Photic Environment and Lightscapes Resource Summary
Timpanogos Cave National Monument

National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science
Natural Sounds & Night Skies Division

The quality of the nighttime environment is relevant to nearly every unit in the NPS System. The 2006 NPS Management Policies (section 4.10) speak of the importance of a natural photic environment to ecosystem function and the importance of the natural lightscape for aesthetics. Photic resources and lightscapes can be important as a natural feature, a cultural feature, or both. Natural lighting conditions are also important to wilderness character and have been identified under the Clean Air Act Amendments as an air quality related value. Therefore, the importance of lightscapes and photic environments is related to an array of park resources and values and has broad implications for park management. Park units should consider the photic environment and lightscapes as important factors that can have a profound effect on the quality of many other park resources and values such as wildlife, wilderness character, visitor experience, cultural landscapes and historic preservation. In addition to night sky considerations, parks with cave environments could consider the photic resources and lightscapes of the cave environment and entrance zone. Artificial light above and below ground may impact cave-specific flora and fauna as well as the temperature and relative humidity of the cave environment.

One way to measure the quality of the photic environment is by measuring total sky brightness averaged across the entire sky and comparing that value to natural nighttime light levels. This measure, called the Anthropogenic Light Ratio (ALR), can be directly measured or modeled when observational data are unavailable. Lower ALR levels reflect higher quality night sky conditions. Figure 1 provides modeled ALR levels for the contiguous U.S.

At **Timpanogos Cave NM**, protecting photic resources, lightscapes and naturally dark skies are related to the following park priorities:

- enhancing visitor experience and ability to view the night sky
- nighttime setting in the park
- transition areas between cave and above ground environments
- nocturnal wildlife

Potential Threats

- Artificial light from park facilities and operations
- Artificial light from nearby development, light domes from bright towns/cities
- Artificial light from visitors

Potential Opportunities

- Park lighting plan
- Retrofit of light sources in order to reduce glare, reduce overall light output, direct lights downward and install warmer color lamps
- Coordinate with neighbors and partners to reduce artificial light that could affect park resources and values
- Night sky and night resources educational and recreational programming

Existing data/planning:

- Predicted ALR conditions based on continental model

Future data/planning:

- Collect baseline data
- Develop a lighting plan
- Develop night skies goals, indicators and standards in park plans and strategies

When managing the nighttime environment, a distinction is made between the photic environment and the lightscape. The *photic environment* represents the totality of the pattern of light at night at all wavelengths. It is a natural physical process that affects a broad range of species and is important for ecosystem function. *Lightscapes* include the human perception of the nighttime scene, including both the night sky and the faintly illuminated terrain. Lightscapes are aesthetic and experiential qualities that are integral to visitor experience and cultural resources.

Wildlife and Other Natural Resources

The condition of the photic environment can affect wildlife interactions and other vital ecological processes including predator/prey relationships, reproduction, navigation and migration. Nearly half the species on Earth are nocturnal. The absence of light, natural or otherwise, is often a key element of their habitat. Adding artificial light to the environment may result in substantial impact to certain species. For example, migrating passerine birds fly at night with reference to the stars and can be disoriented by lights from nearby cities, towers, and some park facilities. Sea turtle hatchlings orient toward the brightest light on the beach, but instead of being drawn to the safety of sparkling waves on the ocean, they are often drawn toward roads and parking lots where they quickly perish. Amphibians, with vision far more sensitive than that of humans, are apt to be disoriented by light. Even when night skies may not be valued for their human aesthetic appeal, natural darkness may still be essential to wildlife. Research into the ecological consequences of artificial night lighting is revealing numerous connections between artificial light and species disruption.

Cultural Resources

The night sky is a timeless and boundless resource important to many people, cultures, and religions. Its importance is vast, from the architectural alignments of Ancestral Puebloans at Chaco Canyon, to the Washington Monument mimicking a giant gnomon at the center of a sundial, and from lyrics of your favorite songs to the myths of ancient Greece embodied in constellations.

The scenic value of the night sky is also culturally significant to the current generation of visitors. With friends and family, visitors may enjoy viewing of a star-filled sky, seeing the Milky Way clearly for the first time, or searching for a particular constellation. These human traditions are important to our cultural experience in parks.

<u>Cultural and Historical Lighting</u>
Many national parks may have historical or cultural sites where nighttime lighting is an intrinsic part of the park. The grandeur of a memorial or the magnitude of a historical event can be enhanced by nighttime lighting. NSNSD acknowledges that nighttime lighting may be significant to the visitor experience of certain parks or required to effectively manage cultural resources. Careful consideration of such lighting should include how it affects resources and values in the park and whether the timing, amount and direction of the lighting are appropriate, both to protect the surrounding natural environment and to retain the suitable cultural lightscape.

Human Health and Visitor Experience

The nighttime environment plays an integral role in human health and physiology. Dark nights (and bright days) are key in keeping our circadian rhythm in sync. It is well documented that without the restorative power of consistent restful sleep, serious health consequences can arise. Chronic disruption in circadian rhythms has even been associated with an increased risk of certain cancers.

Recognizing the importance of lightscapes in a foundation document demonstrates a commitment to providing opportunities to view the night sky and quality nighttime recreation. A park's natural features take on a unique and compelling glow under the powerful light of a full moon or the faint glow of starlight. Those who experience the park at

night are often treated to a dramatic scene that provides opportunities to enhance the richness their overall park experience. Additionally, there are many nighttime recreation activities, such as camping, fishing, or wildlife observation, that benefit from a natural pattern and intensity of light.

Artificial light can impact visitors through two primary processes: direct glare from light fixtures can affect vision and nighttime recreation experiences; and sky glow from collective sources of artificial light scattered in the atmosphere can reduce the ability to view the night sky. Both aspects of artificial light can unnaturally illuminate the ground and diminish visitors' ability to dark adapt their vision.

Considerations for historical and cultural sites are also important. Addressing the lightscape for these areas recognizes that the grandeur of a memorial or the emotional resonance of a historical event can be enhanced by nighttime lighting. It is an important step in retaining the cultural landscape for the nighttime, not just the daytime. Addressing the lightscape and photic environment in the foundation document for such areas can provide a basis for managing and protecting a broad range of cultural and historical resources, enhancing visitor experience, and minimizing the effects from artificial light within and outside the park.

Interpretive Themes

Parks which have stargazing and night-themed programming, should consider incorporating night skies to the interpretive theme section of the foundation document. Even when lightscapes are not directly incorporated as theme, their mention should be considered in other activities that rely upon natural nighttime conditions. Examples of this include wilderness, biodiversity, endangered species that are sensitive to light, cultural or historic landscapes, religious or spiritual connections with the night sky, traditional or pioneer lifestyles, human health, nighttime historical events, and sources of inspiration for art, science, philosophy, or technology.

Many of our parks provide the best opportunity for people to see a natural night sky. Even parks that don't have the highest quality night skies can connect visitors to the nighttime environment. Some parks include relatively dark areas surrounded by highly urbanized lands. The resources in these areas can often serve as a natural preserve for nearby residents, and although degraded, these sites often provide the best available night sky conditions for large numbers of people. Visitors often travel to theses parks to see starry skies. In fact, stargazing events are the most popular ranger-led activity in numerous parks.

A number of parks now host "Astronomy VIPs" or have staff who serve as night sky ambassadors. Other parks have linked cultural heritage to the night, whether via a candle lit civil war battlefield, a discussion of Native American constellations, or simply the traditional experience of fishing before dawn.

Planning and Data Needs

NSNSD has developed an array of tools and services to help parks manage night sky resources and can provide assistance with a variety of planning and data needs. These include night sky quality assessments, development of night sky indicators and standards, night sky quality modeling, facility lighting inventories, park lighting retrofits, International Dark Sky Park Certification assistance, interpretive training assistance, and coordination assistance with local communities concerning lighting ordinances and best practices. The Natural Sounds & Night Skies Division of the NPS is located in at the Washington Area Office in Fort Collins, Colorado and can be contacted via Frank Turina at frank_turina@nps.gov.

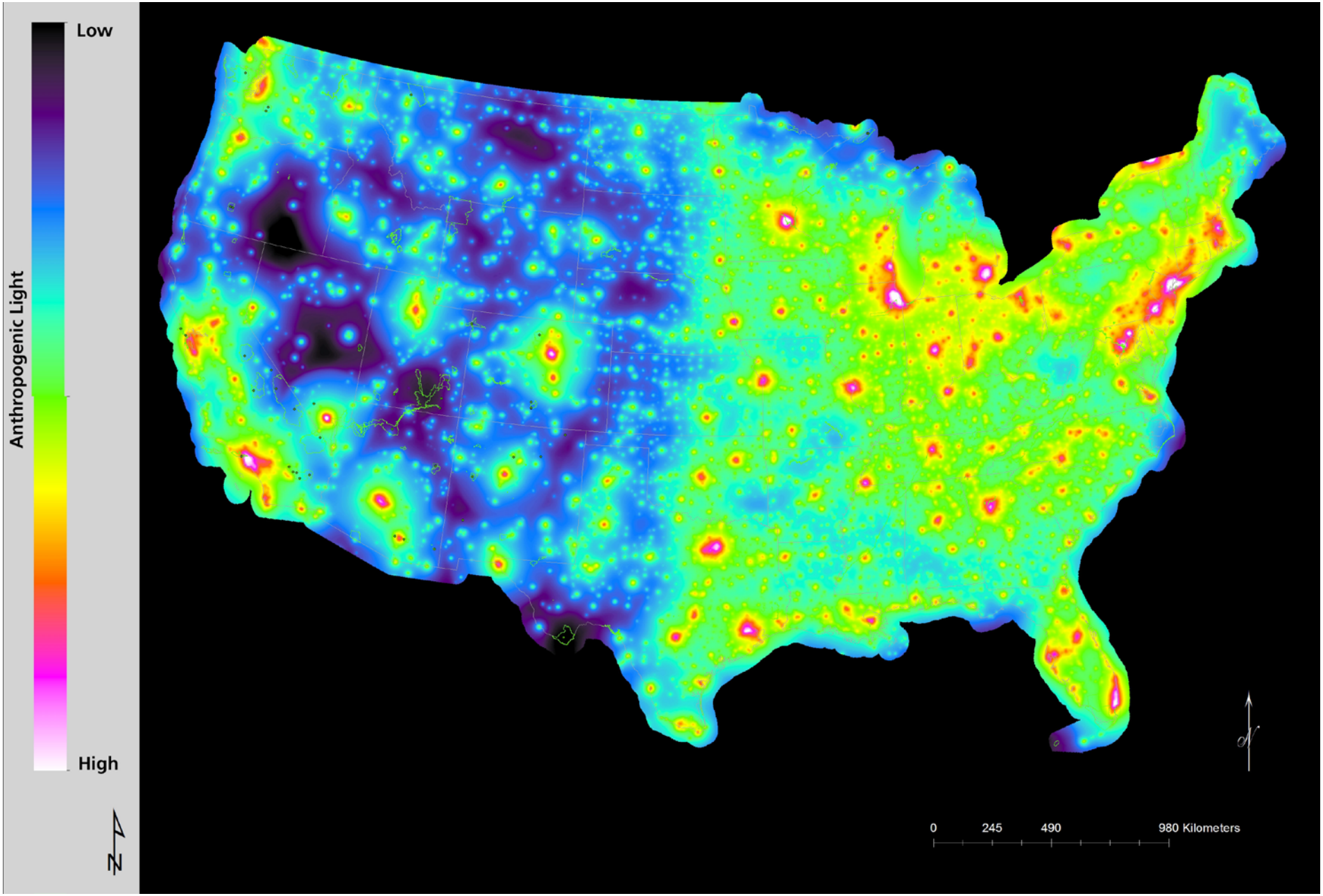

Figure 1. *Anthropogenic Light Ratios (ALRs) for the Contiguous US*. White and red represents more environmental influence from artificial lights while blues and black represent less artificial light.