



BIG BEND RANCH STATE PARK

2017

Dark Sky Park Application
International Dark Sky Association



TABLE OF CONTENTS

EXECUTIVE SUMMARY AND ELIGIBILITY	1
INTERNATIONAL DARK SKY NOMINATION AND SUPPORT LETTERS	1
PARK DESCRIPTION	14
Environmental Setting	15
Cultural History	16
Property Description	20
DARK SKIES IN THE BIG BEND REGION	22
Sky Quality at Big Bend Ranch State Park.....	26
All-sky Photometry.....	26
Sky Quality Meter.....	30
Photography	33
Big Bend Ranch State Park Dark Sky Commitment	37
Big Bend Ranch State Park Complex Lightscape Management Plan (LMP).....	37
Big Bend Ranch State Park Complex Lighting Inventory.....	38
Big Bend Ranch State Park Lighting Restoration Project	56
DARK SKY INITIATIVE INTERPRETIVE AND EDUCATIONAL PROGRAMMING	62
Agency-wide Dark Sky Initiative	62
Big Bend Ranch State Park Initiative	64
REFERENCES	76
CONTRIBUTIONS AND ACKNOWLEDGEMENTS	76
APPENDIX A – Brewster and Presidio County Outdoor Lighting Ordinances	77
APPENDIX B – Senate Resolution 656.....	89
APPENDIX C – Saucedo Historic District Lighting Assessment, McDonald Observatory	92
APPENDIX D – Big Bend Ranch State Park Lighting Management Plan	94

LIST OF FIGURES

Figure 1. Map of BBRSP and vicinity.....	14
Figure 2. Typical desert scrub environment at BBRSP.....	16
Figure 3. Hand prints like these at Manos Arriba at BBRSP are a common rock art design throughout the southwest.....	17

Figure 4. Mercury and other goods were transported via mule trains from Terlingua to Marfa via the Marfa-Terlingua road through what is now BBRSP.....	19
Figure 5. The remains of the Whit-Roy mercury mine at BBRSP.	19
Figure 6. The candelilla plant (left) was harvested and used in the production of wax. The remains of the largest wax factory at BBRSP (right) are located near the Whit-Roy mine.	20
Figure 7. Map of the BBRSP Complex.	21
Figure 8. Map of six counties under the HB 5827 ordinances.....	23
Figure 9. Stripes convenient store in Alpine, TX before (top) and after (bottom) retrofit.	24
Figure 10. Dark Skies blend coffee is now available from Big Bend Coffee Roasters in Marfa, TX.	26
Figure 11. All-sky photometry at BBRSP.	28
Figure 12. Model of light pollution in proximity to BBRSP.	29
Figure 13. Location of SQM readings at the BBRSP Complex.	31
Figure 14. Distribution of sky brightness readings for the BBRSP Complex compared to all DSPs.....	33
Figure 15. Panoramic image from the BBRSP airstrip as seen with the naked eye (top). The bottom image has been lightened to show the horizon.	34
Figure 16. Panoramic images from the Big Hill (top) and the Contrabando Movie Set (bottom).	35
Figure 17. Nightscapes at BBRSP.	36
Figure 18. Restoration project at BWVC.....	57
Figure 19. Public display, upper left.....	58
Figure 20. Public display, upper right.....	59
Figure 21. Public display, lower left.....	60
Figure 22. Public display, lower right.....	61
Figure 23. Heading, top.	62
Figure 24. The TPWD Dark Skies Program has been developed to help protect dark skies over Texas.	63
Figure 25. Making moonscapes to celebrate National Moon Day at our Arts in the Parks program.	65
Figure 26. Announcements for a public star parties at BBRSP.....	67

Figure 27. BBRSP Night Sky Photo contest website announcement.	68
Figure 28. BBRSP 2016 Night Sky Photo Contest winner was Thomas Avery with this image called <i>Ocotillo and Stars</i> . Avery’s images are now sold at the Saucedo gift shop.	68
Figure 29. Booth showcasing dark skies in the Big Bend at the Terlingua Green Scene Community Garden event.	70
Figure 30. Free presentation offered to the public. The presentation was a collaboration between the Compadres del Rancho Grande, BBRSP and the McDonald Observatory.	70
Figure 31. Matt Lara of the Big Bend Conservation Alliance gives lighting demo at an outreach presentation in Terlingua, TX in September, 2016.	71
Figure 32. Arts in the Parks program featured in the Big Bend Gazette. The program included astronomy-themed activities and craft projects.	71
Figure 33. TPWD staff training class at the McDonald Observatory.	72
Figure 34. Dark Sky trunk used for interpretive programming.	73
Figure 35. Promotion of dark skies at BBRSP on social media.	75

LIST OF TABLES

Table 1. Sky Quality Meter readings from the BBRSP Complex.	32
Table 2. Lighting inventory for the BBRSP Complex.	39
Table 3. Minimum requirements for outdoor lighting at BBRSP.	56

EXECUTIVE SUMMARY AND ELIGIBILITY

Big Bend Ranch State Park (BBRSP) is Texas' largest state park at approximately 315,432 acres. It extends along the Rio Grande from southeast of Presidio to near Lajitas, in both Brewster and Presidio counties. Just a stone's throw from Mexico to the south, the park is in an area so remote and rugged that it has been called El Despoblado, or "The Uninhabited." In spite of that name, this awe-inspiring region boasts a rich natural and human history.

The area that encompasses BBRSP was acquired by the state of Texas in 1988 and was open to the public as a state park in 2007. The park offers over 150 miles of non-motorized trails for hiking, mountain biking and horseback riding. There are opportunities for camping, 4 x 4 driving, bird watching, stargazing, boating, nature study, picnicking, photography, and fishing. Its remote location offers some of the darkest skies night skies in North America. With the exception of some undeveloped private inholdings (public access not allowed, all indicated on park map), the entirety of the park is accessible by the public 24 hours a day, 365 days a year. As a largely undeveloped and remote public property, BBRSP meets all of the eligibility criteria set out by the International Dark Sky Association (IDA) to become a Dark Sky Park (DSP) as described in the Dark Sky Park Designation Guidelines published by the IDA (www.darksky.org, 2015).

The following pages present an overview of the BBRSP Complex and its resources and provides documentation to support our application to join our neighbor, Big Bend National Park (BBNP), as an IDA-recognized Gold Tier DSP.

INTERNATIONAL DARK SKY NOMINATION AND SUPPORT LETTERS

The following letters demonstrate community and agency support for our application to the IDA for a Gold Tier DSP certification. Letters from the following individuals are included (in alphabetical order by last name):

- Charlie Angell, Chair, Compadres del Rancho Grande (Friends of BBRSP)
- Taft Armandroff, Director, McDonald Observatory, Fort Davis, TX
- Manuela Catano, Superintendent, BBRSP-Fort Leaton State Historic Site
- Karl Flocke, Superintendent, BBRSP-Sauceda
- Nathanael Gold, BBRSP Complex Superintendent
- Lisa Hendy, Acting Superintendent, Big Bend National Park
- Greg Henington, Owner, Far Flung Outdoor Center, Terlingua, TX
- Ranier Judd, Co-President, Judd Foundation, Marfa, TX
- Matt Lara, Executive Director, Big Bend Conservation Alliance, Alpine, TX
- Marth Latta, Board President, Chamber of Commerce, Alpine, TX
- David Long, Superintendent, BBRSP-Barton Warnock Visitor Center
- Brad Newton, Executive Director, Presidio Municipal Development District, Presidio, TX
- Carter Smith, Executive Director, Texas Parks and Wildlife Department

April 20, 2017



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

Dear Board of Directors,

The Big Bend Ranch State Parks complex encompasses more than 60% of park acreage in Texas and conserves over 300,000 acres of Chihuahuan Desert back-country. Among the numerous attributes which make Big Bend Ranch State Park unique in North America are its dark skies.

Compadres del Rancho Grande is the Texas Parks and Wildlife Department endorsed 501 c (3), non-profit support group for the parks of the Big Bend. We work with TPWD to prioritize and implement projects and enhance the visitor experience, we provide resources to promote and sustain the parks, and we advocate on behalf of the parks. As the "friends" group for Big Bend Ranch State Park we enthusiastically and wholly support Texas Parks and Wildlife's pursuit of Dark-Sky Designation. The designation will protect the future of night sky experiences in the park, contribute to ongoing education and interpretive programs about the value of preserving and protecting dark skies, and add to the expanding portfolio of light-pollution protected natural and inhabited areas in the Big Bend and Far West Texas which include Big Bend National Park, the McDonald Observatory, Sierra La Rana and the City of Alpine (currently pursuing IDA Designation).

To earn Dark Sky-Designation it may be necessary for Big Bend Ranch State Park to amend lighting infrastructure. It is the role and goal of Compadres del Rancho Grande to help fund such improvements. These matters have been discussed at the board level and conceptually approved.

We thank you for considering adding Big Bend Ranch State Park to the growing list of IDA initiatives in Far West Texas.

Respectfully,

Charlie Angell
Chair



McDONALD OBSERVATORY AT MOUNT LOCKE AND MOUNT FOWLKES
THE UNIVERSITY OF TEXAS AT AUSTIN

McDonald Observatory • 2515 Speedway, Stop C1402 • Austin, Texas 78712-1206
512-471-3300 • FAX 512 471 1635 • Web site: <http://www.as.utexas.edu>

August 19, 2015

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

Dear IDA Board Members:

It is with great enthusiasm that I write to nominate the Big Bend Ranch State Park (BBRSP) for Dark Sky Park designation by the International Dark Sky Association (IDA). As a lifetime member of the IDA, McDonald Observatory actively promotes outdoor lighting practices that help preserve the dark night skies of Texas that are key to our astronomical research. Located about 100 miles to the observatory's south, BBRSP is situated in one of the darkest locations left in the country.

A recently completed lighting assessment shows that of the nearly 40 outdoor light fixtures in the park, about half are already dark sky compliant, and most of the others are switched and in use only when needed. This is a very dark park with plans to be even darker.

Additionally, staff from BBRSP have attended residential workshops offered at McDonald Observatory for training in conducting astronomy programs for the visiting public. BBRSP is an excellent example of the commitment the Texas Parks and Wildlife Department continues to show toward the preservation and promotion of the night sky across the state.

On behalf of McDonald Observatory, I heartily endorse the award of IDA Dark Sky Park for BBRSP.

With my best wishes for your enlightened work on dark skies,

Taft Armandroff

A handwritten signature in black ink that reads "Taft Armandroff".

Director, McDonald Observatory
Frank and Susan Bash Endowed Chair



Life's better outside.®

May 12, 2017

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

Commissioners

- T. Dan Friedkin
Chairman
Houston
- Ralph H. Duggins
Vice-Chairman
Fort Worth
- Anna B. Galo
Laredo
- Bill Jones
Austin
- Jeanne W. Latimer
San Antonio
- James H. Lee
Houston
- S. Reed Morlan
Houston
- Dick Scott
Wimberley
- Kelcy L. Warren
Dallas
- Lee M. Bass
Chairman-Emeritus
Fort Worth

Carter P. Smith
Executive Director

Dear IDA Board Members:

The purpose of this letter is to express my support for Big Bend Ranch State Park to be considered as a Gold Tier Dark-Sky Park for the following reasons:

Big Bend Ranch State Park encompasses over 50% of state park land in Texas offering one of the best recreational visitor experiences, including night sky observations. After a day spent in the great outdoors, visitors to Texas' largest state park, continue admiring breathtaking vistas at night by looking up at a sky filled with thousands of stars. Big Bend Ranch State Park truly offers a unique opportunity to camp or lodge under the stars.

Fort Leaton State Historic Site located three miles east of Presidio, Texas serves as the western station for Big Bend Ranch State Park. Our Park serves as the "home of the Texas Dark Skies Festival," which is held annually in October by the City of Presidio. Staff members from the Big Bend Ranch State Park Complex collaborate to bring interpretive programs regarding astronomy and night sky preservation to a wide audience selection during this festival. Throughout the year, Fort Leaton State Historic Site also assists Big Bend Ranch State Park and Barton Warnock Environmental Education Center to bring monthly educational programs on this same topic.

Currently, Fort Leaton State Historic Park is actively retrofitting light fixtures along with other communities in the La Junta area to comply with IDA standards. In fact, an ordinance was passed, approved and adopted on the 22nd of April 2014 by the City of Presidio to improve outdoor lighting within the City of Presidio, which purpose is "to preserve the darkness and clarity of the night sky..."

The Senate of the State of Texas also passed a Resolution on April 30, 2015 recognizing "the Dark Skies of Texas at Big Bend Ranch State Park."

I wholeheartedly thank the International Dark Sky Association on their efforts "to protect the night skies for present and future generations." In order to continue enriching the public's night experience when they visit the Big Bend Ranch State Park, your consideration on this designation is greatly appreciated.

Respectfully,

Manuela S. Cataño
Superintendent
Fort Leaton State Historic Site

cc: Amber Harrison
Nathanael Gold

4200 SMITH SCHOOL ROAD
AUSTIN, TEXAS 78744-3291
512.389.4800
www.tpwd.texas.gov

To manage and conserve the natural and cultural resources of Texas and to provide hunting, fishing and outdoor recreation opportunities for the use and enjoyment of present and future generations.



Life's better outside.®

May 9, 2017

IDA Board of Directors
International Dark Sky Association
3223 North First Avenue
Tucson, AZ 85719

Dear IDA Board of Directors,

- Commissioners
- T. Dan Friedkin
Chairman
Houston
- Ralph H. Duggins
Vice-Chairman
Fort Worth
- Anna B. Galo
Laredo
- Bill Jones
Austin
- Jeanne W. Latimer
San Antonio
- James H. Lee
Houston
- S. Reed Morlan
Houston
- Dick Scott
Wimberley
- Kelcy L. Warren
Dallas
- Lee M. Bass
Chairman-Emeritus
Fort Worth

- Carter P. Smith
Executive Director

I am exceptionally pleased to submit this recommendation of Big Bend Ranch State Park for consideration as a Gold Tier Dark-Sky Park. As the Superintendent of Big Bend Ranch State Park I can assure you of the commitment and support of our staff not only in achieving this auspicious designation, but also in preserving such a precious resource.

The Texas Parks and Wildlife Department has a stated mission to “conserve the natural and cultural resources of Texas and to provide . . . outdoor recreation opportunities for the use and enjoyment of present and future generations.” I can think of no greater opportunity for Big Bend Ranch State Park to achieve this objective than by safeguarding and promoting our dark skies. To this end we have taken on several projects and programs to enhance our night sky experience including:

- **Interpretive Programs:** During peak season Big Bend Ranch SP holds astronomy programs near our central ranger station. Open to all visitors, these free programs educate on aspects of astronomy and night sky preservation. We also collaborate with Fort Leaton State Historic Site and Barton Warnock Environmental Education Center, in the delivery of similar night sky programs.
- **Lighting Retrofit Program:** Big Bend Ranch SP is currently retrofitting light fixtures on our structures to ensure that we are in compliance with IDA standards. While outdoor lighting is already minimal we strive for the smallest impact possible.
- **Night Sky Education for the Staff:** All park interpreters as well as other interested staff, have been trained, or will be trained, in night sky education at the McDonald Observatory.

While many in Texas are familiar with the tune “Deep in the Heart of Texas,” which boasts that “the stars at night are big and bright,” few Texans are fortunate enough to have a truly untarnished view of the night sky. Our park has a night sky that is big and dark, and with your support we plan to keep it that way for generations to come.

Thank you,


Karl T. Flocke
Park Superintendent
Big Bend Ranch State Park
1900 S Saucedo Ranch Road
Marfa, TX 79843

4200 SMITH SCHOOL ROAD
AUSTIN, TEXAS 78744-3291
512.389.4800
www.tpwd.texas.gov

To manage and conserve the natural and cultural resources of Texas and to provide hunting, fishing and outdoor recreation opportunities for the use and enjoyment of present and future generations.



Life's better outside.®

IDA Board of Directors
International Dark Sky Association
3223 North First Avenue
Tucson, AZ 85719

Dear IDA Board of Directors,

Commissioners

Peter M. Holt
Chairman
San Antonio

T. Dan Friedkin
Vice-Chairman
Houston

Mark E. Bivins
Amarillo

Ralph H. Duggins
Fort Worth

Antonio Falcon, M.D.
Rio Grande City

Karen J. Hixon
San Antonio

Dan Allen Hughes, Jr.
Beeville

Margaret Martin
Boerne

S. Reed Morlan
Houston

Lee M. Bass
Chairman-Emeritus
Fort Worth

Carter P. Smith
Executive Director

I write this recommendation, with great enthusiasm, to support the application of the Big Bend Ranch State Park Complex as a Gold Tiered International Dark Sky Park.

Spanning approximately 421 square miles, Big Bend Ranch State Park is considered one of the few remaining wilderness adventure parks in the State of Texas. The Big Bend Ranch Complex provides a much needed natural respite for our visitors. With dark skies becoming rarer each day I can think of no better way to protect the night sky experience in the Big Bend Ranch Complex than with this designation.

Every site in the Big Bend Ranch Complex enthusiastically supports this designation and is committing to the Lighting Management Plan, quality night sky interpretive programming, employee night sky education, and partnering with our local communities to hold night sky events.

Sincerely,

Nathanael Gold
General Superintendent
Big Bend Ranch State Park Complex
21800 FM 170
Terlingua, TX 79852
432-424-3327

Cc: Mark Lockwood
Cc: Amber Harrison



United States Department of the Interior

NATIONAL PARK SERVICE
Big Bend National Park
Rio Grande Wild and Scenic River
P.O. Box 129
Big Bend National Park, Texas 79834-0129



IN REPLY REFER TO:

N16 (7137)

April 20, 2017

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

Dear Board Members:

On behalf of the National Park Service, Big Bend National Park (BBNP) and Rio Grande Wild and Scenic River, I would like to take this opportunity to voice my strong support for the nomination of Big Bend Ranch State Park as a Dark-Sky Park.

As our closest "neighbor" of public lands, being able to share this important designation and share public programming and education, would be an honor. BBNP received IDA designation in 2012. We are confident that Big Bend Ranch State Park can join us in continuing to set an example to West Texas of what can be done to protect dark skies in a cost efficient way without jeopardizing safety and security. Texas Parks and Wildlife Department is committed to the effort of preserving dark skies. The addition of Copper Breaks State Park and Enchanted Rock State Natural Area in 2014 reflects this obligation.

Sincerely,

Lisa Hendy
Acting Superintendent



May 2, 2017

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

Dear Sir/Madam:

It would be easy for me to say as the owner of tourism-based business, that the dark skies of Big Bend have a direct impact on our bottom line.

There is certainly nothing wrong with the bottom line, but the more important concept to us as landowners, citizens and stewards of this great slice of country is for those skies to be preserved in darkness for future generations to enjoy.

It is my understanding that Big Bend Ranch State Park has applied for Dark-Sky designation. As a long-time partner with Big Bend Ranch, we support their endeavors to keep our night skies dark.

We enjoy hearing the squeals of joy from those families who come out to Big Bend and discover, maybe for the first time, what the night sky has to reveal!

We encourage your consideration to grant Big Bend Ranch State Park a Dark-Sky designation!

Sincerely,

A handwritten signature in blue ink, appearing to be "GPH", followed by a horizontal line.

Greg P. Henington
President/Owner

P.O. Box 377 Terlingua, Texas 79852 432-371-2633 432-371-2993 (fax)
www.bigbendfarflung.com info@ffoc.net

Judd Foundation
101 Spring Street, New York NY 10012
Telephone 212 219 2747 Fax 212 219 3125
104 South Highland Avenue, Marfa TX 79843
Telephone 432 729 4406 Fax 432 729 4614
juddfoundation.org

April 18, 2017

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

Dear Board Members,

In Far West Texas many things make a visit and a life invaluable from day to day. The dark skies here is one of the most noticeable rarities that set this region apart and literally, allow it to glow.

On behalf of my Co-President, Flavin Judd and our Board and staff at Judd Foundation I would like to take this opportunity to voice our strong support for the nomination of Big Bend Ranch State Park as a Dark-Sky Park.

We are confident that Big Bend Ranch State Park can continue to set an example to West Texas of what can be done to protect dark skies in a cost efficient way without jeopardizing safety and security.

JUDD

The mission of Judd Foundation is to maintain and preserve the artist Donald Judd's permanently installed living and working spaces, libraries, and archives in New York and Marfa, Texas and to promote a wider understanding of his artistic legacy through guided visits and educational programs. Judd moved to West Texas in the early 1970s primarily because he loved the high desert landscape. He was a long-time member of the Board of Visitors of the McDonald Observatory and an owner of nearly 40,000 acres of ranch land south of Marfa. Judd was a strong advocate for land preservation and wanted to protect the land from over-development. He would have been strongly in support of the nomination of Big Bend Ranch State Park as a Dark-Sky Park.

As an artist-founded organization in Marfa, Texas with spaces and offices in New York City, we are keenly aware of how important the surrounding land, water, and dark skies are to both the local community and the ever-increasing number of visitors.

Thank you so much.

Most sincerely,



Rainer Judd
Judd Foundation
Co-President



IDA Board of Directors
3223 North First Ave.
Tucson, AZ 85719
Phone: (520) 293-3198
Fax: (520) 293-3192

IDA Board of Directors and Application Review Committee,

I would like to formally submit this letter of recommendation on behalf of the Big Bend Conservation Alliance (BBCA).

As a board member of both the BBCA and the Hill Country Alliance (HCA), I have spent the past three years as an advocate and educator for dark sky efforts in both the Big Bend and Hill Country Regions. This work has included delivering dark sky awareness and lighting workshops, interfacing with city/county officials, and developing business recognition programs in efforts towards the reduction of light pollution. To this end, I can firmly attest that the staff and volunteers of BBCA stand at the ready to provide continued support for Big Bend Ranch State Park (BBRSP) in the continued stewardship of the starry night skies in the Big Bend. This will include being an ongoing partner in providing workshops, community outreach, and advocacy that will aid in BBRSP's Dark Sky Park status. Moreover, as a regular visitor to BBRSP, I can personally attest to the Gold-Tier worthy, and awe-inspiring dark skies present within the boundaries of the park.

Having already worked with Barton Warnock's (BBRSP) Interpretive Range, Amber Harrison, during this application process, I can further state that the park is fully capable of managing their dark skies as one of their most precious natural resources. During this process, I have witnessed the community's support for aiding the park in both treasuring and protecting the dark skies that draw thousands of visitors to the Big Bend every year.

I fully support the designation of BBRSP as a Gold Tier Dark Sky park and hope that you choose to vote in favor of this important distinction.

Sincerely,

Matthew B. Lara
Big Bend Conservation Alliance and Hill Country Alliance Board of Directors

bbcamatt@gmail.com 512-300-8254

Big Bend Conservation Alliance P. O. Box 1721 Alpine, TX 79831
www.bigbendconservationalliance.org



April 6, 2017

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

Good Day!

As Board President of the Alpine Chamber of Commerce, I want to express my support for the nomination of Big Bend Ranch State Park as a Dark-Sky Park.

Alpine is also in the process of applying for Dark-Sky Designation, and it is my belief that as more and more entities in our far West Texas region achieve Dark-Sky recognition, our collective efforts will benefit us all. It is also my hope that as more of our region is designated as Dark-Sky friendly, it will give us a greater voice against the outside interests whose business endeavors threaten one of our most precious natural assets.

With McDonald Observatory to our north, Big Bend National Park to our south, and Sierra La Rana just outside the Alpine city limits, adding Big Bend Ranch State Park will only serve to strengthen the recognition of the value of Dark-Skies as an important segment of our tourism economy.

I highly commend Big Bend Ranch State Park for your consideration.

Sincerely,

A handwritten signature in cursive script that reads "Martha J. Latta".

Martha J. Latta, Board President
Alpine Chamber of Commerce

Alpine Chamber of Commerce
PO Box 2325
Alpine, Texas 79831
432.837.2326



Life's better outside.®

12 May 2017

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

Commissioners

- T. Dan Friedkin
Chairman
Houston
- Ralph H. Duggins
Vice-Chairman
Fort Worth
- Anna B. Galo
Laredo
- Bill Jones
Austin
- Jeanne W. Latimer
San Antonio
- James H. Lee
Houston
- S. Reed Morian
Houston
- Dick Scott
Wimberley
- Kelcy L. Warren
Dallas
- Lee M. Bass
Chairman Emeritus
Fort Worth

Carter P. Smith
Executive Director

Dear IDA Board Members

The Big Bend Region of has always been known as one of the darkest regions in Texas. Many of the visitors that come down this way for the first time comment on the strange cloud that stretches from one end of the horizon to the other. When we explain to them that the cloud they are looking at is actually the Milky Way and what they are looking at are billions of stars they are astounded. Many of our first time visitors have never seen the Milky Way before.

I would like to give my full support of the Dark Sky Gold Tier designation for Big Bend Ranch State Park. I know that Interpretive Ranger Harrison has been working with Big Bend Ranch State Park and the gateway communities of the Park to limit their light pollution and enhance the visitors experience in the Big Bend. The communities of Presidio, Lajitas, Terlingua, Study Butte, and Terlingua Ranch depend on tourism for most of their livelihood. The dark skies, stargazing, meteor showers, and star parties are all a major attraction to this area. Big Bend National Park has their Dark Sky status. We would like to see Big Bend Ranch joining them in their pursuit to create a Dark Sky partnership between the parks and our gateway communities to these parks.

I would like to thank the International Dark Sky Association with their effort to promote the Dark Sky initiative. Dark Skies should be considered as a natural resource and as our mission statement proclaims "To manage and conserve the natural and cultural resources of Texas..." Big Bend Ranch State Park promotes and is working towards conserving this natural resource.

Sincerely,

David F. Long, Superintendent
Barton Warnock Visitor Center, BBRSP

Cc: Mark Lockwood
Cc: Nate Gold cc: Karl Flocke
Cc: Amber Harrison cc: Manuela Catano

HC 70 Box 375, Lajitas, Texas 79852

(432) 424-3327

4200 SMITH SCHOOL ROAD
AUSTIN, TEXAS 78744-3291
512.389.4800
www.tpwd.texas.gov

To manage and conserve the natural and cultural resources of Texas and to provide hunting, fishing and outdoor recreation opportunities for the use and enjoyment of present and future generations.



Life's better outside.®

April 17, 2017

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

Dear IDA Board Members:

- Commissioners
- T. Dan Friedkin
Chairman
Houston
- Ralph H. Duggins
Vice-Chairman
Fort Worth
- Anna B. Galo
Laredo
- Bill Jones
Austin
- Jeanne W. Latimer
San Antonio
- James H. Lee
Houston
- S. Reed Morian
Houston
- Dick Scott
Wimberley
- Kelcy L. Warren
Dallas
- Lee M. Bass
Chairman-Emeritus
Fort Worth

Carter P. Smith
Executive Director

On behalf of the Texas Parks and Wildlife Department, I am pleased to offer our support of Big Bend Ranch State Park's nomination as a "Dark Sky Park." The unique outdoor experiences that Texans and out-of-state visitors enjoy in state parks and natural areas are becoming increasingly important as these are often the only publicly accessible places to do so. To experience a magnificent dark sky is most definitely part of the wonderment and discovery we hope all visitors will experience in their parks.

The leadership within Texas State Parks is working in concert with many partners to assess light conditions in our parks and to make the necessary adjustments in our lighting systems to protect the dark sky values we all enjoy. Modeling night sky protection is essential for us in these unique settings. Big Bend Ranch State Park is certainly enjoyed by thousands of visitors every year and its designation as a "Dark Sky Park" will help us to emphasize the value we place on night sky preservation and incorporate important stewardship messages into the programming provided to visitors.

We applaud the International Dark Sky Association for your tremendous work to preserve our night skies. Thank you for your consideration of Big Bend Ranch State Park as a Dark Sky Park.

Sincerely,

Carter Smith
Executive Director

CS:BL:mle

- cc: Mr. Brent Leisure
- Mr. Mark Lockwood
- Mr. Nate Gold
- Ms. Amber Harrison
- Mr. David Long

4200 SMITH SCHOOL ROAD
AUSTIN, TEXAS 78744-3291
512.389.4800
www.tpwd.texas.gov

To manage and conserve the natural and cultural resources of Texas and to provide hunting, fishing and outdoor recreation opportunities for the use and enjoyment of present and future generations.

PARK DESCRIPTION

Big Bend Ranch State Park is comprised of over 315,400 acres of public land administered by Texas Parks and Wildlife Department (TPWD). It is located in the rugged and remote Trans-Pecos region of far west Texas. The Trans-Pecos encompasses seven of the largest and most sparsely populated counties in the state.

The park is bounded by the unincorporated communities of Lajitas to the southeast, Redford to the west, Terlingua and Study Butte to the east and an immense expanse of undeveloped rural private property to the north. The southern end of the park is defined by the Rio Grande River and the steep mesas and rugged canyons of Mexico (Figure 1).

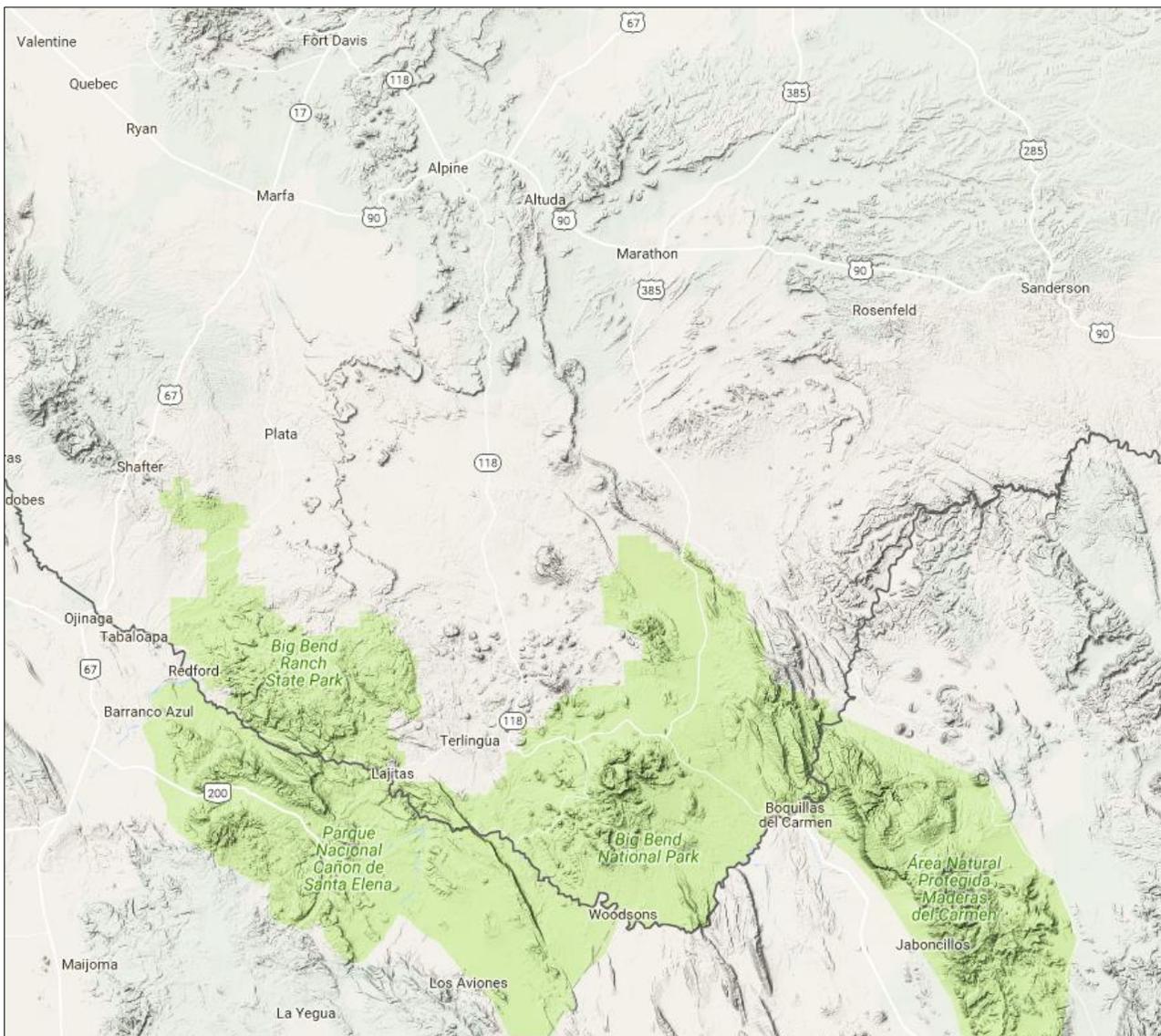


Figure 1. Map of BBRSP and vicinity.

Larger than the state of Rhode Island, the park is comprised of several physiographic areas, each characterized by distinctive geological, geomorphological, and hydrological resources. The park is also home to abundant and diverse flora and fauna. This range of natural resources has attracted human inhabitants to the area for thousands of years, perhaps extending back as early as 12,000 years ago.

The following section provides an overview of the natural and cultural setting of BBRSP. Full references and additional information for the following can be found in Roberts et al., 2017.

Environmental Setting

Big Bend Ranch State Park is located in a region of the Chihuahuan Desert that is bound by the woodlands of the Edwards Plateau on the east, and by the grasslands of the Great Plains and grasslands and woodlands of the Davis Mountains on the north.

The park contains approximately 26 miles of river frontage along the Rio Grande, between the town of Presidio in the west and the community of Lajitas to the east. More than 118 active springs are known to exist across the property, many of which feed drainages that are partially free-flowing much of the year. Tinajas (natural tanks) also provide seasonal sources of water in the park.

Six physiographic zones have been identified within BBRSP – These zones include: 1) Cienega Mountains; 2) Alamito Creek-Ternereros Creek lowlands; 3) Bofecillos Mountains, subdivided into Llano (a flat-lying, deep-soil site east of the main volcanic vents) and Canyonlands (the narrow, deep canyons eroded into the west, south, and east flanks of the volcanic uplands); 4) Rio Grande corridor; 5) Solitario, and; 6) Fresno Canyon-Contrabando lowlands.

The flora and fauna of the area are represented by a wide range of species due to the diversity in the landscape of the northern Chihuahuan Desert. The natural plant communities include mixed desert scrub, desert grassland, riparian and open juniper woodland. The mixed desert scrub is the most widespread of these communities and has replaced the once dominant desert grasslands (Figure 2). The dominant plant in many areas is creosote bush (*Larrea tridentate*), although many other species are present. The open juniper woodlands are only found in the uppermost elevations in the park.



Figure 2. Typical desert scrub environment at BBRSP.

Like the flora of the park, the fauna is also varied, especially the mammalian and herpeto (amphibian and reptile) species. Forty-eight species of mammals have been documented in the park, including 16 species of bats. The herpeto fauna includes at least 30 species of snakes alone. Over 300 species of birds have been reported in the park and immediate vicinity.

Evidence from archeological sites on the state property indicates that deer, rabbit, rodents, turtles, lizards, and snakes were utilized by Native American inhabitants of the area.

Cultural History

For over 10,000 years people have settled in the canyons, mountains and valleys of what is now BBRSP. The materials and structures they left behind tell stories of triumph and hardship in the sometimes hospitable but often relentless land.

More than 600 prehistoric campsites, shelters, middens and rock art sites have been recorded in the park. Many of these are near drainages, springs or tinajas, but some sites are on upland areas away from obvious water sources. The prehistoric peoples of the Big Bend region were highly nomadic hunter-gatherers who harvested desert plants and utilized raw materials to make the tools they needed to survive. Grinding stones, bedrock mortars, chipped stone tools and burned rock middens; as well as rock art are common throughout the park. Rock art motifs found at BBRSP include humans, animals, insects, and stars that may date to as late as 3,000 years ago (Figure 3). Later residents left pictographs of horses, longhorn cattle, Spanish saddles and crosses.



Figure 3. Hand prints like these at Manos Arriba at BBRSP are a common rock art design throughout the southwest.

The earliest historical account of human occupation in the Big Bend dates to 1535 with the arrival of the Spanish explorer, Alvaro Nuñez Cabeza de Vaca, his companion Estebanico and a band of pack traders who happened upon the native communities at La Junta de los Rios, in the vicinity of modern-day Presidio. Subsequent Spanish entradas from 1581-1853 passed through the area, but it was not until 1683 that Spanish missions were established at La Junta.

Accounts written by early Spanish explorers and nineteenth century travelers and settlers provide evidence of several Native American groups in the Big Bend, including the Jumano, Apache, Comanche, Cibola, Pescado, Venado, Chinarra, Pulique, Patarabuey, Cholome, and Suma tribes. Little is known however about the eventual disappearance or assimilation of many of these tribes. It is likely that the remaining Indian groups were assimilated into Mexican populations along the Rio Grande.

The nomadic Apaches and Comanches were far ranging in their travels, especially after acquisition of horses that were reintroduced to North America with the arrival of the Spanish. In the early 1700s, both the Apache and Comanche traversed the Big Bend country to conduct raids on Spanish settlers and mission Indians at La Junta and into Mexico. To try to prevent these raids, the Spanish constructed a series of presidios, including Presidio del Norte in the vicinity of present-day Presidio, Texas. Presidio del Norte was constructed in 1759–1760.

Texas became independent from Mexico in 1836, but the Big Bend region remained under Mexican control, and title to the land in the region continued under Mexican authority.

Indian hostilities continued, and by 1838 Hispanic settlements in the northern frontier were being abandoned.

Despite the threat of Indian attacks, there was still great interest by Mexican and American entrepreneurs to develop trade between the United States and Mexico. In 1839, an expedition led by Henry Connelly, a Missouri physician and prominent Chihuahua merchant, followed an old trail between the port town of Indianola, Texas (through San Antonio) and Chihuahua City, Mexico, seeking to open a shorter trade route than the circuitous route through St. Louis, Santa Fe, and El Paso. Connelly's route, commonly referred to as the Chihuahuan Trail, followed Alamito Creek through present-day Presidio County, crossing the panhandle of what is now BBRSP.

In 1845, Texas became one of the United States, and war was declared on Mexico later that same year. On February 2, 1848, the Mexican government conceded defeat and signed the Treaty of Guadalupe Hidalgo. This treaty established the Rio Grande as the boundary between the United States and Mexico along the southern Texas border.

The cessation of hostilities between Mexico and the United States saw a marked increase in the number of Americans moving into the Big Bend region establishing large ranches and farms, and facilitating trade through the area. In 1854, Fort Davis was established to protect settlers, traders, and travelers passing through the area from the Apache and Comanche who were continuing to conduct raids.

Settlement of the Big Bend region by American ranchers and homesteaders accelerated after 1880, when the last of the Apaches were killed or driven from west Texas. Many of the historic ranches within present-day BBRSP were established in the late nineteenth century.

In the 1910s the Bogel brothers began buying and consolidating small ranches that had been established in the vicinity of the park. After going bankrupt during the Great Depression, the Bogel's land holdings were purchased by Mannie and Edwin Fowlkes, who continued the process of land consolidation initiated by the Bogels. When ownership of the BBRSP passed from the Fowlkes brothers in July, 1958 to Len G. (Tuffy) McCormick, it contained nearly 320,000 acres. The ranch configuration remained essentially unchanged through three subsequent owners. In July 1988, TPWD acquired BBRSP from Robert O. Anderson and Walter Mischer, as well as an additional 3,248 acres from Arrow Investment. Subsequent acquisitions have brought the total acreage of BBRSP to roughly 315,432 acres.

While ranching and farming activities are reflected in many of the historic archeological sites and structures within the present BBRSP, other economic endeavors are also significant to its history. In the park, one can see abandoned quicksilver mines and prospects, roads, and the crude stone huts of the former miners (Figure 4). Reports of the presence of quicksilver in the Big Bend region circulated for over 30 years before the first serious exploration for cinnabar was undertaken in 1884. In 1896, the newly established Marfa and Mariposa Mining Company took up a claim, and extracted over 9,000 flasks of mercury before disbanding in 1903. Figure 5 shows the remains of the Whit-Roy mine at BBRSP. Quicksilver mining in the area enjoyed a short boom during World War I, but gradually played out after the war. Most production ended by World War II.

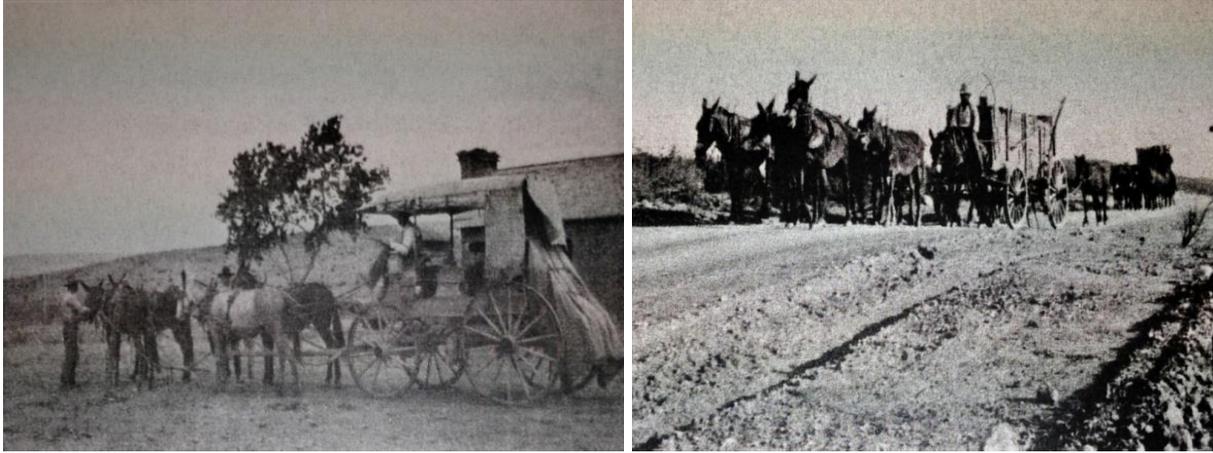


Figure 4. Mercury and other goods were transported via mule trains from Terlingua to Marfa via the Marfa-Terlingua road through what is now BBRSP.



Figure 5. The remains of the Whit-Roy mercury mine at BBRSP.

The remains of wax-rendering operations can also be seen in the park. Wax was rendered from the native candelilla plant. Some candelilla wax production still goes on in Mexico today, but most of the wax-rendering sites on BBRSP probably date to the first half of the nineteenth century (Figure 6). Several wax factories were established in the Big Bend prior to World War I.



Figure 6. The candelilla plant (left) was harvested and used in the production of wax. The remains of the largest wax factory at BBRSP (right) are located near the Whit-Roy mine.

Property Description

The property to be designated totals 315,432 acres and includes the Barton Warnock Visitor Center (BWVC), Fresno Ranch, Fort Leaton State Historic Site (FLSHS), the Saucedo Historic District (SHD) and the Botella and Los Alamos residences (Figure 7).

The property is generally divided into two areas locally referred to as the park Interior and the River Road corridor that follows FM 170 and the Rio Grande River.

FM 170 is the only paved road in the park and runs the entire length of the southern boundary and continues through the community of Redford and into the city of Presidio. The River Road is the main access point for the BWVC, the Fresno Ranch, FLSHS, group campsites, boat ramps, overlooks, and trailheads to many multiuse trails.

The interior of the park is mostly undeveloped wilderness with only three entrance points accessible by the public with a motorized vehicle. The SHD is located near the center of the park and is accessible by the public via a 27-mile maintained dirt road (Main Park Road). The Main Park Road connects to an extensive network of lightly or entirely unmaintained roads and over 50 primitive campsites; as well as a network of multiuse trails closed to motorized vehicles. The BBRSP Airport (unattended) is located a short distance to the east of the SHD.

There are relatively few modern structures within the park boundaries. All of the modern structures administered by TPWD follow the Lightscape Management Plan (LMP) presented below.



Figure 7. Map of the BBRSP Complex.

DARK SKIES IN THE BIG BEND REGION

One of the treasures of the Big Bend region and BBRSP is its dark night sky. With clear skies and little light pollution, the Big Bend region is one of the darkest in the continental U.S. and definitely the darkest in Texas. The Big Bend is home to the McDonald Observatory, a world class facility specializing in astronomy research, education and outreach. The observatory is part of the University of Texas at Austin and is located in the Davis Mountains approximately 111 miles to the north (via Hwy 67) of FLSHS and 133 miles (via Hwy 118) from the BWVC. As the crow flies, however, the distance is much shorter and is well within the distance that the normal human eye can see on a clear dark night. The observatory was established in 1933 and not only is it historically significant, it remains one of the top research facilities in the world due to its location in one of the darkest regions in the nation.

Preservation of the quality of the dark sky in the vicinity of the observatory has always been a priority and is necessary for the continued success of the observatory. In an effort to preserve the quality of the dark sky around the observatory, the state of Texas passed legislation (House Bill 5827) in 2012 mandating the use of dark sky-friendly outdoor lighting for all new development within a 57-mile radius of the observatory. The area affected by the legislation spans six counties (Figure 8).

Following the passage of HB 5827 and to improve outdoor lighting, the City of Presidio initiated an ordinance in 2014 (City of Presidio Ordinance No. 2014-01). The ordinance follows guidelines and standards consistent with the IDA for the purpose to: 1) provide safer, more efficient outdoor lighting; 2) conserve energy; 3) make our community a better place to live and work and a more inviting place to visit; and 4) preserve the darkness and clarity of the night sky, mindful of the needs of McDonald Observatory. The ordinance is applicable to the area within the city limits and in areas that the city “asserts powers of extraterritorial jurisdiction.” Similarly, Brewster County issued a county-wide ordinance in 2016. The Brewster and Presidio County ordinances are presented in Appendix A.

In April, 2015 Senate Resolution No. 656 was signed acknowledging the “value and the beauty of the dark night skies” over the City of Presidio and BBRSP. The resolution recognizes the importance of good lighting practices to reduce light pollution; as well as the need for education and outreach through public programming and events in Presidio and the communities surrounding BBRSP, including Ojinaga, Mexico. It describes efforts in Ojinaga to reduce energy output by retrofitting over 1,000 street lamps (Appendix B).

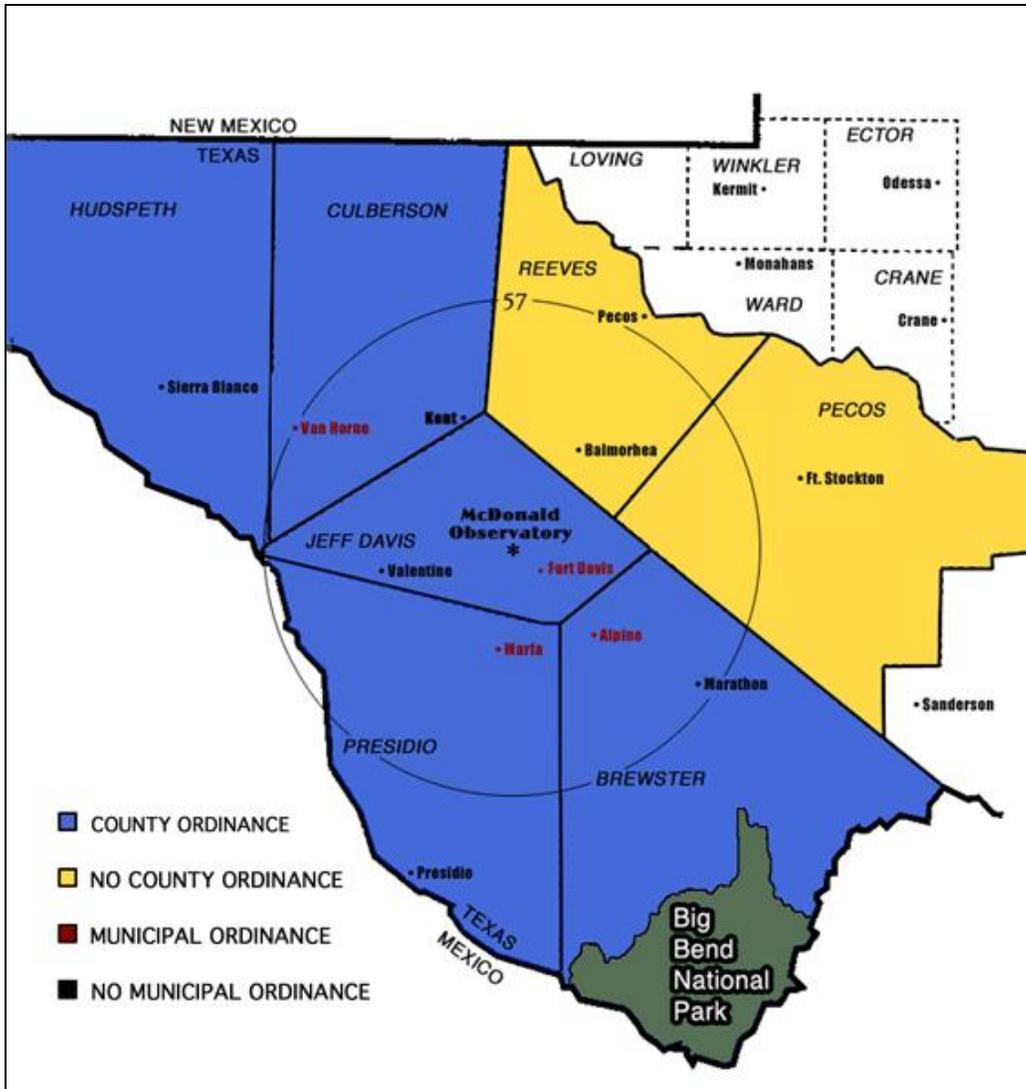


Figure 8. Map of six counties under the HB 5827 ordinances.

Dark sky awareness programs and initiatives in the communities surrounding BBRSP demonstrate a local commitment to dark sky preservation. Experts from the McDonald Observatory have been working directly with the communities of Alpine, Fort Davis, Marfa, Marathon, Presidio and Fort Stockton to combat light pollution and educate the public about the importance of healthy dark skies since the 1980s. With the support of private donors, they have completed lighting retrofits for numerous existing businesses and have helped developers with dark sky-friendly lighting management plans. They have on-going agreements with the American Electric Power (AEP) company to help customers and clients retrofit and install dark sky-friendly lighting. Through that partnership they have installed over 600 light shields around the region and have provided guidance on numerous development projects. Figure 9 shows the before and after results of retrofits at the Stripes convenient stores distributed throughout these west Texas communities.



Figure 9. Stripes convenient store in Alpine, TX before (top) and after (bottom) retrofit.

The observatory has also played an integral role in raising public awareness of dark sky issues on the national and international levels through offering free public access to educational videos, radio programs and websites. In 2010 the observatory introduced a nationally syndicated radio program known as StarDate. The program features a daily segment covering astronomy and dark sky-related topics. The program is produced in both Spanish and English and is available on public radio and the StarDate website. Additional video programs are available on the observatory's Dark Sky website and on YouTube.

In addition to providing general public outreach and education regarding night sky quality and preservation, officials from the observatory have been working with the oil and gas industry to mitigate light pollution as drilling and exploration rapidly moves into the region. In 2016 the observatory began increased efforts to raise awareness among industry leaders about ordinances put in place to protect the observatory from light pollution. Added pressure has led to some significant changes and cooperation among some of the operations directly affecting the observatory. Efforts to reduce the impact of the oil and gas industry in the region are ongoing.

In the same year as the passage of HB 5827, BBNP, located a short distance to the east of BBRSP was designated as an IDA Gold Tier Dark Sky Park. Big Bend National Park is currently the largest and darkest DSP, encompassing over 800,000 acres. In 2015 BBNP was listed as one of the top ten best stargazing sites in the world by the National Geographic. The park offers regularly scheduled dark sky programming to the public.

In 2009, the expansive gated community of Sierra la Rana in Alpine, Texas became the first Dark Sky Community in the area. All new development within the community must comply with dark sky-friendly lighting standards and follow IDA guidelines. The community offers large lots between 10 and 20 acres and has an astronomy village set aside specifically for stargazing. Stargazing programs have been offered at the village since 2014.

In 2015 the Marathon Motel and RV Park located in Marathon, Texas began offering dark sky viewing at the Marathon Sky Park, a 3 acre viewing area equip with pads and telescope rentals. Stargazing programs are hosted at the park on a regular basis.

This year, in partnership with the Big Bend Conservation Alliance, Big Bend Coffee Roasters based in Marfa, Texas added the Dark Skies blend to their list of coffee flavors sold in stores throughout the region and available for purchase online. A portion of the proceeds from the sale of Dark Skies coffee will be donated to the McDonald Observatory to help with the continued protection of dark skies in the Big Bend (Figure 10).

Programs and efforts described above have proven to be successful and continue to raise awareness in the communities of the Big Bend. These and other local efforts demonstrate a regional consciousness regarding the preservation of healthy night skies in the region.

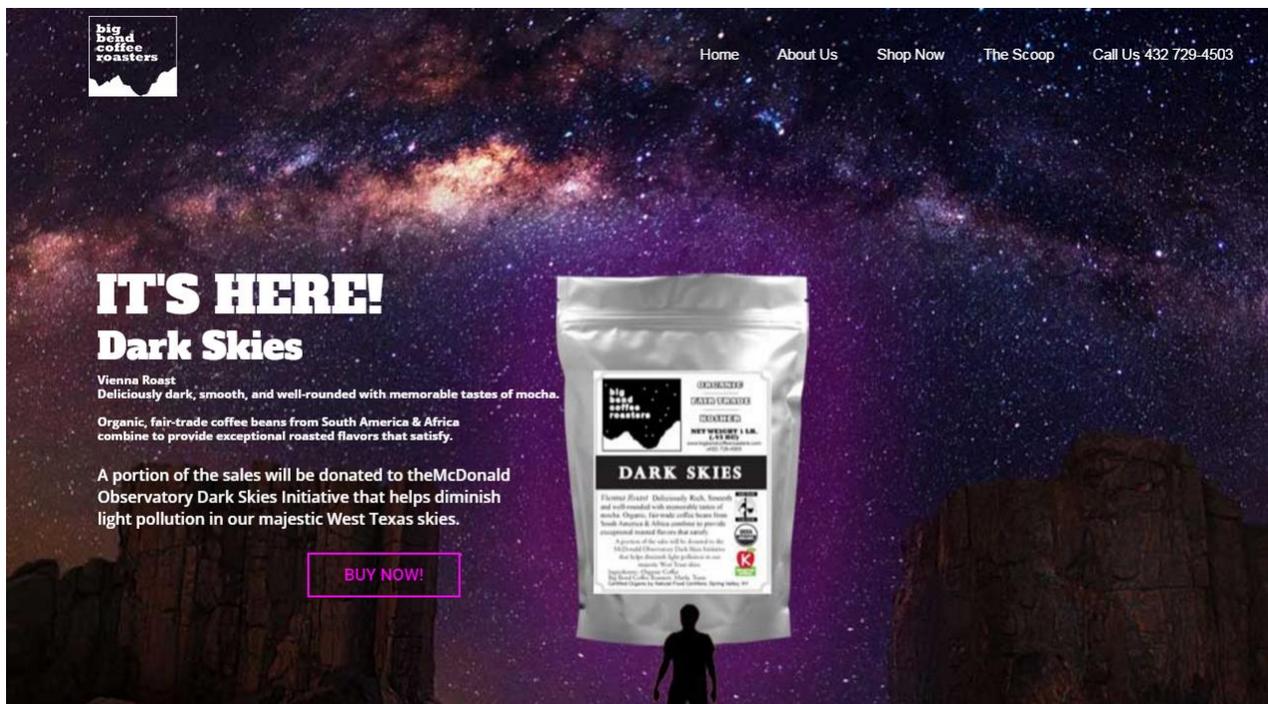


Figure 10. Dark Skies blend coffee is now available from Big Bend Coffee Roasters in Marfa, TX.

Sky Quality at Big Bend Ranch State Park

Big Bend Ranch State Park is situated within two of the largest and most remote counties in far west Texas and, as noted above, it is bounded by small, sparsely populated communities and large expanses of undeveloped private property. As a result of our remote location and community efforts, our night skies remain extremely dark. In an effort to document the quality of the dark sky at BBRSP we utilized All-sky Photometry technology, Sky Quality Meter (SQM) readings and traditional photography.

Our observations demonstrate that the quality of the night sky at BBRSP qualifies us for the Gold Tier rating as described by the IDA. Our measures and observations are described below.

All-sky Photometry

All-Sky Photometry is a method of measuring sky quality that was developed by the National Park Service (NPS) to measure and monitor the night sky quality throughout the NPS network. The method utilizes a high-resolution wide-angle camera to measure light pollution (sky-glow) visible from a particular location on a moonless night. The technology provides an accurate way to quantify the extent of light pollution affecting the night sky from the zenith to the horizon in all directions (Duriscoe, 2013).

The method is subtractive whereby airglow and other natural light sources such as the Milky Way and Zodiacal light are removed from the image with only the artificial sky glow remaining. A ratio

of natural to artificial light is generated and provides an estimate of sky glow. The sky glow measure or All-sky Light Pollution Ratio (ALR) metric provides a measure that quantifies the brightness of the sky as a ratio of light to dark at a particular time and location with all natural light sources subtracted. This value is expressed as a percent.

All-sky images were recorded at BBRSP by Bill Wren from the McDonald Observatory on January 22, 2017. The images were taken at the airstrip in the interior of BBRSP (see Figure 7). The airstrip is considered to be one of the best night sky viewing areas due to its remote location and stable surface. The strip is paved and offers a stable and level surface with no surrounding obstructions or major landforms. It is located near the center of the park with no associated structures or artificial lighting and it is accessible from the Main Park Road with most vehicles.

Two images were generated and compared to determine the overall brightness of the sky from the airstrip. Figure 11 (top) shows the sky as it appears naturally, with the Milky Way, air glow and natural light, as well as some sky glow at the horizon (light domes) clearly visible. Figure 11 (bottom) shows the same image with all natural light (i.e., Milky Way) extracted, leaving only an estimation of artificial light visible on the horizon. In this image, there are three notable areas of artificial light on the horizon. From left to right those are the City of Alpine, Texas; Chihuahua City, Mexico; and Presidio, Texas and Ojinaga, Mexico. Presidio is a smaller suburb of Ojinaga separated by the international border.

The All-sky Light Pollution (ALR) value is the measure used in this application to determine the brightness of the night sky. The ALR value for this site was 0.09, meaning that the brightness due to artificial light is only 9% above the background glow of natural features. This value indicates that the skies over BBRSP at this location remain extremely dark.

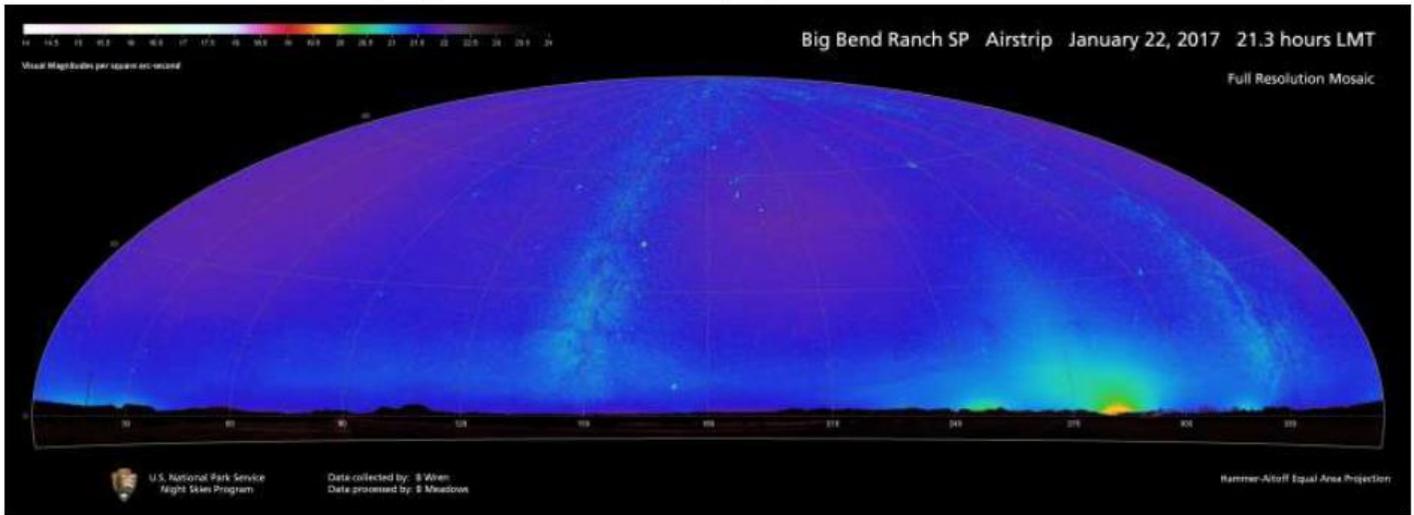
Figure 12 shows a model based upon satellite imagery (from New World Atlas of Artificial Sky Brightness, 2016) illustrating light pollution centers nearest the park. The colors illustrate how many times brighter the zenith of the night sky is relative natural levels without the interference of artificial light. Most of the sky brightness conditions in the park are within a couple of percent of the natural threshold at the zenith (black and gray). The marker on the map indicates the area around the SHD and the BBRSP airstrip. Big Bend National Park is outlined in green. The model presented in Figure 12 is consistent with the All-sky photometry data generated at the BBRSP airstrip; as well as our other sky quality observations described below.

The darkest part of the park (in black) encompasses approximately 8,000 acres and includes many of the areas that are most popular among park visitors. These areas include the Solitario, Fresno Canyon, Chorro Vista and the Contrabando lowlands. While some of the park falls within the gray area, it is still well within the acceptable range for a Gold Tier park.

BBRP170123

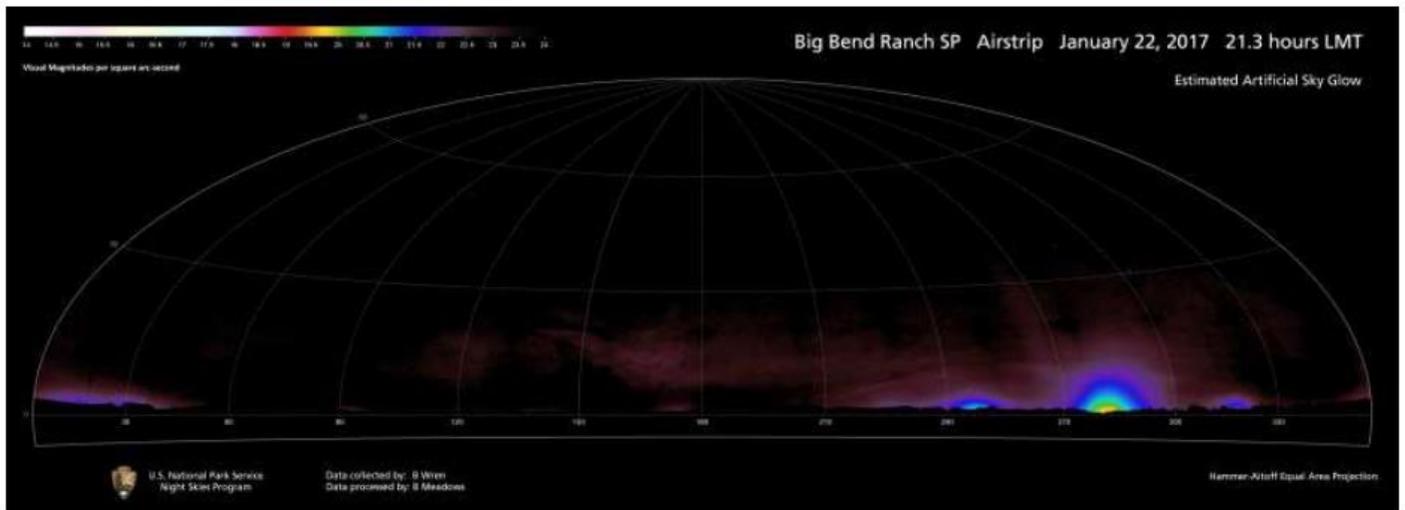
Date (LMT) 22-Jan-17

Time (LMT): 21.34



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 luminance	Synthetic SQM (mag arcsec ⁻²)	Total luminous emittance (mags)	Illuminance (mlux) Horizontal	Max Vert
21.54	261	21.57	255	19.40	1,883	21.62	-7.01	0.748	0.479



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 luminance (μcd/m ²)	All-sky light pollution ratio (ALR)	Total luminous emittance (mags)	Illuminance (mlux) Horizontal	Max Vert
96.0	21	13.8	7.2	0	1,672	0.09	-4.27	0.028	0.070

Figure 11. All-sky photometry at BBRSP.

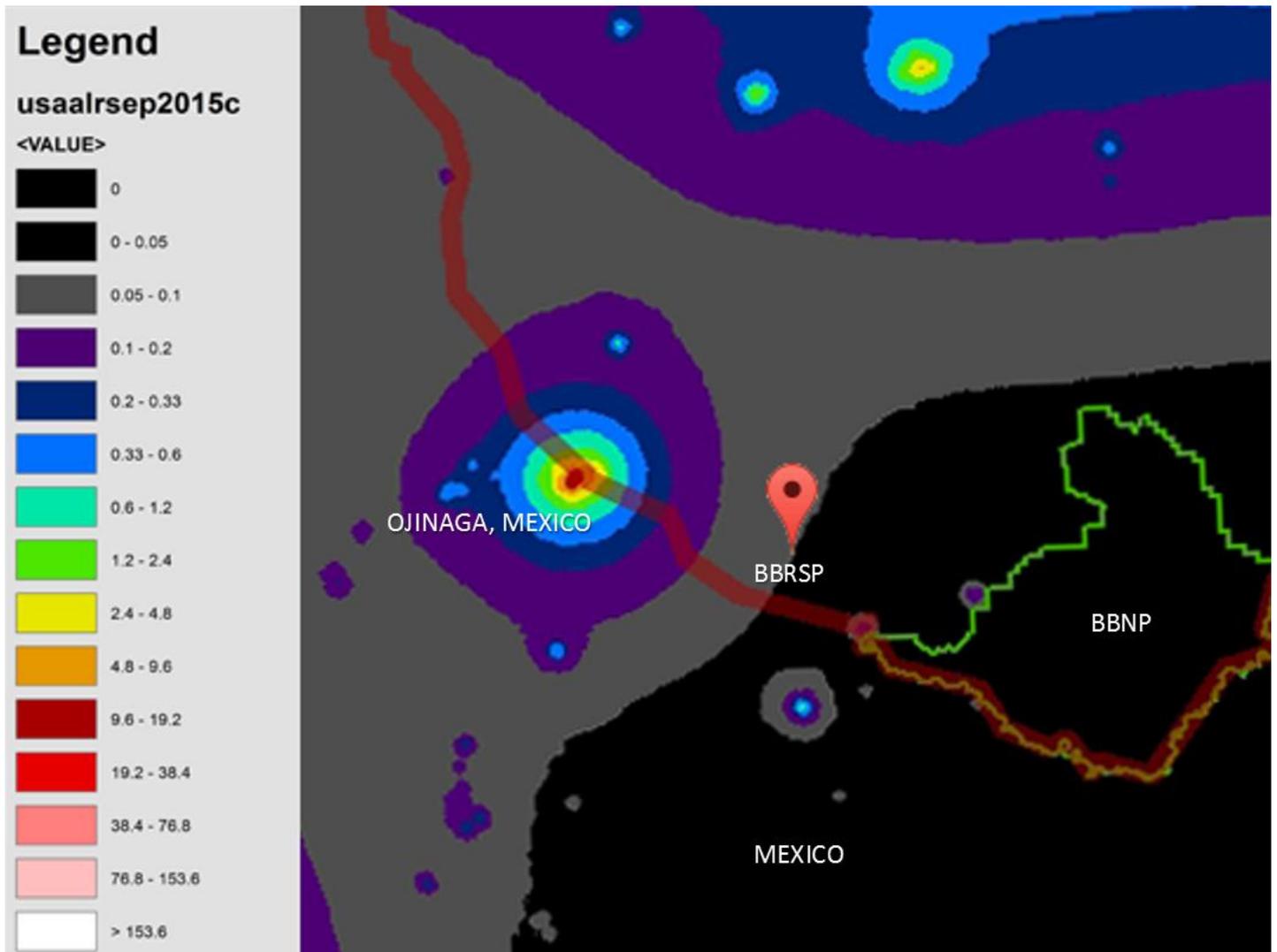


Figure 12. Model of light pollution in proximity to BBRSP.

Sky Quality Meter

A wide-angle Unihedron Sky Quality Meter (SQM) hand-held photometric device was used to collect a series of dark sky points throughout BBRSP. The SQM is one of the most simple and common ways to measure sky quality. The small device is operated by pointing the unit toward zenith and pressing a button until the measurement is taken. For quality assurance, three observations were taken at each location. The output is a number which represents sky brightness in magnitudes per square arcsecond. The higher the output number, the darker the sky. According to the IDA guidelines for conducting sky quality surveys using SQM, a value of 21.75 or greater is considered acceptable for a Gold Tier designation.

A total of 39 measurements were taken at 13 locations at BBRSP (Figure 13). These locations were selected as they are easily accessible and are considered to be popular among visitors who visit the park to stargaze or practice astrophotography.

The time, date, SQM reading, and air temperature were recorded for each observation. Table 1 shows the average of the three readings at each location. The data were collected after sunset, beginning around 9:50 pm on April 23 and into the early morning hours of April 24. The moon was not in the sky during the time of evaluation, thus moon illumination was 0% for all observations. The weather conditions were clear with light winds and humidity typical for these locations at this time of year.

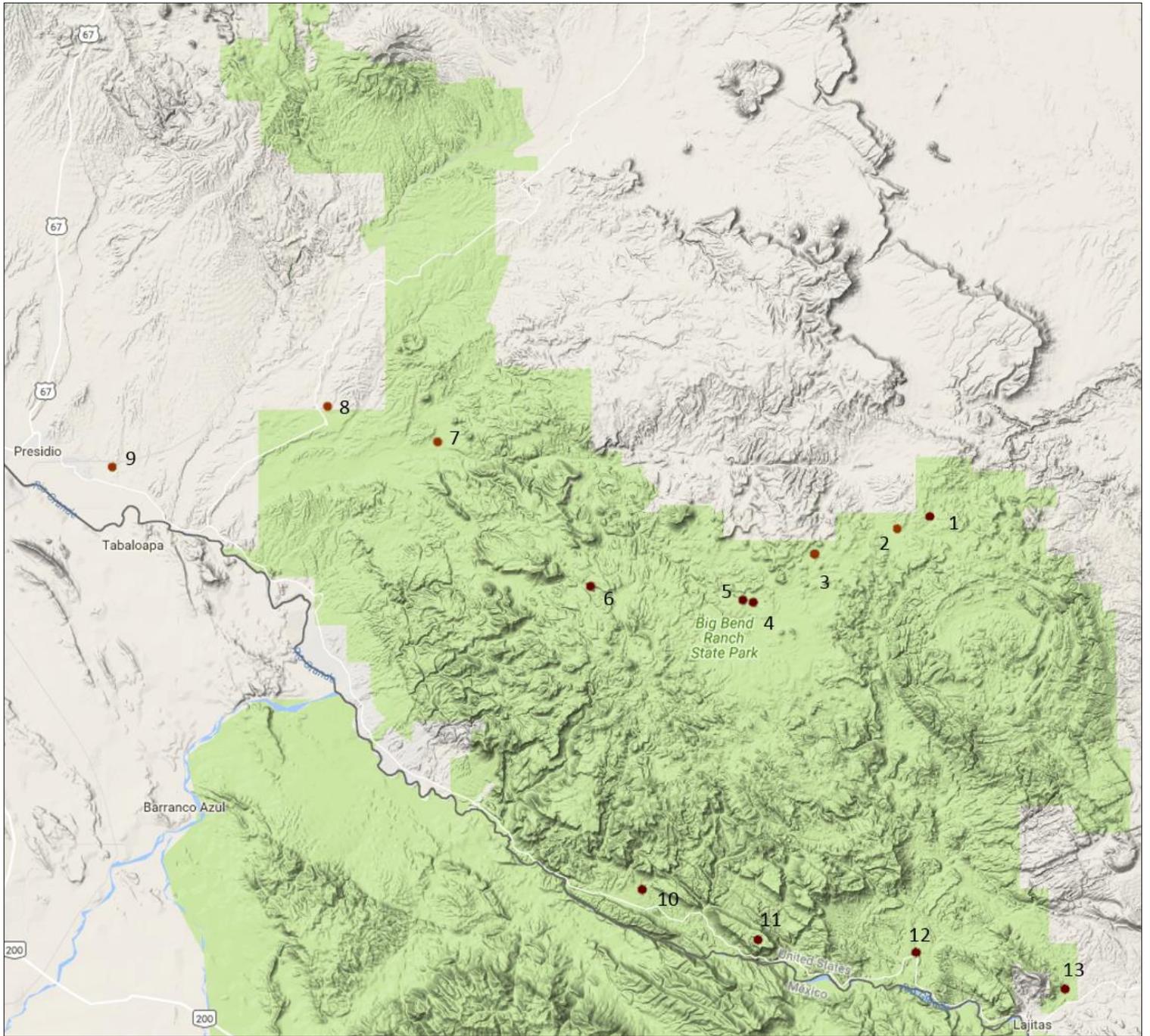


Figure 13. Location of SQM readings at the BBRSP Complex.

Table 1. Sky Quality Meter readings from the BBRSP Complex.

Point#	Location	Date	Time	Latitude	Longitude	Avg. SQM	Temp
1	Jackson Pens Campsite	4/23/2017	9:50 p	29°31'3.599"N	103°50'18.238"W	21.74	69°
2	Pila Montoya 1 Campsite	4/23/2017	10:00 p	29°30'34.30"N	103°51'39.42"W	21.70	65°
3	Papalote Encino Campsite	4/23/2017	10:15 p	29°30'13.20"N	103°53'34.94"W	21.71	64°
4	BBRSP Airstrip	4/23/2017	10:35 p	29°28'15.81"N	103°56'37.57"W	21.78	64°
5	SHD	4/23/2017	10:46 p	29°28'11.36"N	103°57'28.26"W	21.71	64°
6	Agua Adentro Pens	4/23/2017	11:05 p	29°28'50.40"N	104° 2'27.76"W	21.78	64°
7	Botella Junction	4/23/2017	11:40 p	29°32'53.58"N	104° 9'42.09"W	21.68	71°
8	Casa Piedra Rd.	4/23/2017	11:50 p	29°34'30.87"N	104°11'59.56"W	21.53	72°
9	FLSHS	4/24/2017	12:10 a	29°32'34.37"	104°19'31.98"W	20.59	73°
10	Hoodoos Trailhead	4/24/2017	12:40 a	29°20'9.91"N	104° 3'17.57"W	21.94	75°
11	Big Hill/FM 170	4/24/2017	1:00 a	29°17'46.45"N	103°56'30.47"W	22.13	74°
12	Fresno Ranch	4/24/2017	1:20 a	29°17'28.97"N	103°50'45.69"W	22.06	72°
13	BWVC	4/24/2017	1:35 a	29°16'13.19"N	103°45'26.44"W	21.90	72°

Excluding the observation at FLSHS, the site with the brightest artificial light at the immediate location where the observation was recorded, the average SQM for all BBRSP observations is 21.81. The darkest location was at the Big Hill with an SQM reading of 22.13 and the brightest was FLSHS with a reading of 20.59. Excluding nine of the most extreme outliers (those over 21.9 and less than 21.5), the mean reading is 21.73. Figure 14 shows the distribution of the observations (n = 30) taken at BBRSP in comparison to all existing Gold, Silver and Bronze DSPs. The distribution of the data show that the BBRSP Complex meets the criteria to qualify for a Gold Tier DSP certification.

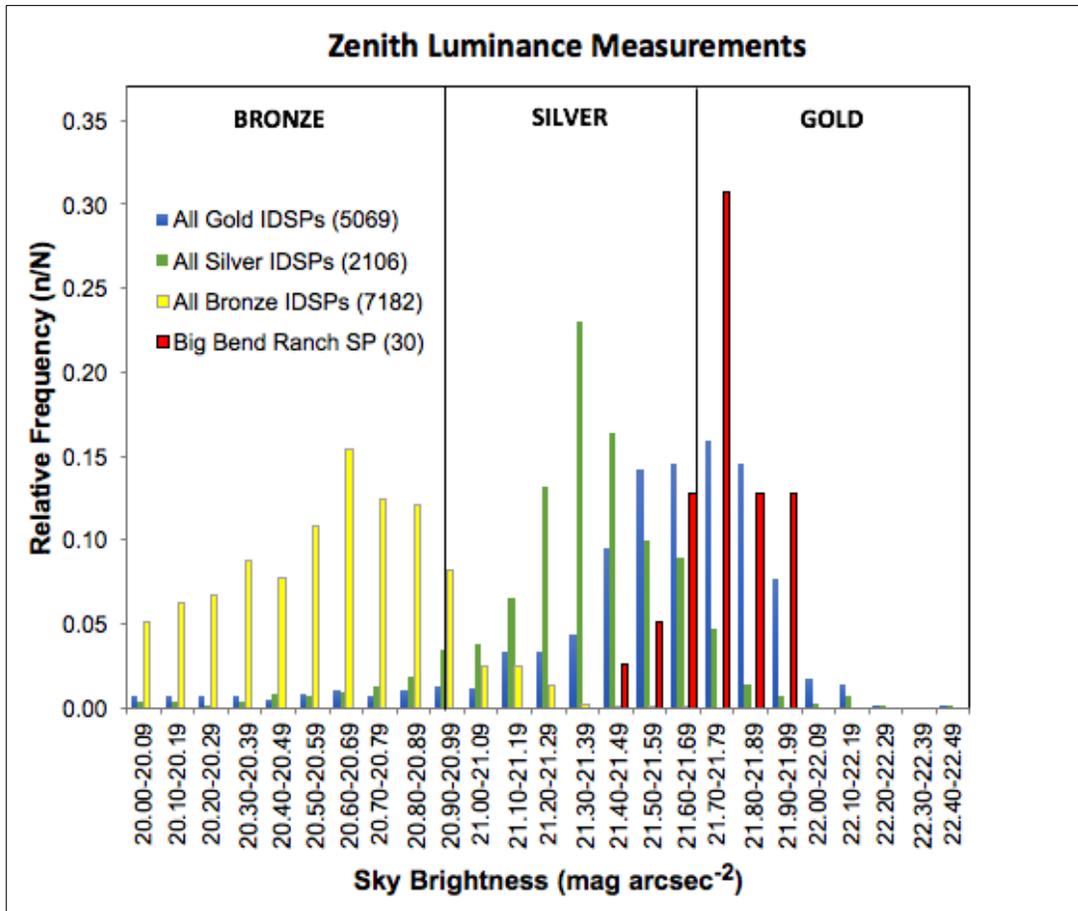


Figure 14. Distribution of sky brightness readings for the BBRSP Complex compared to all DSPs.

Photography

As indicated in the All-sky imagery and satellite image above, the closest and most visible source of the light pollution is Ojinaga, Mexico to the west. Recent photographic documentation at popular stargazing locations in the park visually illustrate the results of the SQM data and demonstrate that while the light dome of Ojinaga is the most dominant, the impact to the sky quality in the park is negligible. Sky glow is barely visible on the horizon with the naked eye and is restricted to the sky only at the horizon. Figure 15 shows the horizon on a clear night looking southwest to northwest from the BBRSP airstrip. The light dome of Ojinaga is barely visible near the center of the image.

Depending upon one's location in the park and the nature of the surrounding geography, sky glow to the west is not visible at all as it does not extend much above the horizon. For example, sky glow is barely visible with the naked eye from the Big Hill, one of the highest and most popular viewing sites located along the River Road. Figure 16 shows examples of long exposures at the Big Hill and the Contrabando lowlands area along the River Road corridor. These images show the glow on the western horizon enhanced beyond what is visible with the naked eye.

BBRSP Airstrip
May 25, 2017
F/3.5
ISO 2000
3 sec. exposure
Photo credit: Mark Lockwood



BBRSP Airstrip
May 25, 2017
F/3.5
ISO 2000
3 sec. exposure
Lightened post-process



Figure 15. Panoramic image from the BBRSP airstrip as seen with the naked eye (top). The bottom image has been lightened to show the horizon.

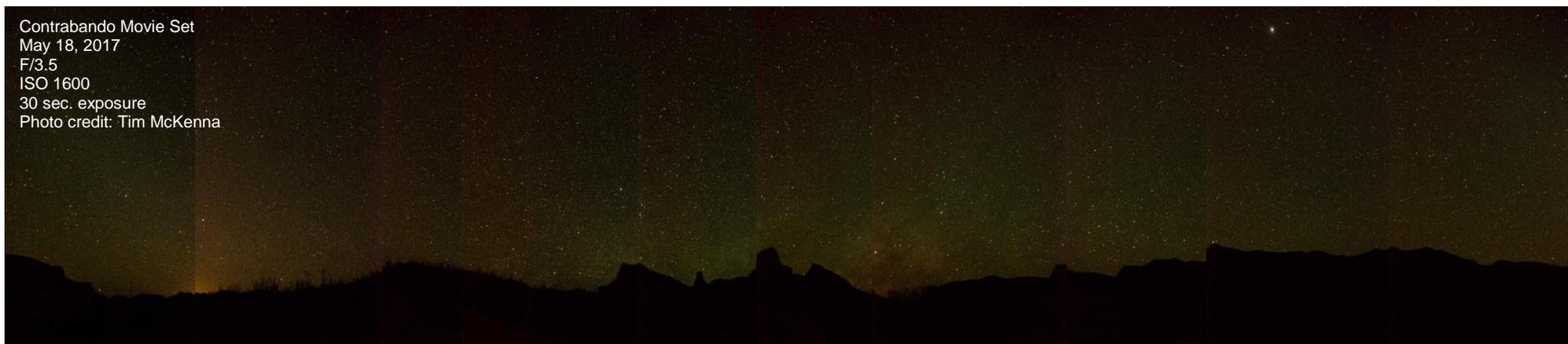
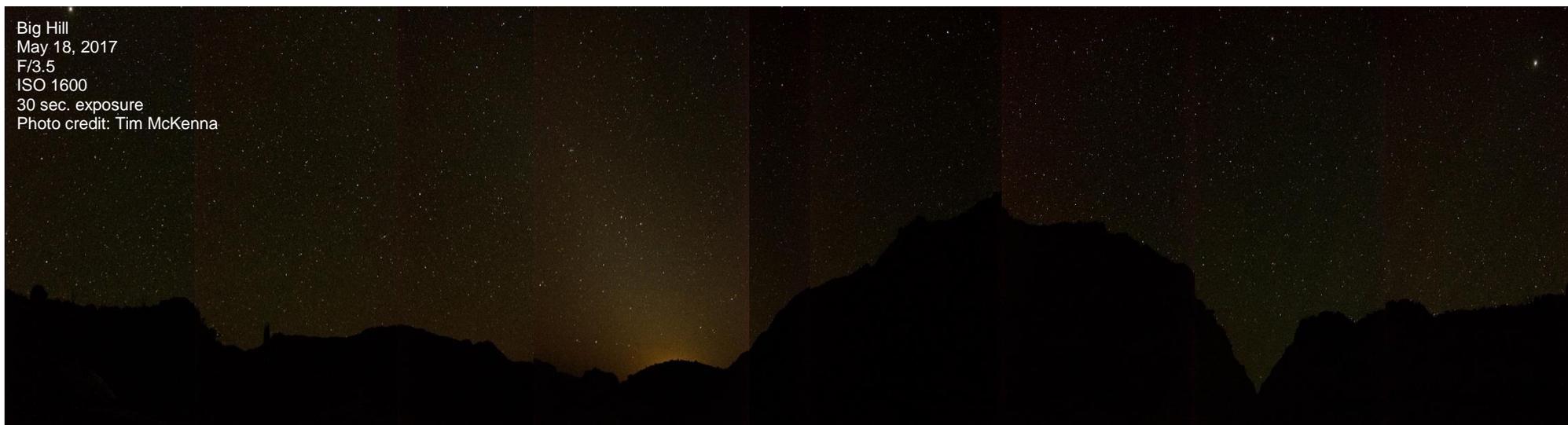


Figure 16. Panoramic images from the Big Hill (top) and the Contrabando Movie Set (bottom).

The data herein demonstrate that the nocturnal environment at BBRSP is largely void of any artificial lighting that may be a distraction to park visitors or that impacts the ability to view the full spectrum of night sky phenomena such as the Milky Way, zodiacal light, meteors and aurora. Figure 17 provides additional examples that show the exceptional quality of the nightscape at BBRSP.



Figure 17. Nightscapes at BBRSP.

Big Bend Ranch State Park Dark Sky Commitment

Light at night, directed where it is not needed can create glare, reduce visibility, waste energy, trespass on neighbors, disrupt wildlife and hide our view of the stars. These challenges are easily overcome with well thought-out, low level lighting that is fully shielded and/or appropriately directed. This type of lighting helps us see better and can actually make us safer.

At every Texas State Park, conservation and preservation of natural and cultural resources are top priorities. Numerous studies have shown that exposure to artificial light at night has an adverse effect on the behavior and health of wildlife. Park activities and facilities are operated in such a way as to minimize negative impacts on wildlife and the environment. That includes using minimal artificial lighting at night.

Big Bend Ranch State Park Complex Lightscape Management Plan (LMP)

In recognition of the importance of continued preservation of the dark skies in the Big Bend region and at the BBRSP Complex, the park has developed an outdoor lighting strategy that follows recommendations outlined in *Guidelines for Outdoor Lighting in Royal Astronomical Society of Canada Dark-sky Preserves* and *IDA Dark Sky Places* adopted by the Royal Astronomical Society of Canada (RASC) (see RASC-GOL revised 2016). We recognize the importance of complying with Brewster and Presidio County lighting ordinances implemented in the interest of preserving dark skies around the McDonald Observatory in Fort Davis. As such, our lighting plans reflect input and recommendations from professionals from that institution to be sure our lighting choices are most suitable for our region (Appendix C).

Although there are no agency-wide lighting policies at this time, TPWD leadership is encouraging each park to adopt dark sky-friendly lighting policies. Agency commitment is evident in the recent additions of three Texas State Parks (Copper Breaks State Park, Enchanted Rock State Natural Area and South Llano River State Park) to the IDAs list of certified DSPs. Big Bend Ranch State Park is fully committed to complying with any state-wide policies and existing and/or new ordinances that may be developed in the future.

Park guidelines for temporary structures (RVs, pop-ups, etc.) and campsites are described in our Public Use Plan (PUP 2008) and in the BBRSP Complex LMP in Appendix D. The PUP requires that campsite lighting be limited to the degree necessary to safely navigate the immediate area. For practical purposes, all light sources should be shielded to only allow light projection below the horizon (i.e., downward and not level or upward) and should be turned off when not in use.

Our LMP for permanent public and residential buildings generally follow three guiding principles: 1) use only light necessary to accomplish the desired outcome (navigation, safety, security); 2) only use lights as needed; and 3) shield or direct light only where it is needed.

All new development requiring lighting will comply with the guidelines described in Appendix G (3-8) of the RASC- GOL (2016). All changes and/or additions to the lightscape or sale/acquisition of park land with modern infrastructure will be tracked and submitted to the IDA by October 1 of every year. A complete BBRSP Complex LMP is presented in Appendix D.

Big Bend Ranch State Park Complex Lighting Inventory

All public and residential buildings currently in use at the BBRSP Complex were evaluated per the standards and guidelines presented in the RASC-GOL (2016). Below are lighting inventories and retrofit actions for permanent fixtures at each functional area of the complex (Table 2). Assistance with this inventory and retrofit recommendations was provided by Bill Wren, Special Assistant to the Superintendent at the McDonald Observatory and Matt Lara of Big Bend Conservation Alliance.

To identify needed retrofit actions each light was evaluated with regard to necessity, purpose and light quality (tone, direction, etc.). As a first step, all lights that were not considered necessary were removed. Our primary lighting goals are safety and navigation for park visitors and staff. Energy consumption was also a factor in determining the most appropriate retrofit action. At public facilities (i.e., orientation kiosks) lighting is set on timers that come on at sunset and turn off at sunrise to ensure that important signage, maps, park information and environmental hazards are illuminated for after-hours arrivals. Lights are manually turned on and off as needed where timers are not installed at low traffic areas in the park's interior. Most lighting is switched and is generally used only on an as needed basis. In some cases overhangs or eaves sufficiently provide full shielding of light as seen from overhead.

Table 2. Lighting inventory for the BBRSP Complex.

Photo	Location*	Description**	Purpose	Shield (Y/N)	< 500 lumens*** (Y/N)	Retrofit Action	Conforms w/ LMP (Y/N)
	BW Entrance 2 fixtures (east side)	halogen floodlight; 18 watt solar powered on a dusk-dawn timer	illuminate front entrance sign	y	y	shielded with rock; no modification needed	y
	BW Entrance (west side)	halogen floodlight; 18 watt solar powered on a dusk-dawn timer	illuminate front entrance sign	y	y	shielded with rock; no modification needed	y
	BW Kiosk 3 fixtures (west side)	partially covered floodlight; on a dusk-dawn timer	illuminate after-hours information board	y	n	shielded one bulb and removed one bulb	y

Photo	Location*	Description**	Purpose	Shield (Y/N)	< 500 lumens*** (Y/N)	Retrofit Action	Conforms w/ LMP (Y/N)
	BW Kiosk (east side)	partially covered floodlight; on a dusk-dawn timer	illuminate after-hours information board	y	n	shielded one bulb and removed one bulb	y
	BW Kiosk (south side)	fixture for lighting flagpole	illuminate flags	na	na	bulbs removed, solar light installed on top of pole	y
	BW Flagpole 1 fixture	solar powered down-facing LED	illuminate flags	y	n	no modification needed	y

Photo	Location*	Description**	Purpose	Shield (Y/N)	< 500 lumens*** (Y/N)	Retrofit Action	Conforms w/ LMP (Y/N)
	BW Front 2 fixtures	2 recessed fixtures	illuminate front of building	na	na	removed both bulbs	y
	BW Front 2 fixtures	2 recessed fixtures	illuminate front of building	na	na	removed both bulbs	y
	BW Front 2 fixtures	2 recessed fixtures	illuminate front of building	na	na	removed both bulbs	y

Photo	Location*	Description**	Purpose	Shield (Y/N)	< 500 lumens*** (Y/N)	Retrofit Action	Conforms w/ LMP (Y/N)
	<p>BW Front 2 fixtures</p>	<p>2 recessed fixtures</p>	<p>illuminate front of building</p>	<p>na</p>	<p>na</p>	<p>removed both bulbs</p>	<p>y</p>
	<p>BW Front 2 fixtures</p>	<p>2 recessed fixtures; floodlight on top; on a dusk-dawn timer</p>	<p>illuminate front of building</p>	<p>y</p>	<p>n</p>	<p>shielded top bulb and removed bottom bulb</p>	<p>y</p>
	<p>BW Front 2 fixtures</p>	<p>2 recessed fixtures</p>	<p>illuminate front of building</p>	<p>na</p>	<p>na</p>	<p>removed both bulbs</p>	<p>y</p>

Photo	Location*	Description**	Purpose	Shield (Y/N)	< 500 lumens*** (Y/N)	Retrofit Action	Conforms w/ LMP (Y/N)
	BW Front 2 fixtures	2 recessed fixtures	illuminate front of building	na	na	removed both bulbs	y
	BW Front 2 fixtures	2 recessed fixtures	illuminate front of building	na	na	removed both bulbs	y
	BW Super. Residence 2 fixtures (1 removed)	fully covered incandescent bulb; 13 watt on a manual switch	illuminate courtyard entrance	y	y	only use as needed; no modification needed	y

Photo	Location*	Description**	Purpose	Shield (Y/N)	< 500 lumens*** (Y/N)	Retrofit Action	Conforms w/ LMP (Y/N)
	BW Super. Residence (front garage)	fixture for floodlight	illuminate garage entrance	na	na	fixture removed	y
	BW Super. Residence (front entrance)	fully covered incandescent bulb; on a manual switch	illuminate residence front door	y	n	only use as needed, change to solid shield	y
	BW Maint. Yard Gate 1 fixture	barn light; on a dusk-dawn timer	illuminate maintenance yard	n	n	replace with FCO LED lamp, new lamp purchased not yet installed; bulb cover painted black	y

Photo	Location*	Description**	Purpose	Shield (Y/N)	< 500 lumens*** (Y/N)	Retrofit Action	Conforms w/ LMP (Y/N)
	<p align="center">BW Maint. Building 4 fixtures</p>	<p>floodlight; on a manual switch</p>	<p>illuminate entrance</p>	<p align="center">y</p>	<p align="center">n</p>	<p>only use as needed; night use is rare; removed one bulb and shielded the other; replace with FCO fixture</p>	<p align="center">y</p>
	<p align="center">BW Maint. Building (entrance)</p>	<p>wall pack; on a manual switch</p>	<p>illuminate maintenance office door</p>	<p align="center">n</p>	<p align="center">n</p>	<p>only use as needed; night use is rare; replace with FCO fixture</p>	<p align="center">n</p>
	<p align="center">BW Maint. (bay)</p>	<p>fully covered florescent tube; on a manual switch</p>	<p>illuminate maintenance bay</p>	<p align="center">y</p>	<p align="center">n</p>	<p>only use as needed; night use is rare; no modification needed</p>	<p align="center">y</p>

Photo	Location*	Description**	Purpose	Shield (Y/N)	< 500 lumens*** (Y/N)	Retrofit Action	Conforms w/ LMP (Y/N)
	BW Trailer Residence 2 fixtures (front porch)	fully covered floodlight; on a manual switch	illuminate residence front porch	y	n	only use as needed; night use is rare; no modification needed	y
	BW Trailer Residence (back porch)	partially covered floodlight; on a manual switch	illuminate residence back porch	y	n	only use as needed; night use is rare; shield or replace with FCO	y
	FR 3 fixtures (carport)	fully covered solar LED; on a manual switch	illuminate carport	y	n	only use as needed; no modification needed	y

Photo	Location*	Description**	Purpose	Shield (Y/N)	< 500 lumens*** (Y/N)	Retrofit Action	Conforms w/ LMP (Y/N)
	FR (carport)	fully covered solar wall pack; on a manual switch	illuminate carport	y	n	only use as needed; no modification needed	y
	FR (porch entrance)	fully covered halogen; on a manual switch; 18 watt solar powered	illuminate side entrance	y	y	only use as needed; no modification needed	y
	FL 2 fixtures (front parking lot)	cobra head administered by AEP; on a dusk-dawn timer	illuminate entrance and orientation sign	n	n	no modification needed	y

Photo	Location*	Description**	Purpose	Shield (Y/N)	< 500 lumens*** (Y/N)	Retrofit Action	Conforms w/ LMP (Y/N)
	FL (front parking lot)	floodlight administered by AEP; on a dusk-dawn timer	illuminate entrance and orientation sign	n	n	floodlight adjusted to point down, will be removed within the year	n
	FLR 1 3 fixtures (driveway)	barn light; on a dusk-dawn timer	illuminate entrance road	n	n	painted black to eliminate glare	y
	FLR 1 (courtyard)	partially covered carriage light; on a manual switch	illuminate courtyard	y	n	only use as needed; no modification needed	y

Photo	Location*	Description**	Purpose	Shield (Y/N)	< 500 lumens*** (Y/N)	Retrofit Action	Conforms w/ LMP (Y/N)
	FLR 1 (Carport)	fully covered incandescent bulb; on a manual switch	illuminate carport	y	n	only use as needed; no modification needed	y
	FLR 2 2 fixtures (back porch)	fully covered, bare incandescent bulb; on a manual switch	illuminate back porch	y	n	only use as needed; replace fixture for safety purposes	y
	FLR 2 (corner of property)	floodlight administered by AEP; on a dusk-dawn timer	illuminate corner of property	n	n	adjusted to face down; light will be removed within the year	n

Photo	Location*	Description**	Purpose	Shield (Y/N)	< 500 lumens*** (Y/N)	Retrofit Action	Conforms w/ LMP (Y/N)
	BR 5 fixtures	CFL floodlights; on a manual switch	illuminate entrances	n	n	use only as needed; replace with FCO fixtures; most lights are inoperable	n
	BR (above front door)	partially covered wall pack; on a manual switch	illuminate front porch	y	n	only use as needed; replace with FCO fixture	n

Photo	Location*	Description**	Purpose	Shield (Y/N)	< 500 lumens*** (Y/N)	Retrofit Action	Conforms w/ LMP (Y/N)
	SHD Ranger Station 5 fixtures	warehouse-style fixtures; fully covered and shielded; on a manual switch	illuminate entrance	y	n	only use as needed; no modifications needed	y
	SHD Bunkhouse 7 fixtures (porch)	partially covered, caged CFL globes; on a manual switch	illuminate porch	y	n	porch open on ends; replace with LED aimed down in existing sockets	n
	SHD Bunkhouse (side door)	partially covered HID floodlight; on a manual switch	illuminate side entrance	y	n	only use as needed; replace with FCO fixture	n

Photo	Location*	Description**	Purpose	Shield (Y/N)	< 500 lumens*** (Y/N)	Retrofit Action	Conforms w/ LMP (Y/N)
	SHD Bunkhouse (side door)	partially covered HID floodlight; on a manual switch	illuminate side entrance	y	n	only use as needed; replace with FCO fixture	n
	SHD Big House 3 fixtures (front entrance)	warehouse style fixture; on a manual switch	illuminate front entrance	na	na	bulb has been removed; will be replaced with FCO when remodeled	y
	SHD Big House (south entrance)	floodlight; on a manual switch	illuminate side entrance	n	n	only use as needed; will be replaced with FCO when remodeled	n

Photo	Location*	Description**	Purpose	Shield (Y/N)	< 500 lumens*** (Y/N)	Retrofit Action	Conforms w/ LMP (Y/N)
	SHD Big House (courtyard)	FCO carriage lamp; on a manual switch	Illuminate front entrance	y	n	only use as needed; no modifications needed	y
	SHD Staff Residence 4 fixtures	FCO LED wall packs; on a manual switch	illuminate front of residence	n	n	only use as needed; no modifications needed	y
	SHD Super. Residence 1 fixture	FCO carriage lamp; on a manual switch	illuminate entrance	y	n	only use as needed; no modifications needed	y

Photo	Location*	Description**	Purpose	Shield (Y/N)	< 500 lumens*** (Y/N)	Retrofit Action	Conforms w/ LMP (Y/N)
	<p align="center">SHD Maintenance Bay 3 fixtures</p>	<p>HID wall pack; on a manual switch</p>	<p>illuminate front of bays</p>	<p align="center">n</p>	<p align="center">n</p>	<p>only use as needed; replace with FCO LED fixtures</p>	<p align="center">n</p>
	<p align="center">SHD Lead Ranger Residence 3 fixtures</p>	<p>floodlight; on a motion sensor</p>	<p>illuminate west side of residence</p>	<p align="center">n</p>	<p align="center">n</p>	<p>only use as needed; no modifications needed</p>	<p align="center">y</p>
	<p align="center">SHD Lead Ranger Residence (side)</p>	<p>floodlight; on a motion sensor</p>	<p>illuminate side of residence</p>	<p align="center">n</p>	<p align="center">n</p>	<p>only use as needed; no modifications needed</p>	<p align="center">y</p>

Photo	Location*	Description**	Purpose	Shield (Y/N)	< 500 lumens*** (Y/N)	Retrofit Action	Conforms w/ LMP (Y/N)
	SHD Lead Ranger Residence (entrance)	partially covered carriage light; on a manual switch	illuminate front porch	y	n	only use as needed; replace with FCO wall sconce	n
	LA 1 fixture	floodlight; on a manual switch; residence not occupied	illuminate entrance	n	n	only use as needed; replace with FCO fixtures	n

* BW = Barton Warnock Visitor Center; FR = Fresno Ranch; FL = Fort Leaton State Historical Site; FLR = Fort Leaton Residence; BR = Botella Residence; SHD = Sauceda Historic District; LA = Los Alamos Residence
 ** AEP = American Electric Power; CFL = Compact Florescent Lamp; FCO = Full Cut-off luminaries; HID = High Intensity Discharge lamp; LED = Light Emitting Diodes
 *** < 500 Lumens are lamps with 500 lumens output or less: 33 watt or less incandescent; 25 watt or less tungsten halogen; 8 watt or less linear florescent; 10 watt or less compact florescent.

There are a total of 73 outdoor fixtures at the BBRSP Complex. The majority of the fixtures (84%) comply with our LMP, however some (16%) require retrofits. Many of the retrofit actions simply require the addition of a shield, removal of a bulb and/or disconnect and capping) or replacement with FCO in the existing sockets/fixtures. In all cases, our goal is to have fully shielded luminaries with longer wavelength output (warm tones, not white/blue) to limit glare and prevent light pollution, as well as reduce energy output and operating costs.

As described in our LMP, *fully shielded* means fixtures that are designed or shielded in such a manner that all light rays emitted by the fixture do not project above a horizontal plane running through the lowest point on the fixture where light is emitted. In some cases deep eaves or roofing is sufficient enough to completely shield the light even if the fixture itself does not have a shield surrounding the bulb. Table 3 below provides a quick reference describing the acceptable luminaries at public and residential units within the BBRSP Complex (see LMP in Appendix D for additional information).

Big Bend Ranch State Park Complex management is committed to bringing all outdoor lighting into compliance with our LMP within one year of the acceptance of this application.

Table 3. Minimum requirements for outdoor lighting at BBRSP.

Maximum lamp Lumens	Not to exceed 1600 lumens or < 20 watts for florescent/LED and <150 watt for an incandescent or use special purpose* (IDA approved for unshielded) lamps
Light type	FCO**, shielded or under porch/eave to block light from extending beyond the horizon
Illumination area	Directly only on subject (orientation maps) or potential hazard (steps)
Cycle/duration	Lighting used only as necessary. Use of sensors, manual switches and timers where appropriate. Dusk-to-dawn lighting only where deemed necessary for after hour visitors.
<p>* Special purpose = lamps with < 500 lumens output or less: 33 watt or less incandescent; 25 watt or less tungsten halogen; 8 watt or less linear florescent; 10 watt or less compact florescent. ** FCO = (0% up-light or fully shielded, 10% max. glare. Meets minimum level of shielding.</p>	

Big Bend Ranch State Park Lighting Restoration Project

The most significant retrofit need that we identified through the above inventory was with the lighting at the Barton Warnock Visitor Center. The center was designed and built in an era when decorative lighting was trendy and before we knew much about the negative consequences of excessive artificial light. Prior to our recent changes, the façade of the building, information kiosk and flagpole were over lit with bright lights causing intense glare.

We identified which lights were not necessary and could be removed or shielded to reduce excess light. In total we removed 15 bulbs, changed the color temperature, added a down-facing flag light and added shields or changed the direction to the remaining lights. These changes reduced the glare significantly. The remaining lights are considered to be the minimum necessary to ensure visitor safety.

In an effort to educate the public about light pollution and to raise awareness about dark sky issues, we documented our restoration project and incorporated into an interpretive display on the east side of the orientation kiosk located in the front of the BWVC building. This display is visible to the public 24 hours a day, 365 days a year and will remain part of our park orientation display. Requirements regarding the incorporation of interpretive and educational information about lighting projects and other dark sky-related topics will be outlined in our LMP/BBRSP Complex Dark Sky Management Plan in the future. Updates and changes to those plans will be included in our annual reports to the IDA.

Figure 18 shows the display in the kiosk to the right of the park map. Each section is 8.5 x 11" and is laminated. Figures 19-23 show the content of each page and the heading. It provides information about the night sky and light pollution and it illustrates the lighting changes made at the BWVC. Additionally, it gives guidance on where to view the night sky in the park based upon our dark sky quality survey using the SQM data presented herein.



Figure 18. Restoration project at BWVC.

BIG AND BRIGHT

Since the beginning of time, the night sky has inspired science, art, astronomy, navigation, exploration, literature, and philosophy.

It is a place we go to reflect and gain perspective.



One of the most recognizable constellations, Orion is a hunter in Greek mythology.

Stories in the sky – There are 88 constellations recognized by modern astronomers, each with its own unique story.

Nearly every human culture has mythological stories about the night sky. Many constellation names come from Greek mythology.



The lifecycles of plants and animals are dependent upon the night sky.

Photo by Morteza Safetaj

Figure 19. Public display, upper left.

We've always known that the night sky over the Big Bend Ranch State Park is dark, but we never really knew how dark until recently.

With clear skies and little light pollution, the Big Bend region is one of the darkest in the continental U.S. and definitely the darkest in Texas. While nearly all areas of the park are exceptional for night sky viewing, the darkest parts of the park are along the River Road (FM 170).

HOW DO YOU KNOW?

On a moonless night in April, 2017 Rangers at BBRSP set out to see just how dark it gets. Using a hand-held photometric device called a Sky Quality Meter (SQM), they took 39 readings at 13 sites in the park. The SQM measures the amount of artificial light in the sky at a given time. The output represents sky brightness in magnitudes per square arcsecond. The higher the output number, the darker the sky. The mean SQM for BBRSP was 21.73. According to the International Dark Sky Association (IDA) guidelines a value between 21 and 22 is considered exceptionally dark.

According to our data, the **West Contrabando Trailhead**, the **Big Hill** and the **Hoodoos** are among the darkest areas in the park.

These sites offer stunning landscapes and spectacular views and are accessible with any vehicle.



Figure 20. Public display, upper right.

KEEPING THE STARS BIG AND BRIGHT OVER BIG BEND

DID YOU KNOW... Light pollution is threatening the quality of the night sky in our region and around the world. **Light pollution** negatively affects the health and wellbeing of humans and wildlife and limits our ability to see stars and planets.

WHAT IS LIGHT POLLUTION?

Light Pollution is the introduction by humans, directly or indirectly, of artificial light into the environment. Light pollution is the most visible form of pollution we create. Like other types of pollution, it has a serious negative affect on our health and the environment.



WHAT YOU CAN DO

3 simple ways to combat light pollution, improve health, protect the environment and enjoy the wonders of the night sky:

1. Turn off the lights when not needed. Increases safety and reduces cost.
2. Shield and direct lights. Inexpensive shields can be added to existing fixtures.
3. Use warm-tone lights. Warm tones reduce glare and promote natural circadian rhythms.

Photo by Morteza Safataj

Figure 21. Public display, lower left.

FOLLOW OUR LEAD... BBRSP LIGHTING RESTORATION PROJECT

Before



After



By simply removing unnecessary lights, light is now focused only where it is needed. Warm-tone lights reduce glare and the cost of electricity is significantly reduced.

GET INVOLVED...Ask a Ranger how you can become a *Dark Sky Steward* and help us keep our stars big and bright.

Visit the Texas Parks and Wildlife Department's Dark Sky Program website and the IDA website for more information on stargazing, dark sky conservation, light pollution and dark sky-friendly lighting.

Sponsored by:



Figure 22. Public display, lower right.



Figure 23. Heading, top.

DARK SKY INITIATIVE INTERPRETIVE AND EDUCATIONAL PROGRAMMING

The mission of TPWD is: “to manage and conserve the cultural and natural resources of the state of Texas for the use and enjoyment of present and future generations.” Big Bend Ranch State Park is fully committed to this mission and we believe that dark sky preservation is very important to conserving both the cultural and natural resources of the state. Agency Directors are focused on integrating dark sky preservation and restoration throughout the system.

“One of our most valued attributes in Texas is the natural beauty that exists in our state. This beauty is not limited by the light of day but extends into the night sky where Texans can enjoy a front row seat to the splendor of the universe. State Parks and Natural Areas are some of our very best public venues to experience this tremendous show, but the view is threatened by our own need for nighttime lighting.”

-- Brent Leisure, State Parks Division, Texas Parks and Wildlife Department

Agency-wide Dark Sky Initiative

The State Parks Division has developed a statewide initiative called the Dark Skies Program which includes a website that anyone can access and get information on light pollution, sky quality data, stargazing, and find astronomy events hosted by TPWD. Through this initiative, TPWD has partnered with various astronomy groups and conservation groups throughout the state to provide programming to park visitors. Texas Parks and Wildlife Department has also partnered with the McDonald Observatory to provide educational programming and informative videos, as well as training opportunities for park staff and volunteers. The Dark Skies Program website can be accessed by following this link: https://tpwd.texas.gov/spdest/programs/dark_skies/ (Figure 24).

Since the beginning of the Dark Skies Program, three Texas State Parks have received DSP certification through the IDA (Copper Breaks State Park, Enchanted Rock State Natural Area and South Llano River State Park). These certifications demonstrate TPWDs commitment to preserving the dark skies over Texas. Agency commitment is further reflected in their full support of this application; as well as inclusion of required dark sky-themed interpretive programming that will be outlined in an updated Interpretive Management Plan (IMP). A memo issued by the Regional Interpretive Specialist states that the updated IMP for the BBRSP Complex will be completed in October 2017. Once the updated IMP is complete we will incorporate it into our current LMP and that will become our BBRSP Complex Dark Sky Management plan. That plan will include interpretive and educational goals/requirements for dark sky-related park programming; as well as lighting guidelines.



Figure 24. The TPWD Dark Skies Program has been developed to help protect dark skies over Texas.

Big Bend Ranch State Park Initiative

Big Bend Ranch State Park is committed to dark sky conservation and recognizes the importance of dark sky preservation. Our philosophy is that the night sky should be managed just as the natural and cultural resource resources of the land. Part of our mission at the BBRSP Complex is to preserve the night skies through public education, outreach and interpretive programs. Through delivering such programs, we can provide the public with the tools necessary to become active participants in the international dark sky movement.

The Park's commitment to dark sky preservation is demonstrated by the following initiatives:

- Adoption of RASC-GOL and IDA guidelines for outdoor lighting and establishment of an LMP based upon those guidelines;
- Collaboration with local communities including Alpine, Fort Davis, Marfa, Presidio and Terlingua/Study Butte in an ongoing effort to maintain good sky quality in the communities surrounding BBRSP;
- Participation of the park's Friends group – Compadres del Rancho Grande, in promoting park programming and healthy night skies;
- Promotion and education through interpretive programs;
- Promotion and education through community outreach and partnerships with local conservation and educational groups; and
- Training and education for park staff;
- Adoption of new regional Interpretive Management Plan regarding dark sky-themed programs.

Park Interpreters have been offering dark sky-themed programs and educational presentations, as well as providing outreach at the park and in the community since 2011. Our dark sky programs focus on educating the public about the importance of healthy natural dark skies and the benefits of good lighting through on-site, hands-on programming such as star parties and off-site programs such as community presentations.

Programs such as star parties are designed to provide personal hands-on opportunities for visitors to experience the wonders of the night sky in a remote setting void of artificial light. These programs focus on identifying astronomical phenomena such as the Milky Way and locating and identifying constellations with specialized telescopes. Participants also learn about light pollution through demonstrations using lights brought to the site. For example, headlights work well to demonstrate the impact of glare from bright lights on the eyes and our ability to view stars and planets. Community presentations are aimed at educating the public about the negative effects of light pollution on both people and wildlife, good lighting practices and issues facing the Big Bend region. Lighting demonstrations are used to illustrate how light shielding works and to show differences in color temperature. A call-to-action message is delivered at each program to inspire the public to get involved in dark sky initiatives in their communities.

Other programs such as our summer Arts in the Parks series incorporates night sky themed projects that are designed to inspire curiosity about the night sky through slideshows, demonstrations and art projects. For example, in 2016 we celebrated the anniversary of the first landing on the moon

on National Moon Day (July 20) by learning about how the landscape of the moon was created, making moon dust foot prints and creating moonscapes with glow in the dark paint and stickers (Figure 25). Incorporating dark sky themes and messages helps to raise awareness among the younger members of the community.



Figure 25. Making moonscapes to celebrate National Moon Day at our Arts in the Parks program.

On or off site, the content of the our programing is intended to bring attention to universal dark sky issues such as the impact of artificial light on human health, the environment and wildlife; as well as issues that face us regionally and locally such as rapid population growth, rural development, and expansion of the oil and gas industry into remote areas of far west Texas.

The following is a selection of dark sky initiative-related events at BBRSP from 2011 to the present (Figures 26-34).

Public Park Programs:

- October, 2011: David Oesper (IDA member of Southwest Texas) gave a star party to the Texas Master Naturalists of the Fort Davis, TX area with telescope and binoculars
- October, 2011: Park Superintendent delivered an astronomy program for the Texas Master Naturalists
- March, 2013: Star party at BBRSP airstrip with Big Bend Astronomers
- November, 30: Star party at BBRSP airstrip with Big Bend Astronomers
- October 24, 2014: Astronomy program put on by BBRSP interpreter at FLSHS in collaboration with the City of Presidio
- November 1, 2014: BBRSP Star Party at Saucedo
- November 22, 2014: BBRSP Star Party at Saucedo
- December 20, 2014: BBRSP Star Party at Saucedo
- March 13, 2015: BBRSP Big Starry Nights Star Party at Saucedo
- March 20, 2015: BBRSP Big Starry Nights Star Party at Saucedo
- May 15, 2015: BBRSP Big Starry Nights Star Party at Saucedo
- June 19, 2015: BBRSP Big Starry Nights Star Party at Saucedo
- August 14, 2015: BBRSP Big Starry Nights Star Party at Saucedo
- September 11, 2015: BBRSP Big Starry Nights Star Party at Saucedo
- January 24, 2015: BBRSP Star Party at Saucedo
- February 21, 2015: BBRSP Star Party at Saucedo
- December 8 – November 30, 2016: Dark Sky Photography Contest



TEXAS PARKS & WILDLIFE | Parks | Hunting | Fishing | Boating | Game Warden | Activities | Wildlife | Land | Water | Media | Calendar | Regulations | Education | Volunteer | More... | Search

Calendar of Events

[Back to All Events](#) | Share Event: [Facebook](#) [Tweet](#) [G+](#)

Big Bend Ranch State Park "Big Starry Nights" Star Party

8:00p to 10:00p
Fri, March 13, 2015

Big Bend Ranch State Park
Map & Directions

Blaine Hall
(432) 358-4444
blaine.hall@tpwd.texas.gov

[Download to Your Calendar](#)

Here at Big Bend Ranch State Park we have some of the darkest of Dark Skies, which makes for spectacularly clear viewing of the night skies. Take advantage of Spring Break. Come tour our "Big Starry Nights" and stay over to experience and enjoy this remote and magnificently scenic park to its fullest.

Big Bend Ranch State Park will host a Spring Break star party for all ages. We'll travel through the constellations and point out other objects that are easily visible to the unaided eye from a dark sky location with "Big Starry Nights" like BBRSP. We will have telescopes and binoculars on hand for closer viewing of the planets, star clusters, nebulas, and even galaxies. If you have a telescope, bring it along and remember to dress for the season.

Participants will gather at the Saucedá Headquarters Visitor Center at sunset. Saucedá is located in the interior of BBRSP about 1.5 hour drive over a dirt /gravel road from Presidio. The park entry fee for 13 years and over is \$5.00 per person. All are encouraged to stay over at Saucedá to have ample time to enjoy the park. Lodging can be reserved by calling 512-389-8919 and for more information call the park directly at 432-358-4444.

We look forward to sharing our Park Stars with you!

Figure 26. Announcements for a public star parties at BBRSP.

TEXAS PARKS & WILDLIFE | Parks | Hunting | Fishing | Boating | Game Warden | Activities | Wildlife | Land | Water | Media | Calendar | Regulations | Education | Volunteer | More... | Search

Calendar of Events

Back to All Events | Share Event: Facebook | Tweet | G+

Night Sky Photo Contest

10:00a Thu, December 08, 2016 to 5:00p Wed, November 30, 2016

Big Bend Ranch State Park | Map & Directions

Ryan Thornton | (432) 358-4444 | ryan.thornton@tpwd.texas.gov

Download to Your Calendar



Milky Way Over Yedra 2 Campsite. Photo Credit: Gary Nored

Calling all photographers and stargazers alike: Big Bend Ranch is holding its first Night Sky photo contest! Make your way out to "the other side of nowhere" to shoot some of the darkest skies in the United States and a chance to have your photo used and displayed in Big Bend Ranch facilities! See details below.

All photos must be taken at Big Bend Ranch State Park

Photos must be submitted via email. Send email submissions to ryan.thornton@tpwd.texas.gov.

Information to be submitted with photos:

Name*
Address*
Phone*

Figure 27. BBRSP Night Sky Photo contest website announcement.



Figure 28. BBRSP 2016 Night Sky Photo Contest winner was Thomas Avery with this image called *Ocotillo and Stars*. Avery's images are now sold at the Saucedo gift shop.

Community Outreach and Education:

- April, 2014: TPWD Interpreter from Franklin Mountains State Park gave a dark sky/light pollution program for park staff
- July 3, 2014: Park Superintendent met with Presidio Tourism Director and the Presidio Mayor to discuss outside lighting and outreach programs
- August 22, 2014: Park Superintendent met with Friends Group (Compadres del Rancho Grande) to discuss future efforts of outreach programs on night skies
- December 18, 2014: BBRSP staff assisted with astronomy program on night sky preservation and constellations at Rio Grande Village at BBNP
- November, 2015: Update of the El Solitario free newsletter to include “Starry Night” article to highlight dark skies and dark sky activities at BBRSP
- July 14, 2016: Park Interpreter and local Terlingua artist hosted Arts in the Parks Program with solar system-themed slideshow presentation and moon-themed activity and art projects
- July 18, 2016: Park Interpreter and local Terlingua artist hosted Arts in the Parks Program with solar system/dark sky-themed slideshow presentation and sun-, light- and shadow-themed activities and art project
- September 10, 2016: In partnership with Big Bend Conservation Alliance, Park Interpreters presented a community presentation on light pollution and the dark sky initiative at the Starlight Theater in Terlingua, TX
- October 22, 2016: Park Interpreter presented dark sky initiative educational materials to the public at the Terlingua Green Scene event at the Terlingua Community Garden
- March, 2017: Park Interpreter developed outreach/educational infographic to be distributed to local businesses to promote dark sky awareness and preservation in the Big Bend and the region
- April 7, 2017: In partnership with Big Bend Conservation Alliance and the McDonald Observatory, Park Interpreter presented a community presentation on light pollution and the dark sky initiative at the Granada Theater in Alpine, TX. The event was funded by the Compadres del Rancho Grande
- April 25, 2017: BBRSP dark sky efforts mentioned in San Antonio Express News article



Figure 29. Booth showcasing dark skies in the Big Bend at the Terlingua Green Scene Community Garden event.

Night sky image taken at the Big Hill at Big Bend Ranch State Park.
Photo by Morteza Safaei

Learn the basics of dark sky-friendly lighting and how you can help protect the starry night skies over the Big Bend – *Better lighting, using less energy, saving more stars...*

Presented by:

Amber Harrison – Big Bend Ranch State Park
 Matt Lara – Big Bend Conservation Alliance
 Bill Wren – McDonald Observatory

Friday, April 7th 2017

6-8 pm at the historic Granada Theater at the Saddle Club

207 E. Holland Ave. Alpine, TX 79830
 For more information call Amber at 432-424-3327

Figure 30. Free presentation offered to the public. The presentation was a collaboration between the Compadres del Rancho Grande, BBRSP and the McDonald Observatory.



Figure 31. Matt Lara of the Big Bend Conservation Alliance gives lighting demo at an outreach presentation in Terlingua, TX in September, 2016.



Figure 32. Arts in the Parks program featured in the Big Bend Gazette. The program included astronomy-themed activities and craft projects.

Staff Training and Tools:

- 2009: High quality telescope was donated from a regional photography group
- 2013: BBRSP acquired a Night Sky trunk with telescopes and educational materials used to host dark sky-themed programs
- 2014: BBRSP acquired a second Night Sky trunk with telescopes and educational materials used to host dark sky-themed programs
- 2014: BBRSP Superintendent attended 3-day training at the McDonald Observatory
- 2015: BBRSP Interpreter attended 3-day training at the McDonald Observatory
- 2016: BBRSP Interpreters attended 3-day training at the McDonald Observatory

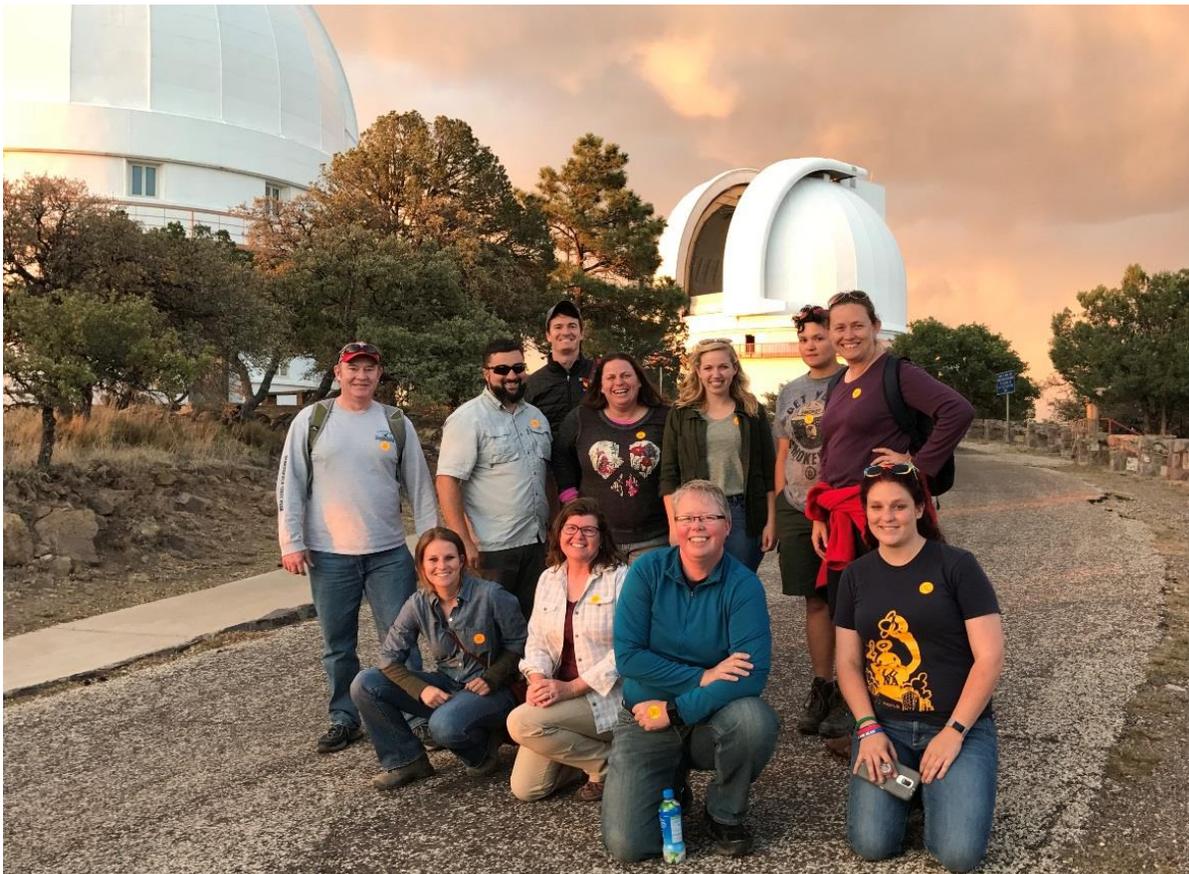


Figure 33. TPWD staff training class at the McDonald Observatory.



Figure 34. Dark Sky trunk used for interpretive programming.

Exhibits, Displays and Dark Sky Merchandise:

In an effort to promote awareness, conservation and preservation of dark skies in the Big Bend region, the gift shops at BWVC, FLSHS and SHD have increased their inventory of dark sky-themed merchandise. Merchandise includes bandannas, playing cards, books, post cards, and sky charts. A dark sky-themed digital slideshow plays on rotation with other interpretive shows at the BWVC on a large monitor. Free informative brochures developed by the IDA are also made available to the public.

Future Plans:

Big Bend Ranch State Park staff will continue to offer dark sky programs to the public, both at the park and in the community. The Park Interpreter is currently coordinating efforts with the Big Bend Citizens Alliance, an advocacy organization in Terlingua, TX to offer dark sky programming in the Study Butte/Terlingua area for the community. The programs will take place at a local ballfield that has been purchased by the organization, but has been under-utilized. The ballfield has been chosen as a location that has exceptionally dark skies and is more centrally located than the more remote BBRSP. Programs at the ballfield will include star parties where participants can learn about astronomy and view the night sky through specialized telescopes under the guidance of amateur astronomers and trained park rangers. Informative presentations may include lighting demonstrations and will focus on ways to combat light pollution and improve lighting in our local community.

As part of the ballfield and other programs (and as an outreach measure) we will utilize SQM data (collected with the park's SQM device) that will be collected at that site and throughout the area to demonstrate the effects of light pollution and to illustrate how dark our community still is. Preliminary SQM data collected near the Terlingua Ghost Town (approximately 12 miles to the east of BWVC) in April, 2017 indicates that the night skies remain exceptionally dark.

The Park Interpreter has plans to gather additional SQM data from the communities surrounding the park. The data can be used in programming to demonstrate local sky quality, demonstrate sky quality in the park and to education the public about the importance for continued preservation and action. The data can also be used to educate the community about their own lighting practices and identify where improvements could be made. Tentative plans have been made for the Park Interpreter to assist Big Bend Conservation Alliance with the collection of sky quality data (using the park's SQM) for the City of Alpine's Dark Sky Community application. Those measurements can be used to satisfy the application requirements; as well as in public presentations and educational programs as described above.

Park staff is also working on efforts to host astrophotography workshops at BBRSP. The workshops will focus on capturing high quality images of the night sky in the park. Images generated during the workshop can be used to promote astrophotography and can be used in presentations to inspire good stewardship and preservation of dark skies in the Big Bend.

Dark sky-themed programs will continue to be offered again at our summer Arts in the Parks Program at the BWVC in July and August, 2017. Additionally, BBRSP staff are planning on participating in the annual Dark Sky Festival held in Presidio, TX in October, 2017.

Park staff has increased the promotion of dark sky tourism in the Big Bend region by encouraging night sky photography and involvement through marketing with the Big Bend Tourism Board, local businesses and on social media (Figure 35). Additionally, in an effort to continue to monitor our night sky quality, a Dark Sky Steward program is being developed. The program will work with the public to enlist amateur and professional photographers to take photographs at various locations and submit them to the park once or twice per year. The images will be used to detect changes in sky quality over time. A formal volunteer opportunity will be posted on the TPWD/BBRSP websites where people can sign up and work directly with the park's Volunteer Coordinator to track the images and time spent in the park. In conjunction with Park Interpreters, Dark Sky Stewards will be encouraged to share their work on social media and participate in public programming as a means to encourage good stewardship, astro-tourism and educate the public about dark sky issues with a focus on the impacts of development and light pollution locally on the park and the surrounding communities of Marfa, Alpine, Presidio, Terlingua/Study Butte and Fort Davis.

Big Bend Ranch State Park-Texas Parks and Wildlife
@BigBendRanchSP

Home
About
Posts
Reviews

Liked Following Share ...

Zech Swendsen If anyone is looking into off road exploring the park there are lots of different forums that have trip reports that contain lots of solid information for someone new to the park.
Unlike · Reply · Message · 1 · March 13 at 10:01pm

Write a comment...

Big Bend Ranch State Park-Texas Parks and Wildlife
Published by YouTube [?] · March 9 ·

Some say we've got the brightest "night life" around - 😊
See for yourself . . . what all there is to capture when the lights go out . . .

Shot in the Dark
Landscape photographer Mike Mezeul II leads a nighttime photography workshop through Big Bend. Join the students as they learn to capture the Milky Way in th...
YOUTUBE.COM

Figure 35. Promotion of dark skies at BBRSP on social media.

REFERENCES

Duriscoe. (2013). Measuring Anthropogenic Sky Glow Using a Natural Sky Brightness Model. *PUBLICATIONS OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC*, 1370-1382.

Roberts, T. (2017). Trails Through Time: Archeological Reconnaissance of Selected Trail Corridors, Big Bend Ranch State Park, Presidio and Brewster Counties, Texas 2004-2010.

www.darksky.org. (2015, October). Retrieved from <http://www.darksky.org>

CONTRIBUTIONS AND ACKNOWLEDGEMENTS

The staff at BBRSP/TPWD thanks the following individuals who contributed to the development of this application:

- Bill Wren of the McDonald Observatory
- Matt Lara and Big Bend Conservation Alliance
- Park volunteers: Robyn Gold and Gary Nored
- Dark Sky Stewards: Tim McKenna, Jennifer Pena, Matt Walter, and Morteza Safataj
- Compadres del Rancho Grande (Friends of Big Bend Ranch State Park)

APPENDIX A – Brewster and Presidio County Outdoor Lighting Ordinances

Orders Regulating Outdoor Lighting In Brewster County Texas

Brewster County Commissioners Court adopts these Orders pursuant to §234.002, Local Government Code, VTCA, for the purpose of preserving dark skies and protecting the continued viability of McDonald Observatory.

These Orders Regulating Outdoor Lighting
In Brewster County Texas supersede any previous Orders Regulating Outdoor
Lighting In Brewster County Texas I. DEFINITIONS - In these orders:

- 1.1 “Outdoor lighting” means any type of lighting, fixed or movable, designed or used for outdoor illumination of building or residences, including lighting for billboards, streetlights, searchlights used for advertising purposes, externally or internally illuminated on or off-site advertising signs, and area-type lighting.
- 1.2 “Installed” means the initial installation or replacement of outdoor lighting as defined herein made subsequent to the enactment of these orders and shall not pertain or apply to outdoor lighting existing at the time of enactment of these orders.
- 1.3 “Fully shielded” means that lighting fixtures shall be shielded in such a manner that light rays emitted by the fixture, either directly from the lamp or indirectly from the fixture, are projected below the horizontal plane running through the lowest point on the fixture where light is emitted.
- 1.4 “Partially shielded” means that those fixtures shall be shielded in such a manner that the bottom edge of the shield is below the plane centerline of the light source (lamp), minimizing light above the horizontal.
- 1.5 “Spot light” means a light fixture having a narrow beam.
- 1.6 “Flood light” shall mean a light fixture having a wide beam.
- 1.7 “Astronomical twilight to astronomical dawn” means the time when the sky is absolutely dark

2. GENERAL REQUIREMENTS

- 2.1 New lighting installations: All outdoor lighting fixtures installed after November 1, 2001 shall be fully shielded, except incandescent fixtures one hundred fifty watts or less or from other sources seventy watts or less which shall be partially shielded.

- 2.2 Recreational facilities: No outdoor public recreational facility shall be illuminated by nonconforming means after midnight except to conclude a specific recreational activity in progress.
- 2.3 Outdoor building or landscaping illumination: The unshielded outdoor illumination of any building, landscaping or signing is prohibited except with incandescent spot lights of less than 150 watts which shall be, at a minimum, partially shielded to prevent light from being emitted away from the target of illumination.
- 2.4 Spot lights and flood lights: For spotlights and flood lights mounted overhead on poles and used for area lighting, the axis of illumination shall be adjusted to an angle not more than 20 degrees from the vertical line between the fixture and the ground (see Exhibits 1 and 2)
- 2.5 Mercury vapor: The installation of mercury vapor fixtures is prohibited effective November 1, 2001.
- 2.6 Searchlights: The operation of searchlights for advertising purposes is prohibited.

3. EXEMPTIONS

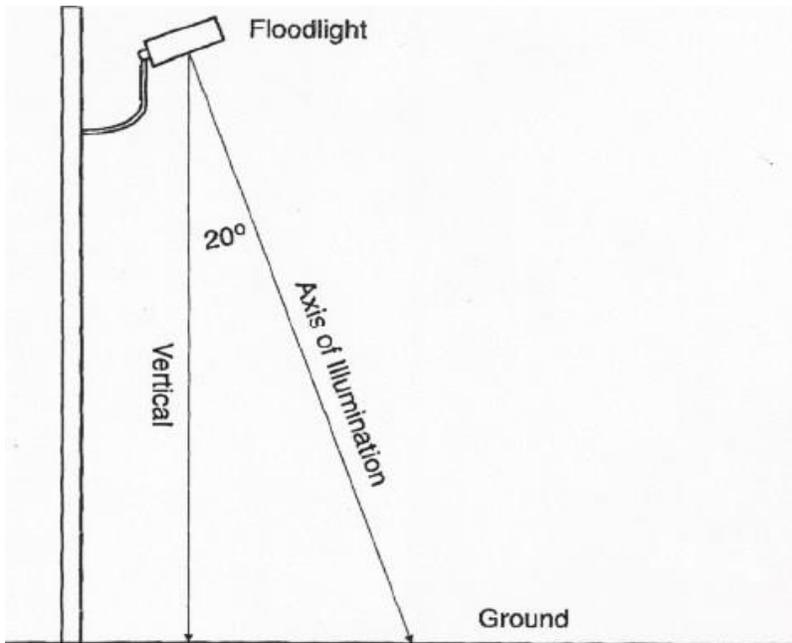
- 3.1 Any individual may submit a written request to the County Commissioner in whose precinct the lighting sought to be exempted is located for a temporary exemption from the requirements of these orders: The request for the temporary exemption shall contain, at a minimum, the following information:
 - A. Proposed use of outdoor light involved and reason an exemption is needed.
 - B. Type of lamp to be used.
 - C. Type of light fixture sought to be exempted.
 - D. Total wattage of lamp or lamps proposed to be exempted
 - E. Proposed location of outdoor light.
 - F. Beginning and ending date of proposed exemption.
- 3.2 If the Commissioner to whom the request for temporary exemption finds that the request is reasonable, that Commissioner may grant the temporary exemption.
- 3.3 No temporary exemption shall be granted for a period greater than six (6) months and all temporary exemptions shall be granted in writing on a form prescribed by Commissioners Court.
- 3.4 Temporary lighting at construction projects is not allowed from astronomical twilight to astronomical dawn. If, exceptionally, construction must continue or take place from astronomical twilight to astronomical dawn a temporary permit

is required. The temporary permit must be obtained from the County Commissioner in whose precinct the construction project is located. If the County Commissioner in whose precinct the construction project is located is not available, the permit may be granted by any available County Commissioner or the County Judge. Permit forms are available in the County Judge's office.

The request for the temporary permit shall contain, at a minimum, the following information:

- A. Proposed use of outdoor light involved and reason an exemption is needed.
 - B. Proposed location of outdoor light.
 - C. Beginning and ending date of proposed exemption.
 - D. If the Commissioner to whom the request for temporary exemption finds that the request is reasonable, that Commissioner may grant the temporary exemption.
- 3.5 These orders do not apply to:
- A. Decorative holiday lighting from November 15th through the next January 10th;
 - B. Lighting required by law to be installed on surface vehicles and aircraft;
 - C. Airport lighting required by law;
 - D. Temporary emergency lighting;
 - E. Federal, State, or local governmental facilities where compelling needs for safety and security are demonstrated, and, in the determination of Commissioners Court, an exemption should be granted.
4. PENALTIES FOR VIOLATION
- 4.1 Violation of this order is a Class C misdemeanor punishable by a fine up to \$500.00.
5. EFFECTIVE DATE
- 5.1 The effective date of this act shall be March 31st, 2016
 - 5.2 Adopted by vote of Brewster County Commissioners Court on March 8th, 2016.

Eleazar Cano, Brewster County Judge



Exhib 1. For spotlights and floodlights mounted overhead on poles and used for area lighting, the axis of illumination shall be adjusted to an angle not more than 20 degrees from the vertical line between the fixture and the ground.

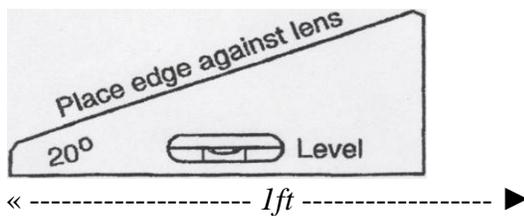


Exhibit 2. A tool for aiming lights as in Exhibit 1, above. Place the upper edge of the tool against the lens, and adjust the fixture so the bubble shows level.

City of Presidio Ordinance No. 2014-01

**AN ORDINANCE TO IMPROVE OUTDOOR LIGHTING IN THE CITY OF
PRESIDIO, TEXAS**

I. Title, Purpose and Scope

- (a) This ordinance shall be known and cited as the "Outdoor Lighting Ordinance."
- (b) The purpose of this ordinance is:
 - (1) To provide safer, more efficient and attractive outdoor lighting;
 - (2) To conserve energy;
 - (3) To make our community a better place to live and work and a more inviting place to visit; and
 - (4) To preserve the darkness and clarity of the night sky, mindful of the needs of McDonald Observatory.
- (c) This ordinance shall apply within the city, hereinafter referred to as city, and within the surrounding areas where the city asserts powers of extraterritorial jurisdiction.

Sec. II. Definitions.

- (a) The following definitions are hereby adopted for the purposes of this article:

Area lighting means light fixtures located on public or private property that are designed to light spaces including but not limited to parks, parking lots, and sales lots.

Axis of illumination means the midline of the beam emitted by a light fixture.

Beam of a light fixture means the spatial distribution of the emitted light.

Candela (cd) means the unit of measurement of the intensity of a point source of light (approximately equal to one candlepower).

Existing light fixtures means those outdoor light fixtures already installed at the time this article is adopted.

Foot candle (fc) means the illuminance measured one foot from a one candela source.

Floodlight means a light fixture having a wide beam.

Full cutoff means a shielded light fixture that emits no light above a horizontal plane touching the lowest part of the fixture.

Glare means visual discomfort or impairment caused by a bright source of light in a direction near one's line of sight.

Horizontal and vertical foot candles means the illuminance measured by a light meter in those positions (illuminance may also be measured in other specified positions or directions).

Illuminance means the intensity of light in a specified direction measured at a specific point.

Lamp or bulb means a source of light.

Light fixture means the assembly that holds or contains a lamp or bulb.

Light pollution means the sky glow caused by scattered light emitted upward from unshielded or poorly aimed light fixtures.

Light trespass means unwanted light falling on public or private property from an external location.

Lumen means the unit of luminous flux, the total amount of light falling uniformly on or passing through an area of one square foot, each point of which is one foot from a one candela source, yielding an illuminance of one foot candle at that distance (the output of lamps and bulbs is customarily measured in lumens, a common 100 watt incandescent light bulb, for example, having an output less than 1,800 lumens).

Private lighting means outdoor light fixtures located on property owned or controlled by individual persons, including but not limited to families, partnerships, corporations, and other entities engaged in the conduct of business or other non-governmental activities.

Public lighting means outdoor light fixtures located on property owned, leased, or controlled by the city or other governmental entity or entities, including but not limited to streets, highways, alleys, easements, parking lots, parks, playing fields, schools, institutions of higher learning, and meeting places, and all entities completely or partly funded by grants obtained by the city or its agents from federal, state or private sources.

Sag-lens or drop-lens means a clear or prismatic refracting lens that extends below the lowest opaque portion of a light fixture.

Searchlight means a light fixture having a narrow beam intended to be seen in the sky.

Spotlight means a light fixture having a narrow beam.

Wallpack means a floodlight mounted on the wall of a building or other structure.

Sec. III. Existing Outdoor Light Fixtures.

(a) To reduce glare, safety hazards for drivers and pedestrians, light trespass, and light pollution, all existing spotlights, floodlights, and wallpacks shall be adjusted in accordance with the following provisions, excepting the lights at existing sports facilities used temporarily during scheduled sporting or related events.

- (1) For spotlights and floodlights mounted overhead on poles and used for area lighting, the axis of illumination shall be adjusted to an angle not more than 20 degrees from the vertical line between the fixture and the ground (see Exhibits 1 and 2).
- (2) For spotlights and floodlights mounted at or near ground level and used to light a building, billboard, or other structure, the axis of illumination shall be adjusted to minimize the amount of light escaping above, below, and to the sides of the illuminated object.

- (3) Wall packs shall be shielded or replaced with full cut off wall packs.
- (b) It shall be the responsibility of the city to publish this article in the newspaper of record and to disseminate the ordinance by other appropriate means; to identify those spotlights, floodlights, and wall packs requiring adjustment; and to inform their owners of these provisions.
 - (1) Any required adjustments shall be completed within six months from the date of the adoption of the lighting ordinance. Any owner who fails to comply with these provisions shall be issued a warning notice. Any owner who further fails to comply after 30 days from the issuance of such warning notice shall be subject to a fine of \$25.00 for each day of noncompliance. It is not the intent of this article to require an additional investment in order to comply with these provisions.
- (c) All exterior lighting shall comply with this lighting ordinance on or before January 1st, 2015.
- (d) An owner of a grandfathered luminaire may replace or modify the luminaire so that it conforms to this light ordinance if requested by a designated city official or a member of the McDonald Observatory staff. However, the replacement or modification of the luminaire must be provided at no cost to the owner including materials and labor. For example, a grandfathered mercury-vapor outdoor light may be retrofitted with a light shield to make it fully shielded.

Sec. IV. New light fixtures installed after the adoption of this article, including replacements for existing fixtures.

- (a) Lighting at public and private outdoor sports facilities, including but not limited to playing fields, arenas, tracks, and swimming pools, shall be shielded as well as is practicable to reduce glare, safety hazards, light trespass, and light pollution; shall provide levels of illuminance consistent with nationally recognized Illuminating Engineering Society of North America (IESNA) standards; and shall be operated on a schedule that coincides with scheduled events.
- (b) No lighting of towers and associated facilities is allowed, except as required by the Federal Aviation Administration or other federal or state agency. In coordination with the applicable federal or state agency, the applicant shall determine the maximum height of the tower that would not require lighting. If a proposed tower would require lighting, the applicant shall demonstrate that a tower height that requires lighting is necessary. Such justification shall include documentation showing:
 - (1) Coverage limitations,
 - (2) Type of system (e.g. cellular, radio, television),
 - (3) Technical and engineering details of the lighting to be installed; and
 - (4) Requirements of federal, state, and local agencies.

If a tower height that requires lighting is justified, the applicant shall demonstrate how the lighting will be shielded from the ground. Shielding of tower lighting onto nearby properties shall be installed as part of construction of the tower. If lighting is justified, slowly blinking red lights must be used at night. White strobe lights at night are prohibited.

- (c) All outdoor lighting fixtures shall be full cutoff fixtures (see Exhibit 3).

City of Presidio Ordinance 2014-01

- (1) New streetlights shall be full cutoff fixtures of approved historical design, utilizing a minimum output consistent with the safety of drivers and pedestrians.
 - (2) Sag-lens or drop lens fixtures are prohibited.
 - (3) Streetlights and private lighting shall be allowed to shine on adjacent property in the absence of a complaint of light trespass by an owner or occupant.
 - (4) Light Trespass is defined as 0.2 fc measured 5 feet above the ground 5 ft inside the property line with the detector aimed at the source. Upon receiving a complaint of light trespass from an owner or occupant, the city shall evaluate the complaint. Where light trespass is found to occur, the city shall take appropriate steps to eliminate or minimize the unwanted light emanating from a light on city property, or from private lighting. If a violation is found to occur the offender may switch to a lower wattage bulb or convert to FCO fixtures to become compliant.
- (d) In the interest of conserving energy and protecting the environment, mercury vapor fixtures are prohibited.
- (e) Each flag shall be lighted by one spotlight emitting no more than 1,800 lumens.

Sec. V. Maximum Maintained levels of illuminance required or permitted at specific facilities.

- (a) Maximum, MAXIMUM average, and minimum levels of illuminance (MAINTAINED) for different facilities are listed below in horizontal foot candles. Unless otherwise specified, minimum levels shall be the lowest consistent with safety and security.
- (1) Parking lots and parking areas: average 2.0 fc; minimum 0.2fc.
 - (2) Entry areas near buildings: maximum 5.0 fc.
 - (3) Service stations and other fueling facilities: maximum 10 fc in the area surrounding pump islands; parking areas and entry areas shall be lighted as required in Sections 5 A (1) and 5 A (2), above; drop-lens fixtures are prohibited, whether mounted under canopies or on poles.
 - (4) Sales lots where merchandise, including automobiles, is displayed at night: maximum 15fc.
- (b) For locations and facilities not specified herein, the board shall set acceptable levels of illuminance upon request based on guideline established by the IESNA
- (c) The use of searchlights is prohibited for advertising, attracting attention to any event, and for any other use except for emergency purposes.

Sec. VI. Large outdoor lighting projects.

- (a) Any outdoor lighting project that will produce a luminous power of 100,000 lumens or more in the aggregate shall file a lighting plan with the planning and zoning board. A lighting plan shall be filed at the same time as any other plans required by the city and shall specify the following:
- (1) Number and types of light fixtures to be used,
 - (2) Their output in lumens; and

City of Presidio Ordinance 2014-01

- (3) Photometric data from the manufacturer(s) showing the spatial distribution of the light output from the proposed fixtures, both on the ground and as a function of angle from the vertical (nadir).
- (b) The outdoor lighting advisory group (comprised of two members of the planning and zoning board, two members of the environmental advisory board, and two citizen appointees knowledgeable about outdoor lighting) shall review the lighting plan taking into account factors including but not limited to levels of illuminance, luminance, glare, safety hazards, light trespass, and light pollution. The outdoor lighting advisory group will make recommendations to the planning and zoning board. The planning and zoning board shall approve or reject the plan within 30 days of submission, returning it to the applicant with an explanation. The applicant shall not move forward with the outdoor lighting project until the lighting plan is approved.

Sec. VII. Exemptions, amendments, and variances

- (a) This article shall not apply to the following:
 - (1) Decorative holiday lighting from November 15 through the next January 15;
 - (2) Lighting required by the law to be installed on surface vehicles and aircraft;
 - (3) Airport lighting required by law;
 - (4) Temporary emergency lighting;
 - (5) Temporary lighting other than security lighting at construction projects; and
 - (6) Governmental facilities where compelling needs for safety and security are demonstrated.
- (b) This article may be amended from time to time as local conditions change, and as changes occur in the recommendations of nationally recognized organizations such as the Illuminating Engineering Society of North America and the International Dark-Sky Association.
- (c) Nothing in this article shall be construed as limiting the right of any person or entity to pursue legal action against any other person or entity under any applicable law, including the doctrine of light trespass.
- (d) The planning and zoning board of the city shall have the power to grant variances in the application of the provisions of this article after review and recommendation by the outdoor lighting advisory group.

Sec. IX. Notification.

- (a) All building permit applicants shall be notified of the City of Presidio Lighting Ordinance.

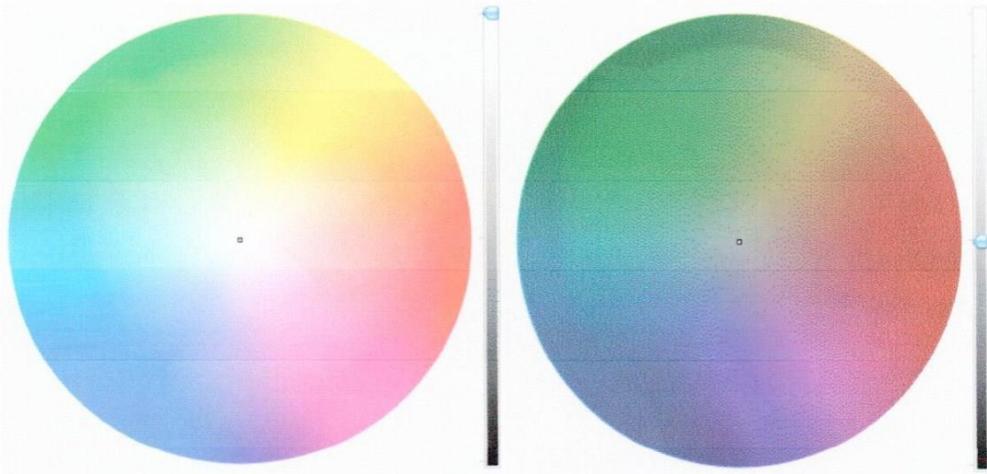
Sec. VIII. SIGN ILLUMINATION.

- (a) All permanent signs may be non-illuminated, illuminated by internal, internal indirect (halo), or lit by external indirect illumination, unless otherwise specified. All illuminated signs shall be extinguished at 11:00 P.M. or when the use or activity closes, whichever is later.

City of Presidio Ordinance 2014-01

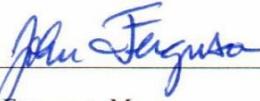
(b) INTERNAL ILLUMINATION. Outdoor, internally illuminated signs, including but not limited to awning/canopy signs, cabinet signs (whether freestanding or building mounted), changeable copy panels or service island signs, shall be constructed with an opaque background and translucent letters and symbols, or with a colored background and lighter letters and symbols. Where white or other night bright colors are part of a logo, such colors are permitted in the logo only, provided that such logo shall represent not more than fifty percent (50%) of the total sign area permitted. Colors considered to be "night bright", as used in this provision, are defined with reference to the color wheel below.

Color Wheel "A" Sign Background - Color Wheel "B" Logo Color



Color Wheel "B" Sign Background - Color Wheel "A" Logo Color

NOW THEREFORE, PASSED, APPROVED AND ADOPTED ON THIS THE 22nd DAY OF APRIL, 2014 AT THE REGULAR CALLED MEETING OF THE CITY OF PRESIDIO. THERE BEING A QUORUM PRESENT, APPROVED BY THE MAYOR AND THE CITY COUNCIL ON THE DATES SET ABOVE.

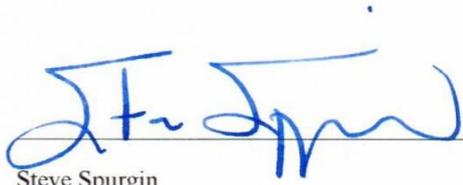


John Ferguson, Mayor

Attest:



Marco Baeza
City Administrator



Steve Spurgin
City Attorney

APPENDIX B – Senate Resolution 656



The Senate of The State of Texas

SENATE RESOLUTION NO. 656

WHEREAS, The Senate of the State of Texas is pleased to recognize the value and the beauty of the dark night skies over Big Bend Ranch State Park; and

WHEREAS, Big Bend Ranch State Park is the largest state park in Texas; it covers 311,000 acres in West Texas between Presidio and Lajitas; the park is bordered on the south by Farm to Market Road 170, which runs along the Rio Grande and the international boundary to Mexico; and

WHEREAS, In addition to excellent stargazing, the park offers visitors the opportunity to enjoy hiking trails, mountain biking, recreation areas, primitive camping, and river access; and

WHEREAS, Big Bend Ranch State Park has received worldwide recognition for having some of the darkest night skies in the world; with a night sky rating of Class 1, or "absolute darkest skies" on the Bortle Light Pollution Scale, the park offers the perfect venue for astronomical observations; and

WHEREAS, In an effort to preserve the view at night, seven counties and their cities in the Big Bend area have passed ordinances against avoidable light pollution; these efforts have focused on eliminating light sources that hamper observations of the night sky, such as those carried out at the McDonald Observatory, one of the state's most valuable assets, which is located near Fort Davis; and

WHEREAS, The dark skies of Big Bend allow everyone to become an astronomer and to view millions of stars otherwise obscured by the light pollution that plagues modern society; and

WHEREAS, Big Bend Ranch State Park is located near the border city of Ojinaga, Chihuahua, Mexico; our good neighbors to the south have also taken steps to reduce light pollution and save electrical energy by installing 1,000 light-emitting diode downward-oriented street lights, with more reduced lighting to come; and

WHEREAS, Tourism is the lifeblood of the Big Bend area's economy, and it is important to be able to market Big Bend Ranch State Park as a year-round astronomy destination for such events as star parties, amateur astronomer gatherings, nighttime photography sessions, and school or university field trips as well as for general tourism; the renewed focus on the Dark Skies of Texas will bring new jobs and revenue to an otherwise under-utilized area of Texas; and

WHEREAS, The City of Presidio and Big Bend Ranch State Park are hosting the Texas Dark Skies Festival on the last weekend of October; the festival features activities related to astronomy, outer space, science fiction, and other "out of this world" topics and is being held on Halloween weekends concurrent with

S.R. No. 656

Presidio's annual "Dude of the Dead" Music Festival; these events combine education, fun, food, and music into a massive Border Zone event for all to enjoy under the Dark Skies of Texas; now, therefore, be it

RESOLVED, That the Senate of the State of Texas, 84th Legislature, hereby recognize the Dark Skies of Texas at Big Bend Ranch State Park and commend the surrounding communities for their efforts to preserve this valuable and unique Texas treasure.

Rodríguez



Jan Patrick
President of the Senate

I hereby certify that the above Resolution was adopted by the Senate on April 30, 2015.

Daisy Spaw
Secretary of the Senate

José Rodríguez
Member, Texas Senate

APPENDIX C – Saucedo Historic District Lighting Assessment, McDonald Observatory

Bill Wren
Special Assistant to the Superintendent
McDonald Observatory
82 Mount Lock Road
Fort Davis, Texas 79734

Sean Dugan
Superintendent
Big Bend Ranch State Park
Sauceda Headquarters 1900
Sauceda Ranch Road
Presidio, TX 79845

Re: Outdoor Lighting Assessment

July 28, 2015

Superintendent Dugan:

Thank you for the opportunity to assess the outdoor lighting at Big Bend Ranch State Park (BBRSP). This assessment was undertaken as part of a project to assist Texas Parks and Wildlife Department (TPWD) to protect the night skies, reduce glare, reduce operating expenses, help Texas parks be examples of good lighting practices for surrounding communities, reduce the intrusion of artificial lighting in the habitat of wildlife, and identify parks that have the potential to be designated as International Dark-Sky Association (IDA) Dark Sky Parks. BBRSP enjoys some of the darkest night skies remaining in the continental United States and is arguably the darkest park in the TPWD system.

Outdoor lighting appears to be in use at only three locations within BBRSP: the Sauceda Headquarters complex, and two residences, one east, and one west. There is a mix of High Intensity Discharge (HID) fixtures such as Metal Halide, Compact Fluorescents (CFLs), and Light Emitting Diode (LEDs). This assessment will list each fixture at each location, and recommended retrofit or replacement, if needed, to provide quality illumination and dark sky compliance.

Many of the light fixtures in BBRSP are reportedly inoperable and removal should be considered if they are not needed. In all instances where illumination is needed, the goal is to use full-cutoff fixtures, i.e., no light shines directly above the horizontal plane intersecting the lowest part of the light-emitting portion of the fixture. Switches, timers and motion sensors are recommended so that lights are in use only when needed. Examples of recommended fixtures, including make and model, and possible sources, will be listed separately.

Best regards,



APPENDIX D – Big Bend Ranch State Park Lighting Management Plan

BIG BEND RANCH STATE PARK COMPLEX

LIGHTSCAPE MANAGEMENT PLAN (LMP)

JUNE 2017



Photo by Jennifer Pena

TABLE OF CONTENTS

INTRODUCTION 1

BIG BEND RANCH STATE PARK COMPLEX..... 3

 Barton Warnock Visitor Center..... 3

 Entrance Sign..... 3

 Information Kiosk..... 4

 Flagpole 4

 Visitor Center 4

 Superintendent Residence..... 5

 Maintenance Yard..... 5

 Resident Trailer 5

 Fresno Ranch..... 5

 Fort Leaton State Historic Site 6

 Historic Site 6

 Ft. Leaton Residence 1 6

 Ft. Leaton Residence 2 6

 Botella Residence 6

 Sauceda Historic District..... 7

 Visitor Center 7

 Big House 7

 Staff Apartments 7

 Superintendents Residence 8

 Bunkhouse 8

 Lead Ranger Residence 8

 Maintenance Facilities..... 8

 Los Alamos Residence 8

TEMPORARY LIGHTING (TENT AND RV CAMPERS)..... 9

FUTURE DEVELOPMENT 9

INTRODUCTION

Texas Parks and Wildlife Department (TPWD) recognizes the need to protect the darkness of the night sky. Implementation of a dark sky-friendly lightscape management plan will help preserve sky quality to protect the natural environment and wildlife, enhance visitor experience, and reduce operating costs.

This document defines the desired outdoor lighting management practices for Big Bend Ranch State Park (BBRSP) Complex (excluding Chininati Mountains State Natural Area). In recognition of the importance of continued preservation of the dark skies in the Big Bend region and at BBRSP, the park has developed a lighting strategy that follows recommendations as stated in *Guidelines for Outdoor Lighting in Royal Astronomical Society of Canada Dark-sky Preserves* and *IDA Dark Sky Places* adopted by the Royal Astronomical Society of Canada (RASC) (RASC-GOL revised 2016).

In addition to compliance with the RASC-GOL (2016), we recognize the importance of complying with Brewster and Presidio County lighting ordinances implemented in the interest of preserving dark skies around the McDonald Observatory in Fort Davis. As such, our lighting plans reflect input and recommendations from professionals from that institution to be sure our lighting choices are most suitable for the needs of our sparsely populated region.

This document describes the facilities and lighting management plan to be implemented at the BBRSP Complex. The Complex encompasses approximately 315,432 acres and consists of the Barton Warnock Visitor Center (BWVC), the Fresno Ranch, Fort Leaton State Historic Site (FLSHS), Botella Residence, Saucedo Historic District (SHD) and the Los Alamos Residence. The park is bounded by the unincorporated communities of Lajitas and Redford to the west, Terlingua and Study Butte to the east and an immense expanse of undeveloped rural private property to the north. The southern end of the park is defined by the Rio Grande River and the steep mesas and rugged canyons of Mexico.



Map of BBRSP Complex facilities

BIG BEND RANCH STATE PARK COMPLEX

Overall, the BBRSP Complex has relatively little outdoor lighting compared to many parks. Only the visitor centers, bunkhouse and residences have permanent outdoor lighting. Because of its remote wilderness setting and relatively low traffic volume, there is no additional lighting for parking lots, pathways, roadways, shorelines areas, campsites, restrooms, roadside pull-offs, or entrances.

All permanent infrastructure at the BBRSP Complex with outdoor lighting can be classified as either public or residential buildings. Since there are no specific guidelines for residential buildings described in the RASC-GOL (2016) we will apply the same guidelines for public buildings to park residences.

As described in section 4.1.2 in the RASC-GOL (2016) the guidelines for public buildings are as follows: Public buildings are defined as those open to the public during business hours and may also contain private offices. Due to the public nature of these buildings with high pedestrian traffic, exterior illumination may be higher than for park administration buildings. After hours, either all interior lighting should be turned off, or window and door blinds should be used to prevent interior light from shining outside. All outdoor lighting should be turned off within 30 minutes of the building being closed. Exterior lighting should be limited to the main door area and steps. Light activated timing circuits should turn the lighting on after sunset and off after a period of time specified by park managers and subject to the building use. Manual reset switches or motion detectors may be used to extend this period by a pre-programmed duration.

In all cases, our goal is to have fully shielded luminaries with long wavelength output (warm tones, not white/blue) to limit glare and prevent light pollution, as well as reduce energy output and operating costs. *Fully shielded* means fixtures that are designed or shielded in such a manner that all light rays emitted by the fixture do not project above a horizontal plane running through the lowest point on the fixture where light is emitted. Given the low illumination levels at the park, efforts will be taken to avoid over illumination by using bulbs with the lowest possible wattage that still offers sufficient visibility. Our goal is to stay below 20 watts (equivalent to a 150 watt incandescent source and not more than 3000 Kelvin Correlated Color Temperature (CCT), preferably 2700K.

The following provides a description of the facilities and LMP at each area containing permanent outdoor lighting in the park. It describes the locations and the types of lights currently (June 2017) in use and provides justification and retrofit plans, if needed, to be completed within one year.

Barton Warnock Visitor Center

The BWVC facility consists of six main areas that have outdoor fixtures: front entrance sign, information kiosk, visitor center, Superintendent residence, maintenance yard and residence trailer. Night-time lighting is generally used for the safety of residents, staff and visitors.

Entrance Sign

The front entrance sign is located at the entrance driveway off of FM 170. It is a low, broad sign with the facility name. The sign is oriented in a north-south direction with lights illuminating the

east and west sides of the sign. The sign is illuminated to direct visitors to the visitor center and to make the sign, entrance driveway and median visible from FM 170. The lights are run on solar power and are on a dusk-to-dawn timer. Lighting for this sign is considered necessary to help direct after-hours visitors to the center to obtain maps, self-pay permits, and park information available at the self-registration kiosk.

The lights used to illuminate both sides of the sign are directed towards the front of the sign. Currently, each light is outfitted with an 18 watt halogen bulb and is shielded under stacked rocks. They will remain on solar power to reduce energy usage and cost. Both lights will remain shielded.

Information Kiosk

An information kiosk is located in the front of the visitor center. The kiosk is oriented north-south and has a fixture on the east and west sides under an overhang. The kiosk displays after-hours park information, self-pay permits, maps and other important park information. There is a fixture for two bulbs on each side of the kiosk under a shallow eave. Lighting for the kiosk is considered necessary to help direct after-hours visitors to obtain maps, self-pay permits and park information.

Only one bulb will be active on each fixture. The lights used to illuminate the kiosk will be directed toward the text on the board with shields to limit glare. The lights are on a dusk-to-dawn timer and are tuned off when the sun rises.

Flagpole

The flagpole is located at the north end of the information kiosk. A United States and a Texas State flag hang 24 hours. Due to staffing shortages, the flag cannot be removed and rehung at dusk and dawn. Flag ethics require that the flags be illuminated at night if they are left hanging.

A downward-facing LED solar light is mounted to the top of the pole. Measures will be taken to ensure that the flag is only lit with down-ward facing lights of the appropriate wattage and color.

Visitor Center

The Barton Warnock Visitor Center facility has a public building (office and gift shop) with an attached residence (Superintendent residence). It is open at 8:00 am and closes at 4:30 pm daily. The building is wired for outdoor lighting that is meant to be both aesthetic and functional. There are 8 posts with two fixtures each (16 total) that are meant to illuminate the façade of the building mostly for decorative purposes.

All but one fixture of the 16 in the front of the building are not considered necessary for any purpose and will remain off. One of the total 16 will remain on to illuminate the front door and step for safety purposes. The single façade light will be shielded and is on a timer to turn on at sundown and turn off at sunrise. After-hours work requiring interior lighting is rarely conducted at the BWVC. In the event that interior lighting is needed after dark, heavy, full-length wooden shutters can be closed to block any glare from the interior.

Superintendent Residence

The residence luminaries are located at two entrances and consist of two decorative fixtures under eaves and a flood light that has been removed above the garage door. Outdoor lighting is considered necessary for navigation and safety purposes.

Light will be directed to only illuminate the immediate area. The inoperable flood light fixture was removed in April, 2017. The entrance lights are on manual switches and are used only when necessary. The residence has window coverings that block glare from interior lights.

Maintenance Yard

There are four light types located at the maintenance yard. Only one light, a barn light located at the entrance gate, comes on at night. The other lights are a wall pack mounted at the entrance of the maintenance yard office, a flood light mounted on the outside entrance to the office, and florescent tubes mounted inside the maintenance bays. The barn light is considered necessary for safety/security purposes and is on a dusk-to-dawn timer and is tuned off when the sun rises. The other lights are on manual switches and are used only when necessary. After-hours work at the maintenance yard is extremely rare.

To comply with this LMP, the wall pack and floodlights will be replaced with full-cut off fixtures. Until the retrofit is complete, only one socket for the dual floodlight will be used. The bulb is directed down and is shielded. The barn light and wall pack will be replaced within one year. The florescent lights are sufficiently shielded by the roof of the bay to not require replacement. Other than the barn light, after-hours use of the maintenance lights is extremely rare.

Resident Trailer

There are two flood light fixtures at the residence trailer, one on the front porch and one at the back entrance. The front fixture is covered by a deep porch and the rear light is covered by a shallow eave. The residence is occupied only on a limited basis. The lights for the residence are considered necessary for safety purposes.

The residence porch lights are sufficiently shielded by roofing. A shield will be installed on the back entrance or the fixture will be replaced with an FCO lamp of within one year. All of the lights are on manual switches, used only when necessary. The residence has window coverings that block glare from interior lights.

Fresno Ranch

The Fresno Ranch consists of one residence and multiple out buildings and structures that are not in use or inhabited. The residence has three solar-powered outdoor lights that illuminate the entrances and carport. Outdoor lighting is considered necessary for navigation and safety purposes.

The residence lights are fully shielded by roofing. The lights are on manual switches and used only when necessary. The residence has window coverings that block glare from interior lights.

Fort Leaton State Historic Site

Fort Leaton State Historic Site consist of a renovated historic fort with gift shop, two residences and a maintenance yard.

Historic Site

The only light at the site itself is a rectangular spotlight and cobra head street lamp located in the parking lot used to illuminate the lot and an orientation sign. The lights are administered by American Electric Power (AEP). The spotlight was adjusted in April by AEP to face down and the cobra head is an FCO fixture. Outdoor lighting is considered necessary for navigation and safety purposes.

A request was made to AEP in May for the rectangular light to be removed as the cobra head alone provides sufficient light for the desired effect.

Ft. Leaton Residence 1

Residence 1 has two outdoor lights to illuminate a courtyard and a carport and one barn light to illuminate the front driveway. Outdoor lighting of the residence is considered necessary for navigation and safety purposes.

The residence lights are fully shielded by roofing. The lights are on manual switches and used only when necessary. The residence has window coverings that block glare from interior lights.

The barn light near the driveway has been painted black to eliminate glare. The fixture will remain painted or replaced with a FCO fixture.

Ft. Leaton Residence 2

Residence 2 has one covered porch light at the front entrance and a rectangular spot light located away from the house. The spot light is administered by AEP. Outdoor lighting of the residence is considered necessary for navigation and safety purposes.

The residence porch light is fully shielded by roofing. The light is on a manual switch and is used only when necessary. While the porch light is shielded by a roof, installation of a FCO fixture is recommended. The residence has window coverings that block glare from interior lights. The spot light was adjusted to face down in April, but complete removal is recommended as the light does not serve a purpose.

Botella Residence

The Botella Residence consists of one residence, a pump house and a storage building. Only the residence has functioning outdoor lighting. It has five outdoor lights that illuminate entrances to the building and battery storage room. Outdoor lighting of the residence is considered necessary for navigation and safety purposes.

Currently, three fixtures at the rear of the house are inoperable, these are 18 watt halogen floodlights. There are no plans to fix the inoperable fixtures as they are rarely used. There is one

partially covered wall pack above the front door that will be replaced with a full-cutoff fixtures to comply with this LMP within one year. All lights are on manual switches and are used only when necessary. They will remain on solar power to reduce energy usage and cost.

Sauceda Historic District

The Saucedo Historic District consists of seven main areas that require night-time lighting: visitor center with 24 hour showers and restroom facility, Big House, bunkhouse, staff apartments, Superintendent residence, maintenance building, and Lead Ranger residence. Night-time lighting is used for residents, staff and visitor safety.

Visitor Center

Saucedo Ranger Station/Visitor Center is a public building with an attached pole barn and 24-hour restroom and shower facility. It is open at 8 am and closes at 6 pm daily. There are 6 warehouse style lights that illuminate the front porch and entrance of the building. Outdoor lighting is considered necessary for navigation and safety purposes.

The lights are fully shielded and are covered by the porch roof. The lights are on manual switches and used only when necessary. There are no lights in the pole barn. After-hours work requiring interior lighting is rarely conducted at the Saucedo Ranger Station. In the event that interior lighting is needed after dark, window coverings can be used to block any glare from the interior.

Big House

The Big House is a large residence that used to be open to the public for lodging. It is currently only used by staff on a limited basis. It is scheduled for renovations. There is one fixture that illuminates the front entrance and one that illuminates the side entrance on the south. The bulb at the front entrance has been removed. Outdoor lighting is considered necessary for navigation and safety purposes.

As part of the renovations, all outdoor lighting will be replaced with a full-cutoff luminaries and window coverings will be installed in the interior to comply with this LMP.

The timeline for renovations is currently not known, but it is expected to be a multi-year process, in the meantime lights will be used only as needed.

Staff Apartments

The staff apartments consist of three row-house style apartments in one standalone building. Each entrance is illuminated with full-cutoff fixtures. Outdoor lighting is considered necessary for navigation and safety purposes.

The lights are on manual switches, are used only when necessary. The residences have window coverings that block glare from interior lights.

Superintendents Residence

The Superintendents residence has one fixture to illuminate the front entrance. The light is a carriage style fixture fully covered under an eave. Outdoor lighting is considered necessary for navigation and safety purposes.

The light is on a manual switch and is used only when. The residence has window coverings that block glare from interior lights.

Bunkhouse

The bunkhouse consists of one standalone building that houses 26 bunks, a community kitchen and commons area. Outdoor lighting at the bunkhouse is considered necessary for navigation and safety purposes. There are 5 caged globe lights under the cover of the front porch and two flood lights at the side entrances. While the caged lights are under the porch, the lights on the ends cause glare beyond the open sides.

All fixtures at the bunkhouse will be replaced with FCO fixtures to comply with this LMP within one year. All exterior lights are on manual switches and are used only when necessary.

The bunkhouse has window coverings that block glare from interior lights.

Lead Ranger Residence

The Lead Ranger residence consist of one standalone building. Two entrances are illuminated with floodlights with motion sensors, and the other is a carriage light on a manual switch. Outdoor lighting is considered necessary for navigation and safety purposes.

The carriage light will be replaced with a FCO fixture within one year. The others will remain on motion sensors. The residence has window coverings that block glare from interior lights.

Maintenance Facilities

The maintenance garage is illuminated with three HID wall packs, one near each entrance. Night use is extremely rare. The lights are on manual switches and are used only when necessary.

All wall packs will be replaced with FCO fixtures within one year.

Los Alamos Residence

The residence consists of one house and an outbuilding. The residence currently not in use and will not be in use for at least one year. No lights are on at that location. Any changes in occupancy or use frequency will be included in the IDA annual report.

Full-cut off fixtures will be installed once the house is occupied.

TEMPORARY LIGHTING (TENT AND RV CAMPERS)

Temporary lighting is considered to be any light that is required by a visitor to navigate a campground, backcountry site, trail, or RV site at night. As stated in the BBRSP Public Use Plan (2008, p. 30):

“The majority of BBRSP is removed from the glow of urban lights. The night sky is a resource like any other aspect of the park. Park visitors are requested to help preserve the night sky for all visitors. All campsite [temporary] lighting should be limited to the degree necessary to navigate the immediate local campsite. For practical purposes all light sources should be shielded to only allow light projection below the horizontal, i.e., downward and not level or upward. Texas Parks and Wildlife Department recognizes the value in actively modeling proper lighting.”

Park visitors are encouraged to use amber or red lights to navigate campsites and trails. Use of high powered flashlights (> 300 lumens) or accessory vehicle lights such as light bars or floodlights is discouraged in all locations.

FUTURE DEVELOPMENT

All retrofits and new development requiring lighting will comply with the requirements described in Appendix G (3-8) of the RASC-GOL (2016). All changes and/or additions to the lightscape or sale/acquisition of park land will be tracked and submitted to the IDA by October 1 of every year.

The table below provides a quick reference describing the acceptable lighting at public and residential units within the BBRSP Complex.

All unshielded special purpose lights will be approved by the IDA. According to IDA guidelines, “lighting of less than 500 lumens may be unshielded for special purposes, such as historical preservation. The approved special uses should be stated [updated] in the LMP.”

Maximum lamp Lumens	Not to exceed 1600 lumens or < 20 watts for florescent/LED and <150 watt for an incandescent or use special purpose* (IDA approved for unshielded) lamps
Light type	FCO**, shielded or under porch/eave to block light from extending beyond the horizon
Illumination area	Directly only on subject (orientation maps) or potential hazard (steps)
Cycle/duration	Lighting used only as necessary. Use of sensors, manual switches and timers where appropriate. Dusk-to-dawn lighting only where deemed necessary for after hour visitors.
<p>* Special purpose = lamps with < 500 lumens output or less: 33 watt or less incandescent; 25 watt or less tungsten halogen; 8 watt or less linear florescent; 10 watt or less compact florescent.</p> <p>** FCO = (0% up-light or fully shielded, 10% max. glare. Meets minimum level of shielding.</p>	

The following chart can be used as a reference for lumen/watt comparisons.

Lumens	Incandescent light bulb watts	Fluorescent / LED watts
375 lm	25 W	6.23 W
600 lm	40 W	10 W
900 lm	60 W	15 W
1125 lm	75 W	18.75 W
1500 lm	100 W	25 W
2250 lm	150 W	37.5 W
3000 lm	200 W	50 W

APPENDIX G from the RASC DSP Lighting Protocol:

1. No additional light fixtures should be installed.

If additional light fixtures are considered necessary by the park manager, and with approval by the DSP nominators, additional fixtures may be installed. All new fixtures should conform to the requirements of Items 3-8 below.

2. Signage should not use active lighting.

Signage should use retro reflective materials. Pedestrian signs should be mounted at a height suitable for illumination with flashlights (<1 metre from the ground).

3. Only full cut-off (FCO) fixtures should be used.

All existing light fixtures should be replaced with FCO fixtures or shielded to prevent light from shining above the horizon or beyond the immediate area requiring illumination.

4. The illumination level produced by all light fixtures should be as low as practical.

Dusk and nighttime pedestrian and vehicle traffic densities should be used in assessing the level of illumination. For vehicles, typically < 70-watt HPS at 6-m is sufficient (3 lux) for large parking lots and high traffic density areas where low speed limits are in effect. Major pedestrian routes may be illuminated by typically < 5-watt incandescent light or <1 watt amber LED (1 lux). Due to the use of vehicle headlights and pedestrian flashlights, lower light wattages can be used with the understanding that they are used only as marker lights. Phosphorescent markers may be used.

5. Structures and barriers should be used to confine illumination to the immediate area.

Illuminated areas should be bordered by trees and bushes or other barriers to prevent the light from shining and scattering beyond the area being illuminated.

6. All light sources should be turned off within 2-hours of sunset (dark time)

Automatic timers should be used to avoid the need for staff to turn off the lights. The timers should detect nightfall and should turn the lights off within 2-hours. If the park manager considers lights will occasionally be required after this time, the timer should be capable of being reset by staff.

7. Indoor lighting should be prevented from shining through exterior windows

If interior lights must be used after sunset, window curtains should be closed within 30- minutes of sunset or interior illumination levels must be reduced significantly so as not to produce glare or light trespass.

8. The colour of all light fixtures should emit <2% blue in their spectrum.

“White” light sources such as metal halide lamps and white LEDs should not be used. High-pressure, and low-pressure sodium lamps, incandescent bulbs and amber LEDs may be used as long as they are in FCO fixtures and they provide the required illumination levels.