

ASSESSING & PROTECTING DARK NIGHT SKIES IN EL MORRO NATIONAL MONUMENT

by

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ABSTRACT

Light pollution is causing the disappearance of dark night skies around the world. In the United States alone, 1/3 of people are unable to see the Milky Way where they live (Ramlagan, 2016). National Park Service sites contain some of the darkest skies in the country. Here at El Morro National Monument, these dark skies are a beautiful and healthy benefit to people in the local community and visitors traveling from afar. El Morro's current park legislation does not include specific measures of protection for the night sky. This capstone project will create a baseline data set of night sky measurements, produce an interpretive program and webpage, implement stronger night sky protection and preservation standards into park management documents, and help El Morro become an International Dark Sky Park.

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INTRODUCTION

Problem Statement

As author Paul Bogard humorously said in his book, *The End of Night*, “At least when it comes to light pollution, what happens in Vegas does not stay in Vegas” (2014). Light pollution is causing the disappearance of dark night skies around the world. In the United States alone, 1/3 of people are unable to see the Milky Way where they live (Ramlagan, 2016). In 1990, 911 dispatchers received frantic calls about “strange clouds hovering overhead” during a Los Angeles power outage (Franknoi, 2008). These residents had never seen the Milky Way before and were concerned about these unusual, hazy clouds. For hundreds of thousands of years, humans have looked up at the night sky for navigational and spiritual purposes, to record time, and to understand the natural world. Humans across the globe are experiencing increased light pollution and are losing the benefits of natural darkness.

National Park Service (NPS) sites contain some of the darkest skies in the country. Here at El Morro National Monument (El Morro), these dark skies provide a beautiful and recreational benefit to people in the local community and visitors traveling from afar. A recent study titled “A laboratory study of the psychological impact of light pollution in national parks” was released in 2018 and tested the effects of night sky quality on visitors’ experience in a pristine outdoor setting. Viewing and experiencing a dark night sky was found to be important to visitor experience regardless of the location of the protected area. The study found that an increase in light pollution led to a decrease in visitor satisfaction which “suggests that the management of light pollution in these areas could become important for creating satisfying visitor experiences and preserving the beneficial outcomes associated with natural scenery generally or night specifically” (Benfield, et al., 2018). Because national parks are protected areas, dark night skies have a psychological impact on visitor experience and illustrate the need to recognize and preserve this valuable resource.

The NPS strives to protect this incredible natural resource in a variety of ways. The NPS Management Policies of 2006 state, “The Service will preserve, to the greatest extent possible, the natural lightscapes of parks, which are natural ... Recognizing the roles that light and dark periods and darkness play in natural resource processes and the evolution of species, the Service will protect natural darkness and other components of the natural lightscape in parks. To prevent the loss of dark conditions and of natural night skies, the Service will minimize light that emanates from park facilities, and also seek the cooperation of park visitors, neighbors, and local government agencies to prevent or minimize the intrusion of artificial light into the night scene of the ecosystems of parks...” (2006). The NPS policy includes verbiage on the protection of dark night skies, but night sky protection at the park level does not always follow such stringent protocols.

El Morro’s current legislation does not include specific measures of protection for the night sky, nor is protection included in the park’s significance statements. El Morro was not created as a national monument because of its incredible dark night skies; the park was preserved primarily for historic inscriptions carved into its sandstone walls. Although natural and cultural resources are protected within park boundaries, El Morro’s Foundation Document only lists *opportunities* for night sky protection. These opportunities – such as “Obtain dark skies preserve certification” or “Community interest in protecting monument resources as part of the state scenic byway and arts trail, including air quality, night skies, and viewsheds, to reduce impacts” – are suggestions, not a mandate (U.S. DOI, 2014). The language and fundamental resources listed in El Morro’s Foundation Document does not indicate dark night skies as a prioritized resource to protect.

Consistent with El Morro’s Foundation Document “opportunities,” this capstone project report involved completing the International Dark Sky Park (IDSP) application through the International Dark-Sky Association (IDA) to make El Morro an IDSP. The application is geared towards helping parks monitor

and protect dark night skies for this and future generations to enjoy. This involved taking night sky measurements, changing park priorities, and strengthening relationships in the local community. The need for educational and community outreach programs was an important requirement of the application. Becoming an IDSP allowed for more stringent night sky protection policies at the park level and required several educational programs to be hosted by the park each year. This application provided guidance for El Morro to protect its dark night skies and has the potential to influence surrounding communities and visitors to follow suit.

Audience

Involved parties included El Morro park staff and personnel from all divisions (Resources, Facilities, Interpretation, Administration, and Law Enforcement) as well as additional help from the NPS Natural Sounds and Night Skies division at the Intermountain Regional Office. The IDSP application was submitted to IDA for committee approval. In addition, park visitors and the regional community benefitted from the protection of night skies and educational events.

Background Information

On May 30, 2013, night sky data was collected at El Morro by the NPS Natural Sounds and Night Skies division. Utah State University then analyzed these data and compiled a Natural Resource Condition Assessment for the park. This report included a comparison of current conditions to what should be “natural” darkness in the park. This data projects a Zenith Sky Brightness (SQM) measurement of 21.51 magnitude per square arc second and a Bortle Scale classification of 3 for the park, which indicates a “good condition” of the night sky at El Morro (Valentine-Darby et al., 2016). This appears to be the only official night sky data that was collected, analyzed, and documented for El Morro. With these measurements, El Morro’s night sky is classified as a *rural sky*, placing El Morro in the *Silver Tier* of the IDSP application.

Currently, there is not a precedent to record night sky quality data for El Morro. Achieving IDSP status created a baseline of night sky measurements, and required yearly measurements to help the park delve deeper into changes in light pollution in the El Morro valley. By continuously updating the dataset, this project sets a precedent for maintaining accurate data collection in the future. Measurements can be taken during a similar time of year to ensure an accurate comparison. Current IDSP applications require at least biannual measurements, in order to account for seasonal variation, and their submission for the annual report by October 1.

Project Goals and Objectives

The project goal was to provide a night sky report to El Morro that can be used to protect natural darkness at this park. In addition, the project aimed to strengthen relationships with the local community in hopes of creating engaged and interested community members who strive to protect dark night skies.

The two primary objectives were completing El Morro’s IDSP application and creating interpretive night sky materials. The first objective involved gaining community support, collecting data, writing a report, and submitting an application to IDA to become an International Dark Sky Park. The second objective involved more of an educational component. This part of the project aimed to help the park host night sky events that involved cultural opportunities for visitors. In addition, this objective involved creating a template for future night sky educational opportunities. An educational night sky website that includes information, helpful links, and cultural aspects of El Morro’s night skies would also benefit the park and help to reach a broader audience. Visitors would have access to more knowledge, events, and information on an easy to navigate, engaging site. All portions of the educational component of this capstone project require the park’s prior approval and oversight to officially publish. Supervisory approval was granted to create these educational and interpretive materials and to complete El Morro’s IDSP application.

METHOD OF ANALYSIS AND DESCRIPTION OF STUDY SITE

The monument is located in western New Mexico, approximately 12 miles E of Ramah (population: 407), 33 miles E of Zuni (population: 6,367), 43 miles SW of Grants (population: 9,011), 55 miles SE of Gallup (population: 21,960) and 119 miles W of Albuquerque (population: 558,545). Road access to the monument is by New Mexico State Highway 53, which runs along the northern edge of the monument and connects El Morro to the northern edge of El Malpais National Monument.

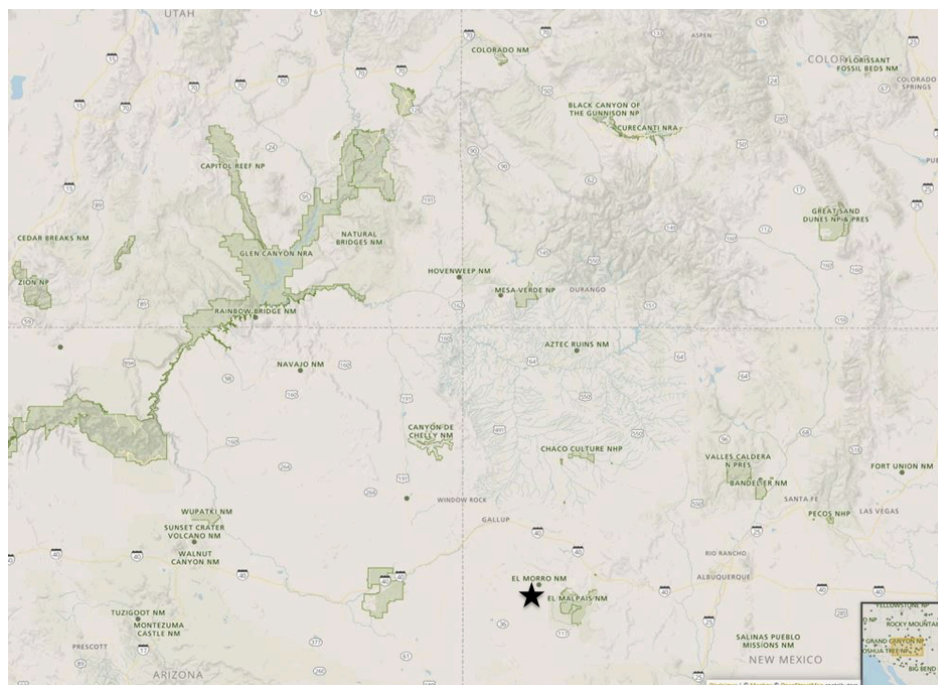


Figure 1: Map of NPS sites located in the 4 corners area illustrating El Morro (black star) in relation to the surrounding monuments. Map created on nps.gov/elmo/planyourvisit/maps.htm.

Data collection for this project consists of Zenith Sky Brightness measurements taken with a Unihedron Sky Quality Meter (SQM-L). As per the requirements of the IDSP application, 6 locations in the park were tested. El Morro is approximately 1,200 acres and is surrounded by private or Ramah Navajo land.

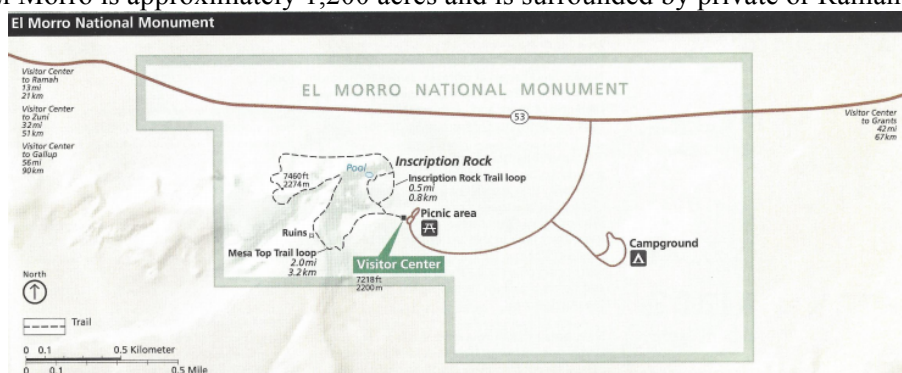


Figure 2: Map of El Morro National Monument.

As per requirements of the SQM-L, the light meter was pointed directly at the zenith and at least 6 measurements are taken (discard the first measurement) and recorded for each location, (IDA, 2018). A Clear Sky Chart is used to examine conditions such as cloud cover, transparency, seeing, and darkness.

This chart also helps to determine post-astronomical twilight, when the sun is more than 18 degrees below the horizon, and it is truly dark (NOAA, 2015). Typically, waiting about 2 hours after sunset and 1 hour before moonrise can eliminate natural sources of light pollution. However, the Clear Sky Chart is consulted before any measurement is taken to ensure entirely dark skies for astronomical observing and measuring. Ideally, data is collected on several nights to ensure accurate readings and account for daily variation. Data should also be collected in the winter and summer months in order to account for seasonal variation. These data are recorded and analyzed by park rangers trained in SQM-L use as part of the IDSP application. After the application has been written and submitted, the information and data uncovered through this process will be used to help create a stronger baseline data set available for the park.

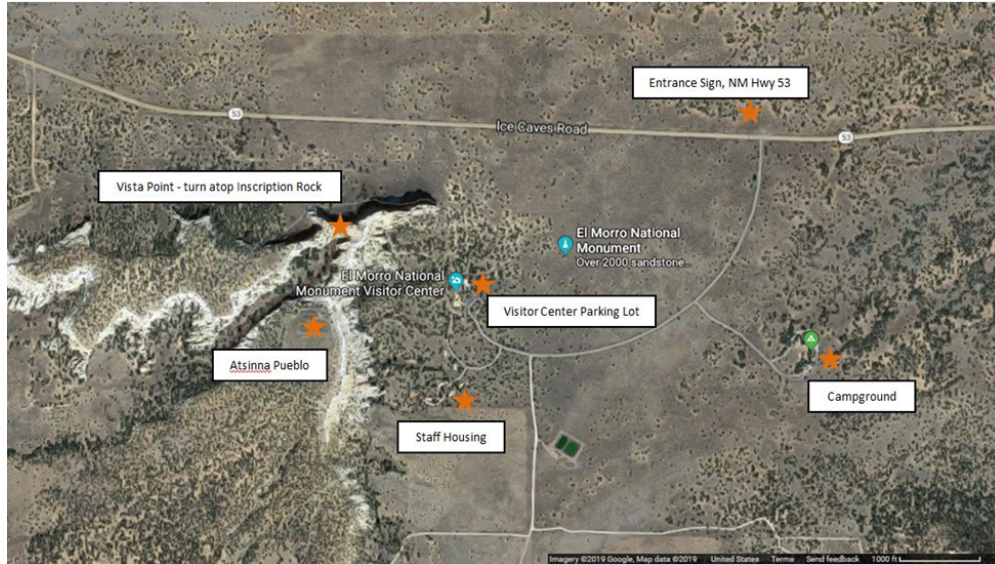


Figure 3: Google Maps satellite image of El Morro National Monument with night sky measurement locations indicated by orange stars.

The other source of data used in this analysis is from the NPS Dark Night Skies Team that was collected in 2013 from the Atsinna Pueblo atop El Morro (NPS Natural Resource Condition Assessment, 2013). Utah State University then analyzed these data and compiled a Natural Resource Condition Assessment for the park. This report included a comparison of current conditions to what should be “natural” darkness in the park (Valentine-Darby et al., 2016). Although these measurements were taken only on one night, it is the only night sky quality data available and will be used as a point of comparison to the measurements taken in this report. The NPS Natural Sounds and Night Skies Team conducted the baseline data collection in 2013 in one specific location in the park. A colleague and myself submitted night sky measurements from the winter of 2018 and summer of 2019 with the IDSP application.

The IDSP application also requires the creation of a Lighting Management Plan (LMP) for the park. This LMP involves creating an inventory of every outdoor light fixture in the park, including photos documentation, documenting locations, and ensuring each fixture and bulb is compliant with IDA nighttime lighting standards. This method involved photo documentation and communication with the State Historic Preservation Office in regards to historic structures.

FINDINGS OF ANALYSIS

El Morro's IDSP application, as IDA states, involves "a rigorous application process requiring applicants to demonstrate robust community support for dark sky protection and document designation-specific program requirements" (2019). The application entailed measuring and recording night sky quality data, community outreach, interpretive programs, allowing nighttime access for visitors, changing all light fixtures within park boundaries to be IDA compliant, creating internal management documents, and setting night sky protection as a management priority and preserved resource within the monument. Specific elements of this IDSP application and capstone are outlined below.

Night Sky Quantitative Data

To quantify the quality of natural darkness in the night sky, El Morro acquired an IDA approved Unihedron Sky Quality Meter (SQM-L) and began taking measurements on clear, moonless nights. Measurements were taken at the 6 sites recorded in Figure 4 (test sites mapped in Figure 5). Degradation of natural darkness at El Morro is due primarily to light domes caused by Grants, Gallup, and Zuni, which are not captured in the SQM-L measurements. These measurements have been in the 21.5-21.6 mag/arcsec² range, with some nights brighter or darker. These data points show that these measurements are relatively consistent around the park, with the exception of those taken atop Inscription Rock. It was atop the rock that the light domes on the horizon were most visible and impacted our measurements. These measurements were taken in winter conditions and summer conditions, but trained staff will continue to monitor conditions through all four seasons to collect baseline measurements. El Morro is committed to measuring night sky brightness every year as a monitoring tool for light pollution impacts on the park. With an average of 21.59 mag/arcsec² measured, El Morro is applying for the *Silver Tier* under the 2015 IDSP guidelines.

The average night sky measurement, collected in November 2018, was recorded as 21.46 mag/arcsec². The night sky data that was collected at El Morro by the NPS Natural Sounds and Night Skies division in 2013 projects a Zenith Sky Brightness (SQM) measurement of 21.51, which indicates a "good condition" of the night sky at El Morro (Valentine-Darby et al., 2016). Darker skies have higher values, and 0.05 mag/arcsec² is a fairly small difference. Further measurements should be collected to differentiate between a greater trend of increasing night sky brightness, or simply a nightly variation. Measurements taken on August 2019 suggest that the night sky is not getting brighter, as the measurements are darker than previously recorded. Figure 4 indicates the individual measurements taken around the same date and time period.

Location	Average SQM-L Measurement	Date & Time (MST)	Average SQM-L Measurement	Date & Time (MST)
Staff Housing	21.53	11-26-2018 20:30	21.76	8-12-2019 04:20
Visitor Center Parking Lot	21.56	11-26-2018 20:20	21.66	8-12-2019 04:30
Entrance Sign Hwy 53	21.59	11-26-2018 20:10	21.70	8-12-2019 04:45
Campground	21.62	11-26-2018 20:00	21.73	8-12-2019 04:40
Atsinna Pueblo	21.44	11-27-2018 20:00	21.76	8-12-2019 05:00
Curve in Headland Trail	21.20	11-27-2018 20:20	21.65	8-12-2019 05:08
Average of 6 readings:	21.46		21.71	Total average of 12 readings: 21.59

Figure 4: Recordings of measurements taken at El Morro in November 2018 and August 2019.

Interpretive Program & NPS webpage

Generating interpretive outreach materials for the public is an important component of the IDSP application. The IDSP application requires that 4 Educational & Interpretive Programs be presented every year. IDA requires that these night sky programs include dark skies as a central theme and “at least a portion of the event must include dark sky awareness or preservation specifically including reference to IDA and what it means to be an International Dark Sky Park” (IDA, 2018). Because El Morro is only open from 9am – 5pm (and 9am – 6pm in the summer), only visitors who are camping in the NPS campground have access to the starry skies in the monument. To address this concern, I scheduled 8 different events that relate to the night sky to provide visitors with after-hours access of the monument. All events discuss the importance of starry skies as a resource worth protecting for both humans and ecosystems. Most programs involve interpreting results of the IDSP application process and the night sky quality measurements. Although different rangers host different events, hosting at least 8 programs will create more opportunities for visitors to experience the monument in the evening. If you don’t get to experience the beauty of El Morro’s night skies, why would you care enough to protect them?



Figure 5. Flyer advertisements of 4 Star Parties and 4 Full Moon Hikes that El Morro hosted in the monument to provide nighttime public access in summer of 2019.

At El Morro, night sky programs involve a formal ranger presentation at the beginning of the event (30 – 45 minutes) followed by informal telescope viewing and learning about deep space objects. The program must be educational and scientifically based, however it must follow stringent NPS interpretive guidelines. An NPS interpretive program contains a central theme that all main points circle back to. Each main point will utilize at least 3 interpretive techniques to address unique learning styles and to connect with visitors on both an emotional and intellectual level. Audience participation is also a key component, especially to merge difficult scientific topics into emotional and personal connections. The main goal of an interpretive program is to facilitate visitors' connection to the night sky in their own meaningful and powerful way. Weaving together the standards of IDA and the NPS, the night sky program was educational, interpretive, and aimed to create stewards of the night sky.

I created a 45-minute interpretive program centered on the night sky and how it inspires humans. This interpretive program was created to allow for either an outdoor or indoor event, as many of our events get cancelled due to inclement weather. El Morro interpreters typically do not have access to PowerPoint slides, projector, or a screen, so this program can be done in any location. This program was written so that any interpreter, with or without astronomy experience, is able to present it. The theme of the program is: *The night sky has inspired humans to create art for centuries and these works of art can connect us to many aspects of the cosmos.* This theme can be adapted to the interpreter, and much more astronomical facts and information can be added if the interpreter feels comfortable. I also used some of these art examples in conjunction with a nighttime constellation tour for visitors. Essentially, there are several art expressions that tie into many interesting aspects of the cosmos. Depending on the time of year, this program can be adapted to different constellations, deep spaces objects, and visible planets. This program includes new interpretive techniques called ACE – Audience Centered Experiences that actively involve the audience and ask them to contribute to the program in meaningful ways. This program is a base structure that new interpreters can use in any way they see fit if they are uncomfortable creating their own program. The outline is a template that involves changing only the constellations and planets (with the seasons) while much of the content remains the same. This outline will serve as a building block for additional night sky programming. This program outline is attached in the Appendix section.

In addition to interpretive programs, El Morro's website aims to provide interpretive resources for the public, but lacks a section on the park's night sky resources. My colleague and I created a draft website that includes helpful links and information for those wanting to learn about the night sky at El Morro. This webpage draft content is currently in review at this time, but will be added as a new link to nps.gov/elmo when it completes its approval process. Although the park supports interpretive programming and night sky education through media, the application *requires* public outreach in order to achieve IDSP status. Having an online media source to promote local astronomy events and learn about El Morro's nighttime skies may reach more of a nation-wide audience. The draft of the writing and images for the night sky webpage is attached in the Appendix section.

Cultural Components of the Night Sky

After discussing traditional knowledge and indigenous stories with staff in the Cultural Resources division, I realized that with regards to the night sky, it is not appropriate for me to share Native American stories from other cultures. Instead, I helped coordinate a Cultural Constellations series to provide a platform for Native speakers in the community to share their perspective of the cosmos. I reached out to a local medicine man and storyteller in the Navajo community and planned a cultural constellation event in December of 2018. This type of event was unique to El Morro, and it drew around 80 people throughout New Mexico and Arizona. This event was an incredibly educational experience, and visitors learned about the Diné (Navajo) interpretation of the night sky and constellations. I provided the introduction, conclusion, constellation tour, and telescope viewing before and after the stories. In May of 2019, a Zuni tour guide from the Zuni Pueblo Department of Tourism presented a cultural story aligned with the cosmology of the A:shiwi (Zuni) world. These cultural events are particularly important because El Morro is an important site for Native groups in the region. El Morro strives to foster these connections and incorporate cultural components into night sky programming. In the future, El Morro plans to continue reaching out to neighboring tribes to provide a platform for multiple perspectives of the night sky. There are several more cultural groups that are interested in participating in such events in the future. The monument and staff hope to continue this Cultural Constellations series in the winter of 2019-2020 due to the positive feedback and results.

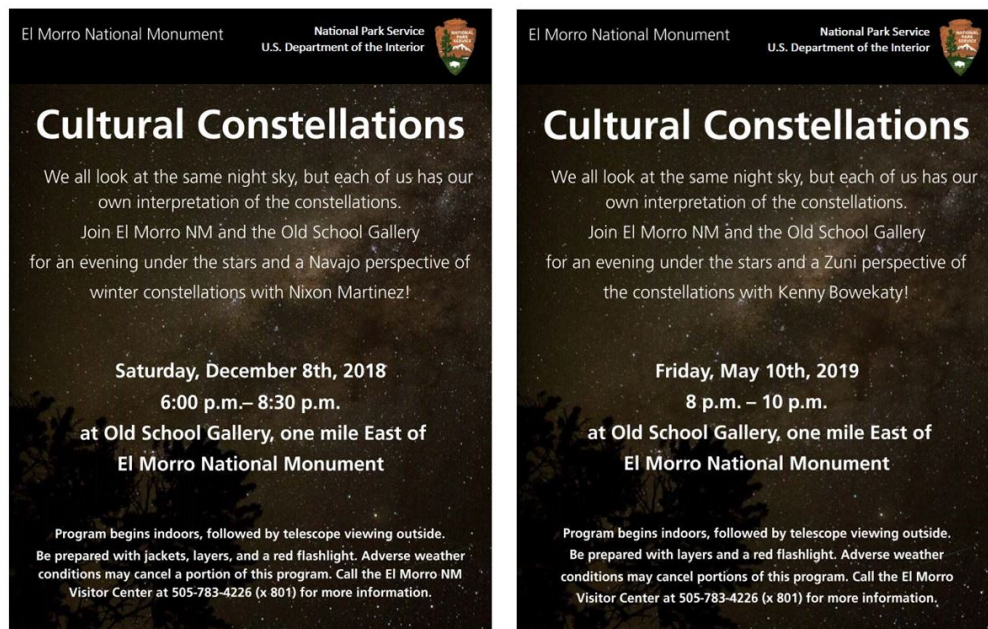


Figure 6. Flyer advertisements of the Cultural Constellation events the monument co-hosted.

El Morro partnered with the El Morro Area Arts Council (EMAAC), a non-profit group located 1 mile outside the park's boundary, to co-host these cultural events. Because indoor facilities at El Morro are limited, this organization allowed El Morro to use their facility to provide a large, warm space to hear cultural stories of the night sky. El Morro also partnered with Western National Parks Association (WNPA) when seeking funding and additional support for these events.

Community Outreach

While El Morro has monitored night sky conditions within park boundaries, light pollution extends miles away from its source. Because of this, it is essential to involve the surrounding community in the park's night sky restoration efforts. The EMAAC and WNPA partnerships have allowed El Morro to connect with many groups in the community, and these partnerships have been the fulcrum of these connections. For example, EMAAC helped El Morro connect with the volunteer fire department, El Morro Ranches Subdivision, and the owner of C&E Concrete, Inc. These connections led to El Morro staff meeting with these groups and planning night sky restoration efforts with organizations in the community. Although restoration and preservation work is an on-going process, this partnership has allowed the monument to forge relationships with community organizations so we can all work towards dark sky restoration.

The connections fostered by EMAAC and WNPA paved the way for concrete actions to be taken toward night sky restoration. El Morro reached out to the Property Owners Association of El Morro Ranches housing community. Their board is currently reviewing El Morro's outdoor lighting ordinance, presented to them by park staff on July 20th, 2019, to decide if this plan will be implemented in their community. In addition, the El Morro Valley Fire District #21 and the monument are working together to find fully shielded light fixtures for their fire station. Installation of new fixtures at the station will be completed by fall 2019. The C&E Concrete, Inc. also agreed to meet with El Morro at their neighboring gravel pit for an inventory of their outdoor light fixtures and nighttime operations on July 26th, 2019. This is one of the largest sources of light in the valley, and Walter Meech Jr., President of C&E Concrete discussed night sky friendly lighting with rangers from El Morro while touring the facilities. Mr. Meech has replaced many of the permanent nighttime lights with partially shielded fixtures simply because they work better and are more efficient. The gravel pit typically does not work at night unless work cannot be completed during the day. However, many lights must remain on throughout the night. There are a few other structures that do not have shielded fixtures and Mr. Meech has agreed to consider purchasing night sky friendly fixtures when finances permit.

In addition to the communities mentioned above, El Morro reached out the Ramah Navajo Chapter house and presented at a planning meeting. The Chapter President was in full support of this project as indicated by a letter of support. The monument hopes to provide a similar presentation at Acoma and Zuni tribal meetings. El Morro strives to provide a platform for people to share their own cultural astronomy. The park recognizes the importance of creating interpretive programs and projects that include a diverse audience and are representative of the communities that surround the monument.

Grassroots movements and community participation start with relationship building. El Morro has begun to establish working relationships with community organizations that surround the monument in order to engage these groups in dark sky restoration. El Morro hopes to continue outreach and education about nighttime lighting in the community and is currently seeking grants to cover the financial costs associated with changing outdoor fixtures.

Policy & Administration

The IDSP application led to the creation of one major policy within the park—a Lighting Management Plan (LMP). In addition, two previous park policies, the Long Range Interpretive Plan and ELMAO's Five-Year Strategic Plan, were rewritten in order to include night sky protection. The creation of the LMP

and adaptations of these policies allowed El Morro to include a new goal centered on dark sky protection, preservation, and interpretation.

Creating a Lighting Management Plan for El Morro is a required aspect of the IDSP application. This plan has the park set its own regulations and rules centralized around the core idea of reducing light pollution by replacing outdoor fixtures with night sky friendly ones. Some of the basic standards set for El Morro was color temperature less than 3,000 Kelvins, lower the lumens, and to ensure that all fixtures are fully shielded. The plan also included considerations of historic structures and Mission 66-era buildings, which can retain unshielded fixtures with a lower lumen bulb. In addition to setting a precedent for light fixtures, the LMP included a voluntary curfew in employee housing to turn off outside lights at 10pm and close blinds to prevent indoor light from escaping outside. Although this curfew is not legally enforceable, it was implemented to change the lighting culture in housing and to get staff to think about reducing light pollution. The LMP is location on page 31 of the IDSP application.

The Long Range Interpretive Plan was initially created in 2017 to outline the goals and objections of the Interpretation Division at El Morro. The LRIP was specifically modified in accordance with this IDSP application to include language about protecting, preserving, and interpreting dark night skies. The modification includes a central goal and list of actions to accomplish this new interpretive plan. Modifications to the LRIP are listed below:

<i>Goal:</i> Actively lead dark sky interpretation and stewardship (in partnership with and for the general public, students, and surrounding communities).
<i>Actions:</i>
<ul style="list-style-type: none"> • Attain International Dark-Sky Association (IDA) certification to become an International Dark-Sky Park (IDSP).
<ul style="list-style-type: none"> • Upon obtaining IDSP status, create a wayside panel that highlights how the park preserves and protects night skies and what it means to be an IDSP.
<ul style="list-style-type: none"> • Create a website page that provides information about cultural and scientific night sky resources, how the park is protecting and preserving natural darkness, showcase astronomical events, and promote local night sky events.
<ul style="list-style-type: none"> • Provide on-site education and outreach about night skies to schools and community groups.
<ul style="list-style-type: none"> • Host (or co-host) cultural astronomy events to help the park improve its connections with local tribes.
<ul style="list-style-type: none"> • Partner with groups such as Western National Parks Association (WNPA) or El Morro Area Arts Council (EMAAC) to co-host night sky events for visitors and the local community.
<ul style="list-style-type: none"> • Host at least 4 night sky events each year at El Morro NM to provide opportunities for public nighttime access and educational opportunities.
<ul style="list-style-type: none"> • Monitor night sky locations (twice a year) with Sky Quality Meter (SQM) darkness reader for the IDSP yearly report.
<ul style="list-style-type: none"> • Become a leader in decreasing light pollution at El Morro NM and in the surrounding communities.
<ul style="list-style-type: none"> • Develop a telescope training program for new interpretive staff.
<ul style="list-style-type: none"> • Connect with other NPS sites for additional resources and become part of the larger night sky ranger network.
<ul style="list-style-type: none"> • Create an infrastructure of resources that includes program outlines, SOPs, contact lists, and seasonal astronomical object lists that can be used to help Interpretation rangers plan and present night sky events.

Although management team supported this dark sky initiative from the beginning, it was not officially outlined in El Morro's management documents. To address this, both El Morro and El Malpais added aspects of night sky protection and preservation into their Five-Year Strategic Plans. In the *Our Vision* section of the Five Year Strategic Plan, it was stated, "Stewardship: We preserve and protect ecosystems composed of biological, cultural, and physical resources for posterity, research, education, and enjoyment. We protect **night skies**, natural quiet, and expansive vistas." It was also added to the *Learning About and Protecting Resources* section, "IDSP (**night sky**) Certification completion for El Morro and application submitted for ELMA" (Leap, 2019). This step confirms the park's dedication and commitment to becoming an IDSP and to preserving the precious night sky as an important resource.

CONCLUSION

The IDSP application is based on an administrative application. However, IDSP included all the core aspects of managing a natural resource. El Morro must find sustainable solutions to address the human dimensions, economics, administrative, ecologic, and policy side of night sky preservation to really tackle the issue from all angles. Currently, the night skies at El Morro appear to be just as dark as they were 5 years ago. This means that El Morro, and the valley it is located in, remains fairly dark. Prior to this project, the measurements taken 5 years ago were the only official night sky data collected, analyzed, and documented for the monument. This project expanded on this singular dataset, and found similar results. Both datasets indicate that El Morro's night sky is classified as a *rural sky*, placing El Morro in the *Silver Tier* of the IDSP application. El Morro submitted its IDSP application and is awaiting a response from IDA. Although the night skies at El Morro are not pristine, they are still very dark and are some of the last remaining dark skies in the country with an average SQM measurement of 21.59 mag/arcsec². These recordings indicate that the monument must focus not on restoration, but on maintenance of the quality of dark night skies that currently exist in the monument and in the El Morro valley today.

Addressing the human component of light pollution is to remind the surrounding community how dark the nighttime sky in the El Morro valley truly is—then provide ways that we can all work together to keep it that way. Community groups were very interested in supporting this initiative and El Morro received more than 10 letters of support for the IDSP application. Since the monument is located in an extremely rural area, El Morro attempted to contact a diversity of groups surrounding the monument including Ramah Navajo Chapter, LGBTQ+ sanctuary, local businesses, and the EMAAC to increase outreach and to attract a variety of community members that live under El Morro valley's starry skies. The application involved working with multiple divisions and all sectors in the NPS, including outside agencies and organizations. The administration and policy side of this project allowed El Morro to implement a Lighting Management Plan to keep outdoor lighting in the monument, both at the visitor center and in employee housing, night sky friendly and reduce the park's light pollution. This will allow the monument to be a leader in dark sky preservation and restoration efforts.

The IDSP application addressed the economics of saving money by changing lights, implementing policy through administrative measures, taking care of the natural ecosystems through restoration efforts, and involving the local community and Native groups every step of the way. This process creates a holistic solution to address the night skies that have been getting brighter and brighter in this country. It is through science and data collection, community outreach and education, and policy that this monument has begun to truly protect, preserve, and promote its dark night skies.

FUTURE RECOMMENDATIONS

By the end of 2019, El Morro should achieve IDA status as an International Dark Sky Park. I recommend the creation of a wayside panel (once status has been achieved) to install a permanent display about light pollution, the importance of dark night skies, and night sky friendly light fixtures. These should be placed along the entrance road at the second pullout because that area is open 24/7 to the public and could be viewed at night as well.

Considering the strong support of the local community, it would be an excellent idea to look into potential grants or funding sources for light fixture replacements. Financial concerns are a barrier to purchasing and installing night sky friendly lighting. Furthermore, the monument is focused on building support from the ground up, and this begins with strengthening relationships in the community. El Morro seeks to educate and spread awareness, opening the door to night sky preservation but not enforcing it. This portion of the project delves into the economic factors that contribute to outdoor lighting choices. These groups may be asked to change or modify outdoor light fixtures to create darker skies surrounding El Morro. These modifications involve financial factors such as longevity of light bulbs and cost-effectiveness. El Morro should strive to research grants to cover the financial repercussions of night sky friendly lighting to have a solution to the situation, instead of just a suggested change.

Another way to further reach out to the communities that surround the monument is to collaborate with local schools to bring kids out to El Morro to stargaze. There is also the opportunity to provide scientific information in conjunction with traditional knowledge. Perhaps the monument could provide the telescope and astronomy lesson in conjunction with a Native presenter appropriate for the school demographics. I researched a similar program that is hosted through Lowell Observatory that weaves together science and traditional knowledge for students. The Lowell website states, “The goals of our program are twofold: 1) To use astronomy to help teachers get Native American children excited about astronomy and science in general, encouraging an interest in STEM careers. 2) To help teachers of Native American students learn about astronomy and astronomy activities that they can incorporate in their classrooms” (Dr. Hunter, 2019). Representatives from this program spoke at the Society for Cultural Astronomy in the American Southwest conference I attended in April 2019. The speakers advocated that combining Native and traditionally cultural knowledge with Western science greatly improved students learning. Considering El Morro’s location to 3 neighboring tribes and reservation schools, there is a big opportunity to provide cultural and astronomical programs for students.

With regards to measuring and recording night sky quality, I recommend that El Morro implement a bi-yearly plan to collect more data. On average, El Morro had an SQM-L value of 21.59, which is very similar to the RSS report value of 21.51 in 2013. While we expanded this dataset throughout this past year, a better set of baseline data needs to be measured for El Morro. As it stands, there are 2 nights of measurements in winter 2018 and summer 2019 as well as one measurement (at one location) in 2013. It is recommended that all permanent staff at El Morro be trained to use the SQM meter and measure at these 6 locations in the monument at least twice a year (preferably in different seasons). It might be useful to monitor different sites in the area to keep measurements of light pollution. For example, the nearby towns of Ramah and Pine Hill, and the C&E Gravel Pit could be measured for brightness. This may give a better baseline for areas that are the brightest in the valley. Then, if these groups start replacing their light fixtures, there will be a point of comparison to what the brightness was before.

Measuring night sky quality is a helpful tool to examine the changes in night sky quality. However, it is important to continue to study and research the effects of light pollution on the ecosystem at-large. Much of the interpretation of light pollution revolves around the human perspective and view of the nighttime sky. But, this doesn’t incorporate the ecological impacts of light pollution on the environment. In 2004,

the article “Ecological Light Pollution” was released as a discussion of the varied effects of light pollution on ecosystems. The article makes the distinction between “astronomical light pollution” and “ecological light pollution.” Light pollution changes how many constellations we see in the nighttime sky and our overall psychological experience at night. However, ecological light pollution involves the ecological effects that alter species interactions with each other and their environment. For example, Figure 7 illustrates how a fully shielded outdoor light fixture keeps the night skies dark for human viewing. But, this fixture can still be potentially detrimental to wildlife. The article argues that the “more subtle influences of artificial night lighting on the behavior and community ecology of species are less well recognized, and constitute a new focus for research in ecology and a pressing conservation challenge” (Longcore & Rich, 2004). As personnel and resources permit, I would make the suggestion that the Resources & Stewardship Sciences division research and study these subtle influences in species at El Morro that may be affected by light pollution. Further research into the effects of light pollution on the organisms in and around El Morro will help to uncover a bigger picture of this environmental impact.

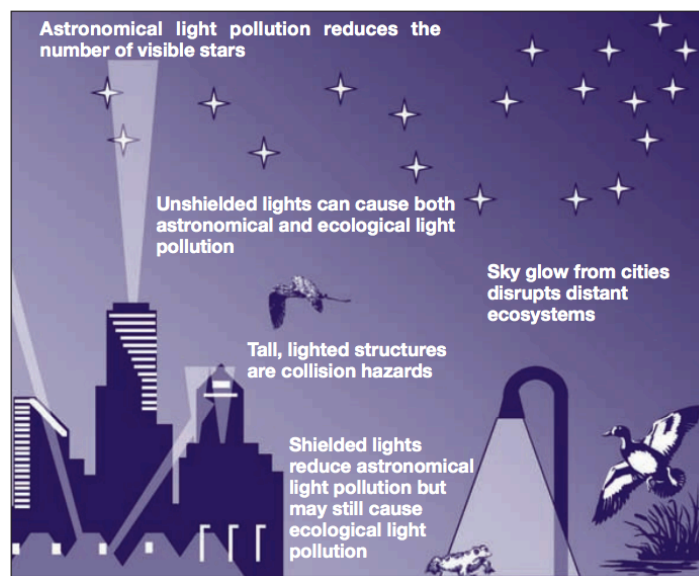


Figure 7. Diagram of ecological and astronomical light pollution (Longcore & Rich, 2004).

Once El Morro receives IDSP status, the monument should plan and coordinate a designation celebration to notify the public and to publically and formally thank all community members and organizations that helped support this initiative. This project was about creating ongoing partnerships with community and neighbors and to continue to foster those relationships for years to come.

Lastly, I would recommend that El Malpais National Monument complete the IDSP application process. The two monuments are managed together and are geographically very close to one another. With both parks gaining status, a larger network (and land area) may provide for further protection and weight in the community. Ideally, one permanent ranger position would be added to El Morro and El Malpais National Monuments to tackle the educational standards, community relationships, and coordinate night sky programming. While many rangers are capable of hosting night sky events and programs at the park, attendance still only amounts to a few hundred people every year. School groups, public events, town hall meetings, and attendance at community events will help spread awareness and help the community see El Morro as a leader in dark night sky restoration.

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SPECIAL THANKS

Special thanks to Ana Mercedes Colón Umpierre for co-writing the IDSP application and for all her help, assistance, and editing with this report—I would not have been able to accomplish this project without her. Thanks to the staff at El Morro National Monument for their help in completing the IDSP application and to my Interpretation supervisors for allowing me to weave my graduate capstone project into my work at El Morro. Thanks to my USU committee members Melanie Conrad, Mark Brunson, and Mark Larese-Casanova who helped me along in this process. Read the “Special Thanks” section in the IDSP application for a list of names of those directly involved in the IDSP application process.

APPENDICES

Night Sky Interpretive Program Outline
El Morro NPS Night Sky Website (Draft)
IDSP application for El Morro

ELMO Interpretive Program Outline	
Interpreter: Leslie Kobinsky	Program Location: Visitor Center Lower Parking Lot
Program Type: Night Sky Program	Date of Outline: 6/18/2019
Program Title: Evening Under the Stars	
Primary Tangible Resource(s): Night sky, constellations, deep space objects, natural darkness	
<p>Program Goal: To inspire visitors to form a deeper connection to the natural beauty of the cosmos through art. This inspiration is intended to inspire action, hopefully leading to preservation and restoration of natural darkness.</p> <p>Objectives:</p> <ul style="list-style-type: none"> ~Audience members will find a connection, whether cultural, historical, or scientific to the night sky as demonstrated by asking a question for deeper meaning. ~25% of brochures left on the table will be taken by audience members. ~75% of the audience will participate in an activity by sharing their thoughts and feelings. 	
<p>Intangible Meanings (underline Universal Concepts):</p> <p><u>Beauty</u>, creation, <u>enjoyment</u>, experience, <u>imagination</u></p>	
<p>Knowledge of the Audience:</p> <p>Typically adults, either community members or travelers, with some children in the audience.</p>	
<p>Program Theme:</p> <p>The night sky has inspired humans to create art for centuries and these works of art can connect us to many aspects of the cosmos.</p>	
<p>Pre-Program Notes: It will be dusk transitioning into total darkness throughout the program. I need to make sure to account availability of light into the program and will conduct the visual aspect of the program in the very beginning.</p>	
<p>I. Introduction</p> <p>My name is Leslie and on behalf of the National Park Service, I would like to welcome you tonight and I'm so excited to share El Morro's starry skies with you. I've worked for the NPS for 5 years and one of my favorite parts about this job is the places it takes me to, and the dark skies I live under. I am not an astronomer or scientist, but I am just as inspired by these diamond and velvet skies and I love seeing what this inspiration has created.</p> <p>For centuries, examining the night sky has led to creations of invaluable work. Paintings, books, movies, music, poetry, all forms using the universal language of art. And so tonight, I want to explore some of those artistic expressions, examine the creations of what a beautiful night sky can produce, and use our imagination to enjoy and experience the cosmos in a new way. Viewing the night sky through the lens of art may be a little unusual, so I ask you all to approach this with an open mind. <u>I'm also going to ask people to share a lot</u>, so be ready for questions and to get the gears in your mind turning. Remember, there is no right or wrong answer to the questions I'll be asking to night; they're to help us all to start thinking and hopefully connect to the starry sky in a unique way.</p>	

I. Introduction

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For centuries, examining the night sky has led to creations of invaluable work. Paintings, books, movies, music, poetry, all forms using the universal language of art. And so tonight, I want to explore some of those artistic expressions, examine the creations of what a beautiful night sky can produce, and use our imagination to enjoy and experience the cosmos in a new way. Viewing the night sky through the lens of art may be a little unusual, so I ask you all to approach this with an open mind. I'm also going to ask people to share a lot, so be ready for questions and to get the gears in your mind turning. Remember, there is no right or wrong answer to the questions I'll be asking to night; they're to help us all to start thinking and hopefully connect to the starry sky in a unique way.

The night sky has inspired humans to create art for centuries and these works of art can connect us to many aspects of the cosmos.

While we still have a little light, I want to take a moment to examine these 5 works of art. I'm going to lay them out at different locations and I would like you to stand by the image that inspires you the most. *Talk about images before or after visitors have a chance to share?*

- 1) Starry Night – Vincent Van Gogh
- 2) Starlight Night - Georgia O'Keeffe
- 3) Milky Way Photograph of Chaco Culture – Li-Wei Hung
- 4) El Morro Poster – Tyler Nordgren
- 5) Night Stories – R.C. Gorman

As you're standing there, think about why you chose the image that you're standing at. What about it inspires you? Why were you drawn to this image? What thoughts or emotions does it evoke? And ask you're thinking about these questions, I would like to open this up as a space to share your thoughts and ideas. *Perhaps share with others who chose that image first, then share with the group?*

Transition

Paintings, photographs, and sketches may be visual representations of the cosmos; some are also inspired to *write* about the starry sky above whether it's short stories, books, or poetry.

A. Poetry

"Einstein's space is no closer to reality than Van Gogh's sky. The glory of science is not in a truth more absolute than the truth of Bach or Tolstoy, but in the act of creation itself." Arthur Koestler, *The Act of Creation*, 1964 *It is a study of the processes of discovery, invention, imagination and creativity in humour, science, and the arts.*

As I read these poems aloud, think about what they might mean to you personally. Do you connect with them in any way?

Arcturus in Autumn by Sara Teasdale

"Bringer of spring" "Lord of the summer nights"

"You will not share our lengthening night" Is this merely about Arcturus, or is this a metaphor?

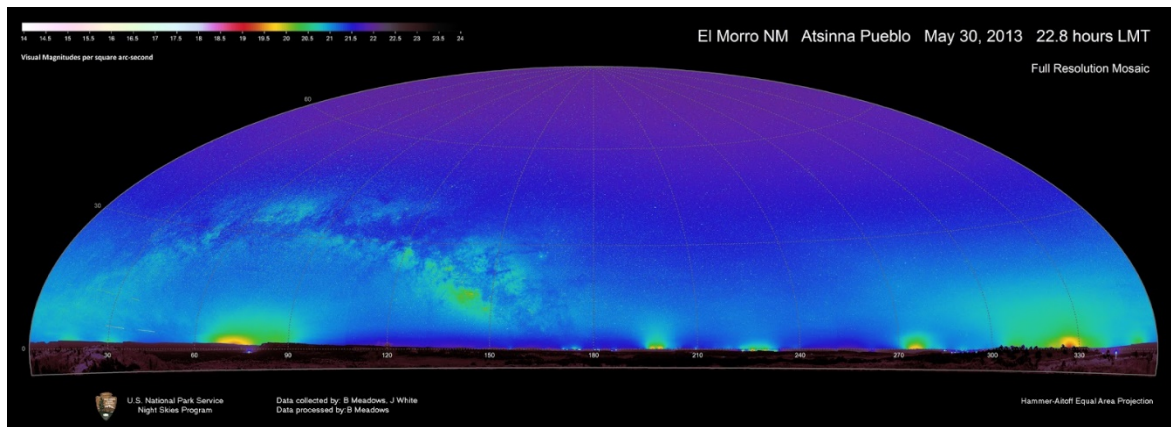
Arcturus – Orange, giant K star. Categorized K in the Hertzsprung–Russell diagram. Look for brightness and temperature (used to correlate age and understand stellar evolution). Our star is a

<p>Transition</p> <p>As we continue to learn more about space through writing, we characterize aspects of this world as well. Artists have created and composed works of music to add personality to the galactic world.</p>
<p>B. Music</p> <p>There were a few songs that came to mind when I first considered the influence of the night sky on music...but don't worry, I'm not going to play Twinkle, Twinkle Little Star on a loop. Instead, I'm taking us back to 1914 to a symphony title <i>The Planets</i>, composed by Gustav Holst. The piece is about an hour long, so I will just play a few clips from it. I chose this because there are no words, because I want you to take a moment, looks up at that starry sky and watch it with a musical background.</p> <p><u><i>The Planets</i> by Gustav Holst written in 1914-1916</u></p> <p>Tried to define the planet's astrological character with music. For the first piece, I will tell you what planet it represents and some scientific information about that specific planet.</p> <p>Jupiter (Zeus in Greek, Leader of the Gods)</p> <p>Most massive planet in the solar system. 11 earths fit across the radius of this planet. 79 moons, but in 1610 the 4 largest "Galilean" moons will be visible in the telescope. Observation and interpretation, then sketching of these objects allowed Galileo to recognize that these were moons.</p> <p>Jaunty tune, happy and inspirational, expansiveness, all encompassing</p> <p>"Bringer of Jollity"</p> <p>2:40 – 4:40</p> <p>Do you think it matches your perception of the planet? Does it match science? Is it ok that the composer had a different interpretation of the characters of these planets than past societies? Than science?</p> <p>For the second piece, I will begin by playing it and I want <u>you</u> to assign it a planet and meanings.</p> <p>Saturn (Cronus In Greek, God of Agriculture)</p> <p>2nd largest planet in our solar system known for its rings made of dust, ice and rock that got caught in its gravitational pull. All gas giants in our solar system have rings as well: Jupiter, Neptune, and Uranus have rings but you can't see these faint rings.</p> <p>"The Bringer of Old Age" - Slow pace, go in and out of soft and loud, is time represented by the drums</p> <p>2:30-3:25</p>
<p>Transition</p> <p>We just examined, read, and heard several examples of artists being so inspired by the night sky they expressed themselves in beautiful, meaningful, and lasting ways. But, what if these artists never had that precious black velvet and diamond sky to gaze upon?</p>
<p>C. IDA & Night Sky Preservation</p> <p>IDA website: "Van Gogh painted his famous "Starry Night" in Saint Rémy, France, in 1889. Now, the Milky Way can no longer be seen from there. If he were alive today, would he still be inspired to paint "Starry Night"?" Francis Bacon wrote "In order for the light to shine so brightly the darkness must be present."</p> <p>El Morro = trying to become a Dark Sky Park</p> <p>Night sky restoration: less lights, lower wattage, warmer colors, and most importantly shielding fixtures. Modify existing fixtures. Connect with surrounding groups to reduce light pollution, and to merely keep this valley as dark as it is now. We've set out some flyers by the restrooms if you'd like to take home more information.</p> <p>80% of the Americans cannot see the Milky Way from where they live and the National Park Service is committed to preserving as many of those places as it can so that future generations of children can lie out on blankets, continue to see the starry sky.</p>

<p>Transition</p> <p>Some are inspired by the night sky to create paintings, learn facts, and compose music. Some are inspired to act, to make a change.</p>
<p>III. Conclusion</p> <p>What would this world be without darkness? Would it have inspired such incredible works of art? Would we have been able to visualize such wonders, to have the imagination to continue to question, explore, and theorize about what's beyond our atmosphere?</p> <p>You don't have to know the constellations. You don't have to know the science. You also don't have to like art. You just have to find some sort of inspiration; to care enough to look up.</p> <p>Next time you look up at the night sky think about how your experience might be different if it was darker: if the Milky Way was so bright and close you could almost touch it. Imagine the there wasn't much darkness, if it was lighter: what if you couldn't see the Milky Way and only a few stars gave off a dull hue. How might art, literature, music, stories, and traditions change if there wasn't that dark sky glittering back at you... The night sky has inspired humans to create art for centuries – I wonder if we will have such creations when we lose this precious resource?</p> <p>I encourage you to continue looking up and remember what a special resource this dark sky truly is. Who knows what it will inspire you to do next ☺</p>
<p>Props/Materials:</p> <p>Images of paintings</p> <p>iPhone and speaker for music</p> <p>Headlamp to read poems</p> <p>Green laser pointer (if I point out the constellations)</p>
<p>Primary References:</p> <p>Star Party SOP</p> <p>NASA.gov</p> <p>Earthsky.org</p>

Night Skies at El Morro

As night falls at El Morro National Monument, visitors experience a beautiful darkness, allowing for incredible views of the nighttime sky. The high elevation, clean air, remote location, and minimal development in and around El Morro combine to produce excellent night sky conditions. Experience the sky filled with natural light from thousands of stars as the Milky Way fills the sky from horizon to horizon! Pictured here is the skyglow of light pollution that surrounds El Morro National Monument. There is some light emerging from nearby cities of Grants, NM and Gallup, NM but the sky remains relatively dark due to its proximity to these cities.



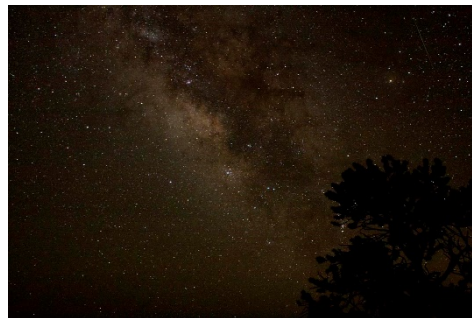
Skyglow surrounding El Morro National Monument. Credit: NPS Natural Sounds and Night Skies Division

Although the trails are only open during business hours, the entrance road, scenic pullouts, and campground are open 24/7. Campers are able to experience the incredible night skies from their site, which is one of the darker areas of the monument as there are no direct sources of light within the vicinity.

[IDSP Status](#)



[Night Sky Events](#)



[Learn More](#)



IDSP Status

El Morro is currently seeking International Dark-Sky Park (IDSP) status. An IDSP is “a land possessing an exceptional or distinguished quality of starry nights and a nocturnal environment that is specifically protected for its scientific, natural, educational, cultural heritage, and/or public enjoyment” ([International Dark Sky Association](#)). By seeking IDSP

status, El Morro hopes to further protect the beautiful night sky landscape at the park, and provide opportunities for visitors to enjoy this compelling resource after hours.

With the help of the [NPS Natural Sounds and Night Skies Division](#), the park created an inventory of current night sky conditions, which will be used for continued monitoring of the night skies at El Morro. In order to preserve this pristine darkness, the park created lighting guidelines in order to minimize the park's contribution to light pollution. This would not be possible without help from community members in the El Morro valley. By working with the local community, we've increased awareness of the effects of light pollution, worked to minimize the area's contribution to light pollution, and created ongoing interpretive programming with an emphasis on protecting El Morro's night skies. El Morro has been working diligently to replace or retrofit existing light fixtures to reduce the monument's emissions of light pollution.



(Left) Mission 66 historic fixtures have light bulbs that emit less than 500 lumens and have a “warm” color temperature in order to reduce the building lighting impact on wildlife. (Right) An employee helps retrofit existing fixtures to reduce light pollution. The inside panels of transparent light fixture panels were painted and modified to direct light down to eliminate light trespass. Credit: NPS Photo

Night Sky Events

El Morro hosts a wide array of night sky events. Check out our [Facebook page](#) and our calendar to learn about upcoming events!

By The Full Moon

Witness the full moon rising above the monument! El Morro National Monument will stay open later into the evening for several dates June - September. Visitors wishing to hike the Headland Trail must arrive at least 2 hours prior to closure at 9:30 p.m. Event is outdoors— be prepared with warm layers, water, and flashlights. The 2-mile Headland Trail involves a strenuous 250 ft elevation gain and uneven surfaces. Call the El Morro National Monument Visitor Center at 505-783-4226 (ext. 801) for more information or visit www.facebook.com/elmorro.nps for current updates.

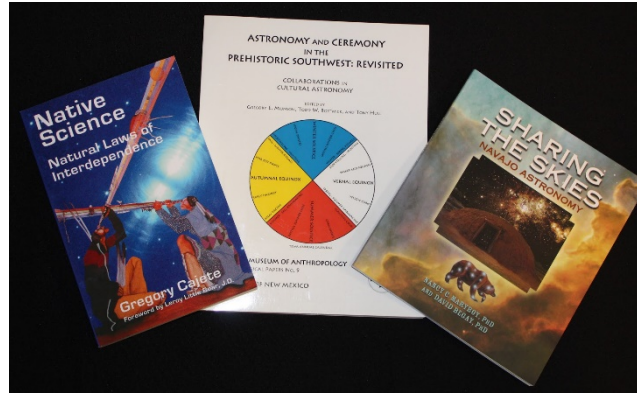


Enjoy experiencing El Morro in moonlight as a full moon rises over the monument.

Cultural Constellations

We all look at the same night sky, but each of us has our own interpretation of the constellations. Join us as community members from local tribes share their perspective of the constellations and the cosmos! Past cultural constellation events have included Navajo storyteller Nixon Martinez and Kenny Bowekaty from the Zuni Pueblo Department of Tourism. Come prepared to listen to a cultural narrative and explore unique spiritual connections to the night sky.

If you would like to present at a Cultural Constellations event, contact the El Morro Visitor Center at (505) 783-4366 ext 801.



El Morro's partner Western National Parks Association sells several cultural materials that provide a variety of perspectives of the constellations and cosmos of the night sky. Credit: NPS Photo

Star Parties

Join El Morro National Monument to stargaze under the cosmos! Meet at the El Morro Visitor Center for a 30-45 minute ranger program followed by a constellation tour and telescope viewing. This event is outdoors— be prepared with warm layers and a red flashlight. Adverse weather conditions may cancel the event. Call the El Morro National Monument Visitor Center at 505-783-4226 (ext. 801) for more information or visit www.facebook.com/elmorro.nps for current updates. *Hiking park trails is not permitted during these events.*

Do you own a telescope and want to volunteer at El Morro's night sky events? Call the visitor center to learn more about getting involved in our star parties: (505) 783-4366 ext 801.

Learn More

Learn about Light Pollution

What do you think of when you hear the word “pollution?” Usually, our minds don’t tend to think of *light* as a pollutant. However, with growing city centers and increased use of artificial light, the starry skies of the past are disappearing. Today, [80% of Americans can’t see the Milky Way from where they live](#). A resource that was once widely available and widely utilized, is no longer part of daily lives. Pristine night skies are endangered and we all play a role in their protection. Fortunately, light pollution is entirely reversible and it starts with you. Learn more about [measures you can take to decrease your contribution to light pollution](#) on the IDA website.

Protecting the Night Sky

IDSP Application

El Morro works tirelessly to decrease our contribution to light pollution. With help from the local community, the park is in the process of applying for International Dark-Sky Park status. As a result, the park has created a long-term plan to minimize our light pollution footprint as much as possible. We encourage you to learn about ways you can [decrease your footprint at home!](#)

How do NPS Scientists measure the Night Sky?

To track changes in night sky darkness, special cameras are used by park scientists to precisely measure light pollution coming from urban areas. For example, this black-and-white image taken from El Malpais National Monument, just east of El Morro, shows the dull glow of Grants and Albuquerque on the horizon.

When analyzed by a computer, an exact level of brightness can be calculated for this image, and is shown below in a rainbow of colors. This allows the light levels from one photograph to be easily compared to another photograph at another location, or taken another year.

Which National Park Service sites have achieved International Dark-Sky Park status?

El Morro is following the footsteps of many National Parks, making the protection and preservation of night skies a priority. Below is a list of National Park Service sites that have achieved International Dark-Sky Park status. Learn more about when and where to stargaze here: <https://www.nps.gov/subjects/nightskies/stargaze.htm>.

- [Big Bend National Park \(TX\)](#)
- [Big Cypress National Preserve \(FL\)](#)
- [Black Canyon of the Gunnison National Park \(CO\)](#)
- [Canyonlands National Park \(UT\)](#)

APPENDIX B

- [Capitol Reef National Park \(UT\)](#)
- [Capulin Volcano National Monument \(NM\)](#)
- [Cedar Breaks National Monument \(UT\)](#)
- [Chaco Culture National Historical Park \(NM\)](#)
- [Craters of the Moon National Monument \(ID\)](#)
- [Death Valley National Park \(CA\)](#)
- [Dinosaur National Monument \(CO\)](#)
- [Flagstaff Area National Monuments \(AZ\)](#)
- [Grand Canyon National Park \(AZ\)](#)
- [Grand Canyon-Parashant National Monument \(AZ\)](#)
- [Great Basin National Park \(NV\)](#)
- [Great Sand Dunes National Park and Preserve \(CO\)](#)
- [Hovenweep National Monument \(UT, CO\)](#)
- [Joshua Tree National Park \(CA\)](#)
- [Natural Bridges National Monument \(UT\)](#)
- [Petrified Forest National Park \(AZ\)](#)
- [Salinas Pueblo Missions National Monument \(NM\)](#)
- [Tonto National Monument \(AZ\)](#)
- [Tumacácori National Historical Park \(AZ\)](#)

El Morro National Monument

National Park Service
U.S. Department of the Interior



International Dark-Sky Park Application

El Morro National Monument

October 2019

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Nomination Letter



December 1, 2018

Dear IDA Board Members:

Please allow me to nominate El Morro National Monument as an International Dark Sky Park. El Morro (ELMO) is located along one of the historic trails that Europeans used traveling west through the region. Its dark skies are an historic connection with the people who have lived and moved through this region for centuries. The park highlights this connection in its interpretive programs. Since the main source of travel through New Mexico is now north along I-40, its skies have been preserved from the light brought by large-scale development.

ELMO staff are committed to preserving the darkness of their skies. To gauge just how dark ELMO's skies are, the staff has conducted Unihedron measurements of the housing area and main road into the park. Their measurements span the range of 21.30 - 21.39 placing the park within the Silver designation on Page 6 of the IDSP application. For context from my own measurements in a range of national parks, undertaken in during Fall 2007 and Spring 2008, these measurements are comparable to Bear Lake in Rocky Mountain National Park, Courthouse Buttes in Arches National Park, and Otter Point in Acadia National Park. Each of these parks is an excellent example of darkness in their region. ELMO fits well within that company.

In 1999, New Mexico passed the New Mexico Night Sky Protection act declaring the night sky to be a cultural resource. Designating ELMO as an International Dark-Sky Park will be another step in acknowledging this cultural connection embodied within the park and thus highlighting what is special about the night skies of the Colorado Plateau. As a former board member of the International Dark-Sky Association, one who has worked extensively with national parks across the country, ELMO is unquestionably worthy of recognition for the work they have done, and are doing there and it is my pleasure to nominate them for Dark-Sky status.

Sincerely,

Dr. Tyler Nordgren
University of Redlands
and
Space Art Travel Bureau.com

Superintendent Letter of Support



United States Department of the Interior

National Park Service
El Malpais and El Morro National Monuments
123 East Roosevelt Avenue
Grants, NM 87020
505-285-4641



December 6, 2018

International Dark-Sky Association
3223 North First Avenue
Tucson, Arizona 85719-2103

Dear IDA Board of Directors:

I am writing in support of El Morro National Monument's application for Dark Sky Park designation. Located in a remote setting in northwest New Mexico, the Monument enjoys outstanding viewsheds and night skies. These resources contribute to the rich cultural landscape that is present here and is important to the Monument's mission.

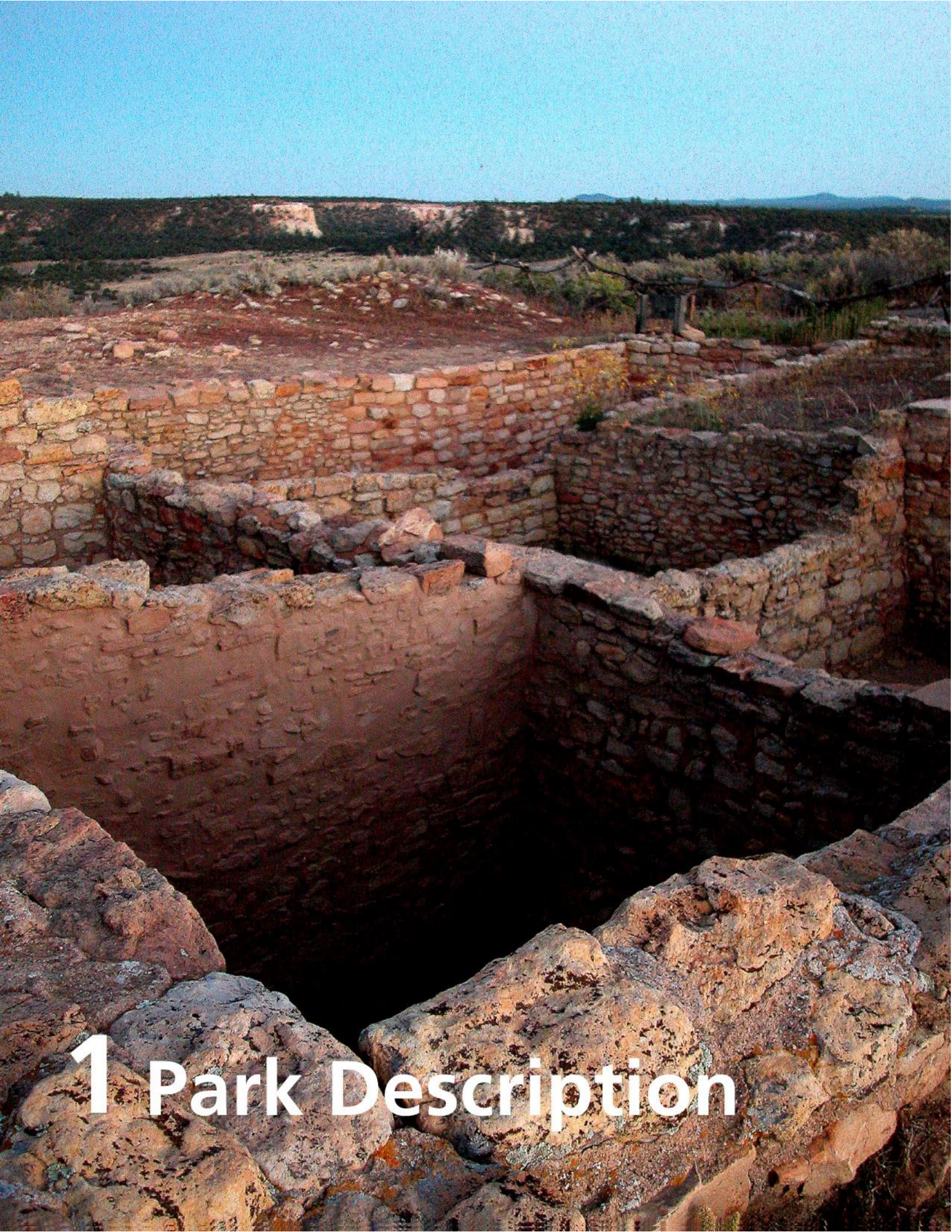
The Monument's management plans recognize dark skies as a fundamental resource, one which is key to preserving the Monument's natural and cultural heritage. Facilities and lighting are limited so as not to compete with the grandeur and context of the pueblo of Atsinna and to limit impacts to the night sky, which is so important to our stewardship of this area. We are also creating a new lighting plan and have already implemented changes to lighting at the Monument's Visitor Center and the government housing area. Public interpretation and education programs involving night skies have been going on here for many years. We are already expanding public night sky programming including a focus on the perspective of night skies through Tribal interpretation. The park is in the process of adding protection of dark night skies as an interpretative theme to the Monument's Long Range Interpretive Plan. We have also garnered support from a small business community one mile from the Monument who have made night sky friendly changes in their lighting.

I am pleased to present this application to you and look forward to El Morro National Monument joining the Dark Sky Park community.

Sincerely,

Mitzi Frank
Superintendent





1 Park Description

El Morro National Monument (El Morro) was created in 1906 by President Theodore Roosevelt in order to protect Inscription Rock, a sandstone bluff containing over 2,000 inscriptions and petroglyphs spanning a cultural continuum of almost 1,000 years. The park also protects significant archeological resources, including a largely unexcavated Ancestral Puebloan village site atop the bluff which is among the largest 13th and 14th century settlements in the American Southwest. The park was expanded in 1916 by President Woodrow Wilson, and again in 1950 by the U.S. Congress. Today, the monument protects 1,278 acres of land at approximately 7,200 feet to 7,500 feet of elevation, and is administered by the U.S. National Park Service (NPS).



Figure 1: Inscription Rock in winter time. NPS photo / Ana Colón

The monument is located in western New Mexico, approximately 12 miles East of Ramah (population: 407), 33 miles East of Zuni (population: 6,367), 43 miles southwest of Grants (population: 9,011), 55 miles southeast of Gallup (population: 21,960) and 119 miles West of Albuquerque (population: 558,545). Road access to the monument is by New Mexico State Highway 53, which runs along the northern edge of the monument and connects El Morro to the northern edge of El Malpais National Monument. The maps below are from <https://www.nps.gov/elmo/planyourvisit/maps.htm> and Google Maps and they illustrate El Morro's location within the context of the Four Corners region of the Southwest.

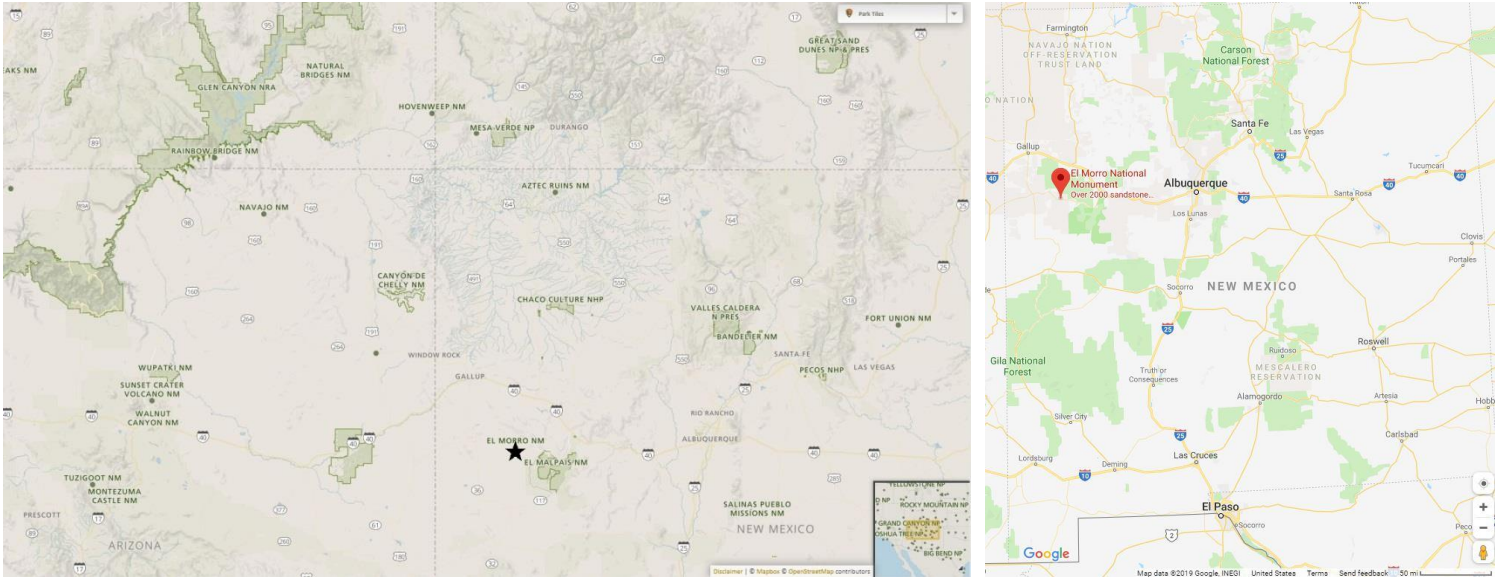


Figure 2: Map of NPS sites in the Four Corners region with El Morro marked with a black star (left). Google Maps image of El Morro within the context of New Mexico (right).

El Morro is applying to become an International Dark Sky Park with Silver Tier skies under the 2015 International Dark-Sky Association (IDA) guidelines. The area to gain status as an International Dark Sky Park includes the entirety of El Morro as shown in the map below:

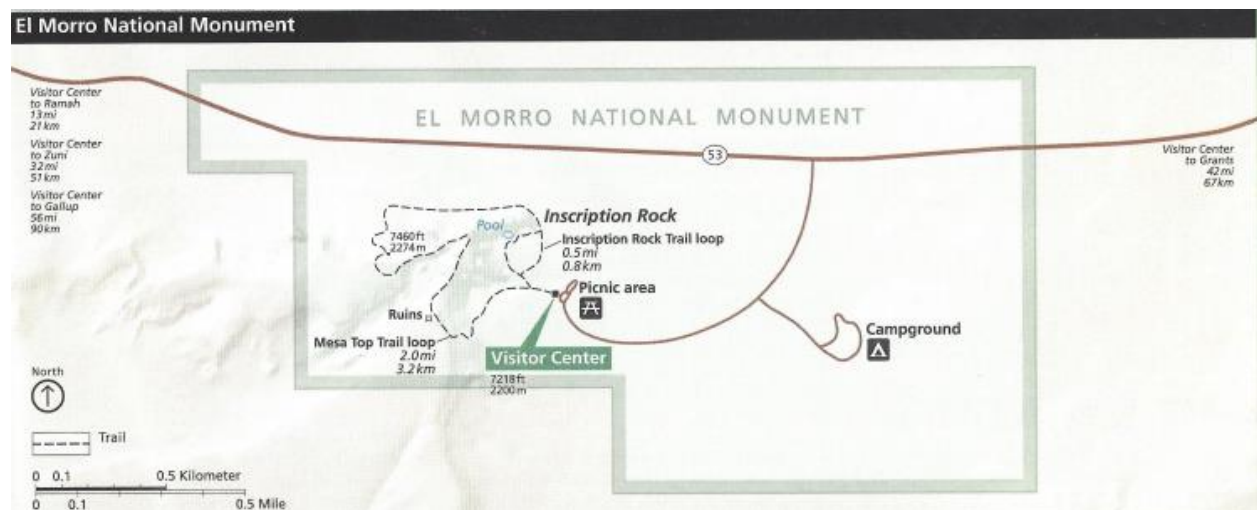


Figure 3: Map of El Morro National Monument.

Visitor Services

El Morro contains a visitor center and bookstore, a nine-site campground, a group picnic area, and a scenic viewpoint on NM Hwy 53. The park receives approximately 30,000 visitors per year. Peak visitation occurs May through October, with May having the highest visitation of the calendar year. There are no entrance fees or camping fees associated with visiting and experiencing El Morro. The

visitor center and trails are open year round, from 9 am – 5 pm with extended hours in the summer, with the exception of Thanksgiving Day, Christmas Day, and New Year’s Day when the park is closed. Although the trails are open year-round, the longer two-mile Headland Trail may have weather related closures due to snow and ice. The campground and scenic pullouts located on the entrance road are open 24 hours a day. Visitors hoping to experience the night sky must view it from one of the viewpoints on the entrance road, stay in the campground, or attend a night sky program hosted by the park.

Although El Morro is located 43 miles from Interstate 40, many off-the-beaten-path travelers and community members stop by for a visit. Regional attractions include the Wild Spirit Wolf Sanctuary, Bandera Ice Caves, and the Pueblo of Zuni.

Park Resources

Fundamental resources and values are those features, systems, processes, experiences, stories, scenes, sounds, smells, or other attributes determined to merit primary consideration during the planning and management process because they are essential to the monument’s purpose and maintaining connections to its significance. The resources protected by El Morro are listed and described below.

- ***Inscriptions, Petroglyphs, and Pictographs:*** Inscription Rock has more than 2,000 inscriptions, petroglyphs, and pictographs that document a cultural continuum of around 1,000 years, from Ancestral Puebloans to Spanish explorers, European American surveyors, pioneers, military expeditions, and other travelers.
- ***Archeological Resources:*** El Morro contains a high concentration of exceptional archeological resources; well-preserved and largely unexcavated pueblo sites atop Inscription Rock are among the largest 13th and 14th century settlements in the American Southwest.
- ***Cuesta and Natural Setting:*** El Morro’s distinctive combination of geologic and geographical features—the natural travel corridor, highly visible landmark with a pool of water at its base, and the carvable texture of its soft sandstone—provided a perfect natural canvas for early inhabitants and travelers to leave their mark.

El Morro contains other resources and values that may not be fundamental to the purpose and significance of the park, but are important to consider in management and planning decisions:

- ***Cultural Landscape:*** The vernacular landscape associated with pre-European contact development and use of the cuesta and the El Morro Valley.
- ***Historic Structures:*** El Morro's historic structures were built to support the early management of the monument by the National Park Service. Buildings, utility systems, trails, and other facilities were constructed, mainly between the late 1920s and mid-1960s.
- ***Museum Collection:*** El Morro's museum collection contains 57,000 cataloged objects, including assemblages of prehistoric and historic artifacts, natural history specimens, and historic and rare archives.

Protecting the night sky at El Morro has benefits not only for astronomers and stargazers, but for the local community as well. Due to the park's cultural nature, El Morro has the unique opportunity to provide outreach events that highlight the cultural significance of night skies to Ancestral Puebloans and their descendants, in addition to providing recreational night sky events for visitors. Furthermore, a naturally dark sky is crucial to maintaining the balance of ecosystems for nocturnal wildlife, an important consideration for the National Park Service.



2 Night Sky Resources

NPS Photo/Derek Wallentinsen

Current Conditions

Light pollution limits the visibility of the Milky Way to the unaided eye, the visibility of nebulae and galaxies seen in telescopes, and raises the noise on CCD astrophotographs. Only the observation of planets and double stars is unaffected. Low light pollution conditions, or dark skies, are one of the most important properties of a good astronomical observing site.

The high elevation, clean air, remote location, and minimal development in and around El Morro combine to produce excellent night sky conditions. El Morro is located within a day's drive of Albuquerque, Santa Fe, and Phoenix, but is far enough away from these population centers to remain unaffected by their skyglow. In addition, the monument is associated with various tribal nations in the area. This makes El Morro uniquely positioned to educate a diverse audience

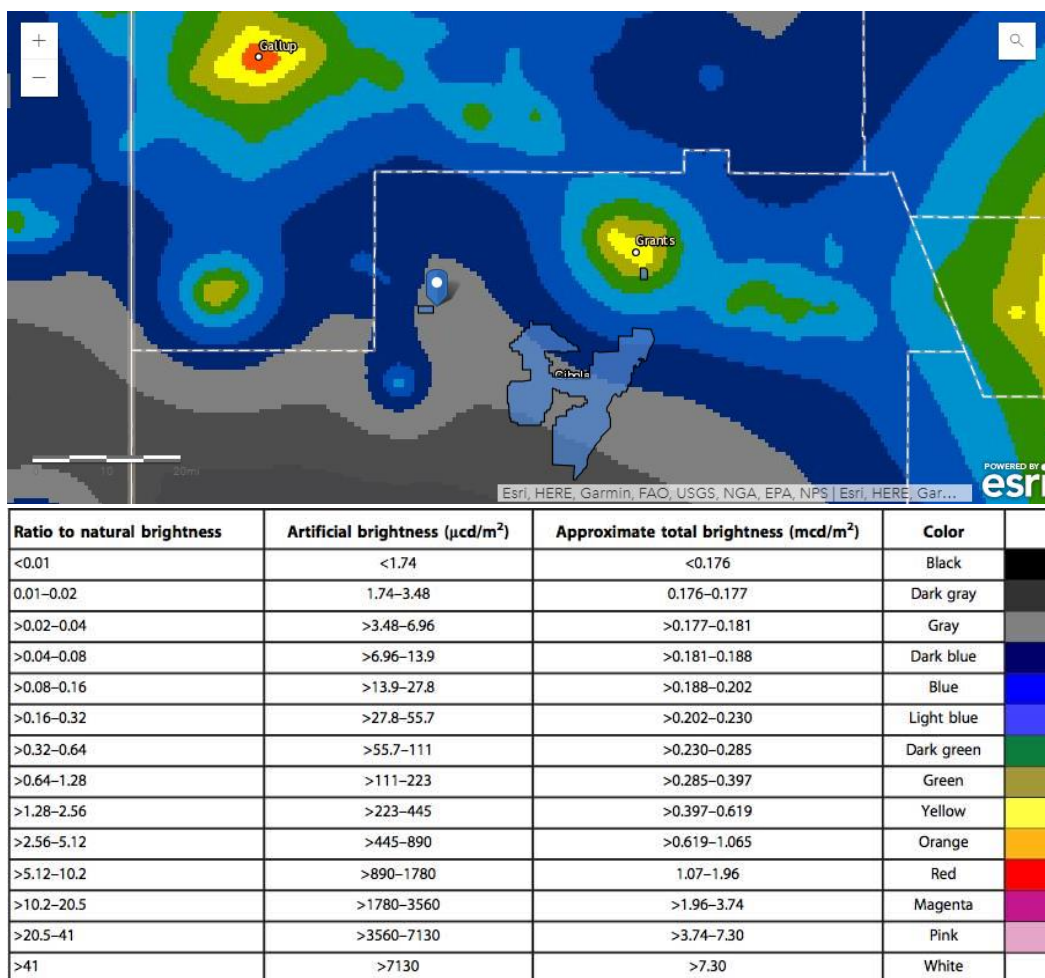
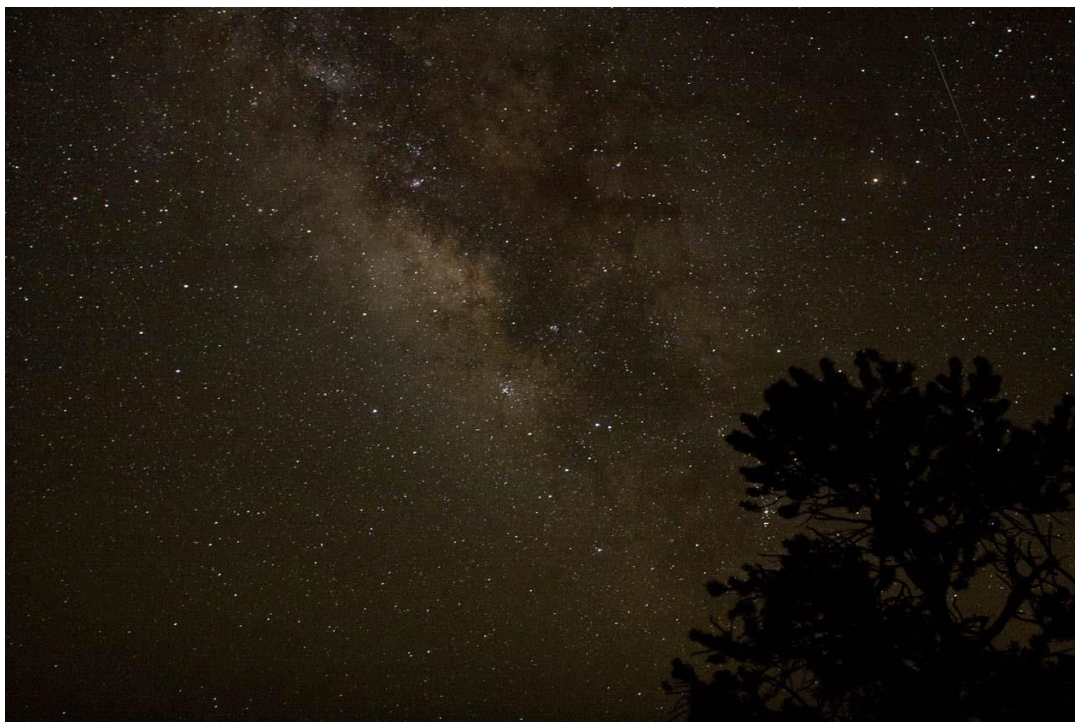


Figure 2: Map of sky glow around El Morro National Monument, with the light blue marker indicating El Morro's location in the gray region.

about the importance of preserving the night sky and the benefits of natural darkness. Sources of outdoor light within the monument itself are minimal. There are few structures in use, all of which are not regularly lit at night, or have dim light fixtures lit only during after-hour events (see Lighting Inventory). The most significant source of artificial light visible from the monument is the skyglow originating from the nearby towns of Gallup (55 miles NW) and Grants (43 miles NE). Despite the aforementioned towns, the quality of skies in El Morro is excellent. Figure 2 shows data adapted from the New World Atlas of Artificial Night Sky Brightness (Falchi et al. 2016) into a localized map. The gray area where El Morro falls (shown by a blue location marker) indicates that the amount of artificial light in the night sky is less than 4% higher than natural conditions.

Visual Observations

A moonless night sky at El Morro is sufficiently dark enough to observe the Milky Way in great detail. Light domes are limited to the horizon, and are as bright as the brightest portions of the Milky Way. The Zodiacal light is easily seen, but a band of gegenschein is difficult to see or is absent. On the Bortle Scale, El Morro fits the description of a Class 3 sky, which is consistent with a rural sky (determined by the NPS Night Sky Team in 2016).



*Figure 3: Night sky conditions taken from the Atsinna Pueblo atop Inscription Rock.
Photo Credit: NPS Photo/Natural Sounds and Night Skies Division*

Night Sky Quality Monitoring

To quantify the quality of natural darkness in the night sky, El Morro acquired an IDA approved Unihedron Sky Quality Meter (SQM-L) in the winter of 2018 and began taking measurements on clear, moonless nights. Measurements were taken at the six sites recorded in Table 1 (test sites mapped in Figure 4). Degradation of natural darkness at El Morro is due primarily to light domes caused by the municipalities of Grants, Gallup, and Zuni, which are not captured in the SQM-L measurements. The darkest measurements were in the 21.7 mag/arcsec² range. The data shows that measurements are relatively consistent around the park, with the exception of those taken atop Inscription Rock. It was at these locations that the light domes on the horizon were most visible and impacted our measurements. These measurements were taken in both winter and summer conditions and trained staff will continue to monitor night sky quality to continue collecting baseline measurements. El Morro is committed to measuring night sky brightness bi-annually as a monitoring tool for light pollution impacts on the park. With an average of 21.59 mag/arcsec² measured, El Morro is applying for the Silver Tier under the 2015 International Dark-Sky Park guidelines.

Location	Average SQM-L Measurement	Date & Time (MST)	Average SQM-L Measurement	Date & Time (MST)
Staff Housing	21.53	11-26-2018 20:30	21.76	8-12-2019 04:20
Visitor Center Parking Lot	21.56	11-26-2018 20:20	21.66	8-12-2019 04:30
Entrance Sign Hwy 53	21.59	11-26-2018 20:10	21.70	8-12-2019 04:45
Campground	21.62	11-26-2018 20:00	21.73	8-12-2019 04:40
Atsinna Pueblo	21.44	11-27-2018 20:00	21.76	8-12-2019 05:00
Curve in Headland Trail	21.20	11-27-2018 20:20	21.65	8-12-2019 05:08
Average of 6 readings:	21.46		21.71	Total average of 12 readings: 21.59

Table 1: El Morro National Monument Sky Quality Measurements (SQM-L) Survey measured in mag/arcsec².

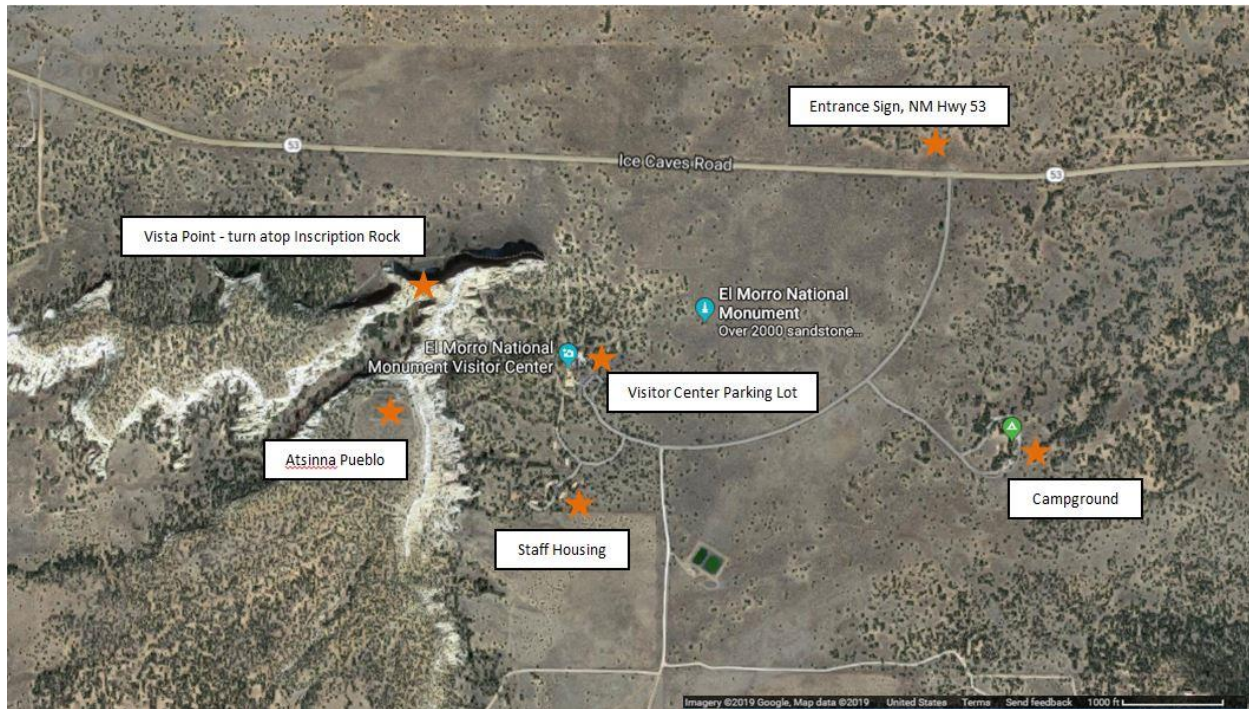


Figure 4: Google Maps satellite image of El Morro National Monument with night sky measurement locations indicated by orange stars.

The El Morro night sky team will continue to take SQM measurements and monitor conditions from the locations highlighted in Figure 4. All three permanent interpretive rangers are trained in using the SQM-L light meter and are able to gather and record these measurements. The measurements will be made twice a year, in summer and winter.

NPS Natural Sounds & Night Skies Division Data

The NPS Dark Night Skies Team conducted an assessment of El Morro's night sky conditions on May 30, 2013 from Atsinna Pueblo atop El Morro. The brightest sources of light in this report came from Gallup, NM and Grants, NM, though these are "visible, but do not interfere with night sky vision" (NPS Natural Resource Condition Assessment, 2013). The light domes from Albuquerque and Santa Fe, NM are also present, but are very faint. The results and images from their assessment are shown below.

Location	All-sky Light Pollution Ratio	Maximum Vertical Illuminance (milli-Lux)	Horizontal Illuminance (milli-Lux)	Zenith Sky Brightness (SQM)	Bortle Scale
Modeled Park-wide	0.15	---	---	---	---
Atsinna Pueblo	0.20	0.12	0.06	21.54	3

Table 2: The ground-based SQM reading was 21.54 mag/arcsec² and measured at Astinna Pueblo in May2013.

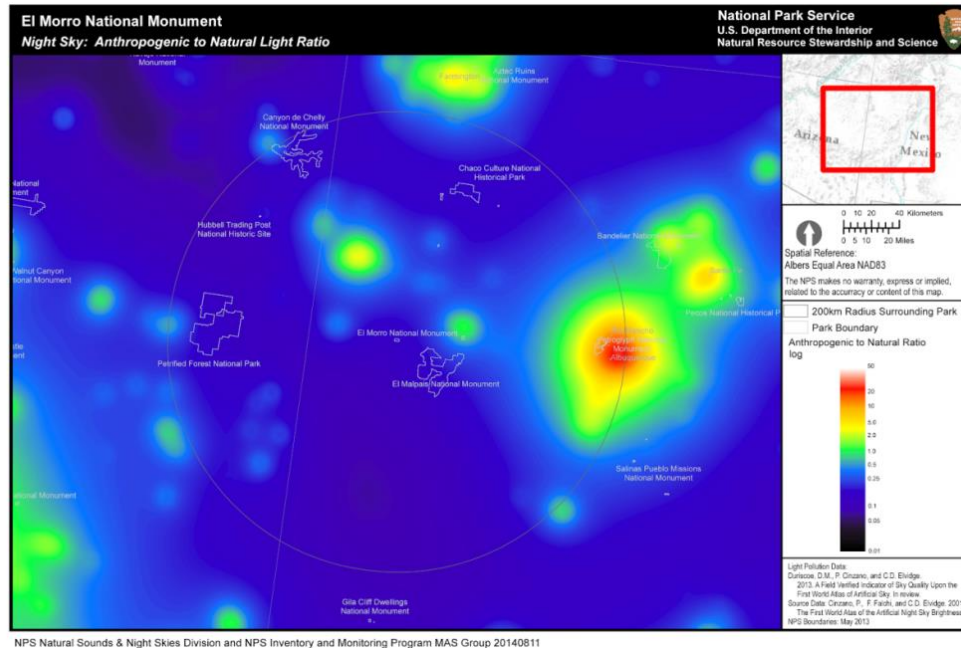
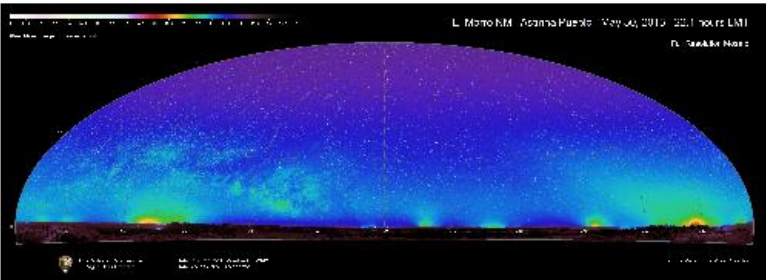
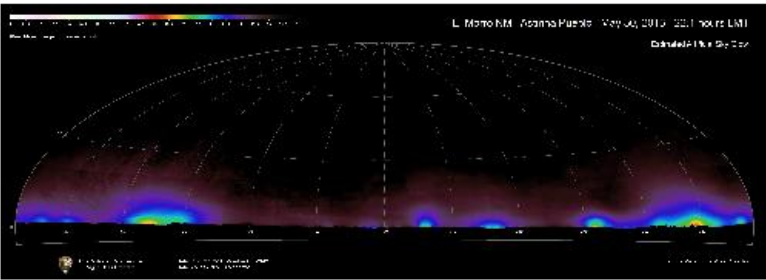


Figure 5: Modeled ALR map for El Morro National Monument. A 200km ring around the park illustrates the distance at which anthropogenic light can impact night sky quality within the park. Credit: NPS/Natural Sounds and Night Skies

Indicator	Measure	Condition	Condition Rationale
Sky Brightness	All-sky Light Pollution Ratio*	Good	Sky brightness as measured by ALR indicates good condition at El Morro NM. This condition is based on NPS Natural Sounds and Night Skies Division benchmarks for non-urban parks and on the ground-based measurement of 0.20 taken in May 2013. The modeled ALR of 0.15 was derived from the 2001 World Atlas of Night Sky Brightness and is similar to the ground-based measurement. The ground-based measurement was collected by the NPS Natural Sounds and Night Skies Division. The confidence level is high.
	Maximum Vertical Illuminance	Good	Sky brightness as measured by maximum vertical illuminance was 0.12 milli-Lux at El Morro NM. This value reflects a rating of 31% above average natural conditions. Specific benchmarks for condition classes have not been set; however, condition is estimated as good (J. White, personal communication, Nov. 2015). This measurement was collected by the NPS Natural Sounds and Night Skies Division.
	Horizontal Illuminance	Good	Sky brightness as measured by horizontal illuminance was 0.06 milli-Lux at El Morro NM. This value reflects a rating of 7% above average natural conditions. Specific benchmarks for condition classes have not been set; however, condition is estimated as good (J. White, personal communication, Nov. 2015). This measurement was collected by the NPS Natural Sounds and Night Skies Division.
	Zenith Sky Brightness	Moderate	Zenith sky brightness indicates moderate condition at El Morro NM. This condition is based on NPS Natural Sounds and Night Skies Division benchmarks for non-urban parks and on a ground-based measurement of 21.54. Confidence level is high.
Sky Quality	Bortle Dark Sky Scale	Good	Sky quality as assessed by the Bortle dark sky scale indicate good condition at El Morro NM. This condition is based on NPS Natural Sounds and Night Skies Division benchmarks for non-urban parks and on the qualitative assessment of Bortle class 3, which is consistent with a rural night sky. Because this measure is qualitative, it has low confidence.

Table 3: This table summarizes night sky indicators, measurements, and conditions rationale at El Morro National Monument. Source: NPS/Natural Sounds and Night Skies Division

Category	Details	Observed and Estimated Artificial Sky Brightness Mosaics
Park:	El Morro NM	<p>Click on either image for a high resolution view --THESE ARE LARGE FILES</p>  
Site Name:	Astinna Pueblo	
Longitude:	-108.35	
Latitude:	35.04	
Elevation (m):	2278	
Date (LMT):	30-May-2013	
Time (LMT Hours):	22.09	
Camera:	ML4	
Lens:	Nikon 1.2	
Observers:	B Meadows J White	
Air temp. (°C):	18.2	
R. H. (%):	28.9	
Wind Speed (mph):	9	
Extinction Coeff. (mag/airmass):	0.23	
NELM:	6.8	
Bortle Class:	3	
Synthetic SQM:	21.77	
SQI All- sky:	90.6	
SQI to Z.A. 70°:	98.2	
Number of stars visible:	3230	

NARRATIVE: Strong winds all day long (20-40 mph) have caused lots of particulates in the atmosphere. Moderate haze up to 10° in the east and south and 5° in the west. Last of clouds dissipated by 9:30 pm. The light domes of Gallup and Grants easily visible, but do not hinder night vision. Numerous single source light sources on scattered homes to the south and SW. Zodiacal light is strong and easily visible to 45°. The Milky Way is visible from 5° above SE horizon to 15° (just above Cassiopeia) in the north. Lots of highway traffic late in the evening returning from Grants (?). Overall, the surrounding artificial lights do not degrade the quality of observations at this site.

Photometric Indicators

Indicator	Observed		Estimated Artificial		Light Pollution Ratio (Artificial/Natural)
Sky Luminance Measures					
Zenith	mag/ arcsec ²	μcd/ m ²	mag/ arcsec ²	μcd/ m ²	< 0.10
	22.03	167	> 24.5	< 17	
Mean all-sky	21.35	312	23.31	51	0.20
Brightest	19.25	2,130	19.34	1,961	11.46
Darkest	22.03	165	> 24.5	< 17	< 0.10
Median	21.40	294	24.30	20	0.08
Illuminance Measures					
Horizontal	mags	milli-lux	mags	milli-lux	0.07
	-6.25	0.80	-3.40	0.06	
Max Vertical	-5.87	0.57	-4.22	0.12	0.31



3 Education and Outreach

Public Access

The El Morro visitor center and trails are open from 9 am – 5 pm with summer hours of 9 am – 6 pm. Although hiking trails are only open during business hours, the entrance road, scenic pullouts, and campground are open 24 hours a day. Campers are able to experience the incredible night skies from their campsite, which is one of the darker areas of the monument as there are no direct sources of light within the vicinity. However, because the trails close at night, the park strives to host events for visitors to experience the monument in the evening.

Dark Sky Interpretive Programs 2018

El Morro hosts several night sky events each year. Evening programs allow daytime visitors to have a new experience in the park through a moonlit hike or star gazing. Interpretive night sky programs offer visitors an excellent way to experience the dark night skies and education regarding solutions for best lighting practices to prevent light pollution. By engaging the local community, El Morro can help visitors and locals reexamine their outdoor lighting practices. In 2018, El Morro hosted 4 dark sky programs, reaching 384 visitors. These are outlined below:

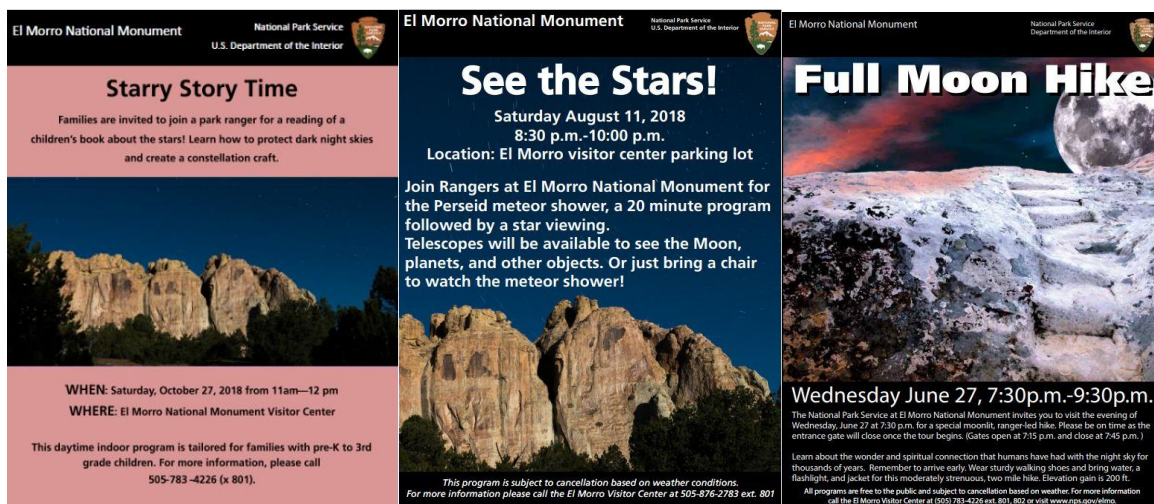


Figure 7: Event flyers demonstrating the different types of programs offered for visitors at El Morro National Monument.

- **Full Moon Hike:** On June 27, 2018, El Morro hosted a ranger-guided full moon hike consisting of a two-mile long guided hike on El Morro's Headland Trail, with stops along the way highlighting the scientific and cultural significance of the moon, and the importance of protecting the night skies at El Morro. This included education on light pollution, and how to

prevent it at home with appropriate lighting practices. The event drew in an incredibly large crowd for such a small park, with over 260 people in attendance.

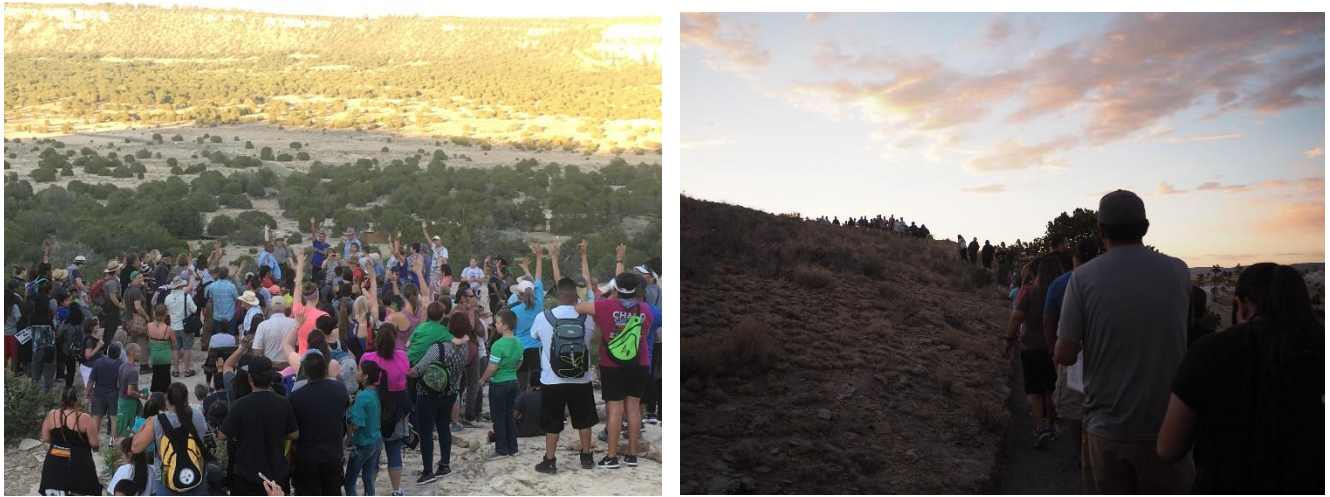


Figure 6: Visitors gather around a ranger at an overlook (left) and hike on the Headland Trail (right) during the June 2018 Full Moon Hike.

- *See the Stars! Star Party:* On August 11, 2018, rangers at El Morro hosted a star party in the lower parking lot outside of the visitor center, with 35 people in attendance. This event consisted of a 30-minute ranger talk about the Perseids meteor shower, and the importance of dark skies to view them. In addition, it highlighted how the dark skies at El Morro made for perfect viewing conditions, but how areas dark enough to see the shower in full clarity were limited, emphasizing the rarity and beauty of the night skies at El Morro. Like the Full Moon Hike, the importance of protecting the night sky was accompanied with information on light pollution, and how to prevent light trespass with proper outdoor lighting practices. This was followed by a telescope portion, where a ranger used a telescope to show visitors different objects.
- *Starry Story Time:* On October 27, 2018, rangers at El Morro hosted a “starry story time”, geared at night sky education for children. There were 9 children in attendance, and the program used children’s literature relating to the night sky, in addition to a craft portion afterwards, that aimed to teach children about the importance of the night sky during a daytime program. Children then practiced sketching constellations they would look for in the night sky that night. Then, children created their own constellations on scratch-and-color paper to take home. Rangers used the model neighborhood display to discuss the impact of light pollution and how to reduce it at your own house. Rangers also distributed flyers to parents showing acceptable and unacceptable light fixtures provided by the IDA.

- *Cultural Constellations, Diné Constellation Stories*: On December 8, 2018, El Morro rangers in conjunction with the El Morro Area Arts Council (EMAAC) hosted a “Cultural Constellations” event at the Old School Gallery (run by EMAAC), with 75 people in attendance. The first half of the program consisted of a ranger emphasizing the uniqueness of the dark skies in the El Morro Valley, and explaining both why light pollution is so minimal in this area, and how the community can work to keep it that way. The rangers handed out IDA brochures talking about proper lighting practices before handing the microphone to Nixon Martinez. Mr. Martinez is a Navajo healer and story-teller, and he spoke for 45 minutes on Diné perspectives of the constellations, going over a few constellations and the significance of these in Navajo culture. Though the plan was to follow this talk up with a telescope viewing, the bad weather led to the cancellation of this portion.

Dark Sky Interpretive Programs 2019

Several night sky events are planned for 2019. These include four Full Moon Hikes, four star parties, two cultural stargazing events, and four campground star programs. A total of 14 interpretive events are planned, with a prediction that these events will reach approximately 800+ people. Descriptions of the events that El Morro has hosted so far this year are provided below:

- *Cultural Constellations, Zuni Constellation Stories*: On May 10, 2019, El Morro rangers in conjunction with the El Morro Area Arts Council (EMAAC) hosted a “Cultural Constellations” event at the Old School Gallery (run by EMAAC), with 20 people in attendance. Unfortunately, inclement weather led to lower attendance, and a cancellation of the telescope portion of this event. However, the indoor ranger talk portion still took place. Similarly to the event on December 8, a ranger spoke about the minimal light pollution in the area, and how to protect our night skies with proper outdoor lighting practices. This was followed by a talk by Kenny Bowekaty, a Zuni storyteller. Kenny spoke about the Zuni creation story, with emphasis on how this creation story is reflected in the stars and planets.
- *Night Without Lights*: On May 25, 2019, an El Morro Ranger hosted a night sky campground program at the amphitheater in El Morro’s campground, with 20 people in attendance. The emphasis of this program was living a life without artificial lights, how different animals adapted to live in the dark, and the importance of natural darkness in for wildlife. In addition, the ranger talked about how humans have affected the natural darkness, and how we can reverse the damage with proper outdoor lighting practices. This program was also given on June 28, 2019, with 9 in attendance, and July 5, 2019, with 4 people in attendance.

- *By the Full Moon, Full Moon Hike*: On June 16, 2019, El Morro hosted a full moon event and kept the park open until 9:30pm. Rangers were stationed at several locations along the two-mile Headland Trail. Each station highlighted a different aspect of the Moon, whether that was the effect of gravity, history of Moon exploration, or importance of the Moon on Earth, all with an emphasis on the 50th anniversary of the Apollo Moon Landing. The event also included a station on educating about light pollution, and how to prevent it at home with appropriate lighting practices. Unfortunately, there was a risk of lightning atop the cuesta, so the hike was limited to a short portion of the trail for safety, and this led to a lower attendance. Sixty visitors attended the after-hours event.
- *Star Party*: On June 29, 2019, rangers lead a star party inside the visitor center, with 28 people in attendance. Inclement weather led to a cancellation of the outdoor telescope portion of the program, which we believe led to a lower attendance. However, the ranger provided an indoor talk emphasizing the influence of the night sky in art and music. The ranger also spoke of the difference between the night skies when a lot of classic works of art were created, and how those same skies look different today due to the introduction of artificial light. The ranger emphasized the reversibility of light pollution through proper outdoor lighting practices and handed out flyers on acceptable and unacceptable lighting fixtures.

A schedule of the night sky events for the rest of the 2019 summer season is listed below:

- July 16, 2019: *By the Full Moon, Full Moon Hike*
- July 27, 2019: *July Star Party*
- August 15, 2019: *By the Full Moon, Full Moon Hike*
- August 31, 2019: *August Star Party*
- September 14, 2019: *By the Full Moon, Full Moon Hike*
- September 27, 2019: *September Star Party*

The park is also planning to schedule two more Cultural Constellation night sky events at the Old School Gallery, in conjunction with the El Morro Area Arts Council for the winter of 2019-2020.

Community Outreach

El Morro is an important site for cultural groups in the region. El Morro strives to foster these connections and incorporate cultural components into night sky programs. In December, 2018, a Navajo storyteller from the local community presented a Diné perspective of winter constellations.

In May, 2019, a Zuni tour guide from the Zuni Pueblo Department of Tourism presented a cultural story aligned with the cosmology of the A:shiwi world. In the future, El Morro plans to continue to reach out to neighboring tribes to provide a platform for multiple perspectives of the night sky.

El Morro has reached out to surrounding tribal nations to involve diverse groups in this process. El Morro presented at a Ramah Navajo Chapter Planning meeting in April, 2019 to share the park's night sky endeavors with this tribal community. The presentation received positive feedback and support, demonstrated by a letter of support from the Ramah Navajo Chapter president. This letter is the beginning of a collaborative effort in night sky preservation and incorporation of Native American perspectives into El Morro's programming.

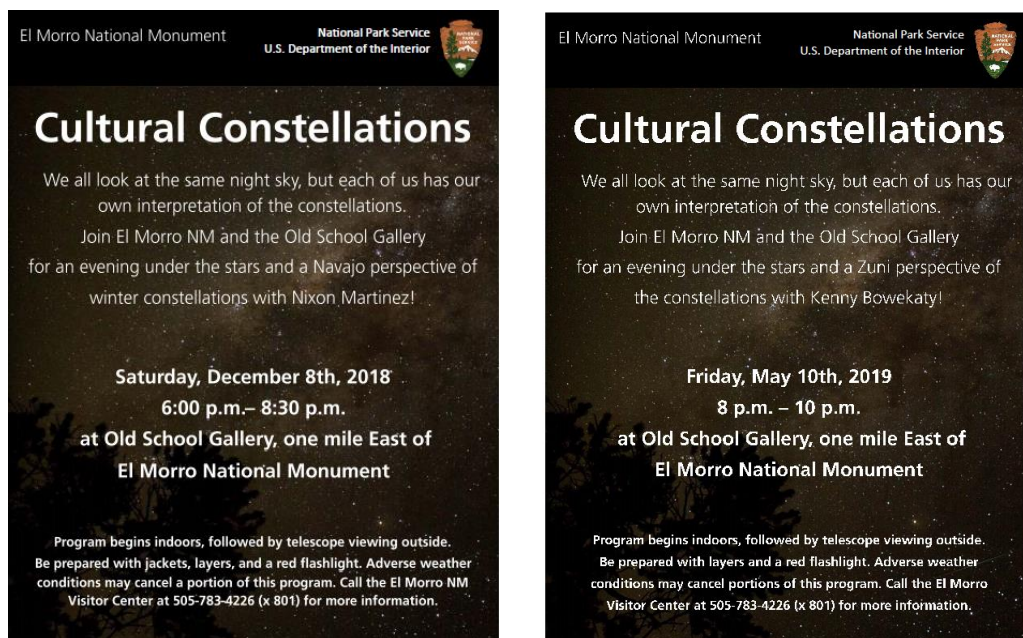


Figure 7: Posters displaying El Morro National Monument's cultural events and partnerships with the local art gallery and neighboring tribal nations.

Several presentations at the Ramah Elementary School were conducted to educate students on El Morro's night sky friendly lighting and to meet El Morro's Long Range Interpretive Plan goals. Presentations involved using a model town to demonstrate the importance of shielding outdoor light fixtures. While the town of Ramah has no streetlights, the middle/high school has a significant number of unshielded lights that remain lit throughout the night. El Morro has submitted a request to the school district superintendent and the school board president to present El Morro's dark sky restoration work at a school board meeting. Rangers will share the park's goals and mission behind becoming a dark sky park and provide a presentation on safe, IDA compliant lighting practices. We plan to meet with this group in the 2019-2020 school year in Gallup, NM.



Figure 9: El Morro ranger holds a neighborhood display to illustrate the importance of properly shielding fixtures. This display was created 2017 and has been used on several occasions to help illustrate the impacts of light pollution.

Future Night Sky Quality Threats

El Morro has been working hard to preemptively address future threats to the park's night sky quality. Due to its remote location, the closest threat to dark night skies in the El Morro Valley is from the potential growth of nearby towns. Specifically, the ***greatest*** threat comes from the towns of Ramah, NM and Pine Hill, NM. While these towns are currently small and significant population increase is deemed unlikely, their growth could lead to increased outdoor lighting. El Morro is primarily surrounded by private and tribal land. There may be a potential for future development projects such as a gas station or convenience store that would involve outdoor lights. To address this issue, our night sky team has met with the Ramah Navajo Chapter (located near Pine Hill) to share our goals in becoming an International Dark Sky Park and night sky friendly lighting practices. Ramah, NM has minimal street lighting, but the biggest source of light comes from the football field at the Ramah High School/Middle School. As mentioned above, the night sky team at El Morro is planning on meeting with the school board and school district superintendent for both Cibola and McKinley county schools to address campus lighting practices. El Morro also plans for more education-based night sky programs that collaborate with local schools in providing astronomy opportunities and night sky preservation outreach.

In addition, another potential threat to the nightscape at El Morro is C&E Concrete Inc. gravel pit's occasional nighttime activities. While many of their lights have been replaced with shielded fixtures, safety standards for nighttime mining require extremely bright light for operations. C&E Inc. infrequently conducts mining operations at night, but in those occasions, this light impacts the night skies in the El Morro Valley. To address this, rangers from El Morro's night sky team met with the president of C&E Inc., which is outlined below in the "Leadership in Dark Sky Restoration - Section B (v.)(2)" section.

Nearby municipalities of Grants, NM and Gallup, NM are considerably more distant than Ramah, NM and Pine Hill, NM, but they emit a faint light dome that is visible from the monument. Although the threat is not as great for El Morro as it is for El Malpais National Monument, El Morro staff has begun helping El Malpais staff work on an International Dark Sky Park application which will involve addressing light pollution in Grants, NM. El Morro staff are committed to helping their sister park work towards night sky preservation.

Visitor Center Displays and Social Media

El Morro creates visitor center displays that highlight worldwide astronomical events. The night sky table in the visitor center also contains information about seasonably visible planets, local astronomy events, reducing light pollution, and free sky maps. Temporary displays are created for the visitor center to highlight astronomical happenings such as NASA's #ObserveTheMoon event, meteor showers, International Dark Sky Week, and the Night Explorer Junior Ranger book.



Figure 10: Examples of temporary visitor center displays El Morro National Monument creates for astronomical events and night sky objects to learn about and search for.

Social media is an excellent way to connect to audiences who virtually visit El Morro. This allows visitors to connect to night skies, learn about astronomy events, and continue to learn about preventing light pollution. El Morro has limited astrophotography photos and hopes to create more posts once additional photos are added to its catalogue.

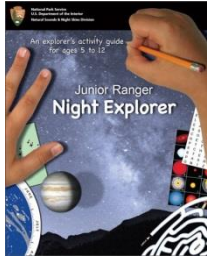


Figure 11: Examples of social media posts El Morro National Monument created to enhance public knowledge and outreach about the cosmos.

Road signs in El Morro indicate the quality of natural darkness and the park's commitment to preservation. These signs help visitors to begin thinking about the night sky and hopefully inspire them to star gaze when they spend the night in the campground.

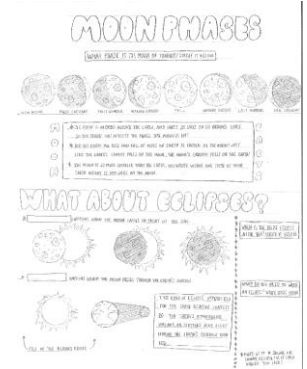


Figure 12: Night sky signs in El Morro National Monument acknowledging the park's beautiful dark night skies.



Currently, El Morro distributes the Junior Ranger Night Explorer book for kids and adults who are interested in learning more about the night sky. This book is a great addition to the night skies program and helps people continue learning after they've left the monument.

El Morro will create a new Junior Ranger activity book for the monument in 2020. It will include 1-2 pages about the night sky and how to protect it. Here is a page that NPS employee Ana Colón drew as an example of a night sky page that could be incorporated into the new activity book.



Leadership in Dark Sky Restoration - Section B (v.)(2)

El Morro demonstrates a long-term commitment to improve lighting conditions and awareness not merely on federal lands, but in the surrounding communities as well. In addition to interpretive events, the night sky team at El Morro has reached out to every community neighboring the park that contributes to the El Morro Valley's lighting footprint. These efforts are outlined below and the park has made significant headway in decreasing not just El Morro's contribution to light pollution, but those of the neighboring communities as well.

El Morro has involved El Morro Area Arts Council (EMAAC) and Western National Parks Association (WNPA) as two external partners in these dark sky restoration efforts and outreach events. These organizations have provided financial aid, support, and a community space to present cultural and interpretive night sky programs. El Morro also partnered with EMAAC, a non-profit group located one mile outside the park's boundary, to co-host these cultural events. Because indoor facilities at El Morro are limited, this group allowed El Morro to use their facility to provide a large, warm space to hear cultural stories of the night sky. El Morro also partnered with WNPA when seeking funding and additional support for these events.

WNPA has helped El Morro pay for many of the resources materials the monument uses to promote dark sky restoration. Many of the books, materials, and flyers El Morro uses when rangers participate in school events or staff an information table are funded through WNPA. This organization helps fund events that the park normally wouldn't have money for and provide many of the supplies for

interpretive programs, books, and gear. WNPA has access to non-federal funds that allow the park to participate and host more events, accessing more opportunities.

El Morro's partnership with the EMAAC has been crucial in hosting night sky events in the winter. El Morro lacks the space to host large indoor events in the wintertime, and the temperature in the winter is too extreme to host events that are entirely outside. As a result, El Morro forged a partnership with the EMAAC in order to host events in their space, the Old School Gallery. The gallery has a large space and stage to host talks, a large field behind the main building that is perfect for telescope viewing, and a proximity to the monument that makes it easy for rangers to coordinate events. The EMAAC has been incredibly supportive of El Morro's dark sky park goals, both in co-sponsoring our winter night sky events (see Cultural Constellations section above), advertising our night sky events, and writing us a formal letter of support. In addition, the gallery is a pillar in the community, oftentimes being used as a gathering space for a myriad of events. By creating a partnership with the EMAAC, El Morro aimed to forge a stronger relationship with the community and involve the community in our night sky preservation efforts. For example, after participating in one of these events, the director of the EMAAC (and Ancient Way Café owner) immediately removed a large unshielded floodlight from outside her café. Unfortunately the light was removed before it was documented to provide a before/after picture, but the owner addresses the removal of the light fixture in her letter of support. Events at the EMAAC have also helped to diversify our audiences. Hosting the Cultural Constellation series at the Old School Gallery helped us reach visitors and residents in tribal nations surrounding the monument. With more audience members attending from Gallup and Zuni, El Morro has noticed a more culturally diverse audience participating in night sky events.

The EMAAC partnership has led community members to learn about our night sky efforts and inspired many to get involved. This includes members of the community who wrote letters of support, expressing their own efforts in maintaining the darkness of the El Morro Valley's skies. The EMAAC partnership has allowed El Morro to connect with many groups in the community and has been the fulcrum of these connections. For example, the EMAAC helped us connect with the volunteer fire department, the El Morro Ranches Subdivision, and the owner of C&E Concrete, Inc. This partnership has been the center of the web that has connected El Morro to its surrounding communities.

El Morro has also reached out to the Property Owners Association of El Morro Ranches housing community. Their board is currently reviewing El Morro's outdoor lighting ordinance met on July 20, 2019, to decide if this plan will be implemented in their community. An El Morro ranger attended this meeting and promoted the adoption of a lighting ordinance to the board.

The El Morro Valley Fire District #21 is comprised of primarily volunteer firefighters who serve the community. This fire house and the monument are working together to find fully shielded fixtures for their fire station. Installation of new fixtures at the station is set to be completed by fall 2019.



Figure 13: El Morro Valley Fire Dept. firefighter points to outdoor light fixtures at the Cibola County fire station along Hwy 53.

The C&E Concrete, Inc. also agreed to meet with El Morro rangers at their neighboring gravel pit for an inventory of their outdoor light fixtures and nighttime operations on July 26, 2019. This is one of the largest sources of light in the valley. Walter Meech Jr., President of C&E Concrete Inc. discussed



Figure 14: Rangers from El Morro and President of C&E Concrete, Inc. discuss nighttime lights at the Tinaja facility. Two main structures have already converted to partially shielded fixtures and a few unshielded fixtures remain.

night sky friendly lighting with rangers while touring the facilities. Mr. Meech has replaced many permanent nighttime lights with shielded fixtures simply because they worked better, are more efficient, and lite the area better. The Tinaja pit typically does not work at night unless work cannot be completed during the day. However, many lights must remain on throughout the night. There are a few other structures that do not have shielded fixtures and Mr. Meech has agreed to consider purchasing night sky friendly fixtures when finances permit.

El Morro's efforts involve grassroots movements and community participation that start with relationship building. El Morro has begun to establish working relationships with community organizations that surround the monument in order to engage these groups in dark sky restoration. El Morro hopes to continue outreach and education about nighttime lighting in the community and is currently seeking grants to cover the financial costs associated with changing outdoor fixtures.

Leadership in Dark Sky Restoration - Section B (v.)(4)

El Morro uses night sky quality data in interpretive programs at the park. In particular, star parties and full moon events are a great place to set up a table and give a demonstration for visitors.



Figure 15: El Morro ranger holds up a SQM meter to demonstrate to visitors how the park measures and monitors night sky quality. Then visitors play a game to guess which light pollution sky glow matches which city.

When El Morro rangers conduct programs that have a night sky theme, they are asked to include the monument's night sky quality data into their programs. There is a short blurb available that can be inserted and woven into any interpretive program. However, rangers are welcome to write their own version and incorporate this information into their program in a way they best see fit. Below is the text that is sent to night sky rangers to be used in any interpretive program:

- *Here at El Morro, rangers are trying to create a baseline data set of night sky quality data to see if our skies are changing. Currently, rangers are collecting data from six sites within the monument, twice a year. However, there was a baseline measurement taken in 2013 atop Inscription Rock at Atsinna Pueblo. There are lots of ways to measure the quality of a night sky. If you are familiar with the constellations, you can record it using your naked eye and use the brightness of certain stars and constellations to tell if there is light pollution impacting your visibility (Bortle Scale). You can also take night sky photos and examine your camera's settings to evaluate if your images appear different over time (documentation). The NPS used this fancy machine to measure all the sources of light pollutants and how much light pollution was impacting El Morro (CCD). And this is the meter we use for taking sky brightness measurements (SQM-L). If you're interested, there are apps you can download to your phone to check night sky quality wherever you go!*
- *In 2013, the measurement atop Inscription Rock at Atsinna Pueblo was 21.54 magnitudes per square arc-second. Although most of the readings collected recently maintain a similar value, some have become a bit brighter and some, a bit darker. These may not seem like big changes, but rangers are trying to see if the skies have gotten brighter in the last 5 years. Keep in mind, this is preliminary data and rangers will continue to collect more data for an accurate baseline. However, it shows how important it is for all of us to remember to cherish and protect the natural dark skies in this monument – they may not stay this dark!*
- *Fortunately, light pollution is entirely reversible and we can show you how to take a closer look at the outdoor lights around your home and community. Let's think about what we can do to continue to protect and preserve the dark night skies in the EL Morro Valley or wherever you're visiting from today!*



4 Lighting Management Plan and Inventory

NPS Photo/Derek Wallentinsen

El Morro National Monument Lighting Management Plan



Prepared by:

Leslie Kobinsky

Leslie Kobinsky, Night Sky Project Lead

6/18/2019

Date

Ana Colón

Ana Colón, Night Sky Team

6/18/2019

Date

Approved by:

Ernie Price

Ernie Price, Chief of Interpretation (acting Superintendent)

6-18-19

Date

Rick Best

Rick Best, Chief of Facilities Operations

6-18-2019

Date

Steve Baumann

Steve Baumann, Chief of Resources Management

06-18-2019

Date

Kelly M. Lynch

Kelly Lynch, Chief Ranger

6.18.2019

Date

W C Bledsoe

William Bledsoe, Chief Administrative Officer

6.18.2019

Date



El Morro National Monument's Lighting Management Plan

Purpose

In 1999, the state of New Mexico implemented the Night Sky Protection Act (NSPA), declaring the night sky as one of the state's most endangered resources and vowing to protect it. This application aims to establish a standard by which El Morro National Monument (El Morro) will preserve its night skies, minimize impacts on the nocturnal environment, while maintaining an environment of safety for both staff and visitors. In doing so, this plan will bring El Morro's regulations in line with those set by NSPA. Moreover, it is hoped that El Morro's LMP will serve as an example that would be adopted by surrounding communities in the El Morro Valley.

This Lighting Management Plan (LMP) is the foundation for El Morro's mission of preserving naturally dark skies. The LMP is based on best practices in night-sky friendly lighting design per NPS Management Policy 4.10— Lightscape Management, Guidelines for Outdoor Lighting in Royal Astronomical Society of Canada (RASC) Dark-Sky Preserves, and the International Dark-Sky Association (IDA) Dark-Sky Parks lighting guidelines.

Lighting Inventory

El Morro is approximately 1,200 acres with few visitor services requiring outdoor lighting. As such, the lighting footprint is minimal. The park has two developed areas with outdoor lighting: the visitor center and employee housing, consisting of five houses and three apartment units. There are currently 20 functional light fixtures in the visitor center, including the maintenance area, and 18 light fixtures in the housing area, some of these 38 fixtures are historic.

Historical Considerations

Most buildings at El Morro were constructed during the historic Mission 66 era. The lighting fixtures are among the character-defining elements of the Mission 66 structures and are not eligible to be replaced. To address historic, non-compliant fixtures, bulbs were changed in all historic fixtures to be low-lumen (355 lumens) and low Correlated Color Temperature (CCT) (< 2700K). Non-functioning historical light fixtures will be replaced in-kind with similar fixtures that are LMP compliant and have the same character as the historic fixtures.

Retrofitted, Non-Compliant Fixtures

For non-historic fixtures that are required to remain due to their historic appearance, the inside glass of the fixtures were painted opaque dark brown to block side escaping light. The retro-fit was applied to all of the #3 fixtures identified in the El Morro Lighting Inventory. These retrofitted, non-compliant fixtures are now in compliance with IDA's standards while maintaining its historic appearance. Non-historic lights in the housing area will be replaced with fixtures to be in compliance with IDA.



Satellite image of developed areas at El Morro National Monument. Note that only the Visitor Center and Staff Housing have light fixtures, while the campground is free of any artificial outdoor lighting.

Park Lighting Standards

1) Warranting- Light only WHERE you need it

- a. Lighting installations should be placed only where uses dictate. New lighting will only be warranted where there has been a public safety hazard identified that may only be mitigated with the use of artificial light at night.

2) Controls- Light only WHEN you need it

- a. Rather than defaulting to a dusk-till-dawn operational cycle, lighting controls should be designed to minimize the amount of time the light is on while still fulfilling the need met by installing the light at that spot in the first place.
- b. El Morro will follow the "Lighting Guidelines" outlined below in addition to encouraging a Lighting Curfew in housing at 10 p.m. Employees will be asked to turn off outdoor lights from 10 p.m. to sunrise and close window blinds to prevent interior lights from impacting outdoor darkness. This guideline is to help change lighting culture in the housing area that will aid in our efforts to protect night skies.

3) Shielding- Direct light DOWNWARD

- a. No fixture should emit light above the horizontal. In most cases, beams of light should be restricted even further. *Lighting of less than 500 initial lumens may be unshielded for preservation of historic fixtures.*

4) Spectrum- Select LAMPS that minimize negative impacts

- a. Humans and many other animals are most sensitive to blue/white light. Most evening lighting goals can be achieved using warmer temperature lighting, which decreases the disruption to wildlife (including insects), maintains the human ability to adapt to low light conditions, and decreases sky glow.
- b. The color tint of white light, the CCT, is measured in Kelvins (K), a scale in which warm-toned white light has smaller values (1800-3000K) and cold-toned light has larger values (5000K and higher). Between 3000 and 5000K, light is said to be "neutral" in tone. The common incandescent lamp is 2700K.
- c. Traditional incandescent lighting is about 2700K, a warm-toned light considered normal for residential and hospitality lighting in North America. For reasons

of consistency and appearance, light sources should be 2700-3000K with a minimum Color Rendering Index of 70. Amber or yellow light sources are preferable, both to limit attraction by insects and to reduce sky glow. Light sources should be chosen for energy efficiency, long life, and low maintenance. Because some locations in the park experience extremes of temperature, elevation and exposure, light sources must be suitable for all expected operating conditions.

5) Intensity- Use the minimum AMOUNT of light necessary, as determined and approved by the Superintendent or their designee.

6) Efficiency- Select the most energy EFFICACIOUS lamp and fixture, as determined and approved by the Superintendent or their designee.

Local Lighting Standards









El Morro's Lighting Management Plan meets and exceeds the state lighting standards of the New Mexico Night Sky Protection Act (NSPA). Neighboring towns of Gallup, Grants, and Ramah, NM do not have specific ordinances for outdoor lighting. However, new buildings must comply with the ordinances of the NSPA. While Ramah and Grants do not have specifications for outdoor lighting practices to protect the night sky, Gallup's city ordinance specifies following those outlined by the Albuquerque Code of Ordinances, Chapter 14, Article 16 Integrated Development Ordinance (IDO): Parts 14-16-5-8 (Outdoor Lighting) of the Albuquerque Code of Ordinances claims the following that is relevant to El Morro's light fixtures:








- All outdoor light fixtures 150 watts or greater for incandescent light sources or 70 watts or greater for other types of light sources shall be shielded using full cutoff light fixtures (i.e. a light fixture with zero intensity at or above 90 degrees above nadir and limited to a value not exceeding 10 percent of lamp lumens at or above 80 degrees).
- No light source for any outdoor light fixture shall be directly visible from any public right-of-way or any adjacent property and shall not be visible from a distance greater than 1,000 feet in any Residential zone district.
- All outdoor lighting shall be shielded and aimed so that light spillover onto the area 10 feet beyond the property line shall not exceed 200 foot lamberts at the property line except where adjacent to walkways, bicycle paths, driveways, or public or private streets.
- All outdoor light fixtures within any Residential or Mixed-use zone district shall remain off between 11:00 p.m. and sunrise except for security purposes or to illuminate walkways, driveways, equipment yards, and parking lots.
- Light fixtures shall have a minimum light intensity of one lumen per square foot and a maximum intensity of two lumens per square foot unless a different standard is provided in this IDO.
- Light fixtures installed in canopies or similar structures shall be flush-mounted or recessed above the lower edge of the canopy and shall be equipped with flat lenses that do not project below the canopy ceiling. The canopy fascia shall not be internally illuminated.
- All exterior light fixtures shall generate at least 80 lumens per watt of energy consumed, as shown on the manufacturers specifications for the fixture.

100% Compliance

Currently, El Morro's lighting fixtures are at 89% compliance with the park's Light Management Plan. El Morro is awaiting State Historic Preservation Office (SHPO) approval on four remaining non-compliant fixtures (two in the housing area and two at the visitor center) and will be at 100% compliance by 2020.

Total lights at ELMO	Compliance with LMP	Non-Compliance with LMP
38 (100%)	34 (89%)	4 (11%)

ID #	Photo (before)	Photo (after)	Location	Application	Fixture	Lamp	Watts/ Lumens /CCT	Shielded?	Compatible with LMP?
1		Changed bulb 	Visitor Center (x8)	Area light, walkway illumination	Historic Unshielded globe	Soft white, incandescent	~40W ~355 lumens ~2,700K	Partially, by overhang	Yes
2			Visitor Center Restrooms (x1)	Walkway illumination	5C014 shielded fixture	Soft white, LED	~6W LED ~450 lumens ~2,700K	Yes, by overhang	Yes
3		 Glass painted	Courtyard (x5)	Walkway illumination	Historic wall fixture	Soft white, LED	~6W LED ~450 lumens ~2,700K	Partially by overhang and glass	Yes, after retrofit.
4			Visitor Center (x1)	Walkway illumination	N/A	N/A	N/A	N/A	Removed fixture.

5		Changed bulb 	Maintenance Building (x1)	Walkway illumination	Historic PrescoLite Fixture	Soft white, incandescent	~29 W ~430 lumens ~2,800K	Partially, by overhang	Yes
6		Changed bulb 	Maintenance Building (x1)	Walkway illumination	Historic PrescoLite Fixture	Soft white, incandescent	~29 W ~430 lumens ~2,800K	Yes	Yes
7		Historic glass, changed bulb 	Maintenance Building (x1)	Security illumination of maintenance walkway	Historic PrescoLite fixture	Soft white, incandescent	~29 W ~430 lumens ~2,800K	Partially, by overhang	Yes, found historic glass to cover.
8			Maintenance Shed (x2)	Security illumination of maintenance area	N/A	N/A	N/A	N/A	Electricity was cut to this light source.

9			Staff Residences (x2)	Walkway illumination	HSP1691A shielded fixture	Soft white, LED	~6W LED ~450 lumens ~2,700K	Partially, by overhang	Yes
10		Changed bulb 	Staff Residences (x10)	Walkway illumination	Historic PrescoLite Fixture	Soft white, incandescent	~29 W ~430 lumens ~2,800K	Partially, by overhang	Yes
11			Staff Residences (x2)	Walkway illumination	P5774-20 shielded fixture	Soft white, LED	~6W LED ~450 lumens ~2,700K	Partially, by overhang	Yes
12			Staff Residences	Walkway illumination	HSP1691A shielded fixture	Soft white, LED	~6W LED ~450 lumens ~2,700K	No	Yes





13			Staff Residences	Porch illumination	HSP1691A shielded fixture	Soft white, LED	~6W LED ~450 lumens ~2,700K	Partially, by overhang	Yes
14			Staff Residences	Porch illumination	HSP1691A shielded fixture	Soft white, LED	~6W LED ~450 lumens ~2,700K	Partially, by overhang	Yes

Table 4: Lighting Inventory taken in October 2018 and completed in August 2019.

As of August 2019, El Morro National Monument is in 100% compliance with IDA's night sky friendly light fixtures guidelines and the monument's LMP.

5. Management Documents

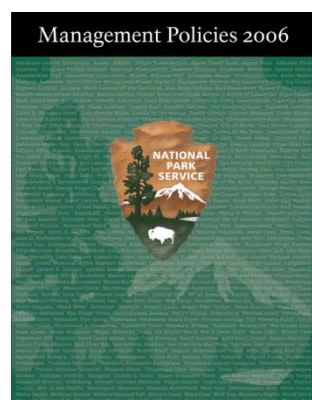
There are several NPS management documents that support dark night skies including the Organic Act of 1916, NPS Management Policies of 2006, and the Green Parks Plan of 2016. El Morro specifically chose Goal #27 Starry, Starry Night of the 2016 Call to Action plan to focus on during the centennial year. El Morro's Foundation Document also lists gaining IDSP certification as an important opportunity. Lastly, with the onset of this application, El Morro was able to edit the monument's Long Range Interpretive Plan to include goals and objectives for planning programs, educational opportunities, and outreach events geared towards dark night skies.

National Park Service Organic Act, 1916

"The service thus established shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified by such means and measures as conform to the fundamental purposes of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."



NPS Management Policies, 2006



"The Service will preserve, to the greatest extent possible, the natural lightscares of parks, which are natural ...Recognizing the roles that light and dark periods and darkness play in natural resource processes and the evolution of species, the Service will protect natural darkness and other components of the natural lightscape in parks. To prevent the loss of dark conditions and of natural night skies, the Service will minimize light that emanates from park facilities, and also seek the cooperation of park visitors, neighbors, and local government agencies to prevent or minimize the intrusion of artificial light into the night scene of the ecosystems of parks...

The Service will:

- Restrict the use of artificial lighting in parks to those areas where security, basic human safety, and specific cultural resource requirements must be met;
- Use minimal-impact lighting techniques;

- Shield the use of artificial lighting where necessary to prevent the disruption of the night sky, natural cave processes, physiological processes of living organisms, and similar natural processes.”

Green Parks Plan, 2016

The Green Parks Plan: Advancing Our Mission through Sustainable Operations. “At this turn-of-the-century moment, we must also increasingly focus our attention on engaging our partners and visitors to help us reduce our environmental footprint both inside and outside park



Preserve Outdoor Experiences, Promote Healthy Engagement

The NPS will promote healthy outdoor experiences and minimize the impact of facility operations on the environment.

Healthy outdoor experiences depend on healthy ecosystems. Well-managed park operations and facilities can ensure that ecosystems are healthy and support human health and wellbeing. Conversely, when park facilities are not well-managed, they can have an adverse effect on outdoor experiences and the environment. For example, exterior lighting can reduce visitors' dark-night-sky quality and disrupt natural light and dark cycles that are essential for wildlife to flourish. Vehicle traffic can also degrade the acoustic environment and disrupt the ability of visitors and wildlife to perceive important acoustic information. The NPS will reduce the impact of Service operations on the environment and seek to preserve night skies, natural sounds, water quality, ecosystems, and viewsheds to improve the visitor experience and protect natural and cultural resources.

Objectives

1. The NPS will use sustainable outdoor lighting principles to reduce light from park facilities, preserving dark night skies.
2. The NPS will minimize noise and protect the acoustic environment of parks.
3. The NPS will preserve opportunities for healthy outdoor experiences to promote people's physical, mental, and spiritual health and social wellbeing.

boundaries. We are committed to working to integrate sustainability principles, actions, and

initiatives into existing partnerships and developing and fostering new partnerships to promote sustainability efforts. Over the next 100 years, we will also strive to

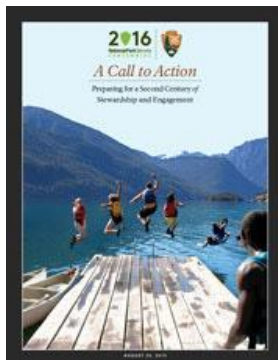
engage and collaborate more fully with the millions of visitors who value and support the national parks, encouraging them to do their part in the parks and at home.” This document highlights the efforts to “minimize the impact of facility operations on the environment.” Specifically listed as the second objective, “The NPS will use sustainable outdoor lighting principles to reduce light from park facilities, preserving dark night skies.”



Green Parks Plan Advancing Our Mission Through Sustainable Operations



Call to Action, 2016



Starry, Starry Night

27

Lead the way in protecting natural darkness as a precious resource and create a model for dark sky protection by establishing America's first Dark Sky Cooperative on the Colorado Plateau in collaboration with other federal agencies, partners, and local communities.

Preserving America's Special Places #27 Starry, Starry Night describes a call to action that is focused on preserving, protecting, and interpreting night sky resources. Goal #27 was selected by the El Morro staff as 1 of 3 Call to Actions the monument chose to focus on in 2016.

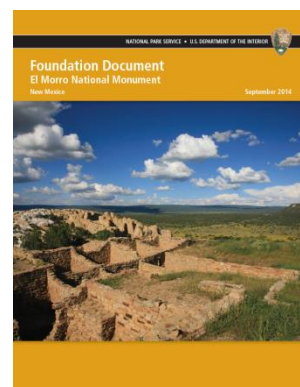
Night Sky Protection Act, New Mexico

In 1999, New Mexico passed the Night Sky Protection Act to help protect the state's dark skies. "The purpose of the Night Sky Protection Act [74-12-1 to 74-12-10 NMSA 1978] is to regulate outdoor night lighting fixtures to preserve and enhance the state's dark sky while promoting safety, conserving energy." This act was updated in 2009 to include measures to enforce the act within the state's boundaries. Another initiative involves the prohibition of certain light fixtures to eliminate "hazardous glare" and "light trespass" which will be brought to the New Mexico senate in early 2019.



Foundation Document, 2014

The foundation document for El Morro National Monument does not specifically outline night skies in main interpretive themes or fundamental resource and values. There were a few sections that highlighted current dark sky trends and mentioned the potential for dark sky protection. These sub-topics are listed below:



Cuesta and Natural Setting (page 16)

- *Current Conditions and Trends*
 - Natural sounds, dark skies, and viewshed are important resources that vary in integrity.
- *Threats and Opportunities*
 - Obtain dark skies preserve certification.
 - Community interest in protecting monument resources as part of the state scenic byway and arts trail, including air quality, night skies, and viewsheds, to reduce impact.

Superintendent's Compendium, 2019

Superintendent's Compendium of El Morro National Monument is a list of designations, closures, permit requirements, and other restrictions. Reducing impact on nocturnal wildlife is in line with the Superintendent's Compendium. Section 2.2(e), Wildlife Protection states, "The use of artificial light sources (such as spotlighting) to deliberately illuminate or view wildlife including infrared, thermal imaging, or ultra-violet (black light) devices of any kind are prohibited." El Morro has determined that activities such as spotlighting or intentionally illuminating wildlife represent deliberate actions that cause significant disturbance to wildlife.

Long Range Interpretive Plan, 2017 (updated 2019)



The LRIP was specifically modified in accordance with this IDSP application to include language about protecting, preserving, and interpreting dark night skies. The modification includes a central goal and list of actions to accomplish this new interpretive goal.

Goal:

Actively lead **dark sky** interpretation and stewardship (in partnership with and) for the general public, students, and surrounding communities.

Actions:

- Attain International Dark-Sky Association (IDA) certification to become an International Dark Sky Park (IDSP).
- Upon obtaining IDSP status, create a wayside panel that highlights how the park preserves and protects night skies and what it means to be an IDSP.
- Create a website page that provides information about cultural and scientific night sky resources, how the park is protecting and preserving natural darkness, showcase global astronomical events, and promote local night sky events.
- Provide on-site education and outreach about night skies to schools and community groups.
- Host (or co-host) cultural astronomy events to help the park improve its connections with local tribes.
- Partner with groups such as Western National Parks Association (WNPA) or El Morro Area Arts Council (EMAAC) to co-host night sky events for visitors and the local community.
- Host at least 4 night sky events each year at El Morro NM to provide opportunities for public nighttime access and educational opportunities.
- Monitor night sky locations (twice a year) with Sky Quality Meter (SQM) darkness reader for the IDSP yearly report.
- Become a leader in decreasing light pollution at El Morro NM and in the surrounding communities.
- Develop a telescope training program for new interpretive staff.
- Connect with other NPS sites for additional resources and become part of the larger night sky ranger network.

- ## El Morro & El Malpais National Monuments Five-Year Strategic Plan

[illegible]

6. Letters of Support

David Jose
President

RAMAH NAVAJO CHAPTER
HC 61, Box 13 Ramah, New Mexico 87321-9601
(505) 775-7130/7132
FAX (505) 775-7137

Jamie Henio
Council Delegate
Navajo Nation Council

Chancey K. Martinez
Vice-President

Tribal Office



Rodger Martinez
Member
Eastern Navajo Land Board

Dixie M. Begay
Secretary/Treasurer

May 1, 2019

Lisa Leap
Superintendent
123 E. Roosevelt Ave.
Grants, NM 87020

Dear Superintendent Leap:

This letter is in response to your staff's presentation on March 7, 2018 regarding International Dark Sky Park certification for El Morro National Monument.

El Morro - *Tsé'k' i Na'asdzoo'* - is a sacred site to the Ramah Navajo, and some etchings on Inscription Rock are of Navajo origin. Historically and through the modern era, Navajo people have used El Morro and have lived close by. We consider the sites of our ancestors to be significant locations of contemporary relevance to our people and part of our traditional landscape. We appreciate your regard for our interest in El Morro and the opportunity to support the protection of its traditional landscapes and night sky.

The Ramah Navajo Chapter therefore supports the designation of El Morro National Monument as a Dark Sky Park, awarded by the International Dark Sky Association, as "a location of exceptional nighttime beauty, dark skies education, and preservation of the nighttime environment." We further appreciate the monument completing the lighting inventory and retrofitting light fixtures while maintaining historic integrity as applicable to comply with lighting guidelines in preparation of submitting a Dark Sky Park application in 2018.

If you have any questions or need additional information, please contact me at (505)-775-7130 or (505) 775-7135 or contact me by email at DavidJose@ramahnavajo.org. Thank you again for your consideration.

Respectfully,

David Jose, President

cc: File



The Albuquerque Astronomical Society (TAAS)
A Nonprofit 501 (C) (3) New Mexico Corporation
P.O. Box 50581
Albuquerque, NM 87181-0581

29 November 2018


International Dark-Sky Association (IDA)
3223 North First Ave.
Tucson, AZ 85719

Dear IDA Board of Directors,

This letter is submitted in support of the El Morro National Monument's application for certification as an International Dark Sky Park. The Albuquerque Astronomical Society (TAAS) is one of the largest and most active amateur astronomy clubs in the United States. Several of our members observe at or in the vicinity of El Morro. TAAS is very interested in preserving the night sky in the El Morro area and enthusiastically supports its designation as an International Dark Sky Park.

Albuquerque is the 32nd largest U.S. city with about half of the New Mexico population living in its metropolitan area. It produces a substantial light dome that inhibits observing in or near the city. El Morro is located just over 100 miles west of Albuquerque. It is easily accessible for observers. It would be the closest and most accessible International Dark Sky Place for most of the population of New Mexico.

Certification of El Morro as an International Dark Sky Park will raise the level of interest in Albuquerque about the night sky and will enhance our efforts to improve the darkness of the skies around Albuquerque. We pledge our support of the monument and its astronomical activities.


James M. Fordice
TAAS President

11/28/2018

Board of Directors

International Dark Sky Association

3223 North First Avenue

Tucson, AZ 85719-2103

Dear Board of Directors:

I am writing to you in support of El Morro National Monument's application for "Dark Sky Park" designation. El Morro National Monument is located in a remote setting in the northwest quadrant of New Mexico that is known for its incredible and varied topography and amazing night skies. These resources along with the rich multi-cultural history of the El Morro Valley serve as a setting for our jewel of a National Monument, El Morro.

As business owners in El Morro and partners, supporters, and participants of programming at El Morro National Monument it excites us to know that the possibility for a "Dark Sky Park" designation will be considered for this National Monument. As amateur astronomers, the dark skies of the El Morro Valley were one of the primary reasons we located our home and our business in this area. We have attended, and supported through our business, many of the astronomy events presented at El Morro National Monument and neighboring El Malpais National Monument. Our relationship with El Morro National Monument started in the years prior to 1996 when we purchased our home site in the Zuni Mountains and has continued on through the establishment and operation in El Morro of our business, Inscription Rock Trading & Coffee Co. in 2005.

We have a deep love and commitment to El Morro National Monument and feel that a designation of "Dark Sky Park" will only further enhance this special Monument's place in the hearts of El Morro Valley residents and future park visitors. Additionally the National Park Service will only benefit from this special designation for the second oldest National Monument in the NPS system.

We encourage you to consider and approve their application.

Thank you. Very Sincerely,

Jonathan and Pamela Pickens

Owners - Inscription Rock Trading & Coffee Co

El Morro, NM

El Morro Feed & Seed: Not Your General Store

4019 Ice Cave Road, HC 61 Box 45, 87321
505-783-4777

October 22, 2018

International Dark-Sky Association
3223 North First Avenue
Tucson, AZ 85719-2103

Dear IDA Board of Directors:


I am writing in support of El Morro National Monument's application for Dark Sky Park Designation. Located miles and miles from sources of light such as towns and industrial sites, El Morro Monument and the "greater El Morro area" enjoys wonderfully clear night skies. Travelers and other visitors to the area are struck by the beauty of the Monument itself and by our breath-taking night skies.

El Morro Feed & Seed has been in existence for 11 years and is one of six local businesses that make up "beautiful downtown El Morroville" just a scant 2 miles from the Monument. Located 12 miles from Ramah, NM (population 407) and approximately 50 miles from either Grants or Gallup, this rural and remote outpost has become a hub for many of the folks who live in the far-flung communities around El Morro Monument as well as a source of delight for many of the people who travel here to visit the Monument and surrounding areas.

El Morro National Monument has partnered with the businesses of "El Morroville" over the years and is a beloved and well used institution. It's current sky programs such full moon hikes, eclipse and meteor viewing have grown in popularity and add a rich dimension to life here. In addition to the Monument's celebration of our night skies many of the locals are dedicated star gazers with many folks having their own telescopes and there is even a privately owned observatory in the area.

An official Dark-Sky designation would benefit all of us local sky gazers with a secondary economic benefit to the community at large as more people would be drawn to visit the Monument with such a designation. I encourage you to approve their application.

Sincerely,



Kate Brown

Owner/Operator El Morro Feed & Seed

P.O. Box 830
Ramah, NM 87321

October 29, 2018

International Dark-Sky Association
3223 North First Ave
Tucson, AZ - 85719-2103

Dear IDA Board Members,

As a founding member of the El Morro Area Arts Council & a 25 year resident of the area, I am writing to enthusiastically support El Morro National Monument's application as a Dark Sky Park.

Our Arts Council has been a community resource for over 20-years, with artists & members from a wide surrounding area, including Ramah, Zuni and Pine Hill. We have benefitted from our proximity to El Morro both because of its beauty & history & also because of its attraction to visitors who also visit us!

The park service staff have created programs that feature night sky events - a treat for locals and a great opportunity for those without dark skies to enjoy the full spectrum of El Morro's beauty.

The Dark Sky Park designation would be a real boon to visitors & locals alike and a commitment to the preservation the great resource of Dark Sky in an increasingly bright night time world.

Sincerely, Jill Acheson

Western
National Parks
Association

October 15, 2018

International Dark-Sky Association
3223 North First Avenue
Tucson, Arizona 85719-2103

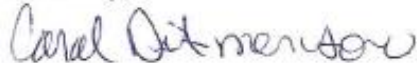
Dear IDA Board of Directors:

The New Mexico Region of Western National Parks Association is pleased to support the nomination of El Morro National Monument for an International Dark Sky Park Designation.

El Morro National Monument is a spectacular resource that reflects the criteria desired for designation as a dark sky resource. Due to its remoteness, high elevation, distance from urbanization, dry air and clear skies, and status as a unit of the National Park System, El Morro National Monument has the ability to preserve, protect, and promote night sky values. In fact, El Morro has already been conducting night sky programs in recent years and the Night Sky Designation would greatly enhance the appeal of these offerings.

Thank you for the opportunity to support this effort to conserve dark skies for the benefit of park visitors, nearby communities, and future generations.

Sincerely,



Carol Ditmanson
Operations Manager
New Mexico Region
Western National Parks Association
PO Box 3434
Las Vegas, NM 87701
Office-505.425.9757
Cell-520.429.2614

Sharron J Dishongh
The Pueblo Ancient Way LLC
HC 61 Box 44
Ramah, NM
87321

Ancient Way Cafe



May 23, 2019
International Dark-Sky Association
3223 North First Avenue
Tucson, AZ 85719-2103

Dear IDA Board of Directors,

I am writing to you in support of El Morro National Monument's application for International Dark-Sky Park designation. El Morro is located in an area of northwestern New Mexico known for its outstanding scenery and natural darkness. Their night sky resources, along with the rich multi-cultural history of the area, are crucial for both the monument's mission and to the people of the El Morro valley. The Ancient Way Café even removed a bright light from our outdoor business to help protect the night skies that surround El Morro National Monument.

El Morro National Monument has a history of partnering with the local businesses in the El Morro valley to work together towards decreasing our overall contribution to light pollution. The night sky programs they host, both within the monument and in conjunction with the El Morro Area Arts Council, have grown in popularity within the community and provide a space for sharing in the phenomenal night skies the monument has to offer. In addition, many members of the community themselves are stargazers and highly value the natural darkness of the area.

The designation of "International Dark-Sky Park" would further enhance this monument's place in the community and benefit future park visitors, placing emphasis on protecting this beautiful resource. We fully support El Morro's nomination to this designation, and we encourage you to approve their application.

Sincerely,

A handwritten signature in blue ink, reading "Sharron J Dishongh". The signature is fluid and cursive, with the first name "Sharron" being more prominent.

GRANTS - CIBOLA COUNTY *Chamber of Commerce*

International Dark-Sky Association
3223 North First Avenue
Tucson, AZ 85719-2103

Nov. 28, 2018

Dear IDA Board of Directors,

The Grants/Cibola County Chamber of Commerce is pleased to write this letter in support of El Morro National Monument seeking certification to become an International Dark Sky Park. El Morro National Monument is one of the greatest outdoor gems in the western area of New Mexico. Along with its striking sandstone formations and dazzling views of Cibola National Forest, the El Morro Valley contains one of the most dazzling views of the nighttime sky. The fact that visitors and residents of the area are a mere 40 minutes away from an area free of noise and light pollution is no small matter, and El Morro National Monument being certified as an International Dark Sky Park will draw even more adventurous people wanting to catch a glimpse of the Milky Way Galaxy. We wholeheartedly support El Morro National Monument and we hope you all see the same great qualities in their park that we do.

Sincerely,

Board of Directors

Grants/Cibola County Chamber of Commerce

New Mexico Mining Museum

(505) 287-4802 – www.grants.org

Phone: (505) 287-4802 • Fax: (505) 287-8224 • Toll Free: 1-800-748-2142
100 N. Iron Ave. • P.O. Box 297 • Grants, New Mexico 87020 • Email: discover@grants.org • www.grants.org

June 21st, Solstice 2019

**Dark Sky Park Designation
El Morro National Monument**



Dear International Dark-Sky Association,

We are writing you in support of El Morro National Monument's application for designation as a Dark Sky Park. Located in rural New Mexico along the Continental Divide, between the massive El Malpais National Park and the local Zuni Mountain range, El Morro National Monument is an absolute cornerstone of our landscape. Central to a number of small, yet vibrant communities in every direction, the Monument continues its hundred - even thousand - year-old tradition of serving as a landmark to travelers & locals alike. One such community is ours; Zuni Mountain Sanctuary.

As a Sanctuary for LGBTQ+ people in rural New Mexico, ZMS is a unique oasis of counter culture, nestled happily against the Zuni Mountains, roughly 10 miles to the north of the Monument. Home to roughly 4 or 5 stewards at a time throughout the last few years, our Sanctuary is well known within the international Radical Faerie community, and thus is host to many travelers as they make their way across the American Southwest. We are honored to offer our guests access to a pristine, picturesque natural setting, which we care for with great reverence. And while the stunning views of the mountains, fields, cliffs and canyons of our surrounding landscape are breath-taking, the experience of an un-interrupted night sky is an awe-inspiring event for our visitors, just as it continues to be a humbling and fascinating reality for our residents. With clarity of the night sky, we're able to observe the movement of the stars through the seasons (or, more accurately, the movement of the Earth through the solar system), learn the names of stars & constellations, and observe phenomena such as meteor showers and planetary movements. Some of our more urban guests have never seen such a clear night sky at all.

The designation of our neighboring monument, El Morro, as a Dark Sky Park would ensure this gift of access to the night sky to us as a Sanctuary for generations to come. It would directly support our own mission to live in harmony with the cycles of nature, as well as promote a culture of conscientious light consumption within the greater area of the El Morro valley.

Thank you for your consideration,
On behalf of everyone here at Zuni Mountain Sanctuary.

Layard Thompson
Co-Coordinator of the Board of Directors & Steward

Zuni Mountain Sanctuary
P.O. Box 636
Ramah, NM 87321
www.zunimountainsanctuary.org
zunimountainsanctuary@gmail.com

El Morro Market, LLC
3380B Bond Street
Ramah NM 87321



Dear International Dark-Sky Association,

I am writing in regards to El Morro Monument's application to be designated as a Dark Sky Park.

As a small business located in Ramah, New Mexico, the nearest town, I find it necessary to promote and preserve the natural beauty of our local landscape, and that applies to the preservation of our night sky. We support our local farmers by selling their organically grown produce & ethically raised livestock. We do our best to keep the currency within our local economy, which is a challenge in the middle of a food desert. A significant source of income comes from visitors to the area, and that is largely due to the Monument.

I believe it would be beneficial to our business, as well as our greater community, for El Morro Monument to be granted this status as a Dark Sky Park. As a local business, we're able to witness the success of events held at the monument, such as Full Moon Hikes and Star Parties. Dark Sky Park designation would ensure longterm access to educational, cultural events at the monument, which will connect locals and visitors alike to our unique landscape, as well as the spectacular beauty of a starry sky!

Thank you for your consideration,

Jaye Wilkinson
Owner/Manager

Family Haven Farms
25 Rim Rock Rd
Pinehill, NM 87357



To IDA board of directors,

We at Family Haven Farms fully support El Morro National Monument application for the Dark Sky Park designation.. Located about 20 miles south of Grants, this area enjoys darker skies than most. Being amateur stargazers, we love the idea of more astro tourism in the area. More people, better economy and stronger community!

Family Haven Farms is a family owned farm 12 miles from the monument. We have a direct line of sight to box canyon, situated within El Morro. We have a completely off grid operation going on, staying away from bright spotlights, flood lights and other such light pollution. Our source of light for those dark moonless nights are small solar powered garden lights. The community in the El Morro valley prides itself on its dark skies, making the monument a perfect candidate for dark sky Park designation.

We hope that you will accept El Morro's application as dark sky Park designation. It will further strengthen El Morro's place in the community.

Sincerely,
Marco Darancou @ Family Haven Farms

7. Acknowledgements

Contributors

Report compiled by:

- Leslie Kobinsky – *Permanent Park Guide*
- Ana Mercedes Colón Umpierre – *Seasonal Park Ranger*

Special Thanks

Special thanks to the staff of El Morro and El Malpais National Monuments whose help made this application possible: Rick Best, Steven Hands, Calvin Chimoni, Steve Baumann, Kelly Lynch, William Bledsoe, Rick Greene, Lisa Leap, Mitzi Frank, April Case, John Davis, Derek Wallentinsen, Wendy Gordge, and Ernie Price. El Morro would like to thank the community members of the El Morro Valley and board members of EMAAC for supporting this dark-sky initiative and helping El Morro to host so many night sky events. Members of the NPS dark sky community Randy Stanley, Bob Meadows, Christa Sadler, Jacob Holderson, and Chris Wonderly are to be thanked for providing support and guidance throughout this process. El Morro appreciates the nomination letter and night sky poster from Tyler Nordgren from the Space Art Travel Bureau. And lastly, thanks to all the individuals, businesses, and organizations that wrote El Morro letters of support or contributed to the application process: Carol Ditmanson and Kathleen Haldeman from Western National Parks Association; Board of Directors from Cibola Chamber of Commerce; Jill Acheson from El Morro Area Arts Council; Kate Brown from El Morro Feed & Seed; Jonathan and Pamela Pickens from Inscription Rock Trading & Coffee Co.; James M. Fordice from The Albuquerque Astronomical Society; Sharon Dishongh from Ancient Way Café; Matt Brown and Caroleta Metzger from Cibola Country Fire Department; Tom Manrodt from El Morro Ranches Property Owners Association; Ericc “Imajinary” Cram and Layard Thompson from Zuni Mountain Sanctuary; Ericc “Imajinary” Cram and Jaye Wilkinson from El Morro Market; Marco Darancou from Family Haven Farms; David Jose, and President of Ramah Navajo Chapter.

8. References

- NPS Natural Sounds and Night Skies Division Report for El Morro National Monument (compiled/analyzed by Utah State University):
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- NPS Management Policies:
https://www.nps.gov/training/nrs/references/references_policies.html
- El Morro National Monument Superintendent's Compendium, 2015:
<https://www.nps.gov/elmo/learn/management/lawsandpolicies.htm>
- El Morro National Monument Foundation Document:
<http://www.npshistory.com/publications/foundation-documents/elmo-fd-overview.pdf>



Half the Park
Is After Dark.

SEE THE STARS

IN EL MORRO NATIONAL MONUMENT

Credit: Tyler Nordgren