WILDERNESS ROCK CLIMBING INDICATORS AND CLIMBING MANAGEMENT IMPLICATIONS IN THE NATIONAL PARK SERVICE

by

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ABSTRACT

WILDERNESS ROCK CLIMBING INDICATORS
AND CLIMBING MANAGEMENT IMPLICATIONS
IN THE NATIONAL PARK SERVICE

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This pilot study addresses the need to characterize monitoring indicators for wilderness climbing in the National Park Service (NPS) as which are important to monitoring efforts as components in climbing management programs per Director's Order #41, Section 7.2 Climbing. This research adopts a utilitarian conceptual framework suited to applied management objectives. Critically, it advances analytical connections between science and management through an integrative review of the resources informing park planning; including law and policy, climbing management documents, academic research on climbing management, recreation ecology, and interagency wilderness character monitoring strategies. Monitoring indicators include biophysical, social, and administrative topics related to climbing and are conceptually structured based on the interagency wilderness character monitoring model. The wilderness climbing indicators require both field and administrative monitoring; field monitoring of the indicators should be implemented by climbing staff and skilled volunteers as part of a patrol program, and administrative indicators mirror administrative wilderness character monitoring methods that can be carried out by a park's wilderness coordinator or committee. Indicators, monitoring design, and recommended measures were pilot tested in two locations: Grand Canyon and Joshua Tree National Parks. Results indicate that monitoring indicators are: plants; animals; geologic resources; ecological processes; use of motorized equipment; remoteness from sights and sounds of human activity inside wilderness; facilities that decrease self-reliant recreation; management restrictions on visitor behavior; deterioration of loss of integral cultural features; and deterioration of loss of other features of value. This research provides a foundation for monitoring, assessing, and managing wilderness climbing resources in NPS wilderness areas.

Keywords: rock climbing, wilderness, National Park, impact, monitoring, indicator, management, plan, change, Joshua Tree, Grand Canyon, recreation.

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Chapter 1. Introduction

"Why wilderness? Because we like the taste of freedom;

because we like the smell of danger."

-Edward Abbey

1.1 Background

Rock climbing in national parks as well as on other public lands has greatly increased in popularity since the 1990s, with an estimated 6.8 million climbers participating in the activity in the United States in 2015 (Outdoor Industry Association, 2014). Even by the time this research was underway in 2017, the number of people participating in climbing activities—including mountaineering, bouldering, gym-, sport-, and traditional climbing—increased to approximately 9.8 million (Outdoor Industry Association, 2017). Factors contributing to the increasing popularity of the activity include the development of rock climbing gyms, improved climbing equipment technologies, publications of detailed guidebooks and online resources, climbing in popular film and media, the upcoming debut of climbing in the 2020 Olympics, and improved accessibility of outdoor rock climbing sites through the growing number of established sport climbs. The cultural and technological changes which drive the shift in climbing visitor use type, amount, and spatial distribution are driven by these cultural and technological changes. For the National Park Service (NPS), these changes manifest as challenges for managing visitor use experiences and resource protection.

Nearly 60% of rock climbing areas are located on public lands (Access Fund, 2013). Approximately 7% (n=30,000) of these climbing areas are located in wilderness, which is a land

designation that receives the highest level of federal protections (E. Murdock, personal communication, December 9, 2019). Wilderness designation protects healthy ecosystems from degradation by development and from the influence of human manipulation on the landscape scale. It also celebrates the cultural symbol of wilderness as part of the American identity and promotes experiences of solitude or unconfined recreation (U.S. Public Law 88-577, 1964). For land managers, wilderness designation adds specific protection and preservation mandates that shape desired conditions and management strategies (USDA, 2015), which also applies to climbing management in wilderness areas.

Many NPS wilderness areas are also iconic climbing destinations, such as those in Yosemite, Joshua Tree, and the Black Canyon of the Gunnison (Access Fund, 2016c; Access Fund & Gunnison Valley Climbers, 2016). As such, the NPS has acknowledged the importance of their wilderness areas in the history and cultural identity of modern rock climbing (NPS JTNP, 2019; NPS WCMN Training, 2018; USDI, 2013). Through Director's Order #41 (DO41), the NPS establishes climbing as a "legitimate and appropriate use of wilderness," (USDI, 2013a, p.15) and formulates specific desired conditions and management objectives for climbing in wilderness. DO41 provides national guidance for wilderness climbing management, including desired conditions for fixed equipment, recommendation to monitor resource impacts and provide public education, and a call for climbers to adopt minimum impact practices. DO41 also reinforces that individual park units reserve the right to manage, restrict, or close park uses or areas if recreational impacts become unacceptable (USDI, 2006a; USDI, 2013a).

Ecological impact from visitor use increases in severity with the constant rise in wildland recreation use (Hammit, Cole, Monz, 2015). Historically, land management agencies have regulated climbing use and impacts through permitting regulations, fixed anchor policies, trail

designation, erosion control, and area or activity-level closures (Attarian & Keith, 2008). In wilderness, additional considerations are added to the matrix of climbing management, such as preserving experiences of solitude, and protecting opportunities for visitors to participate in unconfined types of wilderness recreation. The NPS expects that climbers follow Leave No Trace (LNT) principles, and that "'Clean climbing' techniques should be the norm in wilderness" (USDI, 2013a, p.16).

LNT is not, however, a holistic answer to managing biophysical and social impacts at wilderness climbing sites. The increased popularity and subsequent impacts from rock climbing activities, if left unchecked, pose a threat to park resources, visitor experiences, and to the preservation of wilderness character (USDI, 2013a). Some impacts identified as unacceptable, and specifically illegal, include alteration of rock faces (e.g., chipping or gluing holds), damaging or removing vegetation to facilitate climbing activities, and the use of motorized drills to install fixed anchors. There are more impacts that are not explicitly addressed by federal regulations and must also be considered in assessing wilderness climbing impacts. For example, the management of fixed anchors in wilderness is a central and long-standing issue in wilderness climbing management (Jones & Hollenhorst, 2002; Murdock, 2010).

NPS wilderness units are mandated to monitor impacts from climbing activities and to consequently determine management strategies that balance protection of park resources with appropriate rock climbing access. DO41 states: "Wilderness climbing education and impact monitoring will be important components in climbing management programs" (UDSI, 2013a, p.15). Individual park units have duly begun to implement monitoring programs to address the mandates of DO41. The NPS especially requires flexibility at the local level to best protect the unique resources it has been tasked to preserve (Barnett, 2016). As such, individual parks have

interpreted and implemented DO41 differently, taking into consideration specific resource protection needs and local climbing histories. Studies on implementation of climbing policy have shown increased levels of national consistency in regulations and management objectives benefit visitors' abilities to understand and comply with regulations (Sullivan, 2018). This sets up a managerial tension—to balance local resource protection and visitor understanding—that undergirds the framework of this study.

In wilderness planning, managers must consider the objectives of wilderness management in shaping their climbing management strategies, including managing for wilderness experiences. Considerations in preserving wilderness values should involve implementing the minimum administrative tool in all strategies, including minimizing the administrative burden on the wilderness visitor. Therefore, regulations must be carefully considered and be enacted for compelling visitor or resource protection purposes (USDA, 2015). The balance between providing wilderness experiences and managing for the naturalness of a wilderness is delicate. Currently, there are defined monitoring indicators for wilderness character that are nationally consistent. These indicators appropriately consider biophysical, social, and administrative impacts to wilderness; no such indicators yet exist for climbing monitoring in wilderness.

Traditionally, interdisciplinary committees of experts work collaboratively to develop plans that balance public use and protect park resources (NPS – Planning, n.d.). On a national level in the NPS, climbing management involves interdisciplinary committee work by experts in their fields to develop national policy on both general climbing management and wilderness climbing management (NPS WCMN, 2018). A similar model is used to address the planning

needs of individual parks, where committees form across work groups, and experts are drawn in from the regional and national level (NPS JTNP, 2019).

To move toward designating national indicators for managing climbing in wilderness, a research method was needed that mirrors the work of expert committees. This method must aid in selecting and justifying monitoring indicators for wilderness climbing and marry the applied nature of park planning with the academic knowledge contributing to this planning. With defined and justified monitoring indicators drawn from a critical synthesis of the best information available, climbing managers and stakeholders have a common ground to work from. A broad review of the information available to park planners, coupled with critical analyses of the relationships between bodies of knowledge, was missing in the conversation about wilderness climbing management.

1.2 Problem Statement

Because the NPS recognizes rock climbing as a legitimate and appropriate wilderness activity and monitoring is recommended by DO41 to guide management decisions (USDI, 2013a), it is useful for nationally consistent monitoring indicators to be established based on relevant bodies of research and applied management strategies. For the purposes of this study, indicators are defined as measurable conditions that "are distinct and important components" (USDA, 2015, p.18) to management questions and are used to evaluate the states of wilderness climbing resources.

Few academic studies exist on climbing impacts, and fewer focus on wilderness climbing, but the body of work is growing. The studies on wilderness climbing that are available contribute salient points to the knowledge base in climbing management, and it is timely now to

complete an analysis of the work to weave together themes from their findings. What little work exists is valuable, and its usefulness to the field of climbing management will increase when it is integrated with the robust body of research on wildland recreation ecology and management.

This much larger body of research includes cohesive, expert analyses of recreation research, and provides useful translational tools for climbing management. As but one example, I argue visitor use patterns and ecological implications of human disturbance from recreational activities like backpacking are directly translatable for climbing use patterns, and therefore climbing management. In this research I employ integrative review methods (Snyder, 2018; Torraco, 2005) as a platform for intersecting and translating wilderness climbing literature and principles of wildland recreation ecology toward a more holistic understanding of their implications for managing wilderness climbing resources.

1.3 Purpose of Study

Rock climbing use has expanded across park units and wilderness areas. New research on climbing impacts and management is developing contemporaneous to a national-level revival of focus on and policymaking within the NPS regarding wilderness climbing (e.g., the issuance of DO41 in 2013, the development of Reference Manual 41, and NPS Wilderness Climbing Managers Network [WCMN] trainings). Climbing management documents and Wilderness Stewardship Plans (WSPs) developed in the 1990s and early 2000s are being updated to reflect current uses and issues (NPS JTNP, 2019; USDI, 2015b). Historically, climbing management strategies were locally developed and in concert with the emergence of the activity as new impacts were detected on the landscape (NPS WCMN Training, 2018). This research supplements and honors local processes and expertise in developing nationally standardized

monitoring indicators that must be paired with locally determined measures and thresholds for management action. Integrative review methods (Snyder, 2018; Torraco, 2005) provide a needed and foundational critical analysis and translational synthesis of the underlying framework of law and policy, and the growing body of research that informs climbing management decisions.

This research thus fills the relational gap between bodies of knowledge incorporated into wilderness climbing management and the established wilderness character monitoring indicators. An integrative review method was used to develop nationally consistent monitoring indicators through examination of the informative body of work that supports wilderness climbing management. The work also goes farther, proposing new frameworks for monitoring protocols, including suggested measures and recommended thresholds drawn from the integrative review.

This study also used a Utilitarian conceptual framework (Mautner, 1997) for field-based data collection, and involved a research team experienced in technical climbing, visitor use and recreation management, wilderness management, and NPS field operations. For this study, rock climbing was defined as movement on 5th class terrain, where technical ascent and/or descent of features traditionally require the use of ropes and natural or artificial equipment to protect the climber from long falls (Eng, 2010). DO41 defines climbing to include "rock climbing, snow and ice climbing, mountaineering, canyoneering and caving, where climbing equipment, such as ropes and fixed or removable anchors, is generally used to support an ascent or descent," (USDI, 2013a, p.15). Effective monitoring of indicators will show change over time and allow for comparison of selected site conditions with desired conditions. This research was undertaken with the intent to inform standardized rock climbing indicators to be monitored in NPS wilderness in accordance with wilderness character monitoring standards and frameworks. The guiding questions for this study are listed below.

1.4 Research Questions

1. What are the appropriate monitoring indicators associated with rock climbing in wilderness?
2. What are the climbing management implications of monitoring for these indicators?
3. How can a wilderness climbing monitoring program be implemented at the park level, given traditional resources for wilderness and climbing management programs?

1.5 Researcher Expertise

In order to meet the monitoring mandates of DO41, I, the researcher, was prompted to view the applied practice of visitor use monitoring and planning through an academic lens, and a multi-methods approach was identified as the strongest method. I recognized gaps in the articulable relationships between the diverse bodies of knowledge that collectively inform climbing management decisions. These disparate areas included; managing for wilderness character, recreation ecology, a history of climbing management planning, and the input of stakeholder groups. In addition to these considerations, managers must also protect sensitive resources that overlap with recreational use. I initially attempted to design a standardized monitoring protocol, modeled after recreation monitoring protocols used on other public lands. In these protocols, I found that the rationale for the selection of indicators, especially specific to wilderness considerations, was missing. In order for indicators to be established, I was left to

consider standard indicator selection methods along with understanding the culture and demands of applied wilderness and climbing management.

My experience in advocacy helped me recognize that there was a fundamental omission in identifying *why* certain data were collected. In the development and justification of selection of monitoring indicators lies the core of discourse concerning wilderness climbing management. Without defining *why* an issue needs to be examined for management action, it becomes unproductive to discuss *what* the strategy is, or *how* the strategy is carried out (Sinek, 2011). Without a fair, thorough, and analytical presentation of monitoring indicators based on the synthesis of knowledge in the field of wilderness climbing, stakeholders and managers would struggle to find common ground to productively approach management challenges, such as managing the visual impacts of fixed anchors. My goal in presenting nationally-standardized monitoring indicators is to contribute to a foundation of knowledge available to inform climbing management decisions. This addition to foundational knowledge will build common ground in wilderness climbing management practices and may provoke the exploration and application of new research.

I bring a professional background that is integral to this research and balances academic knowledge with professional practice. My background includes work in climbing guiding and adventure program management, nearly 20 years of personal climbing experience, leadership and volunteer service in local climbing organizations, an NPS wilderness planning fellowship, and work as a wilderness ranger with climbing patrol functions. Collectively, these personal and professional experiences inform my expert analysis of the body of knowledge on wilderness climbing management and monitoring.

My perspectives in this study are informed by these important aspects of my professional experiences and my efforts to carefully and reflexively intersect these with my academic training. I acknowledge my respect for the land manager and support of their responsibility to manage a complex web of resources in a holistic way to protect national parks for generations to come. While all activity, research included, incorporates some form of bias—and various research communities take a variety of positions about and steps to address this reality—my work does not dismiss but carefully attends to this possibility. I adopted a habit of critical self-reflexivity (Carspecken, 1996) to fairly identify and minimize that bias by using academic methods to critically analyze concepts in fair and open ways. And, my analyses were supplemented and sharpened by expert field assistants. These field assistants ranged from climbing rangers, to accredited mountain guides, to pillars of the climbing advocacy and stewardship community, along with the expertise of my graduate committee.

1.6 Literature Review

1.6.1 NPS climbing management in the context of law and policy

This study examined current climbing management strategies in NPS wilderness in conjunction with wilderness character monitoring techniques, stakeholder positions, and scholarship on recreation ecology. The literature review presented below contains information on the legal foundation of wilderness climbing management planning and is different from the integrative review which creates analyses between disparate yet related bodies of literature. This legal framework is fundamental to understand when considering the analysis and integration of other informative bodies of literature. The laws and policies governing wilderness climbing

management in NPS include: the NPS Organic Act, the Wilderness Act, NPS 2006 Management Policies, and NPS Director's Order #41: Wilderness Stewardship (DO41). These laws and policies provide a national framework for managing climbing in wilderness while still allowing local wilderness units to manage unique resources and challenges individually.

The NPS Organic Act

The NPS Organic Act of 1916 (Organic Act) is the legislation that established the NPS and differentiated it from the existing federal land management agency, the U.S. Forest Service (USFS). This act called for a dual mandate for the NPS and tasked the agency with managing for both the protection of unique park resources and providing for public use and enjoyment (U.S. Public Law 16-1, 1916). This dual mandate became the mission of the NPS: "The National Park Service preserves unimpaired the natural and cultural resources and values of the National Park System for the enjoyment, education, and inspiration of this and future generations…." (NPS, n.d.). Thus, the NPS utilizes management strategies that balance public purpose of its lands with the protection of natural and cultural resources. This can be felt in the tension between protecting recreational experiences in wilderness, all the while preserving the naturalness of wilderness ecosystems.

The Wilderness Act

Similarly, the Wilderness Act of 1964 established a multi-faceted mandate to preserve (1) biophysical environments primarily free from modern human manipulation and impact, (2) personal experiences in natural environments relatively free from the encumbrances and signs of modern society, and (3) symbolic meanings of humility, restraint, and interdependence that inspire human connection with nature (NPS, 2017). The Wilderness Act established the National Wilderness Preservation System (NWPS), which is composed of four federal agencies: the NPS,

the USFS, the Bureau of Land Management (BLM), and the U.S. Fish and Wildlife Service (USFWS) (U.S. Public Law 88-577, 1964). Wilderness designation provides the highest protection for public lands. Areas managed as wilderness include all federally designated Wilderness, as well as eligible, potential, proposed and recommended wilderness (USDI, NPS, 2006a). The Wilderness Act mandates that "…each agency administering any area designated as wilderness shall be responsible for preserving the wilderness character of the area" (U.S. Public Law 88-577, 1964, §4(b)). It also outlines prohibited uses, including permanent roads, commercial enterprise, temporary roads, motor vehicles, motorized equipment, landing of aircraft, mechanical transport, structures, and installations (U.S. Public Law 88-577, 1964). The NPS manages more wilderness than any other agency at 40% of America's total wilderness acreage. The NPS is host to 50 wilderness units (NPS, 2017), many of which are home to iconic climbing destinations.

NPS 2006 Management Policies

The NPS 2006 Management Policies (2006 Management Policies) are Level 1 Policies that govern the operation of the agency. 2006 Management Policies addresses recreational use on a broad scale across all NPS lands. As in wilderness, any recreational activity may be restricted or prohibited if adverse impacts are detected, and parks should monitor trends and changes in resource conditions resulting from recreational use. This policy also calls for national consistency of recreation management policies to the extent practicable. It identifies:

> …because of differences in the enabling legislation and resources of individual parks, and differences in the missions of the Service and other federal agencies, an activity that is entirely appropriate when conducted in one location may be inappropriate when conducted in another. The Service will consider a park's purposes and the effects on park

> resources and visitors when determining the appropriateness of a specific recreational activity. (USDI, 2006a, p. 101).

This argument for local flexibility in the implementation of national policies appeals to the unique resources and histories of each park and wilderness unit.

2006 Management Policies, Chapter 6: Wilderness Preservation and Management outlines the agency implementation of the Wilderness Act. Among many things, this policy document requires wilderness stewardship planning, minimum requirements analyses for consideration of allowing prohibited uses in wilderness and mandates the monitoring of wilderness resources. 2006 Management Policies does not specifically address climbing management. However, Section 6.4.3 addresses recreational use management and recreation use evaluation in wilderness. Recreational activities that are compatible with wilderness "will be of a nature that enables the areas to retain their primeval character and influence; protects and preserves natural conditions; leaves the imprint of man's work substantially unnoticeable; provides outstanding opportunities for solitude or primitive and unconfined types of recreation; and preserves wilderness in an unimpaired condition" (USDI, 2006a, p.78), which are all drawn directly from the definition of wilderness in Section 2(c) of the Wilderness Act (U.S. Public Law 88-577, 1964).

Section 6.4.3.1: Recreation Use Evaluation in 2006 Management Policies addresses all recreational use in wilderness, including new and emerging activities, and establishes that these uses must be evaluated for suitability with the purpose of wilderness and compatibility with the preservation of wilderness character. Recreational uses deemed incompatible with wilderness are prohibited. This section also states that changes in use levels or patterns that adversely impact

wilderness character should be subject to National Environmental Protection Act (NEPA) processes to shape the management of adverse impacts.

Director's Order #41: Wilderness Stewardship

In 2013, Director's Order #41: Wilderness Stewardship was issued. Director's Orders are Level 2 Policy used under the 2006 Management Policies. Director's orders identify specific management needs for policies, procedures, and programs in the NPS, including topics like wilderness stewardship and special park uses. DO41 discusses authority, training, stewardship, and visitor use management topics including climbing, commercial services, and accessibility for persons with disabilities. Section 7.2 addresses climbing and provides the national umbrella of policy that governs wilderness climbing management.

Through DO41, the NPS establishes climbing as a "legitimate and appropriate use of wilderness," (USDI, 2013a, p15) and formulates specific desired conditions and management objectives for climbing management in wilderness. DO41 provides national guidance for wilderness climbing management, including desired conditions for fixed equipment, mandates to monitor resource impacts and provide public education, and a call for climbers to adopt minimum impact practices. DO41 also reinforces that individual park units reserve the right to manage, restrict, or close park uses or areas if recreational impacts are deemed unacceptable (USDI, 2013a).

Additionally, DO41 addresses the controversial issue of fixed anchors in wilderness and establishes both (1) fixed anchors may be present and "the occasional placement of a fixed anchor…does not necessarily impair the future enjoyment of wilderness or violate the Wilderness Act" and (2), "Fixed Anchors or fixed equipment should be rare in wilderness" (USDI, 2013a, p. 15). Fixed anchors are the main controversial issue in wilderness climbing

management (Jones & Hollenhorst, 2002; Murdock, 2004) and have been a focus of debate since the late 1980s stemming from restrictions on bolting in the USFS managed Superstition Mountains Wilderness of Arizona, followed in the 1990s when the USFS briefly implemented a national ban fixed anchors in wilderness (Jones & Hollenhorst, 2002; Murdock, 2010). DO41 also specifically states that if unacceptable impacts are occurring in wilderness as a result of climbing activities, the park superintendent may restrict or prohibit the use of fixed anchors (USDI, 2013a). Murdock (2010) describes the relationship between fixed anchor concentration and use levels, though. He infers that use levels are related to impacts. No other studies to date, however, support the relationship between concentration of fixed anchors on climbing routes and impacts.

Fixed anchors are both a resource protection tool and a recreational facility that can concentrate impacts as well as distribute use and provide for unconfined recreation. There is no study to date that shows that fixed anchors attract higher levels of use than climbing resources devoid of fixed anchors (Murdock, 2010). In some climbing areas, anecdotal accounts of higher rates of adverse impacts to park resources and visitor experiences could be attributed to 'bolt-intensive' or sport climbing areas and, namely due to high volumes of use and perhaps new types of users lacking traditional climbing skill sets. 'Bolt intensive' climbs on an otherwise sheer rock face, commonly called 'sport climbs', are determined to be incompatible with wilderness in DO41. It must be acknowledged, in contrast, that fixed anchors can benefit overall wilderness character preservation, as they can be used as a "significant tool for resource management: they can be strategically placed to minimize climbing impacts to fragile soils, vegetation, and wildlife in wilderness areas" (Access Fund, 2011, p. 2). This study explores possible measures for the appropriateness of fixed anchors in wilderness, but this issue is central to wilderness climbing

management discussions and further studies are required to obtain data to support justified ways to quantify, if possible, the appropriateness of fixed anchors in wilderness.

1.6.2 Managing for the preservation of wilderness character in climbing

In wilderness management practice, NPS units monitor and manage wilderness areas according to the qualities of wilderness character (USDA, 2015). The concept of wilderness character first appears in the Wilderness Act, where it states that federal agencies managing wilderness, like the NPS, are responsible for preserving the wilderness character of lands protected as wilderness areas. Wilderness character is treated as holistic, based on the interaction of tangible and intangible elements of (1) biophysical environments primarily free from modern human manipulation and impact, (2) personal experiences in natural environments relatively free from the encumbrances and signs of modern society, and (3) symbolic meanings of humility, restraint, and interdependence that inspire human connection with nature. The establishment of qualities of wilderness character further developed these elements; the definition of wilderness in Section 2(c) of the Wilderness Act lists the qualities of wilderness character: untrammeled, natural, opportunities for solitude or primitive and unconfined recreation, undeveloped, and other features of value (U.S. Public Law 88-577, 1964).

Wilderness character: Untrammeled quality.

The quality of untrammeled wilderness is defined as "…an area where the earth and its community of life are untrammeled by man" (U.S. Public Law 88-577, 1964, §2(c)). The NPS Wilderness Stewardship Division describes untrammeled such that "ecological systems are essentially unhindered and free from the intentional *actions* of modern human control or manipulation," (NPS, 2017) and where 'actions' are specifically emphasized. In wilderness

character monitoring, trammeling actions are measured as individual decisions to manipulate an ecosystem. Some examples of trammeling actions include wildland fire management activities, introduction or removal of species across a landscape, or alteration of waterways. The untrammeled quality of wilderness is commonly prioritized as a foremost element of wilderness character and is a critical component in the preservation of wilderness, and this is often the responsibility of the land manager to control.

Unauthorized trammeling actions are possible but impacts from climbing activities would have to be argued to be an intentional manipulation of an ecosystem. The decision for climbers to trammel would have to occur either to sensitive and localized resources or occur on a large scale across a landscape. Examples of unauthorized trammeling actions include fish stocking, and illicit agriculture such as marijuana grow operations (USDA, 2015).

Wilderness character: Natural quality.

The natural quality is the second quality of wilderness character, though some wilderness managers argue that natural precedes untrammeled in importance (USDA, 2015). The Wilderness Act states that wilderness "…is protected and managed so as to preserve its natural conditions" (U.S. Public Law 88-577, 1964, §2(c)). The NPS Wilderness Stewardship Division differentiates the Natural quality from the Untrammeled quality by establishing that "wilderness ecological systems are substantially free from the *effects* of modern civilization" (NPS, 2017) emphasizing 'effects' specifically, rather than the 'actions' highlighted in the untrammeled quality. Wilderness character monitoring of the natural quality includes measuring indicators that describe the condition or resources relating to animals, plants, air and water, and ecological processes (USDA, 2015). Climbing activities, as established through research in recreation ecology, have impacts on the natural quality (Hammit et al., 2015).

Wilderness character: Undeveloped quality

The third quality of wilderness character is the undeveloped quality, where wilderness is "…an area of undeveloped Federal land … without permanent improvements or human habitation" (U.S. Public Law 88-577, 1964, §2(c)). The NPS Wilderness Stewardship Division expands on the Wilderness Act by asserting that, "wilderness retains its primeval character and influence and is essentially without permanent improvement or modern human occupation when the Undeveloped Quality is preserved" (NPS, 2017). The current interpretation of the undeveloped quality excludes recreational facilities, which are instead measured in the next quality: opportunities for solitude or primitive and unconfined types of recreation, or 'solitude' for short. The guide to interagency strategy to monitor wilderness character explains this distinction, though wilderness enthusiasts and managers alike seem resistant to accept a different treatment for scientific installations than recreational facilities (USDA, 2015). The dual mandate of the NPS to preserve resources while providing for public enjoyment illustrates the value of visitor experience in wilderness as a value (U.S. Public Law 16-1, 1916); therefore, recreational structures are not assessed like administrative or scientific installations. Additionally, DO41 establishes that, "climbing is a legitimate and appropriate use of wilderness," and that, "the occasional placement of a fixed anchor…does not necessarily impair the future enjoyment of wilderness or violate the Wilderness Act" (USDI, 2013a, p.15). For the purpose of this research, recreational facilities and improvements specific to climbing, such as fixed equipment, are assessed according to criteria set out by the quality of solitude.

Specific to climbing management, power drills are considered a motorized tool, and therefore are prohibited for use in wilderness. All use of motorized tools and forms of mechanized travel, including mountain bikes and strollers, are prohibited by Section 4(c) of the Wilderness Act and are assessed under the undeveloped quality of wilderness character. Many wilderness climbing plans address fixed anchors, and within that discussion address the use of power drills. The use of these tools is regulated and monitored in wilderness because of the apparent ease and speed with which they alter wilderness environments (USDI, 1995b; USDI, 1998). Thus, without special permissions granted through Minimum Requirements Analyses (MRAs) (USDI, 2006a), traditional tool use persists: wilderness tree crews use hand and cross-cut saws; wilderness waterways are limited to human-powered travel; and wilderness climbers are expected to hand-drill fixed anchors. Hand drills are not motorized tools, as they drill by being struck by a hammer while being rotated with the human hand.

Figure 1. Tools Used for Hand Drilling: A hand drill and hammer

Wilderness character: Opportunities for solitude or primitive and unconfined recreation quality.

Next is the quality of opportunities for solitude or primitive and unconfined types of recreation, or 'solitude' for short. The Wilderness Act simply states that wilderness "…has outstanding opportunities for solitude or a primitive and unconfined type of recreation" (U.S. Public Law 88-577, 1964, §2(c)). Landres (2015) defines this quality to involve considerations of

administrative constraint on visitors and social impacts to visitor experiences (USDA, 2015). The NPS Wilderness Stewardship Division explains that: “Wilderness provides opportunities for visitors to find solitude and to challenge themselves with a primitive and unconfined type of recreation when the Solitude or Primitive and Unconfined Recreation Quality is preserved” (NPS, 2017). This quality encompasses any impacts that are related to recreation, such as campsites or other recreational facilities in wilderness such as wayfinding signs and recreational facilities (USDA, 2015, p.22), including climbing fixed anchors. The placement of recreational facilities into the solitude category was rolled out in recent years, especially with the establishment of a nationally-consistent wilderness character monitoring protocol (USDA, 2015). Yet some wilderness advocates and wilderness managers still disagree with the placement of fixed anchors into this quality rather than the undeveloped quality.

The management of this quality is one of balance and carefully weighted decisions. Frequently, managing for experiences of solitude requires putting administrative restrictions on the wilderness user such as limiting use or requiring permits. In managing for opportunities for primitive and unconfined recreation the administrative burden is minimized appropriately. Use types, amounts, and patterns define which type of wilderness experience the manager is selecting to preserve. Like all decisions to manage for the preservation of wilderness character, managers must balance impacts to this quality with impacts other qualities, especially in this case the natural quality by putting appropriate regulations in place to protect resources from degradation for visitor use.

Wilderness character: Other features of value.

The fifth quality of wilderness character is other features of value. It is not a universal quality and may not apply to all wilderness areas. These elements are usually identified in

enabling legislation or other significant management documents. Other features include unique resources that are integral to the character of a wilderness area. In the Wilderness Act they are "ecological, geological, or other features of scientific, educational, scenic, or historical value" (U.S. Public Law 88-577, 1964). The NPS Wilderness Stewardship Division expands on this by adding that other features are considered "tangible features of scientific, educational, scenic, or historical value in wilderness add to wilderness character when they are preserved" (NPS, 2017). This quality of wilderness character celebrates the unique values of NPS units.

Some parks have highlighted climbing as a value in management documents or enabling legislation. The North Cascades National Park Foundation Document identifies wilderness recreation, and specifically climbing, as part of the park significance (USDI, 2012). In Mount Rainier National Park (MRNP), wilderness climbing opportunities are considered part of the park significance as well as a fundamental resource or value. The MRNP foundation document also describes the heritage of climbing activities as a park value (USDI, 2015e). Depending on each park's history and relationship with climbing, climbing may be elevated to a recognized and valued activity that could receive special management protection.

1.6.3 Local relevancy versus national consistency

2006 Management Policies calls for national consistency of recreation management policies to the extent practicable. Enabling legislation may identify unique resources in individual parks and 2006 Management Policies states that "an activity that is entirely appropriate when conducted in one location may be inappropriate when conducted in another" (USDI, 2006a, p.101). The NPS will consider (1) the park's purpose and (2) the recreational impacts in that area to determine "the appropriateness of a specific recreational activity" (USDI,

2006a, p.102). It is critical to allow place-based management for the protection of unique resources in the NPS. The challenges this presents are inconsistencies in regulations and visitor expectations. It is also more challenging to share information and strategies between park units. A potential solution is to make monitoring indicators consistent to streamline the interpretation and implementation of policy to the extent practicable.

Though NPS policies establish that local-level implementation of policy is appropriate in the agency, it also alludes to consistency to the "extent practicable" (UDSI, 2006a, p.101). There are a few academic pieces on wilderness climbing management, and they make notable contributions to conversations about local relevance versus national consistency, such as providing evidence that national consistency is related with increased awareness of and compliance with policies among visitors. In Sullivan's (2018) study on the implementation of DO41 across park units, she found that in order for climbing management in NPS wilderness to be effective, the information on general wilderness climbing values and principles presented to the climbing community needed to be consistent across the NPS, despite diversity in policies between park units. On some levels, stakeholders are also interested in nationally consistent policy governing elements of wilderness climbing management (AAC, 2009).

However, when managing wilderness, the NPS must also consider the impacts of nationally consistent policies, regulations, and administrative burdens on wilderness visitors as well. For unique wilderness resources—each with different types, amounts, timings, and patterns of visitor use—nationally consistent policies could unnecessarily degrade wilderness visitors' opportunities for unconfined recreation (Preisendorfer, 2008). Multiple studies have shown, instead, that the preservation of wilderness climbing requires place-based management and unit-based discretion (Murdock, 2010; Preisenderfer, 2008). Barnett (2016) wrote extensively on

place-based management being specifically successful for the NPS, despite high levels of national consistency in implementation of policy in other federal agencies. The NPS's requirement to manage unique resources and honor diverse enabling legislation carries locally relevant management strategies to their success (Barnett, 2016).

In other words, there are compelling evidentiary analyses championing both national-level and local-level managerial practices as both being, paradoxically, best practices for land and visitor alike. This sets up the real possibility for a complex 'both-and' scenario, in which careful analyses of each position must be brought together in a flexible and applicable model that supports a holistic and accessible approach to wilderness climbing management while avoiding contradictions or irrational protocol. This framework of law and policy that governs wilderness recreation management in the NPS is the foundation that interdisciplinary teams work from in the development of local climbing policy. All of the concepts and frameworks proposed through this work's integrative review are built on this legal foundation and follow the guiding principles of management activities in wilderness and in national parks.

Chapter 2. Research Methods

This research establishes nationally consistent monitoring indicators through a parallel process to that of an interdisciplinary committee: an integrative review method. Selected indicators were then field tested in two park units as part of an experimental wilderness climbing monitoring program. Monitoring wilderness climbing is a recommendation of DO41. Joshua Tree NP and Grand Canyon NP serve as the pilot study locations. Results of the innovative monitoring protocol are available in Appendix B.

Due to the non-traditional nature of the study, it is important here to be explicit in the distinction between methods and results. The methods section establishes the process carried out in the integrative review and the design of the pilot study. The results section discusses the nationally consistent monitoring indicators for wilderness climbing that were determined as a result of this study, and recommendations for creating wilderness climbing monitoring programs in parks.

2.1 Research Design

The tradition of interdisciplinary committee work is a common strategy in park planning and fits with the complex nature of planning objectives. Best practices for how to use these committees to support planning are available, and include suggestions such as “indicators should be selected through an interdisciplinary team,” and that “the team should include members with requisite subject matter expertise, including those who would be responsible for implementing the monitoring strategy” (IVUMC, 2019, p.15). Interdisciplinary committee work models have been applied since the beginning of wilderness climbing management efforts, when in the 1990s,

the USFS formed the National Task Group on Fixed Anchors in Wilderness to explore management questions about the emerging use of sport climbing on public lands, and specifically fixed anchors in wilderness (USDA, 1999). In addition to fulfilling NEPA requirements, public and stakeholder input is also integral to: identify perspectives managers may not have considered, identify what is important to the visitor experience, and capture the public's concerns (IVUMC, 2019).

Principles from recreation ecology and wilderness character monitoring were used to structure the wilderness climbing monitoring protocol. Monitoring addresses the recommendation of DO41 to monitor climbing impacts and take management action if triggers are met. Field and administrative monitoring were pilot tested in JTNP and GCNP. The monitoring protocol was the method to evaluate the selected monitoring indicators.

2.1.1 Integrative review

In order to mirror the process of interdisciplinary teamwork among experts in the field, I selected an integrative review method for the determination of monitoring indicators. An integrative review is a research method used to synthesize, critique, and assess literature on an emerging research topic to create new frameworks and perspectives (Torraco, 2005). Bodies of literature analyzed include climbing management plans, wilderness character monitoring frameworks, recreation ecology, academic studies on climbing, and stakeholder position statements. Key concepts (e.g. management restrictions on visitor behavior, threats to ecological processes) were identified in wilderness and climbing management documents. From there, relationships between management the concepts (e.g. social impacts, climbing, and wilderness) were identified in DO41, and thus provided the conceptual structuring for analysis between

bodies of knowledge. Last, the informative bodies of literature were categorized into their best suited management relationship in the conceptual structure. From here, the relationships between ideas and knowledge were analyzed to produce monitoring indicators.

Integrative review: overview.

Integrative reviews are useful as an analytic tool for addressing emerging topics. The purpose is to create initial conceptualizations and new theoretical models. Integrative reviews for new topics require creative data collection, advanced skills or superior conceptualization by the researchers, and will combine insights from different fields (Snyder, 2019; Torraco, 2005). The value of an integrative review for emerging topics is to advance knowledge and theoretical frameworks and strive to generate new conceptual frameworks. Integrative reviews are useful for underexamined topics, as these most benefit from a holistic conceptualization and generation of new models or frameworks that offer new perspectives (Torraco, 2005). Explicitly establishing conventional research methods, and completing analyses in a transparent, thoroughly documented, and reproducible way is critical to the success of an integrative review (Snyder, 2019). Additionally, an integrative review should represent a challenge and extension of existing knowledge, and not simply collect and synthesize previous research as is done in a standard literature review (Baumeister & Leary, 1997; Tranfield, Denyer, & Smart, 2003).

Topic suitability for integrative review.

The management of wilderness recreation resources, and specifically wilderness climbing resources, is framed by law and policy, then locally interpreted to best fit resource needs. Impacts related to climbing in wilderness must be monitored, and if found to be unacceptable prompt management action (USDI, 2013a). Interdisciplinary teams, with the input of public comment, shape the development of management strategies (NPS WCMN Training, 2018;

IVUMC, 2019). But these teams are drawing from, and holding in tension, two competing managerial priorities. A synthesis of available information will create a better foundation, and perhaps common ground, to work from in the conversation about wilderness climbing management.

There is frequently a challenge in bridging land management practices with scientific knowledge (McCormick & Massatti, 2019). The gap between science and management can be bridged by examination and analysis of topics informing wilderness climbing management through an integrative review. A variety of frameworks make up this scholarship: social constructivist approaches to assessing preferences (Jones, Hollenhorst, & Hammit, 2004), or applying a Flow Theory framework to wilderness use modeling (Murdock, 2004) are but two examples. And while there are empirical studies that address national-level considerations for the implementation of wilderness climbing policy (Murdock, 2010; Sullivan, 2018), the most common literature resource on wilderness climbing management remain WSPs and other local-level guidance regarding climbing management.

An integrative review will provide the needed analyses of relationships between the diverse fields that inform wilderness climbing management. These analyses will justify the selection of indicators to be incorporated into monitoring strategy and provide cohesive background information on each of the component parts involved in wilderness climbing management. The establishment of nationally consistent monitoring indicators will allow managers to better understand wilderness climbing impacts in relation to management objectives.

Discussion of omissions or deficiencies

Fixed Anchors

A problematic example worth highlighting is the interpretation of the appropriateness of fixed anchors in wilderness. This issue has a thoroughly documented history (Murdock, 2010) and will continue to challenge wilderness managers. Many climbing plans call for an inventory of fixed anchors, which may have been a possible task at the turn of the 20th century, but with the growth of climbing, changes in technology, and expansion of climbing use evidenced by a booming increase in the number of published routes, a fixed anchor inventory is an impractical task in all but the smallest wilderness climbing areas. Currently, the best tools to inform decisions about fixed anchors in wilderness will be (1) an understanding of historical and appropriate climbing use in the local area and (2) NPS staff who are knowledgeable about wilderness and climbing management and who are capable of sound professional judgement regarding the assessment of fixed anchors in wilderness.

Like any implementation of law and policy, it is hoped that the judgments and decisions of managing authorities are based on a totality of the resource management considerations, the best available information, and the training and expertise of the manager. And, there are aspects of the managerial mandates that will not be replaced within this research, but instead this research will function as a unique and important addition to the best available information. In this way readers might critique this integrative review for not replacing or supplanting ‘rare’ and ‘occasional’ with numeric values, but in the spirit of the law and in recognition of the functional application of management policy, the content of DO41 will be maintained while simultaneously building a referential framework that should give ample guidance for managers to determine the appropriateness of fixed anchors.

Bouldering

Bouldering is not addressed in this study. The reasons for the exclusion of bouldering include: differences in the natural and cultural resources that spatially overlap with bouldering activity, in visitor use patterns, in impacts from technical tools (e.g. bouldering uses crash pads but usually not fixed anchors), and in social impacts. Bouldering is a type of recreation that deserves individual assessment based on these differences from rock climbing as defined in this study. And while the indicators in this study may be translatable for managing bouldering sites, the measures and thresholds for rock climbing must be changed to suit a different type of climbing activity.

Studies are beginning to ask questions about the impact of bouldering on natural and cultural resources. Future researchers considering monitoring bouldering impacts should seek out recent work on cultural resources and bouldering (Marrs, 2012; Marrs & Matthews, 2012) and the effect of bouldering on rock-associated vegetation (Tessler & Clark, 2016).

Highlines and Slacklines

Highlines and slack lines are not included in this research, although they are commonly addressed under climbing management documents. For similar reasons to bouldering, climbing impacts cannot be equated to slacklining or highlining impacts and independent studies should be carried out to investigate management questions.

Integrative review: conceptual structuring.

The conceptual structure of an integrative review is by relationship, not chronology. This section introduces the relationships in wilderness character monitoring in need of new knowledge. To begin, the component parts of wilderness management and climbing management are broken down into themes. The primary sources that contributed themes include Attarian &

Keith (2008) and USDA (2015). Together, these applied, 'how-to' resources provide an overview of issues encompassed in wilderness climbing management. In total, eight topics were selected from these resources to inform the integrative review process (Table 1). These concepts are present in DO41 as overarching relationships in wilderness climbing management (UDSI, 2013a). The conceptual structure for the integrative review was built on relationships between elements within a theme.

Table 1. Themes in Applied Climbing Management and Wilderness Management

Themes from Attarian & Keith (2008)	**Themes from USDA (2015)**
• Natural Resources • Cultural Resources • Social Impacts	• Untrammeled • Natural • Opportunities for Solitude of Primitive and Unconfined Recreation • Undeveloped • Other features of value (including cultural resources)

As noted earlier, wilderness management and climbing management practices are both well developed, but there are analytical gaps where the two are brought into relation with each other. The conceptual structure for the integrative review was designed to highlight and flesh out relationships between these two areas of management.

Relationship 1: Natural resources, wilderness, and climbing.

This analysis explores the relationship of natural ecosystems in wilderness, natural resource management, recreation ecology, and climbing activities. Concepts in this relationship include plants, animals, and ecological processes.

Relationship 2: Cultural resources, wilderness, and climbing.

This analysis explores the relationship of cultural resources management, including Traditional Values and Cultural Landscapes, as an 'other feature of value' in wilderness character and climbing activities.

Relationship 3: Social impacts, wilderness, and climbing.

This analysis explores the relationship of visitor use management, social impacts, social science, preservation of solitude or primitive and unconfined recreation experiences, and climbing activities. Concepts include remoteness from other wilderness visitors and signs of civilization, and burden of rules and regulations on wilderness visitors.

Relationship 4: Other wilderness resources and climbing.

This analysis is unique in assessing recreation, in that it includes special wilderness considerations not encompassed in natural or cultural resource management, or visitor use management. Topics analyzed here are from the undeveloped, untrammeled, and other features of value qualities of wilderness character that do not fit into natural, cultural, or social categories. A unique aspect of climbing included here is the use of motorized tools (power drills).

Table 2. List of Analytical Relationships in Wilderness Climbing Management

Relationships
Relationship 1: Natural Resources, Wilderness, and Climbing
Relationship 2: Cultural Resources, Wilderness, and Climbing
Relationship 3: Social Impacts, Wilderness, and Climbing
Relationship 4: Other Wilderness Resources and Climbing

Integrative review: Literature selection methods.

Literature selection methods for each body of literature is described below. The applied nature of the field of wilderness climbing management requires the assessment of literature types

outside of journal articles and scholarly research. The fields informing these areas includes (1) climbing management planning documents, (2) wilderness character monitoring strategy, (3) recreation ecology, (4) academic research on climbing, and (5) stakeholder position statements (Table 3). The selection criteria for each of the fields are listed below.

Table 3. Literature Groups for Wilderness Climbing Management

Literature Groups
Group 1: Climbing Management
Group 2: Wilderness Character Monitoring
Group 3: Recreation Ecology
Group 4: Climbing Research
Group 5: Social Science
Group 6: Stakeholder Positions

Group 1: Climbing management.

National Park Service climbing management documents from the 1990s and later were selected for review. The development of sport climbing in the 1980s and the initial organized awareness of the wilderness manager on fixed anchors (Murdock, 2010) starts the clock on the modern climbing management timeline. Different systems for managing planning documents have evolved along with climbing during the past 30 years. The most recent climbing management literature was pulled from the NPS Planning, Environment, and Public Comment (PEPC) database. Then to reach back further, an NPS search engine for parks with "wilderness" and "climbing" generated a list of parks that meet those criteria. Some parks with climbing resources were not listed on the NPS search tool, such as North Cascades NP, and GCNP. If parks are known to have climbing resources but weren't captured by either of the search engines, they were researched on MountainProject.com, a crowd-sourced online climbing guidebook resource owned by REI, to verify that there is wilderness climbing in the park. Of the parks that

do not have planning documents in PEPC from the past five to 10 years, I located pertinent climbing management, wilderness stewardship, and general management plans. If a climbing park did not have relevant climbing guidance in any of the above documents, the superintendent's compendium was reviewed. A list of selected plans is in Table 4.

For the PEPC search, a list of climbing management documents resulted from a search of the PEPC database (https://parkplanning.nps.gov/searchAll.cfm) and filtering for the keyword "climbing." This yielded 41 results. Unfortunately, further filtering through the search function of the PEPC website for project types of "climbing management plan" and "wilderness plan" was unsuccessful, yielding only four results though many more relevant plans exist in that database. This filter was removed so all relevant plans were captured by the search. From the original list of 41 documents located through the "climbing" keyword search, I selected document types that included wilderness stewardship plans and climbing management plans.

Older climbing management guidance exist that are not listed on PEPC. These plans are valuable for inclusion and were located through a different type of search. The website "Find a Park – Advanced Search" (https://www.nps.gov/findapark/advanced-search.htm) determined 38 parks that have a climbing resource, and 19 parks that have climbing in wilderness (NPS, n.d.-b). The list generated by Find a Park is not exhaustive, as it does not identify some NPS units with climbing resources. A search of MountainProject yielded additional parks with wilderness climbing. NPS units missing from the NPS Find a Park search but found in MountainProject include North Cascades NP and GCNP.

Searches for wilderness or climbing management documents for each of the parks from Find a Park and MountainProject were conducted through web-based searches of management

sections on park websites and web searches for known titles. Climbingmanagement.org was also a resource for plans but is unfortunately not currently maintained.

Table 4. Selection of NPS Climbing Management Documents

Document Title	Date	Document Type	Wilderness	Source
Grand Teton NP Backcountry Management Plan	1990	WSP/BCMP	Yes	Find a Park
Mount Rainier NP Wilderness Management Plan	1991	WSP/BCMP	Yes	Find a Park
Canyonlands NP and Orange Cliffs Unit of Glen Canyon NRA Backcountry Management Plan	1995	WSP/BCMP	Yes	MountainProject
Devils Tower NM Final Climbing Management Plan/FONSI	1995	CMP	No	MountainProject; Attarian & Keith
Acadia NP Climbing Management Plan	1997	CMP	No	MountainProject
City of Rocks NR Climbing Management Plan and FONSI	1998	CMP	No	MountainProject; Attarian & Keith
Joshua Tree NP Backcountry and Wilderness Management Plan	2000	WSP/BCMP	Yes	Find a Park; Attarian & Keith; Barnett; Murdock
Rocky Mountain NP Backcountry and Wilderness Management Plan	2001	WSP/BCMP	Yes	Find a Park; Barnett
Black Canyon of the Gunnison NP Interim Climbing Management Plan	2004	CMP	Yes	Find a Park
Denali NPP Final Backcountry Management Plan - GMP Amendment and EIS	2006	WSP/BCMP	Yes	Find a Park; Sullivan
Zion NP Backcountry Management Plan and EA	2007	WSP	Yes	Find a Park
Arches NP Climbing and Canyoneering Management Plan	2013	CMP	No	PEPC; Barnett
Shenandoah NP Rock Outcrop Management Project	2013	Project	Yes	PEPC
Lake Mead NRA Wilderness Management Plan/EIS	2015	WSP	Yes	PEPC; Barnett

Sequoia and Kings Canyon NP Wilderness Stewardship Plan and Final EIS	2015	WSP/BCMP	Yes	MountainProject; Barnett
Black Canyon of the Gunnison NP Wilderness and Backcountry Management Plan (2016)	2016	WSP/BCMP	Yes	PEPC; Sullivan
Yosemite NP Superintendent's Compendium	2018	Compendium	Yes	Find a Park
Lassen Volcanic Wilderness Stewardship Plan	2018	WSP	Yes	PEPC
North Cascades NP Superintendent's Compendium	2019	Compendium	Yes	MountainProject; Sullivan
Big Bend NP Superintendent's Compendium	2019	Compendium	Yes	MountainProject
Pinnacles NP Superintendent's Compendium	2019	Compendium	Yes	MountainProject

Key to acronyms: BCMP: Backcountry Management Plan; EA: Environmental Assessment; EIS: Environmental Impact Statement; FONSI: Finding of No Significant Impact; GMP: General Management Plan; NM: National Monument; NP: National Park; NPP: National Park and Preserve; NRA: National Recreation Area; VUMP: Visitor Use Management Plan; WSP: Wilderness Stewardship Plan

*The New River Gorge Climbing Management Plan is extensive but was unavailable at the time of this paper's completion.

References in research on climbing management were also surveyed (Barnett, 2016; Murdock 2004; 2010; Sullivan 2018). These references were supplemented by the bibliography and references section of Attarian & Keith (2008).

Group 2: Wilderness character monitoring.

Interagency guidance has been accepted by the wilderness management community and is thoroughly explained in USDA (2015a). This reference serves as the primary resource for wilderness character monitoring.

Group 3: Recreation ecology.

Recreation Ecology sources were drawn from Hammit et al. (2015). This comprehensive body of work in recreation ecology and management spans the past 50 years. It is a compilation of research that provides a point source for decades of research and knowledge to this field. Major concepts are described in this body of work that are applicable to climbing, such as visitor use patterns, timescales of impact, and ecological impacts from related types use.

Group 4: Climbing research.

The most comprehensive academic study on wilderness climbing published to date is Murdock (2010). Other studies and papers selected address climbing impacts, implementation of climbing policy, fixed anchors, visitor experience. Keywords include climb, rock climb, wilderness, cliff, cliff ecology, and visitor experience.

Group 5: Social science.

Visitor perceptions, attitudes, and expectations shift with culture. The social science studies analyzed in this research include historical overviews of wilderness visitor experience

studies and social science related to climbing and newer than 2010, to align perspectives and expectations to current climbing topics.

Group 6: Stakeholder positions.

Stakeholder positions play an integral component in informing an actionable and applicable climbing management strategy. Key stakeholder groups representing wilderness climbing interest include Access Fund, AAC, American Mountain Guides Association (AMGA), Outdoor Alliance, the Wilderness Society, and National Parks Conservation Association (NPCA). Positions on climbing management issues and comments submitted in response to climbing management scoping are included in this group for 1990 onward. Only positions statements from national-level stakeholder group were included, as they often work with local groups to submit comprehensive and consistent comments.

Criteria for exclusion.

Criteria for retaining or discarding literature yielded by the searches includes climbing management documents or stakeholder positions pre-dating 1990 as this study assumes that the era of modern climbing management takes place from approximately 1990 until present. Climbing management plans for other agencies in the NWPS were excluded for difference in agency missions.

Specialist studies in climbing management were analyzed using their abstracts for the integrative review. These studies are acknowledged as notable and important, but management of threatened or endangered species, and cultural or other sensitive resources require the critical review of an expert and are not appropriate for assessment under a basic monitoring of wilderness climbing. Indicators for these concepts have basic measures designed to document threats to sensitive resources and redirect findings to the appropriate officials for examination.

Justice-oriented wilderness literature is a valuable element of wilderness preservation efforts. Relevance and inclusion in wilderness management is important to engage the next generation of wilderness supporters. Agencies should work at a national and local level to consider the appropriately changing symbol and meaning of wilderness in America. More studies on relevance and inclusion in wilderness should be conducted and inform overall wilderness management, in addition to climbing management.

Integrative review: Literature review methods.

Abstracts were reviewed for the first round of review. For final acceptance into the Integrative Review, literature was reviewed in full and held against the inclusion and exclusion criteria. Main ideas or themes were identified and categorized within groups of literature (e.g. climbing plans, recreation ecology) initially through a concept matrix, then through a concept and relationship matrix based on the existing frameworks in the conceptual structuring identified earlier: wilderness character monitoring, recreation ecology, and climbing management.

Integrative review: Initial verification.

DO41 was used to verify the legal and policy-based foundations to validate concepts and relationships. Stakeholder positions played a special role to add public interest concerns, voice the actual needs of the climber, and provide expert voice in their fields, such as the practical need to differentiate between types and purposes of fixed anchors in climbing management plans (Access Fund, 2011). An example of this dynamic is public comment from stakeholders in the process of developing new plans. Finally, selected indicators were tested in the pilot studies for accurate representation of wilderness climbing issues, management purpose, and identification of possible oversights in the selection of monitoring indicators through integrative review.

To vet the findings of this integrative review, I conducted pilot testing of emerging indictors in two different wilderness climbing resources, JTNP and GCNP. Expert volunteers and rangers served as field technicians and provided insight in pilot testing of the indicators. Quantitative and qualitative examination of indicators were conducted independently by monitoring team members for inter-rater reliability and checks for omissions. Discussions about conflict with indicators, measures, and thresholds was discussed on site. Topics of recurring debate, like fixed anchor appropriateness, were addressed with each field technician at each site.

All field technicians have climbing experience in a professional capacity (i.e., for work) and were provided wilderness training. Many of the field technicians have backgrounds in public land management and policy. These experts do not represent the general climbing populous, rather were selected for their background in understanding the role of climbing in the larger framework of land management and wilderness management. The professional experience of the field team provided critical challenge to indicators generated by the literature review and improved their strength through application on the ground during pilot testing.

2.1.2 Pilot study

Monitoring indicators were pilot tested in two NPS wilderness units, Joshua Tree NP (JTNP) and Grand Canyon NP (GCNP). Indicators were judged during pilot testing for (1) suitability for addressing climbing management questions and (2) applicability and relationship to wilderness character. Possible measures and thresholds drawn from wilderness character monitoring and recreation ecology monitoring were explored throughout the testing of indicators. There are two components to monitoring design: field data collection and administrative

monitoring. Recommendations on monitoring design are included in the results section and monitoring data collection tools are in Appendix B.

Monitoring design.

The data for wilderness climbing sites were collected on a unique survey instrument (Appendix B). The survey instrument was created by adapting and combining recreation impact monitoring tools and interagency wilderness character strategy. Monitoring design was created from a synthesis of recreation monitoring programs that use VERP or LAC models (Frissel & Stankey, 1972; Jenkins, 2017; USDI, 1997) and wilderness character monitoring strategy (USDA, 2015). Wilderness, climbing, and canyoneering recreation impact monitoring tools from multiple agencies and locations were gathered and key measures were identified. These key measures were referenced in "Wildland Recreation" (Hammit et al., 2015).

Wilderness character monitoring strategy was integrated with the recreation impact monitoring strategies to adapt measures to fit wilderness recreation considerations. Specific additions from wilderness character monitoring strategy include measures to assess administrative burden on the visitor, facilities that decrease self-reliant recreation, and wilderness prohibited uses. From wilderness character monitoring, I also adapted justifications for recreation impact monitoring; for example, visual signs of human presence (e.g., trash) is most important to the ideas of remoteness from sights and sounds of human activity inside wilderness. Lastly, administrative monitoring additions were made to the wilderness climbing monitoring protocol to account for experiences of freedom and humility and restraint.

Administrative monitoring, in comparison with field monitoring, is office-based and is conducted once per monitoring cycle to apply to all wilderness climbing areas. Administrative monitoring design was based on wilderness character monitoring tools for measuring humility,

restraint, and freedom. Administrative monitoring distinguishes recreation management in wilderness from non-wilderness. Specific experiential and managerial outcomes are closely examined and managed in wilderness. Administrative monitoring measures are found in Appendix B.

Designed for patrol.

Field data collection was designed to be integrated in existing patrol programs by being situated in parks with a climbing patrol program. In this way, the research did not create a new patrol program but tagged onto common practice. Data collection involved hiking, scrambling, climbing, and descending a route. The monitoring protocol is designed to meet applied management objectives and leverages existing ranger patrol functions to maximize staffing and budgetary capacity (Jenkins, 2017). Site selection should be appropriate to the terrain and staff capabilities, such that all monitoring sites can be visited within the climbing season in a single year. Parks could increase patrol capacity and site quantity by partnering staff with skilled volunteers, such as Climber Stewards, or engaging local guides or guiding organizations for partnership.

Data collection was designed to flow chronologically with a climbing patrol. Zones for data collection are (1) approach, (2) staging, (3) climb, (4) summit, (5) descent. Data collection was completed by technicians with training on how to use the instrument, and who also had professional climbing experience and training about wilderness management as individual assessments were necessary in the data collection process. Multiple people surveyed the same site at the same time to assess reliability and validity of the measures. Measures were simple and easy to collect and abide by recreation ecology principles applied to either stationary sites (nodes) or moving sites (linkages) (Hammit et al., 2015).

During ground-truthing in the field, field research assistants participated in the critique of indicators. All field research assistants were selected for their professional climbing backgrounds and were provided training on wilderness character and law.

JTNP and GCNP do not represent the diversity of wilderness rock climbing resources across the NPS, but they do represent a very high climbing use park and a very low climbing use park (MountainProject, 2019). It was practical for the scope of this study to test monitoring indicators in the field in different NPS units. When translating across units, differences in types of terrain, diversity of park resources, and challenges in climbing management will require critical consideration by the land manager to appropriately adapt monitoring design, including measures and thresholds, at the local level. The indicators presented in this research, however, are broadly relevant to wilderness climbing management.

Site selection.

For this study, a sample of climbing sites were chosen in each park in different geographic zones of wilderness for the purpose of testing monitoring indicators across various terrain. Climbs were selected with different elevations, geology, resource concern, and ease of access. In JTNP climbs were selected based on two factors. First, attractiveness; where high quality of climbing and moderate difficulties (suitability of grade) together contribute to popularity of a climb (Murdock, 2010). Second, areas of climbs of resource concern; where there were known conflict

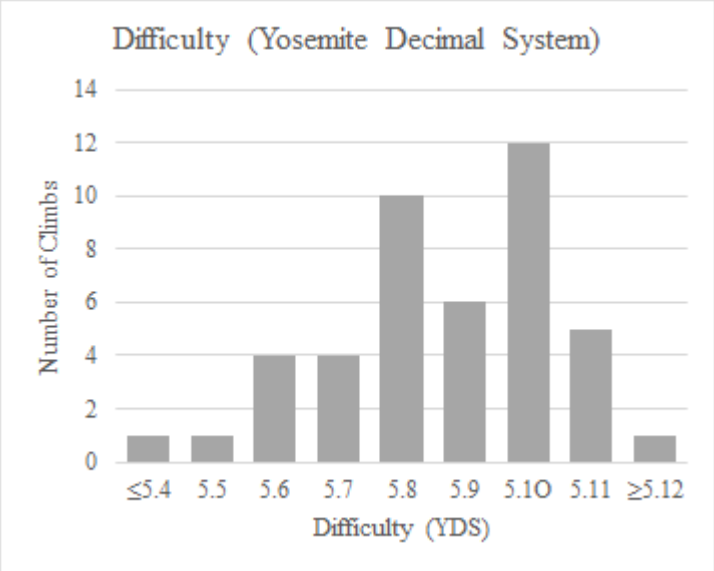

Figure 2. Difficulty of Climbs Monitored

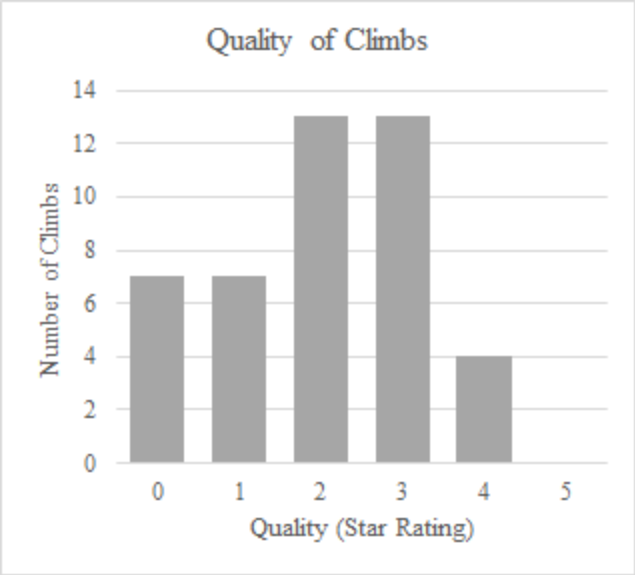

Figure 3. Quality of Climbs Monitored

of resources or new development of sport climbs in wilderness. In GCNP routes were selected that are most likely to see higher amounts of climbing traffic based on (1) accessibility, (2) quality. GCNP climbing routes were anecdotally reported by members of the climbing community to have very low levels of human impacts, so routes with more climbing traffic were monitored to assess the signs of climbing use in the GCNP landscape. In GCNP, river access climbs should be monitored because of the high numbers of people accessing the park via the river. For this study there was not logistical or financial support to conduct this monitoring. Popular third and fourth class climbs in GCNP were monitored to test protocol and indicators on lesser terrain. All sites are located in wilderness. A list of the selected wilderness climbing sites in the case study parks are in Tables 5 and 6.

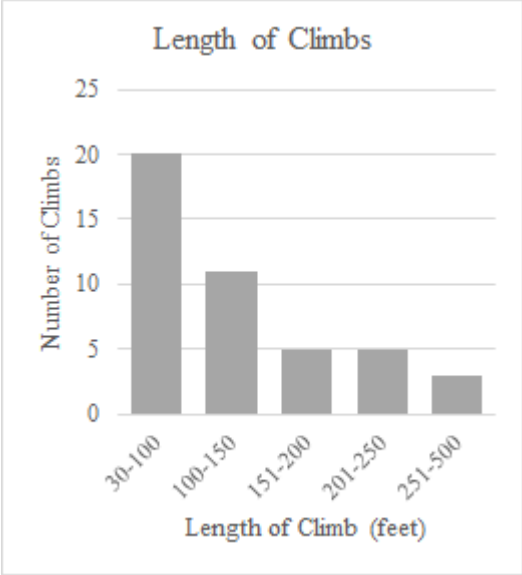

Figure 4. Length of Climbs Monitored

We monitored 44 total climbs; 11 in GCNP and 33 in JTNP. Sites selected included popular routes, selected by quality rating and suitability of difficulty, as well as sites of specific wilderness resource concern as identified by the park. The average difficulty of routes was 5.8-5.10 (Figure 2). The average quality of a route was two-three stars on a five-star rating system (Figure 3). The approach lengths were generally under an

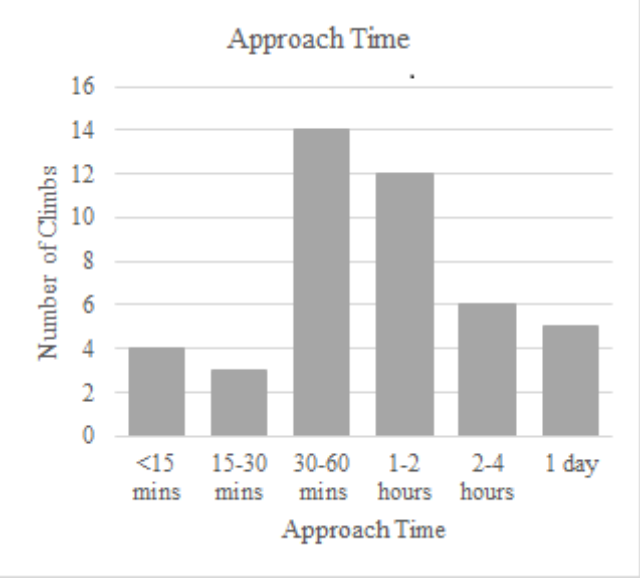

Figure 5. Approach Time of Climbs Monitored

hour in JTNP and ranging from 2 hours to 1 day in GCNP (Figure 5). Length of climbs varied from 1-4 pitches (30-500 feet) (Figure 4), and required multiple descent techniques including walking off, rappelling, and a combination of both. An overview of terrain classifications can be found in Appendix A.

Joshua Tree National Park.

Pilot studies in JTNP occurred from Spring of 2016 until Spring of 2019 for 3 periods in the spring climbing season, and between December 2017-March 2018. Field research assistants included climbing rangers and climber stewards, accredited climbing guides, JTNP wilderness committee members, and wilderness climbing advocates. Popular sites selected were based on moderate grading and quality, which are attractive to the most climbers and will see the highest amount of use (Murdock, 2010). Sites were selected from each of the wilderness sub-districts in the park as commonly designated in climbing guidebooks: Queen Mountain (South areas), Wonderland North, Wonderland South, Split Rock, Geology Tour Road, Indian Cove, Pinto Wye, and North Boundary.

JTNP is an iconic climbing destination and is attractive to newer climbers for its availability of easier graded routes and smaller terrain features. A defined purpose of JTNP is to "provide accessible and diverse opportunities in a remote desert to large and burgeoning urban populations" (USDI, 2017) like Palm Springs, the greater Los Angeles area, and San Diego. Recently, JTNP has faced increased visitation from climbers and increased visitation overall.

Park managers are beginning a new climbing management planning process, and as such support wilderness climbing research and seek documentation of changing resource conditions. Challenges to wilderness visitor use management in JTNP are numerous, and include changes in amount and type of climbing use, publications of many new guidebooks and online resources, unauthorized bolting, aging fixed anchors, flat openness of desert terrain inviting exploration, and lack of public awareness of wilderness and locations of boundaries, etc. (USDI, 2019a).

JTNP represents a high-volume climbing park. JTNP has records of no less than 33 published climbing guidebooks since the 1970s, with 5 currently in print, and additional online sources. Some local climbers estimate that there are 9,000 published climbing routes in the park, and an estimated 15,000-20,000 unpublished routes (Eddie Bauer, 2016). There are over 6,000 routes published on MountainProject (MountainProject, 2019a). And in JTNP, thirty-six percent of the mapped climbing formations are located in wilderness (USDI, 2019a). JTNP is operating with complex and numerous climbing management regulations borne from the 2000 JTNP Backcountry and Wilderness Management Plan (USDI 2000; USDI 2019b). 33 sites were monitored in JTNP wilderness.

Table 5. JTNP Climbs Monitored.

Joshua Tree NP Pilot Monitoring Sites		
Zone	**Rock Formation**	**Route**
Wonderland North	Suicide Horn	Bighorn Dihedral, 5.11****
	Super Dome	The Great Unknown, 5.10***
	East Siberia	Dos Chi Chis, 5.10***
		George's Route, 5.8**
Wonderland South	North Astrodome	Figures on a Landscape, 5.10b/c *****
	South Astrodome	Breakfast of Champions, 5.9****
	Bighorn Mating Grotto	Dangling Woo Li Master, 5.10*****
		Caught Inside on a Big Set, 5.10****

	Lenticular Dome	Mental Physics, 5.7****
	Room to Shroom	Room to Shroom, 5.9****
Geology Tour Road	East Virgin Isles	Diaper Challenge, 5.11**
		Perpetual Motion, 5.10****
	Lava Dome	But Fear Itself, 5.8**
North Boundary	Indian Head	Goof Proof Roof***
		Beer is Good, Great White Face**
	Hospital Crags	Complaining Neighbors*
	PETA Crag	Monkey Burger, 5.8**
		I Love Animals, They Taste Good, 5.9**
Queen Mountain South	Walt's Rocks	Perfect Fingers, 5.10*****
		At Your Pleasure, 5.8***
	Underground Chasm	Survivor, 5.13****
Split Rock Area	Rubicon	Rubicon, 5.10*****
	Isle in the Sky	Bird of Fire, 5.10a*****
	Future Games	Continuum, 5.8***
		Invisibility Lessons, 5.9****
Pinto Wye	The Hawk Hatchery	Hawk's Nest, 5.7***
	Zsa Zsa Gabor Memorial Boulder	Lesbian Lust, 5.9****
	Emerald City	The Rattler, 5.10***
	Beak Boulders	Bath Water, 5.9**
Rattlesnake Canyon	Rattlesnake Buttress	Taken for Granite, 5.8****
		200 Motels, 5.8****
Ryan Mountain	Oyster Bar	Heart of Darkness, 5.11****
Cottonwood Entrance	Butterbags Buttress	Love Bubbles, 5.7**

Grand Canyon National Park.

Pilot studies in GCNP occurred between Fall of 2017 through Fall of 2019 during five climbing expeditions in fall and spring climbing seasons. Field research assistants included climbing rangers, accredited climbing guides, and wilderness climbing advocates. Sites selected were based on moderate grading, quality, and relative ease of access, which collectively project

the popularity of a route (Murdock, 2010). Across the 1.2 million acre Grand Canyon Wilderness (proposed), most visitors access the Grand Canyon from the North or South Rim developed areas, followed by the Colorado River (USDI, 2015d). It was impractical to monitor river-accessed climbs due to the cost and technically prohibitive nature of river expeditions. Monitoring teams visited 11 5th class peaks, most of which are published in the only known guidebook (Tomasi, 2011), with a few newer, harder routes documented on MountainProject. It is noteworthy that MountainProject's published routes at GCNP have increased three-fold during the period when this research took place. The park was divided into wilderness sub-districts classified by point of access: North Rim, South Rim, Corridor, and River. Several high quality 5th class summits in western Grand Canyon were not monitored for this study due to time and logistical constraints.

Routes on the Bright Angel Walls were not surveyed as part of this study, although the area is within the wilderness boundary and is a sport and traditional climbing 'crag' with a concentration of about 30 routes along an approximately ¼ mile length of cliff at rim level. This area was excluded because it sees impacts from millions of visitors annually who walk a popular path at the top of the crag, and scramble below the rim. The area has trash, graffiti, and is constantly within sight and sound of civilization. The health of the Bright Angel Walls is not indicative of GCNP's wilderness character, and it is not feasible to determine overall impacts from climbers separate from the copious—and potentially outweighing—impacts from hikers, scramblers, and other visitors.

GCNP is a rugged and little-known park for wilderness climbing. Ancient sedimentary and metamorphic rocks layer together to create geologically complex and loose terrain. Hiking distances to access 5th class climbing commonly range from 4 miles to 15 miles, and most of that

mileage is off-trail travel in loose, steep terrain. Thousands of feet of elevation change on the approach hikes are normal. Opportunities for day trips to climb are possible, but many of the 5th class Grand Canyon summits are more commonly completed as overnight expeditions. This wilderness attracts a very different type of climber and represents a very different style of rock climbing than JTNP.

GCNP represents a low-volume climbing park. Information on climbing in GCNP is scant, with one out-of-print guidebook, and a few routes published on MountainProject, 2019b). Nearly 100% of climbs in GCNP are in wilderness, as the wilderness boundary largely follows the terrain line of the Canyon Rim, encompassing nearly all vertical terrain in the park, with cherry-stemmed areas of non-wilderness in the cross-canyon Corridor and Colorado River (USDI, 2018a). There are no fixed anchor policies currently in place, and the only climbing regulations in place are that commercial guiding is not allowed and there is a closure to climbing to protect a cultural resource (USDI, 2015; USDI, 2018b).

Table 6. GCNP Climbs Monitored

Grand Canyon NP Pilot Monitoring Sites		
Zone	**Rock Formation**	**Route**
Corridor/Central Grand Canyon	Zoroaster Temple	Screaming Sky Crack, 5.11****
	Buddha Temple	Southeast Face, 5.6**
	Dana Butte	North Cols & Buttress, 5.4*
	Monument Creek Pinnacle	The North Face, 5.11***
	Angel's Gate	The Doghouse (Southwest Face), 5.5**
South Rim	O'Neill Butte	East Face, 5.9**
	Newton Butte	East Ledges, 5.7*
North Rim	Mt. Hayden	South Face, 5.6***
		Pegasus, 5.10+***
	Brady Peak	South Chimney, 5.6***
	Sullivan Peak	Northeast Face, 5.6*

Chapter 3. Research Findings

In this section, I detail the findings of the integrative review and pilot testing. Wilderness climbing monitoring indicators are presented, along with key literature and analysis. Each indicator is presented with a discussion of monitoring strategy, recommended measures, measures considered but not included, and general thresholds. Results for monitoring in the pilot study parks are also included.

3.1 Integrative Review

The integrative review process began with the development of a concept matrix. To initiate this process, I identified key concepts in the climbing sections of each of the selected pieces of literature through reviewing their abstracts, tables of contents, and introduction sections. Key concepts were recorded in a Concept Matrix with topics on one axis and references (by Literature Group) on the other axis (Webster & Watson, 2002). In WSPs or GMPs, key concepts, e.g. general wildlife preservation, may be a fundamental value for a park but if the topic is not discussed in relation to climbing it is not included in the Concept Matrix. It is assumed that all parks with wilderness resources are managing a breadth of natural and cultural resources.

Table 7. Example Concept Matrix

	Citation 1	**Citation 2**	**Citation 3**	**Citation 4**	**Citation 5**
Concept 1	X	X		X	
Concept 2		X	X	X	
Concept 3		X			X

The key ideas identified in climbing management documents during concept identification are listed below (Table 8).

Table 8. Key Concepts in Climbing Management Documents

Key Concepts in Climbing Management Documents	
Vegetation	Damage to vegetation on cliff or base through intentional or unintentional action, including damage to roots, woody plants, and lichens.
Wildlife	Disturbance to wildlife or habitat, especially concerning raptor nesting.
Geologic Resources	Manufacturing of holds (e.g. chipping, gluing), smoothing and grooving of rock.
Water Resources	Water quality as a result of erosion, or contamination of desert water sources.
Soils	Soil compaction, erosion, loss or organic soils.
Social Trails	Trail braiding, erosion, habitat damage and fragmentation
Fixed Anchors	Power drills, recommended hardware, prohibited hardware, 'software' webbing anchors, fixed ropes, authorization processes, special management areas.
Solitude	Remoteness from signs, sight, and sound of other visitors.
Noise	Noise pollution of climbers communicating safety commands on the route, group size and noise, sounds of hand-drilling.
Litter	General litter, climbing specific litter (e.g. athletic tape)
Human Waste	Management recommendations and regulations (pack out, bury, etc.), toilet paper.
Visual Impact	Chalk, brightly colored webbing, uncamouflaged metal bolts, rust streaking from hardware, climbers visible to other visitors while climbing.
Unconfined Recreation	New route development, challenge and adventure.
Visitor Conflict	Conflicts or complaints between user groups.
Administrative Action or Responsibility	Education and patrol.
Administrative Restrictions on Visitor Use	Permits, closures.
Sensitive Resources	Threatened and endangered plant or animal species.
Cultural Resources	Archeologic and historic sites, resources, and cultural landscapes.
Wilderness Character	Allusions to the general preservation of wilderness character.

Concept Matrices 1 and 2 (Tables 9 and 10) contain surveys of the 19 selected NPS climbing management documents in the integrative review. Analysis was split based on wilderness or non-wilderness designation, and then assessed collectively. Any mention of a concept within a climbing management document, regardless of amount of information given, results in a value of 1 assigned to that concept. Numbers of plans that address each key concept are totaled and compared in Figure 5. For NPS wilderness management documents, top issues were (1) fixed anchors, (2) management restrictions on visitor behavior, and (3) natural resource protection (geology, wildlife, vegetation). The top issues were the same, plus visual impact and commitments of administrative resources (e.g. build an interpretive kiosk, patrol programs, education, restoration).

Table 9. Concept Matrix 1: NPS Wilderness Climbing Management

	Grand Teton NP GMP 1990	Mount Rainier NP WMP 1990	Canyonlands NP & Glen Canyon NRA BMP 1995	Joshua Tree NP BWMP 2000	Rocky Mountain NP BWMP 2001	Denali NP WSP 2006	Zion NP WSP 2007	Shenandoah NP ROMP/CMG 2012	Sequoia & Kings Canyon NP WSP 2015	Lake Mead NRA WSP 2016	Black Canyon NP CMP 2016	Lassen Volcanic NP WSP 2018	Yosemite NP SC 2018	North Cascades NP SC 2019	Big Bend NP SC 2019	Totals for Wilderness Plans
Vegetation				1	1		1	1	1	1	1					7
Wildlife			1	1	1			1	1	1				1	1	8
Geologic Resources			1	1	1		1	1	1	1	1		1			9
Water Resources																0
Soils				1	1		1	1	1							5
Social Trails	1			1	1		1		1		1					6
Fixed Anchors		1	1	1	1	1	1	1	1	1	1	1	1	1	1	14
Solitude	1			1					1	1						4
Unconfined Recreation				1				1	1	1	1					5
Visitor Conflict				1	1			1	1		1					5
Noise					1				1		1					3
Litter					1				1		1					3
Human Waste					1		1		1		1		1			5
Visual Impact			1	1	1		1		1		1				1	7
Admin. Action				1	1		1	1	1		1	1				7
Admin. Restrict.	1	1	1	1			1	1	1	1	1		1	1		11
Sensitive Resources				1			1	1								3
Cultural Resources							1	1		1						3
Wilderness Char.				1		1		1	1	1						5

Key to acronyms: GMP-General Management Plan, WMP-Wilderness Management Plan, BMP-Backcountry Management Plan, BWMP-Backcountry and Wilderness Management Plan, WSP-Wilderness Stewardship Plan, ROMP-Rock Outcrop Management Plan, CMG-Climbing Management Guidelines, CMP-Climbing Management Plan, SC-Superintendent's Compendium,

Table 10. Concept Matrix 2: NPS Non-Wilderness Climbing Management and Totals

	Devil's Tower CMP 1995	City of Rocks NR CMP 1998	Arches NP CCMP 2013	Pinnacles NP SC 2019	Totals for Non-Wilderness Plans		Totals for Wilderness Documents	Totals for Non-Wilderness Plans	Totals for All Documents
Vegetation	1	1	1		2		14	2	16
Wildlife	1	1	1		3		11	3	14
Geologic Resources	1	1	1	1	3		9	3	12
Water Resources		1	1		3		8	3	11
Soils	1	1	1		3		7	3	10
Social Trails	1		1	1	2		7	2	9
Fixed Anchors	1	1	1		1		7	1	8
Solitude			1	1	2		6	2	8
Unconfined Recreation	1				3		5	3	8
Visitor Conflict			1		0		5	0	5
Noise	1	1	1		2		5	2	7
Litter		1	1		2		5	2	7
Human Waste		1	1		0		5	0	5
Visual Impact	1	1	1		2		4	2	6
Administrative Action			1		2		3	2	5
Administrative Restriction	1	1	1	1	2		3	2	5
Sensitive Resources		1	1		2		3	2	5
Cultural Resources	1	1	1		3		3	3	6
Wilderness Character					2		0	2	2

Top issues in wilderness character monitoring are summarized by the five qualities of wilderness character: untrammeled, natural, undeveloped, opportunities for solitude or primitive and unconfined recreation, and other features of value (USDI, 2015). Key concepts in wildland recreation ecology are soil, vegetation, wildlife, and water (Hammit et al., 2015). Climbing research provides insight into recreation flow, cliff ecology including flora and fauna, attitudes about fixed anchors and visual impacts, effectiveness of climbing management practices, geologic resources, and the culture of self-governance in climbing.

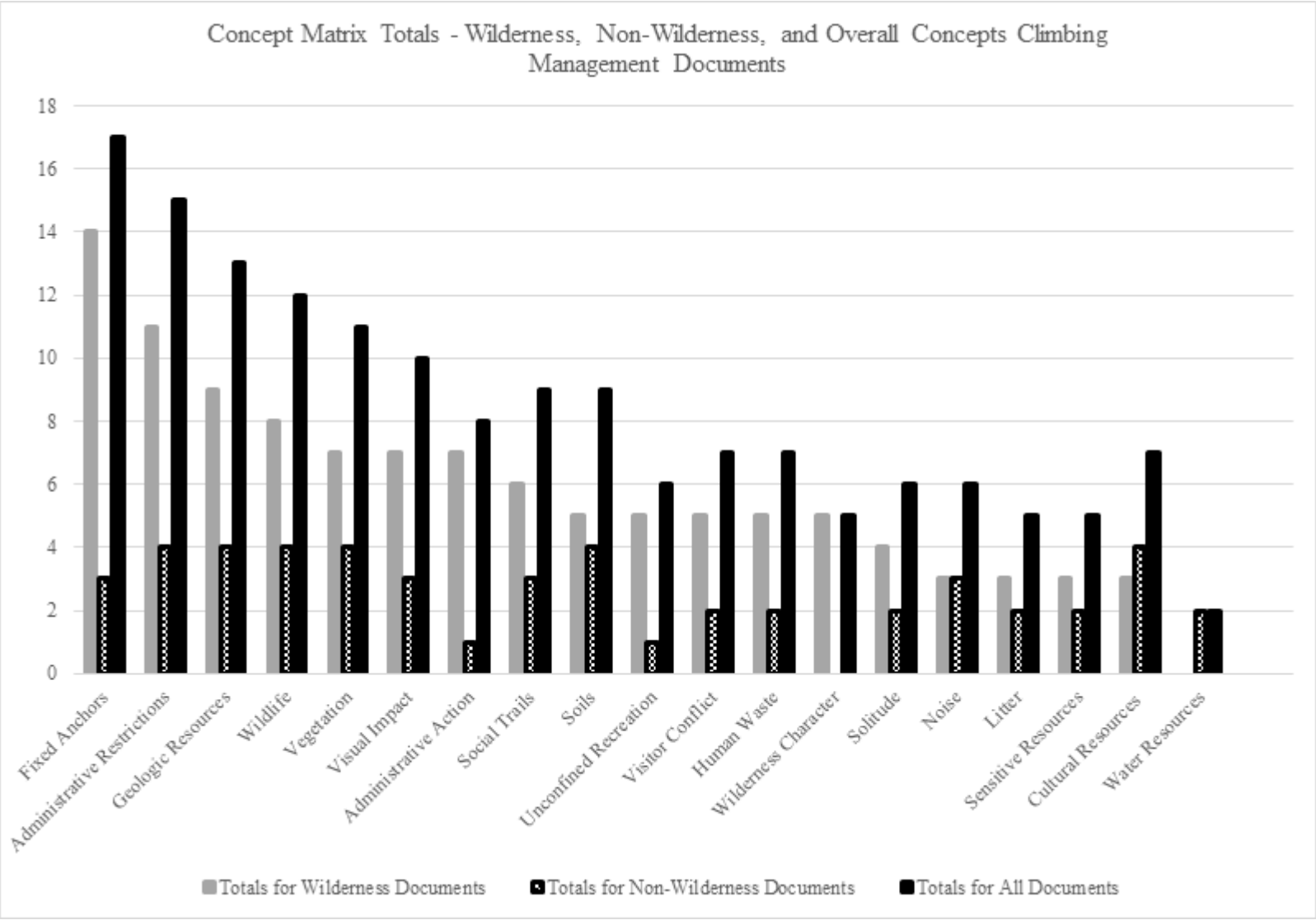

Figure 6. Concept Matrix Totals for Climbing Management Documents

3.2 Monitoring Indicators

The ten indicators selected for wilderness climbing monitoring are:

1. Natural – Plants
2. Natural – Animals
3. Natural – Geologic Resources
4. Natural – Ecological Processes
5. Undeveloped – Use of motor vehicles, motorized equipment, or mechanical transport
6. Solitude – Remoteness from sights and sounds of human activity *inside* Wilderness
7. Solitude – Facilities that decrease self-reliant recreation
8. Solitude – Management restrictions on visitor behavior
9. Other Features – Deterioration or loss of integral cultural features
10. Other Features – Deterioration or loss of other features of value

Documentation of the relationship between wilderness character monitoring indicators and wilderness climbing indicators is found in Table 11.

Table 11. Wilderness Character and Climbing Indicators

Wilderness Character Indicator	Climbing Indicator	Recommended Measure
Untrammeled		
Actions authorized by the federal land manager that intentionally manipulate the biophysical environment	N/A	N/A
Actions not authorized by the federal land manager that intentionally manipulate the biophysical environment	N/A	N/A
Natural		
Plants	1. Plants	Damage to Vegetation

		Presence of Sensitive Plant Species
Animals	2. Animals	Evidence of Animal Use
		Presence of Sensitive Animal Species
Air and water	3. Geologic resources	Damage to Rock
Ecological processes	4. Ecological processes	Social Trails
		Erosion, Hardened, or Denuded Core Area
Undeveleoped		
Presence of non-recreational structures, installations, and developments	N/A	N/A
Use of motor vehicles, motorized equipment, or mechanical transport	5. Use of motor vehicles, motorized equipment, or mechanical transport	Index of Authorized Administrative Motorized Use and Mechanical Transport for Climbing Projects
Opportunities for Solitude or Primitive and Unconfined Recreation		
Remoteness from sights and sounds of human activity *inside* Wilderness	6. Remoteness from sights and sounds of human activity *inside* Wilderness	Cairns or Trail Markings
		Trash
		Human Waste
		Visual Impact to Rock
		Number of Other Climbers Observed
		Number of Other People Observed
Remoteness from sights and sounds of human activity *outside* of Wilderness	N/A	N/A
Facilities that decrease self-reliant recreation	7. Facilities that decrease self-reliant recreation	Index of Facilities that Decrease Self-Reliant Recreation
		User-created Recreational Structures
		Fixed Equipment
Management restrictions on visitor behavior	8. Management restrictions on visitor behavior	Visitor Behavior Restriction Index
Other features of value		
Deterioration or loss of integral cultural features	9. Deterioration or loss of integral cultural features	Presence of Cultural Resources
Deterioration or loss of other features of value	10. Deterioration or loss of other features of value	TBD Area-specific

3.2.1 Justification of indicators

Indicators selected through the integrative review are justified below. Relationships of each indicator to the literature groups—climbing management, wilderness character, recreation ecology, climbing research, social science, and stakeholder positions—are detailed. This research is not meant to repeat the work of other consolidated literary resources for wilderness character, climbing management, or wilderness experiences. Excellent references to supplement these indicators are found in Attarian & Keith (2008), USDA (2015), and Cole (2012). Also documented are recommended and possible measures for each indicator that were determined through pilot testing of indicators. Remember though, that each park unit will select representative measures and thresholds based on their unique resources, histories, and foundations (USDI, 2006a).

The justification of monitoring indicator results section mirrors the format of the concept and relationship tables (Table 12).

Table 12. Example Concept and Relationship Table for Wilderness Climbing

	Relationship 1	
Concept 1		
Literature Group 1	Details and data	Citations
Literature Group 2	Details and data	Citations
Analysis: Conflict/Inconsistency: Indicator:		
Concept 2		
Literature Group 1	Details and data	Citations
Literature Group 2	Details and data	Citations
Analysis: Conflict/Inconsistency: Indicator:		

Indicator 1: Natural – plants.

Description of indicator.

This indicator represents the vegetative community in the vertical environment, including slopes below cliffs, summits, and descent terrain such as gullies and ledges. Climbing activities take place in unique environments which may not attract other recreational use. The vertical environment provides unique habitat for vegetation and wildlife as cliffs create microhabitats with their aspect (angle to the sun), hydrology, soils, and elevation. Climbing-caused damage to plants is most commonly mechanical by trampling or breaking and has been shown overall to degrade vegetative communities (Hammit et al. 2015).

Type of indicator: Field

In wilderness character.

Indicator: Plants

Indigenous plant species and plant communities are an integral part of the Natural Quality of wilderness. Indigenous plants are uniquely adapted to local environmental conditions and contribute to the maintenance of those conditions through such roles as providing soil nutrients and preventing soil erosion. In addition, these plants support the larger community of life by providing food and habitat for indigenous animals. Alterations of plant communities within wilderness may result in changes to the composition, structure, and function of individual plant communities, as well as cascading effects to the larger community of life within the wilderness through the loss, degradation, or alteration of habitat. For convenience, non-vascular plants (for example, bryophytes, lichens, and mosses) and fungi are also included in this indicator.

> This indicator captures the primary threats to indigenous plants and plant communities: the addition of non-indigenous species or the loss of indigenous species. A decrease in the presence of non-indigenous species would result in an upward trend in this indicator. An example of a possible measure for this indicator is the number, distribution, or abundance of non-indigenous invasive plant species. (USDA, 2015, p.41)

In climbing management

Climbing planning documents since the 1990s have included damage to vegetation as a resource protection concern. Plans frequently call out ‘gardening’ which is the intentional removal of plants to facilitate climbing, and the scrubbing of lichens from the cliff face. This act is commonly interpreted to be prohibited by law (Title 36 C.F.R., 2018). Plans also identify that cliff ecosystems are unique communities and many plans identify unique resources living in a vertical environment, such as threated or endangered plants, lichens, and the habitat provided by cliff-side and cliff-base vegetation.

Climbing management plans address vegetation that is lost or damaged by both intentionally means and unintentional means.

- First ascensionists may intentionally remove or cut vegetation to improve ease of access on the approach, at the base, on the route, and on the descent. Signs of this are cut and broken woody vegetation. Unfortunately, the removal of herbaceous plants is undetectable without prior knowledge of their existence through monitoring or photos. Areas at the base of a climbing area see impacts to vegetation that are similar to a backcountry campsite.

- Climbers ‘clean’ cracks by removing vegetation from weaknesses, or crevices, where plants naturally grow. Plants grow on cliffs in the same weaknesses that removable rock protection is placed in. Cleaning also occurs with loose rock that is a hazard for climbers.
- Some first ascensionists are in the practice of scrubbing lichens and mosses from cliff faces to enhance friction for foot holds. If not scrubbed, these lichens and mosses are lost over time with climbing traffic. A critical eye can see the line a climb takes in the difference in rock color on the climbing route versus the un-trampled rock around it.
- Use of trees for anchors also causes damage to plants, as well as the plant communities growing around them. In JTNP, climbing anchors built on vegetation is banned as a resource protection measure (USDI, 2019b). Frequently, water flows in the weaknesses on rocks which have fractures and ledges. These crevices and platforms collect soil, grow plants, and provide habitat. Without fixed anchors on mandatory technical descents, natural anchors are used. Natural anchors are commonly trees or boulders in areas of broken rock on the cliff-side and are rigged with webbing or rope for rappel anchors. It is common for these anchors to run along the ground and are often rigged short if the team doesn’t have enough webbing to leave a properly extended anchor. A short anchor configuration then involves pulling the team’s climbing rope through the cliff-side vegetation and damaging it. Over time, webbing and rope wrapped around trees also wears down bark and eventually damages the plants’ xylem and phloem.

In stakeholder positions.

None.

In recreation ecology.

Environments affected by climbing include approach terrain and informal trails; cliff base, vertical, and cliff-top environments; and descents via rappel or walking off. Although the removal of vegetation is illegal, inadvertent damage to vegetation is inherent to virtually any recreational use, including climbing.

Most recreational use results in trampling to plants. Plants can also be negatively impacted by soil compaction, soil loss, damage and exposure to roots, and cut or broken limbs as a result of recreational use in an area. Tree damage and root exposure is one of the most readily observable and persisting signs of recreational impact, whereas damage to forbs and graminoids often results in the plant disappearing completely from the landscape (Hammit et al., 2015). Damage to woody plants hasn't been shown to contribute to tree mortality, but continued damage over time could degrade the plant beyond survivability (James, et al., 1979; Nylund, et al., 1980; Pelfini & Santilli, 2006). Other concerns found in with recreational use include a change in species composition with a decreased richness of native species, creating opportunity for a higher richness in invasive exotic plant species (IEPs) with a higher tolerance for trampling. Challenges with attributing the presence of IEPs to climbers is challenging, as IEP spread in parks results from many types of visitor disturbance (e.g. OHV incursions, grazing), and notably changing environmental conditions due to climate change.

Figure 7. Photo of Impacted Base Area of Rubicon, JTNP 01/2019

Climbers face unique challenges in vertical terrain that are different than those of the well-studied backpacker. Cliff-base, cliff-side, summit, and descent terrain can all channel visitor use and impacts into small areas (Figure 8. Belay space at Room to Shroom, JTNP). In vertical terrain, fixed

Figure 8. Tree Damage in the Narrow Belay Space at Room to Shroom, JTNP, 01/2019

anchors can be a useful tool to divert traffic, and therefore trampling, onto more durable rock. Vegetation damage from climbers at cliff bases is similar to those of backpackers. In vertical terrain, trees may provide the only options for natural anchors in ascent or descent. Wear from webbing and rope around tree bark, and constriction from poorly fashioned anchors negatively impacts vegetation in vertical terrain.

In climbing research.

With climbing use, vascular plants decrease in species richness, diversity, abundance, density, cover, and species composition (Baker, 1999; Clark & Hessl, 2015; Lorite et al.; 2017; March-Salas, 2019; McMillan & Larson, 2002; Rusterholz, Muller, & Baur, 2004). Lichens are especially sensitive to climbing activities, and effects of climbing on lichen includes reduced cover and diversity (Clark & Hessl, 2015; Nuzzo, 1996). Change in the vegetative community happens through mechanical damage of trampling, breaking or cutting branches, removal of plants, and wear of ropes and webbing around trees (Baker, 1999; Clark & Hessl, 2015). Gardening and scrubbing of lichens are very harmful to cliff ecosystems (Lorite et al., 2017). Species have a different resilience to trampling, which over time changes the species composition (Hammit et al., 2015; March-Salas, 2019).

- More visitor use creates greater impacts on plant communities, whereas areas that receive less use see less disturbance to plant communities (Clark & Hessl, 2015; Lorite et al., 2017)
- Reduced density and cover of plants provide opportunities for invasive exotic species to grow, and like other recreationalists, climbers are a vector of non-native seeds (McMillan & Larson, 2002).

- Sensitive cliff species are at risk because they commonly have limited habitat availability and even small changes to cliff ecosystems could put entire species at risk (Clark & Hessl, 2015)
- Cliff bases and tops bear the brunt of mechanical damage by climbers. This may be created by the ease of terrain which allows use to spread over a wider area than along a technical route or descent, or running of ropes over plans on ascent and descent (Boggess, Walker, & Madritch, 2017; Clark & Hessl, 2015).
- Vascular plants, mosses, and lichens are influenced by different environmental drivers (Boggess et al., 2017).

Traditional cliff ecology research measures sites with a climbing treatment and compares them to control sites. Though there are mature labs focused on cliff ecology research, many studies are emerging which explore new questions. New research asserts that control sites are problematic for a number of reasons and suggest monitoring for change over time at a climbing location rather than assessing climbing sites against control sites (Boggess et al., 2017).

An issue with control sites is systematic abiotic differences between climbed and unclimbed cliffs (e.g. cliff angle, aspect, elevation) cause fundamental differences in the cliff ecosystem (Holzschuh, 2016; Nuzzo, 1996). Local ecosystem conditions are the determinant for vegetation cover and cliff flora, rather than climbing (Adams & Zaniewski, 2012; Nuzzo, 1996). New research asserts that cliff angle, especially in overhanging terrain, has been under-studied as it is challenging to access via rope (Clark & Hessl, 2015; Kunz & Larson, 2006). Cliff angle is a fundamental control, and there is a lack of research in steep and overhanging terrain. Climbers for technical access and digital photography are useful aids to gather better data in overhanging terrain (Clark & Hessl, 2015; Kunz & Larson, 2006). Environmental and physical conditions also

effect desirability and attractiveness for climbers, such that areas where climbing has not yet been developed may have fundamentally different cliff ecosystem and geologic conditions that don't attract climbers to use that cliff (Kuntz & Larson, 2006). Concern in cliff ecology studies is that "the lack of proper controls may lead to the overestimation of the negative effects of rock climbing on biodiversity" (Holzschuh, 2016, p.i).

Justification of indicator.

Any amount of recreational use will degrade vegetative communities, and this is accepted in allowing recreational use as long as the damage is contained, and the practices are sustainable and not increasing beyond tolerance. Some level of damage to vegetation at the cliff base, on the climb, summit, and descent is accepted with recreational use. Assessing trends in degradation to vegetative communities will help inform management practices as climbing use expands and as parks address restoration needs at well-established climbs.

Recommended measures.

- Tree condition/damage to woody vegetation: root exposure, branch breakage, scarring at base, on route, and descent.
- Vegetation cover: estimate in base area by bird's eye view photo point
- Presence of sensitive plant species: report to vegetation staff

Measures considered but not used.

- Vegetation cover estimate in 1 m quadrats or line and point intercept estimating cover at base.
- Species composition (classes native and non-native)

Indicator 2: Natural – animals.

Description of indicator.

The vertical environment provides unique habitat to both plants and wildlife. During breeding or nesting season, climbers may see animals around climbing areas. Wildlife may change movement patterns and habitat use when recreational use threatens them. Not all species are displaced by human recreation.

Type of indicator: Field

In wilderness character.

Indicator: Animals

> The presence of vertebrate and invertebrate species within wilderness is an integral part of the Natural Quality of wilderness and these species play specific roles in the larger community of life. An animal may be food for another animal or regulate the population of plants or animals upon which it feeds. Alterations in the occurrence or abundance of animals may result in cascading changes within the animal community as well as associated plant communities.
>
> This indicator captures the primary threats to indigenous animals: the addition of non-indigenous species or the loss of indigenous species. A decrease in the presence of non-indigenous species would result in an upward trend in this indicator. Examples of possible measures for this indicator are: number, distribution, or abundance of non-indigenous animal species; and an index of stocked lakes that could include, for example, a ratio of indigenous to non-indigenous aquatic species. (USDA, 2015, pp.41-42)

In climbing management.

Climbing management plans focus on protecting sensitive wildlife and habitat. Strategies often include minimizing human presence that may stress wildlife through seasonal or permanent closures of climbing areas. Major themes in wildlife management in climbing is disturbance of threatened or endangered species and wildlife disturbance during breeding, nesting, and fledging periods. Both visible presence and noise are considerations during sensitive seasons, for example during Desert Bighorn sheep lambing season. Birds, and especially nesting raptors, are sensitive to climbers at or above nests and more tolerant of climbers below but at a distance, so summit edges are also closed to protect nests (USDI, 1995b). Bats also see effects of climbing on wildlife activity, such as migration patterns, nest and den selection, feeding, resting, and reproduction.

In stakeholder positions.

Reasonable climbing closures to protect raptor habitat is supported by climbing stakeholders. The appeal for monitoring of closures and timely removal of restrictions is a key piece of promoting climbers' compliance with closures. Closures should be supported by the best available science and be applied consistently (AAC, 2009).

In recreation ecology.

Recreational disturbances to wildlife include direct and indirect impacts resulting in many changes to wildlife including diversity, behavior, reproduction, population levels, species composition, and physiology (Hammit et al., 2015). Factors of recreational activity that influence wildlife are type of recreational activity, recreationists' behaviors, predictability of impact, frequency and magnitude of impact, timing, and location (Knight & Cole, 1995). Most commonly, negative impacts to wildlife occur from recreationists who unknowingly create a

stressful environment for the animal (Larson, 1995). Some wildlife species are attracted to humans, often seeking human food. Reaction of wildlife to human threats varies by species, sex, presence of young, habitat requirements, age, and group size (Hammit et al., 2015).

Noise is a concern in wildlife management, including motorized noise, but most studies have looked at motorized vehicle use (Buckley, 2004; Bowles, 1995; Sheikh and Uhl, 2004). There are no studies on the impact of power tool noise on wildlife. Fast movements toward wildlife tend to create greater stress, whereas slow movement away or tangential to wildlife is less threatening (Hammit et al., 2015). Predictability of recreational behavior tends to desensitize wildlife to recreational disturbance (Knight & Cole, 1997), though nesting raptors are an exclusion to this as they have been shown to react stressfully to routine disturbance that they perceive as threatening. Different species of breeding pairs of raptors behave differently and should be managed by site specific monitoring. In general, nesting birds are disturbed by larger groups and more frequent human presence, but overall tolerances for human disturbance to wildlife is largely unknown (Hammit et al., 2015).

Timing of recreational impact is of critical importance. Breeding season is generally the most sensitive season and disturbances can be highly detrimental. If recreational impacts cross the animal's threshold for disturbance, the result could be nest abandonment and greater exposure of young to predation. Outside of breeding season, recreational disturbance to energy acquisition (e.g. foraging), can also result in energy expenditure (e.g. fleeing) (Hammit et al., 2015; Perona, Urios, & López-López, 2019). Recreational disturbance to raptors has the most research to date, but other wildlife, such as bighorn sheep, bats, and other bird species are also impacted by recreation activities in a vertical environment.

Location of recreational activity is also a critical consideration. Habitat for nesting, lambing, and denning is sensitive to human encroachment. Additionally, recreational activities that occur above wildlife or nest sites is more threatening than recreation occurring below (Hammit et al., 2015). Seasonal and spatial effects are the most important factors in managing recreational use to protect wildlife (Anderson, 1995; Perona, Urios, & López-López, 2019).

Outdoor recreation is the second leading cause in the decline of threatened and endangered species on public lands (Losos et al., 1995). Displacement from recreation is detrimental to wildlife in that it results in energy expense (Belanger & Bedard, 1990), temporal and spatial displacement from preferred habitat (Anthony et al., 1995; Taylor & Knight, 2003), reductions in reproduction rate and population (Burger, 1995), and change in species composition and diversity (Gutzwiller, 1995). Recreationists perceive that it is acceptable to get closer to an animal than that animal's threshold allows (Taylor & Knight, 2003).

The alteration of habitat, especially if the animal is specialized in its habitat selection, can be detrimental. Even the loss of shrubs and dead trees eliminates shelter and habitat (Hammit et al., 2015). Recreational impacts can change the available food, habitat, and relationships between predator-prey species.

Bighorn Sheep are impacted in both the mountains and the desert. They have a low tolerance, especially among their young, to disturbance. Off-trail hikers are more threatening to Desert Bighorn Sheep than on-trail users in Canyonlands National Park, and skiing has been shown to displace sheep in the Tetons (Nickerson, 2015). Bighorn sheep in JTNP were noticeably more removed from busy areas on weekends and holidays. Moderate to high use levels may exclude bighorn sheep from their preferred habitat, but the displacement of sheep

from human use areas is temporary and sheep use patterns will shift back with a decline in pressure from recreationists (Longshore, Lowrey, & Thompson, 2013).

In climbing research.

Avian diversity is lower at high-use climbing formations (Covy, Benedict, & Keeley, 2019). Across non-native and native species, resilient species are more common at popular climbing areas (Camp & Knight, 1998; Covy et al., 2019). Climbing use affects how and when birds use cliffs, as birds are observed in flight and farther from popular climbing cliffs, whereas less popular or unclimbed cliffs have more birds observed perched on the cliff and closer to the wall (Camp & Knight, 1998).

Abiotic factors, such as aspect have a strong influence on the selection of cliff habitat (Covy et al., 2019). The impact of rock climbing on bats is yet unknown, yet bats select habitat that is attractive for climbing use (Loeb & Jodice, 2018).

Justification of indicator.

Cliff ecosystems are unique, and climbing activities are the only activity to spatially overlap with this habitat. Additionally, climbers put unique stresses on animals by gaining high positions, at or above the animal or nest. Noise is commonly addressed in climbing management plans and negatively impacts wildlife, though the specific impacts are unknown. Noise from climbers communicating for safety would be a frequent intrusion, and although less frequent, noise from drilling also creates disturbances. Signs of sensitive wildlife displaced by climbing activity are important, as well as signs of nests and dens. Timing and location of closures should be carefully planned to address wildlife protection, and include areas and distances specifically upsetting to that species. Sensitive species may be displaced early and go undetected by climbers.

Recommended measures.

- Presence of sensitive animal species or evidence of nests or dens: report to wildlife staff

Measures considered but not used.

- Presence of invasive or nuisance species

Indicator 3: Natural – geologic resources.

Description of indicator.

Geologic resources are integral to rock climbing. Type and quality of rock are the definitive value of a climbing area. Qualities of friction and natural weaknesses define the technical style of climbing, and natural weaknesses accept removable protection. Rock should not be physically altered to manufacture holds or excessively clean loose rock.

Type of indicator: Field

In wilderness character.

Indicator: Air and water

Air and water are essential to maintaining properly functioning natural systems inside wilderness. Both are vulnerable to degradation by pollutants produced outside of wilderness as a result of land development and industrial activity. The presence of airborne pollutants in soil and water within wilderness can have direct adverse effects on sensitive plant and animal species and can directly affect essential ecosystem functions such as nutrient cycling. Air pollutants can reduce visibility. In addition to vulnerability to pollutants, water quality, water quantity, and associated features such as stream morphology are vulnerable to the effects of physical manipulations within and outside of

wilderness. For example, dams outside the wilderness can markedly affect water quantity and quality, as well as stream morphology, inside the wilderness. In some cases, such as in some desert wildernesses, loss of cryptobiotic soils from grazing or recreation trampling is a significant concern and would be appropriate to include in this indicator if such data are available.

This indicator captures quantities of selected pollutants present within wilderness, as well as selected measurable physical effects of pollution on visibility or the diversity and abundance of pollution-sensitive species. A wealth of air quality data is available from national sources. Though air pollution originates outside wilderness, identifying trends in air pollutants within wilderness may influence external decision- making processes, especially in wildernesses that are designated as Class I airsheds. This indicator also captures physical manipulations of free-flowing water within wilderness and their effects, as well as the effects of similar manipulations outside wilderness. Examples of possible measures for this indicator are: ozone exposure statistics, concentration of nitrogen and sulfur in wet or dry deposition, visibility statistics, altered water flow rates, and index of pollutant-sensitive lichen species. (USDA, 2015, p.42)

In climbing management.

The main issue concerning geology in climbing management is the manufacturing of climbing holds in the rock by (1) chipping, drilling, or chiseling hand and foot holds, and (2) gluing rock to reinforce holds that would otherwise break off or add new holds to the route. For a period in the late 20th Century, it was more accepted for climbers to manufacture holds by chipping or gluing holds on challenging, cutting edge routes. Though this is no longer common

practice, physical alteration of rock to manufacture climbing holds may be a remnant or could still be occurring. It is understood that climbers will remove loose rocks from routes to clean them for safety, but an over-cleaning, or excessively-forceful cleaning of loose rock should be minimized. Plans address the smoothing of rock with repeated abrasion, where the surface is eroded over time with traffic. Grooves created by rope running across soft rock is also a degradation to the geologic resource.

Older plans discuss fixed anchors as a degradation to geologic resources. There is no question that a bolt requires a permanent hole to be drilled in the rock. A piton, though removable, will widen cracks over time and create pockets called ‘pin scars.’

Notable geologic features, like named arches, are closed to climbing to protect the geologic and scenic value of the formation.

In stakeholder positions.

Climbing stakeholders promote clean climbing (Access Fund & Gunnison Valley Climbers, 2016).

In recreation ecology.

None.

In climbing research.

Research on the effects of rock climbing on geologic resources are scant. A recent study on a sandstone bouldering area in Poland found that rock climbing damages micro-relief of rocks and speeds up the natural weathering processes. Damage to crusts of sandstones intensifies the disintegration of the rock (Alexandrowicz, 2017).

Justification of indicator.

Condition of geologic resources are important, both to climbing activities, and commonly to a fundamental value of the wilderness. Many wilderness rock climbing units are known widely for their cliff and mountain terrain, and these features are valued by the general visitor in addition to the climber. Many types of geologic damage are permanent on the human scale pending a natural event like rock fall. Parks should understand the local trends of climbing impacts to geologic resources to shape management and educational strategies.

Recommended measures.

- Instances of damage to the rock, visible to the climber.

Measures considered but not used.

- None.

Indicator 4: Natural – ecological processes.

Description of indicator.

As discussed in plants and animals, cliff ecosystems are home to unique resources. Ecological processes are altered with physical change to the environment. This indicator captures the relationships between ecosystem elements. Fragmentation of habitat and alteration of hydrology through soil compaction and social trailing changes ecological processes.

Type of indicator: Field

In wilderness character.

Indicator: Ecological processes

The integrity of ecological processes within wilderness is vital to preserving the Natural Quality of wilderness. This indicator captures changes in ecological processes that have impacts on multiple components of the ecological systems within wilderness. Change, at any level, to one of these processes results in long-term cascading effects throughout the natural community. Data for potential measures in this indicator are likely to come from national programs with no local data collection, unless a local office has better data and the means to develop its own protocol.

Ecological processes are complex and difficult to quantify. Therefore, many of the potential measures for this indicator track either the magnitude or intensity of the factors likely to be affecting the natural processes within wilderness. Others quantify the resulting effects of processes that have changed. Finally, potential measures could take advantage of existing datasets that provide an index of the condition of certain processes within wilderness. Examples of possible measures for this indicator are: average watershed condition class, index of fragmentation, and acres of active grazing allotments.

Human-caused climate change measures would be included under this ecological processes indicator if an agency or individual wilderness chooses to include such measures. Climate change has the potential to drastically alter natural systems within wilderness. Despite well-documented impacts to the Natural Quality of wilderness, the feasibility and relevance of climate change measures to wilderness character monitoring need to be carefully considered before including such measures. Appendix 7 provides a detailed discussion and a flowchart to help staff determine whether climate change measures are appropriate for wilderness character monitoring. (USDA, 2015, p.42-43)

In climbing management.

Concerns over social trails are raised in nearly every climbing management document. Cross-country travel and route finding to access cliffs result in the creation of social trails. Social trails are detrimental to soil crusts, create denuded and compacted soils which change hydrology, and contribute to soil loss. Social trails can also pose a risk to sensitive resources, like archeological sites, as they are not planned by the park to avoid such sensitive areas.

Denuded and compacted soils at the base of climbs is also detrimental to cliff ecology. Cliff sides are known to channel water, and cliff bases and gullies are frequently rich with diversity of plant and animals (Hammit et al., 2015). Cliff tops are another unique environment that can become denuded and compacted with climbing use.

In stakeholder positions.

Wild and pristine landscapes that are culturally significant and biologically diverse have high recreational value. It is important to protect these places (AAC, n.d.). And in wilderness destinations with high levels of general visitor use, NPS should consider managing social trail networks for approaches, bivouacs, and descents to avoid environmental degradation (Access Fund, 2016c).

In recreation ecology.

Soil compaction and erosion are intrinsically tied to the vegetative and mycorrhizal communities (Chappell et al., 1971; Reeves et al., 1979). Though a recreationist on foot has magnitudes less impact than a recreational vehicle, the compaction created by foot traffic over time is detrimental to recreation site ecology. Soil compaction negatively impact root permeability and stresses ground flora. As soil compacts, it is increasingly more difficult for water to infiltrate the ground and can result in sheet run off. Sheet erosion results in a loss of

water and soil across broad surfaces (Kruss et al., 1990; Liddle, 1997). Channeling of water on steep, linear features like social trails and gullies causes a pronounced loss of organic matter and soil. Decrease in water infiltration rates is estimated to be the most negatively impactful effect of soil compaction, by leading to a long-term reduction in soil moisture (James et al., 1979). Different types of soils are susceptible to different degrees of compaction, for example sandy soil is less susceptible to compaction. More densely compacted soils also have a tighter pore space and less available space for air and aeration processes (Hammit et al. 2015).

Foot traffic also results in the loss of organic leaf litter and humus layers (O horizon). This loss of organic matter on the soil surface results in a decline in overall organic matter in the soil (Monti & Mackintosh, 1979). Many recreation ecology studies have shown that a loss of organic matter is an early sign of recreational impact and that other impacts are to follow (Marion & Merriam, 1985). Diverse ecosystems have lower or higher baselines for the amount of organic matter present naturally. In ecosystems with lower organic matter, like deserts, the loss of any organic matter can be severe. Once there is a loss of organic matter or crusts on top of the soil, erosion is accelerated by wind and water and will begin to expose roots of plants. Litter loss takes moderate use before erosion becomes substantial (Cole & Hall, 1992). Denuded areas are more prone to erode. Erosion is the most long-lasting and serious human impact on soil (Hammit et al., 2015).

The type of activity affects the impacts: concentrated areas of use receive more soil impacts from duration, intensity, and frequency of use. These areas are commonly flat, though, and so do not see too much erosion unless on a slope (Hammit et al., 2015).

In climbing research.

Sport climbs have nearly three times the size of compacted and denuded base area as traditional climbs (Carr, 2007).

Justification of indicator.

Climbers create social trails and denude vegetation from areas of concentrated use. This fragmentation of habitat and alteration of hydrology changes ecological processes.

Recommended measures.

- Social trails
- Erosion, hardened, or denuded core area

Measures considered but not used.

- Soil moisture
- Percent cover of organic matter on soil

Indicator 5: Undeveloped – use of motor vehicles, motorized equipment, or mechanical transport.

Description of indicator.

The undeveloped quality as it pertains to climbing addresses the use of motorized drills.

Type of Indicator: Administrative

In wilderness character.

Use of motor vehicles, motorized equipment, or mechanical transport

Section 4(c) of the Wilderness Act discusses three forms of mechanization that degrade wilderness character: motor vehicles, motorized equipment, and mechanical

> transport. This indicator tracks these mechanized uses for administrative, emergency, and other non-emergency purposes such as access to mineral rights, state land, and private land, and provision of other laws. Detailed discussion defining motor vehicles, motorized equipment, and mechanical transport can be found in agency policies. Monitoring allows managers to be aware of trends in increasing use and respond to them with appropriate management decisions to reverse or stabilize this trend. Examples of possible measures for this indicator are: index of administrative authorizations to use motor vehicles, motorized equipment, or mechanical transport; percentage of emergency incidents not using motor vehicles, motorized equipment, or mechanical transport; and number of non-authorized uses of motor vehicles, motorized equipment, or mechanical transport per unit of effort or time by law enforcement. (USDA, 2015, p.47)

In climbing management.

The use of motorized drills in wilderness is prohibited by the Wilderness Act. Robust, early climbing management plans from Devil's Tower National Monument (DTNM) and City of Rocks National Reserve (CRNR) (neither are wilderness areas) discuss motorized drills in regard to their contribution to a proliferation of fixed anchors. CRNR attributes the installation of 3,000 bolts in ten years to power drills by means of "quick and easy placement" (USDI, 1998a, p.31), as well as gives some credit in the proliferation of fixed anchors to hand drills. DTNM asserts that power drills aid in the development of routes that were formerly "unclimbable," (USDI, 1995b, p.12) and provide efficient and dependable means for placement of fixed anchors. Many parks that allow the use of power drills in non-wilderness require permission through a special use permit. Drills are also considered an audio disturbance in some plans (USDI, 1995b).

Many older plans discuss fixed anchors as installations in wilderness. The USDA Attorney General ruled that fixed anchors were not an installation on USFS wilderness lands (Murdock, 2010). New plans consider fixed anchors with other recreational facilities in regard to solitude quality, as per USDI (2015).

In stakeholder positions.

Climbing stakeholders support the ban on power drills in wilderness (Access Fund, 2011; AAC, 2009; Access Fund & AAC, 2015)

In recreation ecology.

None

In climbing research.

None.

Justification of indicator.

Though the use of motorized equipment is prohibited by the Wilderness Act, administrative processes could approve the use of a power drill for fixed anchor replacement through a Minimum Requirements Analysis if it is determined to be the minimum tool required. Any authorized power drill use related to climbing should be considered in this indicator, including the preemptive replacement of fixed anchors to be used in routine SAR operations. It may be true that power drills contributed to a proliferation of bolts, which is incompatible with wilderness. But now, with thousands of aging fixed anchors in wilderness, managers are faced with a traditional legal and ethical question about a modern wilderness problem.

Recommended measures.

- Index of authorized motorized tool use and mechanical transport

Measures considered but not used.

- Index of administrative emergency motorized tool use and mechanical transport
- Index of unauthorized motorized tool use and mechanical transport

Indicator 6: Solitude – remoteness from sights and sounds of human activity inside wilderness.

Description of indicator.

Wilderness visitors have individual understandings of solitude and have diverse expectations for their experience, but wilderness may provide an ideal environment to have a collection of meaningful, intensely attained solitude experiences. Experiences of challenge, connection, little sign of human impact, and quiet are commonly considered with experiences of solitude. Solitude may be degraded by sources outside of wilderness, like aircraft overflights or sky glow, but this indicator specifically addresses impacts from climbers that occur in wilderness.

Type of Indicator: Field

In wilderness character.

Indicator: Remoteness from sights and sounds of human activity inside wilderness

Remoteness—being distant from the sights and sounds of civilization—is important for achieving a sense of Solitude. Seeing or hearing other people inside a wilderness directly affects opportunities for Solitude. Opportunities for Solitude can exist on established travel routes and near developments within wilderness if visitation is low, or Solitude can be found by entering undeveloped areas where there are no official travel routes. In addition to visitors, this indicator can also capture trash and debris that degrade

most people's sense of what to expect in a wilderness. For example, in wildernesses that have beaches, trash that washes ashore may be a significant concern and degrades the feeling of remoteness. Similarly, trash and debris from hunting and outfitting camps can negate the feeling of being remote. Examples of possible measures that could be included in this indicator are: number of visitor encounters on travel routes; number of occupied campsites within sight and sound of one another; area of wilderness away from access and travel routes and developments; index of user-created campsites based on the site number, density, and impacts; and miles of user-created trails. (USDA, 2015, p.53-54)

In climbing management.

Both the number of people encountered and group size limits are addressed in climbing management plans. There is also acknowledgement of administrative efforts to provide opportunities for privacy and isolation. Signs of people, especially litter and human waste, are detriments to experiences of solitude. Unnatural noise is addressed as an intrusion on solitude.

Other degradations to solitude are encounters with modern equipment or recreational facilities and installations. These structures include agency-created and user-created structures and facilities.

In stakeholder positions.

Fixed Anchors are a significant tool for managing the climbing experience (Access Fund & AAC, 2015; Access Fund & Levitation 49, 2016). Climbers can be uniquely impacted by noise pollution (Access Fund, 2016).

In social science.

Fifty years of wilderness visitor experiences have been studied and the common thread is that each visitor's experience is individual and that visitors are highly socially adaptable (Borrie

& Roggenbuck, 2001; Cole, 2012). Research into the social purposes of wilderness have reported that "the most prevalent motives involved adventure and exploration, struggling with the elements, and experiencing a less artificial setting away from the care of the …world" (Cole, 2012, p.3), and solitude, social connection to their group, and connection to nature (Lucas, 1964; Roggenbuck & Driver, 2000).

Concepts of solitude are central to the Wilderness Act and have been examined for decades. New researchers examining the psychology of wilderness find that most people travel in wilderness with companions and are not truly isolated in the traditional sense of the word. Hammit (1982) asserted that 'privacy' is a more appropriate to the intent of wilderness as many wilderness experiences are valued for the human connections made in a unique natural and social environment.

Research on the effects of amount of use and crowding on quality of experience have failed to capture that wilderness visitors are adaptable and do not commonly report seeing other visitors as a degradation to solitude (Hall, Johnson, & Cole, 2007). Rather, poor behavior by other visitors is reported as a degradation to experience more than crowding. In ranking order, undesirable visitor actions are (1) illegal actions (e.g., knowingly violating mandatory closures), (2) careless actions (e.g., littering), (3) unskilled actions (e.g., improper human waste disposal), (4) uninformed actions (e.g., over-building of cairns), and (5) unavoidable impacts (e.g., visual impact from chalk). Inappropriate behavior and its remnant signs, such as human waste and litter, are usually top concerns for visitors (Stankey & Schreyer, 1987). It has been shown that visitors who do not enter wilderness seeking solitude are still appreciative of their experiences (Cole, 2012).

The effects of noise from sources outside of wilderness, such as military exercises and aircraft overflights, are well studied in the field of soundscape ecology. Emerging research, specifically out of NPS wilderness areas explores the relationships between sound and wilderness visitor experience. Visitors report that natural quiet as being a motivation to visit wilderness (Mace, Bell, & Loomis, 1999; Miller, Taff, & Newman, 2018; Miller et al., 2018). Visitor-caused sounds, such as noise created by large groups, are detected and found annoying by other visitors, whereas natural sounds like wind and water were found to be pleasing (Pilcher, Newman, & Manning, 2008). Types of noise—aircraft versus human voices—receives mixed reviews as to its impact on the visitor experience (Miller et al., 2018; Taff et al., 2015). Site-specific context is important in the determination of measures for decreased solitude through noise pollution. Noise negatively impacts both wildlife and visitors, and low- and high-level noise both need to be managed. Spatial and temporal zoning paired with education can be useful tools for mitigating noise impacts (Hammit et al., 2015).

In climbing research.

The visual impact of fixed anchors has been studied, but the biophysical impacts of fixed anchors have not. Fixed anchors as a visible sign of civilization was a central issue in the fixed anchor debate of the 1990s (Jones & Hollenhorst, 2002). Uncamouflaged, brilliant fixed anchors in near-view range are reported as a visual impact for all wilderness visitors. Mid- and far-range uncamouflaged anchors, and near-range camouflaged anchors were not reported to be visually disruptive. Additionally, sport climbers did not prefer scenes with fixed anchors more than traditional climbers, despite the difference in their dependence on fixed anchors (Jones, Hollenhorst, & Hammit, 2004).

Many recreation studies indicate increased visitation on weekends and holidays (Murdock, 2010; Perona, Urios, & López-López, 2019). Spatial distribution of climbing use is not spread evenly, and use is driven by ease of access, high quality, and appropriate difficulty (Murdock, 2004; 2010). Concentrated areas of use will have qualities that fit these criteria.

The relationship between soundscape and mountaineering visitor experience found mixed reactions by mountaineers to noise. Some reported feeling safer with aircraft overflight noise because it meant that climbers were being shuttled in and out of camps, as well as NPS rescue operations were functioning. Other climbers reported aircraft overflight noise as an annoyance (Miller et al., 2018).

Justification of indicator.

Each visitor has a different understanding of solitude and a different expectation for their experience. Cultural shifts and adaptability of humans create a moving target for managers, who are better left to choose which user group or which experience/expectation they will manage for (Cole, 2012). Though climbers may or may not be seeking solitude when climbing in wilderness, it is a protected landscape that must offer opportunities for those experiences. As with all wilderness recreation, minimizing signs of civilization should be a goal, including trash, human waste, and uncamouflaged removable and fixed anchors. Likewise, group size limitations and encounters with people are related with managing for solitude as well as for reducing the biophysical impacts of large groups. Unnatural noise is also a consideration in wilderness climbing management, which alludes to both the sound of parties communicating and also the sound of rock drills or other climbing noises.

Recommended measures.

- Encounters with people (climbers and non-climbers)

- Encounters with large groups
- Presence of litter
- Presence of human waste or toilet paper
- Visual impact to the rock (including camouflaged anchors and chalk)
- Presence of trail markings

Measures considered but not used.

- Climber counts or recreation flow
- Encounter rates
- People at One Time

Indicator 7: Solitude –facilities that decrease self-reliant recreation.

Description of indicator.

Facilities that decrease self-reliant recreation are both user-created and administratively created. These facilities are specifically recreational in nature. Fixed anchors are assessed as a recreational facility for climbing, as well as user-created structures such as fire rings, bivouac shelters, stacks of rocks at the base of routes ('cheater stacks' or 'cheater rocks'), signage or marking of route starts, and site hardening and erosion control structures (e.g. belay platforms, stairs). These recreational facilities are considered differently than other signs of civilization in wilderness because they are not the remnant effects of humans, but rather are intentionally built or installed features that facilitate a recreational experience.

Type of indicator: Field and administrative

In wilderness character.

Indicator: Facilities that decrease self-reliant recreation

Primitive recreation requires self-reliance, as well as travel that is unassisted by mechanical or motorized equipment. Many different types of structures, installations, and developments are constructed to facilitate access or use of the wilderness, to improve visitor safety, or to protect other wilderness resources from visitors. Facilities designed for these reasons are categorized as recreational in this monitoring strategy and occur in many wildernesses. Examples are: system trails, trail signs, bridges, sleeping platforms in swamp wildernesses, toilets in high-use areas, aircraft landing strips, food storage lockers or bear poles where bears pose a threat to safety, hardened and designated campsites in high-use areas, and the "comfort" facilities provided by outfitters and guides for their clients. Although trails and other recreation facilities in wilderness concentrate user impact and protect resources, and visitors appreciate and use these facilities, such developments reduce the experience of primitive recreation and the need to practice primitive backcountry skills.

This indicator provides a means for measuring trends in the presence of those durable or relatively permanent facilities provided by the agency and others (such as outfitters and guides) that affect the opportunity for primitive recreation. This indicator also provides a means for monitoring facilities or services that do not have a physical presence but still diminish self-reliant recreation, such as cell-phone coverage. Examples of possible measures for this indicator are: index of authorized recreation facilities that includes number and type, miles of developed trails, and area of cellphone coverage. (USDA, 2015, p.54-55)

In climbing management.

Evidence of human use and modern improvements are considered in climbing management. These include visual impacts left on the landscape like chalk, trash, and human waste. Visual presence of climbers on rock faces are also considered.

In stakeholder positions.

Fixed anchors must be allowed where climbing is allowed, levels allowable should be determined on a case-by-case basis, and should be a tool of last resort (Access Fund, 2011; Access Fund & AAC, 2015; AAC, 2009). Properly managed fixed anchors do not degrade wilderness character and fixed anchors should be rare and occasional in wilderness (Access Fund, 2011; AAC, 2009; Access Fund & AAC, 2015). Climbing stakeholders support limits on bolt-intensive face climbs and identify that there should be allowances made for traditional style face climbs, like those found in JTNP. Policies should allow climbers to maintain and replace fixed anchors. Policies should differentiate between different types of fixed anchors and uses for fixed anchors (Access Fund, 2011).

In recreation ecology.

Recreational facilities will concentrate impacts but may not drive use (Hammit et al., 2015).

In climbing research.

Fixed anchors are a fundamental tool in wilderness climbing and have been used in climbing since 1875 on the first ascent of Half Dome by George Anderson (Jones & Hollenhorst, 2002). The use of fixed anchors long pre-dates the legal concept of wilderness (Access Fund, 2011). Fixed anchors are not proven to be a predictor for visitor flow or biophysical impacts. Census of fixed anchors can give managers an idea of density and spatial extent of wilderness fixed anchors (Murdock, 2010).

There is no research to date on the biophysical impacts of fixed anchors. Though wildlife biologist Richard Knight asserts that: "'Anchors in no way, shape, or form are affecting biodiversity,'…Rather than focusing on anchors, Knight says, federal agencies should better manage the direct impacts of climbing on cliff habitats" (Knight, (1999), as quoted in Baker, 1999, p.1). Fixed anchors can be used as mitigation tools to limit impact to cliff ecosystems (Boggess, 2017; Lorite, 2017).

Justification of indicator.

Like with the addition of any recreational structure or facility in wilderness, the structure itself challenges the concept of wilderness. When considering increasing visitor use and increasing biophysical impacts, recreational structures serve to concentrate impacts from use and direct use away from sensitive features. Fixed anchors are determined to be a necessary tool in wilderness climbing and the occasional placement of a fixed anchor does not violate the Wilderness Act (USDI, 2013a). Per wilderness character monitoring strategy, fixed anchors should be assessed with other recreational facilities like a wayfinding sign on a trail or a toilet (USDA, 2015). These recreational facilities can be used tools for resource protection. There should not be a proliferation of recreational structures in wilderness and use limitations should be implemented to balance impacts from overuse with the permitting of key recreational facilities.

Recommended measures.

- User-created recreational structures
- Fixed equipment

Measures considered but not used.

- Index of facilities that decrease self-reliant recreation

Indicator 8: Solitude – management restrictions on visitor behavior.

Description of indicator.

A key factor that separates wilderness recreation from non-wilderness recreation is the value of freedom from administrative burden. One of the symbolic values of wilderness is outstanding opportunities for unconfined recreation. As visitation on public lands increases, and consequently social and biophysical impacts increase, management restrictions are appropriate to preserve wilderness resources. This indicator examines the administrative restrictions on visitor behavior to appropriateness considering resource protection needs.

Type of indicator: Administrative

In wilderness character.

Indicator: Management restrictions on visitor behavior

> Management restrictions in wilderness are often adopted to protect resources or opportunities for Solitude. However, unconfined recreation refers to types of recreation in which visitors experience a high degree of freedom over their own actions and decisions; management restrictions degrade this sense of freedom and limit opportunities for unconfined recreation. In the context of this monitoring strategy, management restrictions on visitor behavior in wilderness are agency regulations or policies that govern visitors' behavior, travel, or equipment. An example of a possible measure for this indicator is an index of visitor management restrictions based on the size of the area affected, the duration of the restriction, and the intensity or magnitude of the restriction. (USDA, 2015, p.55)

In climbing management.

Self-sufficiency, direct experience in weather and terrain, and freedom to explore are values of wilderness climbing experiences, which includes opportunities to climb new routes. Managers must strike a balance between allowing freedom of climbing activities and protecting biophysical resources and the experiences of other visitors. It is accepted in climbing management plans that climbers are responsible for their own safety and climbing is a high risk activity. There are challenges inherent to the environment that are valuable as a part of an area's wilderness character, and NPS wildernesses are distinct and world class climbing destinations. In these wilderness areas, Leave No Trace and clean climbing ethic should be the norm such that impact on resources and other visitors is minimized and therefore implementation of new regulation can be avoided.

Rocky Mountain (RMNP) and Yosemite National Parks (YNP) specifically have special freedoms for overnight use for climbers. RMNP offers technical climbers a bivouac permit that stipulates a minimal amount of equipment allowed for overnighting (e.g. no tents allowed), gives access to camping locations closer to climbs, and is separate from the busy backpacking permit system; this creates opportunities specifically for climbers to access the wilderness. Zion has permits available for overnighting on climbs as well. YNP, another busy wilderness park, does not require wilderness camping permits for climbers overnighting on a climb.

Examples of restrictions on visitor behavior in climbing management documents are:

- Use limits, permits for access (day or overnight)
- Registration to climb
- Fees
- Permits for fixed anchors (new, replacement, removal)

- Area closures
- Activity closures
- Reporting requirements or permits for new routes
- Group size limits

In stakeholder positions.

Fixed anchors should be authorized locally, and if reasonable through blanket authorizations as not to impose undue burden on the climber (AAC, 2009; Access Fund, 2011; Access Fund & Levitation 49, 2016). There should not be interim bans on new fixed anchors while climbing management plans are being written (AAC, 2009; Access Fund, 2011; Access Fund & Gunnison Valley Climbers, 2016). The guidelines for appropriateness of new routes is such that they should meet the desired conditions of wilderness (Access Fund & Gunnison Valley Climbers):

> Wilderness fixed anchor management should provide provisions (programmatically or case-by-case basis) to allow climbers some level of control, while in a wilderness setting, to make decisions regarding fixed anchor placements where no other options are available. Such policies allow climbers to make legal, critical decisions regarding personal safety in unforgiving conditions often experienced in rugged wilderness. Only a very small minority of climbers partake in wilderness-based first ascents that involve the placement of fixed anchors; however, the ability of climbers to place a *de minimus* number of wilderness fixed anchors is a privilege worth protecting because it embodies "outstanding opportunities for solitude or a primitive and unconfined type of recreation"8 associated with the purest forms of wilderness exploration. (Access Fund & Gunnison Valley Climbers, 2016)

Stakeholders support the use of adaptive management strategies and education strategies to minimize the needs for restrictive closures or limitations (Access Fund & Levitation 49, 2016). In busy wilderness parks, regulations on general wilderness users impose undue limitations on wilderness climbers. Hikers and wilderness climbers are infrequently looking to access the same hiking and camping destinations (Access Fund, 2016c). Likewise, restrictions to enter busy national parks adversely effects climbers, who are destined for climbs away from popular destinations. Entrance permit reservations remove the climber's ability to safely pursue challenging climbs as weather conditions allow (Access Fund, 2017).

In social science.

The concept of 'situated freedom' is integral to assuring that management restrictions are appropriate and administrative burden is minimized on the user (Manning, 2011). In this concept, managers put basic boundaries in place and "within those boundaries recreationists are free to experience the world in highly individual, unique and variable ways" (Cole, 2012, p.5). Leave No Trace education is emphasized because it is an indirect technique that allows users to make their own decisions and should be trialed before the implementation of rules (Dawson & Hendee, 2009).

In climbing research.

99% of the 669 BLM and USFS wilderness units do not have regulations specific to climbing (Griffin, 2017).

Justification of indicator.

In the increasingly busy, popular world of climbing it is all too easy to stack on regulations to slow the perceived onslaught of impacts from climbing. It is critical in wilderness management to recall that outstanding opportunities for primitive and unconfined types of

recreation is a value. Monitoring the administrative burden on the user against impacts recorded in other indicators is a way to track change over time in this indicator and critically assess the effectiveness of regulations to protect resources and visitor experience.

Recommended measures.

- Visitor behavior restriction index

Measures considered but not used.

- None.

Indicator 9: Other features – deterioration or loss of integral cultural features.

Description of indicator.

Loss or degradation of cultural features through recreational use should be monitored. Geologic formations that are attractive for climbing are frequently also related to cultural resources. Climbing use could impact cultural resources on the spectrum of degradation by climbers being visibly present in a cultural landscape, to climbers physically entering and impacting discrete cultural sites at climbing locations.

Type of Indicator: To be determined per local resources and values.

In wilderness character.

Indicator: Deterioration or loss of integral cultural features

This indicator captures the condition of cultural features determined to be integral to wilderness character, as well as authorized and unauthorized actions that damage or disturb these features. “Cultural” is defined broadly to include both prehistoric and historical features. A decline in the condition of integral cultural features or an increase in

> actions that damage or disturb these features degrades wilderness character. Examples of possible measures that could be included in this indicator are: condition index for integral cultural features, and number of authorized or unauthorized actions that damage or disturb integral cultural features. (USDA, 2015, p.60)

In climbing management.

Many climbing plans address cultural resources that spatially overlap with climbing activity. Some rock formations have ethnographic importance and are part of larger cultural landscape. Depending on the cultural use and features of a site, climbing could have adverse effects on prehistoric and historic rock art or structures.

Permanent closures are a typical way to protect cultural sites from climbing. DTNM effects a voluntary closure of Devil's Tower during the month of June to protect the tower as a cultural resource.

In stakeholder positions.

For closures related to cultural landscapes and impact to viewsheds, stakeholders believe that management strategies could be implemented to preserve the cultural resource and allow for recreational use. Additionally, closures to climbing should equitably also include closures to scrambling (Access Fund & Boise Climbers Coalition, 2015).

In recreation ecology.

None.

In climbing research.

Bouldering (Marrs, 2012) and other climbing uses (USDI, 2013b) can have a strong spatial correlation to cultural sites and cultural landscapes.

Justification of indicator.

Cultural resources are commonly an integral feature of wilderness character and are protected under the other features of value quality. Depending on the park's cultural and climbing resources there may or may not be a spatial overlap. Park's cultural resources staff and climbing staff should work together to identify areas of concern. Physical impacts and conflict between rock climbing and cultural sites should be reported to cultural resources staff for further investigation.

Recommended measures.

- Presence of Cultural Resources: report to cultural resources staff

Measures considered but not used.

- Degradation of cultural landscapes through visual presence of climbers
- Documentation of concern over climbing from Traditionally Associated Native American Communities

Indicator 10: Other features – deterioration or loss of other features of value.

Description of indicator.

If a park specifically protects unique resources, as stated in enabling legislation, wilderness legislation, or foundation document, that resource is a candidate for measurement in this indicator. Examples of other features of value are paleontological, educational, scientific, or scenic features.

Type of Indicator To be determined per local resources and values.

In wilderness character.

Indicator: Deterioration or loss of other integral site-specific features

This indicator captures the condition of other site-specific features determined to be integral to wilderness character. Although it is expected that most wildernesses will not have other unique site-specific features that are integral to the area's wilderness character, this indicator is intended to provide additional flexibility to use locally relevant information to capture iconic geological, paleontological, and other features. A decline in the condition of other integral site-specific features degrades wilderness character. Examples of possible measures that could be included in this indicator are: condition index for integral geological, paleontological, or other features; and number of authorized and unauthorized actions that damage or disturb integral geological, paleontological, or other features. (USDA, 2015, p.60)

In climbing management.

None.

In stakeholder positions.

None.

In recreation ecology.

None.

In climbing research.

None.

Justification of indicator.

The wilderness character quality ‘other features of value’ is not required in all wilderness areas and is therefore an optional indicator in wilderness climbing monitoring. If there is a suitable ‘other feature of value’ that relates to or intersects with climbing, then it should be included and measured.

Possible measures.

- Degradation of paleontological resources: report to specialist
- Degradation of scenic resources: report to specialist
- Degradation of geologic resources: report to specialist

Statement of limitations.

The untrammeled quality of wilderness character is not represented in the list of indicators for wilderness climbing monitoring. These are actions that are authorized (or unauthorized) by the federal land manager that intentionally manipulate the biophysical environment. Assessment of trammeling actions requires advanced wilderness management knowledge. If wilderness managers identify trammeling actions related to climbing, there should be specific investigation into those actions.

3.3 Monitoring Design Recommendations

The field monitoring design was built out of the necessity to test indicators identified in the integrative literature review. The results from field monitoring were positive and indicated areas for continued testing and refinement. This field monitoring design presents an integrated approach to wilderness climbing monitoring by combining (1) concepts of recreation ecology,

(2) activity-specific impacts, and (3) considerations for wilderness character. The goal is to obtain baseline information that is systematized, measurable, sensitive, reliable (repeatable), efficient, cost effective, significant to management issues, and that can track change over time in an assessment of the effectiveness of management strategies in achieving desired resource conditions. Field methods involve principles of rapid site assessment (Foti, 2012), flow with standard climbing patrol operations (Jenkins, 2017), and include photographic and geospatial data.

Also, important to note is that the design of this monitoring protocol is developed based on a body rigorous field studies in general recreation ecology impacts. Additionally, applied management frameworks developed by interagency wilderness management committees and interagency visitor use management frameworks are heavily drawn from as applied management foundations (USDA 2015; IVUMF 2016). The protocol was designed to align with the applied nature of management in parks, which do not always allow the time, staff skill, or budget to implement detailed and intensive studies on wilderness climbing management. Keeping up with changing visitor use patterns and intensities and changing environmental conditions due to development or climate change, prompt wilderness managers to act with the best data provided to them in order to secure the wellbeing of park and wilderness resources.

3.3.1 Field data collection

Recommended measures.

Table 13. Recommended Measures

Monitoring indicator	Suggested measure
1. Natural – Plants	• Damage to vegetation
2. Natural – Animals	• Signs of wildlife nest or dens • Wildlife disturbance while climbing
3. Natural – Geologic Resources	• Damage to rock
4. Natural – Ecological Processes	• Social trails • Extent of erosion, hardened or denuded base
5. Undeveloped – Use of motor vehicles, motorized equipment, or mechanical transport	• Administrative motorized or mechanized use index
6. Solitude – Remoteness from sights and sounds of human activity *inside* Wilderness	• Cairns or trail marking on approach • Trash / litter • Human waste / toilet paper • Visual impact to rock
7. Solitude – Facilities that decrease self-reliant recreation	• Fixed equipment on approach • Average # fixed anchors per foot • Appropriateness of fixed anchors • User-created recreational structures
8. Solitude – Management restrictions on visitor behavior	• Visitor behavior restriction index
9. Other Features – Deterioration or loss of integral cultural features	• Presence of cultural features within 50 feet of climb
10. Other Features – Deterioration or loss of other features of value	• TBD: Locally determined

Monitoring techniques.

The monitoring team inventoried the breadth of impacts at each site and matched them with the indicators and looked for omissions or inaccuracies in the monitoring indicators. The teams also tested possible measures for the indicators based on different types of terrain,

organization of the entire climbing site (approach, staging, climb, summit, descent), resource concerns, and social interactions. It was appropriate to format possible measures in a multiple parameter rating-based system (Cole, 1989; 1983). This system individually assessed impacts using either descriptive or quantitatively defined classes. This system does not make categorical estimates and is therefore better suited to track change over time and can be used to examine relationships between indicators (Hammit & Cole, 1998; Marion, 1991). A multiple-parameter rating based system, though requiring researcher judgment, provides the best balance of field monitoring methods between data collection, training requirements of field technicians, and efficiency (Hammit et al., 2015).

Supplemental photo point monitoring was found to be critical in documenting site conditions (Cole, 1989). Photo points taken from a bird's eye view on the climbing route provided an accurate and objective documentation of the staging area. Other recreation ecology techniques were trialed as possible measures and this research proposes some of those measures, but for the overall documentation of cliff-base impact, photo points are the best way to assess change over time.

Training and selection of field technicians.

Field technicians were selected for their background in climbing and wilderness management. Technicians were provided training in wilderness character basics and an overview of the history and topics in climbing management in the NPS. All selected field technicians also had professional experience with climbing, as a park ranger, NPS volunteer, or accredited guide.

Inter-rater reliability.

Quantitative and qualitative examination of indicators at each site were conducted independently by monitoring team members for inter-rater reliability and checks for omissions.

This allowed data reviewers to ensure that a verifiable and objective data set was collected during each monitoring visit, by demonstrating low levels of between-observer variation. This technique is recommended to be carried through application of field monitoring for improved reliability of data. Through this process, thresholds common to wilderness were derived based on desired conditions of wilderness character (USDI, 2014).

Areas of conflict.

Indicators that proved challenging to measure were Natural – Ecological processes, and Solitude – Facilities that decrease self-reliant recreation. Without training in vegetation cover estimations, transect or quadrat assessment, and invasive and sensitive plant identification it was challenging to measure using more sophisticated vegetation impact techniques from recreation ecology. We found high levels of variability in inter-rater reliability with plant identification, cover estimates, or transect/quadrat work. The most reliable method was to assess damage to woody vegetation and to obtain a bird's eye photo of the base area. Repeat photography is a reliable method to document loss of plants over time. A supplemental measure for vegetation is the ecological processed measure of denuded base areas on staging areas, summits, and descents.

Measuring the appropriateness of fixed anchors was another area of conflict among monitoring team members. Judgement based on training and experience must be used to make an appropriateness determination, and therefore results could be variable. Testing and discussion of contentious measures were discussed at each monitoring site with each field technician. As identified in many research papers on climbing, fixed anchors are the central source of conflict in wilderness climbing management (Jones & Hollenhorst, 2002; Murdock, 2010). The number of fixed anchors that constitute rarity in a landscape depends on local factors, like how well the

rock accepts natural protection, the history and tradition of climbing in a specific location, and any other local wilderness considerations.

Field researchers explored multiple iterations of assessment of appropriateness of fixed anchors keeping in mind the management aim for them to be rare in a landscape and placed only occasionally. This research resulted in two measures to be used in combination to begin to assess the appropriateness of fixed anchors: a quantitative assessment of the average number of fixed anchors per foot and a qualitative assessment of the appropriateness of fixed anchors. A discussion of these measures can be found below. These measures should not be taken superficially or without application to local conditions. These measures would be greatly improved by new research on the impacts of fixed anchors on visitor experiences and biophysical resources.

Teams agreed that the measure of average fixed anchors per pitch was inappropriate due to the variability of pitch lengths, availability of natural protection, type of climbing, geomorphology, and break-downs. For example, if a team climbs JTNP wilderness climb "Figures on a Landscape" in two pitches versus three, the results vary as demonstrated below (Table 14). The total length of a climb is consistent, as well as the number of fixed anchors. Pitches can be variable and therefore are a poor metrics to use in calculating fixed anchor acceptability.

Table 14. Comparison of Fixed Anchors per Pitch versus Fixed Anchors per Foot

Comparison of fixed anchors per pitch versus fixed anchors per foot			
Pitch breakdown (1)		**Pitch breakdown (2)**	
P1: 11 bolts, 100 feet (including belay anchors) P2: 1 bolt, 100 feet (including belay anchors) P3: 2 bolts in 40 feet (including belay anchors)		P1: 11 bolts, 100 feet (including belay anchors) P2: 3 bolt, 140 feet (including belay anchors)	
Total	14 bolts; 240 feet; 3 pitches	**Total**	14 bolts; 240 feet; 2 pitches
Bolts per pitch	4.7	**Bolts per pitch**	7
Bolts per foot	1 bolt: 15 feet	**Bolts per foot**	1 bolt: 15 feet

The quantitative measure of fixed anchors per foot is the average number of fixed anchors associated with each pitch, including belay anchors (and excluding rappel anchors not used on ascent). To calculate the measure, count each piece of fixed hardware individually and divide by total number of feet. Through field discussion and testing known wilderness climbing routes through this model, thresholds for the rating-based system were set at fixed anchors per foot were set at: Low -1 fixed anchor per >30 feet; moderate – 1 fixed anchor per 15-29 feet; high - 1 fixed anchor per <15 feet.

The qualitative measure for fixed anchors is the appropriateness of fixed anchors. This measure is to be judged by a technician with wilderness knowledge and professional climbing experience and cannot be determined by a member of the climbing public.

Table 15. Appropriateness of Fixed Anchors Measure

Appropriateness of fixed anchors measure	
After climbing the route does your judgement, which is based on your training and experience, say that the fixed anchors were few and appropriate? Are they rare and selectively placed to protect sections of face that do not take removable protection, and protect against high-risk falls? Is the purpose of some fixed anchors to protect cliff-side resources? Does the bolting on this route match traditional and historic climbing ethic of climbing in this park (including pitches of aid to link crack systems)?	
Low	Few and appropriate, ethically consistent with traditional and historic climbing practices in this park.
Moderate	More anchors exist than meets the 'rare' standard above, but anchors are still deemed appropriate. Route consists of more sections of face climbing than crack, but bolt spacing is not that of a modern sport climb. Natural anchors may be present, but bolts have been added to augment questionable natural anchors, reduce visual impact, or protect cliff resources.
High	A route has sections of what may be considered 'sport' bolting, with fixed anchors at even distances regardless of appropriateness, risk, or difficulty of terrain relative to crux (5.5 sections bolted on a 5.9 route). Belay anchors are bolted, regardless of opportunities to build anchors with feasible removable protection. Top anchors are numerous, when there could be one shared, bolted top anchor.

We tested the monitoring protocol on 3rd and 4th class routes in GCNP. These routes vary based on climber abilities and terrain as to whether they require a rope to safely manage the experience. Due to the differences in physical structure of non-technical terrain, the monitoring design did not work. Likewise, the indicators for technical climbing were not pertinent to managing impacts from non-technical scrambling.

Meaning of measure values.

The design of field data collection allows it to be assessed by individual indicator, sets of indicators, or as a complete climbing site. At this point, field data design is not conducive to making an assessment of landscape-scale wilderness climbing conditions, but rather assesses impacts at popular climbing destinations. Newly popular, or newly developed sites can be assessed through the monitoring protocol. In order to collect enough data across a landscape to

characterize the health of a wilderness climbing system, focused work on site selection needs to be completed as well as obtaining input by resource specialists and law enforcement on areas of concern. Only once the data collected, is considered in relation to the administrative monitoring data and other park data and is brought into conversation with individual assessments by NPS staff, can the data direct management decisions.

3.3.2 Administrative monitoring

Administrative monitoring will occur once per monitoring cycle for each wilderness, regardless of zoning. Administrative monitoring is for the indicators (1) Indicator: Undeveloped – Use of motor vehicles, motorized equipment, or mechanical transport, and (2) Indicator: Solitude – Management restrictions on visitor behavior.

Visitor behavior restriction index – climbing.

The Visitor Use Behavior Restriction Index (VRBI) is a tool to assess the level of administrative burden on visitors and is used as a measure of unconfined recreation (Landres, 2009). While it is important to put in place regulations to protect resources and visitor experiences, it is critical in wilderness management practice that there is not undue restriction placed on visitors. Any restrictions that are nationally consistent, like regulations in 36 CFR or prohibition of drones, are not included, as they do not involve local-level discretion to implement. To use this general wilderness character measure for wilderness climbing, the manager must first measure restrictions applicable to all wilderness visitors, and then must measure regulations specific to climbing.

The original list of management restrictions on visitor behavior is:

Table 16. USFS Visitor Behavior Restriction Index Regulations

USFS Regulations Considered in the VBRI	
• Campfire restriction—designated site only; above designated elevation; mandatory setbacks, other; mandatory setbacks, water; prohibited. • Human waste restrictions—must pack out. • Stock use restrictions—grazing prohibited; feed restricted; mandatory setback, sites; mandatory setback, trail; mandatory setback, water; no camping with stock; no free trailing; no hitching or tethering. • Maximum party size	• Campsite restriction—in designated sites only; mandatory setback, other; mandatory setback, sites; mandatory setback, trails; mandatory setback, water; • Maximum length of stay. • Swimming and/or bathing prohibited. • Dogs restricted—leashed/under control; prohibited. • Permits required—day use; multiple day use; overnight use; • Fees required. • Area closures.

(Landres, 2009)

Climbing-specific restrictions commonly found in climbing management documents are:

- Area closures
- Climbing permits or registration
- Fixed anchor regulations
- First ascent regulations
- Human waste disposal regulations
- Visual impact restrictions (chalk, camouflaged anchors)
- Bivouac restrictions

Chipping or gluing climbing holds on the rock and the removal of vegetation has been consistently interpreted as being illegal under 36 CFR 2.1 in climbing management plans. That regulation states the following is prohibited: "(1) Possessing, destroying, injuring, defacing, removing, digging, or disturbing from its natural state: (1) Plants or the part of products thereof. (iv) A mineral resource…or parts thereof," (Title 36 C.F.R., 2018, p.17). Those regulations are

not included on the list of restrictions on management behavior as they are common to all parks and there is not local-level management discretion regarding these regulations.

To complete the data collection and analysis, the reviewer should identify all regulations applicable to general wilderness visitation in the Superintendent's Compendium, an annually updated regulatory document created by the power of the superintendent. Next, regulations in the Superintendent's Compendium on climbing, both that apply broadly across the park and are restricted to wilderness are noted. Climbing restrictions designated for non-wilderness application are not included. A score is assigned within each category of regulation according to the guidelines presented in Table 17. The geographic extent of the restriction is also recorded. If a wilderness has more than one type of regulation within a given category, the score will be assigned that corresponds to the most restrictive regulation in place. A higher score indicates a greater degree of restriction on visitor behavior. An initial VRBI is completed for general visitor restrictions, then a climbing-specific VRBI is completed.

Table 17. Visitor Behavior Restriction Index Scoring

VBRI Restriction Scoring	
Score	Level of restriction
0	No regulation within the category.
1	Some restriction with retention of some individual choice. • For example, designated site camping policies enable visitors to choose from available sites when they arrive at their destination. • A score of 1 is also assigned in cases in which regulations are restrictive but affect only one segment of the user group (e.g., permits for new fixed anchors effects route developers, whereas permits for any fixed anchor placement, replacement, or removal effects everyone interested in bolting).
2	No choice is permitted. • For example, assigned site policies that require visitors to select campsites before beginning their trip would receive a score of 2.
3	Reserved for the most restrictive regulations: use limits, waste pack-out requirements, closures to stock, and area closures to all use.

(Landres, 2009)

The recommended set of general and climbing VRBIs are listed below.

Table 18. Categories, Scores, and Types of Restrictions for Computing VBRI

Categories, scores, and types of restrictions for computing the VBRI	
General Restrictions	
Fees	0 No fees 1 Fees charged of selected user type 2 Fees charged of all visitors
Camping	0 No restriction 1 Any mandatory setback; designated sites; day use areas 2 Assigned sites
Overnight Permits	0 No permit or registration 1 Voluntary self-registration 2 Mandatory, non-limiting permit or registration, specially available opportunities for permits to climbers 3 Mandatory; use limited (all users)
Campfires	0 No restriction 1 Designated site, above designated elevation, or mandatory setback 2 Total prohibition
Day Use Permits	0 No registration 1 Voluntary self-registration 2 Mandatory, non-limiting permit or registration 3 Mandatory; use limited
Human waste	0 No restriction 3 Pack out required
Length of stay	0 No restriction on length of stay 1 Length of stay limited
Stock use	0 No restriction 1 Permit required 3 Stock prohibited
Swimming/bathing	0 No restrictions 2 Prohibited
Area closure	0 No restriction 1 Seasonal closure 3 Permanent closure
Group size limits	0 No restriction 1 Group size limits in place
Pets	0 No restrictions 1 Required to be on leash 2 Prohibited
Climbing Restrictions	
Permits (climbing)	0 No permit or registration 1 Voluntary self-registration 2 Mandatory, non-limiting permit or registration, specially available

	opportunities for permits to climbers 3 Mandatory; use limited
Group size limit (climbing)	0 No restriction 1 Group size limits in place
Closures (climbing)	0 No restriction 1 Seasonal closure 3 Permanent closure
Human waste regulation (climbing)	0 No restriction 3 Pack out required
Fixed anchor regulations	0 No restriction 1 Permits required for new fixed anchors 2 Permits required for any installation, replacement, removal of fixed anchors 3 Fixed anchor moratorium
New route regulations	0 No restriction 1 Mandatory reporting after completion 2 Permit required for new routes 3 New routes prohibited
Bivouac regulations	0 No restriction 1 Voluntary bivouac permit, no use limitation 2 Mandatory bivouac permit, no use limitation 2 Mandatory bivouac permit, use limited
Visual impact regulations	0 No restriction 1 Restriction on visual impacts; chalk; camouflaged fixed anchors

After the score is assigned for each category of regulation, these scores will be weighted to reflect the geographic coverage of the regulation as follows:

- 1—the regulation applies to a subarea of wilderness.
- 2—the regulation applies to an entire wilderness.

The maximum possible restriction score in the proposed index is 86. The index restriction value will be a percentage representing the actual restriction score divided by the highest possible restriction score (highest restriction value x 2 entire wilderness, for each category).

The example in Table 19 demonstrates the process for the JTNP wilderness. The scores for each of the X types of regulations will be reported for each wilderness along with the total

index score.

Table 19. Climbing Visitor Behavior Restriction Index for JTNP

Climbing Visitor Behavior Restriction Index for JTNP			
General Restrictions			
Type of regulation	Score	Geographic weight	Total score
Fees	2 Fees charged of all visitors	2	4
Camping	1 Any mandatory setback	2	2
Overnight Permits	1 Voluntary self-registration	2	2
Campfires	2 Total prohibition	2	4
Day Use Permits	0 No restriction	2	0
Human waste	0 No regulation	2	0
Length of stay	1 Length of stay limited	2	2
Stock	1 Permit required	2	2
Swimming/bathing	2 Prohibited	2	4
Area closure	3 Permanent closure	1	3
Group size limits	1 Group size limits in place	2	2
Pets	2 Prohibited	2	4
		General index total	**29/54 or 54%**
Climbing Restrictions			
Type of regulation	Score	Geographic weight	Total score
Permits (climbing)	0 No permit or registration	2	0
Group size limit (climbing)	0 No restriction	2	0
Closures (climbing)	3 Permanent closure	1	3
Human waste regulation (climbing)	0 No restriction	2	0
Fixed Anchor Regulations	3 Fixed anchor moratorium (fixed anchor–free zone)	1	3
New Route Regulations	0 No restriction	2	0
		Climbing index total	**6/32 or 19%**
		Overall total	**35/86 or 41%**

Example of calculating the most restrictive regulation in a category: Fixed anchors

Restriction 1:

- JTNP has a closure for all fixed anchors in its fixed anchor free zone, which is a subarea of wilderness.
    - This scores a 3 for restrictions (“3 Fixed anchor moratorium”)

- This scores a 1 for geographic extent because it applies only to a subarea of wilderness.
- The total score for the Visitor Behavior Restriction Index is 3.

Restriction 2:

- JTNP requires superintendent approval (a special use permit) for the placement of any new fixed anchors in wilderness.
    - This restriction scores a 1 ("1 Permits required for new fixed anchors").
    - This scores a 2 for geographic extent because it applies to all wilderness.
    - The total score for the Visitor Behavior Restriction Index is 2.

The highest scored restriction is counted in the index, therefore the value for JTNP's fixed anchors regulations is 3.

Cautions:

Data for the index measure are reliably and accurately reported through [Superintendent's Compendia]. The items tracked encompass the range of management actions likely to affect visitors' feelings of confinement. Despite these characteristics, the index has a significant drawback in that it can capture only three levels of extent (no regulation, subarea, and total wilderness). Ideally, it would be best to have a more precise measure of spatial extent to better track change over time and to more accurately measure the impact on visitors. Another limitation is that, although the weighting scheme seems logical, the specific weights are subjectively determined. This limitation can be addressed through simulations using different weighting schemes, however, and, at the wilderness level, the data will be captured in a way that permits disaggregation of the specific components. (Landres, 2009)

Administrative motorized/mechanized tool use index – climbing.

Motorized or mechanized use in wilderness can be approved through a Minimum Requirements Analysis (MRA) when it is determined that a prohibited tool is the minimum tool required to complete a resource or visitor protection task. In wilderness character monitoring, a weighted index of the type and duration of tool use is recorded. Many wilderness units monitor both administrative prohibited uses as well as emergency prohibited uses. Unless a park has a strong system in place to track prohibited uses in wilderness during emergency operations, this measure is impractical and possibly not useful as all emergency response is planned to be the most efficient, safe, and resource aware. Emergency motorized and mechanized use is not recorded in this wilderness climbing monitoring strategy. For parks wishing to integrate data from emergency incidents, examples of indices are found in "Technical Guide for Monitoring Selected Conditions Related to Wilderness Character" (Landres, 2009).

Table 20. Equipment Types and Inherent Weights for Motorized/Mechanized Index

Equipment type	**Inherent weight**	**Equipment type**	**Inherent weight**
Air compressor	2	Motorcycle	3
Air tanker	3	Motorized watercraft	3
All-terrain vehicle	3	Motorized winch	2
Battery-powered tool	1	Portable pump	2
Bicycle	1	**Motorized rock drill**	**3**
Chain saw	3	Snow machine	3
Concrete equipment	3	Truck	3
Fixed-wing aircraft	3	Wheelbarrow	1
Float plane	3	Wheeled litter	1
Generator	2	Heavy equipment	4
Heavy equipment	4	Helicopter	3
Helicopter	3	Motorcycle	3

The Motorized/Mechanized Tool Use Index provides a measure of development

permitted in wilderness by considering approved projects that involve prohibited uses. Each project has a calculated development weight that considers the inherent impact of each type of tool, the number of tools, and the number of days the tools are in use. Each project is weighed individually in the index, then totals for all projects in the monitoring cycle are added together to provide a cumulative measurement representing development impact (Landres, 2009).

Table 21. Attributes for Measuring Motorized/Mechanized Use Days

Attributes for measuring motorized/mechanized use days
Equipment type*
Number of pieces of equipment*
Number of days actual use*
Name of authorization
* The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.

Primary source is a review of MRAs. The secondary source is the wilderness coordinator. MRAs for a five-year period will be reviewed for motorized tool use related to climbing projects. Ideally, a rolling tally is kept of any approved motorized tool use. From each MRA, the type of equipment is noted (motorized rock drill), along with the number of pieces of equipment, number of days of use, and the name of the MRA. To obtain a value, for each individual tool used:

(inherent weight of tool) x (number of days of use) = (value per tool).

Each value per tool is added to obtain a total value for each project. Each project's total value is added together to assess the five-year value (Landres, 2009). The total index value is calculated as a total of all authorized project index values for a five-year period.

Example of motorized/mechanized tool use index for climbing: In a period of five years,

a park decides to allow use of power drills for climbing projects in wilderness. The first use is to use power drills to replace fixed anchors used regularly in technical rescue on Route ABC. The second is an authorization for fixed anchor replacement with power drills on Dome XYZ.

Project 1: An example index for the Route ABC fixed anchor replacement is below. The park authorizes the use of one power drill for one day to complete the project.

Table 22. Motorized/Mechanized Index for Route ABC

Project Name: Route ABC SAR Fixed Anchor Replacement			
Type of equipment	Inherent weight	Days of actual use	Equipment use value
Rock drill one	3	2	6
		Project motorized index value	**6**

Project 2: An example index for the Dome XYZ fixed anchor replacement is below. The park authorizes the use of two power drills for three days to complete the project.

Table 23. Motorized/Mechanized Index for Dome XYZ

Project Name: Dome XYZ Fixed Anchor Replacement			
Type of equipment	Inherent weight	Days of actual use	Equipment use value
Rock drill one	3	3	9
Rock drill two	3	3	9
		Project motorized index value	**18**

Five-year index for motorized/mechanized use is:

Table 24. Five-Year Value for Motorized/Mechanized Use Index

Motorized/Mechanized Use Index	
Project Name	Project motorized index value
Route ABC SAR Fixed Anchor Replacement	6
Dome XYZ Fixed Anchor Replacement	18
Five-Year Index Value	**24**

Cautions: Concerns about this index are the “arbitrariness” of the weights selected, and debate about “the implied relationship between different numeric values (e.g., that multiple chain

saws used for multiple days has more impact than a single helicopter" (Landres, 2009, p.177). The values of these developments in and of themselves is difficult to derive meaning from, however when used to assess change over time in an individual wilderness (Landres, 2009).

The Motorized and Mechanized Use Index provided is specifically edited to address projects allowing power drills solely. If projects are approved through the MRA process that relate to climbing and incorporate other motorized or mechanized uses (e.g. helicopters, wheelbarrows), then those tools should be added to the index according to the inherent weights provided in Table 20.

3.3.3 Triggers to initiate specialist research

Any resource of special concern that is noted during field monitoring and reported to the appropriate officials for follow-up. These areas of special concern could include presence or signs of threatened or endangered plant or animal species, cultural resources, or law enforcement concerns. Climbing activity can spatially overlap with sensitive resources that includes raptor habitat, bighorn sheep habitat, cliff-adapted plant species of concern, and cultural sites. Each NPS unit will have specific resource concerns intersecting with the terrain that climbers travel in or occupy.

3.4 Joshua Tree National Park Pilot Study

3.4.1 JTNP climbs monitored

Popular moderate climbs in wilderness were the main selection for site monitoring for the purpose of verifying monitoring indicators. By request, a few newly developed and controversial sites were included in monitoring.

Table 5. JTNP Pilot Field Monitoring Sites

Joshua Tree NP Pilot Monitoring Sites		
Zone	**Rock Formation**	**Route**
Wonderland North	Suicide Horn	Bighorn Dihedral, 5.11****
	Super Dome	The Great Unknown, 5.10***
	East Siberia	Dos Chi Chis, 5.10***
		George's Route, 5.8**
Wonderland South	North Astrodome	Figures on a Landscape, 5.10b/c *****
	South Astrodome	Breakfast of Champions, 5.9****
	Bighorn Mating Grotto	Dangling Woo Li Master, 5.10*****
		Caught Inside on a Big Set, 5.10****
	Lenticular Dome	Mental Physics, 5.7****
	Room to Shroom	Room to Shroom, 5.9****
Geology Tour Road	East Virgin Isles	Diaper Challenge, 5.11**
		Perpetual Motion, 5.10****
	Lava Dome	But Fear Itself, 5.8**
North Boundary	Indian Head	Goof Proof Roof***
		Beer is Good, Great White Face**
	Hospital Crags	Complaining Neighbors*
	PETA Crag	Monkey Burger, 5.8**
		I Love Animals, They Taste Good, 5.9**
Queen Mountain South	Walt's Rocks	Perfect Fingers, 5.10*****
		At Your Pleasure, 5.8***
	Underground Chasm	Survivor, 5.13****
Split Rock Area	Rubicon	Rubicon, 5.10*****

	Isle in the Sky	Bird of Fire, 5.10a*****
	Future Games	Continuum, 5.8***
		Invisibility Lessons, 5.9****
Pinto Wye	The Hawk Hatchery	Hawk's Nest, 5.7***
	Zsa Zsa Gabor Memorial Boulder	Lesbian Lust, 5.9****
	Emerald City	The Rattler, 5.10***
	Beak Boulders	Bath Water, 5.9**
Rattlesnake Canyon	Rattlesnake Buttress	Taken for Granite, 5.8****
		200 Motels, 5.8****
Ryan Mountain	Oyster Bar	Heart of Darkness, 5.11****
Cottonwood Entrance	Butterbags Buttress	Love Bubbles, 5.7**

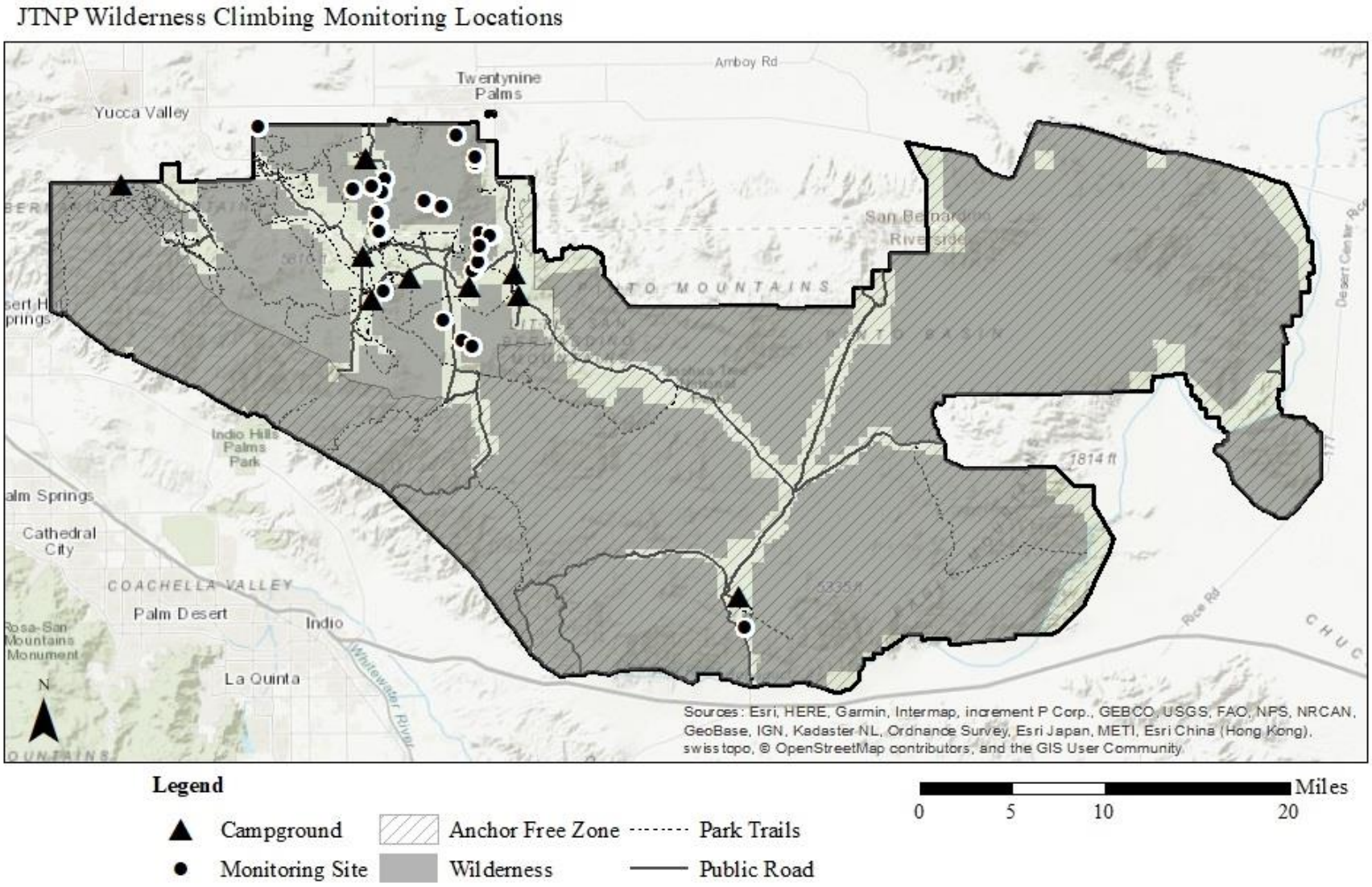

Figure 9. JTNP Wilderness Climbing Monitoring Locations

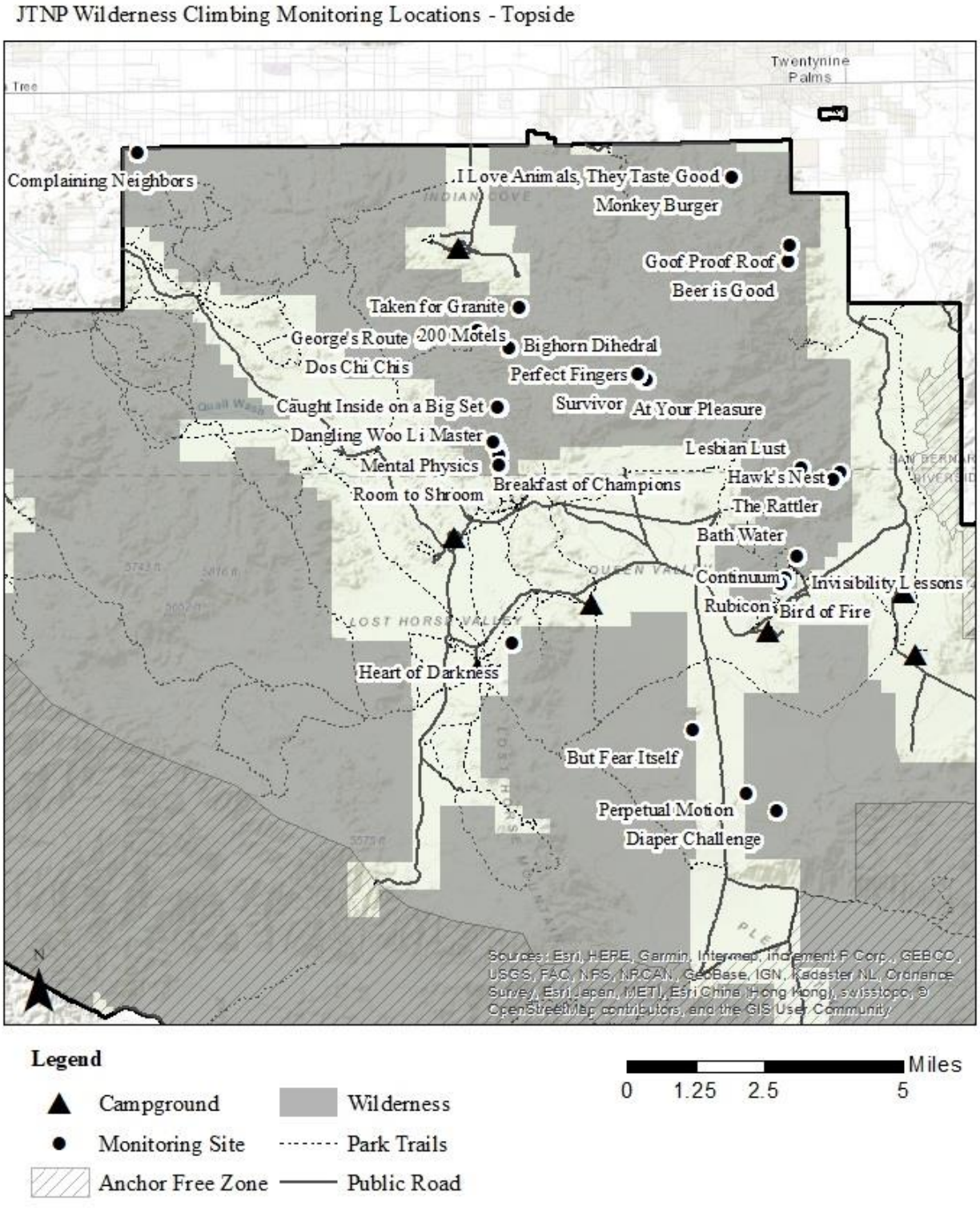

Figure 10. JTNP Wilderness Climbing Monitoring Locations – Detail

3.4.2 Summary of JTNP field monitoring results

JTNP has low occurrences of user created recreational structures, human waste, and damage to rock. The low number of user-created structures is perhaps attributed to the low amount of expeditionary climbing allowed, as the Wonderland of Rocks, perhaps JTNP's largest and most climbing-dense terrain, is a day use only area. The small scale of terrain and reliable temperate weather during peak climbing season may also contribute to a lower number of unexpected nights spent out climbing. Damage to rock was only subtly visible under the smoothing and blackening of rope wear at the top of popular routes (N=2), where climbing ropes rub over the low angle, hard granitic rock. Some damage to rock on climbing routes from intentional cleaning of loose rock was observed at PETA Crag (a bolt was placed in a large scar from a recently and clearly human-removed flake of rock). Otherwise no physical damage to rock was observed outside of normal wear from climbing.

Moderate impacts were seen most commonly on the approach and staging areas of the climb. The measures that frequently scored in the moderate category include the number of cairns or trail markings (N=14), social trails (N=10), litter (N=8), denuded base areas (N=9), and damage to vegetation at the base of climbs (N=7), and damage to vegetation on the descent (N=7). Visual impact on both the climb (N=8) and descent (N=7), which was due to uncamouflaged fixed anchors. These measures indicate impact from decades of climbing use in concentrated areas, especially on high quality moderate routes.

High scores were also recorded in visual impacts on the climb (N=9), where almost all of the high scoring was attributed to uncamouflaged fixed anchors with some instances of rust streaking. High scores were also reported in both fixed anchor measures, for appropriateness of

fixed anchors (N=12) and fixed anchors per foot (N=11). It must be addressed that the quality of rock at JTNP requires the use of an occasional fixed anchor to link disparate sections of climbing that are protected by natural protection. A notable part of the climbing heritage of JTNP is the style of bold slab climbing (or low angle climbing that uses friction on the rock rather than holds to ascend). Fixed anchors are necessary to protect these sections of JTNP climbing routes. There were some routes monitored, however, that are bolt-intensive face climbs that have no opportunities for removable protection and entirely require the use of bolts to protect the ascent.

Monitoring was conducted during the January 2019 government shutdown when the park was mostly empty of visitors. The only places visitors were encountered during the 2019 shutdown was at high quality, moderately graded areas of Lenticular Dome, North and South Astrodomes, and Future Games Wall. Counts of visitors are decreased by the government shutdown.

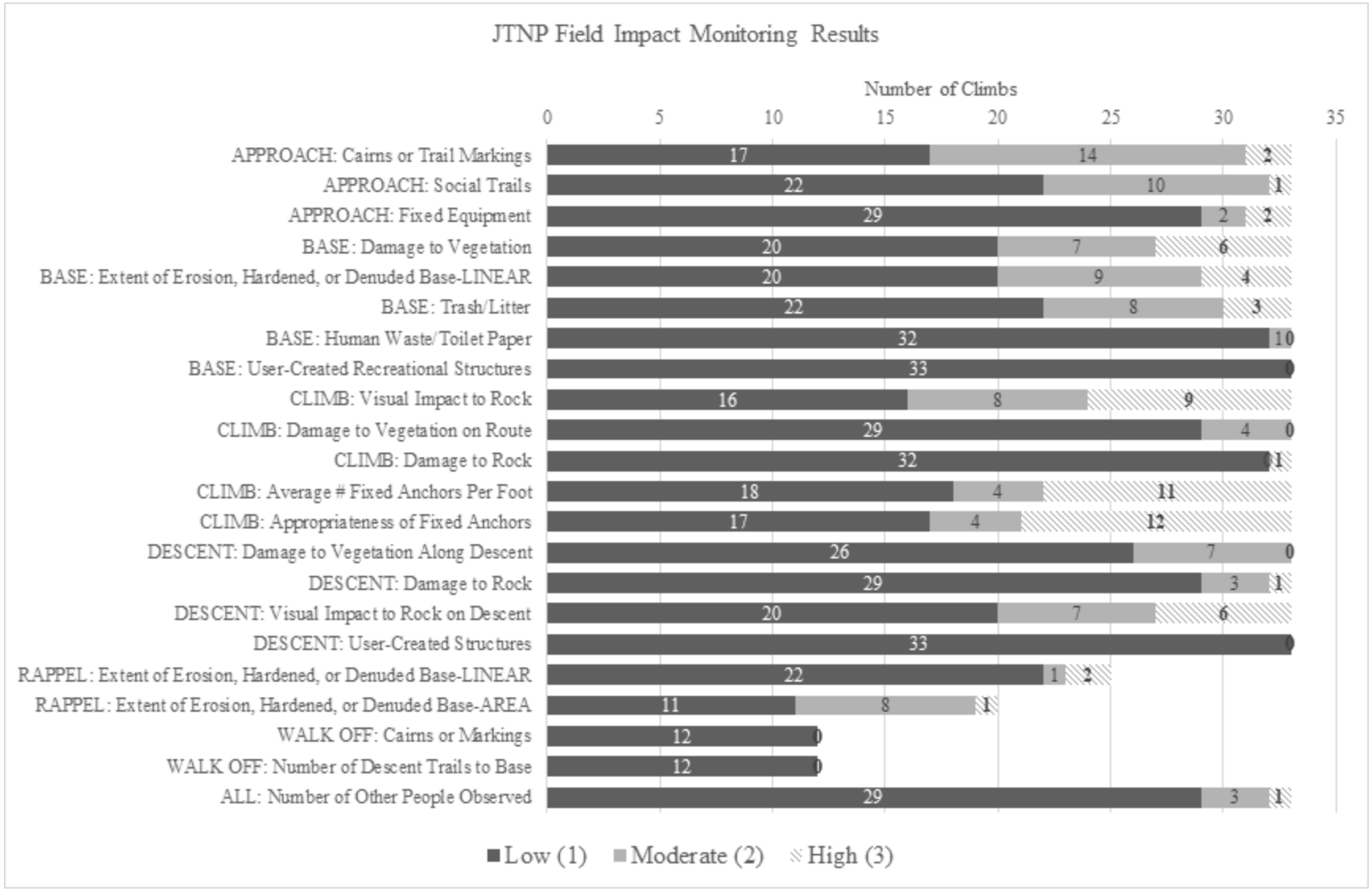

Figure 11. JTNP Pilot Field Monitoring Results

3.4.3 Summary of JTNP administrative monitoring results

JTNP has a general wilderness visitor behavior restriction index value of 54%. Climbing restriction index value totals 19%. Overall, climbers experiencing the JTNP wilderness are subjected to a behavior restriction index value of 41%. This value alone does not have management implications; however, the consideration of new regulations or removal of regulations should be weighed carefully to meet resource and visitor experience objectives. This tool is also useful to track changes in visitor experiences of freedom or confinement over time.

Table 19. Climbing Visitor Behavior Restriction Index for JTNP

Climbing Visitor Behavior Restriction Index for JTNP			
General Restrictions			
Type of regulation	Score	Geographic weight	Total score
Fees	2 Fees charged of all visitors	2	4
Camping	1 Any mandatory setback	2	2
Overnight Permits	1 Voluntary self-registration	2	2
Campfires	2 Total prohibition	2	4
Day Use Permits	0 No restriction	2	0
Human waste	0 No regulation	2	0
Length of stay	1 Length of stay limited	2	2
Stock	1 Permit required	2	2
Swimming/bathing	2 Prohibited	2	4
Area closure	3 Permanent closure	1	3
Group size limits	1 Group size limits in place	2	2
Pets	2 Prohibited	2	4
		General index total	**29/54 or 54%**
Climbing Restrictions			
Type of regulation	Score	Geographic weight	Total score
Permits (climbing)	0 No permit or registration	2	0
Group size limit (climbing)	0 No restriction	2	0
Closures (climbing)	3 Permanent closure	1	3
Human waste regulation (climbing)	0 No restriction	2	0
Fixed Anchor Regulations	3 Fixed anchor moratorium (fixed anchor–free zone)	1	3
New Route Regulations	0 No restriction	2	0

Climbing index total	**6/32 or 19%**
Overall total	**35/86 or 41%**

JTNP has zero climbing projects that approve a prohibited tool, so the motorized and mechanized use index value is zero. Again, this index value sets a baseline and the tool can be used to track administrative actions over time.

Table 25. JTNP Motorized/Mechanized Use Index

JTNP Motorized/Mechanized Use Index	
Project Name	Project motorized index value
None	0
Five-Year Index Value	**0**

3.5 Grand Canyon National Park Pilot Study

Research in GCNP took place between Fall 2016 and Fall 2019. Field research teams included the PI, park rangers, and accredited climbing guides. Most of the climbing in GCNP is expeditionary in nature (requiring spending nights in the wilderness), though some opportunities for climbing in a single day are available. Fast parties may attempt a traditionally expeditionary climb in a single day push, though have limited success (Tomasi, n.d.). Most of the approaches involve lengthy sections of off-trail travel on 4^{th} and 5^{th} class terrain with high exposure. Information on GCNP climbing is available in an out of print guidebook (Tomasi, 2011), MountainProject, and the online forum Grand Canyon Mountaineering.

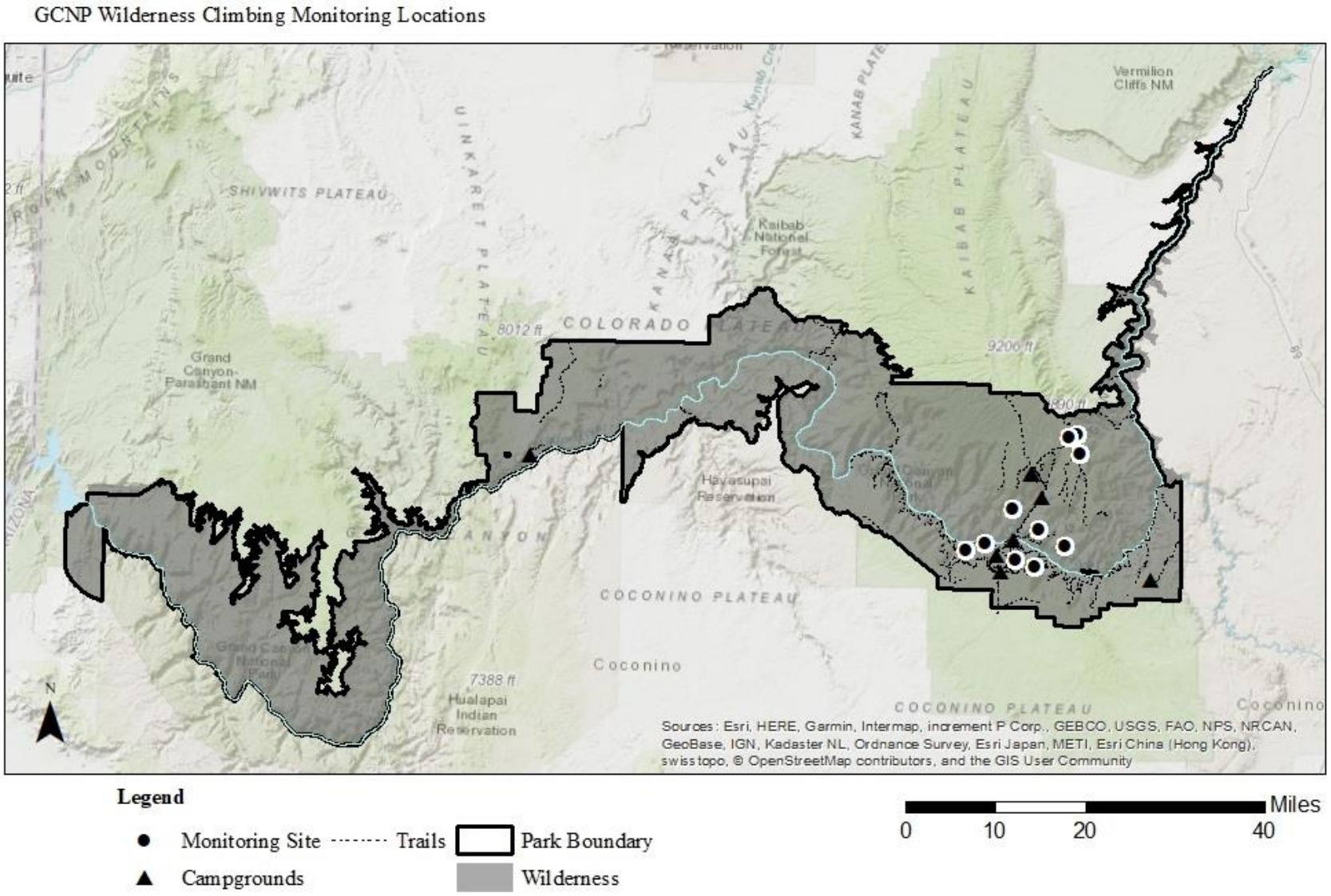

Figure 12. GCNP Wilderness Climbing Monitoring Locations

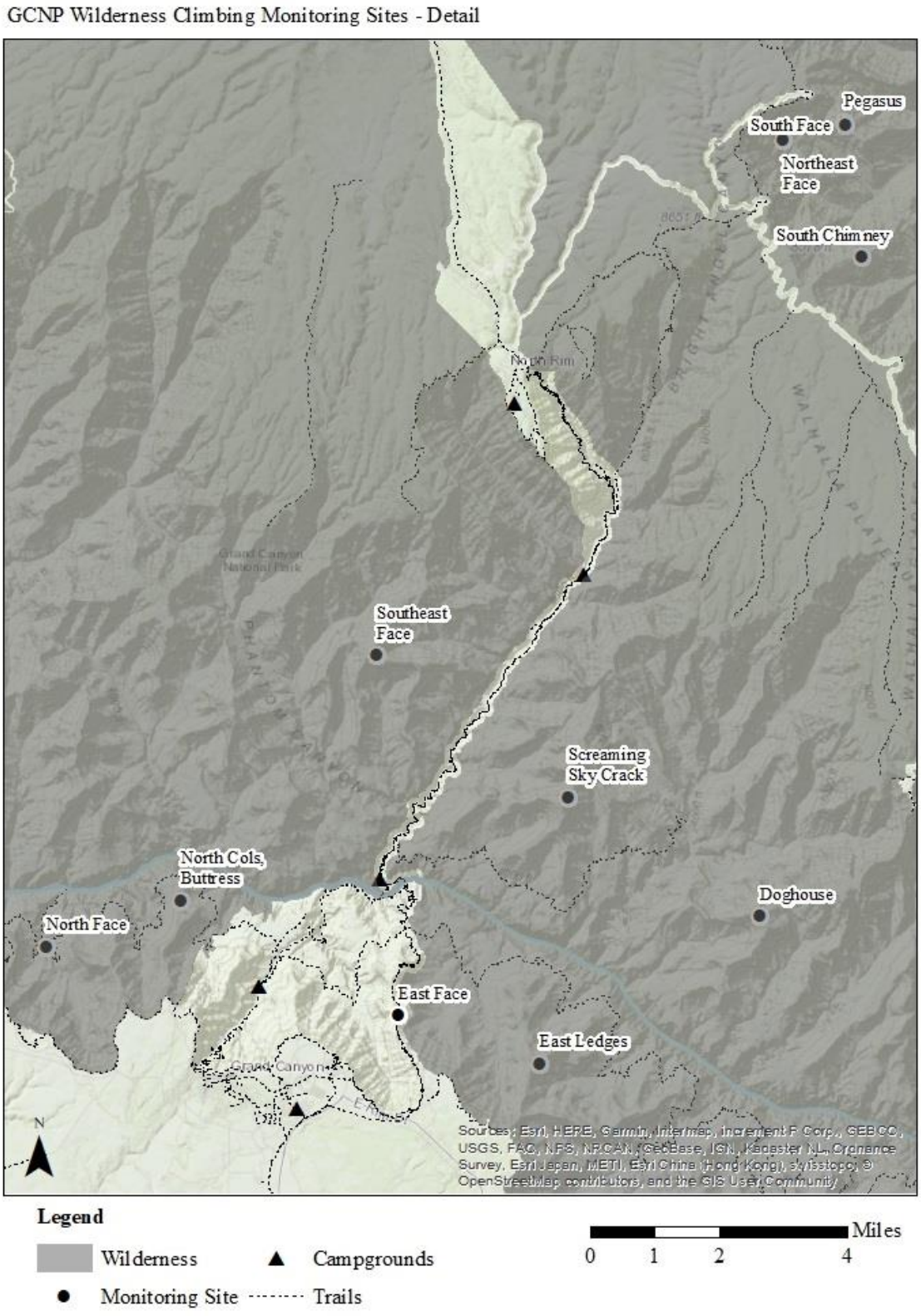

Figure 13. GCNP Wilderness Climbing Monitoring Sites - Detail

3.5.1 GCNP climbs monitored

Teams monitored 11 5th class climbing routes in Grand Canyon, out of a total of 25 published routes. Since the field research has been completed, new and old routes have been added to MountainProject. GCNP has ample opportunity for pure wilderness climbing adventure. Routes ranged from 5.4 to 5.11, including some routes with sections of aid climbing. Geologic layers in GCNP contribute to climbs that range from 1-4 pitches over a range of 80-400 feet, though longer climbs are possible in the canyon rim. Few temples have more than two routes on a formation, so most climbing traffic in an area would intend to climb the same route.

Routes approached from the river were not monitored due to logistical constraints due to time, lack of river access and funding. GCNP could monitor these routes on river missions to collect a more thorough data set on Grand Canyon climbing. 5th class climbs in western GCNP were not monitored also due to logistical constraints (time), as those routes individually require 5 days to complete with travel. Table 26 below lists the river access and western GCNP 5th class climbs that were not surveyed. Two attempts were made to monitor Isis Temple (5.8***) but were unsuccessful. This summit is becoming increasingly popular and should be monitored.

Table 26. GCNP Pilot Monitoring Sites - Including 3rd & 4th Class

Grand Canyon NP Pilot Monitoring Sites		
Zone	**Rock Formation**	**Route**
Corridor/Central Grand Canyon	Zoroaster Temple	Screaming Sky Crack, 5.11****
	Buddha Temple	Southeast Face, 5.6**
	Dana Butte	North Cols & Buttress, 5.4*
	Monument Creek Pinnacle	The North Face, 5.11***
	Angel's Gate	The Doghouse (Southwest Face), 5.5**
South Rim	O'Neill Butte	East Face, 5.9**
	Newton Butte	East Ledges, 5.7*
North Rim	Mt. Hayden	South Face, 5.6***
		Pegasus, 5.10+***
	Brady Peak	South Chimney, 5.6***
	Sullivan Peak	Northeast Face, 5.6*
Grand Canyon NP 3rd and 4th Class Summits		
3rd and 4th Class Summits	The Battleship	East Chimney, Cl.3*
	Cheops Pyramid	Cheops Pyramid, Cl.3
		Cheops Plateau Cl.4*
	Sinking Ship	Southwest Face, Cl.4
	Tritle Peak	East Ridgeline, Cl.4+*
	Sinking Ship	West Chimney, Cl.4
	Dana Butte	Little Dana, Cl.4+
Grand Canyon NP – Climbs Not Monitored		
River-Access	Dox Castle	West Ridgeline, 5.4
	Horus Temple	Southside, East Face, 5.8*
	Hutton Butte	North Face, 5.7R*
	Malgosa Crest	South Dihedral, Chimney 5.4**
	Scylla Butte	Southwest Face, South Chimney, 5.6
Western Grand Canyon	Excalibur	Northeast Face, 5.11***
	Holy Grail Temple	South-southeast Face, 5.8**
	Wallace Butte	East Face, 5.2*

3.5.2 Summary of GCNP field monitoring results

GCNP climbs scored low on most measures, including social trails, cairns or trail markings, litter, human waste, user created recreational structures, visual impacts, damage to vegetation on the climb, summit, and descent, average number of fixed anchors per foot, and damage to rock. Overall, GCNP has very low biophysical and social impacts related to rock climbing. The opportunities for solitude, freedom, adventure, and classic wilderness climbing abound in GCNP.

Approximately 1/3 of the climbs monitored (N=4) scored in the moderate rating for erosion and appropriateness of fixed anchors. Some of the climbs with moderate erosion at the base also showed moderate vegetation. The climbs that scored in the moderate category for appropriateness of fixed anchors (N=4) all scored low for average number of fixed anchors per foot. This could be attributed to the geology at GCNP, such that many climbs accept removable protection. It was also more common to have fixed anchors for rappel than ascent. Climbs beginning to show moderate impacts were routes that were closer to established trails and high quality, attractive and better publicized climbs like Screaming Sky Crack on Zoroaster Temple, the South Face of Mount Hayden, and the North Face of Monument Creek Pinnacle. Judging by comparisons in summit registers, the three summits listed above see considerably more use and have names entered in the summit registers that are not recorded in the more obscure climbs along with the ‘usual characters’ of GCNP climbing.

High scores were recorded for encounters with other visitors at two locations: O’Neill Butte and Monument Creek Pinnacle. These two climbs are situated directly on popular hiking trails. Other climbing parties were not observed during monitoring, except for a single party

encountered while hiking. The GCNP summits that are even a short distance from popular trails have exceptional opportunities for solitude.

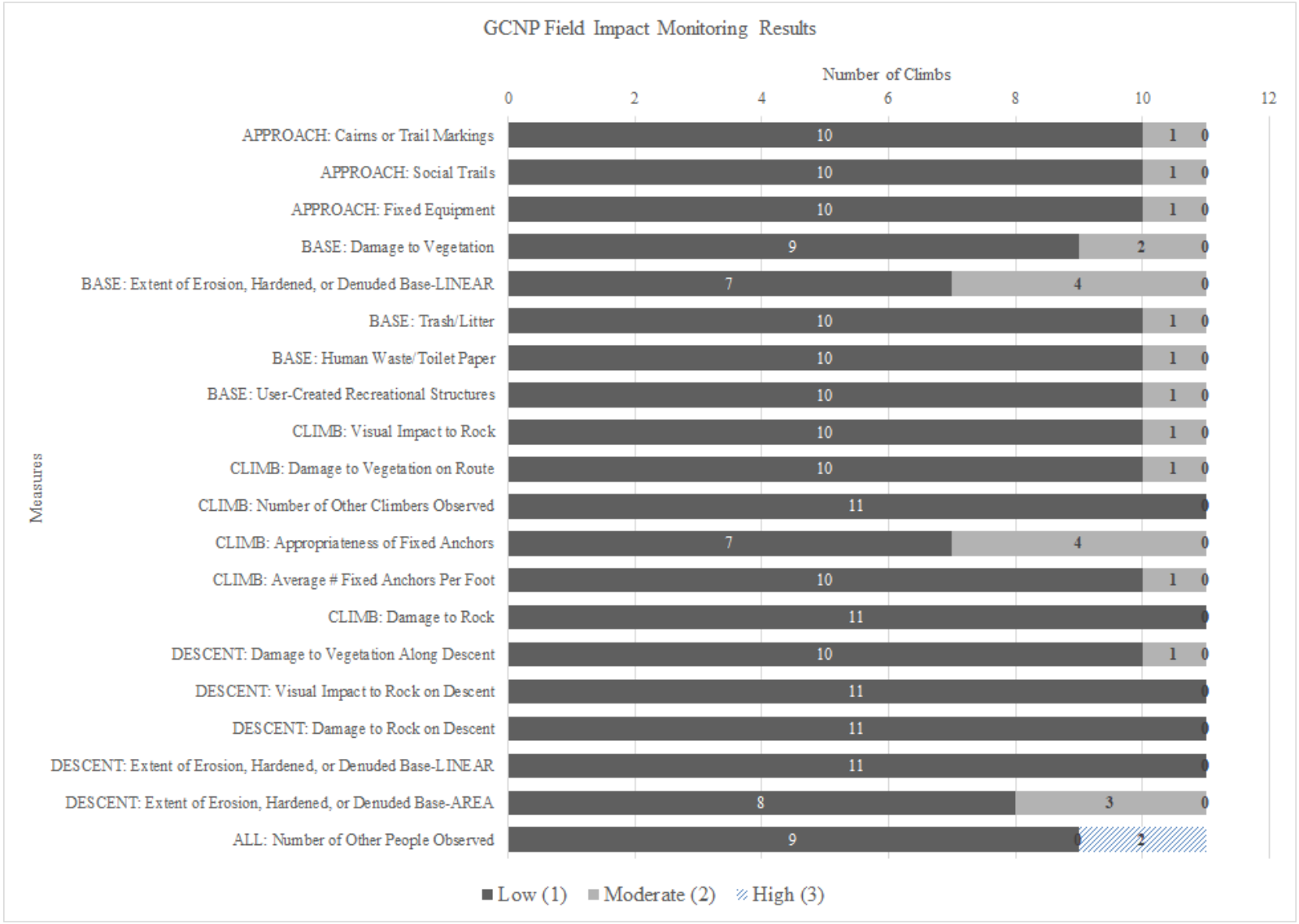

Figure 14. GCNP Pilot Field Monitoring Results

3.5.3 Summary of GCNP administrative monitoring results

GCNP has a general wilderness visitor behavior restriction index value of 50%. Climbing restriction index value totals 9%. Overall, climbers experiencing the GCNP wilderness are subjected to a behavior restriction index value of 35%. This value alone does not have management implications; however, the consideration of new regulations or removal of regulations should be weighed carefully to meet resource and visitor experience objectives. This tool is also useful to track changes in visitor experiences of freedom or confinement over time.

Table 27. Climbing Visitor Behavior Restriction Index for GCNP

Climbing Visitor Behavior Restriction Index for GCNP			
General Restrictions			
Type of regulation	Score	Geographic weight	Total score
Fees	2 Fees charged of all visitors	2	4
Camping	1 Any mandatory setback; designated sites; day use areas	2	2
Overnight Permits	3 Mandatory; use limited (all users)	2	6
Campfires	2 Total prohibition	2	4
Day Use Permits	0 No registration	2	0
Human waste	0 No restriction	2	0
Length of stay	1 Length of stay limited	2	2
Stock use	0 No restriction	2	0
Swimming/bathing	0 No restrictions	2	0
Area closure	3 Permanent closure	1	3
Group size limits	1 Group size limits in place	2	2
Pets	2 Prohibited	2	4
		General index total	**27/54 or 50%**
Climbing Restrictions			
Type of regulation	Score	Geographic weight	Total score
Permits (climbing)	0 No permit or registration	2	0
Group size limit (climbing)	0 No restriction	2	0
Closures (climbing)	3 Permanent closure (Anasazi Bridge)	1	3
Human waste regulation (climbing)	0 No restriction	2	0

Fixed anchor regulations	0 No restriction	1	0
New route regulations	0 No restriction	2	0
		Climbing index total	**3/32 or 9%**
		Overall total	**30/86 or 35%**

GCNP has zero climbing projects that approve a prohibited tool, so the motorized and mechanized use index value is zero. Again, this index value sets a baseline and the tool can be used to track administrative actions over time.

Table 28. GCNP Motorized/Mechanized Use Index

GCNP Motorized/Mechanized Use Index	
Project Name	Project motorized index value
None	0
Five-Year Index Value	**0**

Chapter 4. Discussion and Conclusion

Wilderness climbing is a unique resource to monitor and manage. It keeps alive the tension from the NPS Organic Act in the mandate to provide for visitor experiences and protect park resources. Climbing in NPS wilderness is a unique and valuable resource worth preserving. Rapid changes in amount and type of visitor use, and the culture and education of climbers make staying ahead of issues challenging for land managers.

4.1 Management Implications

Wilderness rock climbing in America's national parks is part of the global identity of rock climbing, as well as an integral component of the history of modern climbing (NPS WCMN, 2018). As a wilderness experience, rock climbing provides challenge, adventure, and risk in the increasingly developed, connected, and inconsequential civilized world. When managed to be wilderness-compatible, rock climbing is a staple of wilderness experience and meets the spirit and the symbolism of wilderness as an American value, as is put forward in the Wilderness Act (U.S. Public Law 88-577, 1964).

4.1.1 JTNP management implications

Based on monitoring findings from JTNP, the park should focus its management efforts on impacts to the approach and base of climbs. Assessment of cairns and trail markings, social trails, erosion and denuded base areas should receive management attention, as they already are. Fixed anchors management is another area that JTNP should focus on. One specific aspect of

fixed anchor management is in regard to the visual impact from un-camouflaged fixed anchors and rust streaking from aging fixed anchors.

Table 29. Summary of JTNP Impacts by Indicator

JTNP Impacts by Indicator	
Indicator	**Value on a scale of 1-3 Low (1), Moderate (2), High (3)**
1. Natural – Plants	1.3
3. Natural – Physical Resources	1.11
4. Natural – Ecological Processes	1.27
6. Solitude – Remoteness from sights and sounds of human activity inside Wilderness	1.46
7. Solitude – Facilities that decrease self-reliant recreation	1.33
Indicator	**Other value (not ranked in multiple parameter rating-based system)**
2. Natural – Animals	2 conflicts
5. Undeveloped – Use of motor vehicles, motorized equipment, or mechanical transport	0
8. Solitude – Management restrictions on visitor behavior	19% climbing / 41% overall
9. Other Features – Deterioration or loss of integral cultural features	1 conflict
10. Other Features – Deterioration or loss of other features of value	N/A

Additionally, high-concentration areas of fixed anchors exist in JTNP from throughout the decades. East Virgin Isles (Diaper Challenge) is an area with low biophysical impact from climbers, but plenty of bolt-intensive routes. Hard sport routes in the Underground Chasm on Queen Mountain is one example. Although I am not skilled enough to climb the route, I collected basic data on Survivor, a hard sport climb in the Underground Chasm. I chose to monitor the area because of conflict that occurred about a decade ago over the development of a hard sport climbing area in the JTNP wilderness. There was documentation by the NPS of holds chipped and cut vegetation, as well as illegal campfire rings, and gear and water caches. The park and climbers took efforts to restore what damage they could at the Underground Chasm (SuperTopo,

2012). When I monitored the route Survivor at Underground Chasm in Spring 2019, the only signs of past impacts were the many fixed anchors and a bolt-intensive face climb, but there were no detectable biophysical impacts from climbing use.

In order to better understand the diversity of the wilderness climbing resources in JTNP, the park should select more monitoring sites that are representative of their management concerns, such as new climbing areas, climbing areas that intersect with cultural resources, sport climbing areas. With full time climbing staff and skilled volunteers, JTNP is poised to collect more data on climbing impacts across the landscape, which can be used to inform climbing management decisions.

The JTNP visitor behavior use restriction index documents a moderate-to-high level of regulation placed on wilderness climbers. Some of the only high restriction components from the current JTNP climbing management strategy is day use or climbing permits and restrictions on new route development. Despite a well-developed plan that involved climber input in the late 1990s, it still seems that some of the regulations are missing the mark. JTNP has a low staffing level for its 800,000 acres and increases in staff presence will be helpful with climber compliance to regulations. In order to reach the climbing masses who unintentionally create impacts, JTNP must leverage educational strategy and community connection. The high volume of climbers with diverse cultures and expectations that climb in the JTNP wilderness is perhaps the park's greatest impact management challenge.

4.1.2 GCNP management implications

GCNP wilderness climbing is adventurous and remote. Outside of the areas along busy trails, it is pristine and overall has experienced low biophysical impacts from climbing. In order

to develop a better picture of wilderness climbing impacts, the park should monitor river-accessed climbs to better understand the impacts in wilderness terrain accessed by the tens of thousands of boaters annually. Currently, social trailing, cairns and erosion levels are rated as low impacts.

The three most popular 5th class climbs in the region of GCNP that were surveyed are Screaming Sky Crack on Zoroaster Temple, North Face of Monument Creek Pinnacle, and South Face of Mount Hayden. Mount Hayden and Monument Creek Pinnacle have very low impacts at their bases. The off-trail approach to Mount Hayden, while short and easy by GCNP standards, burned in a wildfire in 2016 and now appears to have become less popular as the approach has grown into a thicket of thorny locust and oak. I monitored the South Face of Mount Hayden in Fall of 2016, following the fire, and Fall of 2019 and observed that the level of impacts across

Table 30. Summary of GCNP Impacts by Indicator

GCNP Impacts by Indicator	
Indicator	**Value on a scale of 1-3 Low (1), Moderate (2), High (3)**
1. Natural – Plants	1.12
3. Natural – Physical Resources	1
4. Natural – Ecological Processes	1.18
6. Solitude – Remoteness from sights and sounds of human activity inside Wilderness	1.07
7. Solitude – Facilities that decrease self-reliant recreation	1.16
Indicator	**Other value (not ranked in multiple parameter rating-based system)**
2. Natural – Animals	0 conflicts
5. Undeveloped – Use of motor vehicles, motorized equipment, or mechanical transport	0
8. Solitude – Management restrictions on visitor behavior	9% climbing / 35% overall
9. Other Features – Deterioration or loss of integral cultural features	1 conflict
10. Other Features – Deterioration or loss of other features of value	N/A

the data sheet have consistently decreased. It appears that the terrain is recovering from mild impacts with less use. The start of the climb at Monument Creek Pinnacle begins approximately 150 feet from the Tonto Trail, and traverses slick rock to the base of the route. Hikers regularly access the social trail out to the Pinnacle, but beyond the natural point where a hiker would turn around and the approach terrain becomes low 5th class, there is only a slight amount of erosion at the base attributable to climbers. Zoroaster Temple was the only climb that creeped into the moderate category overall by scoring in the moderate impact category for erosion, cairns, fixed equipment on the approach, appropriateness of fixed anchors, and damage to vegetation. The long off-trail approach to this temple was more well-worn and marked than any other summit we monitored in Grand Canyon, but it wasn't so well worn that we avoided getting lost once or twice.

GCNP has a relatively high level of administrative restriction on visitor behavior for general overnight wilderness users (50%), but few restrictions that targets climbers specifically (9%). GCNP is an excellent park to manage for maintaining the freedoms of wilderness climbing, as there are few impacts evidenced so far to regulate climbing activity. The slow increase of fixed anchors on climbing routes is far eclipsed by the increase of fixed anchors on canyoneering routes (Jenkins, 2017). A fixed anchor policy would benefit the canyoneering resource and could benefit the climbing resource, but an evaluation of climbing fixed anchors alone does not merit more than a blanket authorization for fixed anchors for rock climbing.

4.1.3 Repeat monitoring

To reflect change over time, monitoring should be repeated every five years, as per wilderness monitoring standards (USDA, 2015). This time-scale allows for measurable change to

be evident, if present (Cole, 1989). A five year monitoring cycle is also conducive to illustrating trends in a time frame that is compatible with park planning processes, especially as parks trend toward adaptive management plans and portfolios of focused planning documents (IVUMC, 2016). With the development of new climbing areas and the increased availability of information about climbs with new guidebooks and increasing online resources, land managers should be keen to monitor change over time.

Recreation ecology studies indicate the first year a new site receives use, it will have the most damage to vegetation and soils, with the following two years having more modest loss (Marion & Cole, 1996). Sites will become hardened with use over time, perhaps reaching a point of stability rather than loss (Cole & Hall, 1992). JTNP's Rubicon may serve as an excellent example of stabilization after hardening. It is possible for sites to recover from recreational use over years if the use subsides. JTNP's East Virgin Islands climbing area may represent a climbing area with many fixed anchors, but little use, and therefore low impacts from climbing.

4.1.4 Education and stakeholder engagement

As a principle of wilderness management, the first choice is to enact management strategies that originate from outside of wilderness rather than strategies that are seen or felt on the ground during a wilderness experience. This includes providing education opportunities and current, relevant information to climbers and the public (USDI, 2015), engagement and cooperation with stakeholders and user groups (Sullivan, 2018), and consistency in regulation with other wilderness climbing NPS units to the extent practicable (USDI, 2006a). Successful wilderness climbing management strategies can include partnering with climbers to take on stewardship efforts, like has recently developed in Zion NP for raptor nesting observation and at

Washington Pass, WA on USFS non-wilderness land to improve access trails in (Access Fund, 2019; WCC, 2018). Even with a robust climbing staff, wilderness parks will never have the personnel presence to be sure that wilderness climbers are following regulations. Parks must leverage relationships, partnerships, and education to implement wilderness climbing management strategies on the ground.

4.1.5 Considering a new era of visitor use in wilderness

The pressures of increasing visitor use occur across parks and activities in both developed and wilderness areas. And, changes in culture and technology are reshaping rock climbing, not all of which are negative. For example, a technological advancement like a personal locator beacon might seem to contrast with the spirit of wilderness risk-taking, but the tool also mitigates impacts to wilderness and personnel by increasing precision and timeliness of response in search and rescue efforts. Similarly, fixed anchors can be used to minimize social and biophysical impacts of climbing.

With increased use comes increased unintentional impacts from climbers. In non-wilderness, land managers implement site hardening to control the spatial extent of impacts by concentrating use and stabilize environmental degradation like erosion. In wilderness, these strategies may be too heavy handed to be in line with wilderness values. Fixed anchors are an excellent example as a tool to concentrate use, and though this hardens areas within their line, the practice preserves the wilderness character around them. I argue these managerial strategies should be seen as a compatible technique for wilderness preservation. JTNP provides a clear example, where to reduce damage to cliff-side plants the park has outlawed the use of vegetation for anchors and has compromised by permitting the installation of bolts to replace these natural

anchors (Access Fund, 2015). The foundation of wilderness law and policy doesn't justify heavy development or stabilization of climbing sites as found in non-wilderness climbing destinations, such as the building of fences, belay platforms, etc. It doesn't welcome sport climbing development, in whichever terms it is defined, as being wilderness compatible either. If results from monitoring the given indicators trigger management actions, it is recommended strategies to address the concern from outside the wilderness boundaries, such as through education or use limits, are explored first rather than hands-on, head-first management action at the wilderness site such as removal of bolts or closure of sites. The process of Minimum Requirements Analyses (MRAs) provide the template to explore the most unobtrusive, yet effective strategies to address management concerns in wilderness.

The baseline for wilderness climbing management has been gracefully outlined in DO41 but its implementation will look different across wilderness units. JTNP will not see the same types or extent of climbing impacts as GCNP because the history of climbing, the experiences offered, and the resources are quite different. Wilderness managers are faced with hard decisions to select management strategies that are best for local resources and visitor uses. Parks start with a baseline in the NPS that climbing is a wilderness appropriate activity and fixed anchors are a necessary tool for climbing (USDI, 2013). This provides the foundation to then locally implement creative strategies to best protect unique resources and visitor experiences (USDI, 2006a).

4.1.6 Logistical considerations

To assess wilderness climbing monitoring indicators, through any monitoring process, it is imperative that parks have ensured professional staff have the necessary resources—skills,

knowledge, and time—to perform these evaluations. Skilled volunteers and partnerships will bolster the capacity of a wilderness climbing program but cannot be relied on solely. Minimum staff resources to implement wilderness climbing monitoring include staff capable of climbing patrols and a wilderness coordinator or committee member who can give time to an administrative review of wilderness climbing activities and regulations. For parks with the staffing capacity to provide training, and local climbers invested in stewardship activities, a citizen science program could be designed to capture more widespread data.

The time dedicated to field monitoring activities should be commensurate with the amount of climbing use in a wilderness area. Areas like JTNP that receive high volumes of climbing use and have a conservative approximation of 9,000 climbing routes should survey more locations on a rotating schedule to boost their coverage of the climbing resource. Areas like GCNP with less climbing visitation and far fewer routes, can have a smaller, yet adequate, number of sites sampled. Parks with alpine-style climbs that are remote, long, and travel in diverse terrain will have less sites sampled than those with easily accessible or less complex climbs. In order to not overtax field staff resources, the monitoring strategy presented here is designed to collect data at all sites in one climbing season (within one year) and is to be repeated every five years. With the design of this propose monitoring strategy, monitoring should only add a minor imposition to the activities of the patrol team with minimal increases in time requirements and equipment weight. Partnership with skilled volunteers through Climber Steward programs or new forays into partnerships, such as a Cooperative Ecosystem Study Unit (CESU) with guiding organizations like the American Mountain Guides Association (AMGA) would dramatically increase the park's patrol capacity as well as build trust and cooperation with the climbing community.

Administrative monitoring investment should be a simple collateral duty for a wilderness coordinator or wilderness committee member. Administrative monitoring requires an understanding of the MRA process as well as park projects approved through MRAs, and a familiarity with park rules and regulations. For best quality in administrative data collection, staff assigned to administrative monitoring should coordinate with climbing patrol staff, fee or permit supervisors, and law enforcement staff. For staff familiar with administrative dimensions of wilderness management, this task should not be an extended time commitment.

4.2 Research Needs

The impacts of fixed anchors are still unknown (Murdock, 2010). Research efforts to understand the actual impacts generated by fixed anchors should be completed to begin to address this topic of debate. The terms ‘rare’ and ‘occasional’ (USDI, 2013) to describe the appropriate levels of fixed anchors in wilderness are, at best, nebulous. Empirical assessments made by experts who understand climbing, wilderness, and other overlapping resource concerns are the best strategy to assess fixed anchors and as a way to generate series of data on their impact. More research on fixed anchors could include the relationship between fixed anchors and changing visitor use (types, patterns, demographics), fixed anchors as a resource protection tool, and strategies for legacy-management of fixed anchors (replacement of fixed anchors in wilderness). The information available is insufficient to use to quantify the rarity of fixed anchors across a wilderness landscape or to quantify the occasional placement of a fixed anchor. Valuable research could include statistical modeling to estimate density of fixed anchors across a landscape.

Research on the relationships between indicators would also benefit the field of climbing management. This monitoring strategy is designed to track change over time and allow for analysis on data between different indicators within a site, and between same indicators across space or time. My work focused on the development and initial reliability and validity of an instrument, and the next major research step—correlational and holistic analyses of data—would be beneficial to further inform management decisions. Likewise, it will be beneficial to bring the indicators into conversation with non-climbing monitoring data, such as those used among wildlife biologists or archeologists, to further investigate the relationship between climbing and other resources as well as the local impacts of climbing on unique park resources.

Lastly, the body of knowledge in each of the fields examined is growing and new information should be accounted for as it emerges. The conceptual framework for the determination of indicators can be used to account for new knowledge. Innovative research findings may replace or build on indicators, or they may support the current underpinnings of the topic. Regardless, the volume of new research being produced on climbing or wilderness can be integrated and update existing knowledge using the integrative review method presented.

4.3 Conclusion

This critical analysis and synthesis of relationships between key topics and bodies of knowledge fills a gap in wilderness climbing management practice and supports the management directives of agency policy. Many of the selected monitoring indicators presented through this research may seem obvious to seasoned climbing managers and stakeholders, but this review creates a new framework to support the importance and value of selected indicators. The indicators were developed through an analysis of relationships between concepts. These

relationships—between the recreational activity, wilderness, ecology, resource protection, and visitor use—are the same for all wilderness activities being evaluated and managed by the NPS. Though the indicators for wilderness climbing are distinct to that activity, the conceptual framework of this review can be applied to emerging park uses or new management questions.

Themes of solitude, naturalness, remoteness from civilization, and challenge in an unrestrained landscape guide the path of wilderness climbing management. The spirit of wilderness is the overarching guidance in the management of wilderness recreational activities. Not all rock faces are suitable for cutting edge routes if they must be fixed anchor intensive. Not all challenges of navigation and terrain management should be revealed by markings. Not all attempts to reach a summit should be successful. The environment that you climb through should not be scrubbed of its wild naturalness. Wilderness climbing is not virtuous because of its easy accessibility, suitability for the masses, or engineering of safety. It is a truly unique recreational experience that is distinct from gym climbing, front-country crags, and even multi-pitch sport climbs. I hope that these virtues can be honored and preserved by cooperation from both the land manager and the climber.

References

Adams, M. D., & Zaniewski, K. (2012). Effects of recreational rock climbing and environmental variation on a sandstone cliff-face lichen community. *Botany*, *90*(4), 253–259. https://doi.org/10.1139/b11-109

Alexander, R. M. (2010). *People and Nature on the Mountaintop A Resource and Impact Study of Longs Peak in Rocky Mountain National Park*. Unpublished manuscript. Center for Public History and Archaeology, Colorado State University. Retrieved from https://publiclands.colostate.edu/wp-content/uploads/sites/57/2013/12/longspeak.pdf

Alexandrowicz, Z. (2017). The impact of rock climbing on the micro-relief of sandstone surfaces: The case study of the Carpathian tors. *Episodes*, *40*(1). https://doi.org/10.18814/epiiugs/2017v40i1/017009

Attarian, A. & Keith, J. (2008). *Climbing Management: A guide to climbing issues and the development of a climbing management plan*. Boulder, CO: Access Fund.

Access Fund. (2013). *Protect Public Lands*. Retrieved from https://www.accessfund.org/index.php?p=our-causes/protect-public-lands

Access Fund. (2011). *Access Fund Position re National Park Service Director's Order 41 Section 7.2 on Climbing*. Retrieved from https://www.accessfund.org/legacy/uploads/National--NPS_DirectorsOrder41_Comments_3.10.2011.pdf

Access Fund. (2015). NPS Wilderness Climbing Management: The Good, the Bad, and The Ugly. Retrieved from https://www.accessfund.org/open-gate-blog/nps-wilderness-climbing-management-the-good-the-bad-and-the-ugly

Access Fund. (2016a). *The Pact*. Boulder, CO: Access Fund.

Access Fund. (2016b). *Scoping comments for the proposed action for Wrangell St. Elias National Park and Preserve backcountry/wilderness stewardship plan*. Retrieved from https://www.accessfund.org/uploads/AK-Access-Fund-and-Levitation-49-Scoping-Comments-on-Wrangell-St-Elias-Stewardship-Plan.pdf

Access Fund. (2016c). *Access Fund Comments on Yosemite National Park Wilderness Stewardship Plan, Preliminary Ideas and Concepts.* Retrieved from https://www.accessfund.org/meet-the-access-fund/our-approach/climbing-policy-advocacy/positioning-statements

Access Fund. (2017). *Access Fund Comments on the Zion National Park Preliminary Alternative Concepts for the Visitor Use Management.* Retrieved from https://www.accessfund.org/meet-the-access-fund/our-approach/climbing-policy-advocacy/positioning-statements

Access Fund. (2019). *Climbers Partner with Park Service to Protect Zion's Peregrine Falcons*. Retrieved from https://www.accessfund.org/news-and-events/news/climbers-partner-with-park-service-to-protect-zions-peregrine-falcons

Access Fund and American Alpine Club. (2015). *Access Fund and American Alpine Club Policy on Fixed Anchors*.

Access Fund & Boise Climbers Alliance. (2015). *Access Fund Comments on City of Rocks National Reserve General Management Plan / Environmental Impact Statement.* Retrieved from https://www.accessfund.org/meet-the-access-fund/our-approach/climbing-policy-advocacy/positioning-statements

Access Fund & Gunnison Valley Climbers. (2016). *Comments: Alternative Scoping for the Black Canyon of the Gunnison National Park and the Curecanti National Recreation Area Wilderness and Backcountry Management Plan*. Retrieved from

https://www.accessfund.org/meet-the-access-fund/our-approach/climbing-policy-advocacy/positioning-statements

Access Fund & Levitation 49. (2016). Scoping comments for the proposed action for Wrangell St. Elias National Park and Preserve backcountry/wilderness stewardship plan. Retrieved from https://www.accessfund.org/meet-the-access-fund/our-approach/climbing-policy-advocacy/positioning-statements

American Alpine Club. (n.d.). *Draft Public Lands Policy – Core Values.*

American Alpine Club. (2009). *AAC Policy Positions*.

Anderson, S.H. (1995). Recreation disturbance on wildlife populations. In: Knight, R.L. and K. J. Gutzwiller (Eds). *Wildlife and Recreationists* (pp. 157-168). Washington DC: Island Press.

Anthony, R.G., Steidl, R.J., & K. McGarigal. (1995). Recreation and bald eagles in the Pacific Northwest. In: Knight, R.L. and K. J. Gutzwiller (Eds). *Wildlife and Recreationists* (pp. 223-242). Washington DC: Island Press.

Baker, B. (1999). Controversy over use of rock-climbing anchors may be missing the mark. *BioScience*, *49*(7), 529. https://doi.org/10.1093/bioscience/49.7.529

Baumeister R.F., & Leary, M.R. (1997). Writing narrative literature reviews. *Review of General Psychology*, *1*. 311-320. https://doi.org/10.1037/1089-2680.1.3.311

Belanger, L. & Bedard, J. (1990). Energetic cost of man-induced disturbance to staging snow geese. *Journal of Wildlife Management*, *54*, 36-41.

Boggess, L. M., Walker, G. L., & Madritch, M. D. (2017). Cliff Flora of the Big South Fork National River and Recreation Area. *Natural Areas Journal*, *37*(2), 200. https://doi.org/10.3375/043.037.0209

Borrie, W. T., and J. R. Roggenbuck. (2001). The Dynamic, Emergent, and Multi-phasic Nature of On-site Wilderness Experiences. *Journal of Leisure Research 33,* 202–228.

Burger, J. (1995). Beach Recreation and Nesting Birds. In: Knight, R.L. and K. J. Gutzwiller (Eds). *Wildlife and Recreationists* (pp. 281-295). Washington DC: Island Press.

Camp, R.J., & Knight, R.L. (1998). Rock Climbing and Cliff Bird Communities at Joshua Tree National Park, California. *Wildlife Society Bulletin*, *26*(4), 892–898.

Clark, P., & Hessl, A. (2015). The effects of rock climbing on cliff-face vegetation. *Applied Vegetation Science*, *18*(4), 705–715. https://doi.org/10.1111/avsc.12172

Carr, C. (2007). *Variation in Environmental Impact at Rock Climb Areas in Red River Gorge Geological Area and Adjacent Clifty Wilderness, Daniel Boone National Forest, Kentucky*. (Unpublished master's thesis). University of Cincinnati, Cincinnati, OH.

Carspecken, P.F. (1996). Critical Ethnography in Educational Research: A theoretical and practical guide. New York and London: Routledge. Cincinnati, OH: University of Cincinnati.

Chappell, H.G., Ainsworth, J.F., Cameron, R.A.D., & M. Redfern. (1971). The effect of trampling on chalk grassland ecosystem. *Journal of Applied Ecology*. 8, 63-71.

Crow, D. (2017). Is Rock Climbing Bad for Cliffs? Retrieved from https://www.sierraclub.org/sierra/rock-climbing-bad-for-cliffs?utm_source=facebook&utm_campaign=sierramag&utm_medium=sierra_social

Cole, D.N. (1989). *Wilderness campsite monitoring methods: a sourcebook* (*General Technical Report INT-259).* U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Ogden, UT.

Cole, D. N. (2012). Wilderness visitor experiences: A selective review of 50 years of research. *Park Science*, *28*(3). Retrieved from https://www.fs.usda.gov/treesearch/pubs/40398

Cole, D. N., & Hall, T. E. (2012). Wilderness experience quality: Effects of use density depend on how experience is conceived. In Cole, D.N. (Ed.). *Wilderness visitor experiences: Progress in research and management* (pp. 96–109). Retrieved from https://www.fs.usda.gov/treesearch/pubs/40912

Covy, N., Benedict, L., & Keeley, W. H. (2019). Rock climbing activity and physical habitat attributes impact avian community diversity in cliff environments. *PLOS ONE*, *14*(1), e0209557. https://doi.org/10.1371/journal.pone.0209557

Dawson, C. P., & Hendee, J. C. (2009). *Wilderness Management: Stewardship and Protection of Resources and Values (4th ed.)*. Missoula, MT: WILD Foundation.

Eddie Bauer. (2016, June 28). YouTube [YouTube]. Retrieved from https://www.youtube.com/watch?v=HQUwdfuEkKk&feature=youtu.be

Eng, R. (Ed.). (2010). *Mountaineering: The freedom of the hills (8th Edition).* Seattle, WA: Mountaineers Books.

Engbretson, J. M., & Hall, T. E. (2019). The Historical Meaning of "Outstanding Opportunities for Solitude or a Primitive and Unconfined Type of Recreation" in the Wilderness Act of 1964. *International Journal of Wilderness 25*(2). Retrieved from https://ijw.org/historical-meaning-in-wilderness-act/

Griffin, C. B. (2017). Managing Unconfined Recreation in Wilderness. *International Journal of Wilderness*, *23*(1). Retrieved from https://ijw.org/managing-unconfined-recreation-in-wilderness/

Gutzwiller, K.J. (1995). Recreation disturbance and wildlife communities. In: Knight, R.L. and K. J. Gutzwiller (Eds). *Wildlife and Recreationists* (pp. 161-181). Washington DC: Island Press.

Hall, T.E., Johnson, B.J., & Cole, D.N. (2007). *Dimensions of wilderness experience: A*

qualitative investigation. Unpublished manuscript. Aldo Leopold Wilderness Research Institute, Missoula, Montana. Retrieved from http://leopold.wilderness.net/research/fprojects/docs7/qual_interview_rept_final.pdf.

Hart, J.B. Jr. (1982) Ecological Effects of Recreation Use on Campsites. IN: D.W. Countryman and D.M. Sofranko, eds. *Guiding Land Use Decisions: Planning and Management for Forests and Recreation.* Baltimore, MD: John Hopkins Press, 150-182.

Holzschuh, A. (2016). Does rock climbing threaten cliff biodiversity? - A critical review. *Biological Conservation, 204*, 153–162. https://doi.org/10.1016/j.biocon.2016.10.010

Interagency Visitor Use Management Council. (2016). *Visitor Use Management Framework: A Guide to Providing Sustainable Outdoor Recreation* (1). Retrieved from https://visitorusemanagement.nps.gov/Content/documents/lowres_VUM%20Framework_Edition%201_IVUMC.pdf

Interagency Visitor Use Management Council. (2019). *Monitoring Guidebook: Evaluating Effectiveness of Visitor Use Management* (1). Retrieved from https://visitorusemanagement.nps.gov/Content/documents/508_final_Monitoring_Guidebook_Edition_One_IVUMC.pdf

James, T.D.W. et al. (1979). Effects of camping recreation on soil, jack pine, and understory vegetation in a northwestern Ontario park. *Forest Science, 25,* 333-349.

Jenkins, M. (2017). Canyoneering at Grand Canyon National Park: Monitoring pockets of wilderness in the canyon corridor. *Park Science 33*(1)., 91-98.

Jones, C. D., & Hollenhorst, S. J. (2002). Toward a Resolution of the Fixed Anchors in Wilderness Debate. *International Journal of Wilderness, 8*(3), 15–20.

Jones, C., Hollenhorst, S., & Hammitt, W. (2004). Assessing the Social Construction of Visual-Spatial Preferences for Wilderness Impacts. *Journal of Park and Recreation Administration, 22*(3). Retrieved from https://js.sagamorepub.com/jpra/article/view/1464

Knight, R.L. & Cole, D.N. (1991) The Effects of Recreational Activity on Wildlife in Wildlands. In *Transactions of the 56th North American Wildlife and Natural Resources Conference*, 238-247.

Kruss, F.R., Graefe, A.R., & Vaske, J.J. (1990). *Visitor Impact Management: A Review of Research.* Washington DC: National Parks Conservation Association.

Kuntz, K. L., & Larson, D. W. (2006). Influences of Microhabitat Constraints and Rock-Climbing Disturbance on Cliff-Face Vegetation Communities. *Conservation Biology*, *20*(3), 821–832. https://doi.org/10.1111/j.1523-1739.2006.00367.x

Landres, P. (2009). *Technical Guide for Monitoring Selected Conditions Related to Wilderness Character*. Retrieved from http://winapps.umt.edu/winapps/media2/leopold/pubs/678.pdf

Liddle, M.J. (1997). *Recreation Ecology: The ecological impact of outdoor recreation and ecotourism.* London, England: Chapman & Hall.

Loeb, S. C., & Jodice, P. G. R. (2018). Activity of Southeastern Bats Along Sandstone Cliffs Used for Rock Climbing. *Journal of Fish and Wildlife Management*, *9*(1), 255–265. https://doi.org/10.3996/032017-jfwm-020

Longshore, K., Lowrey, C., & Thompson, D. B. (2013). Detecting short-term responses to weekend recreation activity: Desert bighorn sheep avoidance of hiking trails. *Wildlife Society Bulletin*, *37*(4), 698–706. https://doi.org/10.1002/wsb.349

Lorite, J., Serrano, F., Lorenzo, A., Cañadas, E. M., Ballesteros, M., & Peñas, J. (2017). Rock climbing alters plant species composition, cover, and richness in Mediterranean limestone cliffs. *PLOS ONE, 12*(8), e0182414. https://doi.org/10.1371/journal.pone.0182414

Losos, E.J. Hayes, A. Phillips, D. Wilcove, & C. Alkire. (1995). Taxpayer-subsidized extraction harms species. *BioScience 45*, 446-455.

Lucas, R.C. (1964). *The recreational capacity of the Quetico-Superior area. Research Paper (LS-15).* USDA Forest Service, Lake States Forest Experiment Station, St. Paul, Minnesota.

Mace, B. L., Bell, P. A., & Loomis, R. J. (1999). Aesthetic, Affective, and Cognitive Effects of Noise on Natural Landscape Assessment. *Society & Natural Resources*, *12*(3), 225–242. https://doi.org/10.1080/089419299279713

MacKenzie, C.M. (2017). *Are we playing (or hiking or skiing or climbing) too hard? Recreation, Ecology, and Recreation Ecology | PLOS Ecology Community*. Retrieved from https://blogs.plos.org/ecology/2017/11/22/are-we-playing-or-hiking-or-skiing-or-climbing-too-hard-recreation-ecology-and-recreation-ecology/

Manning, R. E. (2011). *Studies in Outdoor Recreation: Search and Research for Satisfaction (3rd ed.)*. Corvallis, OR: Oregon State University Press.

March Salas, M. (2019). *The effect of rock climbing on Mediterranean cliff vegetation: first steps for the implementation of an innovative and comprehensive methodology in a wide geographical range*. Retrieved from American Alpine Club Research Reports website https://static1.squarespace.com/static/55830fd9e4b0ec758c892f81/t/5c7f079ca4222f175fec5d76/1551828895245/AAC_Final_Report_2019_02_28_Mart%C3%AD_March_Salas.pdf

Marrs, C. (2012) Draft. *The Bouldering Project: Archeological Inventory and Cultural Resource Management Recommendations at Published Bouldering Locations in Joshua Tree National*

Park. Project No.: JOTR 2007 P. On file at Joshua Tree National Park, Cultural Resources Office.

Marrs, C. & Matthews, K. (2012). *The Boulder Mapbook: Brief Depiction of Bouldering Locations and the Extent of Known Resource Damage as of 2012*. Joshua Tree National Park. Project No.: JOTR 2007 P. On file at Joshua Tree National Park, Cultural Resources Office.

Marion, J.L. & Merriam, L.C. (1985). *Recreational Impacts on Well-established Campsites in the Boundary Water Canoe Area Wilderness.* University of Minnesota Agriculture Experiment Station Bulletin, AD-SB-2502, St Paul, MN.

Marion, J.L., & Leung, Y. (2011). Indicators and protocols for monitoring impacts of formal and informal trails in protected areas. *Journal of Tourism and Leisure Studies*, *17*(2), 215–236.

Marion, J. L., Leung, Y.-F., Eagleston, H., & Burroughs, K. (2016). A Review and Synthesis of Recreation Ecology Research Findings on Visitor Impacts to Wilderness and Protected Natural Areas. *Journal of Forestry*, *114*(3), 352–362. https://doi.org/10.5849/jof.15-498

Mauthner, K. (2016). *Dual Capability Two Tensioned Rope Systems (DC TTRS1)*. Retrieved from http://itrsonline.org/wordpress/wp-content/uploads/2016/11/Mauthner-Presentation-ITRS-2016-v2.pdf

Mautner, T. (Ed.). (1997). *The Penguin Dictionary of Philosophy*. Retrieved from https://www.utilitarianism.com/bentham.htm

McCormick M., Massatti R. et al. (2019 September). *Producing science that makes a difference: perspectives from managers and scientists.* In 15th Biennial Conference of Science and Management for the Colorado Plateau and Southwest Region. Symposium conducted at Northern Arizona University, Flagstaff, AZ.

McMillan, M. A., & Larson, D. W. (2002). Effects of Rock Climbing on the Vegetation of the

Niagara Escarpment in Southern Ontario, Canada. *Conservation Biology*, *16*(2), 389–398. https://doi.org/10.1046/j.1523-1739.2002.00377.x

Miller, Z., Taff, B. D., & Newman, P. (2018). Visitor Experiences of Wilderness Soundscapes in Denali National Park and Preserve. *International Journal of Wilderness*, *24*(2). Retrieved from https://ijw.org/2018-visitor-experiences-of-wilderness-soundscapes/

Miramontes, R. (2011). *Joshua Tree: A Color Guide to the 2600 Best Rock Climbs & Boulder Problems*. Silt, CO: Wolverine Publishing.

Mohonk Preserve. (2018). *Research Report #38; Wildlife of the Shawangunk Cliffs*. Retrieved from https://medium.com/@MohonkPreserve/research-report-38-wildlife-of-the-shawangunk-cliffs-1aca93139dd7

Monti, P., & Mackintosh, E.E. (1979). Effects of camping on surface soil properties in the boreal forest region of northwestern Ontario, Canada. *Soil Science Society of America Journal*. 43, 1024-1029.

Monz, C. et al. (2005). Climbers' Attitudes Toward Recreation Resource Impacts in the Adirondack Park. *Proceedings of the 2005 Northeastern Recreation Research Symposium GTR-NE-341*, 204-211.

Mountainproject.com. (2017). *GCNP Rock Climbing.* Retrieved from https://www.mountainproject.com/v/gcnp/105787841

MountainProject. (2019a). *Climbing in Joshua Tree National Park, Joshua Tree National Park.* Retrieved from https://www.mountainproject.com/area/105720495/joshua-tree-national-park

Murdock, E. (2010). *Perspectives on Rock Climbing Fixed Anchors Through the Lens of the Wilderness Act: Social, Legal and Environmental Implications at Joshua Tree National Park, California* (Unpublished doctoral dissertation). School of Natural Resources and the

Environment, The University of Arizona, Tucson, AZ.

Murdock, E. (2004). *Understanding Recreation Flow to Protect Wilderness Resources at Joshua Tree National Park, California*. Available from *Working Papers of the Finnish Forest Research Institute 2*, Rovaniemi, Finland.

National Park Service. (n.d.). *What We Do (U.S. National Park Service)*. Retrieved from https://www.nps.gov/aboutus/index.htm

National Park Service. (n.d.-a). *National Park Service - Planning*. Retrieved from https://parkplanning.nps.gov/ManagementPlans.cfm

National Park Service. (n.d.-b). *Advanced Search (U.S. National Park Service)*. Retrieved from https://www.nps.gov/findapark/advanced-search.htm

National Park Service. (2016). *NPS PEPC - WSP Preliminary Concepts and Ideas: July - September 2016 [Presentation slides]*. Retrieved from https://parkplanning.nps.gov/document.cfm?parkID=347&projectID=47112&documentID=74332

NPS Wilderness Climbing Managers Network. (2018). *Wilderness Climbing Management Training*. Symposium conducted at Western Archeological Conservation Center in Tucson, AZ.

NPS Joshua Tree National Park (2019). *Climbing Management Plan Pre-NEPA Workshop*. Symposium conducted at Joshua Tree National Park, Twentynine Palms, CA.

Nickerson, G. (2015, March 16). Bighorn sheep survive migration loss, now pressed by skiers | WyoFile. Retrieved November 18, 2019, from https://www.wyofile.com/bighorn-sheep-survive-migration-loss-now-pressed-skiers/

Nix, J. H., Howell, R. G., Hall, L. K., & McMillan, B. R. (2018). The influence of periodic increases of human activity on crepuscular and nocturnal mammals: Testing the weekend

effect. *Behavioural Processes, 146,* 16–21. https://doi.org/10.1016/j.beproc.2017.11.002

Nuzzo, V. A. (1996). Structure of cliff vegetation on exposed cliffs and the effect of rock climbing. *Canadian Journal of Botany, 74*(4), 607–617. https://doi.org/10.1139/b96-077

Nylund, L. et al. (1980). Radial growth of Scots pine and soil conditions at some camping sites in southern Finland. *Silva Fennica. 14;* 1-13.

Outdoor Industry Association. (2014). *2014 Annual Report*. Boulder, CO: Outdoor Industry Association.

Outdoor Foundation. (2013). *Outdoor Participation Report 2013*. Boulder, CO: The Outdoor Foundation.

Outdoor Industry Association. (2017). *2018 OUTDOOR PARTICIPATION REPORT*. Retrieved from https://outdoorindustry.org/resource/2018-outdoor-participation-report/

Pelfini, M, and Santilli, M. (2006). Dendrogeomorphological alanlyses on exposed roots along two mountain hiking trails in the central Italian Alps. *Geogrefiska Annaler, Series A: Physical Geography, 88;* 223-236.

Perona, A. M., Urios, V., & López-López, P. (2019). Holidays? Not for all. Eagles have larger home ranges on holidays as a consequence of human disturbance. *Biological Conservation*, *231*, 59–66. https://doi.org/10.1016/j.biocon.2019.01.010

Pilcher, E. J., Newman, P., & Manning, R. E. (2008). Understanding and Managing Experiential Aspects of Soundscapes at Muir Woods National Monument. *Environmental Management*, *43*(3), 425–435. https://doi.org/10.1007/s00267-008-9224-1

Preisendorfer, J.J. (2008). *Technical Climbing's Effects on Wilderness Ecosystems*. Unpublished manuscript.

Reeves, F.B., Wagner, D., Moorman, T., & Kiel, J. (1979). The role of endomycorrhizae in vegetation practices in the semi-arid West. I. A comparison of incidence of mycorrhizae in severely disturbed vs. natural environments. *American Journal of Botany* 66, 6-13.

Richardson, C. T., & Miller, C. K. (1997). Recommendations for Protecting Raptors from Human Disturbance: A Review. *Wildlife Society Bulletin*, *25*(3), 634–638.

Roggenbuck, J. R., & Driver, B. L. (2000). Benefits of nonfacilitated uses of wilderness. In S. F. McCool, D. N. Cole, W. T. Borrie, and J. O'Loughlin (Eds.). *Wilderness Science in a Time of Change Conference Volume 3: Wilderness as a place for scientific inquiry. Proceedings RMRS-P-15-VOL-3* (pp. 33-49). USDA Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado, USA.

Rose, J. (2013). Terrain classification, climbing Exposure, and technical management. *Journal of Outdoor Recreation, Education, and Leadership*, *5*(3), 242–257. https://doi.org/10.7768/1948-5123.1176

Rusterholz, H., Müller, S. W., & Baur, B. (2004). Effects of Rock Climbing on Plant Communities on Exposed Limestone Cliffs in the Swiss Jura Mountains. *Applied Vegetation Science, 7*(1), 35–40.

Seekamp, E., Hall, T., & Cole, D. N. (2012). Visitors' conceptualizations of wilderness experiences. In *Wilderness visitor experiences: Progress in research and management* (pp. 50–61). Missoula, MT. Retrieved from https://www.fs.usda.gov/treesearch/pubs/40908

Sinek, S. (2011). *Start with Why: How great leaders inspire everyone to take action*. New York, NY: Portfolio Penguin.

Stankey, G. H., & Schreyer, R. (1987). Attitudes toward wilderness and factors affecting visitor behavior. In R. C. Lucas, (Ed.). *Proceedings: National Wilderness Research Conference:*

Issues, State-of-Knowledge, Future Directions. General Technical Report INT-220 (pp.246-293). USDA Forest Service, Intermountain Research Station, Ogden, Utah.

SuperTopo. (2012). *Joshua Tree Ethics: SuperTopo Rock Climbing Discussion Topic - page 12*. Retrieved from http://www.supertopo.com/climbing/thread.php?topic_id=1772094&tn=210

Taff, B. D., Weinzimmer, D., & Newman, P. (2015). Mountaineers' Wilderness Experience in Denali National Park and Preserve. *International Journal of Wilderness 21*(2), 7–15. Retrieved from https://issuu.com/ijwilderness/docs/august_2015_ijw

Taylor, A. R. & Knight, R.L. (2003). Wildlife responses to recreation and associated visitor perceptions. *Ecological Applications 13*, 951-963.

Tessler, M., & Clark, T. A. (2016). The impact of bouldering on rock-associated vegetation. *Biological Conservation*, *204*, 426–433. https://doi.org/10.1016/j.biocon.2016.10.004

Title 36 C.F.R. § 2 (2018).

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *Britist Journal of Management, 14*, 207-222. https://doi.org/10.1111/1467-8551.00375.

Tomasi, P. (n.d.). *Grand Canyon Mountaineering*. Retrieved from http://pseudalpine.discussion.community/

Tomasi, A. and Tomasi, P. (2010). *Grand Canyon Summits Select: A Compilation of Obscure Ascents in the Grand Canyon Backcountry*. Tempe, AZ: Pseudalpine.

USDA, United States Forest Service. (1999). *Convening Report for the Potential of a Negotiated Rulemaking on Fixed Anchors for Climbing in Wilderness Areas Administered by the Forest Service.*

USDA, United States Forest Service (2015). *Keeping it Wild 2: An updated interagency strategy to monitor trends in wilderness character across the National Wilderness Preservation System.*

USDI, National Park Service. (1991). *Mount Rainier National Park Wilderness Management Plan.*

USDI, National Park Service. (1995a). *Canyonlands National Park and Orange Cliffs Unit of Glen Canyon National Recreation Area Backcountry Management Plan.*

USDI, National Park Service (1995b). *Devils Tower Final Climbing Management Plan/Finding of No Significant Impact.*

USDI, National Park Service. (1997). *Visitor Experience and Resource Protection Framework: A handbook for planners and managers*. Retrieved from http://obpa-nc.org/DOI-AdminRecord/0048953-0049060.pdf

USDI, National Park Service. (1998a). *City of Rocks National Reserve Climbing Management Plan and Finding of No Significant Impact.*

USDI, National Park Service. (2000). *Joshua Tree National Park Backcountry and Wilderness Management Plan*.

USDI, National Park Service. (2001). *Rocky Mountain National Park Backcountry and Wilderness Management Plan.*

USDI, National Park Service. (2006a). *Management Policies.*

USDI, National Park Service. (2006b). *Denali National Park and Preserve Final Backcountry Management Plan -General Management Plan Amendment and Environmental Impact Statement.*

USDI, National Park Service. (2007). *Zion National Park-Backcountry Management Plan and Environmental Assessment.*

USDI, National Park Service. (2012). *Foundation Document: North Cascades National Park Complex*. Retrieved from https://www.nps.gov/noca/learn/management/upload/North-Cascades-NP-Complex-Foundation-Document_small.pdf

USDI, National Park Service. (2013a). *Director's Order #41: Wilderness Stewardship.*

USDI, National Park Service. (2013b). *Arches and Canyonlands National Parks: Climbing and canyoneering management plan.*

USDI, National Park Service. (2015a). *Jimbilnan, Pinto Valley, Black Canyon, Eldorado, Ireteba Peaks, Nellis Wash, Spirit Mountain, and Bridge Canyon Wilderness Areas Final Wilderness Management Plan and Environmental Impact Statement.*

USDI, National Park Service. (2015b). *Sequoia and Kings Canyon National Parks Wilderness Stewardship Plan and Final Environmental Impact Statement.*

USDI, National Park Service. (2015d). *Grand Canyon National Park Backcountry Management Plan Draft Environmental Impact Statement.*

USDI, National Park Service. (2015e). *Foundation Document: Mount Rainier National Park.* Retrieved from https://www.nps.gov/mora/learn/management/upload/MORA_FD_Signatures_emailsize_10-2017.pdf

USDI, National Park Service. (2016). *Annual Park Recreation Visitation (1904-Last Calendar Year): Joshua Tree.* Retrieved from http://irma.nps.gov/stats/reports/park/jotr.

USDI, National Park Service. (2016). *Annual Park Recreation Visitation (1904-Last Calendar Year): Grand Canyon.* Retrieved from http://irma.nps.gov/stats/reports/park/grca.

USDI, National Park Service. (2017). *About Us.* Retrieved from https://www.nps.gov/aboutus/index.htm.

USDI, National Park Service. (2017). *Joshua Tree Foundation Document.*

USDI, National Park Service. (2018a). *Grand Canyon Wilderness Character Narrative and Baseline Monitoring Assessment: Building blocks for wilderness stewardship.*

USDI National Park Service. (2018b). *Superintendent's Compendium – Grand Canyon National Park (U.S. National Park Service)*. Retrieved from https://www.nps.gov/grca/learn/management/upload/2018-grca-supt-compendium.pdf

USDI, National Park Service. (2019a). *Joshua Tree Wilderness: Building blocks for wilderness stewardship.*

USDI National Park Service. (2019b). *Superintendent's Compendium - Joshua Tree National Park (U.S. National Park Service)*. https://www.nps.gov/jotr/learn/management/superintendents-compendium.htm

USDI, National Park Service. (2019c). *North Cascades National Park Complex Superintendent's Compendium.*

USDI, National Park Service. (2019d). *Big Bend National Park Superintendent's Compendium*.

USDI, National Park Service. (2019e). *Pinnacles National Park Superintendent's Compendium*.

U.S. Public Law 16-1. National Park Service Organic Act of August 25, 1916. 39 Stat. F35.

U.S. Public Law 88-577. The Wilderness Act of September 3, 1964. 78 Stat. 890.

Wallace, G. N. (1990). *Law Enforcement and The Authority of the Resource*. Retrieved from https://lnt.org/sites/default/files/ART_Wallace_Original.pdf

Webster, J., & Watson, R.T. (2002). Analyzing the Past to Prepare for the Future: Writing a literature review. *MIS Quarterly, 26(2),* xiii-xxiii.

Washington Climbers Coalition. (2018). *2018-19 Liberty Bell Conservation Initiative*. Retrieved from https://washingtonclimbers.org/index.php/2018/01/14/liberty-bell/

National Park Service. (2017). Wilderness Character - Wilderness Stewardship Division (U.S. National Park Service). Retrieved from https://www.nps.gov/orgs/1981/wilderness-character.htm

Wilderness Connect. (n.d.). *Wilderness Connect*. Retrieved from https://wilderness.net/learn-about-wilderness/agencies.php

Wilderness Connect. (2018). *Wilderness Connect for Practitioners*. Retrieved from https://wilderness.net/practitioners/toolboxes/recreation-site-monitoring/default.php

Appendix A. Glossary of Terms

Clean Climbing:

1. "A rock climbing term that describes techniques and equipment that climbers use in order to avoid damaging the rock by widening cracks or drilling holes. Clean climbing techniques may date back to the 1920s and possibly earlier. The term itself likely emerged around 1970 with the widespread and rapid adoption of nuts (also called chocks), hexes, and cams in the United States and Canada. These were adopted for use in preference to pitons, and at times bolts, which damage rock and are more difficult and time-consuming to install." (USDI, 2015b)

Clean Aid:

1. "Clean aid involves the use of temporary equipment and anchors that can be placed and removed without altering the environment (e.g. slings, cams, nuts, chocks, and stoppers)," (USDI, 2013b).

Climbing (see 'Rock Climbing' below):

1. "Rock climbing, snow and ice climbing, mountaineering, canyoneering and caving, where climbing equipment, such as ropes and fixed or removable anchors, is generally used to support an ascent or descent," (USDI, 2013a, p.15).
2. "Climbing is defined as ascending or descending very steep terrain, usually by using hands and feet to maintain balance, and typically utilizing ropes and anchors to prevent falls. This includes rock climbing, ice climbing, canyoneering, caving, rappelling, and other similar activities." (USDI, 2015b)

Fixed anchor:

1. “Any piece of climbing protection left in place to facilitate safe ascent or rappel,” (Murdock, 2004).
2. “Climbing equipment (e.g., bolts, pitons or slings) left in place to facilitate ascent or descent of technical terrain. These anchors are a critical component of a climber’s safety system. Fixed anchors are typically placed by the first ascentionist on technical ascents and descents (rappels) where removable anchor placements are not viable.” (Access Fund & AAC, 2015)
3. “Consist of webbing, bolts, pitons, chains, and other devices and equipment permanently or semi permanently attached to rocks (or other natural features) that are left in place after a rock climbing activity. These may be divided into two categories: 1) permanent anchors (e.g., bolts and pitons), and 2) removable or abandoned anchors (e.g., slings, nuts) with or without accompanying hardware such as carabiners.” (USDI, 2015b)
4. “Any man-made article, either hardware or software (webbing, rope, cord, etc.) that is used to aid ascent or descent, or as protection, and is left on route by a climbing or canyoneering party after the completion of the route.” (USDI, 2013b)

High Exposure:

1. “A fall would be more than 15 feet above a comfortable landing zone, or when a shorter fall is unlikely to stop; a fall would reasonably result in a significant injury or fatality,” (Rose, 2013).

Terrain Classification:

“1st class: Hiking.

2nd class: Simple scrambling, with possible occasional use of hands.

3rd class: Scrambling on steeper terrain; hands are often or regularly used for balance.

4th class: Simple climbing on steeper terrain; hands are often or regularly used to

support body weight or for vertical or horizontal movement.

5th class: Simple and advanced rock climbing techniques are consistently engaged on steep terrain for vertical or horizontal movement. Where rock climbing begins in earnest." (Rose, 2013)

Rock Climbing:

1. Movement on 5th class terrain, where technical ascent and/or descent of features traditionally require the use of ropes and natural or artificial equipment to protect the climber from long falls (Eng, 2010).

Appendix B. Monitoring Tools and Templates

Visitor Behavior Restriction Index Template

Table B 1. Template for Climbing Visitor Behavior Restriction Index

Climbing Visitor Behavior Restriction Index for _____			
General Restrictions			
Type of regulation	Score	Geographic weight	Total score
Fees			
Camping			
Overnight Permits			
Campfires			
Day Use Permits			
Human waste			
Length of stay			
Stock			
Swimming/bathing			
Area closure			
Group size limits			
Pets			
		General index total	**__/54 or __%**
Climbing Restrictions			
Type of regulation	Score	Geographic weight	Total score
Permits (climbing)			
Group size limit (climbing)			
Closures (climbing)			
Human waste regulation (climbing)			
Fixed Anchor Regulations			
New Route Regulations			
		Climbing index total	**__/32 or __%**
		Overall total	**__/86 or __%**

To complete the data collection and analysis, the reviewer should identify all regulations applicable to general wilderness visitation in the Superintendent's Compendium. Next, regulations

in the Superintendent's Compendium on climbing, both that apply broadly across the park and are restricted to wilderness are noted. Climbing restrictions designated for non-wilderness application are not included. A score is assigned within each category of regulation according to the guidelines presented in Table B2. The geographic extent of the restriction is also recorded. If a wilderness has more than one type of regulation within a given category, the score will be assigned that corresponds to the most restrictive regulation in place. A higher score indicates a greater degree of restriction on visitor behavior. An initial VRBI is completed for general visitor restrictions, then a climbing-specific VRBI is completed.

Table B 2. Visitor Behavior Restriction Index Scoring

VBRI Restriction Scoring	
Score	Level of restriction
0	No regulation within the category.
1	Some restriction with retention of some individual choice. • For example, designated site camping policies enable visitors to choose from available sites when they arrive at their destination. • A score of 1 is also assigned in cases in which regulations are restrictive but affect only one segment of the user group (e.g., permits for new fixed anchors effects route developers, whereas permits for any fixed anchor placement, replacement, or removal effects everyone interested in bolting).
2	No choice is permitted. • For example, assigned site policies that require visitors to select campsites before beginning their trip would receive a score of 2.
3	Reserved for the most restrictive regulations: use limits, waste pack-out requirements, closures to stock, and area closures to all use.

(Landres et al, 2009)

The recommended set of general and climbing VRBIs are listed below.

Table B 3. Categories, Scores, and Types of Restrictions for Computing VBRI

Categories, scores, and types of restrictions for computing the VBRI	
General Restrictions	
Fees	0 No fees 1 Fees charged of selected user type 2 Fees charged of all visitors
Camping	0 No restriction 1 Any mandatory setback; designated sites; day use areas 2 Assigned sites
Overnight Permits	0 No permit or registration 1 Voluntary self-registration 2 Mandatory, non-limiting permit or registration, specially available opportunities for permits to climbers 3 Mandatory; use limited (all users)
Campfires	0 No restriction 1 Designated site, above designated elevation, or mandatory setback 2 Total prohibition
Day Use Permits	0 No registration 1 Voluntary self-registration 2 Mandatory, non-limiting permit or registration 3 Mandatory; use limited
Human waste	0 No restriction 3 Pack out required
Length of stay	0 No restriction on length of stay 1 Length of stay limited
Stock use	0 No restriction 1 Permit required 3 Stock prohibited
Swimming/bathing	0 No restrictions 2 Prohibited
Area closure	0 No restriction 1 Seasonal closure 3 Permanent closure
Group size limits	0 No restriction 1 Group size limits in place
Pets	0 No restrictions 1 Required to be on leash 2 Prohibited
Climbing Restrictions	
Permits (climbing)	0 No permit or registration 1 Voluntary self-registration

	2 Mandatory, non-limiting permit or registration, specially available opportunities for permits to climbers 3 Mandatory; use limited
Group size limit (climbing)	0 No restriction 1 Group size limits in place
Closures (climbing)	0 No restriction 1 Seasonal closure 3 Permanent closure
Human waste regulation (climbing)	0 No restriction 3 Pack out required
Fixed anchor regulations	0 No restriction 1 Permits required for new fixed anchors 2 Permits required for any installation, replacement, removal of fixed anchors 3 Fixed anchor moratorium
New route regulations	0 No restriction 1 Mandatory reporting after completion 2 Permit required for new routes 3 New routes prohibited
Bivouac regulations	0 No restriction 1 Voluntary bivouac permit, no use limitation 2 Mandatory bivouac permit, no use limitation 2 Mandatory bivouac permit, use limited
Visual impact regulations	0 No restriction 1 Restriction on visual impacts; chalk; camouflaged fixed anchors

After the score is assigned for each category of regulation, these scores will be weighted to reflect the geographic coverage of the regulation as follows:

- 1—the regulation applies to a subarea of wilderness.
- 2—the regulation applies to an entire wilderness.

The maximum possible restriction score in the proposed index is 86. The index restriction value will be a percentage representing the actual restriction score divided by the highest possible restriction score (highest restriction value x 2 entire wilderness, for each category).

Example of calculating the most restrictive regulation in a category: Fixed anchors

Restriction 1:

- JTNP has a closure for all fixed anchors in its fixed anchor free zone, which is a subarea of wilderness.
    - This scores as a 3 for restrictions ("3 Fixed anchor moratorium")
    - This scores a 1 for geographic extent because it applies only to a subarea of wilderness.
    - The total score for the Visitor Behavior Restriction Index is 3.

Restriction 2:

- JTNP requires superintendent approval (a special use permit) for the placement of any new fixed anchors in wilderness.
    - This restriction scores a 1 ("1 Permits required for new fixed anchors").
    - This scores a 2 for geographic extent because it applies to all wilderness.
    - The total score for the Visitor Behavior Restriction Index is 2.

The highest scored restriction is counted in the index, therefore the value for JTNP's fixed anchors regulations is 3.

Cautions: "Data for the index measure are reliably and accurately reported through [Superintendent's Compendia]. The items tracked encompass the range of management actions likely to affect visitors' feelings of confinement. Despite these characteristics, the index has a significant drawback in that it can capture only three levels of extent (no regulation, subarea, and total wilderness). Ideally, it would be best to have a more precise measure of spatial extent to better track change over time and to more accurately measure the impact on visitors. Another limitation is that, although the weighting scheme seems logical, the specific weights are subjectively determined. This limitation can be addressed through simulations using different weighting schemes, however, and, at the wilderness level, the data will be captured in a way that permits disaggregation of the

specific components." (Landres et al, 2009)

Administrative Motorized/Mechanized Tool Use Index – Climbing

Table B 4. Project Motorized Index Value

Project Name:_____			
Type of equipment	Inherent weight	Days of actual use	Equipment use value

Five-year index for motorized/mechanized use is:

Table B 5. Template for Motorized/Mechanized Use - Five Year Index

Motorized/Mechanized Use Index	
Project Name	Project motorized index value
Five-Year Index Value	

Motorized or mechanized use in wilderness can be approved through a Minimum Requirements Analysis (MRA) when it is determined that a prohibited tool is the minimum tool required to complete a resource or visitor protection task. In wilderness character monitoring, a weighted index of the type and duration of tool use is recorded. Many wilderness units monitor both administrative prohibited uses as well as emergency prohibited uses. Unless a park has a strong system in place to track prohibited uses in wilderness during emergency operations, this measure is impractical and possibly not useful as all emergency response is planned to be the most efficient, safe, and resource aware. Emergency motorized and mechanized use is not recorded in this wilderness climbing monitoring strategy. For parks wishing to integrate data from emergency incidents, examples of indices are found in "Technical Guide for Monitoring Selected Conditions

Related to Wilderness Character" (Landres et al, 2009).

Table B 6. Equipment Types and Inherent Weights for Motorized/Mechanized Index

Equipment type	Inherent weight	Equipment type	Inherent weight
Air compressor	2	Motorcycle	3
Air tanker	3	Motorized watercraft	3
All-terrain vehicle	3	Motorized winch	2
Battery-powered tool	1	Portable pump	2
Bicycle	1	**Rock drill**	**3**
Chain saw	3	Snow machine	3
Concrete equipment	3	Truck	3
Fixed-wing aircraft	3	Wheelbarrow	1
Float plane	3	Wheeled litter	1
Generator	2	Heavy equipment	4
Heavy equipment	4	Helicopter	3
Helicopter	3	Motorcycle	3

The Motorized/Mechanized Tool Use Index provides a measure of development permitted in wilderness by considering approved projects that involve prohibited uses. Each project has a calculated development weight that considers the inherent impact of each type of tool, the number of tools, and the number of days the tools are in use. Each project is weighed individually in the index, then totals for all projects in the monitoring cycle are added together to provide a cumulative measurement representing development impact (Landres et al, 2009).

Table B 7. Attributes for Measuring Motorized/Mechanized Use Days

Attributes for measuring motorized/mechanized use days
Equipment type*
Number of pieces of equipment*
Number of days actual use*
Name of authorization
* The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.

Primary source is a review of MRAs. The secondary source is the wilderness coordinator. MRAs for a five-year period will be reviewed for motorized tool use related to climbing projects. Ideally, a rolling tally is kept of any approved motorized tool use. From each MRA, the type of

equipment is noted (motorized rock drill), along with the number of pieces of equipment, number of days of use, and the name of the MRA. To obtain a value, for each individual tool used:

(inherent weight of tool) x (number of days of use) = (value per tool).

Each value per tool is added to obtain a total value for each project. Each project's total value is added together to assess the five-year value (Landres et al, 2009). The total index value is calculated as a total of all authorized project index values for a five-year period.

Cautions: Concerns about this index are the "arbitrariness" of the weights selected, and debate about "the implied relationship between different numeric values (e.g., that multiple chain saws used for multiple days has more impact than a single helicopter" (Landres et al, 2009). The values of these developments in and of themselves is difficult to derive meaning from, however when used to assess change over time in an individual wilderness (Landres et al, 2009).

The Motorized and Mechanized Use Index provided is specifically edited to address projects allowing power drills solely. If projects are approved through the MRA process that relate to climbing and incorporate other motorized or mechanized uses (e.g. helicopters, wheel barrows), then those tools should be added to the index according to the inherent weights provided in Table B6.

Sample Field Data Sheet

Wilderness Climbing Monitoring Form v9

Date _____ Monitoring team members _____

Climb name _____ Pitches: _____ Difficulty Rating: _____ Length (ft) _____

Year climb was established (if known): _____ Quality Rating (consensus rating from guidebooks, adjust to 5-star system): _____

Weather Observations (circle all that apply): Sun Overcast Rain Wind Snow Hot Col Commitment Grade: I II III IV V VI

This form covers the all travel components (approach, staging, climb and descent) for a selected climb.

For prototype monitoring forms, exact counts on measures are recorded. Final monitoring form goal is to establish parameters for low/medium/high impact

LOCATION

Rock formation/area name _____ Guidebook sources _____

Coordinates at base of climb (UTM) _____

Datum _____

Primary parking _____ Secondary parking _____

Number of other known routes on formation/area _____

APPROACH

FULL APPROACH INFORMATION: from parking area to base of staging area

Access via established* (est.) trail? YES / NO if "yes', list Trail names _____

*Established trails are catalogued and maintainted by the National Park Service. This does not include climber access routes.

Length of approach on est. trail _____ Length of approach off of est. trail _____ Total approach length _____

Total approach time _____

Terrain Classification and Exposure: 3rd 4th 5th High exposure

If harder than 2nd class, please select all applicable terrain classifications.

1st class: Hiking.

2nd class: Simple scrambling, with possible occasional use of hands.

3rd class: Scrambling on steeper terrain; hands are often or regularly used for balance.

4th class: Simple climbing on steeper terrain; hands are often or regularly used to support body weight or for vertical or horizontal movement.

5th class: Simple and advanced rock climbing techniques are consistently engaged on steep terrain for vertical or horizontal movement. Where rock climbing begins in earnest.

Also please note if any section of approach is high exposure: such that a fall would be more than 15 feet above a comfortable landing zone, or when a shorter fall is unlikely to stop; a fall would reasonably result in a significant injury or fatality.

Terrain type circle all that apply: [dirt] [historic road] [creek bed/wash] [est. trail] [forest] [snow] [talus] [rock slab] [glacier] [meadow][brush] [other:]

Other attractive features or uses sharing off-trail approach (recreational uses, resource attractions, water sources): _____

Approach Description: _____

INFORMATION BELOW IS RECORDED ONLY FOR APPROACH ROUTE OFF OF EST. TRAILS

Cairns or trail marking (6. Solitude – Remoteness from sights and sounds of human activity inside Wilderness)			**Few**-next markers only visible when moved past current marker.	**Appropriate**-next markers generally visible at current marker.	**Many**-multiple markers visible from single view point	Cairns or other route markers, such as reflectors, signs, etc.
Social trails (4. Natural – Ecological Processes)			0-2 social trails	3-5 social trails	>5 social trails	Social trails to base of cliff within 50m of staging area
Fixed equipment on approach (7. Solitude – Facilities that decrease self-reliant recreation)			**Few and appropriate for the terrain**: all sparingly placed fixed equipment only where necessary. Visually match rock.	**Moderate to protect the terrain**:most fixed equipment necessary for safe approach/ descent, few may be placed in areas that don't require them.	**Many**: Fixed equipment may be placed in areas where other safe and durable surface approach/descent options are available	Fixed lines or anchors (fixed or natural) in place to facilitate safe approach/descent and resource protection in high angle approach terrain.

Notes:

STAGING/BASE

Terrain type circle all that apply: [dirt] [historic road] [creek bed/wash] [est. trail] [forest] [snow] [talus] [rock slab] [glacier] [meadow] [other:_____]

Staging area continuous / fragmented (general) continuous=one joined area for surrounding routes, fragmented=many separate staging areas.

Indicator	Rating	Exact #	1 - Low Impact	2-Moderate Impact	3-High Impact	Notes
Damage to vegetation at base (1. Natural – Plants)			0-4 damaged plants	5-9 damaged plants	>9 damaged plants	Intentional or unintentional damage to vegetation at base: cut/broken branches, exposed roots

Extent of erosion, hardened or denuded base-LINEAR (4. Natural – Ecological Processes)			0-2m	2-5m	>5m	Measure greatest extent of staging area impact from cliff base, perpendicular to cliff (start at impacted base area nearest to cliff and pace to edge of impacted area farthest from cliff.
Extent of erosion, hardened or denuded base-AREA (4. Natural – Ecological Processes)			0-4 sq m	4-25 sq m	>25 sq m	Estimate the area of impact to the staging area: measure greatest distance of staging area impact from cliff base, perpendicular to cliff, then width of staging area through its widest part, in parallel to the base. These areas are primarily dirt, and disturbed such that soil has compacted and/or plants no longer grow there as they do compared to undisturbed areas in the immediate area
Organic Ground Cover in Staging Area (4. Natural – Ecological Processes)			50-100%	25-49%	<25%	Estimate overall percentage of staging area with organic material (leaf litter, pine needles, sticks, etc.)
Trash / litter (6. Solitude – Remoteness from sights and sounds of human activity inside Wilderness)			Minimum microtrash present <10 pieces	Some microtrash (10-20 pieces) or macrotrash (1-2 pieces) present	Excessive microtrash (>20 pieces) or macrotrash >2 pieces present.	Number of pieces of trash present (micro=small pieces of trash items ex. tape bits, macro=whole or large pieces of trash, ex. food wrapper). Chalk spills included as micro or macrotrash depending on the spill. Pack out found trash. *Include in this count trash found on approach within 30m of staging.*
Human waste / toilet paper (6. Solitude – Remoteness from sights and sounds of human activity inside Wilderness)			**None** present	**1 pile visible TP present**, no feces present	**>1 piles visible TP present, any amount of feces present**	Number of visible human waste impacts including toilet paper and unburied waste

User-created recreational structures (6. Solitude – Remoteness from sights and sounds of human activity inside Wilderness)			0-1 structure	2-4 structures	>5 structures	Bivy shelters, fire rings, cheater rock stacks, route markers. Not associated with cultural resources.
Notes:						

CLIMB/ROUTE						
Indicator	Rating	Exact #	1 - Low Impact	2-Moderate Impact	3-High Impact	Notes
Average # fixed anchors per foot (7. Solitude – Facilities that decrease self-reliant recreation)			1 fixed anchor per >30 feet	1 fixed anchor per 15-29 feet	1 fixed anchor per <15 feet	Average number of fixed anchors per foot, including belay anchors (but excluding rappel anchors not used in ascent). Divide the total length of the climb (in feet) by the total number of pieces of fixed hardware.
Appropriateness of Fixed Anchors (7. Solitude – Facilities that decrease self-reliant recreation)			low*	moderate*	high*	*See below

*****This is a standard based on your perception as a climbing professional, not a member of the climbing public.**

After climbing the route does your judgement, which is based on your training and experience, say that the fixed anchors were few and appropriate? Are they rare and selectively placed to protect sections of face that do not take removable protection, and protect against high-risk falls? Is the purpose of some fixed anchors to protect cliff-side resources? Does the bolting on this route match traditional and historic climbing ethic of climbing in this park (including pitches of aid to link crack systems)?

Low: Few and appropriate, ethically consistent with traditional and historic climbing practices in this park.

Moderate: More anchors exist than meets the "rare" standard above, but anchors are still deemed appropriate. Route consists of more sections of face climbing than crack, but bolt spacing is not that of a modern sport climb. Natural anchors may be present but bolts have been added to augment questionable natural anchors, reduce visual impact, or protect cliff resources.

High: A route has sections of "sport" bolting, with fixed anchors at even distances regardless of appropriateness, risk, or difficulty of terrain relative to crux (5.5 sections bolted on a 5.9 route). Belay anchors are bolted, regardless of opportunities to build anchors with feasible removable protection. Top anchors are numerous, when there could be one shared, bolted top anchor.

Visual Impact to Rock (6. Solitude – Remoteness from sights and sounds of human activity inside Wilderness)			Impact only visible while climbing the route	Some visual impact on route visible from staging area or approach.	Visual damage highly apparent from staging area or approach.	Rust streaks, excessive chalk, blackening or smoothing from rope wear, or un-camouflaged natural or fixed anchors.
Damage to rock (3. Natural – Geologic Resources)			Minimal damage to rock, <2 individual instances of damage.	Moderate damage to rock, 2-4 individual instances of damage.	Heavy damage to rock, >4 individual instances of damage.	Damage or alteration to rock, including scars from pried off plates, hammered edges, chipped/glued holds, or grooving from rope wear.
Damage to vegetation on route (1. Natural – Plants)			Minimal damage to cliff vegetation	Some damage to cliff plants, cracks may be cleaned, some wearing of lichens	scrubbing/wearing of lichens, removal of cliff plants, presence of dead woody plants.	Damage to any vegetation on route, including woody & herbaceous plants, scrubbing or removal of mosses, lichens.

Notes:

DESCENT (COMMON/POPULAR)

Type rappel walk-off circle all that apply - complete corresponding descent monitoring block(s) below (rappel, walk-off)

List alternative descents (not monitored): _____

Rappel

Total # rappel stations _____

Fixed anchor rappel stations? YES / NO Number fixed anchor stations _____

Natural anchor rappel stations? YES / NO Number natural anchor stations _____

Concerns with resource damage due to location of anchors (fixed or natural)? YES / NO describe in notes

Some Rappel anchors shared with a climbing route? YES / NO Number of anchors shared with other route: _____ complete remainder of descent d

If all rappel anchors are shared with climbing route being monitored (aka rappel the route) skip remainder of descent data

Indicator	Rating	Exact #	1 - Low Impact	2-Moderate Impa	3-High Impact	Notes
Extent of erosion, hardened or denuded base-LINEAR (if different than staging) (4. Natural – Ecological Processes)			0-2m	2-5m	>5m	Measure greatest extent of staging area impact from cliff base, perpendicular to cliff (start at impacted base area nearest to cliff and pace to edge of impacted area farthest from cliff.
Extent of erosion, hardened or denuded base-AREA (if different than staging) (4. Natural – Ecological Processes)			0-4 sq m	4-25 sq m	>25 sq m	Estimate the area of impact to the staging area: measure greatest distance of staging area impact from cliff base, perpendicular to cliff, then width of staging area through its widest part, in parallel to the base. These areas are primarily dirt, and disturbed such that soil has compacted and/or plants no longer grow there as they do compared to undisturbed areas in the immediate
Visual Impact to Rock on descent (6. Solitude – Remoteness from sights and sounds of human activity inside Wilderness)			Impact only visible while climbing the route	Some visual impact on route visible from staging area or approach.	Visual damage highly apparent from staging area or approach.	Rust streaks, excessive chalk, blackening or smoothing from rope wear, or un-camouflaged natural or fixed anchors.
Damage to rock on descent (3. Natural – Geologic Resources)			**Minimal damage** to rock, <2 individual instances of damage.	**Moderate damage** to rock, 2-4 individual instances of damage.	**Heavy damage** to rock, >4 individual instances of damage.	Damage or alteration to rock, including scars from pried off plates, hammered edges, chipped/glued holds, or grooving from rope wear.

Damage to vegetation on descent (1. Natural – Plants)			**Minimal damage** to cliff vegetation	**Some damage** to cliff plants, cracks may be cleaned, some wearing of lichens	**Obvious damage**: scrubbing/wearing of lichens, removal of cliff plants, presence of dead woody plants.	Damage to any vegetation on route, including woody & herbaceous plants, scrubbing or removal of mosses, lichens.

Notes:

Walk-off

Terrain type circle all that apply: [dirt] [historic road] [creek bed/wash] [est. trail] [forest] [snow] [talus] [rock slab] [glacier] [meadow] [other:_____]

Indicator	Rating	Exact #	1 - Low Impact	2-Moderate Impa	3-High Impact	Notes
Cairns or marking on descent (6. Solitude – Remoteness from sights and sounds of human activity inside Wilderness)			Few-next markers only visible when moved past current marker.	Appropriate-next markers generally visible at current marker.	Many-multiple markers visible from single view point	Cairns or other route markers, such as reflectors, signs, etc.
Number of descent trails to the base (4. Natural – Ecological Processes)			0-2 descent trails	3-5 descent trails, separated by vegetation and non-eroded terrain	>5 descent trails or largely eroded slope/gully from descent traffic	
Damage to vegetation on descent (1. Natural – Plants)			0-3 damaged plants	4-8 damaged plants	>8 damaged plants	Number of plants on descent with damage, including cut/broken branches, exposed roots

User-created structures ((6. Solitude – Remoteness from sights and sounds of human activity inside Wilderness)			0-1 structure	2-4 structures	>5 structure	Bivouac structures, fire rings

Notes:

Number of other people (6. Solitude – Remoteness from sights and sounds of human activity inside Wilderness)			0-2 parties	3-5 parties	>5 parties	Number of other parties climbing on the formation, visible during any component of climb (approach, staging, climb, descent)

OTHER

Does this route pose a threat to unique cultural or natural resources? Explain:

_____

_____

_____

climbers observed during staging, climb or descent _____ # all people (including climbers) observed _____

Patrol Narrative: