Black Canyon of the Gunnison

National Park Service
U.S. Department of the Interior

Black Canyon of the Gunnison
National Park

Black Canyon of the Gunnison National Park International Dark Sky Park Application Package May 2015

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April 26, 2015

IDA Board of Directors
International Dark-Sky Association
3225 North First Avenue
Tucson, Arizona 85719

IDA Board of Directors:

As President of Black Canyon Astronomical Society, I'm honored to nominate the Black Canyon of the Gunnison National Park (BLCA) as an IDA Dark Sky Park.

The Black Canyon of the Gunnison National Park is located in western Colorado on the edge of the Colorado Plateau.

The Black Canyon Astronomical Society (BCAS) was founded in 1998. In June 1998, working with Ranger Jorge Maldonado, BCAS conducted the first outreach at BLCA. Outreach sessions were also conducted with Ranger MJ Simmons at the Elk Creek Visitor Center, Curecanti National Recreation Area. Curecanti NRA and BLCA are separate units in the National Park Service, however they share a common administration. This submission is for BLCA.

The initial partnership between BLCA and BCAS was strong, because of the support of NPS staff and their willingness to provide access for BLCA and the willingness of founding BCAS members to share their knowledge of the night skies.

This robust partnership continues today. BCAS is able to provide amateur astronomers with a variety of equipment for public outreach and BLCA provides an excellent venue with very dark skies, as well as knowledgeable interpretative rangers and summer volunteers.

While the elevation in the national park has a significant range, our primary outreach location is 8200 feet. Median SQM readings over the last three years were 21.4 with 90% of the values between 21.2 and 22.0.

Since 2011, at least 3600 park visitors have participated in joint BLCA/ BCAS outreach events. This includes presentations, typically by the BLCA Interpretive Division, and observing, both day-time and night-time.

The joint BLCA/BCAS outreach program is comprised of:

1. At least two night events in the winter. At the Jan 17, 2015 event, 70 visitors enjoyed spectacular night skies (SQM reading = 21.2). 120 visitors attended the Mar 24, 2015 session. SQM reading for that night was also 21.2.
2. Wednesday and Friday nights from June to October, between 3rd and 1st quarter moon,
3. Special events, such as solar eclipses.

The major event of the summer is the 4-day BLCA Astronomy Festival in June. This consists of daily solar and night observing, plus many educational activities for children and adults. The 2015 AstroFest will be the 6th.

Evening talks prior to observing cover a variety of topics, including the night sky, light pollution, links between geological time and cosmological time, and the planets.

What is personally most impressive about the BCAS / NPS relationship is the enthusiasm and dedication of everyone involved, BCAS members, BLCA management and staff, and the summer NPS volunteers. There is a tremendous depth of knowledge and everyone involved evokes "oh wows" from the park visitors.

BLCA staff are to be commended for their efforts to eliminate “IDA non-compliant” lighting within the Park.

I endorse the designation of the Black Canyon of the Gunnison National Park as an IDA Dark Sky Park.

Please contact me if you need more information. Thank you for your consideration.

Bryan Cashion, President

IDA Member #47494

970-497-2644

Black Canyon Astronomical Society

http://www.blackcanyonastronomy.com

Significance of Black Canyon Dark Skies

Black Canyon of the Gunnison National Park is in a critical location. Situated on the Western Slope of Colorado between the superb dark skies of the Four Corners region and the Front Range of Colorado, Black Canyon is at the forefront of dark skies preservation and education. The park has the fortunate combination of high quality dark skies and a large local and regional population eager to learn about them. The park meets or exceeds the criteria below set by the International Dark Sky Association for dark sky park status.

1. **Philosophy: Nighttime environments that have negligible to minor impacts from light pollution and other artificial light disturbance, yet still display outstanding quality night skies and have superior nighttime landscapes.** The communities of Montrose, Delta, and Olathe are located just to the West of the park but display little to no light dome impacts to park skies. SQM readings taken at High Point (on South Rim Drive, closest to those communities) were over the gold-tier standard of 21.75. The most recent reading was 21.86 on March 24, 2015.

2. **Artificial Light and Skyglow: Typical observer is not distracted by glary light sources. Light domes are only dim and restricted to sky close to horizon.** Much of Black Canyon is very remote and has few light impacts from surrounding communities. The steep and deep nature of the canyon provides nighttime visitors to the inner canyon with an even more protected view of the dark sky.

3. **Observable Sky Phenomena: The full array of visible sky phenomena can be viewed.** The views of the Milky Way are spectacular throughout the year along with deep sky objects, satellites, comets and meteor showers.

4. **Nocturnal Environment: The area is devoid of obvious lights that can cause wildlife disorientation. Artificial light levels are thought to be below the threshold for plant and animal impact. Ecological processes related to nocturnality are unaltered. There is no lighting atop towers or buildings within park boundary.** Nocturnal wildlife are abundant within the park. Mountain lions, bobcat, and various nighttime birds are common in the park due in part, to the protected darkness. Most lighting in the park is limited to motion sensors and turns off when not in use. No building or facilities have lights on rooftops or towers.

5. **Visual Limiting Magnitude: Equal or greater than 6.8 under clear skies and good seeing conditions.** The NPS Night Skies Team has determined at 3 points in the park, a Zenith Limiting Magnitude of 6.7, 6.8 and 7.0. See Section 1 of this application for details.

6. **Bortle Sky Class: 1-3. T**he NPS Night Skies Team has determined a Bortle class of 3 at several sites in the park. See Section 1 of this application for details.

7. **Sky Quality Meter: Greater than 21.50** Park staff and local astronomers have taken numerous SQM readings in a variety of locations in the park using the Dark Sky Meter App and Unihedron Sky Meter. Readings were commonly at or above 21.50 throughout the park. See Section 1 of this application for details.

Black Canyon of the Gunnison

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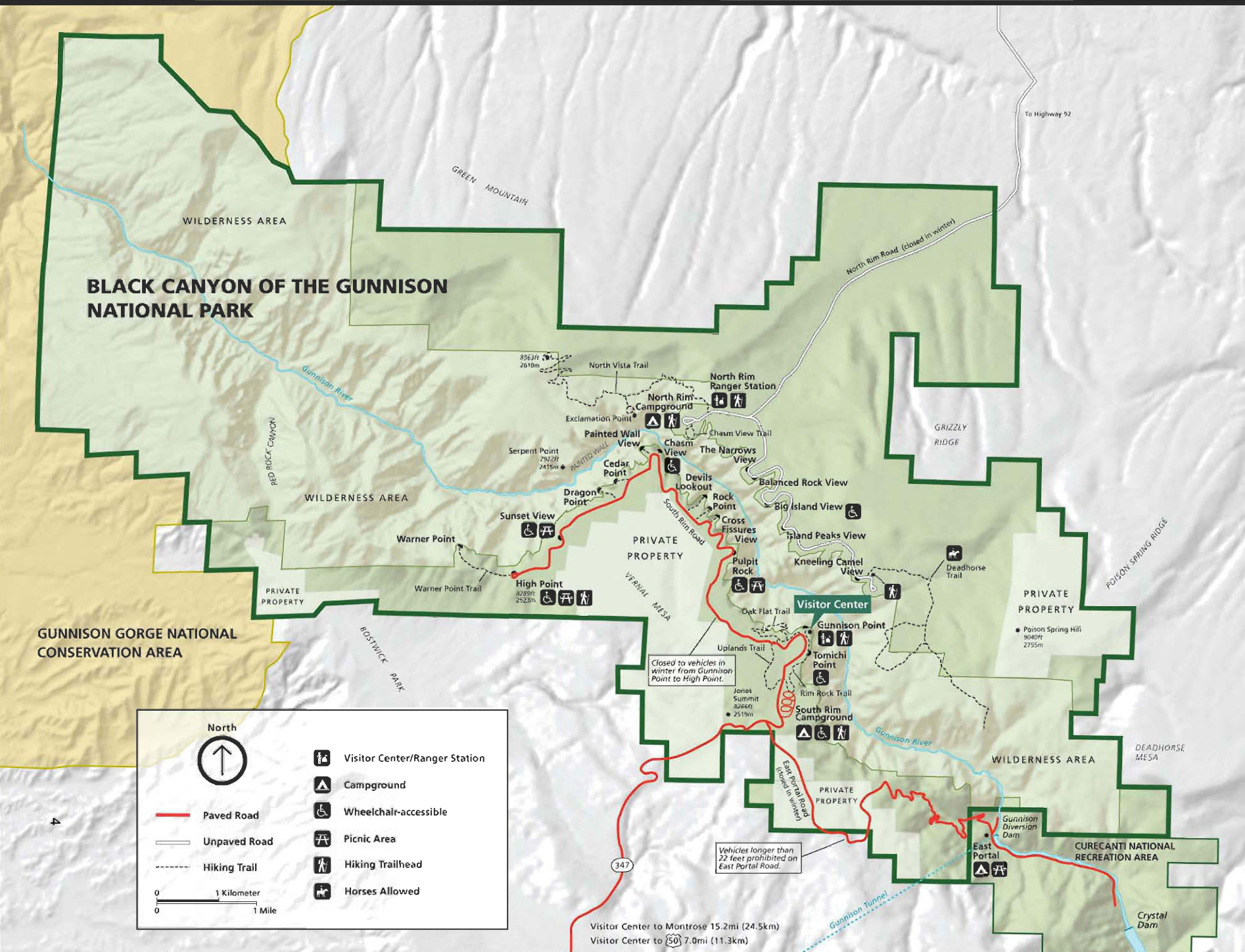


1 Night Sky Resources and Education

Location and Description of the Park

Black Canyon of the Gunnison National Park was first established as a national monument through Presidential proclamation in 1933 and was redesignated as a national park through Public Law 108-78 in 1999. The park consists of 30,750 acres in western Colorado. 15,599 acres of the park is Congressionally designated wilderness under the Wilderness Act.

Black Canyon is located about 210 miles from Denver, Colorado. The most popular access to the park is via the South Rim which is approximately 15 miles from Montrose, Colorado via U.S. Highway 50 and Colorado Highway 347.

The North Rim of the Black Canyon is 11 miles southwest of Crawford, Colorado via Colorado Highway 92 and North Rim Road which is mostly unpaved.

Access to the North Rim from the South Rim takes between 2-2 ½ hours. There is no bridge connecting the two sides of the canyon.

Significance of Park Resources

Enabling Legislation

In the national monument proclamation of 1933, Black Canyon was set aside for the: "preservation of the spectacular gorges and additional features of scenic, scientific, and educational interest." The legislation establishing Black Canyon of the Gunnison National Park in October 1999 states: “the Black Canyon of the Gunnison and adjacent upland include a variety of unique ecological, geological, scenic, historical, and wildlife components, … extensive opportunities for educational and recreational activities, … unique geological, paleontological, scientific, educational, and recreational resources; …”

Ecology

The canyon rims are dominated by scrub oak and pinyon-juniper forests intermixed with patches of high-desert sagebrush communities. The canyon's north-facing slopes favor Douglas-fir and Colorado blue spruce, while the river bottom has a number of deciduous trees and shrubs characteristic of river strands in the region.

Geology

The Black Canyon is a textbook example of a canyon carved by a superimposed stream. Canyon walls rise precipitously 2,000 feet or more above the Gunnison River, which roars in the canyon depths at an average gradient of 95 feet per mile in the park. The Black Canyon is one of the world's foremost wild canyons. About 1.3 to 1.7 billion years ago, canyon rocks (gneiss, schist, quartz-monzonite, and granite-pegmatite) were formed far below the Earth's surface. Around 60 million years ago, during the forming of the Rocky Mountains, these hard crystalline rocks were uplifted to near the earth's surface in the Gunnison uplift. From 35 to 18 million years ago, volcanic action from the West Elk and San Juan Mountains covered the area with ash, tuff, and breccia. Erosion slowly wore away these volcanic layers along with the under lying sedimentary rocks and established the course of the Gunnison River. Two million years ago, the river started cutting into igneous and metamorphic rocks to begin carving the canyon.

History and Culture

The canyon has long been a mighty barrier to humans. Only the rim, never the gorge, show evidence of human occupation - not even by Ute Indians living in the area since written history began. It was an obscure geographic feature to explorers for hundreds of years. The Spanish were the first Europeans to canvas western Colorado with two expeditions, one led by Juan Rivera in 1765, and the other by Fathers Dominguez and Escalante in 1776. Both were looking for passage to the California coast, and both passed by the canyon. Fur trappers of the early 1800s undoubtedly knew of the canyon in their search for beaver pelts but they left no written record of the canyon.

By the middle of the 19th century, exploration of the American west had captured the nation's attention. Expeditions came to the Black Canyon searching for railroad passageways, mineral wealth, or in a quest for water.

Visitation and Seasons

The park is open year-round, 24 hours a day. Visitors access the park for hiking, fishing, sightseeing, stargazing, cycling and camping to name a few. The recreational visitors to the park numbered 183,045 in 2014 with the highest visitation in June, July and August. December and January are traditionally the quietest months in the park.

Weather, Climate, and Visibility

Elevation ranges from 5,400 feet at canyon bottom to 8,775 feet on Signal Hill. Average temperatures range from a low of 15°F in the winter to approximately 85°F in the summer. Average annual precipitation is 16–20 inches. Snowfall measures between 30–55 inches. Most precipitation occurs in the form of spring and summer rains.

The Black Canyon Wilderness is a Class I area under the Clean Air Act. The NPS monitors air resources within the wilderness to assess potential air pollution impacts and protect air quality. On especially clear days, daytime visibility ranges up to 170 miles.

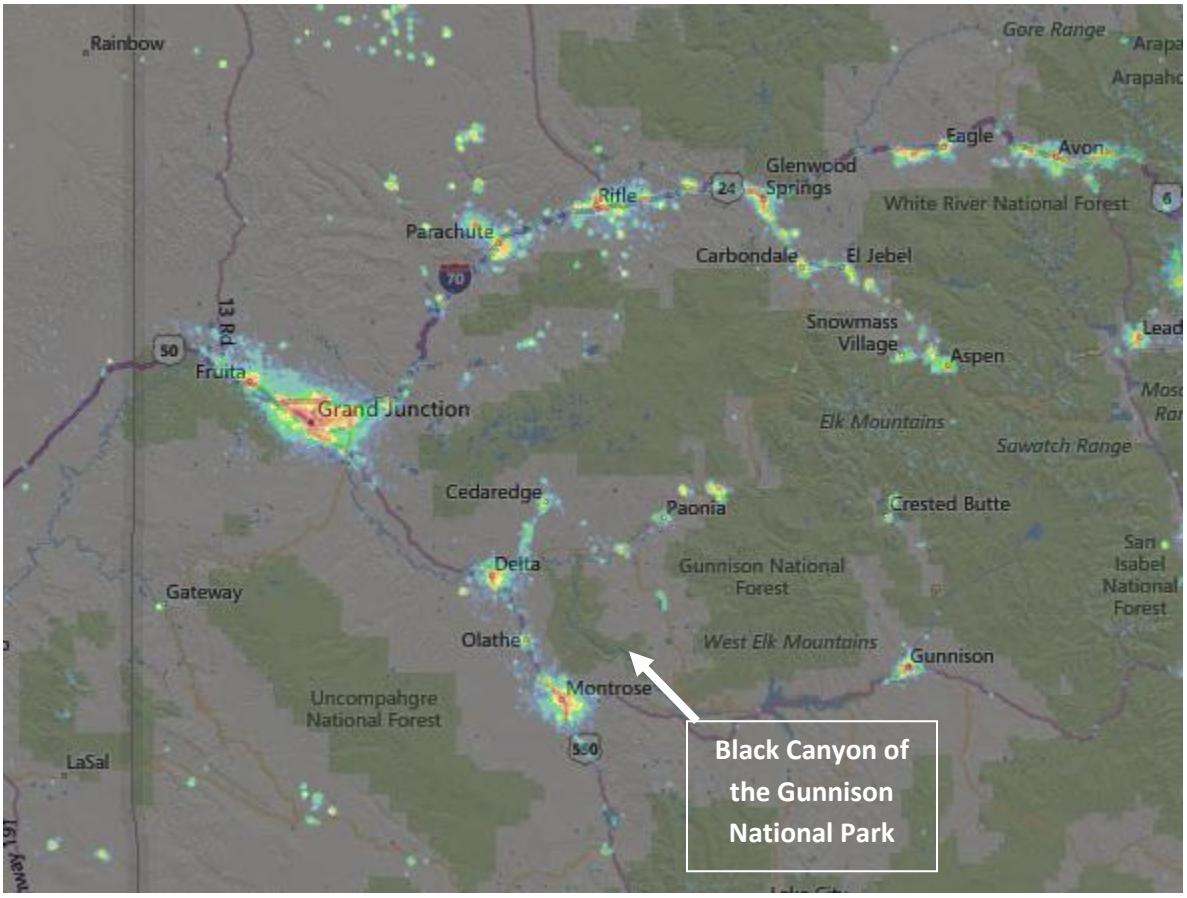
Isolation from Light Pollution

This map depicts a large area of western and central Colorado. The significance of Black Canyon (marked by the arrow on the map) as a dark sky location is obvious, in that it rests on the edge of one of the largest urban centers of the Western Slope of Colorado and the darkest, most remote portions of the southwest. The I-70 corridor to the north, and Denver about 210 miles over the Rocky Mountains to the east, contribute the greatest share of light pollution in Colorado. Areas to the west of the park have virtually pristine dark skies, making Black Canyon a phenomenal location to educate the public on dark sky resources and limiting the growth of light pollution.

Many local communities, including Montrose and Grand Junction, have established some variance of a lighting ordinance with the mission of protecting dark skies.

Montrose Lighting Ordinance: http://iesrmsdenver.org/wp-content/uploads/citymontrose.pdf

Map courtesy of: http://www.lightpollutionmap.info



Park SQM Monitoring

Using the IDA approved Dark Sky Meter App, park staff collected SQM readings at 13 locations throughout the park. Listed readings were taken on March 24, 2015.

1. Park Boundary at East Portal: 21.10 at 8:30 pm
2. South Rim Entrance Station: 21.17 at 9:06 pm
3. South Rim Visitor Center: 21.65 at 9:10 pm
4. Chasm View: 21.30 at 9:26 pm
5. Painted Wall View: 21.50 at 9:35 pm
6. Sunset View: 21.97 at 9:48 pm
7. High Point: 21.86 at 9:53 pm
8. Dragon Point: 21.06 at 10:00 pm
9. Cedar Point: 21.15 at 10:04 pm
10. Devils Overlook: 21.25 at 10:09 pm
11. Pulpit Rock: 21.50 at 10:14 pm
12. Tomichi Point: 21.59 at 10:24 pm
13. South Rim Administration Building and Campground: 21.69 at 10:30 pm

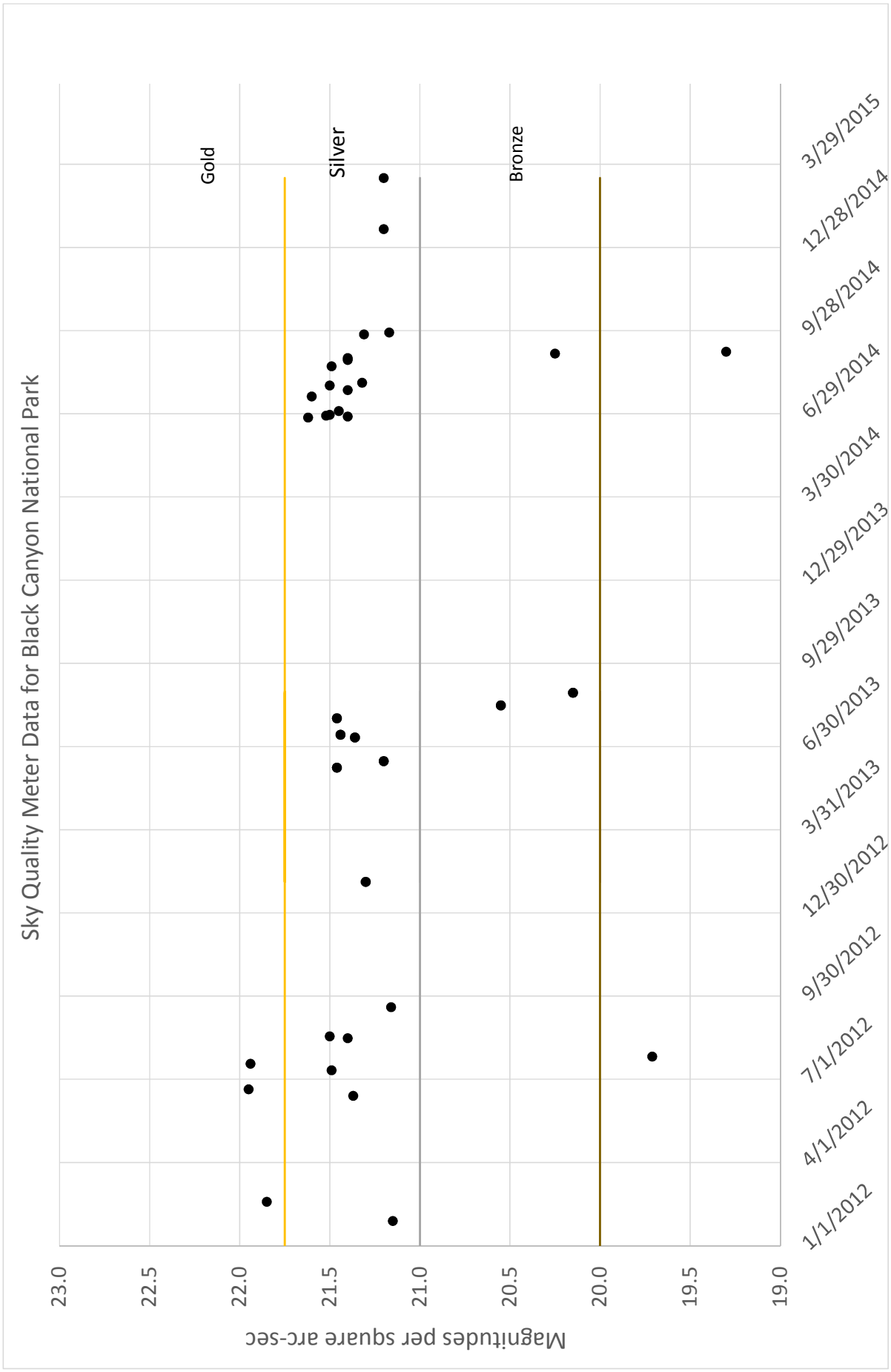
The average SQM reading for Black Canyon of the Gunnison National Park on March 24, 2015 was 21.45.

Local astronomers at an outreach and sky monitoring event.

Black Canyon Astronomical Society SQM Monitoring

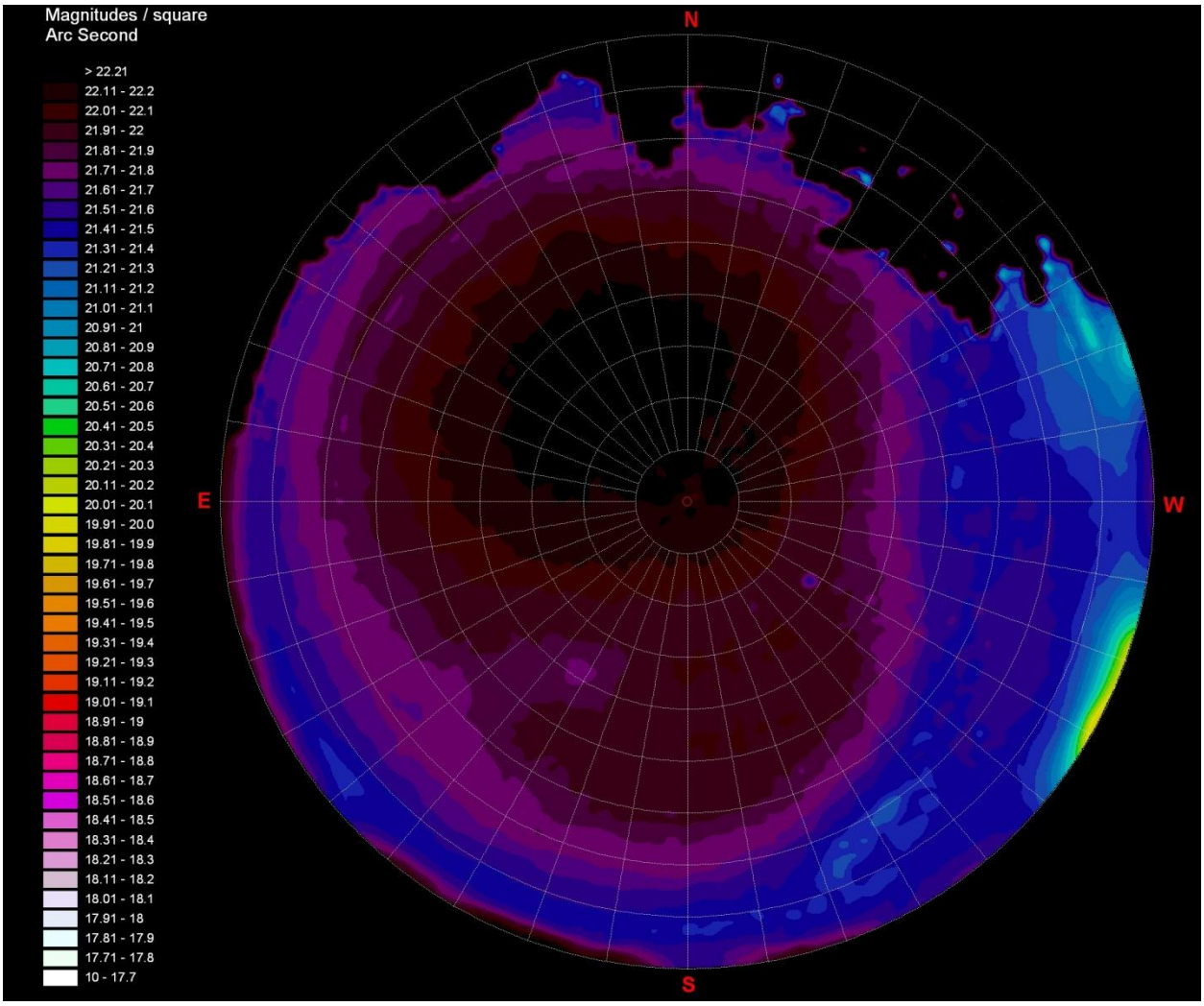
Black Canyon of the Gunnison National Park has a premiere astronomy partner in the Black Canyon Astronomical Society (BCAS). Based in the communities of Montrose and Delta, BCAS has a very active membership that participates in frequent outreach events in the park. Over a period of time from December 2011 to March 2015, BCAS has collected significant SQM data using the Unihedron Sky Quality Meter. These readings were all collected near the BCAS telescope staging area near the South Rim Campground of the park or in the South Rim Visitor Center parking area. The chart on the following page displays this collection of long-term SQM data.

Astro-photographer at the Painted Wall


Sky Quality Meter Data for Black Canyon National Park
Magnitudes per square arc-sec
23.0
22.5
22.0
21.5
21.0
20.5
20.0
19.5
19.0
Gold
Silver
Bronze
1/1/2012
4/1/2012
7/1/2012
9/30/2012
12/30/2012
3/31/2013
6/30/2013
9/29/2013
12/29/2013
3/30/2014
6/29/2014
9/28/2014
12/28/2014
3/29/2015

NPS Night Skies Team Report

Sky Quality data were collected at Black Canyon by the National Park Service Night Skies Team in 2004 and 2008. The detailed report from 3 locations in the park and the report analysis and explanation are found on the following pages.



Example of NPS Night Skies Team data from the South Rim of the Black Canyon

NPS Night Skies Program Data Night Report Explanation

D Duriscoe
February 2015

Introduction

This document provides a quick explanation of so-called "Data Night Reports" generated automatically from the Night Skies Program master database. A brief description of each table, and each attribute reported within them, is included. For the theoretical basis and methods of computation the reader is referred to a more complete document (Duriscoe 2015).

A "Data Night" is an unique combination of date and location representing when and where sky brightness data was collected. The Night Skies Program uses a code, usually a combination of 4 letters and 6 numbers, that describes the park or other area and date. The date is defined at the start of data collection in Universal Time (UT). Hence it s often one day later than Local Time, either Standard, Daylight, or Local Mean Time (LMT), for locations in North America if data collection is begun in the evening. A "Data Set" is one complete set of 45 images that cover the entire sky. Multiple data sets are often taken over the course of the night to detect changes in artificial sky glow from evening to early morning.

The NPS Night Skies Program Data Night Report contains three main sections: 1) general attributes of the data night and each data set, 2) a list of populated places that may contribute to sky glow observed, and 3) the sky brightness and estimated artificial sky glow mosaics for each data set, illustrated in false color in panoramic equal-area projection, with a table of derived statistics and indicators of the impact of light pollution. The report provides a “snapshot” of the photic environment at the time of the observations as well as an estimate of the impact from artificial sources.

Photometric units of measure used include *SI* units of luminance (candela per square meter) and illuminance (lux), as well as astronomical units of luminance (magnitudes per square arc second) and illuminance (magnitudes) in the V, or visual, band. *SI* units are linear, astronomical units are inverse logarithmic, that is, smaller values indicate brighter objects, and negative values are possible.

Page 1. Metadata and visual observations

First line: Data Night Code, Park or other area, Location name, and Date (UT)

Data Night Attributes Table

Longitude: Longitude in decimal degrees (west is negative), Datum WGS 84, taken with GPS receiver, typical horizontal positional accuracy 5 meters

Latitude: Latitude in decimal degrees (north is positive), Datum WGS 84, taken with GPS receiver, typical horizontal positional accuracy 5 meters

Elevation (m): Elevation above mean sea level in meters, taken with GPS receiver, typical vertical positional accuracy 15 meters

Camera: Short description of the camera used. The camera name is usually the manufacturer, such as SBIG (Santa Barbara Instruments Group), followed by a number separating multiple cameras used with the same manufacturer.

# of sets: A count of the number of individual data sets collected over the night at this location.

Exposure (secs): Exposure (or integration) time of each image in seconds.

Air Temp (C): Air temperature at start of image acquisition as measured by a portable weather meter in degrees Celsius. Typical accuracy is 3 degrees.

R.H. (%): Relative humidity at start of image acquisition as measured by a portable weather meter. Typical accuracy is 5%.

Wind Speed (mph): Average wind speed at the start of image acquisition as measured by a portable weather meter held at eye level. Typical accuracy is 3 mph.

ZLM: Zenith limiting magnitude, or the faintest stars than can be observed visually without optical aid (naked eye) near the zenith, or darkest part of the sky. This observation varies somewhat from observer to observer, but all observers are instructed to practice the same methods. 6.6 is considered near pristine under average conditions. 7.0 is achievable under good seeing conditions and with proper dark adaptation of the eye. 7.4 is excellent, just about the faintest attainable, although some observers have confirmed seeing stars as faint as magnitude 8.2 with the naked eye. A number lower than 6.3 usually indicates significantly degraded sky quality.

BORTLE: A semi-quantitative measure of the sky quality observed visually, as developed by astronomer John Bortle. Classes are whole numbers 1-9, with 1 the very best and 9 the poorest.

SQM: A measurement taken with the Unihedron Sky Quality Meter, in magnitudes per square arc-second (mag arcsec^{-2}), aimed at the zenith.

OBS-1, OBS_2, OBS_3: Name(s) of the observer(s).

NARRATIVE: A descriptive narrative of the conditions observed visually during the night of data collection. This usually includes seeing (a measure of atmospheric steadiness), and transparency (a measure of atmospheric clarity) in semi-quantitative terms. Also may include characteristics of the site, the appearance of certain astronomical features, and the suitability of the site for visual astronomy by park visitors.

Data Set Attributes Table

Data Set: Data set number

Quality Flags: *Useable*--Y or N (yes or no), a determination as to whether or not the data should be included or rejected based upon inspection of the mosaic; *Collection*--(1-5, 1 poorest, 5 best) a semi-quantitative judgment as to the quality of data collection, including such factors as camera and mount performance, accuracy of mount setup, presence of stray light; *Processing*--(1-5, 1 poorest, 5 best) a

semi-quantitative judgment as to the quality of data processing, including image calibration, atmospheric extinction calculation, instrument zeropoint calculation; *Atmosphere*--(1-5, 1 poorest, 5 best) a semi-quantitative judgment as to the quality of atmospheric conditions, where excellent transparency and steadiness, low relative humidity, and the complete absence of clouds or smoke plumes is best.

Natural Sky Model: A report of the amount of natural *airglow* used at the *zenith* in micro-candela per meter squared (μcd m^{-2}), the *Fit Quality* of the model (1-5, 1 poorest, 5 best), a semi-quantitative judgment as to the quality of natural sky model fit based upon inspection of the artificial sky glow mosaic as compared to the natural sky model mosiac, and *Natural sky model fit notes*, which explain why the operator assigned the zenith airglow intensity and fit quality reported.

Extinction: A report of calculated all-sky atmospheric extinction for each data set. Extinction is a measure of the opacity of the air, the units are astronomical magnitudes per airmass. Airmass depends on its zenith angle and the relationship is not linear. A star viewed at the exact zenith is by definition view through one airmass. This value is computed for each data set from measurements of 50-150 standard stars on the images over the entire sky.
Attributes reported in the table include: *Extinction coefficient* in V magnitudes per airmass, *Standard error of Y*, in V magnitudes, a measure of the fit of the observed data to a regression line (0.03 or smaller is excellent while 0.06 and larger is poor), and the *Number of* reference *Stars used* and *rejected* in the regression equation. Rejected stars are outliers of greater than 0.1 magnitude, presumably because they were partially masked by horizon obstructions or clouds, measured incorrectly because of scintillation, or measured incorrectly because of within-pixel variations in the sensitivity of the CCD detector.

Collection Properties: A report of the observed *percentage of clouds* in the entire sky, the *Average Pointing Error* of the camera mount system in degrees (less than 0.25 is excellent, more than 0.5 is poor), the Maximum Pointing Error of the camera mount system in degrees (less than 0.4 is excellent, more than 1.0 is poor), and the *total bias drift* of the camera over the course of the 45 images in each data set in raw camera ADUs (more than 10 ADU drift may indicate a camera problem).

Page 2(-3). Populated Places Table

A table of places within 300 km of the observing site is displayed ordered with decreasing potential to produce artificial sky glow. The places name (*Place*) and *Population* are given from the 2010 U.S. Census. The *Distance* in kilometers, apparent *Azimuth* , and *Apparent Half-Width* in degrees as seen from the observer's location are given based upon the longitude and latitude of the place's centroid and assuming a circular area whose diameter is computed based upon the land area of the populated place given in the Census database. Finally, each place is ordered according to *Walker's* Law, a formula which predicts sky glow intensity of a populated place as a function of its population and distance from the observer. The numbers shown in the table for this attribute are a unitless ratio with linear scaling. An arbitrary cutoff is made for the lower limit of this value that includes a reasonable number of populated places (less than 50).

Pages 3(4) +. All-sky Photometry Report

The all-sky photometry report is scaled so that one data set fits on one page, and multiple data sets are reported on succeeding pages.

First Line: The *Data Night* Code, the *Date* in Local Mean Time (LMT), the *Time* of the middle of image collection in LMT in decimal hours, whether or not (Y or N) the data set is the *Reference* set for the night,

and the *Data Set Number*. Local Mean Time is used for comparison between locations and data nights, with local midnight being 0.0 hours. Local midnight is the time when the sun is at its maximum position below the horizon.

First Figure -- Full Resolution Mosaic

The full resolution mosaic of the data set's images rendered in false color. Each individual image is placed in the mosaic after correction for pointing errors, and projected into a Hammer-Aitoff equal area projection with the horizon at the center vertically and a fixed azimuth at the center horizontally. The false color scheme reveals a wide dynamic range of sky brightness values in a logarithmic scale from 14 to 23 mag arcsec^{-2}. The all-sky image mosaic (zenith to 6 degrees below the level horizon) contains about 34 million pixels. Land features and individual light trespass sources are often visible in this rendering.

Photometry of all sources Table

A table of summary measures from the sky brightness mosaic is given. The sky brightness mosaic is derived from the full resolution mosaic by applying a strong median filter to screen out stars, then resampling to 0.05 degrees per pixel resolution, for a total of about 8 million pixels covering the entire sky in an equal-area projection. Bright unshielded lights in the land portion of the mosaic will not be accurately measured for two reasons: they commonly are so bright their recorded luminance exceeds the dynamic range of the detector so they become clipped or saturated at the maximum ADU value, and the median filter will remove most of the light from these sources since they resemble stars or point sources. Therefore "all sources" should not be interpreted to include accurate measures of light tresspass from visible individual lights, even if they appear in the full resolution mosaic. Very bright sources such as this will often cause vertical lines or "column bleeds" in the full resolution image; these are removed by the median filter technique before statistics are calculated. A graphic of the sky brightness mosaic is not shown in the report.

Average Sky Luminance is an important statistic describing the photic environment. It is reported in logarithmic units of mag arcsec^{-2} and linear units µcd m^{-2}. The natural moonless reference condition is set at 21.6 mag arcsec^{-2} or 250 µcd m^{-2}. This is an unbiased measure of the amount of light reaching the observer from sky luminance.

Zenith Luminance is often reported as a sky quality indicator in the astronomical literature. This measure is calculated from the median pixel value of an approximately one degree diameter circle centered on the zenith. 22.0 mag arcsec^{-2} or 172 µcd m^{-2} is generally considered to represent the darkest part of pristine skies, any value lower (brighter) than 21.3 mag arcsec^{-2} usually indicates significantly degraded sky quality, unless the measurement falls in the Milky Way, the natural airglow, or bright portions of the Zodiacal Light.

Brightest Luminance is an important value because the human eye's ability to dark adapt will be impaired by the brightest part of the visual scene, and because bright parts of the sky may cast shadows from 3D objects on the land surface, giving depth to an otherwise uniformly lit natural landscape. The brightest part of the Milky Way is 19.6 mag arcsec^{-2} or 1500 µcd m^{-2}. Brighter values will begin to impair dark adaptation, values brighter than 17.0 mag arcsec^{-2} can cast shadows.

The *Synthetic SQM* value is given for comparison to a measure with the Unihedron Sky Quality Meter. It is considered to be more accurate than the actual measure, since it is computed from the sky brightness mosaic based upon accurate alignment to zenith and accurately calibrated CCD camera data. The sky

brightness values in the data set are subjected to an algorithm that matches the SQM response curve with zenith angle. The units are mag arcsec^{-2}. Values of 21.3 and greater (darker) fall within the range of "natural" skies (Bortle Class 1-3), 19.5-21.3 may be considered significantly degraded skies (Bortle Class 4-6), while values less than 19.5 may be considered severely degraded (Bortle Class 7-9). The SQM is only sensitive to areas of the sky 30 degrees above the horizon and higher, so will not measure bright sources of artificial sky glow along the horizon.

Total luminous emittance exactly correlates with average sky luminance, but in units of illuminance. It represents the total luminous flux from the sky if all the light were collected into a point or source of small angular diameter, like the moon. This summary value excludes the light from individual stars and planets and glare from unshielded lights but includes the Milky Way, Airglow, Zodiacal Light, and artificial sky glow. When expressed in astronomical magnitudes it can be compared with the moon at various phases (-8 at crescent, -11 at half phase, and -12.5 at full phase). A value larger (darker) than -7.0 is exceptionally dark; between -7.5 and -7.0 is typical for near pristine locations. A value smaller (brighter) than -8.0 usually indicates significantly degraded sky quality.

Horizontal and Maximum Vertical Illuminance are important measures of the amount of light striking the ground (horizontal) or a vertical plane (vertical). The units are milli-lux (mlux). The natural reference condition for moonless nights is 0.8 mlux for horizontal and 0.4 mlux for vertical. The maximum vertical illuminance is for a plane facing the brightest part of the sky near the horizon.

Second Figure -- Estimated Artificial Sky Glow

The sky glow mosaic is the sky brightness mosaic subjected to pixel by pixel subtraction of a registered natural sky model mosaic (the natural sky model is not shown as a graphic in the report) rendered in the same false color scale as the full resolution mosaic. The resolution is 0.05 degrees per pixel. Land features and individual light trespass sources are masked out so that only sky luminance from artificial sky glow is shown. This is an at-a-glance representation of the amount of light pollution from sky glow observed at the site. Artificial sky glow will always be brighter near the horizon than at the zenith and its impact on the natural lightscape substantial.

Photometry of Artificial Sky Glow Table

This table includes indicators of sky quality based upon the estimated artificial sky glow mosaic in absolute, relative, and index units.

The *Sky Quality Index* is a synthetic index derived from the distribution of sky luminance values in the artificial sky glow mosaic. Its range is 0-100, where 100 is a sky free of artificial sky glow. Values of 80-100 may be considered to represent skies that retain all of the natural characteristics throughout most of the sky, 60-80 retaining most of the natural sky features, but only in areas within 40 degrees of the zenith, 40-60 represents skies where the Milky Way is not visible or only the brightest parts are visible near the zenith, 20-40 represents skies only stars and planets remaining and the land is illuminated at a level of moonlight, and 0-20 indicates only the brightest stars remain, and the land is in perpetual twilight.

The *Average Sky Luminance, Zenith Luminance,* and the *Brightest Luminance* are reported as in the all sources table, but in linear units only. The whole sky mosaic is clipped at 80 degrees zenith angle and 70 degrees and an average sky luminance computed for each in order to provide a more unbiased comparison to areas that may have blocked horizons.

The *All-sky Light Pollution Ratio* (ALR) is the most important indicator of light pollution from artificial sky glow. It is merely the ratio of the all-sky average luminance from artificial sources to the natural reference condition of 250 μcd m^{-2}. This unit-less ratio may be easily interpreted is a linear measure of the amount of light from sky brightness above the natural background. For example an ALR of 1.0 indicates there is 100% more light in the environment than natural conditions, 2.0 = 200%, 0.5 = 50%, etc.

The *Total Luminous Emittance* from artificial sky glow express in magnitudes may be compared to astronomical objects such as Sirius or Jupiter (-2), Venus (-4), a thin crescent moon (-7), or the moon at other phases as described above.

Horizontal and *Maximum Vertical Illuminance* are reported as in the all sources table. These values may also be compared to the reference condition of 0.8 mlux and 0.4 mlux, respectively.

References

Duriscoe, D.M. (in preparation) Assessing night sky quality with all-sky broadband photmetric imaging. NRSS, Fort Collins, CO.

NPS NIGHT SKIES PROGRAM DATA NIGHT REPORT

BLCA081030 Black Canyon of the Gunnison NP **Sunset View** **30-Oct-08**

Data Night Attributes

Longitude:	-107.73343	Camera:	IMG 1	Air temp. (C):	10.6	ZLM:	6.80	OBS_1:	C Moore
Latitude:	38.56881	# of sets:	2	R. H. (%):	26.0	BORTLE:	3	OBS_2:	
Elevation (m):	2465	Exposure (secs):	14	Wind Speed (mph):	2	SQM:		OBS_3:	

NARRATIVE: Transparency seemed average with some increased haze and possibly contrails to distant north. Airglow was less than previous night, but still visible. Zodiacal band was traced visually over 40 degrees of sky and geginschein was easy to see. Extinction was higher than target condition, so Hotchkiss and Denver were not visible this night. Higher extinction also accentuates Montrose and Grand Juction skyglow.

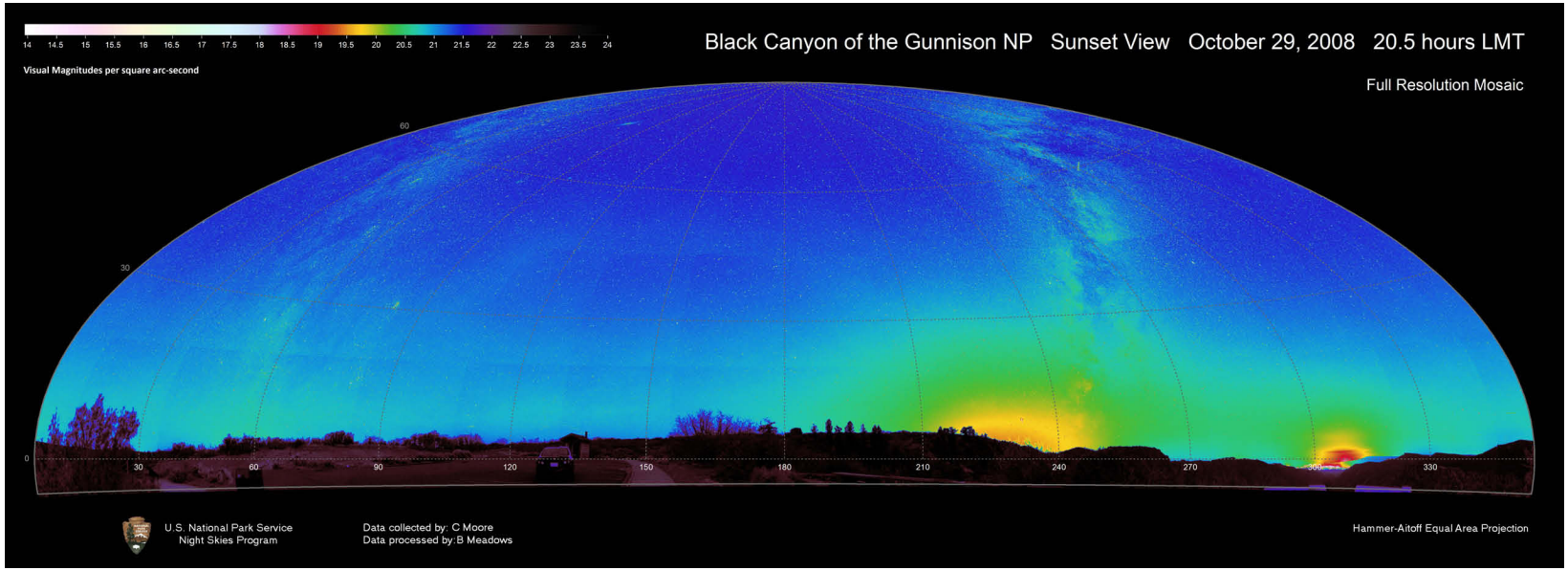
Data Set Attributes

	Quality Flags				Natural Sky Model			Extinction				Collection Properties			
Data Set	Use-able	Col-lection	Pro-cessing	Atmo-sphere:	Zenith airglow (µcd/m²)	Fit quality	Natural sky model fit notes	Ext. coeff. (mag/ airmass)	Std err Y	# stars used	# stars reject	% Clouds	Ave. Point Error	Max Point Error	total bias drift
1	Y	4	4	4	137	3		0.174	0.05	66	9	3	0.13	0.31	5.7
2	Y	4	4	4	140	3		0.171	0.04	77	8	3	0.19	0.34	7.1

Populated Places

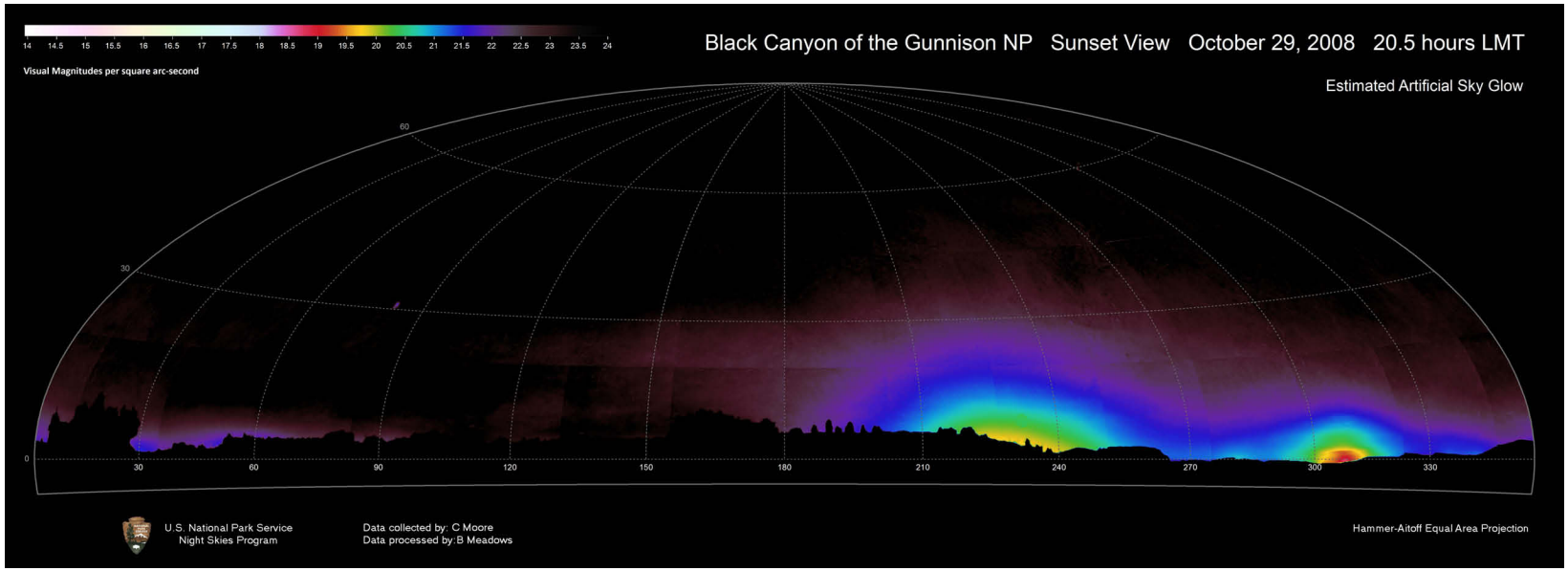
Place	Population (2010)	Distance (km)	Azimuth	Walker's	Apparent Half-Width (degrees)
Montrose city	19,132	15.7	225	1.972	13.7
Delta city	8,915	36.7	306	0.110	5.2
Olathe town	1,849	22.1	282	0.081	2.8
Grand Junction city	58,566	92.4	309	0.071	3.5
Orchard City town	3,119	34.0	323	0.046	5.2
Denver city	600,158	279.2	61	0.046	2.3
Colorado Springs city	416,427	259.8	82	0.038	2.8
Clifton CDP	19,889	84.5	312	0.030	1.5
Crawford town	431	18.6	35	0.029	1.4
Hotchkiss town	944	25.6	4	0.028	1.9
Aurora city	325,078	290.3	64	0.023	2.2
Cedaredge town	2,253	39.8	335	0.023	1.8
Paonia town	1,451	35.6	20	0.019	1.3
Albuquerque city	545,852	396.8	166	0.017	1.8
Gunnison city	5,854	70.0	92	0.014	1.3
Lakewood city	142,980	258.1	60	0.013	1.3
Fruitvale CDP	7,675	87.0	312	0.011	1.0
Fruita city	12,646	107.4	307	0.011	1.3
Orchard Mesa CDP	6,836	85.8	308	0.010	1.2
Arvada city	106,433	264.9	58	0.009	1.2
Redlands CDP	8,685	98.4	306	0.009	1.9
Thornton city	118,772	282.9	57	0.009	1.1
Highlands Ranch CDP	96,713	261.7	65	0.009	1.0
Westminster city	106,114	272.2	57	0.009	1.1
Pueblo city	106,595	273.7	96	0.009	1.4
Boulder city	97,385	268.0	52	0.008	1.0
Centennial city	100,377	271.9	64	0.008	1.0
Fort Collins city	143,986	317.2	45	0.008	1.2
Farmington city	45,877	205.1	191	0.008	1.4
Rifle city	9,172	107.9	358	0.008	1.1

BLCA081030 Date (LMT) 29-Oct-08 Time (LMT): 20.55



PHOTOMETRY OF ALL SOURCES

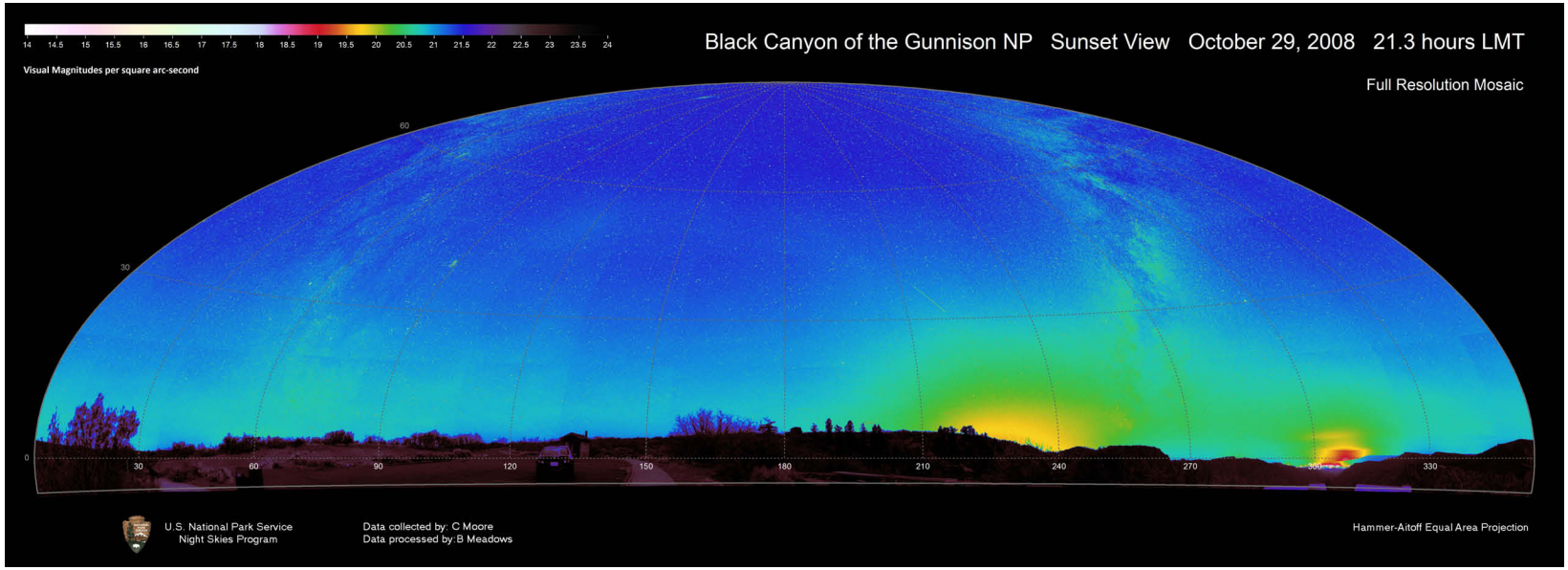
Average Sky Luminance (mag arcsec-²)	Average Sky Luminance (µcd/m²)	Zenith Luminance (mag arcsec-²)	Zenith Luminance (µcd/m²)	Brightest luminance (mag arcsec-²)	Brightest lumininance	Synthetic SQM (mag arcsec-²)	Total luminous emittance (mags)	Illuminance (mlux) Horizontal	Max Vert
21.02	424	21.59	252	18.10	6,269	21.35	-7.50	1.128	0.842



PHOTOMETRY OF ARTIFICIAL SKYGLOW

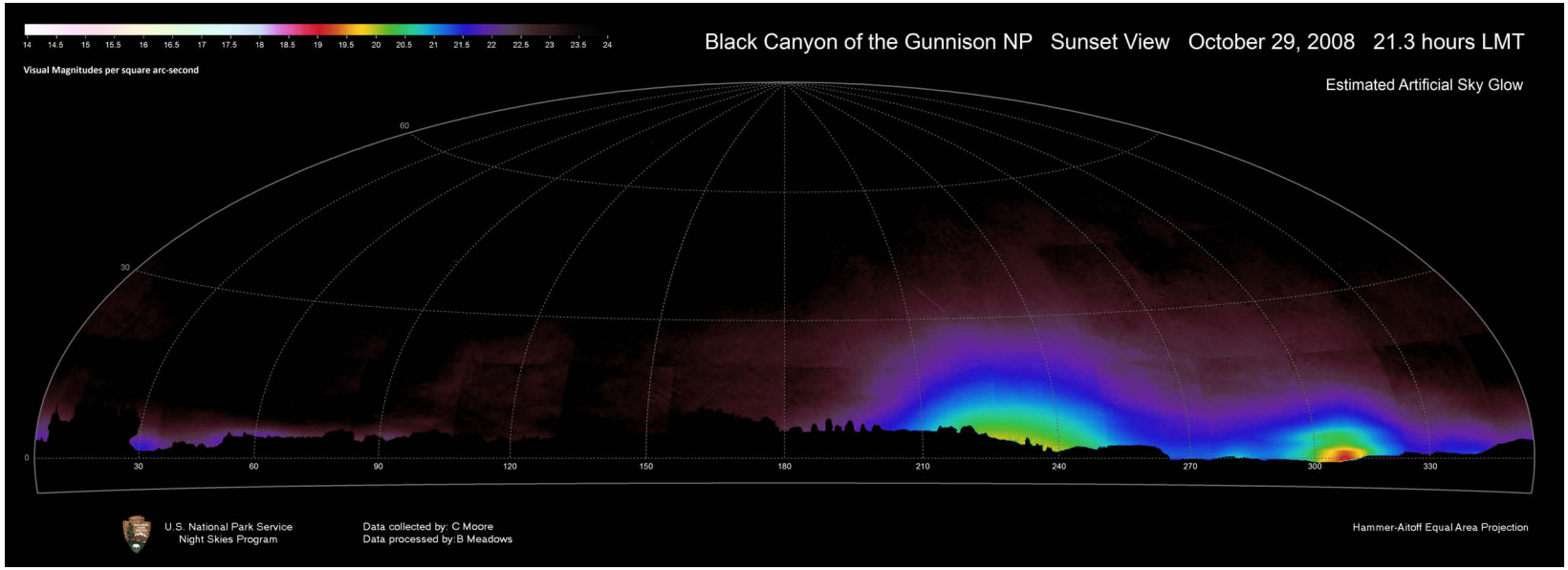
Sky Quality Index (SQI)	Average Sky Luminance (µcd/m²)	Average Sky Luminance to zenith angle 80°	Average Sky Luminance to zenith angle 70°	Zenith Luminance	Brightest lumininance (µcd/m²)	All-sky light pollution ratio (ALR)	Total luminous emittance (mags)	Illuminance (mlux) Horizontal	Max Vert
89.0	65	39.1	25.2	-1	3,576	0.26	-5.43	0.092	0.230

BLCA081030 Date (LMT) 29-Oct-08 Time (LMT): 21.33



PHOTOMETRY OF ALL SOURCES

Average Sky Luminance (mag arcsec-²)	Average Sky Luminance (µcd/m²)	Zenith Luminance (mag arcsec-²)	Zenith Luminance (µcd/m²)	Brightest luminance (mag arcsec-²)	Brightest lumininance	Synthetic SQM (mag arcsec-²)	Total luminous emittance (mags)	Illuminance (mlux) Horizontal	Max Vert
21.02	422	21.56	259	18.12	6,137	21.34	-7.50	1.133	0.826



PHOTOMETRY OF ARTIFICIAL SKYGLOW

Sky Quality Index (SQI)	Average Sky Luminance (µcd/m²)	Average Sky Luminance to zenith angle 80°	Average Sky Luminance to zenith angle 70°	Zenith Luminance	Brightest lumininance (µcd/m²)	All-sky light pollution ratio (ALR)	Total luminous emittance (mags)	Illuminance (mlux) Horizontal	Max Vert
89.7	59	36.1	23.8	3	3,209	0.24	-5.33	0.086	0.216

NPS NIGHT SKIES PROGRAM DATA NIGHT REPORT

BLCA081029 Black Canyon of the Gunnison NP **Sunset View** **29-Oct-08**

Data Night Attributes

Longitude:	-107.73343	Camera:	IMG 1	Air temp. (C):	3.3	ZLM:	6.70	OBS_1:	C Moore
Latitude:	38.56881	# of sets:	3	R. H. (%):	30.0	BORTLE:	3	OBS_2:	
Elevation (m):	2465	Exposure (secs):	14	Wind Speed (mph):	5	SQM:		OBS_3:	

NARRATIVE: This night and the next night both have significant amounts of airglow. However this night was of above average transparency. Milky Way interferes with Delta/Grand Junction glow, so that light dome measurement should be considered suspect. M33 was easy to spot, despite airglow, and MW has much more detail than data just taken at CURE. Geginschein barely seen, but limiting magnitude measurement was lower than expected.

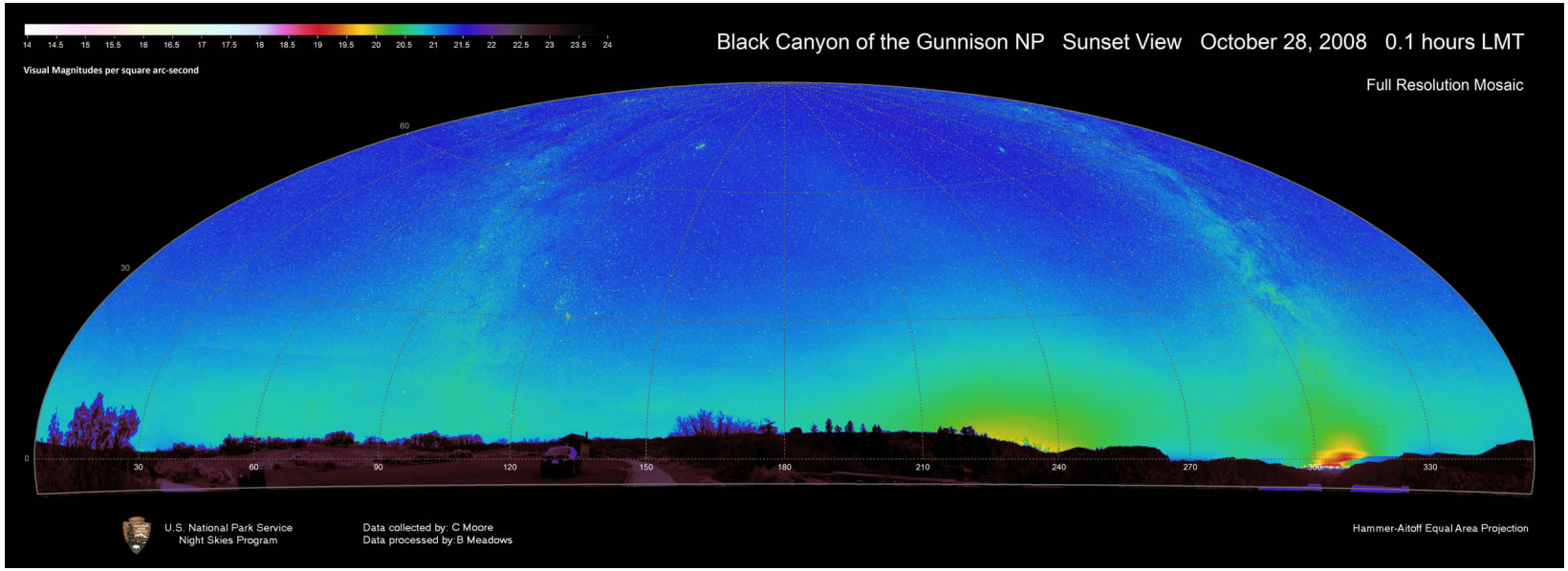
Data Set Attributes

	Quality Flags				Natural Sky Model			Extinction				Collection Properties			
Data Set	Use-able	Col-lection	Pro-cessing	Atmo-sphere:	Zenith airglow (µcd/m²)	Fit quality	Natural sky model fit notes	Ext. coeff. (mag/ airmass)	Std err Y	# stars used	# stars reject	% Clouds	Ave. Point Error	Max Point Error	total bias drift
1	Y	4	4	4	140	3		0.149	0.04	87	5	2	0.21	0.46	13.9
2	Y	4	4	4	140	3		0.151	0.04	88	7	2	0.23	0.45	10.2
3	Y	4	4	4	140	3		0.153	0.04	89	5	2	0.26	0.45	12.3

Populated Places

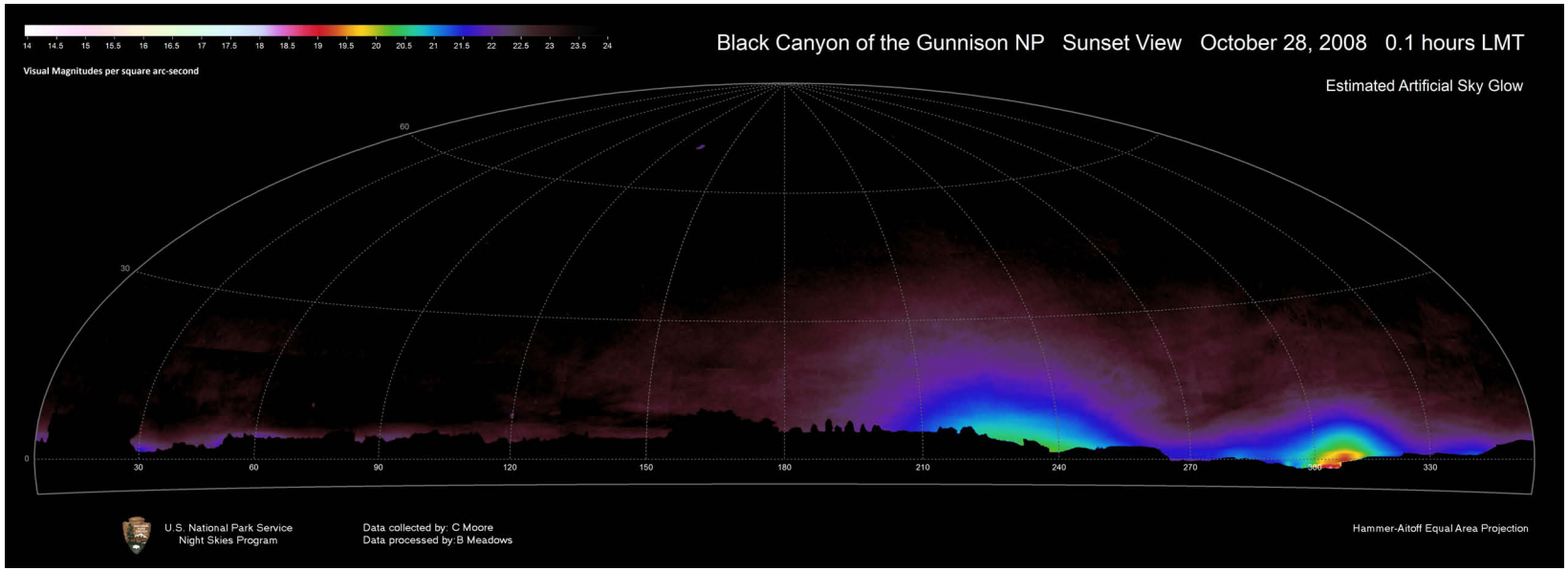
Place	Population (2010)	Distance (km)	Azimuth	Walker's	Apparent Half-Width (degrees)
Montrose city	19,132	15.7	225	1.972	13.7
Delta city	8,915	36.7	306	0.110	5.2
Olathe town	1,849	22.1	282	0.081	2.8
Grand Junction city	58,566	92.4	309	0.071	3.5
Orchard City town	3,119	34.0	323	0.046	5.2
Denver city	600,158	279.2	61	0.046	2.3
Colorado Springs city	416,427	259.8	82	0.038	2.8
Clifton CDP	19,889	84.5	312	0.030	1.5
Crawford town	431	18.6	35	0.029	1.4
Hotchkiss town	944	25.6	4	0.028	1.9
Aurora city	325,078	290.3	64	0.023	2.2
Cedaredge town	2,253	39.8	335	0.023	1.8
Paonia town	1,451	35.6	20	0.019	1.3
Albuquerque city	545,852	396.8	166	0.017	1.8
Gunnison city	5,854	70.0	92	0.014	1.3
Lakewood city	142,980	258.1	60	0.013	1.3
Fruitvale CDP	7,675	87.0	312	0.011	1.0
Fruita city	12,646	107.4	307	0.011	1.3
Orchard Mesa CDP	6,836	85.8	308	0.010	1.2
Arvada city	106,433	264.9	58	0.009	1.2
Redlands CDP	8,685	98.4	306	0.009	1.9
Thornton city	118,772	282.9	57	0.009	1.1
Highlands Ranch CDP	96,713	261.7	65	0.009	1.0
Westminster city	106,114	272.2	57	0.009	1.1
Pueblo city	106,595	273.7	96	0.009	1.4
Boulder city	97,385	268.0	52	0.008	1.0
Centennial city	100,377	271.9	64	0.008	1.0
Fort Collins city	143,986	317.2	45	0.008	1.2
Farmington city	45,877	205.1	191	0.008	1.4
Rifle city	9,172	107.9	358	0.008	1.1

BLCA081029 Date (LMT) 28-Oct-08 Time (LMT): 0.11



PHOTOMETRY OF ALL SOURCES

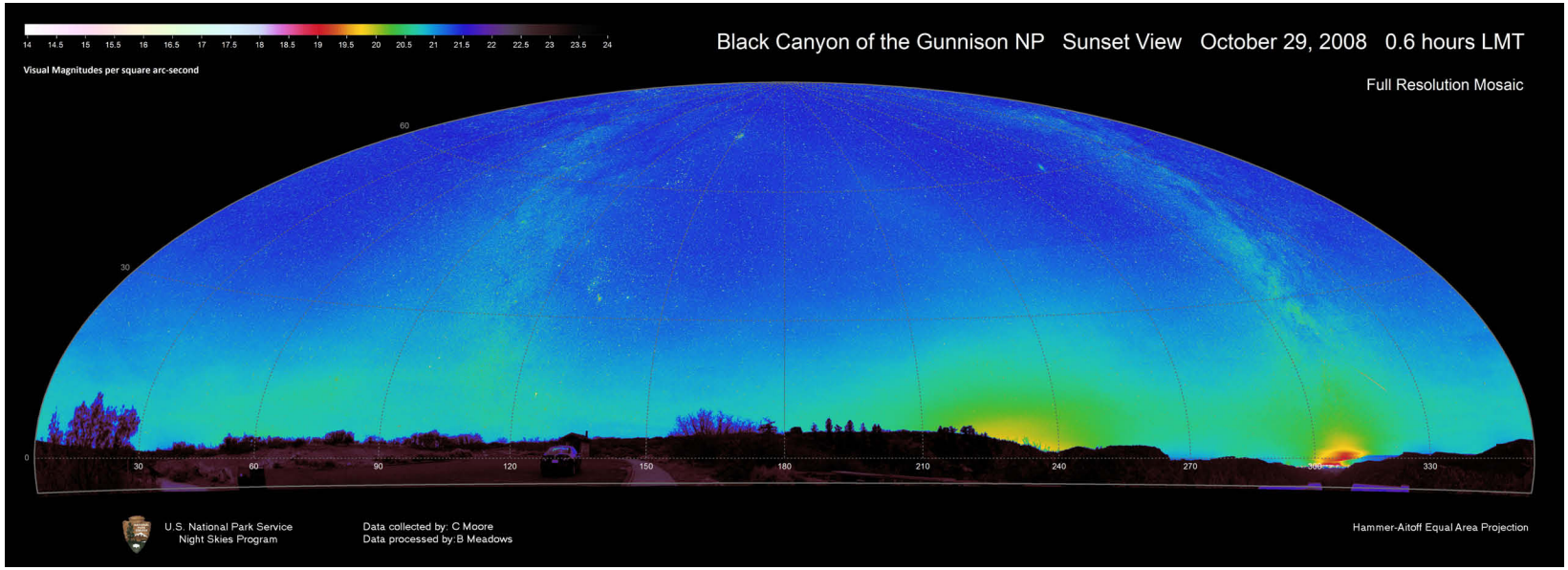
Average Sky Luminance (mag arcsec-²)	Average Sky Luminance (µcd/m²)	Zenith Luminance (mag arcsec-²)	Zenith Luminance (µcd/m²)	Brightest luminance (mag arcsec-²)	Brightest lumininance	Synthetic SQM (mag arcsec-²)	Total luminous emittance (mags)	Illuminance (mlux) Horizontal	Illuminance (mlux) Max Vert
21.03	421	21.47	280	18.15	5,957	21.32	-7.50	1.138	0.766



PHOTOMETRY OF ARTIFICIAL SKYGLOW

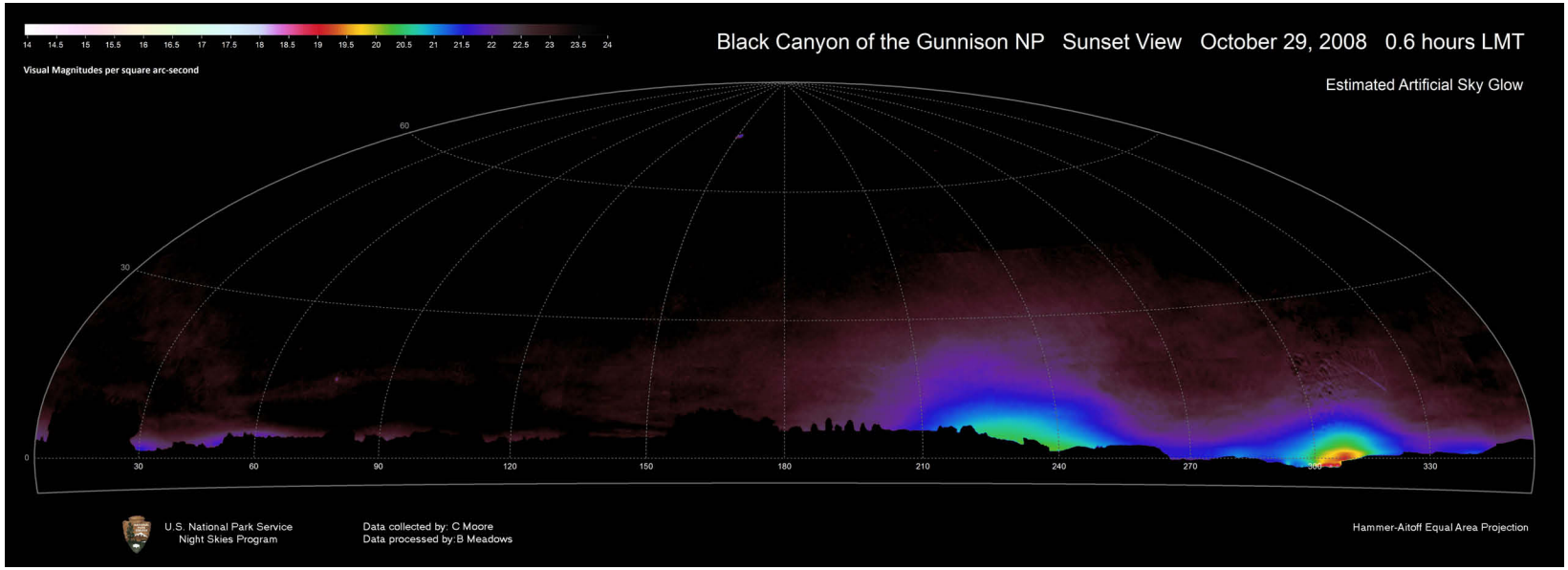
Sky Quality Index (SQI)	Average Sky Luminance (µcd/m²)	Average Sky Luminance to zenith angle 80°	Average Sky Luminance to zenith angle 70°	Zenith Luminance	Brightest lumininance (µcd/m²)	All-sky light pollution ratio (ALR)	Total luminous emittance (mags)	Illuminance (mlux) Horizontal	Illuminance (mlux) Max Vert
91.0	48	30.1	19.8	-10	5,728	0.19	-5.10	0.068	0.162

BLCA081029 Date (LMT) 29-Oct-08 Time (LMT): 0.55



PHOTOMETRY OF ALL SOURCES

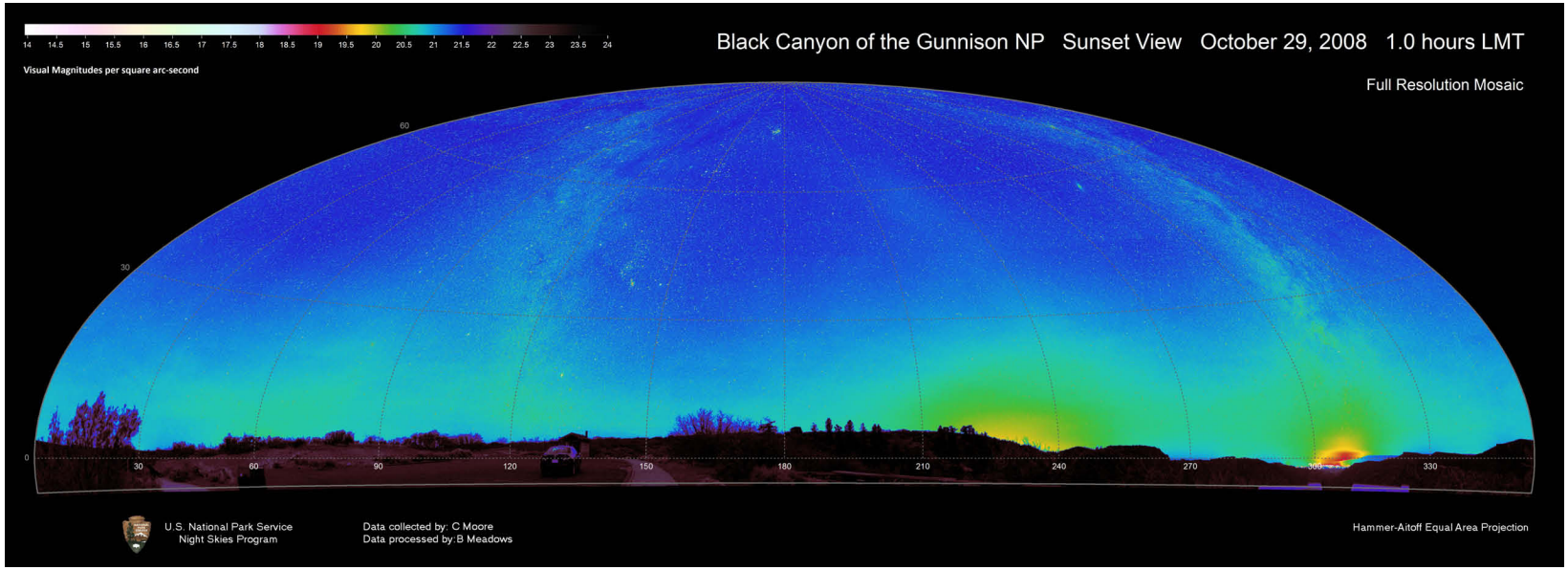
Average Sky Luminance (mag arcsec-²)	Average Sky Luminance (µcd/m²)	Zenith Luminance (mag arcsec-²)	Zenith Luminance (µcd/m²)	Brightest luminance (mag arcsec-²)	Brightest lumininance	Synthetic SQM (mag arcsec-²)	Total luminous emittance (mags)	Illuminance (mlux) Horizontal	Max Vert
21.03	420	21.43	290	18.18	5,777	21.31	-7.49	1.140	0.762



PHOTOMETRY OF ARTIFICIAL SKYGLOW

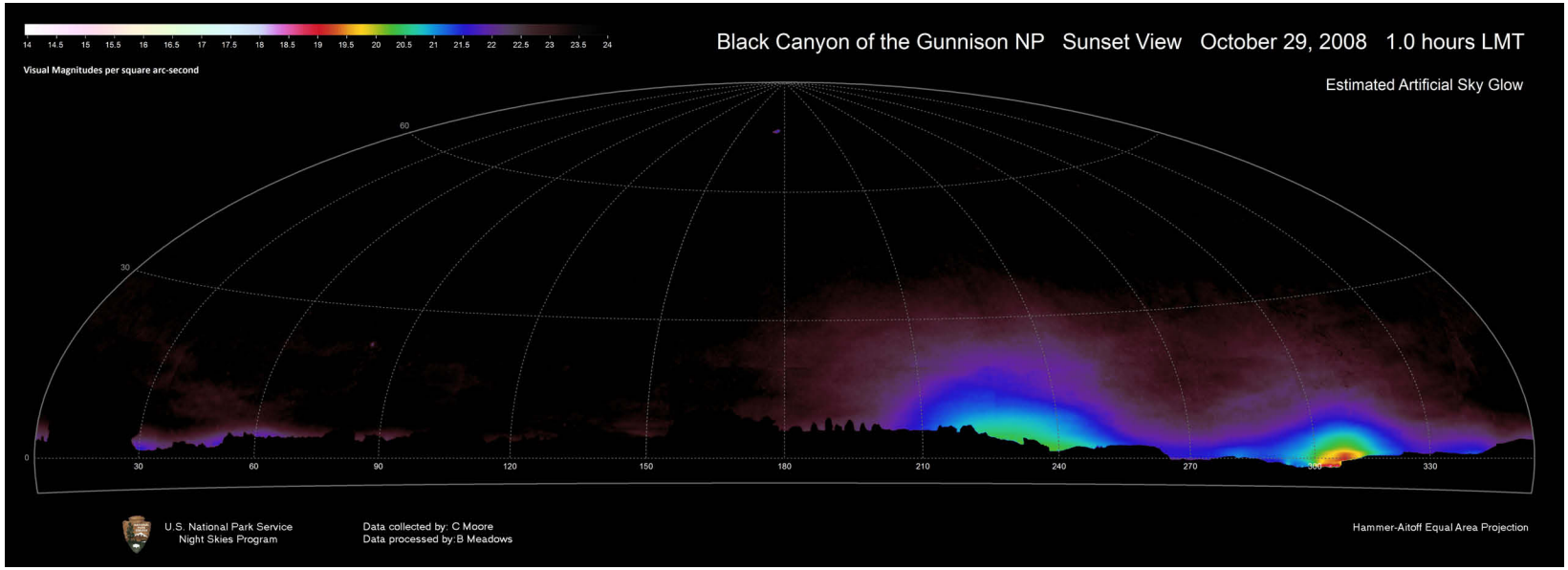
Sky Quality Index (SQI)	Average Sky Luminance (µcd/m²)	Average Sky Luminance to zenith angle 80°	Average Sky Luminance to zenith angle 70°	Zenith Luminance	Brightest lumininance (µcd/m²)	All-sky light pollution ratio (ALR)	Total luminous emittance (mags)	Illuminance (mlux) Horizontal	Max Vert
91.2	48	29.8	19.7	0	5,550	0.19	-5.10	0.070	0.161

BLCA081029 Date (LMT) 29-Oct-08 Time (LMT): 1.00



PHOTOMETRY OF ALL SOURCES

Average Sky Luminance (mag arcsec-²)	Average Sky Luminance (µcd/m²)	Zenith Luminance (mag arcsec-²)	Zenith Luminance (µcd/m²)	Brightest luminance (mag arcsec-²)	Brightest lumininance	Synthetic SQM (mag arcsec-²)	Total luminous emittance (mags)	Illuminance (mlux) Horizontal	Max Vert
21.04	415	21.46	281	18.18	5,788	21.33	-7.48	1.123	0.757



PHOTOMETRY OF ARTIFICIAL SKYGLOW

Sky Quality Index (SQI)	Average Sky Luminance (µcd/m²)	Average Sky Luminance to zenith angle 80°	Average Sky Luminance to zenith angle 70°	Zenith Luminance	Brightest lumininance (µcd/m²)	All-sky light pollution ratio (ALR)	Total luminous emittance (mags)	Illuminance (mlux) Horizontal	Max Vert
92.2	43	24.7	14.3	-8	5,563	0.17	-4.98	0.052	0.158

NPS NIGHT SKIES PROGRAM DATA NIGHT REPORT

BLCA041016 Black Canyon of the Gunnison NP **Sunset View** **16-Oct-04**

Data Night Attributes

Longitude:	-107.73332	Camera:	IMG 1	Air temp. (C):	11.1	ZLM:	7.00	OBS_1:	C Moore
Latitude:	38.56896	# of sets:	3	R. H. (%):		BORTLE:	3	OBS_2:	R Stark
Elevation (m):	2470	Exposure (secs):	15	Wind Speed (mph):	4	SQM:		OBS_3:	

NARRATIVE: Clear night with some minor haze to NE. Transparent air and steady seeing allowed limiting magnitude of 7.0, which is notable despite light domes. Most of light pollution is restricted to near horizon while majority of sky is very good. Zodiacal band faintly visible. Upon analysis, Grand Junction (along with Fruita and Delta) and Montrose are of equal brightness. Milky Way adding slightly to Grand Junction glow. Montrose would be brighter if not obstructed by terrain. Camera may be picking up glow from Denver 281 km away, not atypical for a city of that size. Visible sky improvement can be made with better lighting in Montrose.

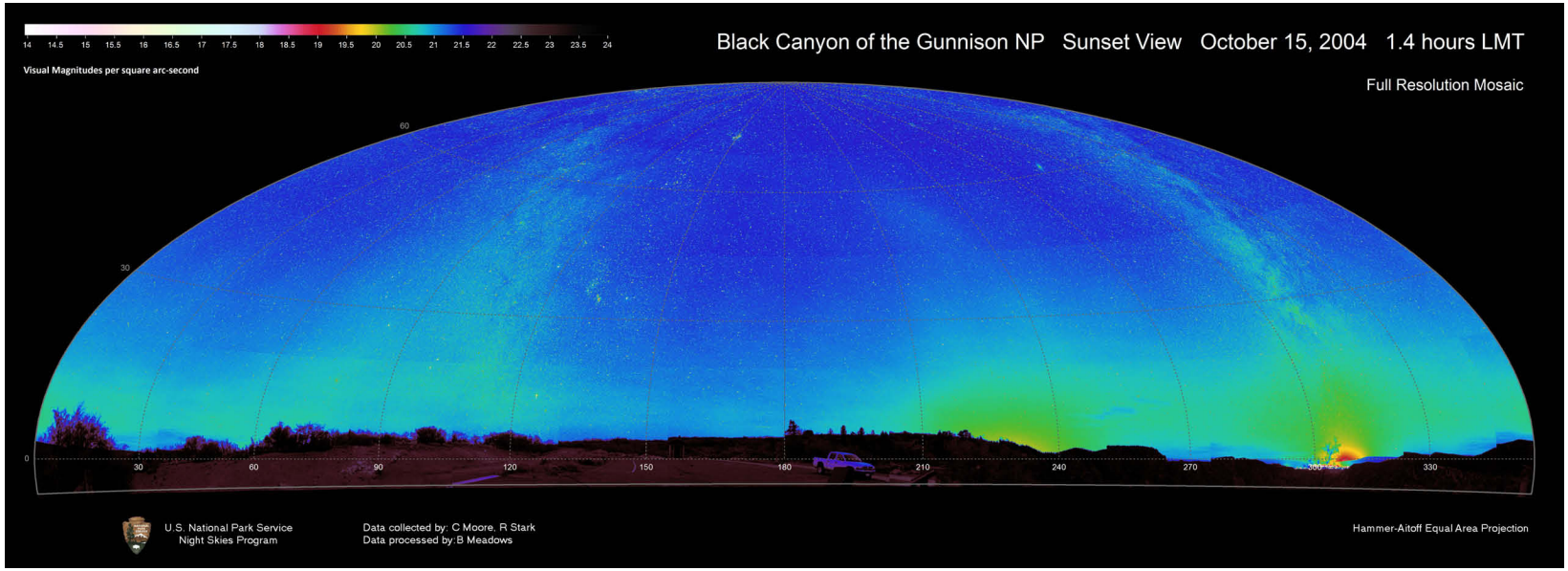
Data Set Attributes

	Quality Flags				Natural Sky Model			Extinction				Collection Properties			
Data Set	Use-able	Col-lection	Pro-cessing	Atmo-sphere:	Zenith airglow (µcd/m²)	Fit quality	Natural sky model fit notes	Ext. coeff. (mag/ airmass)	Std err Y	# stars used	# stars reject	% Clouds	Ave. Point Error	Max Point Error	total bias drift
1					134	3		0.139	0.04	96	2		0.19	0.46	9.4
2					127	3		0.136	0.04	97	3		0.19	0.46	7.0
3					127	3		0.139	0.04	85	0		0.19	0.46	6.7

Populated Places

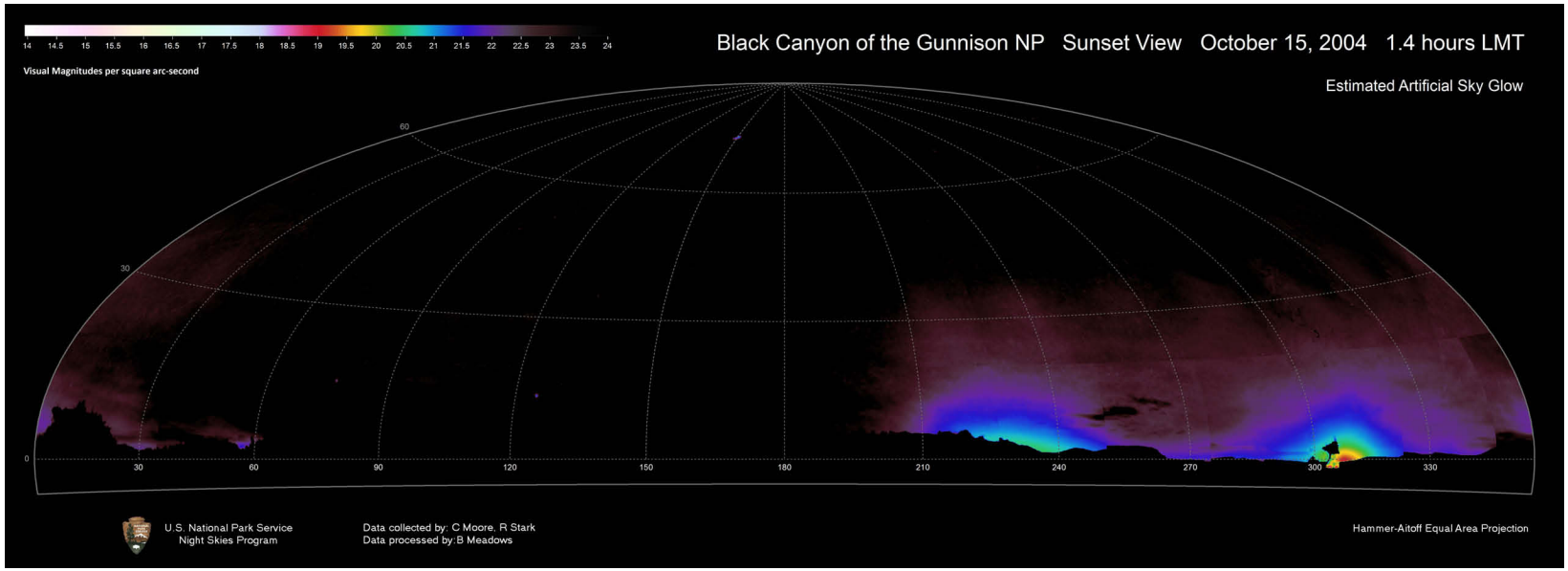
Place	Population (2010)	Distance (km)	Azimuth	Walker's	Apparent Half-Width (degrees)
Montrose city	19,132	15.7	225	1.966	13.7
Delta city	8,915	36.7	305	0.110	5.2
Olathe town	1,849	22.1	281	0.080	2.8
Grand Junction city	58,566	92.4	309	0.071	3.5
Orchard City town	3,119	34.0	323	0.046	5.2
Denver city	600,158	279.2	61	0.046	2.3
Colorado Springs city	416,427	259.8	82	0.038	2.8
Clifton CDP	19,889	84.5	312	0.030	1.5
Crawford town	431	18.5	35	0.029	1.4
Hotchkiss town	944	25.6	4	0.028	1.9
Aurora city	325,078	290.3	64	0.023	2.2
Cedaredge town	2,253	39.8	335	0.023	1.8
Paonia town	1,451	35.6	20	0.019	1.3
Albuquerque city	545,852	396.8	166	0.017	1.8
Gunnison city	5,854	70.0	92	0.014	1.3
Lakewood city	142,980	258.1	60	0.013	1.3
Fruitvale CDP	7,675	87.0	312	0.011	1.0
Fruita city	12,646	107.4	307	0.011	1.3
Orchard Mesa CDP	6,836	85.8	308	0.010	1.2
Arvada city	106,433	264.9	58	0.009	1.2
Redlands CDP	8,685	98.4	306	0.009	1.9
Thornton city	118,772	282.9	57	0.009	1.1
Highlands Ranch CDP	96,713	261.7	65	0.009	1.0
Westminster city	106,114	272.1	57	0.009	1.1
Pueblo city	106,595	273.7	96	0.009	1.4
Boulder city	97,385	267.9	52	0.008	1.0
Centennial city	100,377	271.9	64	0.008	1.0
Fort Collins city	143,986	317.2	45	0.008	1.2
Farmington city	45,877	205.1	191	0.008	1.4
Rifle city	9,172	107.8	358	0.008	1.1

BLCA041016 Date (LMT) 15-Oct-04 Time (LMT): 1.40



PHOTOMETRY OF ALL SOURCES

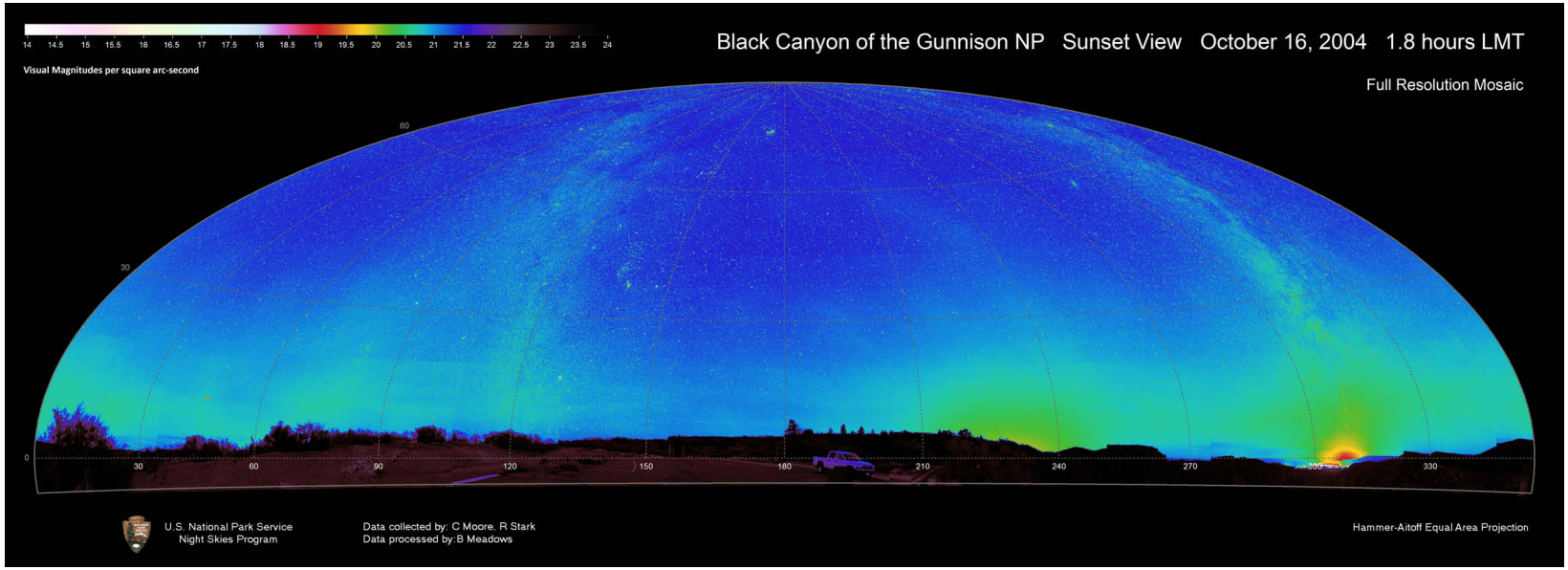
Average Sky Luminance (mag arcsec-²)	Average Sky Luminance (µcd/m²)	Zenith Luminance (mag arcsec-²)	Zenith Luminance (µcd/m²)	Brightest luminance (mag arcsec-²)	Brightest lumininance	Synthetic SQM (mag arcsec-²)	Total luminous emittance (mags)	Illuminance (mlux) Horizontal	Max Vert
21.07	406	21.45	285	18.33	5,043	21.33	-7.46	1.114	0.739



PHOTOMETRY OF ARTIFICIAL SKYGLOW

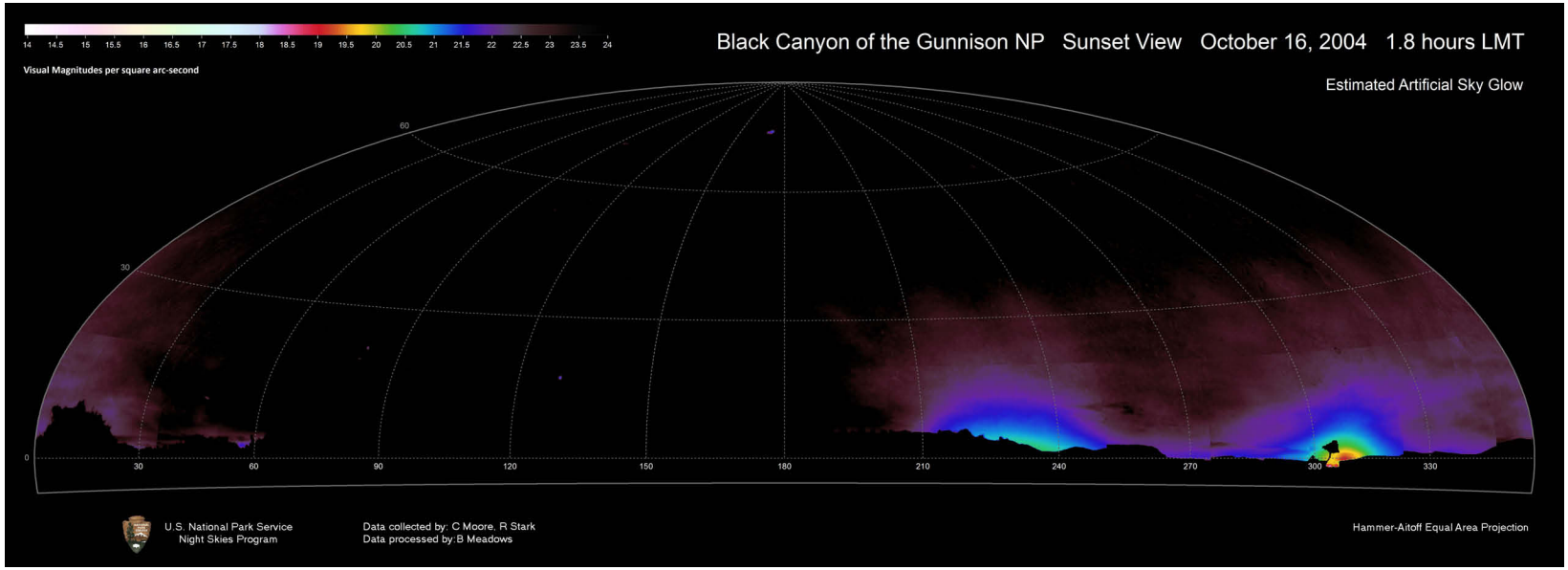
Sky Quality Index (SQI)	Average Sky Luminance (µcd/m²)	Average Sky Luminance to zenith angle 80°	Average Sky Luminance to zenith angle 70°	Zenith Luminance	Brightest lumininance (µcd/m²)	All-sky light pollution ratio (ALR)	Total luminous emittance (mags)	Illuminance (mlux) Horizontal	Max Vert
92.8	34	22.1	15.7	-1	4,808	0.14	-4.74	0.052	0.133

BLCA041016 Date (LMT) 16-Oct-04 Time (LMT): 1.81



PHOTOMETRY OF ALL SOURCES

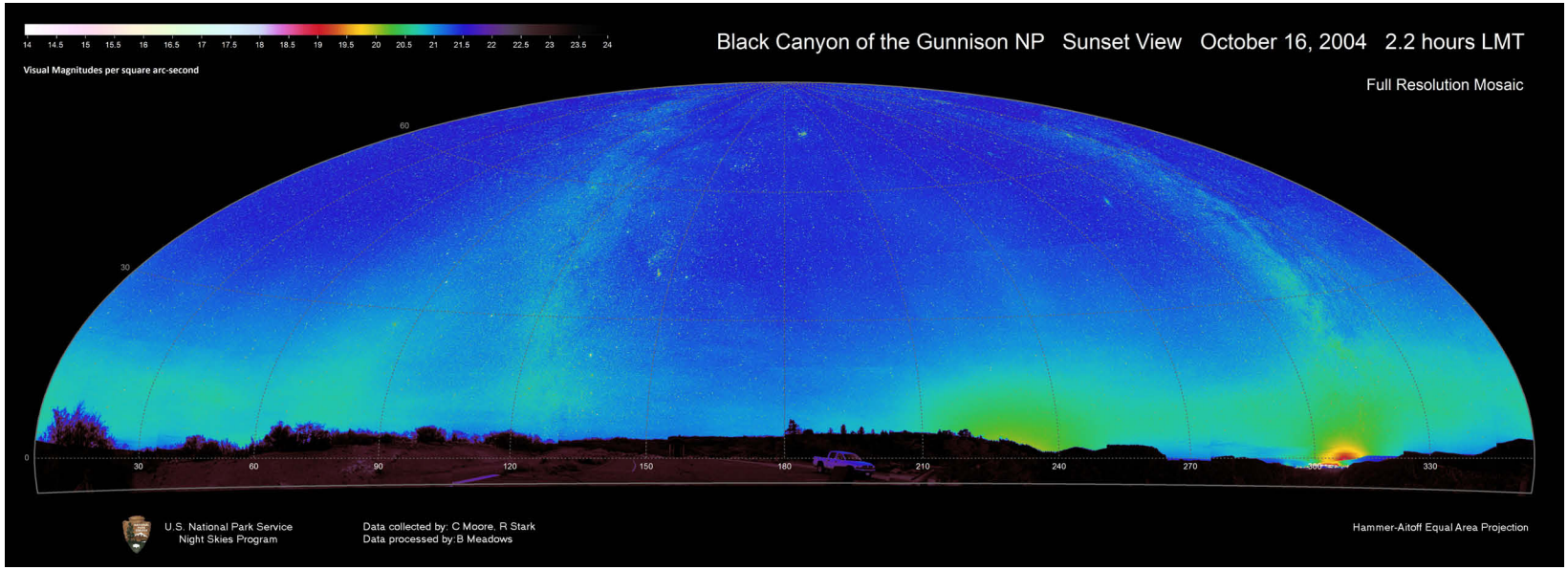
Average Sky Luminance (mag arcsec-²)	Average Sky Luminance (µcd/m²)	Zenith Luminance (mag arcsec-²)	Zenith Luminance (µcd/m²)	Brightest luminance (mag arcsec-²)	Brightest lumininance	Synthetic SQM (mag arcsec-²)	Total luminous emittance (mags)	Illuminance (mlux) Horizontal	Max Vert
21.09	399	21.44	287	17.90	7,487	21.34	-7.44	1.092	0.729



PHOTOMETRY OF ARTIFICIAL SKYGLOW

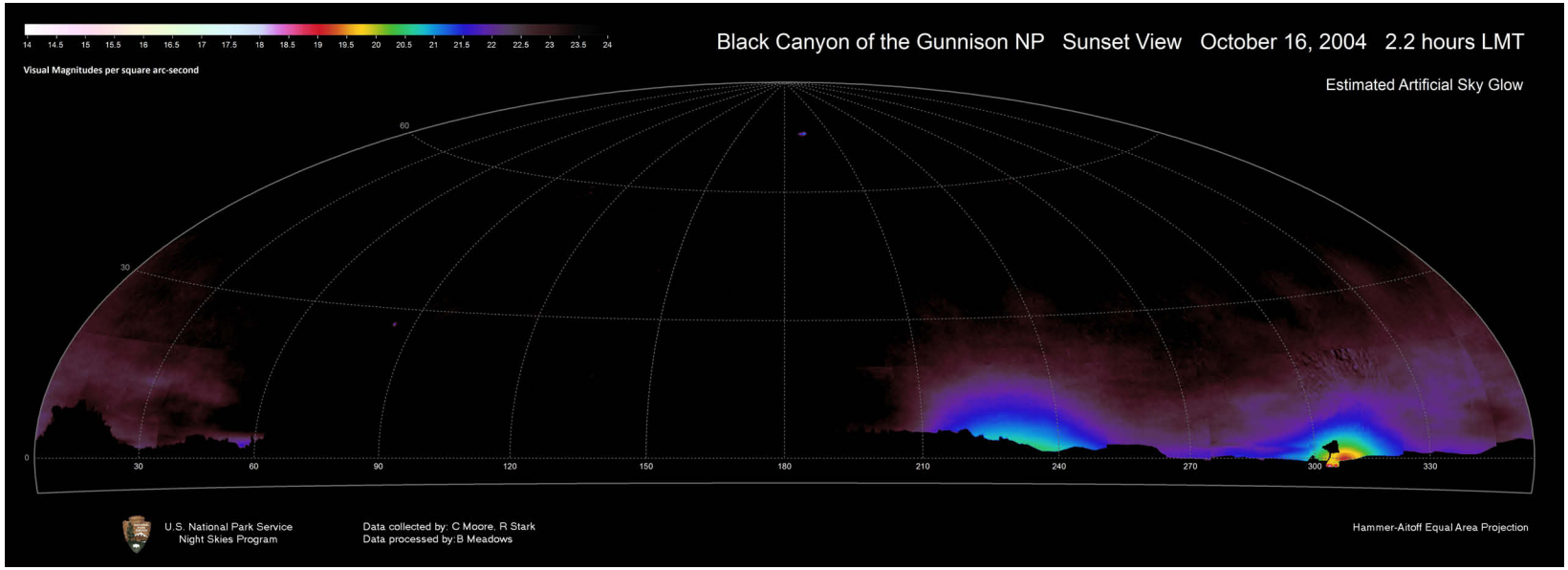
Sky Quality Index (SQI)	Average Sky Luminance (µcd/m²)	Average Sky Luminance to zenith angle 80°	Average Sky Luminance to zenith angle 70°	Zenith Luminance	Brightest lumininance (µcd/m²)	All-sky light pollution ratio (ALR)	Total luminous emittance (mags)	Illuminance (mlux) Horizontal	Max Vert
92.5	34	21.9	14.8	4	7,249	0.13	-4.72	0.050	0.136

BLCA041016 Date (LMT) 16-Oct-04 Time (LMT): 2.21



PHOTOMETRY OF ALL SOURCES

Average Sky Luminance (mag arcsec^{-2})	Average Sky Luminance (µcd/m^2)	Zenith Luminance (mag arcsec^{-2})	Zenith Luminance (µcd/m^2)	Brightest luminance (mag arcsec^{-2})	Brightest lumininance	Synthetic SQM (mag arcsec^{-2})	Total luminous emittance (mags)	Illuminance (mlux) Horizontal	Max Vert
21.10	395	21.47	279	17.95	7,174	21.35	-7.43	1.083	0.708



PHOTOMETRY OF ARTIFICIAL SKYGLOW

Sky Quality Index (SQI)	Average Sky Luminance (µcd/m^2)	Average Sky Luminance to zenith angle 80°	Average Sky Luminance to zenith angle 70°	Zenith Luminance	Brightest lumininance (µcd/m^2)	All-sky light pollution ratio (ALR)	Total luminous emittance (mags)	Illuminance (mlux) Horizontal	Max Vert
93.4	30	18.7	11.1	0	6,940	0.12	-4.62	0.040	0.119

Sky Ranger Programs and Education Outreach

Black Canyon of the Gunnison National Park has long been committed to night sky interpretation. Going back to 1998, the park established a partnership with the Black Canyon Astronomical Society (BCAS). Over the years, they have hosted events in the park year-round. Numerous club members share their equipment and expertise with park visitors. Since February 2011, BCAS has contacted 3650 park visitors while conducting telescope-based nighttime astronomy programs, evening amphitheater presentations, in addition to solar observing and eclipse programs. In the summer months, BCAS participates in 2 outreach events in the park per week. Near the full moon, they have monthly meetings in Montrose or Delta. Park Sky Rangers often present programs for BCAS club meetings. This partnership has been critical in establishing the astronomy program at Black Canyon.

Park management has been committed to funding seasonal and permanent park staff dedicated to interpreting nocturnal ecology, astronomy, solar resources, clean air and viewsheds for many years. This has resulted in well-developed programming throughout the year. In the summer the park offers astronomy themed evening programs 2-3 times a week followed by night sky observation using park and BCAS telescopes. These are commonly the most well attended programs in the park with attendance for summer programs ranging from 20-80 for each program. Solar observation in 2014 during June, July and August numbered 1500 and winter programs in 2015 counted 75 visitors in January and 150 in March. Both were record numbers.

2015 will mark the 6th annual astronomy festival on June 17-20. This will include citizen science programs, planet walks, telescope tips, photography workshops, evening programs, solar observation and night sky viewing. We are proud to host special speakers from partner organizations each year. In 2015, Scott Kardel of IDA has agreed to be our keynote speaker.

Astronomy interpretation at Black Canyon also includes full moon hikes monthly in the summer and full moon cross country ski trips in winter. Both events fill to capacity every time, often with an extensive waiting list.

During the summer months, visitors from around the world come to Black Canyon to attend astronomy programs. Winter programs are most frequently attended by local citizens. Park program offerings clearly serve a diverse range of audiences year-round.

Inventory, Monitoring, and Sky Quality Outreach

Standing room only for light pollution/trespass presentation at the South Rim Visitor Center

Park management and staff along with our partner, Black Canyon Astronomical Society (BCAS), are committed to the continuation of long term monitoring and education of dark skies at Black Canyon. NPS staff has purchased basic unihedron sky quality meters, the IDA approved Dark Sky Meter App for the park Ipad, and has created a data collection form to support long-term collection. Staff and BCAS astronomers, will continue to collect data at each of 13 collection sites at minimum twice per year and will collect additional measurements as weather, sky conditions and staffing allow. BCAS collects SQM data at each of their outreach events in the park (twice a week from June – September) and will continue to do so. The NPS Night Sky Team has also collected valuable sky data from the park and plans to provide more in the future.

This data has been used in a wide variety of ranger-led and partner-led programs for several years. Sky rangers use Night Sky Team data and SQM data to reinforce the significance of Black Canyon dark skies, the efforts the park has undertaken to install night sky friendly lighting and how visitors can do the same in their hometowns. This is done through park evening programs, BCAS programs at their public meetings/outreach events, and ranger outreach programs. Ranger outreach programs on sky data and preservation efforts include presentations at the Montrose Public Library and local "Ignite" programs.

Ranger outreach program at the Montrose Public Library interpreting Black Canyon dark skies, light pollution, data collection and preservation efforts.

The park is committed to the continuation and expansion of these programs as more data is collected and analyzed.

Citizen science programs are planned during the 6th annual Astronomy Festival during June 2015 that will enlist visitors with the Dark Sky Meter App to take readings throughout the park. The NPS and BCAS also will sponsor a night sky photography workshop during the Astronomy Festival. Photos taken will help establish tangible sky quality data at specifics sites annually.

Night sky observation, photography and SQM data collection at the South Rim Visitor Center.

The park employs one year-round astronomy/sky ranger and up to 3 seasonal astronomy/sky rangers. Having funded positions specifically geared towards astronomy is very rare in the NPS and shows the commitment the park has to dark sky protection and education. This consistency in astronomy positions guarantees high quality data collection and education will continue for years to come.

Night Sky Junior Ranger and Social Media Astronomy

The park has an active junior ranger program focused on dark sky preservation, appreciation and astronomy. This program is designed for ages 5-12 but is often used by adults as well. Many activities are park specific but also can be enjoyed anywhere there is a dark night sky.

Black Canyon has a vibrant social media audience on Facebook and Twitter. Commonly, dark sky activities, photos and news are the most "liked" posts by the nearly 9,000 followers on Facebook.

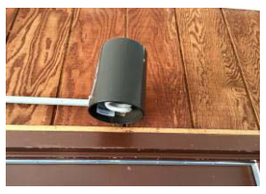
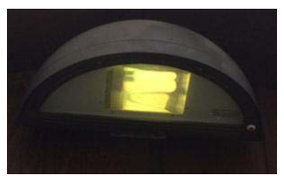
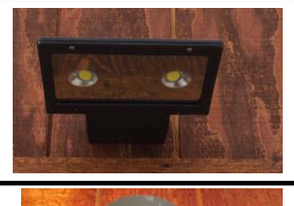
Examples of night sky related posts on the Black Canyon Facebook page.

2 *Park Lighting Inventory*

Overview

Black Canyon of the Gunnison National Park has a very limited lighting footprint. To date, there are 48 light fixtures in place in the park. 44 of those lights are on the South Rim and only 4 are on the North Rim. Lighting at the South Rim Visitor Center, South Rim Entrance Station and South Rim Administration offices is used primarily for security and park resident needs. Residents are encouraged to ensure housing lights are off when not in use. A great majority of the park contains no artificial lighting. To manage future lighting needs, the park has been divided into lighting zones.

Total lights operational in the park: 48
Total lights in compliance with Lighting Management Plan: 48
Park lighting is 100% in compliance with the Lighting Management Plan

General									
Light ID#	**Day Photo**		**Location**	**Application**	**Controls**	**Luminaire**	**Lamp**	**Watts**	
Black Canyon North and South Rim									
1, 2 , 3, 4			South Rim Entrance Station	**Area** lighting & **Security** lighting	switch	inset horizontal down light	CFL	30	
5			South Rim admin building NE entrance. Lower level	**Egress** lighting & **Security** lighting	motion sensor and switch	Single lamp with shield and motion sensor	CFL	30	
6, 7			South Rim admin building NW entrance. Lower level	**Egress** lighting	motion sensor	double par with fixture shields	halogen	20	
8			South Rim housing area at top of stairway	**Area** lighting & **Safety** lighting	motion sensor	shielded	CFL	30	
9-21 13 lights			Front and back porch lights for south rim apartments and laundry room	**Egress** lighting	switch	closed globe porch light	CFL	30	
22			On Brown House NW corner	**Area** lighting	motion sensor	shielded	CFL	30	
23			In vestibule in maintenance building East of brown house	**Egress** lighting	switch	closed globe porch light	CFL	30	
24, 25			Maintenance car garage	**Area** lighting	motion sensor	double par shielded	CFL	14	
26			Maintenance car garage	**Area** lighting	switch	shielded	halogen	50	
27			Maintenance shop	**Area** lighting	motion sensor	shielded	CFL	30	
28, 29			campground registration board south rim	**Area** lighting	motion sensor	double par with fixture shields, faces inside	red incandescent	25	
30, 31			South Rim VC restroom	**Egress** lighting	switch	inset horizontal down light	CFL	14	
32, 33			South Rim VC entrance	**Egress** lighting	switch	inset horizontal down light	CFL	30	
34, 35, 36, 37			South Rim VC North and South eaves for lighting front sidewalk and back porch	**Area** lighting	switch	inset horizontal down light	CFL	14	
38,39,40,41 42, 43			South Rim VC West eaves	**Area** lighting - **not in use unless emergency.**	switch	inset horizontal down light	CFL	30	
44			WNPA storage shed	**Egress** lighting	switch	shielded down facing	Halogen	20	
45, 46, 47, 48			North Rim Ranger Station / Housing	**Egress** lighting	switch	closed globe porch light	CFL	30	

3 *Management Documents*

NPS Management Policies

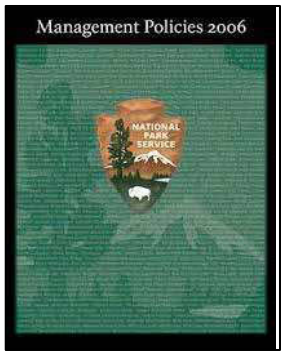
NPS Management Documents Supporting Dark Skies

National Park Service Organic Act

The Organic Act was passed in 1916 to protect and manage the national park lands of the United States. The act protected the ecological and scenic values within federal lands, under which falls dark sky resources. "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 purpose 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."

2006 NPS Management Policies

4.10 Lightscape Management: The Service will preserve, to the greatest extent possible, the natural lightscapes of parks, which are natural resources and values that exist in the absence of human caused light....The stars, planets, and earth's moon that are visible during clear nights influence humans and many other species of animals, such as birds that navigate by the stars or prey animals that reduce their activities during moonlight nights. Improper outdoor lighting can impede the view and visitor enjoyment of a natural dark night sky. 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 not use artificial lighting in areas such as sea turtle nesting locations where the presence of the artificial lighting will disrupt a park's dark-dependent natural resource components.



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, 4/2012 (www.nps.gov/greenparksplan)

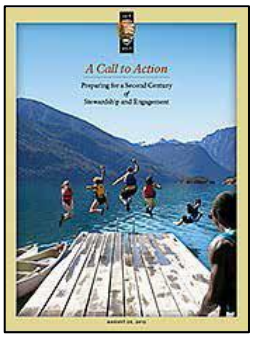
The NPS will reduce light pollution from park facilities with the goal of dark night sky preservation. (under the heading "Preserve Outdoor Values")

Night Sky Team (www.nature.nps.gov/sound_night/)

Starry night skies and natural darkness are important components of the special places the National Park Service protects. National parks hold some of the last remaining harbors of darkness and provide an excellent opportunity for the public to experience this endangered resource. The NPS is dedicated to protecting and sharing this resource for the enjoyment of current and future generations.

The NPS uses the term "natural lightscape" to describe resources and values that exist in the absence of human-caused light at night. Natural lightscapes are critical for nighttime scenery, such as viewing a starry sky, but are also critical for maintaining nocturnal habitat. Many wildlife species rely on natural patterns of light and dark for navigation, to cue behaviors, or hide from predators. Lightscapes can be cultural as well, and may be integral to the historic fabric of a place. Human caused light may be

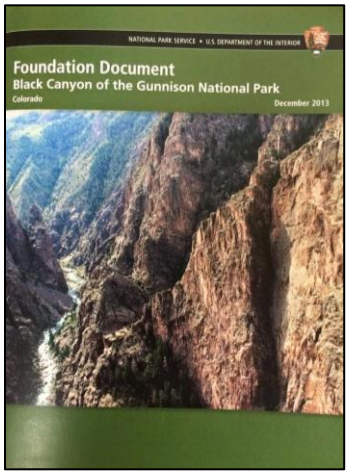
obtrusive in the same manner that noise can disrupt a contemplative or peaceful scene. Light that is undesirable is a natural or cultural landscape is often called “light pollution.”



Call to Action, 2012
The Director’s Call to Action Report is a guideline for employees and partners that contains specific goals and measurable actions, and charts a path towards unified goals. Action 27: Starry, Starry Night: “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.”

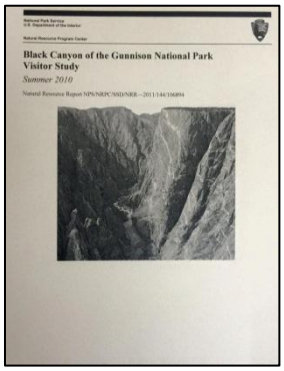
Black Canyon Lighting Management Plan

Purpose and Goals
This plan serves as the foundation for preserving naturally dark skies at Black Canyon of the Gunnison National Park. These guidelines will be the basis for management decisions about lightscape management, upkeep and possible future lighting projects. In the 2006 NPS Management Policies document, lightscape management is defined as: “the effective use of good design to appropriately light areas and minimize or eliminate clutter, the spill-over of light into areas where light is not wanted, and light pollution, all of which wastes energy and impacts park visitors, neighbors and resources.”



The 2013 Foundation Document for Black Canyon includes “Wilderness” and “Spectacular Views” as Fundamental Resources of the park. Night skies are a key part of both of those Fundamental Resources. The Foundation Document recognizes that lighting from nearby homes, park structures and communities could have an impact on sky quality within the national park. Protecting the daytime and nighttime viewshed is recognized in the document by stating: “Keep the viewshed in mind when the NPS is planning for development or infrastructure; set a good example.” If we are to be a good neighbor to our local communities and set the standard for protecting dark skies, we must have a solid lighting plan in place.

In the 2010 Black Canyon of the Gunnison National Park visitor study, visitors reported that dark night skies were of significant importance to their current and future visits. 94% said that clean air was “extremely important” or “very important”. 73% reported that dark, starry night skies were “extremely important” or “very important”. 48% of visitors said that they would like to attend ranger-led astronomy programs on a future visit, the highest percentage for any program category. Black Canyon is quickly becoming an astronomy destination.



The proximity to the large population centers of the Western Slope make access to the park relatively easy. Yet, the park is far enough away from these population centers to ensure a dark sky with some of the highest quality on the Colorado Plateau. This combination of factors makes the opportunity for excellent outreach and education opportunities today and into the future, if park lighting is managed appropriately.

At this time, there are no State or Montrose County laws governing night skies in western Colorado. Nearby Mesa County does mandate night sky protection in certain areas of the county:
http://iesrmsdenver.org/wp-content/uploads/mesa.pdf

This lighting plan will help ensure that the location, duration, and intensity of artificial lighting will be limited to only that which is needed to achieve a basic level of safety, security, and convenience for NPS employees, residents, and visitors. Additionally, Black Canyon has established a *Standard Lighting Zone,* the area of the park where lit buildings already exist. Any future lighting will be limited to this zone. The remainder of the park consists of a *Natural Darkness Zone.* Artificial lighting in this zone is prohibited.

Lighting Guidelines

All exterior lighting in Black Canyon of the Gunnison National Park shall be designed to eliminate light trespass, minimize glare, and use an intensity, color, and duration that will preserve the natural darkness as much as possible.

NPS Management Policies direct parks to use artificial light on an "only as needed" basis and to minimize impact whenever possible. Merely shielding a light does not necessarily constitute lightscape, wildlife, or night-sky friendliness; especially if that light is unnecessary in the first place. Even when a light is necessary, the incorporation of a timer, motion sensor, or switch can greatly reduce its impact.
The mitigation of outdoor lighting impacts upon the environment is best accomplished by addressing six parameters of lighting.

1) Warranting- Light only WHERE you need it

a. Lighting installations should be placed only where uses dictate.

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.

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.

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 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. The following light sources are acceptable for outside use:

i. LED 2700K “warm” white lamps, yellow, or amber colored, 1, 3, or 7 watt. LED’s superior 54 life, energy efficiency, instant starting and low temperature performance are superior but some capabilities of the source are limited. Use with caution in hot climates. Use amber LEDs in most environmentally sensitive areas.

ii. Compact fluorescent, 9 watt, twin tube and 13 watt double twin tube or Edison base spiral 3, 7, 10, 13 or 26 watt (2700K only or yellow “bug lamps”). Because of low starting temperature and low cost components, this light source can be used for many basic outdoor lighting applications.

iii. Halogen IR, 20 watt, 12 volt MR16 lamp. Uses are generally limited to temporary (presence detector activated) lighting applications. Because of their low luminous efficacy they should not be used in continuous duty applications.

iv. Ceramic metal halide lamps, 20 watts, T4.5 and 39 watt, T6, 3000K only. In general, these are the most powerful light source to be used outdoors, but warm up and restrike time preclude use where frequent switching or power quality issues are present.

5) Intensity- Use the minimum AMOUNT of light necessary

6) Efficiency- Select the most energy EFFICACIOUS lamp and fixture

Existing Standards and Codes

A Royal Astronomical Society of Canada (RASC) Dark Sky Park is defined as an area whose night sky has little or no sky glow and minimal lighting within the DSP. As such, Black Canyon has created and adapted a lighting guideline outline that minimizes the lighting within the park.

From the NPS Interim Outdoor Lighting Guidelines:

Best management practices for outdoor lighting will:

- Curtail and reverse the degradation of the nighttime visual environment and the night sky, including casual observation, astronomy, and air quality related values.
- Minimize glare, light trespass, obtrusive light, and artificial sky glow by limiting outdoor lighting that is misdirected, excessive, or unnecessary.
- Ensure good neighbor lighting by minimizing light trespass.
- Help minimize suspected health risks to humans from adverse exposure to light at night.
- Help protect natural ecosystems from the damaging effects of night lighting.
- Permit reasonable and rational use of outdoor lighting for nighttime safety, utility, security, and productivity.
- Help to conserve energy and resources.
- Minimize maintenance and operating costs
- Provide some flexibility for architectural and artistic lighting within the above constraints

Lighting Zones

Black Canyon is a largely undeveloped park. Lighting is focused on the South Rim Visitor Center, South Rim Administration Area and South Rim Entrance Station. Campgrounds, restrooms (with the exception of the South Rim Visitor Center) and trailheads remain dark, and fulfill the visitor expectation for a wilderness experience.

The park can be divided into two zones:

• **Zone One**, where minimum artificial lighting is deemed necessary for safety—such as at residential and visitor services areas. Zone one exists as a **Standard Lighting Zone** (SLZ), and contains structures that support the operational needs of the park. Lighting here exists on a level dictated by necessity only, and should be restricted temporally and spatially.

• **Zone Two** is the majority of the park, and contains no artificial lighting. This zone includes campgrounds, trailheads, and roads, as well as the general wilderness areas of the park. Zone two is a **Natural Darkness Zone** (NDZ), where no permanent light fixtures exist. Any lighting needs in this zone will be on an individual case, and will be addressed by temporary lighting devices such as flashlights. This zone comprises the wilderness and solitude values of the park, and minimizing and eliminating light trespass into this zone is paramount.

Lighting Standards

Standard Lighting Zone (SLZ)

Exterior Lighting exists solely for security and convenience. Lights shall remain on only in minimum capacity, and with the aim of safety and security. Permanent fixtures are allowed in this zone, provided they are limited to immediate task area. Artificial lighting is used only when necessary for safety, as in lights around fee stations, maintenance facilities, residential porches, and visitor centers. Any future buildings or projects will conform to these standards. In order to alleviate light trespass, the following basic principles are observed:

• Light fixtures should exist only where needed for specific tasks.
• Light should only exist when necessary. Lights should operate on manual switches or motion sensors/timers.
• Light should only exist in the minimum amount necessary. Individual fixtures should be limited to 600 lumens, with exceptions for specific safety and special uses based on need.
• Lights should be selected with warm colors, such as amber (≤2500K color temperature).
• Energy efficiency should be considered when choosing lighting. Standard bulbs should be compact fluorescent (CFL), which are low-wattage, or light-emitting diodes (LED).
• Lights should be directed downward and shielded.

Natural Darkness Zones (NDZ)

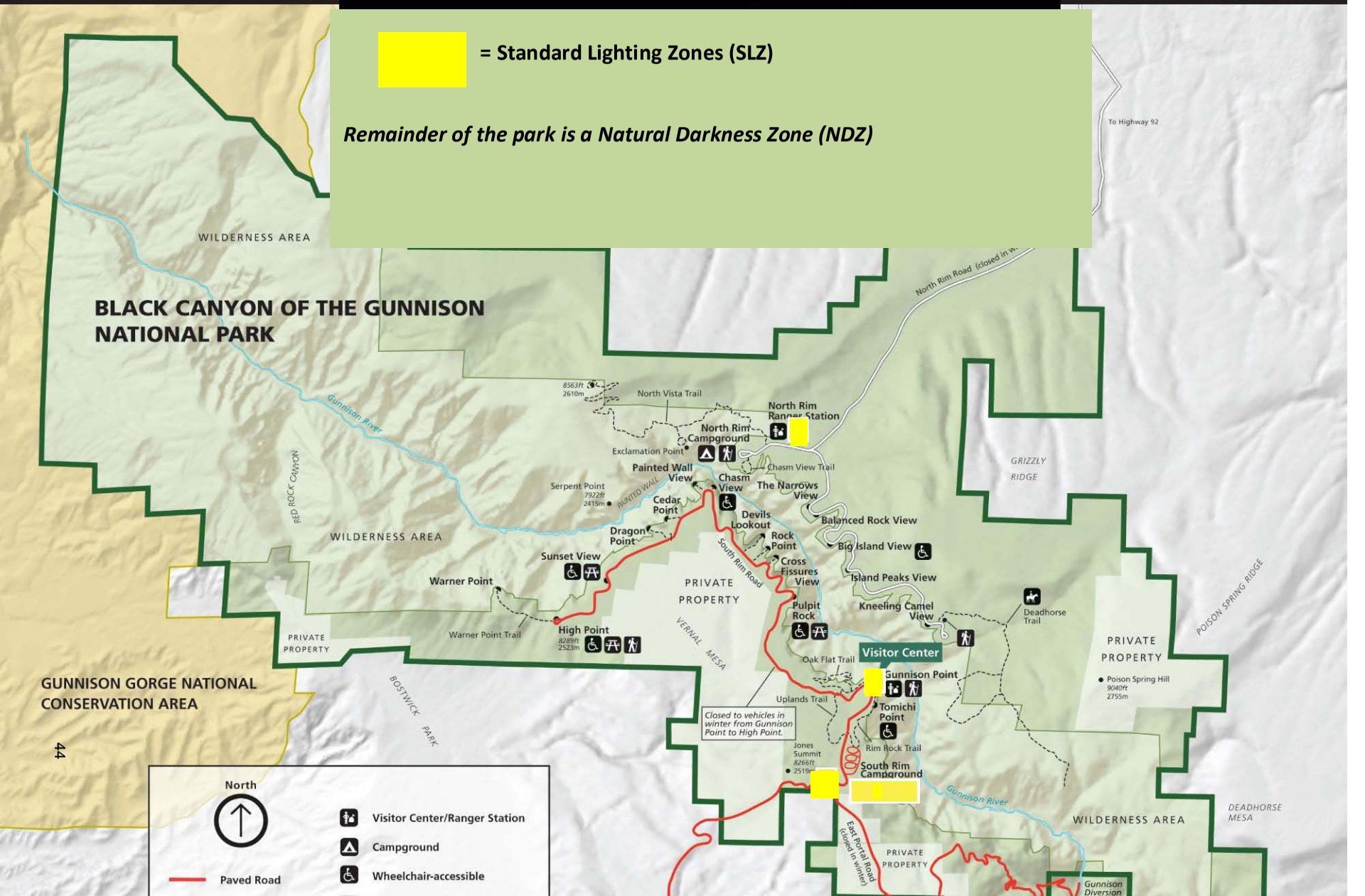
All other areas of the park fall under this zone. These areas include the South Rim and North Rim Drive, South Rim and North Rim campgrounds, overlooks and restroom facilities. No permanent lighting exists or is allowed in this area. Light trespass from outside sources and Zone One is minimal and all attempts are made to eliminate any excess light pollution. This area makes up the large majority of the park, including the federally designated Black Canyon Wilderness Area.

Black Canyon of the Gunnison

National Park
U.S. Department of the Interior

= Standard Lighting Zones (SLZ)

Remainder of the park is a Natural Darkness Zone (NDZ)



Private Lands within the Park Boundary

In 1984, Congress passed a law (Public Law 98- 357) to modify the boundary of the then national monument to include adjacent private lands that were in the viewshed of the canyon. It states: "The purpose of this Act is to establish a boundary for the monument in order to promote, perpetuate, and preserve the character of the land and to preserve scenic and historic resources." The Act's language recognized Black Canyon as possessing "outstanding recreational opportunities and natural characteristics of high value which...contribute as an enduring resource..." The background congressional record information provided with boundary expansion legislation states, "Although the monument contains a multitude of scientific, educational, cultural, historical, and other benefits, the center of attraction to the area is, without a doubt, the viewshed."

This gave authorization to purchase private lands within the statutory boundary if they become available for sale or to negotiate conservation easements for viewshed protection.

The NPS has since acquired interests in all the North Rim tracts of private land within the boundary adjustment. Some of this land was acquired in fee simple (meaning NPS purchased all interests in the land, and it is therefore open to public access). But on some tracts, NPS negotiated instead a conservation easement, meaning that the land can never be developed; however, they remain private property and their ranching use can continue. The North Rim parcels protected by conservation easements are shown as "private property" on the park map. There are conservation easements on the South Rim as well. The area of Vernal Mesa just south of the South Rim Drive is the main example. Grazing continues on that land, but it cannot be developed.

Private land along the boundary of the park to the southeast along the East Portal Road, does include a private residence. While the exact lighting of the residence is unknown, it is of the night sky friendly variety and is almost never seen by visitors or astronomers in the park.

Conclusion

Black Canyon is dedicated to maintaining a lighting system that is low-impact and exists only as necessary for safety. Future lights will comply with this low-impact lighting management system and be compatible with NPS Management policies, which state that it is important to specify the need in each case of outdoor lighting and choose the appropriate lighting design. Artificial lighting in the park does not exist in areas where there is an expectation for darkness by the visitor and employee.

4 Letters of Support

Evening Astronomy Event at the South Rim Campground

United States Department of the Interior
NATIONAL PARK SERVICE
Black Canyon of the Gunnison National Park
Curecanti National Recreation Area
102 Elk Creek
Gunnison, CO 81230

IN REPLY REFER TO:
N16 (BLCA/CURE)

March 18, 2015

IDA Board of Directors
International Dark-Sky Association
3225 North First Avenue
Tucson, Arizona 85719

Dear Board Members:

As park superintendent, I am most pleased to offer my support for International Dark Sky Park designation for Black Canyon of the Gunnison National Park.

In the mid-1970s, I took a night flight from Denver to Laramie, Wyoming where I attended college. As a kid who grew up on the East Coast, the concept of dark night skies was foreign to me. I still vividly remember looking out the plane window that night and being absolutely astonished by the absence of lights on the landscape below me. Sadly, someone taking a similar flight today would notice a lighting landscape much altered from the mid-1970s.

On the positive side, there are still vestiges of the same dark night skies here on the Western Slope of Colorado that I recall from bygone days. It is important to recognize the value of those night skies as a means of protecting them. One of those places where the dark night skies are very much worth protecting is at Black Canyon of the Gunnison National Park.

Fortunately, our park staff, our visitors, and the local population already have a deep appreciation for the night sky values at Black Canyon. In response to that high level of interest, we offer a wide range of night sky programs year- round. In the summer we offer astronomy themed evening programs 2-3 times a week followed by night sky observation via park and Black Canyon Astronomical Society telescopes. We will be presenting our 6th annual astronomy festival in late June. This includes special day time programs, evening programs, special speakers and night sky viewing. This year we will host the Managing Director from your very own International Dark Sky Association as our keynote speaker. Other offerings include full moon hikes, full moon skis, winter night sky observation, and solar observation talks.

Our astronomy programs are commonly our highest attended interpretive offerings. Summer evening programs range from 20-80 visitors, solar viewing contacts about 1500 people a month during June, July and August. Winter programs range from 50-70 attendees.

In terms of the aforementioned local support, the Black Canyon Astronomical Society certainly stands out. They provide extensive outreach and support to the park. From February 2011 to the present, they have contacted 3650 visitors through evening telescope observation and special events (eclipses). They will also be providing us with the nomination letter of support for IDA certification. A letter of support is

also anticipated from the Office of Tourism and the Chamber of Commerce in Montrose, CO, our gateway community at Black Canyon of the Gunnison National Park. There are other examples that could be offered, but suffice it to say that the level of support for dark sky protection at Black Canyon is very high among the local population.

We are also in the process of conducting an updated inventory of all park lighting at Black Canyon. From the work completed thus far, we have identified many accomplishments in reducing the night sky impacts from park lighting and have also singled out some areas for further improvement. All of this information will be spelled out in a lighting management plan that will be included with our nomination package.

In short, we see innumerable benefits flowing from International Dark Sky Park designation at Black Canyon of the Gunnison National Park. We certainly hope you agree. In closing, let me thank you for all you do as Board Members to protect the integrity of dark night skies in the United States and beyond.

Sincerely,

Bruce Noble

Bruce Noble,
Superintendent

CITY OF MONTROSE
OFFICE OF THE CITY MANAGER
OFFICE OF BUSINESS AND TOURISM

From the desk of Rob Joseph

Direct: 970 240 1427
Mobile: 303 258 0700
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April 20, 2015

Board of Directors
International Dark-Sky Association
3223 North First Avenue
Tucson, Arizona 85719

Dear IDA Board Members:

The City of Montrose has been an active partner with the Black Canyon of the Gunnison National Park for many years. We have come to love this remarkable park and admire its breathtaking and surreal presence. There are a number of business owners in the Montrose community who are involved in tourism, and they have found that the dark skies, regular evening programs, and annual astronomy festivals provided by both the Black Canyon Astronomical Society and national park staff are popular and enriching attractions to the traveling public.

A core 2015 departmental goal for the Office of Business and Tourism is to bolster staff understanding of the park while enhancing what are already very good interagency staff relations. We have started the conversation with park personnel for the 2016 centennial events and are discussing complementary programs and packages – some of which center on folks experiencing our magnificent pitch-black skies that sparkle as if laced with diamonds.

Whether it's the effect on the local quality of life, or the look of wonder on visitors' faces, protecting the night sky ought to be considered of paramount importance. This belief, carried by our city councilors, community members, park rangers, business proprietors, and visitors, is authorized by city government by ordinance. As an advocate of the International Dark Sky Park designation for Black Canyon of the Gunnison National Park, I thank you for what you do and for taking a moment to read this plea in support of keeping this portion of our national sky dark and starry.

Respectfully,

Rob Joseph
Assistant City Manager
Office of Business and Tourism Director

Colorado Plateau Dark Sky Cooperative

2282 S. West Resource Blvd
Moab, UT 84532

March 18, 2015

VIA ELECTRONIC COPY ONLY- NO HARD COPY TO FOLLOW

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

Dear IDA Board of Directors:

The Colorado Plateau Dark Sky Cooperative is pleased to support the Black Canyon National Park International Dark Sky Park nomination. The park offers an exceptional, unfettered view of the dark night skies above the dramatically deep canyon and surrounding public lands. The dark skies of Black Canyon have immense value to rural western character, astronomical observation, and wildlife conservation in the region. For the last 17 years, Black Canyon has partnered with the Black Canyon Astronomical Society to host a series of astronomy events and festivals that are free to the public. In addition, Black Canyon International Dark Sky Park designation would assist in the conservation of dark night skies in neighboring Curecanti National Recreation Area.

As an essential piece of the newly formed Colorado Plateau Dark Sky Cooperative, Black Canyon National Park is taking lighting, conservation, and educational steps to fulfill the mission of the NPS Call To Action #27, Starry Starry Night. This voluntary initiative forms America's first Dark Sky Cooperative, and links communities, tribes, businesses, state/federal agencies, and citizens in a collaborative effort to celebrate the view of the cosmos, minimize the impact of outdoor lighting, and ultimately restore natural darkness to the area. Black Canyon International Dark Sky Park designation would bring further awareness and legitimacy to the Cooperative.

We fully support the efforts of Black Canyon National Park as they seek designation of the Black Canyon International Dark Sky Park. Such efforts to conserve dark skies will benefit park visitors, nearby communities, and future generations. Should you have any questions, please contact Nate Ament at 435-719-2349.

Sincerely,

Nate Ament

Colorado Plateau Dark Sky Cooperative Coordinator

United States Department of the Interior
NATIONAL PARK SERVICE
Intermountain Region
12795 West Alameda Parkway
Lakewood, CO 80228

March 17, 2015

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

Dear IDA Board of Directors:

The National Park Service (NPS) Intermountain Region is pleased to support the Black Canyon of the Gunnison National Park International Dark Sky Park nomination. Black Canyon of the Gunnison National Park is located in rural western Colorado. The park offers an exceptional, unfettered view of the dark night skies above the dramatically deep canyon and surrounding public lands. The dark skies of Black Canyon have immense value to rural western character, astronomical observation, and wildlife conservation in the region. In addition, Black Canyon International Dark Sky Park designation would assist in the conservation of dark night skies in the neighboring Curecanti National Recreation Area.

As an essential piece of the newly formed Colorado Plateau Dark Sky Cooperative, Black Canyon of the Gunnison National Park is taking lighting, conservation, and educational steps to fulfill the mission of the NPS Call To Action #27: *Starry, Starry Night.* This voluntary initiative forms America's first Dark Sky Cooperative, and links communities, tribes, businesses, state/federal agencies, and citizens in a collaborative effort to celebrate the view of the cosmos, minimize the impact of outdoor lighting, and ultimately restore natural darkness to the area. Black Canyon International Dark Sky Park designation would bring further awareness and legitimacy to the Cooperative.

The Intermountain Region's Natural Resources Division is pleased to continue to support the worldwide network of committed individuals who care deeply about preserving the beauty and heritage of our night skies. We fully support the efforts of Black Canyon of the Gunnison National Park as they seek dark sky park designation. Such efforts to conserve dark skies will benefit park visitors, nearby communities, and future generations. Should you have any questions, please contact Nate Ament at 435-719-2349.

Sincerely,

Patrick Malone
Assistant Regional Director, Natural Resources

Cc: Bruce Noble, Superintendent, BLCA
Paul Zaenger, Supervisory Park Ranger, BLCA
Nickolos Myers, Lead Interpretive Ranger, BLCA
Ken Stahlnecker, Chief of Resource Stewardship and Science, BLCA
David Vana-Miller, Resource Stewardship Program Manager, IMR
Nathan Ament, Colorado Plateau Dark Sky Cooperative Coordinator

Contributors

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Ken Stahlnecker, Chief of Resources, Black Canyon NP
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Bernie Forman, Astronomy Volunteer
Phil Kelton, Astronomy Volunteer

Special Thanks
NPS Night Skies Team
NPS Intermountain Region, Colorado Plateau Dark Sky Cooperative
Membership of the Black Canyon Astronomical Society
Montrose Office of Business and Tourism

References

Guidelines for Outdoor Lighting in RASC-Dark-sky Preserves and IDA Dark Sky Places

Guidance for Outdoor Lighting Capitol Reef National Park

Hovenweep National Monument Lighting Management Plan

Chaco Culture NHP Outdoor Lighting Guidelines

Canyonlands National Park Lighting Management Plan

Black Canyon of the Gunnison Foundation Document

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Northern Colorado Plateau Monitoring Network: Black Canyon brief:
http://science.nature.nps.gov/im/units/ncpn/parks/blca.cfm

Black Canyon of the Gunnison NP website: www.nps.gov/blca