RIB_GDB_Design.pdf
- legacy_and_scratch
- 2013_RIB_ArcGIS_Diagrammer_DR.docx
- 2013_RIB_GDB_Design.pdf
- 2013_RIB_GDB_Design.xlsx
  - D_Confidence$
  - D_Edit_Status$
  - D_Impact_Line$
  - D_Impact_Plyg$
  - D_Impact_Pnts$
  - D_Motive$
  - D_RIB_AOI$
  - D_Trend$
  - Datasets$
  - Domain_Index$
  - FC_AOI_Plyg$
  - FC_Edit_Check_Fishnet$
  - FC_Impact_Line$
  - FC_Impact_Line_Field$
  - FC_Impact_Plyg$
  - FC_Impact_Plyg_Field$
  - FC_Impact_Pnts$
  - FC_Impact_Pnts_Field$
  - Feature_Datasets$
  - GDB_Info$
  - RIB_2013_Impacts_Topology$
- 2013_RIB_Topology_Screenshots.docx
- SUCR_2013_Recreation_Impacts_Basemap_SCHEMA.xml
- SUCR_2013_RIB_Basedata_SCHEMA.xml

- SUCR_2013_RIB_Basedata_SCHEMA.xml
- Worksheet_Page_01.jpg
- Worksheet_Page_02.jpg
- Worksheet_Page_03.jpg
- Worksheet_Page_04.jpg
- Worksheet_Page_05.jpg
- Worksheet_Page_06.jpg
- Worksheet_Page_07.jpg
- Worksheet_Page_08.jpg
- Worksheet_Page_09.jpg
- Worksheet_Page_10.jpg
- Worksheet_Page_11.jpg
- Worksheet_Page_12.jpg
- Worksheet_Page_13.jpg
- Worksheet_Page_14.jpg
- Worksheet_Page_15.jpg
- Worksheet_Page_16.jpg
- Worksheet_Page_17.jpg
- Worksheet_Page_18.jpg
- Worksheet_Page_19.jpg
- Worksheet_Page_20.jpg
- Worksheet_Page_21.jpg

Programming
- FieldCalc_Impact_ID.cal
- FieldCalc_PhotoPath_1.cal
- RIB_2013_Impacts_Topology_RuleSet.rul

SUCR_2013_Recreation_Impacts_Basemap.gdb
- AOI_Development_NAD83HARN
  - AOI_Edit_Plyg_2
  - AOI_Edits_B1_S3_Clip_C1
  - AOI_Edits_B1_Smooth_PAEK10m_S3
  - AOI_Edits_Buff_10m_1
  - AOI_Edits_Plyg
  - AOI_Field_Line
  - AOI_Field_Plyg
  - AOI_Field_Pnts
  - AOI_Plyg_FINAL
- RI_Future_Monitoring_SHELLS
  - Impact_Line_Field_SHELL
  - Impact_Plyg_Field_SHELL
  - Impact_Pnts_Field_SHELL
- RIB_2013_Analysis
  - Edit_Check_Fishnet
  - Impact_Edit_Plyg_SCRATCH
  - plyg_to_line_20140426
  - RIB_Desktop_Edit_Scratch

- RIB_2013_Impacts
  - AOI_Plyg
  - Impact_Line
  - Impact_Line_Edit
  - Impact_Line_Field
  - Impact_Plyg
  - Impact_Plyg_Edit
  - Impact_Plyg_Field
  - Impact_Pnts
  - Impact_Pnts_Edit
  - Impact_Pnts_Field
  - RIB_2013_Impacts_Topology
  - SUCR_Boundary
- Impact_Line__ATTACH
- Impact_Line__ATTACHREL
- Impact_Plyg__ATTACH
- Impact_Plyg__ATTACHREL
- Impact_Pnts__ATTACH
- Impact_Pnts__ATTACHREL
- TrimbleSessions
- TrimbleSessions__ATTACH
- TrimbleSessions__ATTACHREL

- SUCR_2013_Recreation_Impacts_Basemap_LITE.gdb
  - AOI_Plyg
  - Impact_Line
  - Impact_Plyg
  - Impact_Pnts
- SUCR_2013_RIB_Basedata.gdb
  - RIB_SUCR_Basedata
    - SUCR_Boundary
  - LFT_HH_015m_1
  - RIB_AOIs_Intensity_015m
  - RIB_AOIs_Intensity_05m
  - SUCR_2010_NAIP
  - SUCR_2012_BareEarth_DEM
  - SUCR_2012_Slope

- GNSS_GPS
  - Backup
  - Check-in
    - 20130610_NAD83HARN_2
    - 20130610_NAD83Orig_2
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    - RIB_20130611_AOIs
    - RIB_20130611_HARN_testing
    - RIB_20130617_AOIs
    - RIB_20130625_Impact
    - RIB_20130627_Impact
    - RIB_20130627_LINETEST_shp
    - RIB_20130701_Impact
    - RIB_20130701_WGS84_testing
    - RIB_20130702_Impact
    - RIB_20130718_Impact
    - RIB_20130722_Impact
    - RIB_20130723_Impact
    - RIB_20130729_Impact

- RIB_20130730_Impact
- RIB_20130731_Impact
- RIB_20130801_Impact
- RIB_20130802_Impact
- RIB_20130805_Impact
- RIB_20130807_Impact
- RIB_20130913_Impact
- RIB_20130916_Impact
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- RIB_20130918_Impact
- RIB_20130919_Impact
- RIB_20130923_Impact
- RIB_20130924_Impact
- RIB_20130925_Impact
- RIB_20130926_Impact
- RIB_20130927_Impact
- RIB_20130930_Impact
- RIB_20131021_Impact
- RIB_20131022_Impact
- RIB_20131023_Impact
- RIB_20131024_Impact

Check-out

GPS EMPTY

Metadata
- [Project]_GNSS_Log.xlsx
- Arcpad transformation for CORS96.docx
- Output from GEOID09 at Lava Flow TH.docx

Imagery
- Photographs EMPTY
- RIB_2013_Field_Photos
  - 20130625
  - 20130627
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- 20131024

- Tabular
  - Summary_Statistics
    - Raw_Summary_Tables
      - Individual_AOIs
        - BIA
          - BIA_Impact_Line_Type.dbf
          - BIA_Impact_Plyg_Type.dbf
          - BIA_Impact_Pnts_Type.dbf
        - GAZ
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          - GAZ_Impact_Plyg_Type.dbf
          - GAZ_Impact_Pnts_Type.dbf
        - LCA
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        - MTA
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          - MTA_Impact_Plyg_Type.dbf
        - SSL
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      - AOI_Plyg_ALL.dbf
      - Impact_Line_AOI.dbf
      - Impact_Line_AOI_Field.dbf
      - Impact_Line_Motive_1_ALL.dbf
      - Impact_Line_Motive_2_ALL.dbf
      - Impact_Line_Type_ALL.dbf
      - Impact_Plyg_AOI.dbf
      - Impact_Plyg_AOI_Field.dbf
      - Impact_Plyg_Motive_1_ALL.dbf
      - Impact_Plyg_Motive_2_ALL.dbf
      - Impact_Plyg_Type_ALL.dbf
      - Impact_Pnts_AOI.dbf
      - Impact_Pnts_AOI_Field.dbf
      - Impact_Pnts_Motive_1_ALL.dbf
      - Impact_Pnts_Motive_2_ALL.dbf
      - Impact_Pnts_Type_ALL.dbf

- 2013_RIB_SumStats.pdf
- 2013_RIB_SumStats.xlsx
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  - BIA$
  - Fieldwork$
  - GAZ$
  - LCA$
  - LFT$
  - Line_ALL$
  - Motive_ALL$
  - MTA$
  - Plyg_ALL$
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  - SSL$
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- 2013_RIB_SumStats_Page_02.jpg
- 2013_RIB_SumStats_Page_03.jpg
- 2013_RIB_SumStats_Page_04.jpg
- 2013_RIB_SumStats_Page_05.jpg
- 2013_RIB_SumStats_Page_06.jpg
- 2013_RIB_SumStats_Page_07.jpg
- 2013_RIB_SumStats_Page_08.jpg
- 2013_RIB_SumStats_Page_09.jpg
- 2013_RIB_SumStats_Page_10.jpg
- 2013_RIB_SumStats_Page_11.jpg
- 2013_RIB_SumStats_Page_12.jpg
- Tables_for_FLAG_NR.pdf
- Tables_for_FLAG_NR.xlsx
  - Impact_Area$
  - Impact_Length$
  - Impact_Points$
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- Tables_for_FLAG_NR_Page_2.jpg
- Tables_for_FLAG_NR_Page_3.jpg

RIB_2013_Impacts_Topology_ErrorSummary.txt

- Documentation
  - Admin
    - Planning
    - Proposal
      - NAU_practicum_proposal_Hansen_20130904.docx
      - SUCR_RecImpacts_proposal_Hansen_20130529.docx
  - Communication EMPTY
    - Email EMPTY
    - Meetings EMPTY
    - Outreach EMPTY
    - Paper EMPTY
  - Graphic
    - Figures
    - Imagery EMPTY
    - Maps

- Guides_Protocols_SOPs
  - Analysis EMPTY
  - Equipment
    - PositionsArcPadExtension_AdminGuide_10_0_0_2B.pdf
    - PositionsArcPadExtension_v10_0_0_2A_UserGuide.pdf
    - PositionsDesktopAddIn_v10_1_0_2A_AdminGuide.pdf
    - PositionsDesktopAddIn_v10_1_0_2A_UserGuide.pdf
    - PositionsMobileExtension_v10_1_1_1A_AdminGuide.pdf
  - Field EMPTY
  - Legacy EMPTY
  - Office EMPTY
  - Reporting EMPTY
  - Safety
    - FLAG NR FieldWorkJHA 2013.doc
- References_Literature
  - GIS_GNSS
  - Land_Management
  - Misc
  - Rec_Impacts
  - Resources
- Reports
  - Drafts
  - Final
- README.txt