National Park Service
U.S. Department of the Interior

Saguaro National Park

Wild Space in an Urban Setting

Wilderness Building Blocks for Saguaro National Park

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Saguaro National Park
National Park Service
3693 S. Old Spanish Trail
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ON THE COVER
A sunset in Tucson Mountain District of Saguaro National Park
Photograph by: John Williams

Executive Summary

This report consists of building blocks which provide a foundation for effectively integrating wilderness character into the management of the Saguaro Wilderness in Saguaro National Park. Its intention is to highlight the salient and unique components of the wilderness, determine their current condition, develop a shared understanding of their value and context and make recommendations for appropriate measures that can be monitored to assess changes in these components over time.

Chapter One provides an overview of wilderness character and describes its importance to park managers. This chapter is based on content from *Keeping it Wild*: *An interagency strategy to monitor trends in wilderness character across the National Wilderness Preservation System* (Landres et al., 2008). Chapter Two is a qualitative description of what is unique about the Saguaro Wilderness, including the challenges managers face in managing an urban wild space, and how the wilderness fits into the larger story of the uniquely American wilderness idea. This chapter provides important context for understanding the specific measures described in the remainder of the report and is based informal interviews with park staff, coding and analysis of the Wilderness Stewardship Plan Scoping Meeting notes, and an overview of historical and planning documents. Chapters Three through Seven provide specific measurements that are intended to capture the unique nature of the Saguaro Wilderness and represent the five qualities of wilderness character outlined in *Keeping it Wild.* The goal of these chapters is to provide measures that are important to wilderness stewardship and that can be monitored yearly or every five years as a way to track wilderness quality over time. Data compiled in 2017 will be compared with baseline data collected in 2012 to determine the state of wilderness character at that time. This process is to be repeated every five years in order to track changes in wilderness character and to better understand the practical implications of park operations on the overall quality of the wilderness.

The last chapter describes issues and opportunities related to wilderness character for park management to consider in future operations. It outlines simple steps, some unique to Saguaro, that park management can follow to better integrate wilderness character into decision making, public scoping, and the overall management of Saguaro's unique wilderness.

Table of Contents

Page

Figures iv

Tables v

Appendices vi

List of Acronyms Used vii

Chapter One: Introduction to Wilderness Character 1

Chapter Two: Wilderness Character Narrative 6

Chapter Three: Natural Quality Measures 20

Chapter Four: Untrammeled Quality Measures 32

Chapter Five: Undeveloped Quality Measures 37

Chapter Six: Opportunities for Solitude or Primitive and Unconfined Recreation Quality Measures 46

Chapter Seven: Other Features Quality Measures 54

Chapter Eight: Wilderness Stewardship Issues and Opportunities at Saguaro National Park 58

References 63

Appendices 64

Figures

Page

Figure 1. Conceptual Model of wilderness character monitoring. 3

Figure 2. Map of TMD, RMD and the Tucson metropolitan area 7

Figure 3. Map of the Sky Island region 9

Figure 4. Departure from fire return interval at RMD, October 2012 29

Figure 5. Map of development within 30km of TMD and RMD, October 2012 31

Tables

Page

Table 1. Status of sensitive species 23

Table 2. Inherent weighting for the fire return interval 27

Table 3. Total index value for the fire return interval 28

Table 4. Total development index value 30

Table 5. Temporal Value of Trammeling 35

Table 6. Level of biophysical manipulations 35

Table 7. Example index values of authorized research that intentionally manipulates the biophysical environment 36

Table 8. Inherent weights of different types of motorized equipment and mechanical transport used in wilderness 42

Table 9. Inherent weights for the actual uses of motorized equipment and mechanical transport 42

Table 10. Example calculation of the use level value for emergency uses of motorized equipment and mechanical transport 43

Table 11. Extent of unauthorized uses 44

Table 12. Total score for all unauthorized uses 45

Table 13. Quality of Cell Phone Reception 51

Table 14. Management Restrictions on Visitor Behavior 53

Table 15. Conditional index value of archeological sites 57

Appendices

Page

Appendix A. Natural Quality Data Table 64

Appendix B. Untrammeled Quality Data Table 66

Appendix C. Undeveloped Quality Data Table 67

Appendix D. Solitude or Unconfined Type of Recreation Quality Table 68

Appendix E. Other Features Quality Table 70

Appendix F-1. List and Weight of NPS Infrastructure 71

Appendix F-2. List and Weight of NPS Data Collection Infrastructure 72

Appendix G. List and Weight of Recreational Structures 73

List of Acronyms Used

CCC	Civilian Conservation Corps
CE	Common Era
EA	Environmental Assessment
DHS	Department of Homeland Security
DMAFB	Davis-Monthon Air Force Base
GIS	Geographic Information System
LCS	List of Classified Structures
MRDG	Minimum Requirements Decision Guide
NPS	National Park Service
NWPS	National Wilderness Preservation System
RMD	Rincon Mountain District
SAGU	Saguaro National Park
TEK	Traditional Ecological Knowledge
TIA	Tucson International Airport
TMD	Tucson Mountain District
USFS	United States Forest Service
WFMI	Wildland Fire Management Information

Chapter One

Introduction to Wilderness Character

In 1964, the Wilderness Act was signed into law by President Lyndon B. Johnson. This law created a formal mechanism for designating wilderness and mandated the protection of "wilderness character." Despite this mandate, the four U.S Federal wilderness management agencies have lacked a consistent definition of wilderness character and the tools to evaluate how it is changing over time. A monitoring framework was utilized in this report to determine indicative measures to track trends in wilderness character over time. This framework is outlined in *Keeping it Wild: An Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System* (2008), which provides a nationally consistent approach to describing and assessing trends in wilderness character across the full extent of the National Wilderness Preservation System (NWPS). Both *Keeping it Wild* and this document provide consistent use of language relevant to wilderness character. Considering the complexities in wilderness management, it is important to develop a shared vocabulary among park staff to be able to better understand the implications of park operations on wilderness character.

What is Wilderness Character?

The 1964 Wilderness Act does not define wilderness character and the congressional committees that debated the Wilderness Act did not discuss its meaning (Scott, 2002). The United States Forest Service's (USFS) national framework for monitoring wilderness character (Landres et al., 2005) identified three mutually reinforcing societal ideals integral to the historical purpose of wilderness and to understanding wilderness character:

- Natural environments that are relatively free from modern human manipulation and impacts;

- Personal experiences in natural environments that are relatively free from the encumbrances and signs of modern society; and

- Symbolic meanings of humility, restraint, and interdependence in how individuals and society view their relationship to nature.

Wilderness character may be described as the combination of biophysical, experiential, and symbolic ideals that distinguish wilderness from other lands. These ideals combine to form a complex and subtle set of relationships among the land, its management, its users, and the

meanings people associate with wilderness. In total, these relationships and meanings are described as "wilderness character." Howard Zahniser, the primary author of the Wilderness Act, wrote that "to know the wilderness is to know a profound humility, to recognize one's littleness, to sense dependence and interdependence, indebtedness, and responsibility" (1956). This and other writings of Zahniser strongly reinforce the idea that, fundamentally, wilderness character is the capacity of an area to elicit humility, awaken a sense of relationship and interconnectedness with the community of life, and evoke a feeling of restraint and obligation toward nature.

Five Qualities of Wilderness Character

Congressional intent for the meaning of wilderness character is expressed in the Definition of Wilderness, Section 2(c) of the 1964 Wilderness Act (McCloskey, 1999; Rohlf and Honnold 1988; Scott 2002). The USFS national framework (Landres et al., 2005) applied this congressional intention to identify four tangible qualities of wilderness that make the idealized description of wilderness character relevant and practical to wilderness stewardship:

Natural

The Wilderness Act states that wilderness is "protected and managed so as to preserve its natural conditions." In other words, wilderness ecological systems are substantially free from the effects of modern civilization. This quality is degraded by intended or unintended effects of the actions of modern people on the ecological systems inside the wilderness.

Untrammeled

The Wilderness Act states that wilderness is "an area where the earth and its community of life are untrammeled by man," and "generally appears to have been affected primarily by the forces of nature." In short, wilderness is essentially unhindered and free from modern human control or manipulation. This quality is degraded by modern human activities or actions that control or manipulate the components or processes of ecological systems inside the wilderness.

Undeveloped

The Wilderness Act states that wilderness is "an area of undeveloped federal land retaining its primeval character and influence, without permanent improvements or human habitation," "where man himself is a visitor who does not remain" and "with the imprint of man's work substantially unnoticeable." This quality is degraded by the presence of structures, installations, habitations, and by the use of motor vehicles, motorized equipment, or mechanical transport that increases people's ability to occupy or modify the environment.

Solitude or a primitive and unconfined type of recreation

The Wilderness Act states that wilderness has "outstanding opportunities for solitude or a primitive and unconfined type of recreation." This quality is about the *opportunity* for people to experience wilderness; it is not directly about visitor experiences per se. This quality is degraded by settings that reduce these opportunities, such as visitor encounters, signs of modern civilization, recreation facilities, and management restrictions on visitor behavior.

Other features

In many cases, a park may find that the above four qualities do not fully express the values and features found in its wilderness areas. The National Park Service (NPS) has defined a fifth quality, Other Features, based on the last clause of Section 2(c) of the Wilderness Act which states that a wilderness "may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value." This fifth quality may be used by a park to capture elements that are not included in the other four qualities. Unlike the preceding four qualities that apply throughout every wilderness, this fifth quality is unique to an individual wilderness based on the features that are inside that wilderness. These features typically occur only in specific locations within a wilderness and include cultural resources, paleontological localities, or any feature generally not under the other four qualities that have scientific, educational, scenic, or historical value. This quality is preserved or improved by the preservation or restoration of such features, even when such management actions degrade other qualities of wilderness character. Loss or impacts to such features degrade this quality of wilderness character.

These five qualities together comprise an approximation of wilderness character for wilderness planning, stewardship, and monitoring. For the purpose of this interagency monitoring strategy, all five qualities are equally important and none is held in higher or lower regard than the others.

Wilderness Character Monitoring

Wilderness character monitoring protocols are outlined in *Keeping it Wild.* Figure 1 illustrates this hierarchical monitoring protocol by representing the tangible aspects of wilderness character to specific indicators and measures. 'Wilderness Character' and 'Section 2(c) Definition of Wilderness' are taken directly from the 1964 Wilderness Act. 'Qualities of Wilderness', 'Monitoring Questions for each Quality', 'Indicators for each Monitoring Question', and 'Measures for each Indicator' were developed for the monitoring protocol outlined in *Keeping it Wild*.

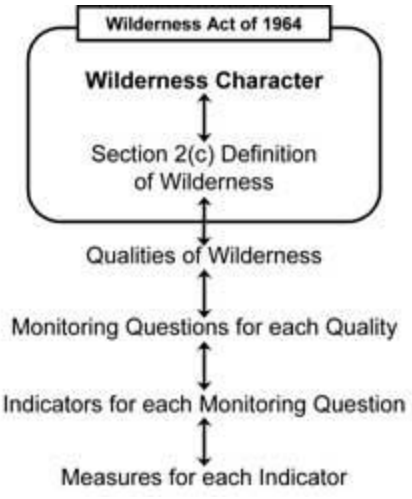


Figure 1
Conceptual model of wilderness character monitoring (Landres et al., 2008)

The Section 2(c) Definition of Wilderness was used to identify specific qualities of wilderness that are related to the concept of wilderness character. Each of these qualities of wilderness is then sequentially divided into a set of monitoring questions, indicators, and measures. 'Monitoring questions' set specific monitoring goals, 'indicators' are the types of information used to answer each monitoring question, and 'measures' are the numeric values that are measured or derived to quantify change over time in the indicator. In Figure 1, the downward-pointing arrowheads show that the concept of wilderness character drives the selection of all the subsequent elements and ultimately the data that are collected. The upward-pointing arrowheads show how data collected on the measures are used to evaluate successively higher elements in the model.

Why is this important to managers?

A primary role for managers in Wilderness areas is to preserve and enhance wilderness character through management actions and decisions. These actions decisions can vary widely depending on the issues and threats in each wilderness, and may include managing visitor impacts and opportunities; working with concessioners, contractors, and tribes, and other stakeholders who use wilderness; and working on regional planning efforts to minimize impacts on wilderness character due to land uses outside of wilderness.

Wilderness character can also be preserved or degraded by the operations of park managers. For example, the choices to not use a chainsaw for trail maintenance, erect new fencing, or suppress a naturally ignited fire may preserve certain qualities of wilderness character. In contrast, other management actions, such as limiting travel to trails or authorizing administrative use of motorized equipment and mechanical transportation, may diminish certain qualities of wilderness character.

The challenge of wilderness stewardship, however, is that decisions and actions taken to protect one aspect of wilderness character may diminish another aspect. For example, the use of herbicides to control the infestation of an invasive species benefits the natural ecosystem but also manipulates the biophysical environment.

Given this, the accumulated result of seemingly small decisions and actions may cause a significant improvement or degradation of wilderness character over time. Because of this complexity, preserving wilderness character requires that managers approach wilderness stewardship with humility, respect, and restraint.

Additionally, this report provides the use of language relevant to wilderness, such as the names and descriptions of the five qualities of wilderness character. The consistent use of this language among park staff and with the public provides a basis for mutual understanding about the complexities in the Wilderness Act and of wilderness stewardship in general.

Lastly, in order to effectively manage wilderness, managers must understand its current state and future trends. Understanding the implications of park operations on the five qualities of wilderness character is integral to preserving Saguaro's unique wilderness resource. As park staff knows, monitoring strategies often become obsolete over time. Wilderness character monitoring is an evolving framework that can shift in relation to advances in knowledge or technology in collecting data over time. Given this, there may be measures in this document that may seem less indicative of their respective qualities in the future. Because of this, measures can be altered or eliminated from the monitoring strategy if they are less informative in the coming years.

Chapter Two

Wilderness Character Narrative

The Saguaro Wilderness is a unique and special place. This chapter is a qualitative description to communicate the complex relationship between wilderness values and the reality of wilderness management at Saguaro.

Background of the Saguaro Wilderness

The United States Congress designated the Saguaro Wilderness in 1976 and it now has a total of 70,905 acres. All of this wilderness is located in Arizona and is managed by the National Park Service. Saguaro National Park was created as a national monument in 1933, by President Herbert Hoover, noting the "outstanding scientific interest" of the Rincon Mountains because of the "exceptional growth thereon of various species of cacti, including the so-called giant cactus." An area in the Tucson Mountains was added to the Monument in by President John Kennedy in 1961, and the area was declared a national park by Congress in 1994.

This mountainous wilderness has two districts – the Rincon Mountain District (RMD) east of Tucson and the Tucson Mountain District (TMD) west of Tucson. Both districts of the park are in Pima County, Arizona, and are separated by the city of Tucson. The RMD is bordered on the east and portions of the north and south by the Coronado National Forest. Residential developments border sections of the western, southwestern, and northwestern boundaries of this district. The TMD is bordered primarily by Tucson Mountain Park on the south and residential development on the north, east, and west.

In 2011, Pima County had a population of approximately 990,000, and the city of Tucson's population was nearly 526,000 residents. The city is growing rapidly both in terms of population and land area. Between 1990 and 2000, the area of land within Tucson city limits increased by more than 25% through the annexation of more than 40 square miles of unincorporated Pima County land. The 1950's were witness to a dramatic increase in Tucson's population. From 1950-60, the population jumped from approximately 45,000 to 212,000. When TMD was added to the monument in 1961, the city was in flux. The 30 miles separating the two park districts now "bookend" the city of Tucson, halting development at their borders. Urbanization outward from the city core has been the development trend over previous decades. Additionally, the city limits have expanded to abut the park boundaries in some locations.

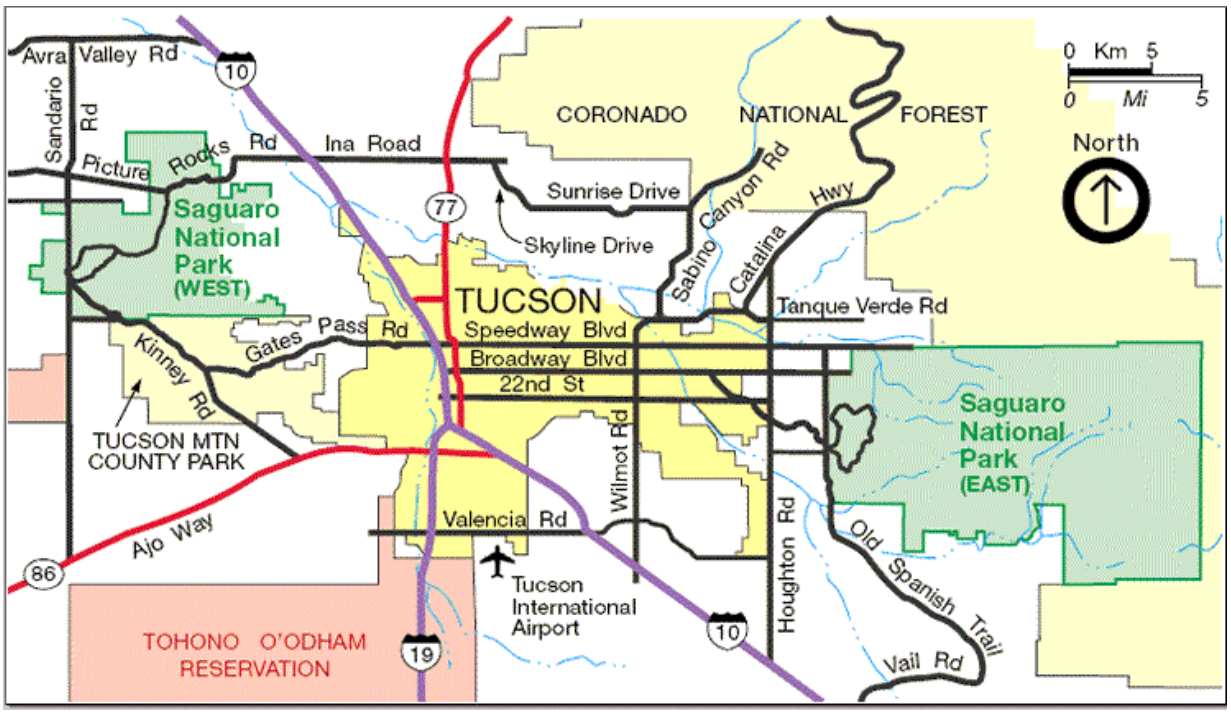


Figure 2
Map of TMD, RMD and the Tucson metropolitan area

Traversed by well-maintained dirt roads and a busy commuter road that runs through the heart of the district, the TMD receives mostly day-use visitors. Although it offers a visitor center and the 8-mile Cactus Forest Loop Road, the RMD is primarily road less, mostly attracting backpackers and day-users that enter almost exclusively via the Douglas Spring Trail and by bicyclists who use the Loop Road. RMD's trail system contains about 77 miles of maintained pathways, but overnight camping is limited to six campgrounds with 21 camp sites in wilderness.

The Saguaro Wilderness protects a superb example of the Sonoran Desert Ecosystem, featuring exceptional stands of saguaro cacti, important wildlife habitat, critical riparian areas, and associated high elevation ecosystems. It also protects significant cultural resources sites important to the Tohono O'odham people and historic structures erected by the Civilian Conservation Corps (CCC).

Saguaro cacti in the park depend on the administrative protection of the desert landscape.

A visit to the Saguaro Wilderness allows visitors to come in close contact with one of the most interesting and unusual collections of desert life in the United States. Visitors of all ages are fascinated and enchanted by the desert giants, saguaro cacti, and their many interesting and complex interrelationships with desert life. The park provides exceptional opportunities for visitors to escape the sprawling Tucson metropolis and discover what plants and animals can live in their backyard. Its close proximity to Tucson provides ample opportunities for city-dwellers to directly experience natural surroundings, thus facilitating intimate interactions with the environment.

The Gila Woodpecker eats beetles, grasshoppers and ants inside Saguaros.

Saguaro is a land of stark contrasts. In less than one day, a backpacker can hike among the human-like saguaros in the lower elevation cactus forest and stumble upon a landscape with stands of vanilla-scented ponderosa pine as they reach the mountain peaks. While in the wilderness, he or she may encounter an Arizona black rattlesnake elusively meandering among the detritus of the park's geologic past, startle a black bear nervously drinking from a *tinaja,* or simply stare into the flickering Tucson skyline after the campfire has been reduced to coals – their shadowed silhouettes illuminated onto the forest's edge by the artificial lights of civilization below.

Elf Owls, among other avian species, take advantage of holes created by Gila Woodpeckers in saguaro cacti.

When Saguaro was originally established as a monument, the To'hono O'odham had already been removed from the landscape, forced onto reservations, and stripped of their way of life. As the monument became another fortress of conservation and became administratively “wild,” its existence is further perpetuated the duality between natural and human by asserting that wilderness and naturalness only exist in places where humans do not. Its story, like all other designated wilderness areas, is one of paradox. The paradoxes embedded

into the landscape reveal a history riddled with struggle, contradictions, immense aesthetic beauty, and great social and natural complexities.

What follows is a discussion of the Saguaro Wilderness in the context of the five qualities of wilderness character. Due to the highly reductionistic nature of deriving meaning from a suite of single measures, the narrative addresses the shortcomings inherent in quantitative analysis. It is not meant merely as a supplement to the measures, but as an integral component to be used to understand the current state of the wilderness and to guide its future management.

Natural Quality of Wilderness Character

Due to the diverse landscape and unique geographic position between the Sierra Madre Mountains in Mexico and the Rocky Mountains in the United States, the Saguaro Wilderness is home to a striking variety of unique wildlife.

The TMD ranges from an elevation of 2,180 to 4,687 feet and contains two biotic communities: desert scrub and desert grassland. Average annual precipitation is approximately 10.27 inches. Common wildlife includes iconic desert species such as the sidewinder, roadrunner, coyote, Gambel's quail, Gila monster, and desert tortoise.

The RMD, on the other hand, ranges from an elevation of 2,670 to 8,666 feet and contains six biotic communities. The biotic communities (starting from the lowest elevation) include desert scrub, desert grassland, oak woodland, pine-oak woodland, pine forest and mixed conifer forest. Average annual precipitation is approximately 12.30 inches in the desert, but 20.8 inches at higher elevations. The Rincon Mountains peak at a considerably higher elevation than the Tucson Mountains, therefore there are a greater number of biotic communities and increased plant and wildlife diversity. Because of the higher elevation in the Rincons, animals like the black bear, Mexican spotted owl, Arizona mountain king snake, and white-tailed deer live in this district. The RMD is representative of the "Sky Island" ecosystem (Figure 3).

Figure 3
Situated between the Sierra Madres and Rocky Mountains and the Sonoran and Chihuahuan Deserts, the large species diversity in RMD is a product of both its geomorphology and geographic location.

The 70,000-square-mile Sky Island region of southeastern Arizona, southwestern New Mexico, and northwestern Mexico contains 40 mountain ranges that are connected by corridors utilized by fauna for travel. Each Sky Island has a distinct ecosystem, and the region is globally unique due to its rich diversity of species and habitats. The RMD of Saguaro National Park is included in this Sky Island Archipelago, containing the largest road-less Sky Island in North America.

Before the climate in the southwest began to change approximately 15,000 years ago, forests stretched from the Rocky Mountains down into the Mexican Sierra Madres. Wolves, black bears, tree squirrels and wild turkeys moved freely along this wooded corridor. But with the end of the ice age, temperatures rose and precipitation dropped and the desert to the south spread north. The species that needed water and cooler temperatures found themselves marooned at high elevations separated by arid gulfs. The result was mountaintop Sky Islands amid a 20-million-acre sea of desert.

***"To my mind these live oak-dotted hills fat with side oats grama, these pine-clad mesas spangled with flowers, these lazy trout streams burbling along under great sycamores and cottonwoods, come near to being the cream of creation."* - Aldo Leopold 1937**

Weldon Heald, famous nature writer and resident of southeastern Arizona, coined the term "Sky Islands" in 1967 to denote mountain ranges that are isolated from each other by intervening valleys of grassland or desert. The valleys of this basin and range country act as barriers to the movement of certain woodland and forest species, somewhat like saltwater seas isolate plants and animals on oceanic islands. Other species, such as mountain lions and black bears, depend on movement corridors between mountain islands to maintain genetic diversity and population size. Considering this, urban development in the city of Tucson has greatly fragmented this unique ecosystem. Nevertheless, RMD is an island of great species abundance and diversity.

Abundant in the Rincon Mountains, black bear cubs perch on a Ponderosa Pine branch.

Wildlife types in the Saguaro Wilderness are diverse, reflecting the park's unique geographic location. In addition to being situated between the Sierra Madres and Rocky Mountains, the RMD lies at the interface of the Sonoran and Chihuahuan deserts. The San Pedro River, just east of RMD, and the major drainages of the Rincon Mountains, which form the headwaters of the Tanque Verde Creek and Pantano Wash, add riparian components to the park's faunal diversity, as well as provide wildlife movement

corridors that link mountain ranges throughout the surrounding desert landscapes. Overall, the park supports a unique and diverse assemblage of thousands of invertebrates, including approximately 70 varieties of mammals, 200 bird species, 50 reptile species, and eight species of amphibians. The challenge in maintaining this biodiversity is underscored by the fact that since the turn of the last century, desert bighorn, Mexican gray wolves, jaguars, grizzly bears, and Gila topminnows have been extirpated from RMD, while the TMD has lost desert bighorn and white-tailed deer.

Saguaro's iconic species, the saguaro cacti, is severely threatened by the invasion of buffelgrass (*Pennisetum ciliare*), a perennial bunchgrass from Africa. In the last decade, buffelgrass has rapidly spread across southern Arizona and threatens the Sonoran Desert ecosystem and the plants and wildlife that inhabit the desert. According to park staff, buffelgrass is the greatest non-native species threat the park has ever faced because it competes with native plants for resources, creates dense stands which inhibit native plant growth, and promotes high intensity fires in a community dominated by plants and animals, such as saguaros and desert tortoises, that are not adapted to fire.

Regional and international change, such as increased urban development in Tucson and global climate change, also pose challenges to land managers at Saguaro. Urban development has impeded upon crucial wildlife corridors for species such as the black bear. Climate change, on the other hand, poses an existential threat to the Sonoran Desert and Sky Island Ecosystems. Considering its inevitability, park managers must manage for change. The need for flexibility in management, due to the rapidly changing contexts national parks are situated in, was outlined most recently in *Revisiting Leopold: Resource Stewardship in the National Parks* (2012). This fact, however, makes it difficult to manage wilderness. Recent research suggests that managing for "naturalness" is more important than "wildness" among wilderness users (Hall, 2011). In other words, wilderness users would rather see natural communities persist rather than being taken over by non-native invasive species. Given this, the concept of naturalness may have to be reconsidered in the context of both a rapidly changing world and the growing understanding of the role of change in ecological systems (Cole and Yung, 2010). In order to understand the complex changes that are occurring in the Saguaro Wilderness, scientific inquiry is needed.

The value of science cannot be understated at Saguaro National Park. The scientific and educational importance of the saguaro cactus, and thus the park, is mentioned in the monument's enabling legislation in 1933. Through research, managers are better able to understand the complexities of the Sky Island ecosystem and the Sonoran desert. With an in-depth understanding of the natural and socio-natural processes occurring in and around the park, managers are more apt at responsibly managing the wilderness. Research in wilderness, however, must be approved through a Minimum Requirements Decision Guide (MRDG) process and is only allowed to occur if the research cannot be conducted outside of the wilderness boundary and if the impacts on the wilderness are reasonable. Given this, research in

wilderness must be done with the same humility, respect and restraint as other park operations.

Untrammeled Quality of Wilderness Character

Freedom is a fundamental quality of wilderness. This was eloquently captured by Howard Zahniser, the main author of the Wilderness Act, in the selection of the relatively obscure word "untrammeled" to define wilderness. A "trammel" is a net used for catching fish, or a device used to keep horses from walking. To trammel something is to catch, shackle or restrain it. Untrammeled means something is free or unrestrained. Considering this, wilderness areas are to be unconstrained by humans. Zahniser defined "untrammeled" in the Wilderness Act as "not being subject to human controls and manipulations that hamper the free play of natural forces."

Often cited by managers as a handicap for effective management of the wilderness, the untrammeled quality is controversial and often misunderstood. In the context of wilderness, it is meant to facilitate restraint among wilderness managers. Although not articulated within the Wilderness Act, it protects landscapes and ecological processes against unforeseen consequences of human action in highly complex social-ecological systems, such as wilderness designated areas.

Increased complexity, due to the global movement of people, plants and the dramatic increase in human population since late the 1950's and early 60's, has challenged wilderness managers to maintain an untrammeled approach in managing wilderness. In the case of the Saguaro Wilderness, the saguaro cactus is threatened by buffelgrass; an African grass brought to the region as forage for cattle. If “wildness” takes precedence over “naturalness” in this instance, the saguaro cactus may cease to exist in the near future. Given this, the park plans to more aggressively manage invasive species through the use of helicopters to apply herbicide to large and inaccessible areas. Decisions to participate in controversial actions, such as these, are not made lightly among park staff. There is a highly involved bureaucratic process to determine the effects on nearly every aspect of the park, including wilderness character, through an MRDG and an Environmental Assessment (EA).

Additionally, the fire history of the park has been affected significantly by historical trammeling. Fire suppression, in particular, has increased fuel loads by significantly departing from the natural fire return interval in the higher elevations of RMD. The build-up of fuel loads, such is in the case of RMD, may lead to unnaturally catastrophic fires. This would negatively impact other aspects of wilderness character, such as increasing restrictions on the wilderness user in the case of a fire or the degradation of natural processes in the wilderness. Prescribed fires are a tool used to return the wilderness to a more natural fire return interval. Although it constitutes a manipulation of the natural environment, and thus is considered trammeling, it may be essential in the management of ecosystems.

Usurping the human tendency to alter the natural environment is a challenging and noble goal. Considering wilderness areas are profoundly cultural constructions, the recognition that we should show restraint is highly profound. While Howard Zahniser was articulating the American wilderness ethic in the Wilderness Act, great scientific advancements in the field of ecology were being achieved by Aldo Leopold. Considering humans have profoundly altered virtually all the environments they have lived in and the Leopoldian recognition that all biotic life is connected and dependent upon one-another, Zahniser developed an ideal to strive towards in the Wilderness Act: through recognition of human's tendency to trammel, we can overcome our subconscious urge to alter our biophysical environments and begin to respect the autonomy of ecological processes in their own right. This highly democratic notion that wilderness, as an entity, has a right to be free from the influence of humans, despite its dependence of a government's legal redefinition of the landscape, is truly revolutionary in Western culture.

Manning Cabin existed prior to wilderness designation. Although it acts as an administrative building, its legacy plays an important role in the historical narrative of the wilderness.

Undeveloped Quality of Wilderness Character

The jarring contrast between Tucson's urban development with the jagged granite peaks, rolling grasslands, and saguaro studded low-lands of the wilderness exemplify the undeveloped quality of wilderness character at the Saguaro.

Although there was historical ranching and mining in the Saguaro Wilderness, the park has reclaimed many of the installations related to it. There are, however, a few exceptions.

Manning cabin is the oldest remaining structure in the RMD high country, with a history dating back to the early 20th century. Originally built as a private residence by Levi Howell Manning, the structure was and continues to be used by National Park staff, primarily the backcountry ranger and fire crews. The cabin has survived considerable periods of

In addition to monitoring the health of mammal communities in the wilderness, wildlife cameras provide memorable images which can be used in educating the public.
Above: A Mountain Lion in RMD.

deterioration, followed by reconstruction and modification, and efforts to remove the structure all together. In 1975, the cabin was added to the National Register of Historic Places, and continues to be maintained and protected.

Although there are no active mines or existing mining claims in the Saguaro Wilderness, the history of mining in the area is seen in the landscape. A vast majority of the mines are in TMD. Many of these mines are surrounded by fencing or gated off in order to protect the public. Mines, despite being a development, serve to remind visitors of a past more connected to the natural world – a time where, through work, Americans created tangible goods from natural resources. Despite its exploitative nature, mining, like other extractive industries, allowed workers to reconsider their relationship to the natural environment. This relationship, however, was defined by their generation's desire to manipulate and dominate the natural world for the furtherance of modernity and its economic systems. In today's society, however, our relationship with nature has become more abstract. Perhaps due to this abstraction, we have come to idealize the natural world. In part, this idealization has led to great strides forward in the protection of public land. Abandoned mines, and other historical extractive installations, serve as reminders of our shifting relationship with the landscape. They also, on the other hand, degrade the undeveloped quality of wilderness character.

The use of built structures for research is also an important element in the management of Saguaro National Park. Data collection structures, such as climate monitoring stations or wildlife cameras, are an integral part of the understanding ecological processes, wildlife composition and other important aspects of managing the park. However, like administrative structures, they nevertheless degrade the undeveloped quality of wilderness character. This issue, however, may become somewhat mitigated as technology progresses and research devices get smaller.

Solitude or a Primitive and Unconfined Type of Recreation Quality of Wilderness Character

There is a diversity of experiences available to visitors in the Saguaro Wilderness. Visitors may experience solitude, self-discovery, revitalization, freedom from the constraints of society, or personal challenge and self-reliance within the wilderness. The wilderness context gives visitors a time to reflect on and understand the interconnectedness and interrelatedness of the socio-natural world and their individual connections to it. With this understanding comes a deep appreciation of the natural world, public lands and wilderness.

Although the Saguaro Wilderness is in close proximity to Tucson, park staff considers the RMD backcountry to be an under-utilized local resource. Some believe that one reason for its lack of usage is due to the long hike on the Douglas Spring trail to the Manning Camp area. If transportation infrastructure to Miller Creek, Turkey Creek and/or the Italian Springs trailheads were improved, it is thought that there would be more pressure on the backcountry from

wilderness users. At this point, however, USFS roads leading to these trailheads require 4X4 vehicles and skilled drivers. Given this, the majority of backcountry traffic begins in the far northwestern part of the park on the Douglas Spring Trailhead. There has, however, been an increase in backcountry use since the completion of the Quilter trail and rerouting of the Arizona Trail in 2011. In the year of its completion, there was an increase of approximately 500 more backcountry nights in the wilderness compared to previous years. As the Arizona Trail becomes more popular, this will increase the amount of both day and night users in the park's wilderness.

Additionally, its campground infrastructure is relatively small for a park of its size. As of today, it has six campgrounds with a total of 21 campsites. The campgrounds are well dispersed throughout the park, representing a healthy portion of the six distinct biotic communities found throughout the wilderness.

Restrictions, such as no off trail travel above 4500 feet in RMD, impact wilderness users' opportunity to have a primitive and unconfined experience. Although this is meant to protect the health of the natural ecosystem, it nevertheless degrades this quality of wilderness character.

The wilderness faces serious threats in the form of urban development. As backpackers ascend into the high country, they are faced with two distinct disturbances to their opportunity to experience solitude: low flying military, commercial and commuter flights degrading the natural soundscape and the ever present view of the city of Tucson below. Depending on the subjective experience of the wilderness user, seeing Tucson from the high country may elicit feelings of separation from the modern world and appreciation of the space that temporarily separates them from civilization. Others, however, may feel sights of modern development encroach on their viewshed and degrade their wilderness experience. Nevertheless, the sights and sounds of modernity in wilderness are a constant reminder of the city below.

Another impact on wilderness that results from being in close proximity to a city is the availability of cell phone service. Although this may seem unimportant on the surface, the ability to communicate with the outside world in wilderness significantly impacts the user's opportunity to have a primitive experience and may lead to unsafe and risky behaviors. One would think this is outside the realm of management of wilderness resources, however, a Verizon cell

"Never forget that a peril of portable phones is a loss of self-reliance. With the spread of cell towers and satellites, our society now has unrealistic expectations for rescues in the wilderness. Search and rescue personnel tell tales of adventurers who expect quick responses in the middle of nowhere while they sit passively and do little to help themselves." - NOLS

tower was boosted in preparation for the 2011 BioBlitz event for safety reasons. The improved signal has remained, significantly altering the wilderness experience for those who turn on their portable devices in the backcountry and for those who share campgrounds with them. As cell phone coverage becomes more ubiquitous in wilderness, park managers may have to focus on educating wilderness users on the implications of cell phone usage. Mobile technology significantly alters the experience of the wilderness user. Further research, however, must be completed in order to better understand its impacts on wilderness users and park managers.

Managers at Saguaro have the opportunity to take responsible action to facilitate opportunities for solitude or primitive and unconfined recreation. In order to ensure responsible management of its wilderness lands, managers must understand the implications of altering restrictions of visitor use on the other four wilderness qualities. As they have done in the past, they will continue to analyze the impacts of their management actions and attempt to facilitate opportunities for solitude and a primitive and unconfined type of recreation for wilderness users.

Other Features Quality of Wilderness Character

The fifth quality is unique to the park and is based on the special features in the Saguaro Wilderness and its environs. For Saguaro, the Other Features quality relates to the historical and contemporary human-environmental relationship in what is now wilderness.

Considering Saguaro's close proximity to the City of Tucson, engagement of an urban community with the wilderness is an integral component to its wilderness character and to the current and future protection of the wilderness resource. The future of wilderness preservation is dependent upon maintaining an interest in wilderness among the American public. As the demography in the United States shifts away from the traditional wilderness user, the middle class white male, towards a more diverse array of peoples and cultures, the wilderness ideal must remain a part of the national dialogue in order to ensure its protection. By engaging Latino and other growing demographic groups with the wilderness, Saguaro is both sharing and perpetuating this uniquely American ideal.

The park's interpretative branch is making great efforts to reach out to all spectrums of the Tucson community. From school visits to field trips, the park is consciously attempting to increase the amount of students experiencing and learning about wilderness and wilderness ethics. In October 2012, the park, working in conjunction with local community members, had an overnight camping trip for Latino youth and their families. Rangers brought children and their families into the wilderness, taught Leave No Trace ethics, and lectured about the park's cultural and ecological history to a demographic traditionally underserved by the wilderness preservation community.

Additionally, the park distributes one permit per year to a member of the To'hono O'odham nation to harvest saguaro and cholla fruit in the traditional manner. A tribal member is allowed

to camp in TMD for approximately six weeks prior to the monsoon season and collect fruit. By knocking off the ripened fruits at the top of the saguaro with the wooden ribs of the same plant, the To'hono O'odham are continuing a cultural tradition that has occurred since time immemorial. This culturally salient practice preserves the Traditional Ecological Knowledge (TEK) of the nation. A time has passed, however, there is a fear among tribal members that future generations will be uninterested in this cultural practice as they become further assimilated into the American cultural milieu.

A gift from the desert, the Saguaro fruit is eaten fresh or made into syrup by the To'hono O'odham.

Saguaro National Park was established in 1933 for its "outstanding scientific interest," and the fundamental value of science at the park has been reaffirmed in many subsequent planning documents. Since the 1930s, scientific research by both cooperating scientists (particularly from the nearby University of Arizona) and park staff have been an integral aspect of park activities. Much of this research has centered on the saguaro because of the great interest in this unusual, long-lived plant. However, the park has generated a number of important papers on geology, fire history, the Sonoran Desert tortoise and other topics. Literally hundreds of scientific papers based on research at the park have been published in the past 70 years.

Researchers measuring a saguaro in the 1970s as part of a study of growth rates and climate. Much of what we interpret about this plant in Saguaro National Park is based on research at the park.

In turn, the park has a long history of incorporating science into decision making, such as management of the saguaro, and the decision to expand the southern

boundary of the RMD in the 1990s. In addition, because much of what we know about saguaros and Sonoran Desert plant is based on research at the park, this interest has spurred many fruitful opportunities to educate visitors and local students about the desert. Because scientific values are one of the values identified in Section 2(c) of the Wilderness Act, the Saguaro Wilderness provides a unique opportunity to encourage science that enhances and supports wilderness character. This is particularly important as many national parks, especially Saguaro, experience significant ecological change to climate change and urban encroachment. In addition, the Saguaro Wilderness has the potential to provide a living science classroom to the many young people who live near the park.

Lastly, the Saguaro Wilderness holds vast amounts of evidence of its human history in the form of archeological sites from Paleo-Indians, the Hohokam peoples, European explorers, settlers and more recent peoples. A major critique of the wilderness ideal is that it attempts to erase human history in natural environments and create fictional narratives of pristine Edenic landscapes that never truly existed. From an honest wilderness perspective, it is important to consider and appreciate the profound human history of the wilderness. By doing so, we promote a more accurate historical narrative of peoples' relationship with the landscape and can convey that humans historically do not have to dominate the land base in which they live. Signs of this historical landscape are seen today in the form of archeological sites. It is imperative that these cultural resources are allowed to exist in wilderness in order to promote a more accurate understanding of the historical human-environmental relationship in what is now Saguaro National Park.

There are, however, threats to this resource. Vandalism, theft and the simple passage of time have degraded it. While managers should do all that is possible to preserve the material culture of these peoples, it is important to integrate their histories into the narrative of the park and the wilderness. Saguaro, as of now, does an excellent job at promoting this human history in the context of the park. This history, however, is not found in any literature related to the park's wilderness.

The preservation of this resource not only promotes a more representative and accurate understanding of the environmental history of the landscape, it shows that what we generally perceive of as "modern civilization" is not the only way of life that existed, or exists.

A spiral petroglyph etched into Signal Rock in TMD by indigenous inhabitants of what is now Saguaro National Park. Although its intended meaning is unknown, its simple presence reminds contemporary peoples of the land's profound human history.

Chapter Three

Natural Quality Measures

A definition of 'natural' from *Keeping It Wild:* The Wilderness Act states that wilderness is "protected and managed so as to preserve its natural conditions." In short, wilderness ecological systems are substantially free from the effects of modern civilization. This quality is degraded by intended or unintended effects of modern people on the ecological systems inside the wilderness since the area was designated.

See Appendix A for data tables.

Monitoring Question: What are the trends in terrestrial, aquatic and atmospheric natural resources inside wilderness?

Indicator: Plant and animal species and communities

Measure 1-1. Number of non-native plant species

Description: Number of non-native plant species known to exist in wilderness.

Context: As of 2012, there are 42 non-native, plant species present in the Saguaro Wilderness. Of the non-native species in the park, 20 are considered invasive.

The number of non-native invasive plants in wilderness is a count of the species that have been recorded as observations in wilderness since the 1997. The number of different invasive non-native plants present in wilderness may not be absolute because revisiting the original observations does not occur; some populations of different species may have died out or have been eradicated.

Non-native plant species significantly threaten the natural quality of wilderness character because they are species that can severely alter the ecosystem. There is a potential these non-native plant species may become species of concern, which are addressed in Measure 1-2.

Data source / Process used to compile or gather data: Dana Backer, park ecologist /
Dana manages all non-native plant surveying in the park and has a working list of non-native species currently present in the wilderness.

2012 Baseline Data Value**:** 42

Unit of Measure / Data type: Species / Number – Integer

Frequency of Measures (years): 1

Confidence: High

Measure 1-2. Number of invasive plant species of concern

***Description*:** Number of non-native, invasive plant species known to exist in wilderness. This measure includes only species currently managed and species of concern.

***Context*:** Of the non-native species in the park, 20 are considered invasive. Non-native species of concern highly threaten Saguaro's natural ecosystem and are a significant threat to the natural quality of wilderness character.

Invasive plant species significantly threaten the natural quality of wilderness character because they are species that have been shown to severely alter Saguaro's ecosystem.

***Data source / Process used to compile or gather data*:** Dana Backer, park ecologist / Dana manages all non-native plant surveying in the park and has a working list of exotic species currently present in the wilderness. Dana was asked which of the non-native species were considered invasive.

2012 Baseline Data Value: 20

Unit of Measure / Data type: Species / Number – Integer

***Frequency of Measures (years)*:** 1

Confidence: High

***Condition*:** Caution

***Significant change*:** Any

Condition: Caution

Significant change: ± 5

Measure 1-3. Acres of non-native invasive plant infestation

Description: The known amount of acres in wilderness with significant infestation of non-native invasive plants.

Buffelgrass, a non-native invasive species, threatens the Sonoran Desert ecosystem.

Context: Non-native invasive plants highly threaten the natural quality of wilderness character in the Saguaro Wilderness. Although significant action has been taken to control invasive species, there are inaccessible areas of the park where they have proliferated. Some invasive species, such as buffelgrass, are highly flammable. Once these patches of buffelgrass ignite, they burn at extremely high temperatures. Sonoran species, such as saguaro

cacti and the desert tortoise, are not adapted to fire. Given this, a high intensity fire poses a significant threat to the existence of these important flora and fauna in the Saguaro Wilderness, and thus the natural quality of wilderness character.

Data Source / Process used to compile or gather data: Dana Backer, park ecologist / The data was obtained by selecting all of the plant records in wilderness throughout the entire data set, merging all of the polygons of plants that were manually and chemically treated (517 acres as of August 30, 2012) and removing the overlap of the treatment polygons from the polygons of non-native invasive plants that were not treated.

2012 Baseline Data Value: 438.0

***Unit of Measure / Data type*:** Acres / Number - Decimal

Frequency of Measures (years): 1

Confidence: Medium

***Condition*:** Caution

Significant change: ± 150.0

Measure 1-4. Status of sensitive species

***Description*:** This measurement is a sum of the values for the "status" (based on abundance and distribution) of five sensitive species identified by park biologists as indicative of the natural quality of wilderness character. A numerical reduction in the measurement is indicative of a degradation in the natural quality of wilderness character.

A desert tortoise triumphantly trudges along on a cloudless summer day.

***Context*:** Five sensitive species were identified by park biologists as being important indicators of the natural quality in wilderness character: the Desert Tortoise (*Gopherus agassizii*), Lowland Leopard Frog (*Rana yavapaiensis*), Spotted Owl (*Strix occidentalis*), Lesser Long-nosed Bat (*Leptonycteris yerbabuenae*), and American Black Bear (*Ursus americanus*).

These five species represent mammalian, reptilian, amphibian and avian species and have varied in abundance and distribution over the park's history. For example, American black bears were once rare, probably due to poaching and over-hunting outside of park boundaries. Although the status of these species is often impacted by factors outside of the control of park managers, it is nonetheless important to the natural quality of wilderness character.

Data source / Process used to compile or gather data: Professional judgment from park biologists (currently Don Swann and Natasha Kline) based on monitoring data / The status of the five species were given a value of 1 to 4 based on the biologist's professional opinion of their overall fitness level in wilderness. The key in Table 1 (see below) was used to determine the rating of "abundance and fitness" for each of sensitive species communities:
After each of the 5 species was given a rating, the ratings added up together. This sum is the final measurement.

Status of each sensitive species in wilderness	Rating
Extirpated	1
Poor	2
Somewhat healthy	3
Very healthy	4

Table 1
Status of sensitive species

2012 Baseline Data Value: 16

***Unit of Measure / Data type*:** Index / Number - Integer

Frequency of Measures (years): 1

Confidence: High

***Condition*:** Caution

Significant change: ± 4

Measure 1-5. Number of extirpated, native plant and animal species

***Description*:** Number of native plant and animal species that have been extirpated since European contact.

Context: This measure assesses a trend based on the known history of the area from the time of European contact to the present day. If wildlife species were extirpated before wilderness

The illusive jaguar, widely believed to be limited to Central and South America, once roamed what is now Saguaro National Park.

designation and later restored to a wilderness, this would be an improvement in the natural quality. The natural quality is degraded if the number of extirpated native species increases.

Data source / Process used to compile or gather data: Published inventory reports and other data; Professional judgment of park biologists /
This measure is based, in part, on results of periodic inventories of the park's vascular plants and vertebrate animals (Powell et al. 2006, 2007) and in part on species-specific studies of individual species.

2012 Baseline Data Value: 42

***Unit of Measure / Data type*:** Species / Number - Integer

Frequency of Measures (years): 5

Confidence: Medium – High

***Condition*:** Caution

Significant change: Any

Measure 1-6. Estimated number of saguaro cacti

Description: Estimated number of saguaro cacti in wilderness.

Context: Written in the park's legislative mandate is language which specifically protects the saguaro cactus. It exists as a unique component of the Sonoran desert ecosystem; a valued cultural, interpretive and scientific resource; and important habitat and food for elf owls, white-winged doves and other wildlife species.

Saguaro cacti dot the hillside in TMD.

Data source / Process used to compile or gather data: Saguaro Census data / The Saguaro Census is an established monitoring program that takes place every 10 years (1990, 2000 and 2010) and includes components based on plots established as long ago as 1941. The Saguaro Census results are published and widely accessible.

2012 Baseline Data Value: 1,896,030 (2010)

***Unit of Measure / Data type*:** Cacti / Number - Integer

Frequency of Measures (years): 10

Confidence: High

***Condition*:** Good

Significant change: ± 190,000

Indicator: Physical Resources

Measure 1-7. Air quality

***Description**:* Ozone, wet deposition, and visibility parameters are included.

***Context*:** Trends in air quality are monitored because of the effects of air pollutants on plants, animals, soil, and water inside wilderness. As a Class I land, Saguaro National Park is protected under The 1977 Clean Air Act.

Data source / Process used to compile or gather data: Air Quality Estimates (IM Materials) / Data is available online at: www.nature.nps.gov/air/planning/index.

***2012 Baseline Data Value*:**	**Ozone:** 68.4 ppb (4th Highest 8-hr) *Condition*: Moderate *Confidence*: High *Significant change:* -8.5 ; + 7.7 **Sulfur deposition (Total-S):** 1.0 kg/ha/yr *Condition*: Moderate *Confidence*: Medium *Significant change*: - .1 ; + 2.1	**Nitrogen deposition (Total-N):** 2.0 kg/ha/yr *Condition:* Moderate *Confidence*: Medium *Significant change*: ± 1.1 **Visibility (Group 50 Visibility minus Natural Conditions):** 6.2 dv *Condition*: Moderate *Confidence*: High *Significant change*: - 4.3 ; + 1.9

Nationally defined condition of the air quality indicator is based on the following thresholds:

Ozone (parts per billion – ppb):

< 60 ppb - Good
61-75 - Moderate
> 76 - Significant Concern

Total-N and S (based on wet deposition in kilograms per hectare per year – kg/ha/yr):

<1 - Good
1-3 - Moderate
> 3 - Significant Concern

Visibility (deciviews – dv):

< 2 dv - Good
2-8 dv - Moderate
> 8 dv - Significant Concern

2012 Baseline Data Value: See above
Frequency of Measures (years): 5
***Condition*:** See above
***Unit of Measure / Data type*:** See above
Confidence: See above
Significant change: See above

Indicator: Biophysical processes

Measure 1-8. Average number of dry days per year in Rincon Creek

Description: 5-year running average of number of dry days a year in Rincon Creek

Context: Water resources are an integral component to the ecosystem in the Saguaro Wilderness, and loss of surface water can significantly impact a variety of flora and fauna within the wilderness. The Science and Resource Management division of the park has been collecting data on the number of dry days/year in Rincon Creek since 2003. It is considered indicative of the overall state of water quantity in the park.

Data source / Process used to compile or gather data: Rincon Creek water summary; will be published in 2013, currently available from biologist Don Swann / The middle reach of Rincon Creek is walked by a park volunteer every 2 weeks, and all locations of surface water are recorded using GPS. The creek can range from full and running to completely dry. These data are compiled annually and mapped, so that the number of "dry days" based on 2-week intervals can be easily calculated.

2012 Baseline Data Value: 10.0 (2011)

***Unit of Measure / Data type*:** Days a year / Number – Decimal

Frequency of Measures (years): 5

Confidence: High

***Condition*:** Caution

Significant change: ± 5.0

A *tinaja* in the Rincon Mountains provides habitat for a diversity of desert species.

Measure 1-9. Mean *tinaja* sediment volume throughout the RMD.

***Description*:** Average percent volume of sediment in a large number of representative natural rock pools (tinajas) located throughout the RMD.

***Context**:* Tinajas are important drinking sources and habitat for sensitive wildlife. The amount of water in tinajas varies among wet and dry years, but is also greatly influenced by large flood events that typically occur after very intense wildfires (that are themselves the result of fire suppression and climate change). Sediment may remain in tinajas and degrade their value as wildlife habitat for decades following a large fire. The park monitors the volume of sediment in approximately 30 selected tinajas every 3-4 years.

Data source / Process used to compile or gather data: Data to date is summarized in a technical report (Pruden

et al., 2010) and reports are issued after each monitoring event, every 3-4 years / The park has a written protocol to measure and estimate volume of sediment in each tinaja.

2012 Baseline Data Value: 42.0 (2010)

***Unit of Measure / Data type*:** Percentage / Number – Decimal

Frequency of Measures (years): 3-4

Confidence: High

***Condition*:** Good

Significant change: ± 6.3

Measure 1-10. Departure from natural fire return interval

***Description*:** An index of the sum of five distinct categories of departures from the fire return interval. **The closer the value of the index is to <u>one</u>, the closer conditions are to the natural fire regime.**

Context: Natural fires are an integral component to the higher elevations of the Saguaro Wilderness. Due to fluctuations in fire management policy over time, the wilderness has deviated from its natural fire return interval substantially. Desert areas historically had little or no fire. Non-native grasses have been introduced and filled in the gaps, allowing fires to spread into biomes not adapted to fire. The greater the departure from the fire return interval in wilderness, the more degradation occurs to the natural quality of wilderness character.

Due to the episodic tendencies of fire and because of the complexity of the Sky Island's ecosystems relationship to fire, the defined "natural" fire interval at Saguaro is based on scientific literature and professional judgment.

Data source / Process used to compile or gather data: Records kept by Perry Grissom, the park's fire ecologist.

There is a four step process to determine the value for this measurement:

1) Five distinct categories were identified and given values by the Park's fire ecologist:

Category	Weight
Forest/grassland in wilderness not departing from a natural fire return interval, <10 years	1
Forest/grassland in wilderness departing from natural fire return interval of 1-2 intervals, 11-30 years	2
Forest/grassland in wilderness departing from natural fire return interval of 3 or more intervals, 31+ years	3
Desert not departing from the natural fire return interval	1
Desert having burned and departed from natural fire return interval	4.2

Table 2
Inherent weighting for the fire return interval

2) For each of the aforementioned five categories, multiply the number of acres within each category by the value attributed to it.
3) Add up the five values for the penultimate sum.
4) Divide the penultimate sum by the total acres of wilderness (71,598 – based in GIS layers with some inherent error in the amount of acreage of wilderness) to get a ratio – this is the final measure. **The closer the value of the ratio is to <u>one</u>, the closer conditions are to the natural fire regime.** Refer to Table 3 for data used to determine the baseline data value.

Category	Weight	Total Acres	Total Value
Forest in wilderness not departing from a natural fire return interval, <10 years	1	2,715	2,715
Forest in wilderness departing from natural fire return interval of 1-2 intervals, 11-30 years	2	25,053	50,106
Forest in wilderness departing from natural fire return interval of 3 or more intervals , 31+ years	3	13,511	40,533
Desert not departing from the natural fire return interval	1	26,045	26,045
Desert having burned and departed from natural fire return interval	4.2	4,092	17,186
			Penultimate value = 136,585
			Total index value = 1.907

Table 3
Total index value for the fire return interval

2012 Baseline Data Value: 1.907

***Unit of Measure / Data type*:** Index / Number - Integer

Frequency of Measures (years): 5

Confidence: Medium

***Condition*:** Poor

Significant change: ± .350

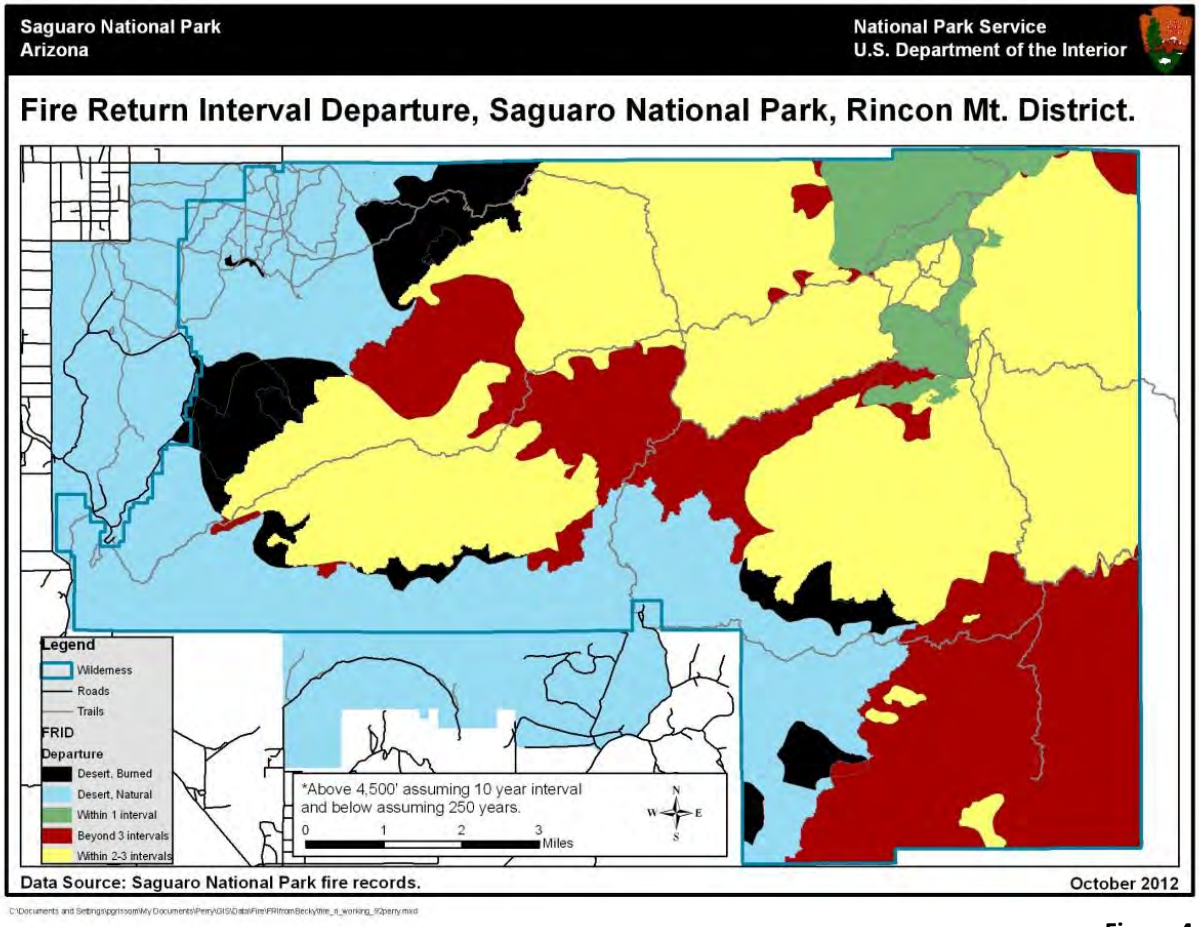


Figure 4
Departure from fire return interval at RMD, October 2012

Measure 1-11. Index of development within 30km of wilderness boundary

Description: Index of development within 30km of TMD and RMD.

***Context*:** Over time, the metropolitan area near the park has become more developed and urbanized. Some areas bordering the park are public lands, so, development on these lands should be relatively static. As time passes, however, private land may continue to become more developed, impacting wildlife corridors, night sky quality, air quality and a myriad of other processes related to ecological health and wilderness character.

The "figure 8" region around the RMD and TMD was used in the NPScape exercise which examined how the Tucson metropolitan area influences the park on a landscape level. As part of the project, the team collected and analyzed data on urban development in the Tucson area. It is thought that the higher amount of urban development, the greater impact on biophysical

processes on the park. Given this, if the index of development increases within 30km of the park decreases, the natural quality will be degraded.

Data source / *Process used to compile or gather data:* Landscape Dynamics of Saguaro National Park report; NPScape / After creating a union between land ownership and land cover layers in ArcGIS, the following land cover types were given values based upon their impact to the biophysical environment inside of Saguaro. Factors, such as fragmentation and loss of habitat, were taken into account when attributing values to each land cover type (Table 4).

The total acres of each of the following land cover type were given inherent weights based on their perceived impact to the natural quality of wilderness character (see Figure 5 for map). The sum of these values was divided by 1,000,000 to determine a manageable final index value. As the value rises, development increases and the naturalness of the Saguaro Wilderness is degraded.

Land Cover Type	Weighting	Total Acres	Total Value
Mines / quarries	8	11,049	88,392
Developed Land	6	157,410	944,460
Agricultural land	3	32,606	97,818
Undeveloped private land	2	512,080	1,024,160
Undeveloped reservation land	1.5	152,506	228,759
Undeveloped publically managed land	1	1,219,073	1,219,073
			Total = 3,602,662 / 1,000,000 = 3.602
			Total Development Index Value = 3.602

Table 4
Total development index value

2012 Baseline Data Value: 3.602

***Unit of Measure / Data type*:** Index / Number - Decimal

Frequency of Measures (years): 5

Confidence: Medium – data from 2001 and 2005.

***Condition*:** Caution

Significant change: ± .900

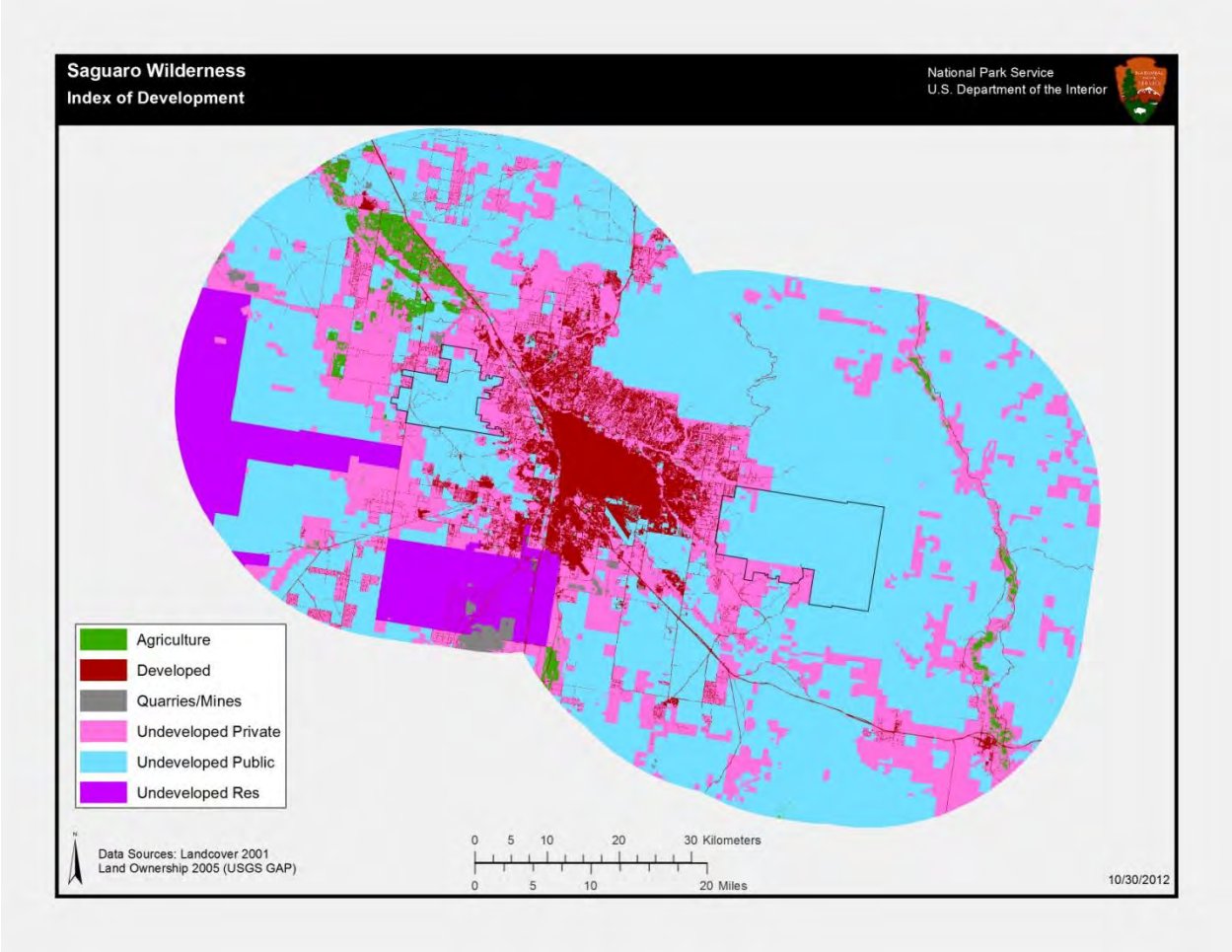


Figure 5
Map of development within 30km of TMD and RMD, October 2012

Chapter Four

Untrammeled Quality Measures

A definition of 'untrammeled' from *Keeping it Wild*: The Wilderness Act states that wilderness is "an area where the earth and its community of life are untrammeled by man," and "generally appears to have been affected primarily by the forces of nature." In short, wilderness is essentially unhindered and free from modern human control or manipulation. This quality is degraded by modern human activities or actions that control or manipulate the components or processes of ecological systems inside the wilderness.

See Appendix B for data tables.

Monitoring Question: What are the trends in actions that control or manipulate the "earth and its community of life" inside wilderness?

Indicator: Actions <u>authorized</u> by the park manager that manipulate the biophysical environment

Measure 2-1. Number of naturally ignited fires in which the management impacted the amount of acres burned

Description: Number of natural fires suppressed or managed within the boundaries of wilderness – affecting the number of acres burned by management action.

Context: The mosaic of ecosystem types in Saguaro's Wilderness has had varying interactions with fire in the past. Historically, natural fires would have impacted forests and grasslands in the higher elevations of the wilderness. The current landscape, suppression history, its proximity to an urban setting, presence of listed and sensitive species, and the management goals of the park, however, have created an environment in which the infrequent natural fires that ignite in wilderness may require manipulation. This may vary from extinguishing a fire as soon as possible, to managing a fire to stop spread on one part of the fire, or to limiting spread until more favorable weather occurs.

Future changes in climate may alter fire frequency, intensity, and character. Only fires that were naturally ignited are included in this measure - fires that were human-caused are not included. A suppression response counts only if the action is taken within the wilderness Area - it is not counted if it occurs outside the boundary.

The untrammeled quality is degraded by an increasing number of natural fire starts that are suppressed or manipulated in some manner.

Data source / Process used to compile or gather data: Wildland Fire Management Information (WFMI) entered by park staff / Perry Grissom, the park's fire ecologist, reviewed his records and provided data.

2012 Baseline Data Value: 0

***Unit of Measure / Data type*:** Number of Fires Suppressed / Number - Integer

Frequency of Measures (years): 1

Confidence: High

***Condition*:** Good

Significant change: Any

Measure 2-2. Acres of prescribed burning

***Description*:** Number of wilderness acres prescribed burned per fiscal year.

Context: Fire suppression since settlement in the 1800s has resulted in altered vegetation structure and species mixtures. Prescribed fire is used to restore the landscape's fire return interval and to reduce hazardous fuels in higher elevations (above 4500 feet) of the wilderness.

A park staff member ignites a prescribed burn.

Even though the park has provided management direction for use of prescribed fire, little controlled burning has been conducted in wilderness in the last decade due to logistical and financial limitations.

Although prescribed burning can improve the natural quality of wilderness character by lowering fuel loads and helping the forest return to a more natural fire return interval, an increase in prescribed fires degrades the untrammeled quality because it is a human action which intentionally manipulates the biophysical environment.

Data source / Process used to compile or gather data: All prescribed fire activities on the park are managed by John Thornburg, the park's Fire Management Officer / Perry Grissom reviewed the park's WFMI and provided data.

2012 Baseline Data Value: 0

***Unit of Measure / Data type*:** Acres / Number - Decimal

Frequency of Measures (years): 1

Confidence: High

***Condition*:** Good

Significant change: Any

Measure 2-3. Number of acres of treatment of non-native, invasive plants

Description: Number of acres of treatment of non-native, invasive species by park staff and volunteers.

The spraying of buffelgrass is one strategy used to control the spread of this devastating species.

Context: Invasive plants have a presence both inside and outside wilderness at Saguaro. Each year efforts are expended to control and reduce populations of certain invasive plants in wilderness areas, with particular emphasis on early detection and treatment.

Herbicides and pulling efforts are intended to target only a specific invasive plant species, but impacts, albeit minor, occur beyond that single stem. While this management activity constitutes trammeling, it is an effort intended to improve the natural quality of wilderness character.

The ecological health of the Saguaro Wilderness is highly threatened by invasive species. The current strategy of mechanically and chemically treating plants has not been effective enough to completely eradicate the problem. Because of this, the park is in the process of evaluating the environmental effects of the use of helicopters to apply herbicide to invasive plants inside wilderness through an Environmental Assessment (EA).

***Data source / Process used to compile or gather data*:** Heston Smith, the park's GIS tech / This number of acres was based on treatment records in the park's exotic plant geodatabase. Manual and chemical treatment areas were mapped using handheld computers and GPS units with accuracy of 3-5 meters. Polygons are mapped and assigned attributes such as the type of treatment, number of individuals, percent cover of the invasive plant, etc.

2012 Baseline Data Value: 86.0 (2011)

***Unit of Measure / Data type*:** Acres / Number – Decimal

Frequency of Measures (years): 1

Confidence: High

***Condition*:** Good

Significant change: ± 300.0

Measure 2-4: Number and extent of authorized research

***Description*:** Index of time and intensity of all authorized research projects which intentionally manipulate the biophysical environment.

Context: The scientific value of research that intentionally manipulates the biophysical environment is clear, but certain scientific actions and structures have the potential to degrade the untrammeled quality of wilderness character. A goal for the park should be to minimize manipulations of the biophysical environment to the fewest absolutely necessary with the lowest impact and to, when possible, conduct research using temporary structures.

Data source / Process used to compile or gather data: Don Swann, Park biologist / Consulted with Don Swann, the Park's biologist, who compiled a list of all the research projects that occurred within wilderness in 2012. Together, we analyzed the list and determined the extent of each research project. The extent of each research project was based on the following two factors:

1) The amount of time a research project manipulated any aspect of the biophysical environment
2) The level or intensity, of biophysical manipulation of the research project

Length of time	Value
Immediate	1
Between immediate and seven days	2
Between one week and four weeks	3
More than four weeks	4

Table 5
Temporal Value of Trammeling

+

Level of biophysical manipulations	Value
Low	1
Medium	2
High	3

Table 6
Level of biophysical manipulations

= Value for one research project

These values for each research project were determined by using Table 7 (next page).

Research Project	*Length of time*	*Value*	*Level of manipulation*	*Value*	*Total*
Capture and release of wildlife	*Between immediate and seven days*	*2*	*Medium*	*2*	*4*
Wildlife tracking collars	*More than 4 weeks*	*4*	*Medium*	*2*	*6*
					Total Index Value = 10

Table 7

Example of index values of authorized research that intentionally manipulates the biophysical environment

The sum of the values attributed to each research project is the final measure. As the value of the measurement increases, the untrammeled quality of wilderness is degraded.

2012 Baseline Data Value: 0

***Unit of Measure / Data type*:** Index / Number - Integer

Frequency of Measures (years): 1

Confidence: High

***Condition*:** Good

Significant change: ± 15

Chapter Five

Undeveloped Quality Measures

A definition of 'undeveloped' from *Keeping it Wild:* The Wilderness Act states that wilderness is "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation," "where man himself is a visitor who does not remain," and "with the imprint of man's work substantially unnoticeable." This quality is degraded by the presence of structures, installations, habitations, and by the use of motor vehicles, motorized equipment, or mechanical transport that increases people's ability to occupy or modify the environment. *See Appendix C for data tables.*

Monitoring Question: What are the trends in non-recreational development inside wilderness?

Indicator: Non-recreational installations, structures, and developments

Measure 3-1. Number and extent of built NPS infrastructure

The system to provide safe drinking water to Manning Camp includes an impoundment, water tank, solar panels and other structures.

Description: The total sum of the number of administrative buildings and other miscellaneous NPS infrastructure, inside wilderness multiplied by their development level. These structures include water tanks, solar panels, weatherports, administrative buildings, and others. *See Appendix F-1 for list of all permanent NPS Infrastructure included in this measure.*

Context: In order to effectively manage the wilderness, it is thought that administrative and other structures need to be in the designated wilderness area.

However, the structures do serve to remind recreationists of the presence of humans. A goal for the park should be to minimize structures to the fewest absolutely necessary with the lowest impact and to, when possible, install structures only temporarily. Although this may facilitate a seemingly simpler way of managing the wilderness, the presence of park infrastructure degrades the undeveloped quality.

Data source / Process used to compile or gather data: GIS Specialist, Becky MacEwen; Brad Shattuck, Chief of Maintenance / Process used to compile or gather data: Counted the amount of NPS infrastructure several GIS layers and confirmed list with Brad Shattuck, the Chief of Maintenance. Each structure was given a value based on its "development level" (Low=1, Medium=2, High=3). The values of each structure were added up and the sum is the final measurement. Note that Appendix F-1 does not include temporary structures, such as warning signs for safety issues such as bees or trail work, spike camps for field crews, crew caches for water and equipment, etc. , which are difficult to quantify.

2012 Baseline Data Value: 77

***Unit of Measure / Data type*:** Index / Number – Integer

Frequency of Measures (years): 5

Confidence: High

***Condition*:** Caution

Significant change: ± 30

Weather station in the higher elevations of RMD. Although RMD's wilderness weather stations collect important data, such as early warning to Tucson residents of impending flooding, their presence degrades the undeveloped quality of wilderness character.

Measure 3-2 Number of contemporary data collection structures and equipment installed

Description: Number and extent of permanent or temporary research and other data collection structures and equipment installed in the wilderness. *See Appendix F-2 for list of all NPS Infrastructure included in this measure.*

Context: Several research and ongoing data collection projects require semi-permanent or temporary installation of structures and equipment in wilderness. At Saguaro, this includes semi-permanent structures such as weather stations and monitoring wells, as well as temporary structures such as wildlife cameras and small mammal traps.

These installations generally have a clear value (for example, the weather station at Manning Camp serves as an early warning of floods in Tucson, which is intended to save lives; other temporary installations serve to monitor the environmental measures identified in Chapter 3), but the structures serve to remind recreationists of the presence of humans. A goal for the park should be to minimize

installations to the fewest absolutely necessary with the lowest impact and to, when possible, install equipment only temporarily. In addition, the park should continue to use the smaller structures that can be hidden from public view. As the value of the measurement increases, the undeveloped quality of wilderness is degraded.

Data source / Process used to compile or gather data: Don Swann, Park biologist; Heston Smith; GIS Tech

Each research structure was given a weighting based on its perceived impact to the wilderness area. This was done because some research installments have greater impacts on the undeveloped quality than others. Additionally, the amount of time the structure is in wilderness is taken into account. The longer the amount of time a structure is in wilderness, the more degradation to the undeveloped quality. Temporary research structures are typically easier to track than temporary administrative structures because research permits are usually required for any type of research.

2012 Baseline Data Value: 17

***Unit of Measure / Data type*:** Index / Number – Integer

Frequency of Measures (years): 5

Confidence: High

***Condition*:** Good

Significant change: ± 20

Measure 3-3. Number of abandoned and closed mines inside wilderness

Description: The total number of abandoned mines inside of wilderness.

Context: There are many abandoned mines in the Saguaro Wilderness. There has been an effort in the recent past to reclaim some of these mines; however, substantial process has not been made due to financial constraints. Mines, being semi-permanent fixtures on the landscape, degrade the undeveloped quality of wilderness character. As the number of mines decreases, the undeveloped quality improves.

Abandoned mines remind users of historical development and our changing relationship with the landscape.
Above: An abandoned mine in TMD.

Data source / Process used to compile or gather data: GIS

Specialist, Becky MacEwen / Counted the number of abandoned mines on the GIS Mine layer.

2012 Baseline Data Value: 115

***Unit of Measure / Data type*:** Mines / Number – Integer

Frequency of Measures (years): 5

Confidence: High

***Condition*:** Caution

Significant change: ± 50

Monitoring Question: What are the trends in mechanization inside wilderness?

Indicator: Use of motor vehicles, motorized equipment, and mechanical transport

Measure 3-5. Index of emergency motor vehicles, motorized equipment and mechanized transport

Helicopters are often used in fire suppression activities and life-threatening emergency situations.

Description: Type and amount of emergency use of motor vehicles, motorized equipment, or mechanical transport.

Context: This monitoring question assesses the effect of motorized equipment and mechanical transport use on the undeveloped quality of wilderness. This monitoring question covers uses for emergency purposes. Although authorized by the Wilderness Act under certain conditions, the use of these devices diminishes the undeveloped quality. Monitoring motorized equipment and mechanical transport can be used to compare and contrast equipment and transport use over time and to help make well-considered management decisions grounded within the Wilderness Act.

The seemingly low inherent weight attributed to the use of mechanical transport should not diminish the importance of using other primitive equipment as an alternative. When primitive tools are the minimum required tool for a particular park mandated action, they should always be used - this both follows the mandate and spirit of the Wilderness Act.

Data source / Process used to compile or gather data: Paul Austin, RMD District Ranger / This measure involves the calculation of a use level index, which assesses the cumulative impact level of each use of a specific equipment type. These indexes are calculated by evaluating each

type of use, assigning weights based on perceived differences in the level of impact, and then multiplying this weighted use by the amount of use or its assigned inherent weight. The index for each of the individual measures will be combined to determine an overall index that can be used to inform managers about trends in the indicator and to directly address the monitoring question. Not all equipment types have the same impact level associated with them. For example, a wheelbarrow has a significantly different impact level than a bulldozer has.

To account for these differences, an inherent weighting has been assigned to each equipment type based on its perceived impact to social and biophysical resources, as shown in Table 8. Mechanized or motorized equipment with a relatively low level of impact are assigned a value of between 0.25 and 1, motorized equipment with a moderate level of impact is assigned a value of 2, motorized equipment with a high level of impact is assigned a 3, and motorized equipment with a very high level of impact is assigned a 4. Equipment types were assigned a low inherent weight if typically they cause a small impact to the social environment and little to no impact to the biophysical environment.

The overall use level will be calculated for each authorization by multiplying the number of pieces of equipment by its inherent weight by the amount of use by weight assigned to use categories for the emergency use (see Table 9). At the end of each fiscal year, these values will be added together to cumulatively provide a single total use level index for each measure. Table 10 is an example calculation.

Equipment Type	Inherent Weight
Air compressor	2
Air tanker	3
All-terrain vehicle	3
Battery-powered tool	0.1
Bicycle	0.25
Chain Saw	3
Concrete equipment	3
Fixed-wing aircraft	3
Float plane	3
Generator	2
Heavy Equipment	4
Helicopter	3
Motorcycle	3
Motorized watercraft	3
Motorized winch	2
Portable pump	2
Rock drill	3
Snow machine	3
Truck	3
Wheelbarrow	0.1
Wheeled litter	0.1

Table 8

Inherent weights of different types of motorized equipment and mechanical transport used in wilderness

Amount of Actual Use	Actual Use Weight
One piece, 1 day	1
Multiple pieces, 1 day	2
One piece, multiple days	2
Multiple pieces, multiple days	3

Table 9

Inherent weights for the actual uses of motorized equipment and mechanical transport

Type of equipment	*Inherent weight*	*Amount of actual use*	*Actual use weight*	*Equipment use value*
Helicopter one	*3*	*One piece, 1 day*	*1*	*3*
Helicopter two	*3*	*One piece, 1 day*	*1*	*3*
Chain Saw	*3*	*Multiple pieces, 1 day*	*2*	*6*
Generator	*2*	*Multiple pieces, multiple days*	*3*	*6*
				Use level value = 18

Table 10
Example calculation of the use level value for emergency uses of motorized equipment and mechanical

2012 Baseline Data Value: 6

***Unit of Measure / Data type*:** Index / Number – Decimal

Frequency of Measures (years): 1

Confidence: High

***Condition*:** Good

Significant change: ± 40

Measure 3-6. Index of administrative and nonemergency motor vehicles, motorized equipment and mechanized transport use

Description: Type and amount of non-emergency use of motor vehicles, motorized equipment, or mechanical transport.

Context: Unlike emergency situations, there is **more significant symbolic meaning behind the authorized use of motorized vehicles, motor equipment and mechanical transport in wilderness in nonemergency situations.** In addition to violating the spirit of the Wilderness Act, the authorized use of these types of equipment both erodes our relationship to historical public lands maintenance and creates a precedent for wilderness users to also engage in these types of activities. Additionally, by utilizing modern tools in the wilderness context, a set of primitive skills is lost. So, although the use of certain modern tools and technologies may be more cost effective and efficient in the management of the wilderness, the use of these technologies in park operations has negative implications related to not only the undeveloped quality of wilderness character, but to carrying-on the traditional skill sets that made our national park system great.

This monitoring question assesses the effect of motorized equipment and mechanical transport use on the undeveloped quality of wilderness and only covers uses for emergency and for administrative and other nonemergency purposes. Although authorized by the Wilderness Act under certain conditions, the use of these devices diminishes the undeveloped quality. Monitoring motorized equipment and mechanical transport can be used to compare and contrast equipment and transport use over time and to help make well-considered management decisions grounded within the Wilderness Act.

Data source / Process used to compile or gather data: Dan Green, Maintenance and Dana Backer, park ecologist / Same as Measure 3.5 above**.**

2012 Baseline Data Value: 9.2

***Unit of Measure / Data type*:** Index / Number – Decimal

Frequency of Measures (years): 1

Confidence: High

***Condition*:** Good

Significant change: ± 20.0

Measure 3-7: Number and extent of unauthorized uses

Description: Number and extent of unauthorized motor vehicle, motorized equipment, and mechanical transport uses in or over wilderness.

Context: Wilderness boundaries at Saguaro are not marked. Given this, the public may either knowingly or unknowingly, use motor vehicles, motorized equipment, or mechanical transport in wilderness.

Unauthorized uses of motorized or mechanical vehicles, equipment, and transport can be particularly damaging and may leave longstanding evidence of their presence.

Data source / Process used to compile or gather data: Paul Austin, RMD District Ranger / Inquiries made to Law Enforcement. See Table 11 below for scoring (multiply frequency of unauthorized use by extent of unauthorized use for each category) and Table 12 for sums at Saguaro.

Category	Frequency of unauthorized use	Score	Extent of unauthorized use	Score
Public	Common	3	Many locations	3
	Occasional	1	1 or 2 locations	1
	None	0	None	0
Permittees	Common	5	Many locations	3
	Occasional	3	1 or 2 locations	1
	None	0	None	0
Agencies	Common	5	Many locations	3
	Occasional	3	1 or 2 locations	1
	None	0	None	0

.

Table 11
Extent of unauthorized uses

Type of Use	Total Score from Table 11 (above)
Motorized vehicle	*(this is a numerical value representing the total score of **motorized vehicle** usage by adding together public, permittees and agency scores)* **Score = 1**
Motorized equipment	*(this is a numerical value representing the total score of **motorized equipment** usage by adding together public, permittees and agency scores)* **Score = 0**
Mechanical transport	*(this is a numerical value representing the total score of **mechanical transport** usage by adding together public, permittees and agency scores)* **Score = 3**
	Total sum for all scores = 4

Table 12
Total score for all unauthorized uses

2012 Baseline Data Value: 4

Frequency of Measures (years): 1

***Condition*:** Good

Unit of Measure / Data type: Index / Number - Integer

Confidence: Medium

Significant change: Any

Chapter Six

Solitude or a Primitive and Unconfined Type of Recreation Quality Measures

A definition of 'solitude or a primitive and unconfined type of recreation' from *Keeping It Wild*: The Wilderness Act states that wilderness has "outstanding opportunities for solitude or a primitive and unconfined type of recreation." This quality is about the opportunity for people to experience wilderness; it is not directly about visitor experiences per se. This quality is degraded by settings that reduce those opportunities, such as visitor encounters, signs of modern civilization, recreation facilities, and management restrictions on visitor behavior.

See Appendix D for data tables.

Monitoring Question: What are the trends in outstanding opportunities for solitude inside wilderness?

Indicator: Remoteness from sights and sounds of people inside the wilderness

Measure 4-1. Number of backcountry permits issued

Description: Number of backcountry permits issued per fiscal year.

Context: Although the park's management goal should not be to lower park visitation and use at this point in time, the amount of backcountry permits is a useful indicator of backcountry use. In order for this measurement to severely impact wilderness users opportunity to experience solitude, there would need to be a very large increase in the amount of backcountry permits issued. As the population in Tucson and the southwestern United States grows, there is a possibility of more pressures on backcountry travel. These theoretical future pressures could severely impact the wilderness user of the future. Given this, once the wilderness reaches a threshold of overuse and more backcountry travelers are present, opportunities to experience solitude diminish.

Data source / Process used to compile or gather data: Melanie Florez; monthly public use report / Data are in the monthly use report. The sum of each month was determined for the fiscal year.

2012 Baseline Data Value: 1916

***Unit of Measure / Data type*:** Backcountry nights / Number - Integer

Frequency of Measures (years): 1

Confidence: High

***Condition*:** Good

Significant change: ± 1000

Measure 4-2. Condition of Campgrounds

Description: The level of impact due to human use on each campground.

Context: The condition of campgrounds is indicative of the amount of human use at a particular site. If the campground is degraded, it reminds wilderness users of the presence of other humans, thus degrading their opportunity to experience solitude.

Data source / Process used to compile or gather data: Inquiry made to backcountry ranger / Each campground was given a value based on the level of human impact (Low=1, Medium=2, High=3); the sum of the conditions of the six campgrounds is the final measure.

2012 Baseline Data Value: 9

***Unit of Measure / Data type*:** Index / Number – Integer

Frequency of Measures (years): 1

Confidence: High

***Condition*:** Good

Significant change: ± 3

Measure 4-3. Total number of day users in wilderness

Currently, determining the total number of day users in the park is the responsibility of Law Enforcement and is required by the General Management Plan. Unfortunately, two issues are preventing this from occurring:

1) Law enforcement does not have enough trail counters to monitor all trails in the park. Given this, they would not have an accurate understanding of day use visitation unless they were provided more trail counters.
2) Law Enforcement currently lacks the manpower for this type of activity.

In order to effectively manage the park and wilderness, it is essential to determine the amount of day users. Considering the high cost of trail counters, this can be accomplished in more cost effective ways. Volunteers could conduct counts, park staff could choose random days and conduct counts, wildlife cameras could be installed at wilderness boundaries on trails, etc. The most simple and efficient method, however, is to install trail counters.

Indicator: Remoteness from occupied and modified areas outside the wilderness

Measure 4-4. Miles of road on wilderness boundaries

Description: Miles of road within ¼ miles of wilderness boundaries.

Context: Roads are a prominent feature which fracture parts of wilderness, especially in TMD. As of August 2012, there was a plan to convert Golden Gate Road in TMD, into a multi-use trail. Actions, such as these, increase remoteness from occupied and modified areas outside of wilderness.

The presence of road on wilderness boundaries increases both the frequency with which wilderness visitors are subjected to human sights (presence of cars, motorcycles, bicyclists, etc.) and sounds (automobile and motorcycle engine noise, etc.).

Data source / Process used to compile or gather data: ArcGIS data layer of all Saguaro roads used to isolate and measure all roads on wilderness boundaries / Measure length tool used in ArcGIS to calculate distance of all individual road segments along wilderness boundaries.

2012 Baseline Data Value: 37.95

***Unit of Measure / Data type*:** Miles / Number - Decimal

Frequency of Measures (years): 5

Confidence: High

***Condition*:** Caution

Significant change: Any

Measure 4-5. Soundscape

Saguaro does not current collect any data related to soundscapes. Park biologists, however, are committed to collecting this data in the near future.

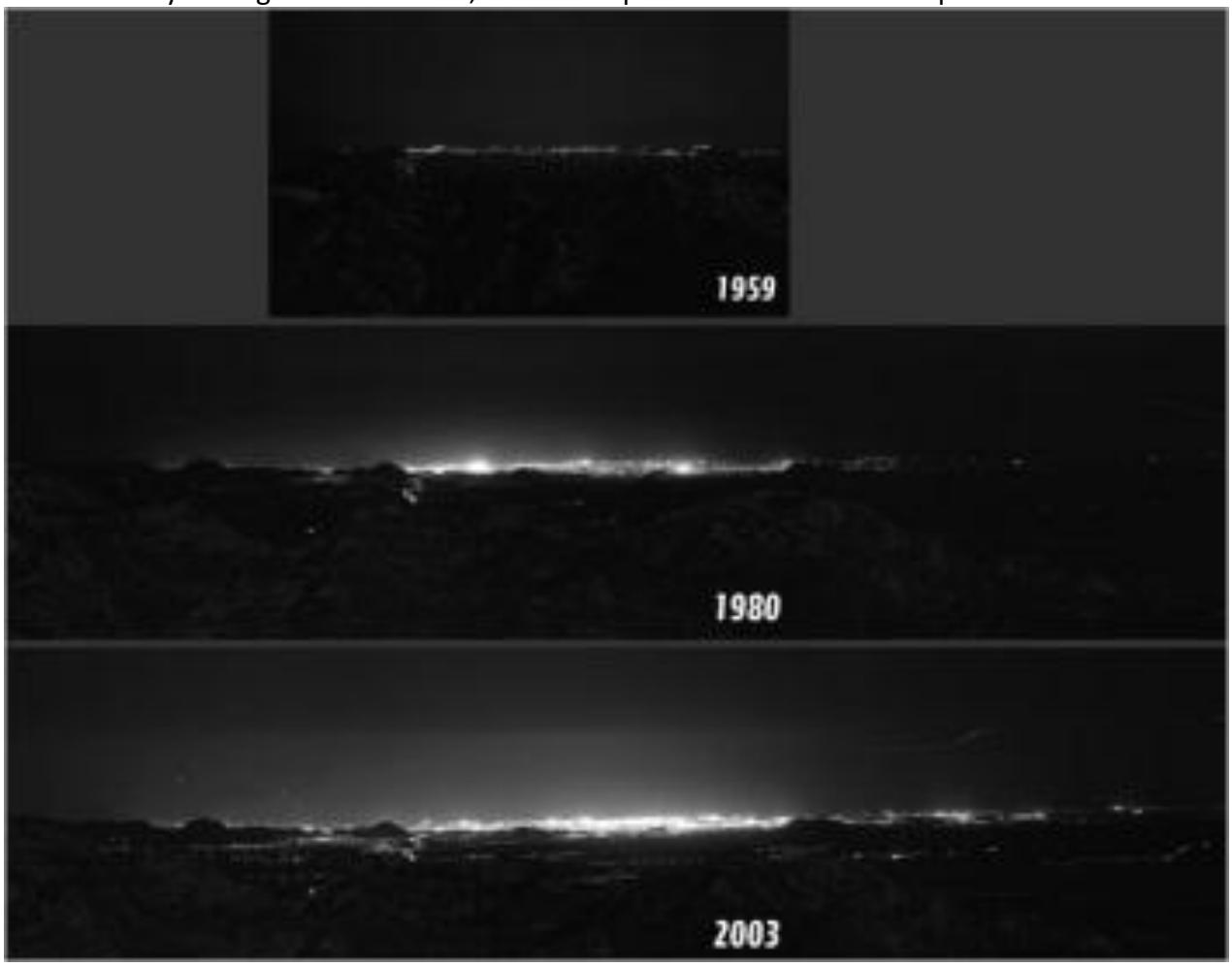
The natural soundscape is critically important in providing wilderness users the opportunity to experience solitude. When the natural soundscape is disrupted by a military jet, a helicopter or a passing motorcycle, it significantly impacts the opportunity to experience solitude because they are reminded of the sounds of the modern world.

The Saguaro Wilderness lies under the flight path of both the Tucson International Airport (TIA) and Davis-Monthon Air Force Base (DMAFB). Given this, there are many over-flights occurring inside of wilderness. The sound emitted from over flights diminishes opportunities to experience solitude in the wilderness. It is a reminder of the wilderness area's proximity to Tucson and the urban development many users seek to temporarily escape.

Measure 4-6. Night Sky Quality

Saguaro does not current collect any data related to night sky quality. Park biologists, however, are committed to collecting this data in the near future.

The night sky quality at Saguaro is exceptional in the RMD. These remarkable night skies allow the wilderness user to participate in star gazing. Star gazing, among other activities related to the night sky, give the opportunities for wilderness users to participate in a primitive activity. This activity connects contemporary peoples with their ancestors and can be part of a path to self-discovery through self-reflection, a crucial aspect of the wilderness experience.



The night sky quality in the wilderness has been degraded as development in and around Tucson has spread. Above: Repeat photography nighttime photographs near Manning Camp.

Monitoring Question: What are the trends in outstanding opportunities for primitive and unconfined recreation inside wilderness?

Indicator: Facilities that decrease self-reliant recreation

Measure 4-7. Number and extent of park maintained facilities

Description: This measure is the sum of the number of all park maintained recreational facilities multiplied by their development level.

See Appendix H for a full list for facilities used in this measure

Context: Although the presence of facilities in wilderness may broaden the proportion of public interested in willing to recreate in wilderness areas, park maintained facilities are detractors from wilderness solitude and opportunities for primitive recreation and therefore should be kept at a minimum.

Data source / Process used to compile or gather data: Shelley Lane, Trails Supervisor; Becky MacEwen, GIS Specialist; Brad Shattuck, Chief of Maintenance / Inquiries made with Shelley Lane, Brad Shattuck and Becky MacEwen. A list was compiled of all park maintained recreational facilities in wilderness and park staff determined each facility's "development level." We then gave each facility of weighting value based on its development level and added up the values of all structures to determine our final measurement (High=3, Medium=2, Low=1). The sum of the values of all structures is the final measure.

2012 Baseline Data Value: 148

***Unit of Measure / Data type*:** Index / Number – Integer

Frequency of Measures (years): 5

Confidence: Medium - number of recreational signs and bear boxes is estimated.

***Condition*:** Good

Significant change: ± 50

Measure 4-8. Miles of improved trail

Description: Miles of park maintained and improved trail within wilderness.

Context: Maintaining and creating new trails allows visitors to more easily experience the Saguaro Wilderness. Although increased accessibility is positive because it allows a larger spectrum of the population to have a wilderness experience, it degrades the opportunity to have a primitive and unconfined experience due to increased accessibility.

Data source / Process used to compile or gather data: Becky MacEwen, GIS Specialist
Inquiry made to Becky MacEwen; information collected from in trails layer in GIS database.

2012 Baseline Data Value: 127.38

***Unit of Measure / Data type*:** Miles / Number – Decimal

Frequency of Measures (years): 1

Confidence: High

***Condition*:** Good

Significant change: Any

Measure 4-9. Extent of cell phone reception

Description: Index of internet and cell phone reception among 4 major cell phone companies in wilderness.

Context**:** As part of the BioBlitz citizen science event in October, 2011, Verizon agreed to boost their signal strength into Saguaro for safety reasons. As a result, cell phone reception is high in many areas of the wilderness for Verizon customers. Other providers, such as A T & T, have very poor reception throughout the wilderness.

Although the presence of cell phone service in wilderness may increase the perceived safety of visitors, it decreases their self-reliance (which can negatively impact their safety) and serves as a reminder of modernization and the technologicalizaiton of society, which is something many users seek to temporarily escape.

Data source / Process used to compile or gather data: Survey conducted with park staff who spend a significant amount of time in the backcountry / Spoke with relevant staff to determine what cell phone service they used and asked to rate its reception in wilderness on a scale from 1-5. Below is a key that was used to standardize their ratings:

Quality of Cell Phone Reception in Wilderness	Score
Always can get internet and phone reception	5
Occasionally can get internet and almost always can get phone reception	4
Never/rarely get internet and always get phone reception	3
Never/rarely get internet and occasionally get phone reception	2
Never/rarely get internet and never/rarely get phone reception	1

Table 13
Quality of Cell Phone Reception

The cell phone companies had adequate representation among the sample group and each cell phone company was given an average rating from 1 to 5. The sum of the 4 average ratings for each company is the final measurement.

2012 Baseline Data Value: 8

Unit of Measure / Data type**:** Index / Number – Integer

Frequency of Measures (years): 1

Confidence: High

Condition**:** Good

Significant change: ± 4

Indicator: Management restrictions on visitor behavior

Measure 4-10. Visitor Restriction Index

Description: An index derived from all management restrictions which impact wilderness users.

Context: These regulations are aligned with management policies and in most cases serve to protect the resources of the wilderness. This quality degrades if the type and extent of management restrictions increases

Wilderness is unrestricted by definition, but some administrative policy or rules and regulations may prohibit certain activities or behavior within wilderness areas. Visitors may feel parts of their wilderness experience have been impacted in one way or another because of management restrictions. On the other hand, sometimes management restrictions are established to offset the effects of behavior within wilderness if the management restrictions were not in place. The effect of management restrictions on visitor wilderness experiences should be considered.

Data source / Process used to compile or gather data: TMD and RMD District Rangers; Information Pamphlet "The Saguaro Wilderness Area" / Rangers determined the values for Table 14 (see next page). 11 categories were rated based on its numerical scale and each of these categories was given a further weight of 1 (if limited in wilderness) and 2 (if restriction is wilderness wide). The sum of the weightings given to the 11 categories is the final measure.

2012 Baseline Data Value: 31

***Unit of Measure / Data type*:** Index / Number – Integer

Frequency of Measures (years): 5

Confidence: High

***Condition*:** Caution

Significant change: ± 15

Category	Type of Restriction	Score
Camping	No restriction	0
	Any mandatory check	1
	Designated sites	2
	Assigned sites	3
	Overnight use prohibited	4
Campfires	No regulation	0
	Designated site; seasonal restrictions; or prohibited above (or below) designated elevation; or mandatory setback	1
	Total prohibition	2
Fees	No fees	0
	Fees charged of selected user type	1
	Fees charged for all visitors	2
Permits	No permit or registration	0
	Voluntary self-registration	1
	Mandatory, non-limited permit or registration	2
	Mandatory, use-limited	3
Length of stay	No restrictions on length of stay	0
	Length of stay limited	1
Stock use	No restrictions	0
	Grazing by stock prohibited	1
	No off-trail stock use	2
	No camping with stock	3
	Stock use prohibited	4
Human waste	No regulation	0
	Pack out required	3
Swimming/bathing	No restrictions	0
	Prohibited	2
Area closure	No restriction	0
	Area closed to use	5
Group size limits	No restrictions	0
	Group size limits in place	1
Leash requirements	No restriction	0
	Dogs required to be on leash	1
	Dogs prohibited	2

Table 14
Management Restrictions on Visitor Behavior

Chapter Seven

Other Features Quality Measures

Unlike the other qualities that apply to every wilderness, this quality may not be present. When it is present, this quality is unique to an individual wilderness based on the features that are inside that wilderness. These features typically occur only in specific locations within a wilderness and include cultural resources, historical sites, paleontological localities, or any feature not in one of the other qualities that has scientific, educational, scenic, or historical value. While many different types of features could be included, the intent is to include those that are significant or integral to the wilderness. Features mentioned in wilderness enabling legislation would likely qualify if not otherwise included in another quality. Measures will be dictated by the specific attribute or feature.

See Appendix E for data tables.

Monitoring Question: What are the trends that promote urban community engagement with the wilderness?

Indicator: Instances of community involvement with the wilderness

Measure 5-1. Number of youth in wilderness on curriculum based field trips

Description: The total amount of youth on field trips in wilderness.

Context: Although the amount of people inside wilderness can drastically influence visitor's opportunity to experience solitude and can lead to degradation of the wilderness, the number of young students experiencing wilderness first hand engages the community and promotes wilderness among a culturally and economically diverse group.

Considering the park's proximity to the City of Tucson, it is in the unique position to engage many youth in wilderness. This engagement helps promote the wilderness and could help promote a wilderness ethic. Given the unique opportunity to engage urban youth in wilderness, this was considered integral to the character of the Saguaro Wilderness.

Data source / Process used to compile or gather data: Melanie Florez, RMD District Interpreter; Chip Littlefield, Park Ranger / Melanie Florez and Chip Littlefield have the amount of school field trips and estimated the amount of time they spent in wilderness.

2012 Baseline Data Value: 1165

***Unit of Measure / Data type*:** People / Number - Integer

Frequency of Measures (years): 1

Confidence: Medium – the amount of field trips in wilderness is an estimation.

***Condition*:** Caution

Significant change: ± 500

Measure 5-2. Percentage of socio-economically disadvantaged youth in field trips

Description: Percentage of the amount of schools which visit SAGU for field trips that have 50 % or more of free and reduced lunches.

Context: Considering the Saguaro Wilderness' close proximity to the Tucson metropolitan area, there is a unique opportunity to get urban youth excited about wilderness by directly experiencing it. Recent wilderness research (Dvorak et al., 2012) implies that the ages of wilderness users have been steadily increasing over the past 4 decades. By promoting the use of and respect for wilderness among urban youth, Saguaro is planting the seed for future wilderness advocates.

Additionally, wilderness is often perceived as an upper-middle class and white activity. Considering the changing demographics in the United States, the four agencies must engage with communities of color in order maintain an influential amount of political capital in the wilderness preservation movement. If wilderness is to be protected in the future and be a truly democratic phenomenon, it must be not only seen as an upper-middle class and white activity – its users should represent the diverse mosaic of cultures in the United States, not just the privileged few.

Considering the park's proximity to the city of Tucson, it is in the unique position to engage many impoverished youth in wilderness. This engagement helps promote the wilderness and could help promote a wilderness ethic. Given the unique opportunity to engage urban youth in wilderness, this was considered integral to the character of the Saguaro Wilderness.

As the percentage of field trips from schools with 50% or more of free-or-reduced lunch increases, the Other Features quality improves.

Data source / Process used to compile or gather data: Melanie Florez, RMD District Interpreter; Chip Littlefield, Park Ranger, Arizona Department of Education Free and Reduced Lunch Data / The Arizona Department of Education has a datasheet listing all public schools in the state and the percentage of children on free-and-reduced lunch at each school. By cross-referencing this list with a list of schools participating in field-trips, a count of the number of schools where more than 50% of students receive free and reduced lunch was divided by the total number of schools on field trips at Saguaro.

2012 Baseline Data Value: 54.3

***Unit of Measure / Data type*:** Percentage of Youth / Number - Decimal

Frequency of Measures (years): 1

Confidence: Medium – private and homeschools were not counted.

***Condition*:** Caution

Significant change: ± 5.0%

Monitoring Question: What are the trends in structures or installations of historical importance?

Indicator: Structures or installations of historical importance

Measure 5-3. Conditional index of all List of Classified Structures (LCS) structures

Description: Conditional index of documented the 33 LCS structures inside wilderness.

Context: The LCS is a computerized inventory of all historic and prehistoric structures, in which the Saguaro has, or plans to acquire, any legal interest. These structures must have historical, architectural or engineering significance. These structures convey the human history of the Saguaro Wilderness. The presence of these resources is integral to maintaining a wilderness which does not seek to erase the human history of the land.

Data source / Process used to compile or gather data: Ron Beckwith, park archeologist and LCS / Consulted with Ron Beckwith who provided a list and condition of all LCS structures from the Regional LCS Coordinator in the Intermountain Regional Office in Denver. Ron then highlighted all LCS structures that are in wilderness. Each site was given a value based upon its condition (3=Good, 2=Caution, 1=Poor).

2012 Baseline Data Value: 84

***Unit of Measure / Data type*:** Index / Number – Integer

Frequency of Measures (years): 5

Confidence: High

***Condition*:** Caution

Significant change: ± 15

Monitoring Question: What are the trends in cultural resources inside wilderness?

Indicator: Condition of statutorily protected cultural resources

Measure 5-4. Conditional index of representative archeological sites

Description: Total index value for the condition of 10 representative archeological sites

Context: Archeological sites convey a deep human history with the landscape. They show that prior to European colonization there existed great cultures. They convey that other ways of living are possible in the seemingly monotonous and developed landscapes of today. Like other wilderness areas, Saguaro has fair amount of archeological sites. These sites are integral to the character of the Saguaro Wilderness and show a unique relationship that once existed between humans and their environment in the desert southwest.

Data source / Process used to compile or gather data: Ron Beckwith, park archeologist / 10 representative archeological sites were chosen by the park's archeologist. Each site has a corresponding Arizona State Museum Archeological Site Card (ASMASC) associated with it, which the archeologist provided. Each site was given a value based upon its condition (3=Good, 2=Caution, 1=Poor). The sum of all 10 sites serves as the final measure. The following are the 10 sites selected for this measure to be revisited in 2017 for reassessment:

ASMIS Site Number	Condition	Weighting
AZ AA:12:763	Good	3
AZ AA:12:134	Good	3
AZ AA:12:807	Good	3
AZ AA:12:808	Good	3
AZ BB:14:342	Good	3
AZ BB:12:48	Good	3
AZ BB :14:286	Good	3
AZ BB:14:32	Good	3
AZ AA:12:840	Good	3
AZ BB:14:658	Good	3
		Total Index Value = 30

Table 15
Conditional index value of archeological sites

2012 Baseline Data Value: 30

***Unit of Measure / Data type*:** Index / Number – Integer

Frequency of Measures (years): 5

Confidence: High

***Condition*:** Good

Significant change: ± 10

Chapter Eight

Wilderness Stewardship Issues and Opportunities in the Saguaro Wilderness

Like the wilderness idea itself, Saguaro's status as an urban wilderness can complicate its management. If understood, these complexities can be utilized to compliment the wilderness user's experience and to improve the park's overall wilderness character. The following issues related to the Saguaro Wilderness are provided by the Wilderness Fellow and are based on his experience and conversations with park staff. They represent identified issues and opportunities that, if addressed by park management, can positively impact the character of the Saguaro Wilderness.

Recognition of the Complexity of Wilderness Character

This framework has provided a suite of measures to consider in future wilderness management at Saguaro National Park. Although it may be tempting for park managers to slightly alter operations to improve particular measurements, the goal of this framework is to convey the state and trends in wilderness character in the park's wilderness. Although fundamentally reductionistic, this suite of measures tells a story of interconnectedness and interrelatedness among the five wilderness qualities. A manager cannot simply focus on improving one quality, indicator or measurement without considering its implications on others. For example, the treatment of buffelgrass has potentially long term, major beneficial impacts to the natural quality of wilderness character while having short term, major adverse impacts to the untrammeled quality of wilderness character. Additionally, the treatment or non-treatment of buffelgrass, depending on the method employed, can significantly impact the three other wilderness character qualities. This framework provides a nuanced method to understand the fundamentals of wilderness character at Saguaro. Thus, it can be used to both improve the park's wilderness character and to facilitate a meaningful dialogue within the park staff and with the public regarding the vexing complexities of managing wilderness on public lands.

Engaging the Community with Wilderness

Although the city of Tucson is surrounded by public land, there is an overall lack of awareness of wilderness. A majority of people have an abstract relationship with the mountains surrounding their community – they see them as places which lack urban development, offer recreation and provide a habitat for flora and fauna. They, however, do not understand the underlying meaning of the mosaic of bureaucratic designations on the landscape and,

specifically, the implications of what it means for land to be designated as wilderness. Saguaro is incredibly effective at promoting not only the park itself, but, the awesome natural phenomena that exists due to the legal definition of the landscape. With that said, however, a greater emphasis on wilderness in environmental education and community outreach could have positive implications. This report has outlined specific language to use in describing wilderness character in the context of analysis. This language can also be used to make wilderness more understandable for the public.

Saguaro's existence as an urban wilderness also provides the opportunity for a diverse demographic to experience wilderness. As mentioned throughout this report, the park staff recognizes the importance of engaging culturally diverse groups with the park. Events, such as Camp Moreno, can give an introduction to the parks, camping and responsible wilderness practices. With that said, an event celebrating the 50th anniversary of the Wilderness Act in 2014 with a focus on youth and minority populations would be an excellent way to promote the park's wilderness and the wilderness idea to this dramatically growing demographic. Although these one-off events are positive, the park must make a formal commitment to engage with youth and minority populations in the park's wilderness.

Additionally, current military members and veterans represent a large portion of the Tucson community. This gives the park the unique opportunity to engage with the military community. Programs, such as the Wounded Warrior project, bring veterans into Parks and Forests to help them transition into society after being physically and/or psychologically wounded while serving in the military. A formal commitment to engage with these groups would further promote park's wilderness and provide a place for veterans to find peace and solitude during the transitional time between military and civilian life.

In addition, cultural resources are not mentioned in the information packet distributed to backcountry users. Although many users would like to think they are in a pristine and untouched environment, a reminder of the great cultural history of the area could be appropriate, if park staff deem this is an important aspect of the park's wilderness. By conveying that people used to live in what is now "wilderness" without the dualistic presupposition that divides the natural and unnatural, wild and not-wild, this could lead to wilderness users experiencing a greater sense of place and a greater appreciation for other ways-of-living beyond the modern society in which many are seeking to temporarily escape.

Finally, it is important to recognize that most of the threats to wilderness character that are perceived by visitors come from outside the park – that is, the noise from traffic on Old Spanish Trail that roars to sunset hikers on the Tanque Verde Ridge trail, or the over flights from commercial and military airplanes, or the glow of the city of Tucson that creeps through the tent walls of campers at Manning Camp. Yet the existence of wilderness can be used to talk to the public about how they can act to preserve it, and can inspire people to think about how their actions and decisions have impacts that are regional and even global in their effects.

Use of Consistent Language When Talking About Wilderness

Prior to my arrival, there were several staff trainings related to wilderness character. These exercises involved brainstorming activities and general information on wilderness character. These trainings and this assessment utilize language related to wilderness character that is easy to understand and useful when talking about wilderness with park staff and the public. By describing wilderness character in the context of its five qualities, a template for understanding develops. Through deliberate and consistent use of this language, wilderness stewardship becomes easier to talk about and understand. Increased public understanding lends itself to more effective management through the creation of a public with more understand of and engagement with the wilderness.

Backcountry Development and Other Issues

The backcountry in the Saguaro Wilderness is generally free of modern developments or improvements on the landscape. There is, however, one highly developed area in the backcountry which highly degrades the undeveloped quality of wilderness character. The area surrounding Manning Camp, not necessarily the cabin itself, has significant modern development. Saguaro National Park has the opportunity to improve this quality by removing unneeded infrastructure. Park staff would need to determine what, if any, infrastructure is not essential. If, however, the park feels all infrastructure surrounding Manning Camp is essential, a commitment should be made to not constructing any additional development in the area.

Although excessive use of the backcountry leads to the degradation of multiple wilderness character qualities, Saguaro has the opportunity to promote the backcountry to a unique demographic. According to a former backcountry ranger at Saguaro, there are a surprisingly small number of users using the backcountry wilderness at RMD. Acute in his analysis, he believes it is due to the lack of access to the backcountry outside of wilderness. There are only two easily accessible trails which lead to the high country in RMD – Douglas Spring and Tanque Verde Ridge. For other trail heads, such as Italian Springs, Miller Creek and Turkey Creek, one needs a 4X4 vehicle to reach the trailhead. Considering access roads for the more difficult trails are in Forest Service land, it may be difficult to coordinate with them for easier access, but worth the effort. Another solution, far more complicated, would be opening up X-9 Ranch Road to people with backcountry permits to start a backcountry trip at the Madrona Trailhead. This would allow give wilderness users the opportunity to more easily experience the six biomes of the Saguaro Wilderness, the historical legacy of Manning Cabin, and would lead to a greater appreciation of this precious resource.

Fragmentation of the Tucson Mountain District

As of September 2012, the park plans to convert Golden Gates Road into a multi-use trail. Although this is preferable to continuing to allow vehicular traffic, converting it to a single-use hiking trail would improve wilderness character. In addition to giving wilderness users the opportunity to experience solitude, the park would be able to create a contiguous wilderness in the TMD. Currently, there is political pressure to allow bicyclists in the park, however, as the Tucson metropolitan area grows in size and population, people may want to seek solitude in greater numbers and the Saguaro Wilderness will become an even more valuable resource. Considering TMD is relatively small and is in closer proximity to impoverished parts of Tucson, the park would also be providing opportunities to better experience wilderness to a largely overlooked demographic segment of the population.

Undocumented Migrants and Drug Smuggling

The increased efforts of the Department of Homeland Security (DHS) to secure the nation's borders have pushed undocumented migrants and drug smugglers to more peripheral landscapes. In other words, the building of physical or technologically securitized walls has simply pushed migrants further eastward and into more inhospitable environments. The Saguaro Wilderness, in the TMD in particular, has seen a dramatic increase in "border activity" in the past few years. Despite the reasons for this dramatic increase in border activity, it exists as an additional element while considering wilderness management operations. Navigating between the nation's desire to secure the border and the Park Service's mandate to protect public lands is a challenging endeavor.

While border security often takes precedence over protecting public lands, engaging in a dialogue with the DHS while using the language of wilderness character may lead better education of border patrol agents and thus facilitate more environmentally responsible behavior. So, even though the DHS and the NPS may have seemingly conflicting missions, an opportunity exists to reach out border patrol and start a conversation about wilderness values.

Additionally, park operations ought not be dictated solely by border or law enforcement issues. There are major implications on the natural and social landscape, some permanent, of the securitization of public lands. The spatial imaginaries, or the way in which people or organizations perceive what space should 'look like,' of the NPS and DHS are very different. The NPS view the landscape as a space for future public use and the protection of the natural environment. The DHS, on the other hand, perceives public space along the border as a something that needs to be controlled in order to protect the American public. Neither of these viewpoints is right or wrong, they are simply different perceptions of space meditated by departmental mandates and culture. The potential social and environmental implications of securitization actions should not be completely eclipsed by the spatial imaginary of the DHS. Additionally, conversations about how departmental-level perceptions of space impact the

actual space itself, including wilderness, should occur between the staff of the DHS, NPS and the public.

Making a Commitment to Collect Missing Wilderness Character Assessment Measures

As of 2012, there are three measures in this report that the park is not currently collecting data for. In order to understand trends in the park's unique wilderness character, it is essential that data are collected for these measures in the future. The following are the three measures with missing data:

1) Total number of days users in wilderness
2) Soundscape
3) Night sky

As mentioned in Chapter One, this monitoring strategy should be understood as an evolving process. As technology and advancements in knowledge allow researchers to more accurately understand our socio-natural world, new or altered research methodologies should be integrated into the wilderness character assessment in order to keep the monitoring strategy useful and relevant to park managers.

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Appendix A

Natural Quality Measures							
Indicator	**Measure**	**Description**	**Unit of Measure / Data Type**	**Frequency (years)**	**Year – Data – Condition / Confidence**	**Significant Change**	**Comments**
Plants and wildlife species and communities	Number of non-native plant species	Number of non-native plant species known to exist in wilderness.	Species / Number – Integer	5	2012 – 42 – Poor / High	± 5	
	Number of invasive plant species of concern	Number of non-native, invasive plant species known to exist in wilderness. This measure includes only species currently managed and species of concern.	Species / Number - Integer	5	2012 – 20 – Poor / High	Any	
	Acres of non-native invasive plant infestation	The known amount of acres in wilderness with significant infestation of non-native invasive plants.	Acres / Number – Decimal	1	2012 – 438.0 – Poor / Medium	± 150.0	
	Status of sensitive species	This measurement is a sum of the values for the "status" (based on abundance and distribution) for five sensitive species identified by the park biologist as indicative of the natural quality of wilderness character.	Index / Number - Integer	1	2012 – 16 – Good / High	± 4	
	Number of extirpated, native plant and animal species	Number of native plant and animal species that have been extirpated since European contact.	Species / Number – Integer	5	2012 – 42 – Caution / High	Any	
	Estimated number of saguaro cacti	Estimated number of Saguaro cacti in wilderness	Cacti / Number – Integer	10	1990 – 1145784 – Caution / High 2000 – 1624821 – Good / High 2010 – 1896030 – Good / High	± 190,000	
Physical resources	Air quality (Visibility)	Group 50 visibility minus natural conditions	Dv / Number – Decimal	5	2010 – 6.2 - Moderate / High 2005 – 5.8 –	- 4.3 ; + 1.9	2010 data

					Moderate / High		
	Air Quality (Ozone)	Fourth-highest eight-hour ozone concentration	Parts per billion / Number – Decimal	5	2010 – 68.4 – Moderate / Medium 2005 – 69.4 – Moderate / Medium	-8.5 ; + 7.7	2010 data
	Air Quality (Total – N)	Nitrogen deposition	Kg/ha/yr / Number – Decimal	5	2010 – 2.0 – Moderate / Medium 2005 – 2.25 - Moderate / Medium	± 1.1	2010 data
	Air Quality (Total – S)	Sulfur deposition	Kg/ha/yr / Number – Decimal	5	2010 – 1.0 - Moderate / Medium 2005 – 1.35 - Moderate / Medium	- .1 ; + 2.1	2010 data
Biophysical processes	Average number of dry days per year in Rincon Creek	5-year running average of number of dry days a year in Rincon Creek	Days a year / Number – Decimal	5	2011 – 10.0 – Caution / High	± 5.0	Measure related to climate change.
	Mean *tinaja* sediment volume throughout RMD	Average percent volume of sediment in a large number of representative natural rock pools (*tinajas*) located throughout RMD	Percentage / Number / Decimal	3	2005/6 – 36 – Good / High 2007 – 45 – Good / High 2010 – 42 – Good / High	± 6.3	Used to understand soil erosion processes.
	Departure from natural fire return interval	An index of the sum of five distinct categories of departures from the fire return interval.	Index / Number – Integer	5	2012 – 1.907 – Poor / Medium	± .350	
	Index of development within 30km of wilderness boundary	Index of development within 30km of TMD and RMD.	Index / Number – Integer	5	2012 – 3.602 – Poor / High	± .900	Data from 2001 and 2005.

Appendix B

Untrammeled Quality Measures							
Indicator	**Measure**	**Description**	**Unit of Measure / Data Type**	**Frequency (years)**	**Year – Data – Condition / Confidence**	**Significant Change**	**Comments**
Actions authorized by the park manager that manipulate the biophysical environment	Number of naturally ignited fires in which the management impacted the amount of acres burned	Number of natural fires suppressed or managed within the boundaries of wilderness – affecting the number of acres burned by management action..	Fires suppressed / Number - Integer	1	2012 – 0 – Good / High	Any	Only include suppression of fires where the sole intent was to extinguish or strongly limit the amount of acres burned.
	Acres of prescribed burning	Number of wilderness acres prescribed burned per fiscal year.	Acres / Number - Decimal	1	2012 – 0 – Good / High	Any	
	Number of acres of treatment of non-native, invasive plants	Number of acres of treatment of non-native, invasive species by park staff and volunteers	Acres / Number – Decimal	1	2011 – 86.0 – Caution / High	± 300.0	The park is in the process of evaluating the use of helicopters to apply herbicide to invasive plants inside wilderness through an EA. If implemented, this would drastically increase this measure.
	Number and extent of authorized research	Index of time and intensity of all authorized research projects which intentionally manipulate the biophysical environment.	Index / Number – Integer	1	2012 – 0 – Good / High	± 15	

Appendix C

Undeveloped Quality Measures							
Indicator	**Measure**	**Description**	**Unit of Measure / Data Type**	**Frequency (years)**	**Year – Data – Condition / Confidence**	**Significant Change**	**Comments**
Non-recreational structures, installations, and developments	Number and extent of contemporary data collection structures and equipment installed	Number and extent of permanent or temporary research structures, other data collection structures and equipment installed in the wilderness.	Index / Number – Integer	1	2012 – 50 – Good / High	± 20	
	Number and extent of built NPS infrastructure	The total sum of the number of administrative buildings, including water tanks and other miscellaneous NPS infrastructure, inside wilderness multiplied by their development level.	Index / Number - Integer	5	2012 – 77 – Caution / High	± 30	
	Number of abandoned and closed mines	The total number of abandoned mines inside of wilderness	Mines / Number - Integer	5	2012 – 115 – Caution / High	± 50	
Use of motorized vehicles, motorized equipment, or mechanical transport	Index of emergency motor vehicles, motorized equipment and mechanized transport	Type and amount of emergency use of motor vehicles, motorized equipment, or mechanical transport.	Index / Number – Decimal	1	2012 – 6 – Good / High	± 40	
	Index of administrative and nonemergency motor vehicles, motorized equipment and mechanized transport use	Type and amount of non-emergency use of motor vehicles, motorized equipment, or mechanical transport.	Index / Number – Decimal	1	2012 – 9.2 – Good / High	± 20.0	
	Number and extent of unauthorized uses	Number and extent of unauthorized motor vehicle, motorized equipment, and mechanical transport uses in or over wilderness	Index / Number - Integer	1	2012 – 4 – Good / Medium	Any	

Appendix D

Solitude or a Primitive and Unconfined Type of Recreation Quality Measures							
Indicator	**Measure**	**Description**	**Unit of Measure / Data Type**	**Frequency (years)**	**Year – Data – Condition / Confidence**	**Significant Change**	**Comments**
Remoteness from sights and sounds of people inside wilderness	Number of backcountry permits issued	Number of backcountry permits issued per fiscal year.	People / Number - Integer	1	2008 – 1514 - Good / High 2009 – 1794 – Good / High 2010 – 1450 – Good / High 2011 – 1672 – Good / High 2012 – 1916 – Good / High	± 1000	Completion of Quilter Trail in 2011 may have led to the increase in the amount of backcountry nights.
	Condition of Campgrounds	The level of impact due to human use on each campground.	Index / Number - Integer	1	2012 – 9 – Good / High	± 3	6 is the optimal number; as it increases the resource is degraded.
	Total number of day users in wilderness	Total number of day users in wilderness per year.	People / Number – Integer	1	NA	NA	Will be collected in future.
Remoteness from occupied and modified areas outside the wilderness	Miles of road on wilderness boundary	Miles of roads within ¼ mile of the wilderness boundary.	Miles / Number - Decimal	1	2012 – 37.95 – Caution / High	Any	Golden Gates Rd. in TMD will eventually be turned into a multi-use trail. This, and other similar actions, will improve this quality. It will, however, continue to fragment the wilderness.
	Soundscape	Will collect after 2012	NA	NA	NA	NA	Will be collected in future.
	Night sky	Will collect after 2012	NA	NA	NA	NA	Will be collected in future.
Facilities that decrease self-reliant recreation	Number and extent of park maintained facilities	This measure is the sum of the number of all park maintained recreational facilities multiplied by their development level. This includes, but not limited to, backcountry campsites, bathrooms, trail signs, etc.	Index / Number - Integer	1	2012 – 147 – Good / Medium	± 50	
	Miles of improved trail	Miles of improved trail	Miles / Number – Decimal	1	2012 – 127.38 – Good / High	Any	

	Extent of cell phone reception	Index of internet and cell phone reception among 4 major cell phone companies in wilderness.	Index / Number – Integer	1	2012 – 8 – Good / High	± 4	
Management restrictions on visitor behavior	Visitor Restriction Index	An index derived from all management restrictions which impact wilderness users.	Index / Number – Integer	5	2012 – 31 – Caution / High	± 15	Refer to p. 65 of Tech. Guide for index rating guide.

Appendix E

Other Features Quality Measures							
Indicator	**Measure**	**Description**	**Unit of Measure / Data Type**	**Frequency (years)**	**Year – Data – Condition / Confidence**	**Significant Change**	**Comments**
Extent of community involvement with the wilderness	Number of youth in wilderness on curriculum based field trips	The total amount of youth on field trips in wilderness.	Field trips / Number - Integer	1	2012 – 1165 – Good / Medium	± 500	All wilderness visits occur in TMD, if travel below 4500 ft. is restructured at TMD, number will decrease substantially.
	Percentage of socio-economically disadvantaged youth in field trips	Percentage of the amount of schools which visit SAGU for field trips that have 50 % or more of free and reduced lunches	Percentage of Schools / Number - Decimal	1	2012 – 54.3 – Good / Medium	± 5.0%	
Structures or installations of historical importance	Conditional index of all LCS structures	The total number and condition of documented the 33 LCS structures inside wilderness.	Index / Number – Integer	5	2012 – 84 – Caution / High	± 15	
Condition of statutorily protected cultural resources	Conditional index of representative archeological sites	Index value for the condition of 10 representative archeological sites inside wilderness.	Index / Number – Integer	5	2012 – 30 – Good / High	± 10	

Appendix F

F-1. List and Weight of NPS Infrastructure

Name of Structure	Level of Impact	Weight Given
Serpertine Wall	Low	1
Dobe Robinson Wildlife Supply Windmill	Medium	2
Dobe Robinson Wildlife Supply Reservoir 1	Low	1
Dobe Robinson Wildlife Supply Reservoir 2	Low	1
Garwood Dam	High	3
Machinery base at Garwood Dam	Low	1
Steel tank, vicinity of Garwood Dam	Medium	2
Corral at Steel Tank	Low	1
Trough at Steel Tank	Low	1
Gould Mine Outbuilding	Medium	2
Porhyry Dam	Medium	2
King Canyon Dam	Medium	2
Amole Dam	Medium	2
East Amole Dam 1	Medium	2
East Amole Dam 2	Medium	2
East Amole Dam 3	Medium	2
East Amole Dam 4	Medium	2
Mark's Dam	Medium	2
Javelina Dam 1	Medium	2
Javelina Dam 2	Medium	2
Javelina Dam 3	Medium	2
Rincon Dam 1	Medium	2
Rincon Dam 2	Medium	2
King Canyon Mine Dam 1	Medium	2
King Canyon Mine Dam 3	Medium	2
Helispot 1 (RMD)	Low	1
Helispot 2 (RMD)	Low	1
Mica Mountain Repeater	Low	1
Radio Tower	High	3
Wasson repeater	Medium	2
Horse Corral (TMD)	Low	1
Radio Tower (TMD)	Medium	2
Happy Valley Lookout	High	3
Manning Cabin	High	3
Water Tank at Manning Cabin	Medium	2
Horse Corral at Manning Cabin	Medium	2
Weather Ports at Manning Cabin (6 total)	Low	1 each; 6 total
Water Pumphouse at Manning Cabin	Medium	2
Manning Cabin Dam	Low	1
Manning Comfort Station at Manning Cabin	Medium	2
		Total = 77

F-2. List and Weight of NPS Data Collection Infrastructure

Name of Structure	Level of Impact	Weight Given
RAWS weather station, Manning Camp	Medium	2
Pima County flood control station, Manning	Medium	2
Rincon Creek/Madrona monitoring wells	Low	1
Rincon Creek stream gages (USGS and NPS)	Low	1
USGS Magnetic Station	High	3
Archeological plot markers	Low	1
Saguaro Census plot markers	Low	1
Tree ring/fire effects plot markers	Low	1
Water sensors - tinajas	Low	1
Water sensors – TV wash and King's Canyon	Low	1
Wildlife cameras (temporary)	Low	1
Wildlife water catchments (3 at TMD)	Medium	2
		Total = 17

Appendix G

List of Recreational Structures inside wilderness

Name of Structure	Development Level	Weight Given
Mam-a-gah Comfort Station	Medium	2
Mam-a-gah Picnic Area Ramada	Low	1
Juniper Basin Pit Toilet	Low	1
Happy Valley Comfort Station	Low	1
Douglas Spring Comfort Station	Medium	2
Bear Boxes (approximately 15 total)	Low	1 each; ≈ 15 total
Grass Shack Comfort Station	Medium	2
Trail Signs (approximately 98 total)	Low	1 each; ≈ 98 total
Douglas Spring Trailhead Ramada	Medium	2
Campsites (21 total)	Low	1 each; 21 total
Interpretative Sign at Manning	Low	1
Manning Comfort Station	Medium	2
		Total = 148