Introduction

Purpose of the Study

The purpose of this study is to guide national park (and similar protected areas) managers in protecting darkness and the night sky as resources and for the visitor experience. Using survey methods, this research will be a descriptive, cross-sectional study that addresses the following research questions:

1. What is the importance of darkness and the night sky to visitors and their experiences in national parks?
2. Does their importance to visitors vary from park to park?
3. Do various light sources serve as indicators of quality for visitor experiences at night in a national park?
4. Do objects in the night sky serve as indicators of quality for visitor experiences at night in a national park?
5. Do visitor expectations for darkness and night sky conditions vary from park to park?

Answering these questions will provide an understanding of how visitors value darkness and the night sky. Further, they will identify indicators of quality for night sky viewing experiences in national parks, as well as lead to associated standards of quality for those variables.

Darkness and the Night Sky

Darkness is significant as a natural resource, for the biological processes of plants, animals, and humans depend in on it (Longcore & Rich, 2007). Many species of plants bloom at dusk and in darkness, and excessive light exposure disrupts photosynthetic cycles of trees that are sensitive to day length (Chaney, 2002). Artificial lighting discourages female sea turtles as they select a nesting site and also disorients hatchlings seeking to reach the ocean (Witherington & Martin, 2000). Additionally, artificial lighting attracts migrating birds that rely on starlight for navigation, leading to high mortality from collisions with buildings or other structures (Akesson et al., 2001; Le Corre et al., 2002). Nocturnal animal species depend on darkness to flourish, where predators need darkness to hunt successfully and prey need darkness to remain concealed (Lima, 1998). When it comes to humans, excessive artificial light exposure has been linked to loss of sleep and other health concerns (Stevens & Rea, 2001; Pauley, 2004).

The night sky is also regarded as a cultural resource rich in navigational, symbolic, and spiritual value (National Park Service, 2012). An alternative form of archaeology, archaeo-astronomy, attempts to understand how much astronomy ancient cultures knew and the influence the sky had on their way of life (Zeilik, 1984; Shattuck & Cornucopia, 2001). How night sky conditions have changed over time in the modern era (for example, the night sky as it looked during a civil war battle compared to now [Smith & Hallo, 2011]) also enhances a cultural connection to the night sky. Moreover, some may sense familiarity with constellations, as they observe figures of humans and creatures that dot the sky, illustrating still captures of their associated tales. The visibility

of a familiar "starscape", however, dwindles as development (e.g. cities, structures) emits more light pollution toward the sky.

A dark night sky has the ability to evoke humility and awe in its observers, and astronomers have advocated for the night sky's restoration for decades (Riegel, 1973). It is estimated that more than two thirds of people in the United States cannot see the Milky Way from their homes due to light pollution (Cinzano, 2001). Light pollution is defined as "any adverse effect of artificial light, including sky glow, glare, light trespass, light clutter, decreased visibility at night, and energy waste" (International Dark-sky Association). Even areas perceived as remote remain subject to the impacts of light pollution, as it can extend 100 miles or more away from its original source (Duriscoe 2001, Moore & Duriscoe, in prep., National Park Service, 2012).

National Parks, Darkness, and the Night Sky

The National Park Service (NPS) traditionally protects landscapes of scenic beauty, wildlife, culture, and history. Recently, what constitutes a landscape to the NPS has been extended to include darkness and the night sky, or *lightscapes.* National parks serve as some of the last places where one can experience a natural night environment that is almost free of light pollution given off by development today.

NPS management policies include managing lightscapes among other resources (2006). A growing consciousness of the value of the night sky and its disappearance has led to an effort by the NPS to protect the opportunity to experience natural darkness and the night sky and to educate visitors about these resources. This is seen through more darkness and night sky related interpretive programming, the hosting of astronomy

festivals and star parties, and the establishment of the NPS Natural Sounds and Night Skies Division (and Night Sky Team), where current darkness conditions are inventoried and will be monitored over time (Moore, 2001; Moore & Duriscoe, in prep).

Chaco Culture National Historical Park (New Mexico) leads the way as a park that emphasizes the night sky as a theme in telling the park's story. The night sky in Chaco is one of the darkest in the contiguous 48 United States, and is close to the night sky that the Chacoan people witnessed thousands of years ago. The park included the night sky as a natural resource in its general management plan in 1993 (Shattuck & Cornucopia, 2001), and later replaced, modified, or eliminated its lighting to reduce impacts within park boundaries (Manning & Anderson, 2012). An observatory was built in 1998, bolstering an already prominent astronomy program in the park (Shattuck & Cornucopia, 2001). Further, the New Mexico Night Sky Protection Act passed as a result of collaboration between the NPS, interest groups (such as the New Mexico Heritage Preservation Alliance), and legislators, aiming to address impacts to the night sky that are beyond park boundaries (Rogers & Sovick, 2001). Efforts at Chaco Culture have forged a path for a larger, regional initiative to minimize the impacts of light pollution on some of the country's darkest skies.

The Management Perspective

The National Parks and Conservation Association (NPCA) administered a survey to 376 national park superintendents to assess light pollution impacts in the national park system (1999). Of parks that offer overnight visitation, responses reflect a positive attitude toward the night sky. Ninety-four percent of these parks think dark night skies are

important. Sixty-four percent believe light pollution is a resource problem, where about 35% of these parks think light pollution is a "slightly serious" problem and another 35% believe it is "moderately serious" or "very serious". Unfortunately, superintendents reported that few actions had been taken to addresses light pollution within park boundaries: about 21% of parks had taken no action, 12% had taken action in all areas of their parks. Further, only ten percent of parks said that nearby communities had lightning ordinances to minimize light pollution. A large number (79%) of parks, however, have made efforts to reduce light pollution in *some* areas of their park, and it is possible that more actions have been taken since the time of the survey.

In 2011, a mail survey was sent to park personnel to assess the use of night resources and recreation in approximately 300 NPS units (Smith & Hallo, 2011). Respondents consisted of the most informed staff on the subject, not just superintendents. Once again, responses to survey items show a positive NPS attitude toward night resources, such as darkness and the night sky. For example, managers agreed, on average, with the statements "Night resources are important to visitors' experiences in my park" and "My park should identify and manage its night resources." About 29% of parks have worked with the NPS Night Sky Team, and approximately 42% said they have consulted with an astronomer or astronomy clubs to address protection of darkness and the night sky. Thirty-five percent of respondents indicated that they have worked with lighting professionals, and about 36% have modified their park's lighting.

Little is empirically known, however, about how visitors value darkness and the night sky. Results from Smith and Hallo (2011) and NPCA (1999) show that visitor attitudes towards these resources need to be understood for their protection for current

and future generations. Moreover, indicators and standards of quality should be established to ensure high quality night sky viewing experiences in national parks (Smith & Hallo, 2011). Indicators and standards of quality guide management-by-objective frameworks, such as the Visitor Experience and Resource Protection framework developed by the NPS (National Park Service, 1997). To guide management, this research will attempt to both explore visitor attitudes towards darkness and the night sky and identify indicators of quality for night experiences in national parks.

Literature Review

Indicators and Standards of Quality in Outdoor Recreation

Indicators and standards-based management is often applied when addressing issues of *carrying capacity*. The carrying capacity for a recreation area is the amount and kinds of visitor use an area can sustain without degrading resources or the visitor experience to unacceptable levels (Manning, 2011). Early studies of recreation impacts emphasized those sustained by natural resources with increased visitation (Meinecke, 1929; Bates, 1935), but Wagar (1964) later recognized that carrying capacity in outdoor recreation also encompasses human values and management actions. Therefore, management decisions should be accompanied by a threefold framework that includes resource, social, and managerial components.

Management by objectives (or desired conditions) helps address the question of how much impact to these conditions is acceptable, or what is the limit of acceptable change. This question led to the development of several carrying capacity management frameworks, such as the Limits of Acceptable Change (LAC) (Stankey et al., 1985;

McCool & Cole, 1997) and Visitor Experience and Resource Protection (VERP) frameworks (National Park Service, 1997). These frameworks call for establishing management objectives: statements that include the resource conditions, recreation experiences, and management involvement to be provided in a given recreation setting (Manning, 2011). Indicators and standards of quality are then developed to help realize these objectives. Indicators of quality are manageable, measureable variables that define high quality resource and experiential conditions, while standards of quality are the minimum acceptable conditions of indicator variables (Manning, 2011, p. 86). Conditions and visitor satisfaction are then monitored over time to evaluate the effectiveness of management decisions, and managers revisit steps of the frameworks as necessary.

Numerous studies have focused on identifying indicators for a variety of recreation activities and recreation settings, as summarized by Manning (2011). Many studies concentrate on indicators of quality for wilderness (and similarly, backcountry) experiences on trails and at campsites given input from visitors/backpackers (Roggenbuck et al., 1993; Shafer & Hammitt, 1994; Bacon et al., 2004; Cole & Stewart, 2002; Glaspell et al., 2003; Dawson & Alberga, 2004; Cole & Hall, 2009) in addition to managers of these areas (Merigliano, 1990; Bacon et al., 2006). Even more studies identify indicators for experiences at highly used recreation areas and attraction sites from visitors (e.g. Manning et al., 1995; Manning et al., 2002; Manning et al. 2003; Bacon et al., 2003; Budruk & Manning, 2004). Further, several studies apply the use of indicators internationally (e.g. Heywood & Aas, 1999; Inglis et al., 1999; Kim et al., 2003; Leujak & Ormond, 2007; Roman et al., 2007), illustrating the versatility of

indicators as a tool to manage outdoor recreation. Although management frameworks and indicators of quality are commonly applied to issues related to carrying capacity, they can be used to address a variety of impacts to outdoor recreation experiences (Manning, 2004).

What Makes a Good Indicator?

Indicators of quality only benefit the LAC and VERP processes if they are effective. Indicators of quality are most effective when they are specific, objective, and quantifiable (Whittaker & Shelby, 1992; Manning, 2011). Whittaker and Shelby use the example of "water quality" as a poor indicator because one does not know how it is defined. By making "water quality" more specific, such as "bacteria per volume of water", the indicator can now be measured quantitatively and is an objective value. Indicators of quality should also be related to and proportionally sensitive to visitor use (Stankey et al., 1985, Manning, 2011), given that the primary goal of LAC and VERP is to successfully maintain a balance between protection of park resources/experiences and visitor use. The sensitivity of indicators to use in important in identifying "early warning mechanisms" (Manning, 2011) that help managers address a problem before it gets much worse.

Further, indicator variables should be cost-effective to measure and monitor, and be reliable and repeatable (Stankey et al., 1985, National Park Service, 1997, Manning, 2011). Monitoring of indicator variables and how they compare to their associated standards of quality is a crucial component of outdoor recreation management frameworks. Variables that minimize the burden of monitoring them are more effective because they allow for multiple people (compared to just a specialist) and fewer

187 resources (time, equipment) to monitor them (Manning, 2011). Indicators should also be
188 manageable and monitoring should reflect the effectiveness of management actions in
189 reaching desired conditions (Manning, 2011). Perhaps most importantly, indicators of
190 quality should be meaningful to visitors when managing for high quality experiences
191 (Whittaker & Shelby, 1992; Stankey et al., 1985, Manning, 2011).

192 Additionally, indicators of quality should span a range of resource, experiential,
193 and managerial variables. The indicators identified in the above studies reflect this
194 threefold framework of outdoor recreation management (Table 1).

195
196 **TABLE 1** Examples of indicators

Dimension	*Indicators*
Resource	Trail erosion, seeing wildlife, campsite conditions
Social	Noise, groups encountered on trails, persons at one time at attraction sites
Managerial	Trail markers, information services, regimentation

197

198 *Using Importance-Performance Analysis to Identify Indicators of Quality*
199
200 Indicators of quality have been identified using qualitative methods, quantitative
201 methods, and combinations of both. Qualitative studies (e.g. Glaspell et al., 2003; Farber
202 & Hall, 2007; Hallo et al., 2009) utilize interviews or free response questions and are
203 considered useful for determining possible indicators for activities, places, and types of
204 visitors/recreationists where little is known (Manning, 2011). Several studies have used
205 variations of "importance-performance analysis", a quantitative method, to identify
206 indicators of quality (Guadagnolo, 1985; Mengak et al., 1986; Hollenhorst & Stull-
207 Gardner, 1992; Hollenhorst et al., 1992; Hollenhorst & Gardner, 1994; Hunt et al., 2003;

Pilcher, et al., 2009). Importance-performance analysis is an evaluation technique that originated in marketing that offers a way to evaluate customer satisfaction with various goods and services provided by a firm (Martilla & James, 1977). The analysis measures satisfaction as the *importance* of a service to a customer and the *performance* of the firm in delivering that service. An "action grid" (Figure 1) displays resulting data divided into four quadrants. Labeling these quadrants offers management suggestions for resource allocation to improve satisfaction.

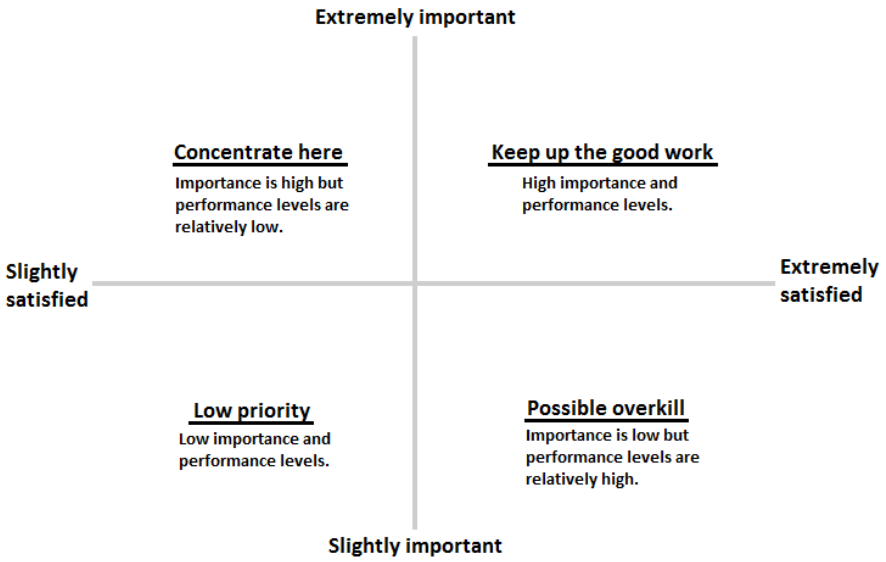

FIGURE 1 Importance-performance grid. Modified from Mengak et al. (1986).

The quadrants are then placed on top of an x and y-axis that depict the evaluation scales for importance and performance (Figure 2). The grid lines that delineate the quadrants are commonly placed at the neutral or middle points of each axis (Martilla & James, 1977) but can be placed elsewhere based on the judgment of the manager or the researcher. Adjusting the placement of the grid lines can denote a standard of quality (e.g. maintaining conditions where visitors have a certain average performance rating)

and narrow the problem areas down to those worth focusing on, helping agencies with limited resources make the best decisions (Guadagnolo, 1985; Megnak et al. 1986; Hollenhorst et al., 1992). However, these adjustments can lead to misinterpretation of results (e.g. turning a "keep up the good work" item into a "possible overkill" item) and require careful thought (Oh, 2001; Bruyere et al., 2002). With grid lines in place, one then interprets the results based on where items fall in the quadrants. Items that fall into the "concentrate here" and "keep up the good work" quadrants are identified as possible indicators of quality for visitor experiences when applied to outdoor recreation (Pilcher et al., 2009).

Some papers identify limitations and issues with importance-performance analysis. When only importance and performance are addressed, it is hard to tell what number of something is unsatisfactory to visitors. For example, if visitors are unhappy with the number of groups they encounter on trails, it is unknown how many groups would be acceptable (Hollenhorst & Gardner, 1994). Without establishing a standard of quality specifically associated to indicator variables it is difficult to actually address the problem and gauge management success. To address this, Hollenhorst & Gardner asked visitors to set their standards then rate how well they were met. Additionally, Oh (2001) suggests that importance-performance analysis fails to clearly define the concept of "importance" and, at times, confuses "importance" and "expectation" of variables.

FIGURE 2 Importance-performance grid with axes.

Despite these limitations, importance-performance analysis can be a useful tool to identify indicators of quality for recreation experiences, especially in areas where less is understood. Natural quiet, or the natural "soundscape", has recently received attention from park managers, as mandated by NPS management policies (2006). Pilcher et al. (2009) used a variation of importance-performance analysis as a part of a multi-stage project to identify indicators and standards of quality for natural quiet in national parks, and to better understand the role of soundscapes in visitor experiences. "Groups of unknown people talking" fell into the "concentrate here" quadrant, suggesting this variable as an indicator of quality. With this information, the researchers worked to establish a standard of quality for visitor-caused sounds.

Developing Standards of Quality Using Normative Theory

Standards of quality provide baselines for the quality of resources and recreation experience. Similarly to indicators, standards of quality should be quantifiable and related to impacts (National Park Service, 1997). The NPS VERP handbook (1997) goes on to say that standards should be bounded by time or space, such as encounters *per day*, or social trails *per mile*. They should also be expressed as a probability in order to address random times where management cannot maintain desired conditions. For example, "no more than 10 groups encountered on the river 80% of days during peak season" could be a standard of quality for managing recreation on the Colorado River. Lastly, standards of quality should be realistic and attainable.

Previous research suggests that normative theory and methods play and important role in the use of indicators and their associated standards of quality for managing outdoor recreation (Vaske et al., 1986; Heywood, 2002; Manning, 2007). A discussion on normative theory and methods originated with Jackson's (1966) development the Return Potential Model, a way to measure norms. This model evaluates the potential return (amount of approval or disapproval) for a behavior (e.g. littering). The maximum potential return represents the ideal behavior recommended by those of a social system, or a norm. When applied to outdoor recreation, norms are standards that individuals use to evaluate recreation conditions that can be aggregated to test for the existence of broader social acceptability. To identify norms, visitors may be asked to rate levels of possible impacts to resources and experience due to increasing recreation use, thus reflecting norms for preferred and minimum acceptable conditions (Manning, 2011). Mean visitor responses can then be graphed to illustrate a social norm curve. An example is illustrated in Figure 3.

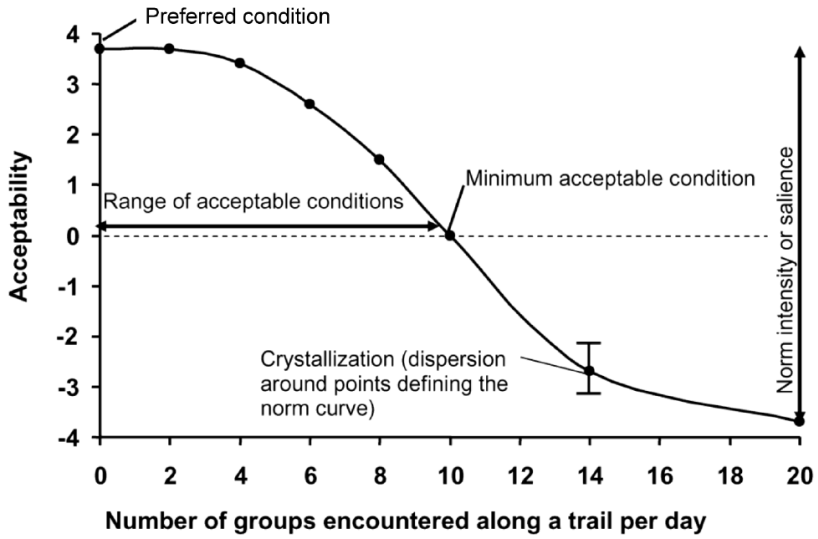

FIGURE 3 Hypothetical social norm curve (from Manning, 2011).

In this example, visitors are asked to rate the acceptability of encountering a range of groups along a trail per day, where they rate the acceptability on a scale from -4 (very unacceptable) to +4 (very acceptable). The range of groups encountered a long a trail per day (0, 2, 4, 6 and so on) could be given to the visitor as descriptions of scenarios one might experience in that area. Results from this hypothetical curve show that visitors prefer to encounter no groups along the trail per day, and the most groups they tolerate encountering is 10. This is then the standard of quality that managers would strive to maintain conditions at or above to ensure visitor satisfaction. The greater the distance of the curve both above and below the neutral line illustrates the importance of the indicator variable being measured to visitors. Measuring the crystallization, or level of agreement, of all visitor responses surrounding the mean response on the curve reveals how widely held the perception or preference is held, offering support that broader social norms exist for these conditions.

Methods

Sampling and Data Collection

Research questions will be addressed by using two paper survey instruments administered to visitors in four national park service units: Acadia, Grand Canyon, and Yosemite national parks and Golden Gate National Recreation Area. Access to the parks will be obtained with research permits from the NPS. Additionally, the use of human subjects in this study requires us to submit the surveys to the Institutional Review Board for approval. The surveys will likely be exempt because neither survey asks for, nor will we retain, any personal/identifiable information from our respondents.

Study Sites

Acadia, Grand Canyon, and Yosemite national parks are included in this study because they are geographically diverse, receive high levels of nighttime visitation, and offer opportunities for visitors to camp, hike at night, and observe the night sky. Despite lower night visitation and fewer opportunities to observe the night sky, Golden Gate National Recreation is included to make a comparison between an "urban" park and the "crown jewel" nature-based parks, and represents the diversity of units managed by the NPS.

Acadia National Park

Acadia National Park is located on Mount Desert Island on Maine's coast. The park's scenic ocean vistas and undulating landscape are experienced via historic hiking trails, an extensive network of multi-modal use carriage roads, and the Park Loop Road. Popular attractions in the park include Sand Beach (the largest sandy shore in the park), Thunder

Hole (a small inlet where crashing waves mimic the sound of distant thunder), and Cadillac Mountain (known as the first point in the United States to be hit by sunlight from sunrise at certain times of the year). Small harbor towns dot the island and serve as popular day and overnight destinations for park visitors.

The park had 153,798 overnight stays in 2011, the majority of which occurred in June, July, August, and September (National Park Service, unknown[a]). Visitors stay overnight in the park's campgrounds as there are not privately operated campgrounds or lodges in the park. The park has three major campgrounds, Blackwoods, Seawall, and Duck Harbor. Blackwoods and Seawall receive the most visitation given their proximity to attractions on Mount Desert Island; Duck Harbor is located on the remote island Isle au Haut and therefore gets fewer overnight visitors.

In addition to being the first national park established east of the Mississippi River, Acadia prides itself as a premier location to view the night sky in the Eastern United States. The importance of the night sky as a natural resource to Acadia is underscored by the park's annual Night Sky Festival, a four day event featuring special presentations, activities, and star parties (free telescope viewing offered with the help of local amateur astronomers). Acadia's regularly scheduled ranger programming also features night walks and astronomy evening programs.

Grand Canyon National Park

Grand Canyon National Park lies on the Colorado Plateau in northwestern Arizona. The canyon is a spectacle of geologic time, where the erosion and weathering of rocks by the Colorado River and precipitation have revealed "basement rocks" as old as 1.8 billion

years. The vast majority of park visitors experience the park on the canyon's South Rim (fewer visit the North Rim), taking it all in from many scenic viewpoints. Trails that lead into the inner canyon's backcountry offer visitors a different perspective of the park and opportunities for solitude. Those who are lucky enough to win a permit lottery may find themselves on a rafting trip down the famed Colorado River at the heart of the canyon.

A total of 1,357,679 visitors stayed overnight in Grand Canyon in 2011, where the park's peak season is May through August (National Park Service, unknown[b]). The park's concessionaire operates several private lodges, where about 47 percent of overnight visitors stayed, and one campground. The park manages three campgrounds on the canyon rim, Mather and Desert View on the south and North Rim on the north. Primitive camping in the inner canyon is allowed with a backcountry permit.

Several national parks are on the Colorado Plateau. These parks, including Grand Canyon, have reputations for protecting the darkest night skies in the contiguous United States. Staff at Grand Canyon are aware of this allure and the park hosted its 22nd annual, weeklong star party in 2012. During that week, the park offers astronomy evening programs in addition to telescope viewing for visitors to enjoy.

Yosemite National Park

Yosemite National Park is located in California, approximately 165 miles due east of San Francisco. Visitors enjoy valleys, meadows, waterfalls, and groves of giant sequoias via the park's scenic drives, a multi-modal use paved path in Yosemite Valley, and over 750 miles of hiking trails. Granite cliffs and domes serve as a scenic backdrop for these

locations. The most famous of these features, El Capitan and Half Dome, attract rock climbers and intrepid hikers looking to scale these iconic monoliths.

Yosemite saw 1,630,610 overnight visitors in 2011, with most of those stays in June through September (National Park Service, unknown[c]). Approximately 47 percent of those visitors stayed in five lodges operated by the park's concessionaire. The concessionaire also manages two campgrounds in Yosemite Valley and several tent cabins in the park's backcountry. The NPS manages thirteen campgrounds throughout the park, where about 45 percent of overnight visitors stayed. Yosemite also features extensive wilderness where visitors can camp with a permit.

Currently the park does not offer an astronomy festival or star parties like Acadia and Grand Canyon. However, programming offered regularly by the NPS and the park's concessionaire features stargazing, night walks, and even night bike rides.

Golden Gate National Recreation Area

Several units make up Golden Gate National Recreation Area in and around San Francisco. Visitors can have a variety of experiences at Golden Gate, ranging from touring prison cells of Alcatraz Island, to standing beneath some of the world's tallest trees at Muir Woods National Monument. The Marin Headlands, the Presidio of San Francisco, and Point Bonita Lighthouse are some other popular units managed in the area, while the City of San Francisco has a draw all its own.

Compared to Acadia, Grand Canyon, and Yosemite, Golden Gate received relatively little overnight visitation in 2011 with 60,927 stays (National Park Service, unknown[d]). The NPS manages four small campgrounds (at most, 5 campsites) in the

Marin Headlands and a group camp in the Presidio of San Francisco, where approximately 20 percent of overnights occurred. Hostels and lodges in the parks received the greatest proportion of overnight visits (about 80 percent of overnight visits).

Golden Gate's ranger programming does not regularly include astronomy programs or night hikes, nor do park units hold night sky related festivals. There are some locations within the parks that have no artificial lighting and provide opportunities to observe the night sky, however, these areas are affected by light pollution from San Francisco.

Observation Survey Instrument (Observation Survey)

The first survey instrument is an observation exercise to be completed by campground visitors at Acadia National Park. We will seek a sample size of at least 200 respondents over a two week time frame. Respondents will be intercepted in Blackwoods Campground and Seawall Campground. We will sample from campground visitors because we will know they are nighttime users of the park. In cases where we intercept personal *groups* of campers, one survey will be given to the group for the group's "leader" to complete. The observation survey will attempt to identify indicators of quality for park experiences related to experiencing natural darkness and observing the night sky, and determine the importance of darkness and the night sky to visitors. The potential indicators of quality are:

1. Objects in the night sky,
2. light from towns or cities outside the park,

3. visitor-caused light, and
4. light from park facilities.

Visitors will be asked to pay attention to their surroundings, including the night sky, at night in the park. Visitors will be given the survey the morning or early evening and will be instructed to complete the questionnaire later that night or early the following morning. An incentive (a coupon for a free ice cream cone at a local restaurant) will be issued to respondents to foster a high response rate.

Visitor responses should be based on *one* night of observing their surroundings . The visitors will complete a table that lists items they may have seen that night *in the park* (see Appendix A). The table asks respondents to indicate whether or not they saw items in the park that night. This study will focus on visitors' ability to see objects in the night sky, light from towns or cities outside the park, visitor-caused light, and light from park facilities. If respondents saw one of these items, they are asked to indicate to what extent seeing the item added to or detracted from their park experiences. Visitors will rate how much the item added or detracted on a scale from -4 to +4, where -4 is "detracted from a lot" and +4 is "added to a lot". If respondents did *not* see an item, they are asked to indicate to what extent *not* seeing the item added to or detracted from their park experiences. The same scale from -4 to +4 will be used.

Visitors will also indicate how much they agree or disagree with six statements about viewing the night sky, or stargazing, in general, in Acadia, and in national parks:

1. Viewing the night sky ("stargazing") is important to me.

2. One of the reasons I chose to visit Acadia is to view the night sky.
3. Acadia has a good reputation as a place to view the night sky.
4. The National Park Service should work to protect the ability of visitors to see the night sky.
5. The National Park Service should conduct more programs to encourage visitors to view the night sky.
6. I would visit Acadia less often if it became more difficult to see the night sky.

Respondents will rate how much they disagree or agree with the statements on a scale from -2 to +2, where -2 is "strongly disagree" and +2 is "strongly agree". These statements will measure the importance of darkness and the night sky to Acadia's visitors.

Night Recreation Visitor Survey Instrument (Recreation Survey)

The second survey instrument will be administered to visitors at Yosemite, Grand Canyon, and Acadia national parks, and at Golden Gate National Recreation Area. The survey was developed to collect information to help formulate indicators and standards of quality for nighttime visitor experiences, specifically camping, stargazing, and night hiking/walking. Additionally, the survey attempts to understand visitor attitudes toward night resources and recreation and associated management issues and actions.

Visitors will be intercepted at viewpoints, ranger programs, and in campgrounds. Visitors will be asked if they have experienced that park at night on this trip or on previous trips. Having spent time in the park at night prior to completing the survey

should give respondents better judgment as they answer questions related to nighttime recreation and resources they experienced in the park. This sample of respondents will not be limited to campers; it will also include visitors staying in lodging inside and outside of park boundaries. Similarly to the observation survey, one survey will be given to each personal group encountered for the group's "leader" to complete. We desire a sample of 1,200 respondents, or 300 from each park, after spending approximately two weeks sampling in each park.

Visitors will also be asked to rate the acceptability of various light sources used at campsites, such as campfires, flashlights, and lanterns. Acceptability will be rated using a scale from -4 (very unacceptable) to +4 (very acceptable). Responses may validate the use of visitor-caused light sources as indicators of quality.

Importance of darkness and the night sky to visitors and their experiences in national parks will further be measured by visitor responses to a series of statements that are introduced with the question, "How important are each of the following to your overall experience in this park?". These statements include:

1. Stargazing,
2. Seeing a "falling star" or meteor
3. Experiencing natural darkness (absence of human-caused light).

Reponses to these statements will be based on a scale ranging from 1 (extremely unimportant) to 9 (extremely important). Additionally, visitors will be asked to rate how much they agree or disagree with the statement, "Preserving a natural night environment

is as important as protecting other natural resources in this park." Responses to this statement will be based on a scale from 1 (strongly disagree) to 9 (strongly agree). Responses from all four parks will be compared to determine the importance of darkness and the night sky to park visitors, and whether or not the importance of these resources to visitors varies from park to park.

Finally, to measure visitor expectations for darkness and night sky conditions in these parks, visitors will be asked to indicate how much they agree or disagree with the following statements:

1. I expected it would be very dark at night in this park.
2. One reason for visiting this park was to experience a natural night environment.

Responses to these statements will be based on a scale from 1 (strongly disagree) to 9 (strongly agree), and will be compared across parks.

Data Analysis

Reponses to both surveys will be entered into an electronic database using a statistical analysis software program, SPSS. A percentage for the number of respondents that saw and item will be calculated for each item from the observation survey. Similarly, percentages will be calculated for those who did *not* see the items. Mean responses to the statements "how did seeing this item add to or detract from your park experience" and "now did *not* seeing this item add to or detract from your park experience" will be

calculated. Additionally, mean responses to the six statements about stargazing will be calculated.

Means will also be determined from responses to statements in the recreation survey. An analysis of variance (ANOVA) will be performed to determine if responses to these statements significantly differ from park to park.

Measuring Level of Agreement

We will determine if the mean responses from both surveys result from widely dispersed individual responses or responses clustered around the mean. This level of agreement, or crystallization, for responses will be determined using Van der Eijk's (2001) measure of agreement, *A*. The extent of crystallization of participant responses has traditionally been measured using the standard deviation, the coefficient of variation, and the interquartile range of a data set, but each of these methods has its problems; primarily, they fail to account for skewed distributions and varying response scales (e.g. 1 to 5, 1 to 9) (Van der Eijk, 2001; Krymkowski et al., 2009). Krymkowski et al. (2009) identified Van der Eijk's A as a measure that should be adopted in outdoor recreation studies because it has an upper bound (1, which equals complete agreement) and a lower bound (-1, which equals complete disagreement), allowing for intuitive interpretation of crystallization when survey questions have varying response scales. Responses are distributed evenly across all options on the scale when A = 0. The formula for Van der Eijk's A is:

$$A = U\left[1 - \frac{(S-1)}{(K-1)}\right]$$

where:

U is the degree of "unimodality" (distance between clusters of responses) in the distribution,

S is the number of responses that have nonzero frequencies, and

K is the number of possible responses.

Measuring the level of agreement is important when researching social norms. If there is high agreement in responses, there is more support that a broader social norm exists for a standard of quality for indicator variables. The research proposed here does not ask visitors about their standards of quality for indicators, but measuring the level agreement for responses to the two surveys still has management implications. For example, if high agreement is found for responses to a statement where the mean response strongly supports management actions to protect visibility of the night sky, managers will realize that this attitude is representative of the survey respondents, and possibly the visitor base more broadly.

Importance-Performance Analysis of Observation Survey Data

Observation survey responses will be analyzed using a variation of importance-performance analysis. Items from the observation survey instrument will each be plotted into one of the four quadrants of the action grid. The percentage of visitors that reported

seeing an item will be placed on the x-axis (instead of importance) and the extent to which the item was annoying or pleasing to the visitor will be placed on the y-axis (instead of performance), producing the modified grid in Figure 3.

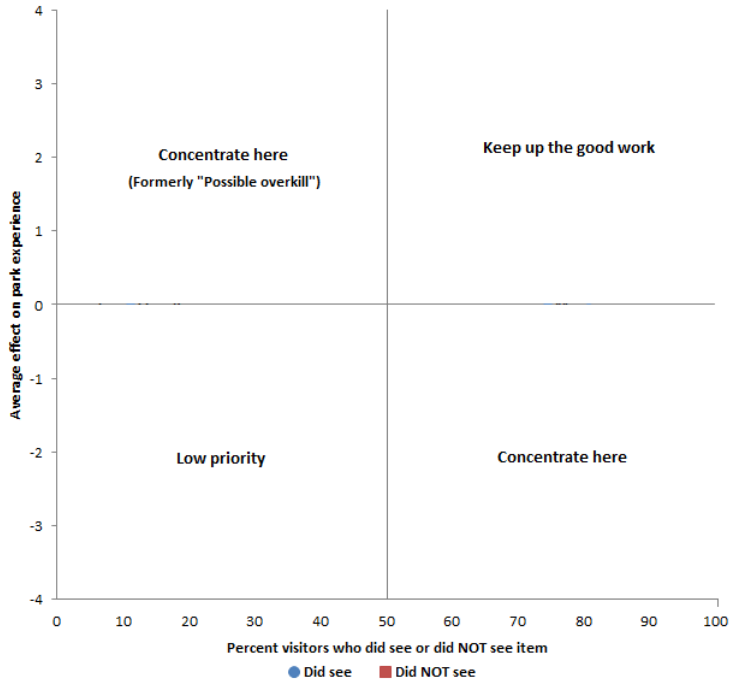

FIGURE 3 Modified importance-performance grid. Modifed from Pilcher et al. (2009).

The resulting grid offers easy interpretation of what parks managers should focus on to ensure visitor satisfaction. If many visitors notice an item that adds to their experiences, managers should "keep up the good work" and maintain opportunities to see that item. On the other hand, if few visitors notice an item that detracts from their experiences, managers should see this as less of a concern ("low priority").

Placing the response scale for average effect on experience on the y-axis causes two quadrants to switch from their original places, "concentrate here" and "possible overkill". We chose to re-label "possible overkill" as "concentrate here" and results in two areas of the grids where managers should "concentrate here". We changed the

labeling after realizing that if relatively few visitors noticed an object, but it added to their experiences when they did, managers should create more opportunities for visitors to observe it. Additionally, if many visitors notice an item that detracts from their experience, park managers should work to minimize the visibility of that item. The items that fall into "concentrate here" and "keep up the good work" quadrants will serve as indicators of quality for night sky viewing experiences.

Limitations

The sampling method described above has some limitations. First, the relatively short amount of time spent sampling in each park (approximately 2 weeks per park) limits our ability to generalize our findings to all visitors of these parks over the course of a year, let alone during the parks' peak seasons. Additionally, night sky viewing conditions are susceptible to varying weather and atmospheric phenomena as seasons change, causing the night sky to be visible more or less often and more or less clearly depending on the time of year.

Second, we anticipate encountering many groups and fewer individuals camping. Groups will be given a single survey for one group member to complete. It may be near impossible to ensure that participants complete the survey by themselves without family members or friends influencing or pooling their responses.

Third, as noted in Hollenhorst & Gardner (1994), we will not know what number or brightness of lights or level brightness of objects in the night sky is acceptable to visitors. The information gathered in this study, however, ideally will set the stage to further develop these indicators of quality for night sky viewing experiences.

602

603 **Timeline of Activities**

604

605 The methods described above are expected to be completed on the timeline in Table 2.

606

607 **TABLE 2** Timeline of activities

Activity	*To be completed*
Develop survey questionnaire	Spring/summer 2012
Submit to Institutional Review Board for approval	Summer 2012
Administer recreation survey in Yosemite	July 2012
Administer recreation survey in Grand Canyon	July 2012
Administer both surveys in Acadia	August 2012
Administer recreation survey in Golden Gate	August 2012
Input data electronically and analyze using IBM SPSS statistical software and Microsoft Excel	Winter 2012/2013

608

609 ## Anticipated Conclusions

610

611 The surveys used in this research are the first known to explore visitor attitudes of

612 darkness and the night sky and their effect on the visitor experience in national parks.

613 They are also the first to potentially identify indicators of quality for condition of the

614 night sky, a resource subject to light pollution from park facilities, nearby communities,

615 and distant cities. The results from these surveys will provide information to establish

616 standards of quality for these experiences and test for broader social norms for

617 experiencing darkness and night sky conditions. Findings from this research can also

618 support the implementation of common outdoor recreation management frameworks and

619 have the ability to guide park managers as they work within and beyond park boundaries

620 to minimize impacts to the night sky and other resources sensitive to darkness. Moreover,

they will provide justification that these resources are significant in national parks and deserve management attention.

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Appendix A

Acadia National Park Survey

We are conducting a short visitor survey that addresses observing Acadia National Park at night. You will be asked to answer some questions about things you see and hear tonight. Please answer these questions at the end of the evening (as you prepare to sleep) or tomorrow morning (shortly after you awake). Your answers will inform the National Park Service and others about visitor experiences in parks. This survey is voluntary and anonymous. It will take approximately 15-20 minutes to complete. We hope you find some of the questions interesting. As a token of our appreciation, each member of your group will receive a certificate for a free Ben & Jerry's ice cream cone when you return your completed questionnaire to the campground attendant.

This study is funded and conducted by

Researcher Use Only:

Survey ID # _____ **Time** _____ **Date** _____ **Survey Staff** _____ **Location** _____

Sky brightness:_____ **Ambient light:** _____ **Cloudy/ Partly Cloudy / Clear** **Full Moon / Partial Moon / No Moon**

What did you see and hear in Acadia National Park after dark?

Please think about the things you saw and heard in Acadia National Park after dark tonight (or last night if you are completing the questionnaire in the morning). Using the table below, please complete the questionnaire as follows:

1. Read the list of things in column 1 of the table **("Things you may or may not have seen or heard after dark")**.

2. In column 2 (**"Seen or heard"**), check the box for the things you saw or heard after dark.

3. In column 3 (**"How did seeing or hearing this add to or detract from the quality of your park experience?"**), circle one number to indicate how each thing you saw or heard affected the quality of your park experience. For example, if you saw the Moon and this added to the quality of your park experience, you would circle one of the positive numbers in column 3. (Circle one number for each thing you saw or heard.)

4. In column 4 (**"How much did <u>not</u> seeing or hearing this add or detract from the quality of your park experience?"**), please circle one number to indicate how each thing you <u>did not</u> see or hear affected the quality of your park experience. For example, if you did not see the Moon and this detracted from the quality of your park experience, you would circle one of the negative numbers in column 4. (Circle one number for each thing you did <u>not</u> see or hear.)

Did you do any of the following things tonight/last night in Acadia after dark?

1. Please check all of the following things you did tonight/last night in Acadia after dark. (Check each item that applies.)

   - ❑ Attended a ranger program
   - ❑ Walked around the campground
   - ❑ Walked somewhere in the park other than the campground
   - ❑ Stargazed
   - ❑ Visited another place in the park (e.g., Sand Beach, Cadillac Mountain)
   - ❑ Listened for wildlife or other sounds in the night
   - ❑ Other (Please specify: _____)

What do you think about recreation at night in Acadia National Park?

1. Please indicate the degree to which you agree or disagree with the following statements. (Circle one number for each statement.)

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Viewing the night sky ("stargazing") is important to me.	-2	-1	0	1	2
One of the reasons I chose to visit Acadia is to view the night sky.	-2	-1	0	1	2
Acadia has a good reputation as a place to view the night sky.	-2	-1	0	1	2
The National Park Service should work to protect the ability of visitors to see the night sky.	-2	-1	0	1	2
The National Park Service should conduct more programs to encourage visitors to view the night sky.	-2	-1	0	1	2
I would visit Acadia less often if it became more difficult to see the night sky.	-2	-1	0	1	2
Seeing/hearing wildlife after dark is important to me.	-2	-1	0	1	2
One of the reasons I chose to visit Acadia is to see/hear wildlife after dark.	-2	-1	0	1	2
Acadia has a good reputation as a place to see/hear wildlife after dark.	-2	-1	0	1	2

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I would visit Acadia less often if it became more difficult to see/hear wildlife after dark.	-2	-1	0	1	2
The National Park Service should work to protect the ability of visitors to see/hear wildlife after dark.	-2	-1	0	1	2
The National Park Service should conduct more programs to encourage visitors to see/hear wildlife after dark.	-2	-1	0	1	2

Please tell us some things about you.

1. Is this your first visit to this park? *(Check one.)*

   ❑ Yes
   ❑ No → Approximately how many times have you visited <u>in total</u>? _____

2. How many people are in your party, including you?

   Less than age 18: _____ Age 18+ :_____

3. Do you live in the United States? *(Check one.)*

   ❑ Yes. What is your U.S. zip code? _____

   ❑ No. What country, state, and town do you live in? _____

4. In what year were you born? _____

5. What is your gender? *(Check one.)*

   ❑ Male ❑ Female

6. What is your race/ethnicity? *(Check all that apply.)*

   ❑ American Indian or Alaska Native
   ❑ Asian
   ❑ Black or African American
   ❑ Hawaiian or Pacific Islander
   ❑ Hispanic or Latino/Latina
   ❑ White
   ❑ Other (please specify): _____

7. What is the highest level of formal education you have completed? *(Check one.)*

- ❑ Less than high school
- ❑ Some high school
- ❑ High school graduate
- ❑ Vocational/trade school certificate
- ❑ Some college
- ❑ Two-year college degree
- ❑ Four-year college degree
- ❑ Master's Degree
- ❑ Ph.D., M.D., J.D., or equivalent

Thank you for your help!
Please return your completed questionnaire at the entrance station to the campground to receive your gift.

If you have questions regarding this survey, please contact:
Jeffrey C. Hallo, PhD. ♦ (864)656-3237 ♦ jhallo@clemson.edu

1	2	3									4								
Things you may or may not have seen or heard after dark	**Seen/ Heard**	**How much did seeing or hearing this add to or detract from your park experience?**									**How much did <u>not</u> seeing or hearing this add to or detract from your park experience?**								
		Detracted from a lot				Neither				Added to a lot	Detracted from a lot				Neither				Added to a lot
Seeing the Moon	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Seeing stars and/or planets	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Seeing constellations	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Seeing the Milky Way	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Seeing meteors/shooting stars	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Seeing satellites	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Seeing automobile lights	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Hearing automobiles	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Hearing wildlife (specify:_____)	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Seeing wildlife (specify:_____)	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Seeing street lights	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Hearing emergency vehicles	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Seeing emergency vehicle lights	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Seeing campfires	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Hearing aircraft	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Seeing aircraft	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4

(Table continues onto the next page.)

1	2	3									4								
Things you may or may not have seen or heard after dark	**Seen/ Heard**	**How much did seeing or hearing this add to or detract from your park experience?**									**How much did not seeing or hearing this add to or detract from your park experience?**								
		Detracted from a lot				Neither				Added to a lot	Detracted from a lot				Neither				Added to a lot
Seeing flashlights	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Seeing lanterns	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Seeing park building lights	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Seeing light from nearby towns	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Seeing light from distant cities	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Hearing leaves rustling	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Hearing waterfalls, running water, or waves	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Hearing people talking	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Hearing people walking	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Seeing people walking	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Hearing power generators	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Seeing portable work lights	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Hearing wind	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Other (specify:_____)	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Other (specify:_____)	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4
Other (specify:_____)	☐	-4	-3	-2	-1	0	+1	+2	+3	+4	-4	-3	-2	-1	0	+1	+2	+3	+4