

Glen Canyon Rainbow Bridge

National Park Service
U.S. Department of the Interior

Glen Canyon National Recreation Area
Rainbow Bridge National Monument



Rainbow Bridge National Monument International Dark-Sky Association, Dark Sky Sanctuary Application September 2017



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Executive Summary

Rainbow Bridge National Monument, tucked among the isolated canyons at the base of Navajo Mountain, was established on May 30, 1910 and recognized by President William Howard Taft as an "extraordinary natural bridge, having an arch which is in form and appearance much like a rainbow, and which is of great scientific interest as an example of eccentric stream erosion (Presidential Proclamation 1043)." It was not until the passing of the Organic Act (1916), establishing the National Park Service, that the NPS became the managing agency for Rainbow Bridge National Monument.

Rainbow Bridge National Monument is a remote, 160 square acre monument in south-central Utah administered by Glen Canyon National Recreation Area. The Bridge is located at 37.0774° N, 110.9644° W, and the Monument is in the south-western corner of San Juan County, Utah. It is accessible only by either an approximately two-hour boat trip from one of three marinas on Lake Powell, or via one of the two hiking trails from Navajo Mountain which are 14 and 18 miles, approximately.

Currently, there is no capacity to generate electricity at Rainbow Bridge National Monument and there are no luminaires present inside its borders. The nearest light-at-night is generated at Dangling Rope Marina (7 miles to the northwest) or at the Navajo Mountain Chapter of the Navajo Nation (6 miles to the southeast), and the steep walls of Bridge Canyon, in which Rainbow Bridge is housed, further isolates the Monument from artificial light-at-night.

The International Dark-Sky Association's Dark Sky Sanctuary guidelines require that, "the park must provide an exceptional dark sky resource where the night sky brightness is routinely equal to or darker than 21.5 magnitudes per square arcsecond." As illustrated in this document, every sky quality measurement taken at Rainbow Bridge National Monument has exceeded this benchmark.

Introduction

History

Rainbow Bridge National Monument has been known for centuries by the Native Americans who lived in the area, many of whom derive significance from the formation. Though it was likely seen by wandering trappers and prospectors by the 1800s, it was not until a 1909 expedition, led by Paiute guides, that its existence was publicized to the outside world. Following a five-day journey across slickrock and in and out of canyons, on August 14, 1909 Nasja Begay and Jim Mike led explorer John Wetherill, University of Utah Dean Byron Cummings, a government surveyor W.B. Douglass, and their team of men and horses into what is now Bridge Canyon, giving the team their first views of the expansive stone bridge.

The following year, on May 30, 1910, President William Howard Taft established Rainbow Bridge National Monument to preserve this “extraordinary natural bridge, having an arch which is in form and appearance much like a rainbow, and which... is of great scientific interest as an example of eccentric stream erosion.” It was not until the passing of the Organic Act (1916), establishing the National Park Service, that the NPS became the managing agency for Rainbow Bridge National Monument.

The years that followed the Monument’s designation saw a few more adventurers visit Rainbow Bridge, including both Teddy Roosevelt and Zane Grey. Until the completion of the Glen Canyon Dam and creation of Lake Powell in 1963, which allowed visitors access the Monument by boat, the trip to Rainbow Bridge still required several days. Visitation to the site is now approximately 85,000 people per year.

Physical Geography and Geology

Rainbow Bridge is located upon the Colorado Plateau Province; a region marked by vast plateaus, deep canyons and mesas. Located in Bridge Canyon, one of the nearly 100 named canyons in Lake Powell, Rainbow Bridge is formed in the relatively soft, upper layer of Navajo Sandstone which rests on a harder layer of Kayenta Sandstone (both Jurassic Era formations). Created by water flowing off of Navajo Mountain, the Bridge is ultimately the result of these flows meandering across the Navajo Sandstone, following the path of least resistance, and making their way down to the Colorado River. Flowing into a tight curve and around a fin of soft

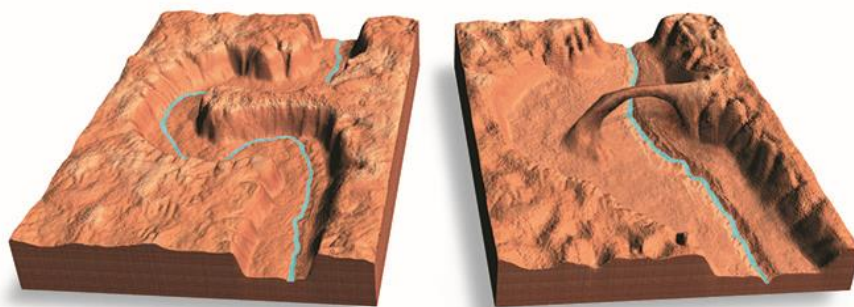


Figure 1. Illustration shows the process by which Rainbow Bridge was formed, beginning about 90 million years ago.

Navajo Sandstone, the stream of runoff cut down as far as the harder Kayenta Sandstone layer, causing the water to churn against the fin. Eventually, water broke through the fin and the processes of water-erosion, freeze and thaw, and wind action has sculpted the Bridge into its existing shape.

From the bottom of Bridge Creek to the top of the arch, it is 290 feet – nearly the height of the Statue of Liberty – and spans 275 feet across Bridge Creek; the top of the arch is 42 feet thick and 33 feet wide – approximately wide enough for a two-lane road.

The cliff faces of Bridge Canyon present easily visible layers of Kayenta and Navajo Sandstone interspersed with limestone lenses. These lenses mark ancient oases in the sand dunes which solidified to become the Navajo Sandstone. Visitors to Rainbow Bridge also pass a hanging garden on the trail from the boat docks to the Bridge itself. Hanging gardens are fed by springs derived from a local aquifer primarily supplied by winter precipitation. This water supply moves downward through the porous stone to provide water to the colonies of plants clinging to the vertical wall of a cliff. They often form in alcoves or “glens” where conditions are cooler and moister than in the surrounding desert.

Flora and Fauna

Rainbow Bridge National Monument has an average of approximately six inches of precipitation per year and poor, thin soil. However, it boasts more than 750 species of plants. The following major vegetation types are found within Rainbow Bridge National Monument:

Warm Desert Shrub common species: James’ galleta grass (*Pleuraphis jamesii*), blackbrush *Coleogyne ramosissima*, Indian ricegrass (*Achnatherum hymenoides*), six weeks fescue (*Vulpia octoflora*), and Mormon tea (*Ephedra viridis*).

Salt Desert Shrub common species: Some of the most important species are shadscale (*Atriplex confertifolia*), Gardner saltbush (*Atriplex gardneri*), mat saltbush (*Atriplex corrugata*), fourwing saltbush (*Atriplex canescens*), greasewood (*Sarcobatus vermiculatus*), winterfat (*Ceratoides lanata*), and spiny hopsage (*Grayia spinosa*).

Pinyon-Juniper common species: Two needle pinyon (*Pinus edulis*), Utah juniper (*Juniperus osteosperma*), broom snakeweed (*Gutierrezia sarothrae*), Mormon tea (*Ephedra viridis*), Indian ricegrass (*Achnatherum hymenoides*), Jones’ pepperweed (*Lepidium montanum*), and Bigelow sage (*Artemisia bigelovii*).

Sand Shrub common species: sand sagebrush (*Artemisia filifolia*), yucca, Indian ricegrass (*Achnatherum hymenoides*), and Harvard oak (*Quercus havardii* var. *tuckeri*)

Slickrock/Barren common species: Button brittlebush (*Encelia frutescens* var. *frutescens*), Cottam’s milkvetch (*Astragalus monumental* Barneby var. *cottamii*). Sandstone slickrock, shale or talus, with only scattered vegetation.

Riparian common species: Scouring rush horsetail (*Equisetum hyemale*), white sagebrush (*Artemisia ludoviciana*), cheatgrass (*Bromus tectorum*), Fremont cottonwood (*Populus fremontii*), mountain rush (*Juncus balticus* var. *montanus*), five stamen tamarisk (*Tamarix chinensis*), narrowleaf willow (*Salix exigua*), and Emory’s baccharis (*Baccharis emoryi*).

Seeps, Springs, and Hanging Garden common species: common maidenhair (*Adiantum capillus-veneris*), obovate buckthorn (*Frangula betulifolia*), three nerve goldenrod (*Solidago velutina*), Gambel oak (*Quercus gambelii*), stream orchid (*Epipactis gigantea*), Rydberg's thistle (*Cirsium rydbergii*), and tapered rosette grass (*Dichanthelium acuminatum*).

Bird life in Bridge Canyon is also rich and varied. Surveys of the aquatic birds of Lake Powell were initiated in 1994 and continue to the present. Surveyors observed dabbling ducks, diving species, waders (long-legged shorebirds and herons), and aerialists. Known water bird species increased from 32 species before 1963 to 83 in 2007. Several federally listed species have been documented in Lake Powell's canyons and may be present in Bridge Canyon, including the Mexican spotted owl, bald eagle, and Southwestern willow flycatcher.

While native species, like the bighorn sheep, kangaroo rat, and coyote, are integral parts of the Colorado Plateau ecosystem, other area mammals include pocket mice, woodrats, deer mice, black-tailed jackrabbit, Northern river otter, bobcat, and mountain lion. Several species of bat are also present inside the borders of Rainbow Bridge National Monument.

As Bridge Creek is an intermittent stream fed by runoff from Navajo Mountain, there are not, consistently, fish species within the Monument's borders. Lake Powell supports a wide variety of fish species including, Northern pike, walleye, common carp, striped bass, largemouth bass, and channel catfish.

Section 1. Location of Rainbow Bridge National Monument

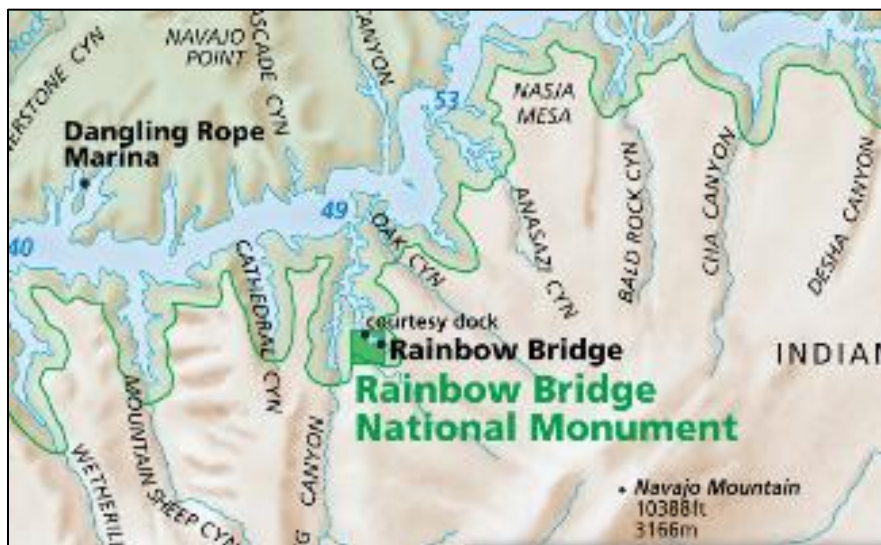


Figure 2. Location of Rainbow Bridge National Monument in relationship to Dangling Rope Marina and Navajo Mountain.

1.1 Geographical Location

Rainbow Bridge National Monument is a remote, 160 square acre monument in south-central Utah administered by Glen Canyon National Recreation Area. The Bridge is located at 37.0774° N, 110.9644° W, and the Monument is in the south-western corner of San Juan County, Utah. There are no private in-holdings within Rainbow Bridge National Monument and

the entirety of the 160 square acres are under the jurisdiction of the National Park Service.

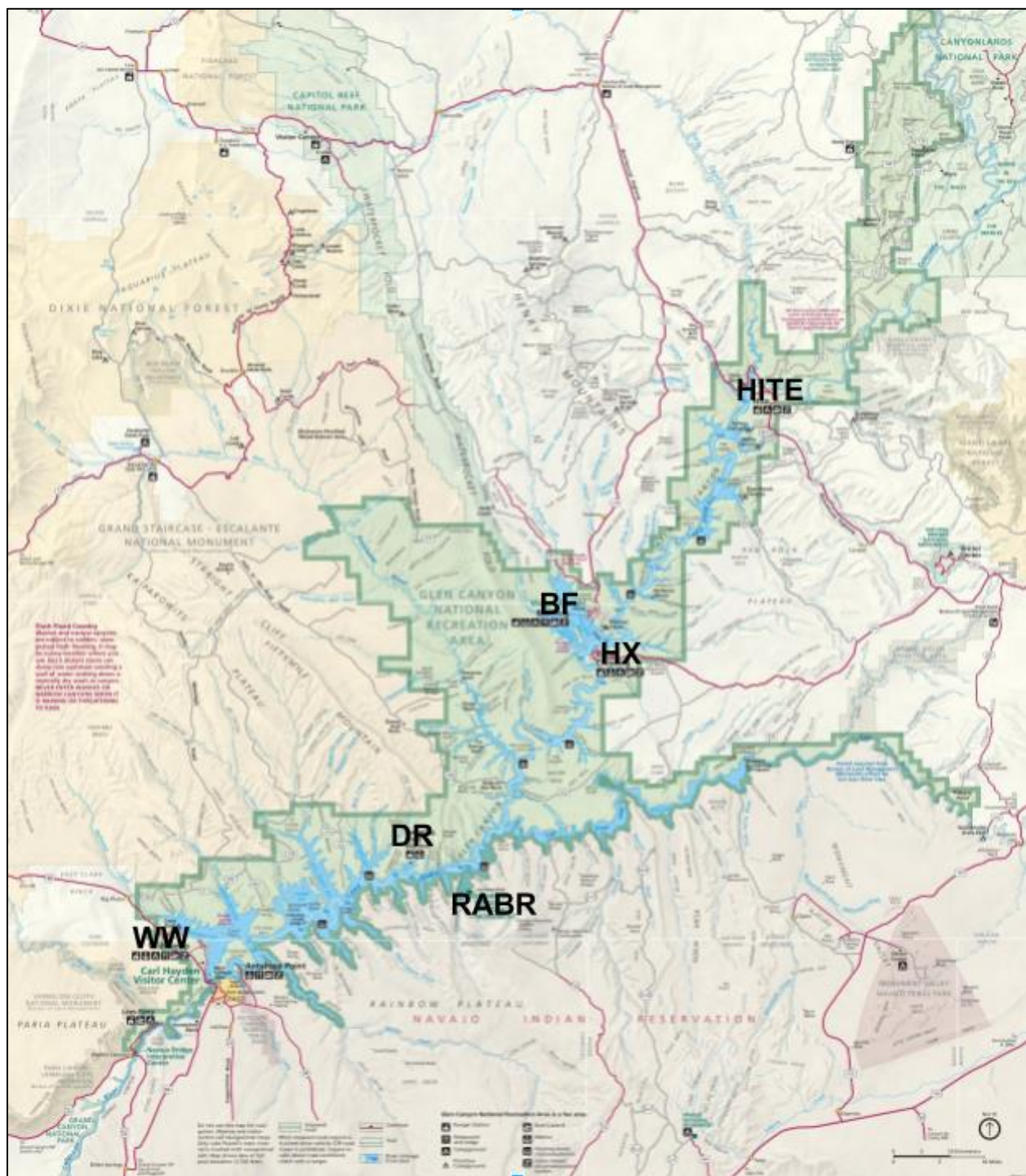


Figure 3. Location of Rainbow Bridge (RABR) in relationship to Wahweap Marina (WW), Halls Crossing Marina (HX), Bullfrog Marina (BF), Dangling Rope Marina (DR), and Hite (HITE).

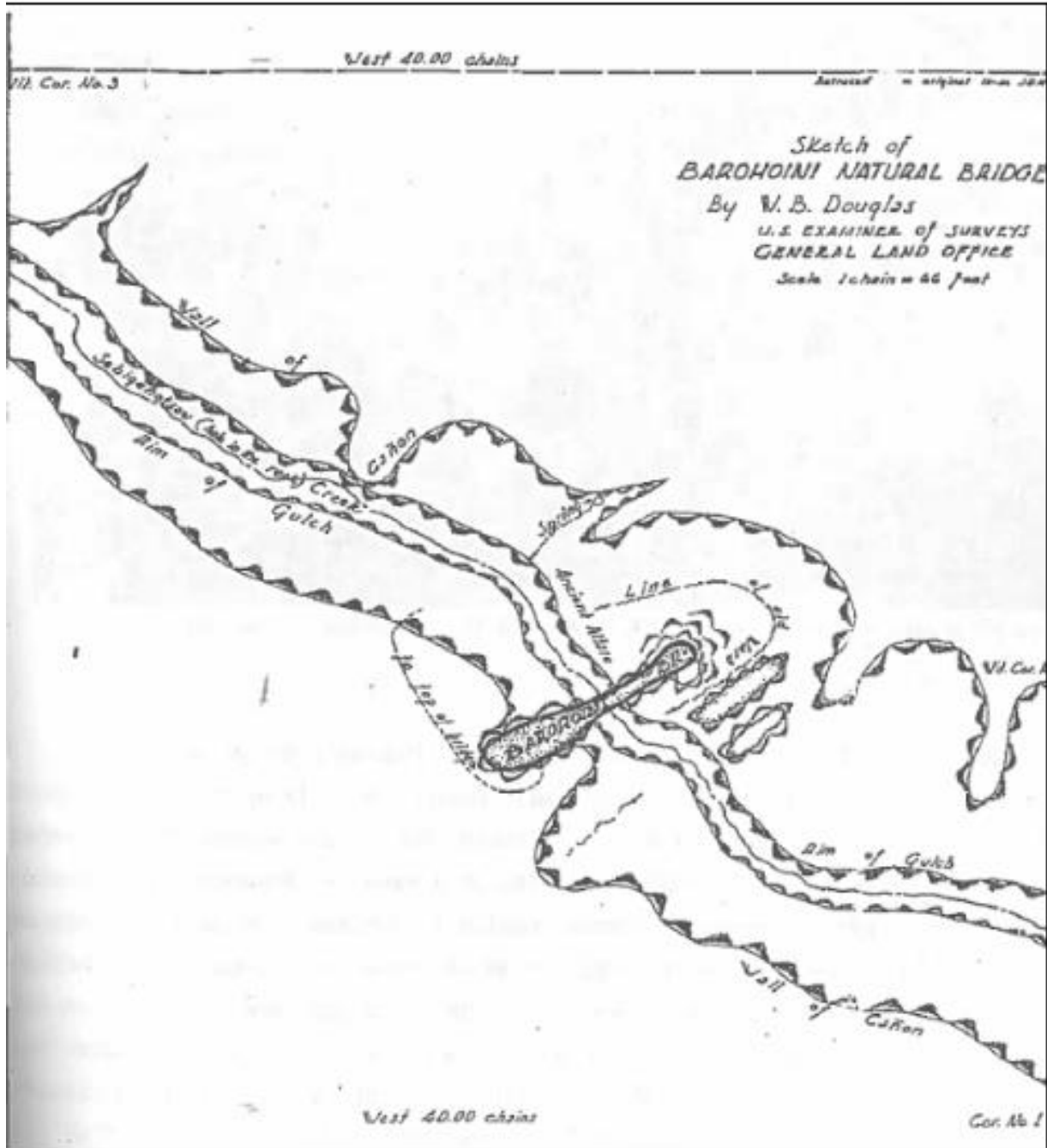


Figure 4. Original drawing of the Rainbow Bridge National Monument by W.B. Douglass drafted in 1909.

1.2 Accessing Rainbow Bridge National Monument

Bordered by both Glen Canyon National Recreation Area and the Navajo Nation, this extremely remote Monument is not accessible by car. Visitors to the site can gain access by boat from either Wahweap Marina or Antelope Point Marina near Page, AZ, Bullfrog Marina in Kane County, Utah, or Halls Crossing Marina in San Juan County, Utah, or via one of the two hiking trails from Navajo Mountain which are approximately 14 and 18 miles (trails require a Navajo Nation permit for use). Visitors may also take aerial tours through several tour operators in Page, AZ, and boat tours to can be arranged through a park concessionaire.

1.3 Night-Time Access to the Monument

There is very little night-time visitation of Rainbow Bridge National Monument, as camping is not allowed within its borders and night-time boating on Lake Powell is discouraged. Those wishing to overnight in the vicinity often camp at Echo Camp, a historical campsite on the Navajo-Mountain-to-Rainbow-Bridge trail system. This campsite is approximately 1 mile from Rainbow Bridge and within the borders of the Navajo Reservation, thus requiring a Navajo Nation permit for use. Visitors may also camp from a boat in Lake Powell, though they are not permitted to leave a boat tied to the Rainbow Bridge docks (outside of the Monument, but inside Bridge Canyon) overnight.

Section 2. Night Sky at Rainbow Bridge National Monument

2.1 Weather, Climate and Visibility

Rainbow Bridge National Monument has an arid climate with precipitation averaging approximately six inches per year. Elevations in the Monument range from approximately 3,655 feet above sea level in the creek bed to approximately 5,000 feet above sea level atop the Monument's cliffs.

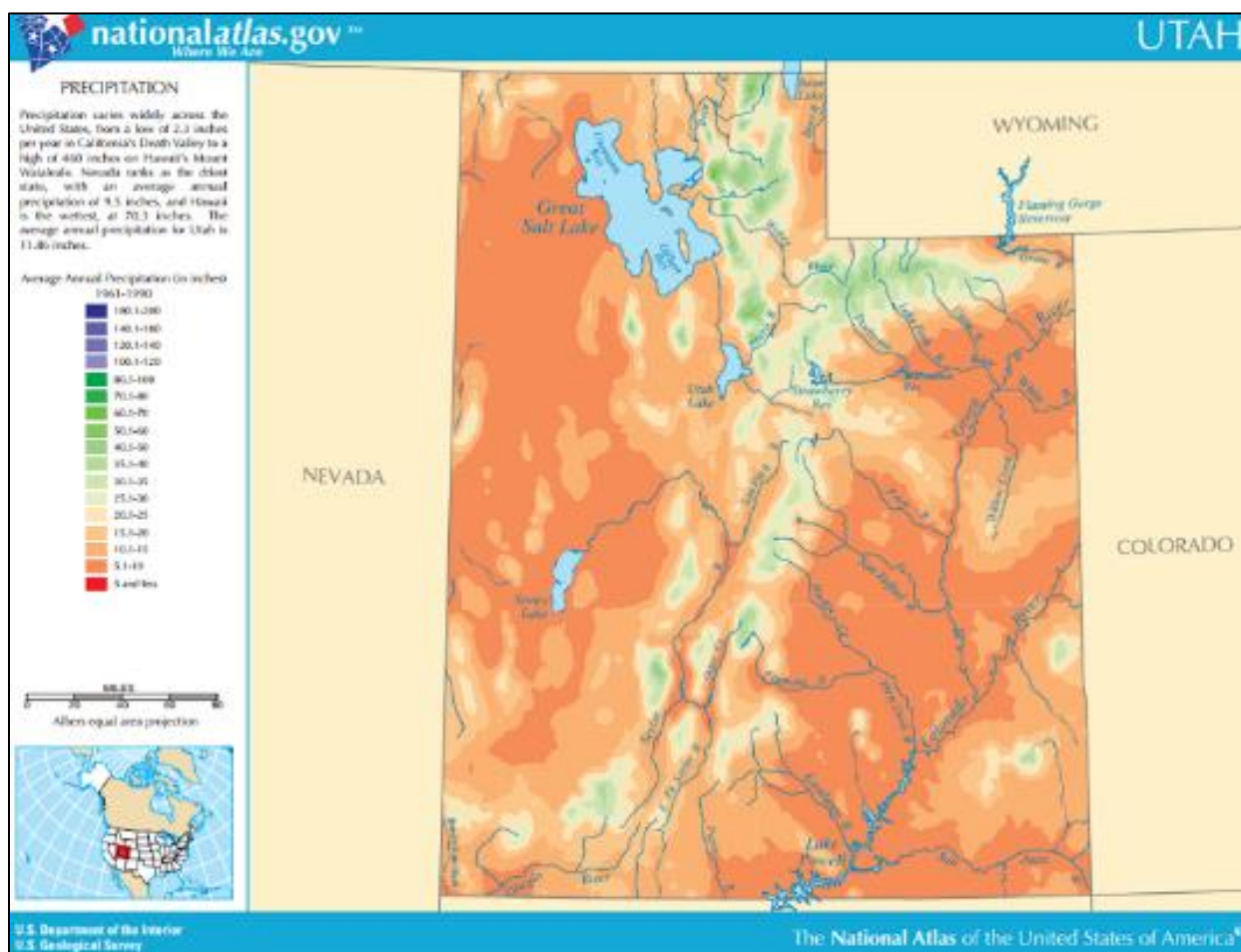


Figure 5. Annual precipitation in the State of Utah.

https://nationalmap.gov/small_scale/printable/images/pdf/precip/pageprecip_ut3.pdf

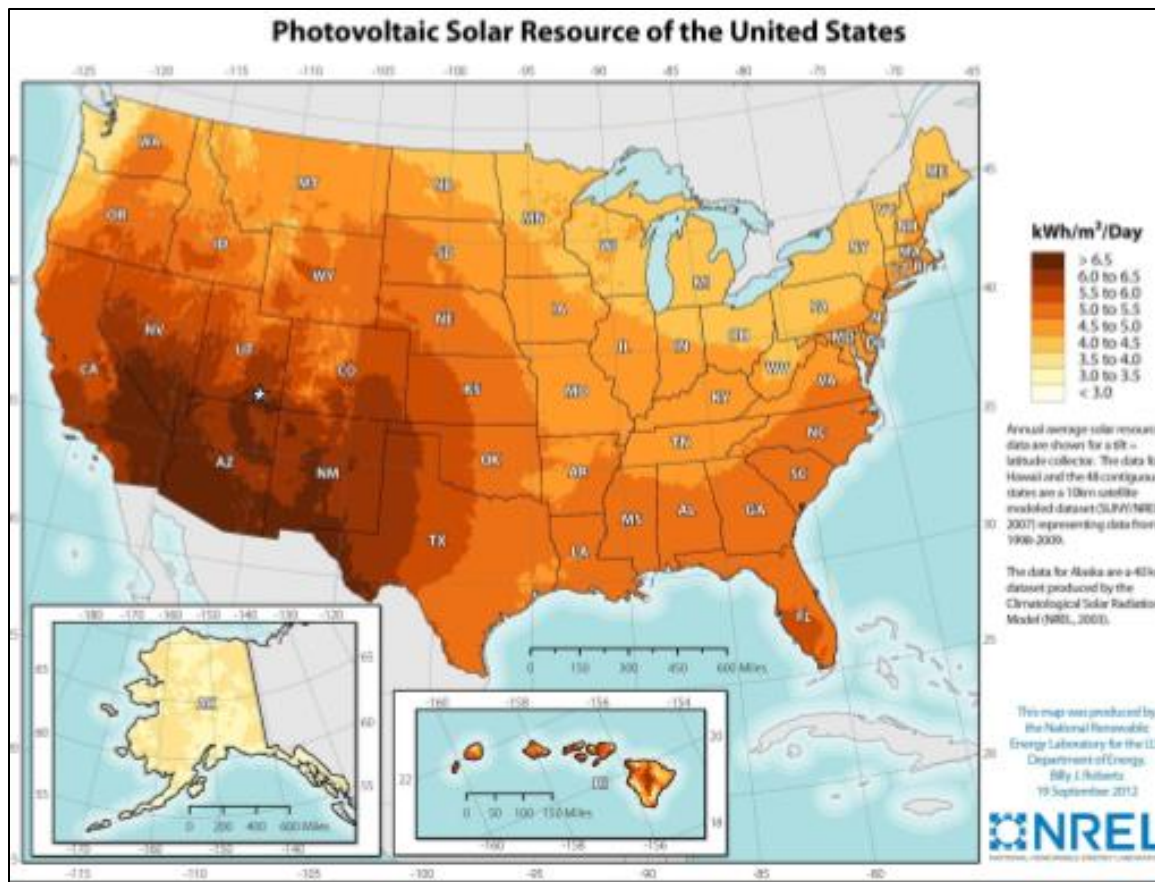


Figure 6. Map showing insolation received as a proxy for cloud-cover. Star marks monuments' approximate location.

Temperatures at Rainbow Bridge National Monument range from lows around 0 degrees Fahrenheit in December and January to highs around 110 degrees Fahrenheit in June and July.

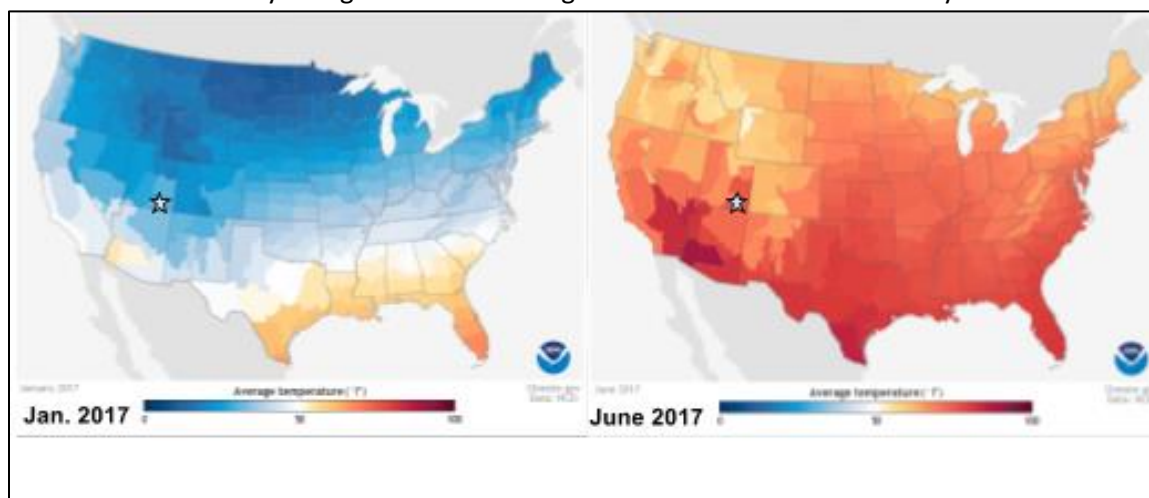


Figure 7. Monthly average temperatures across the United States. Star marks the Monument's approximate location. www.climate.gov/maps-data/data-snapshots/averagetemp-monthly-cmb-2017-06-00?theme=Temperature

2.2 Isolation from Light Pollution

Light pollution limits the visibility of the Milky Way to the unaided eye, the visibility of nebulae and galaxies seen in telescopes, and raises the noise on charge coupled device (CCD) astrophotographs. Only the observation of planets and double stars is unaffected. Low light pollution conditions, or dark skies, are one of the most important properties of a good astronomical observing site. Figures 8 and 9 illustrate Rainbow Bridge National Monument's isolation from light pollution, based on data from Light Pollution Atlas 2006 by David Lorenz and the National Park Service Natural Sounds and Night Skies Team's Anthropogenic Light Ratio Continental Model.

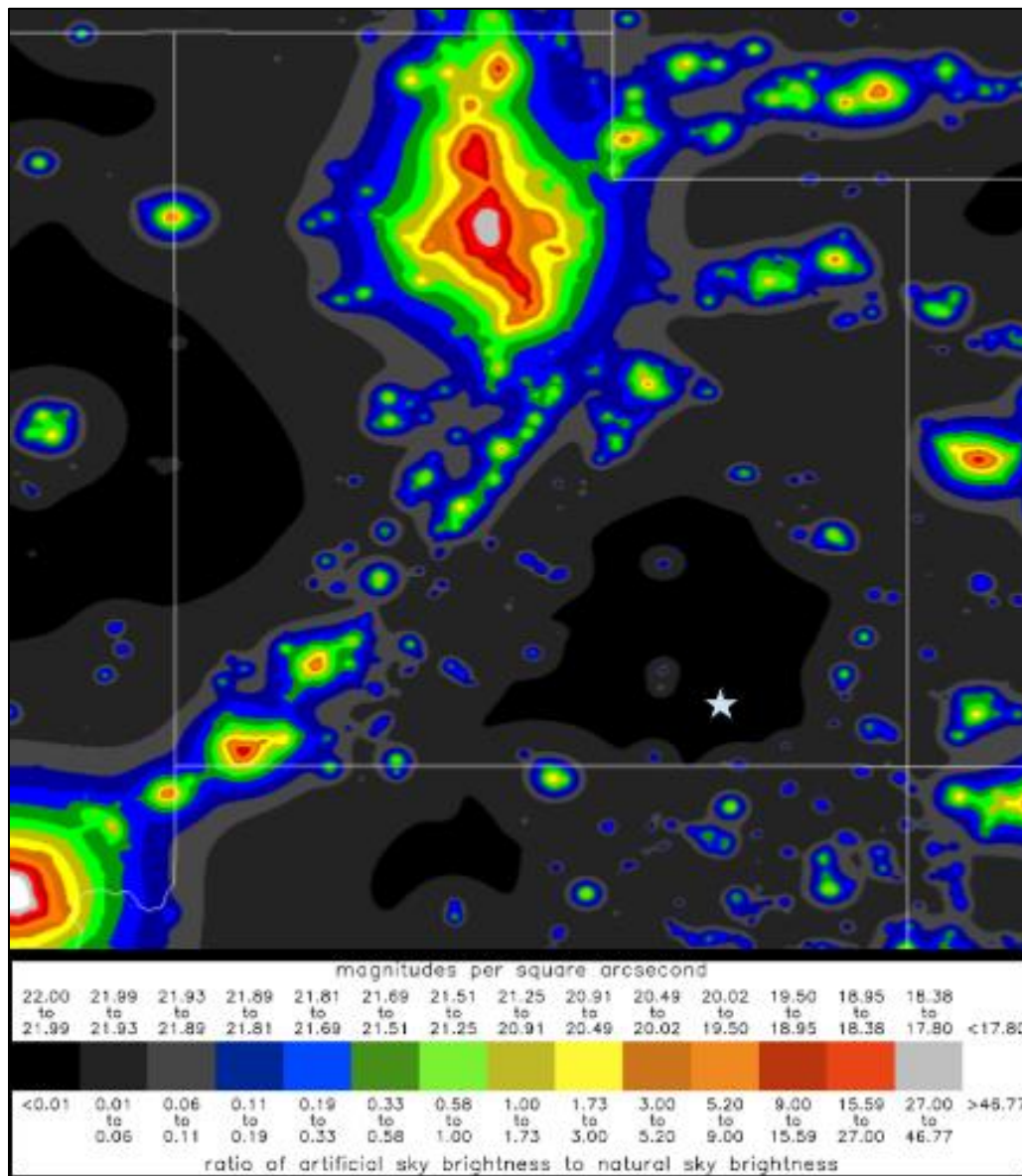


Figure 8. Ratio of artificial sky brightness to natural sky brightness and magnitudes per square arcsecond from David Lorenz's 2006 Light Pollution Atlas.

<https://djlrenz.github.io/astronomy/lp2006/NorthAmerica2006B.png>

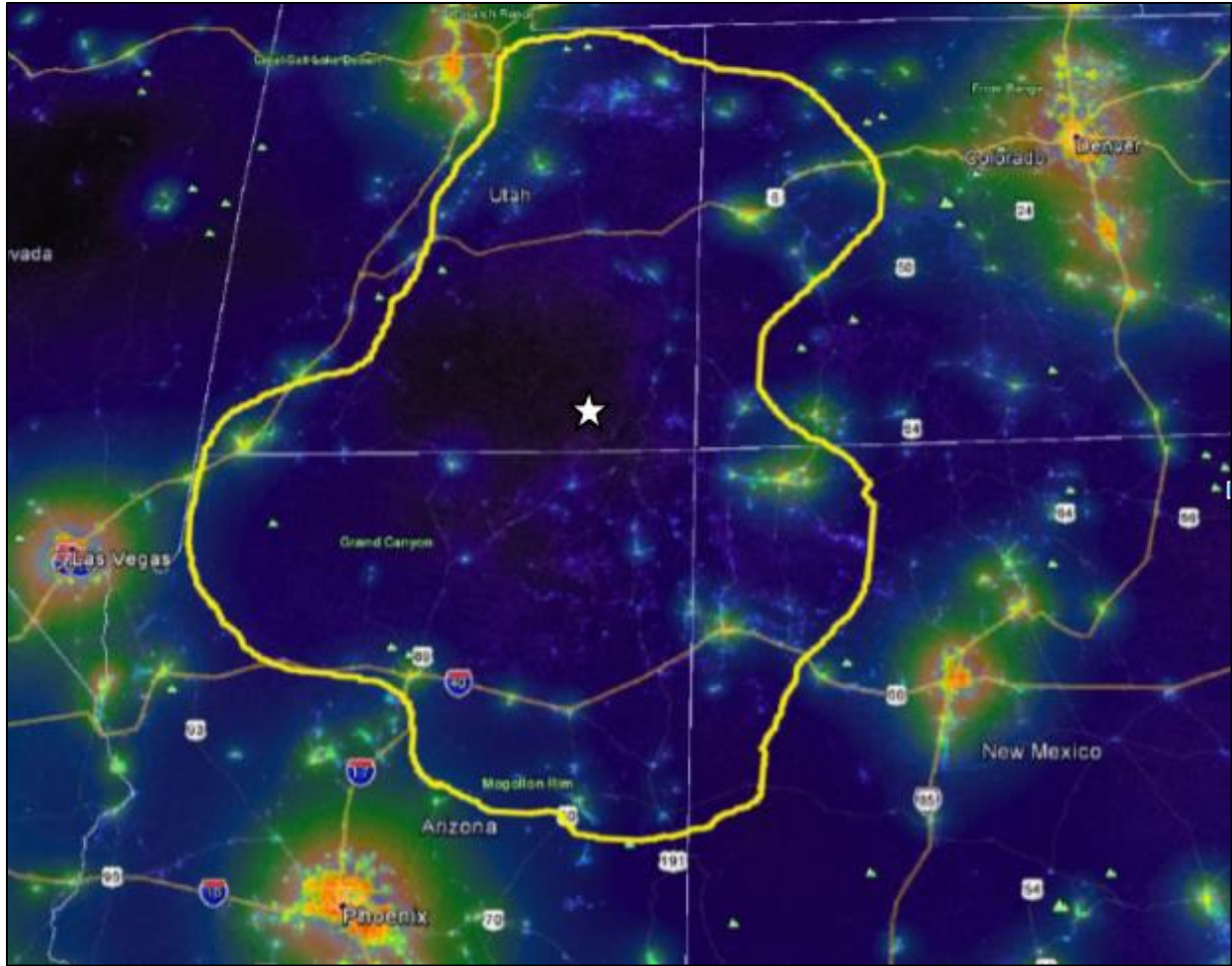


Figure 9. Outline for Colorado Plateau with light pollution sources. Star marks approximate location of Rainbow Bridge National Monument. NPS Night Skies Team Anthropogenic Light Ratio Continental Model (2014).

Rainbow Bridge National Monument's isolation from light pollution can further be illustrated by its geographical distance from developed areas (Table 1), while its location inside the steep-walled Bridge Canyon - whose walls are roughly 1,000 feet high - further isolate the monument from artificial light at night.

Town	Distance (Miles)	Population	Direction
Navajo Mountain, Utah	6	379	Southeast
Dangling Rope Marina, Utah	7	15	Northwest
Page, Arizona	29.39	7,440	Southwest
Halls Crossing, Utah	29.68	20	Northeast
Bullfrog, Utah	33.39	313	Northeast
Oljeto, Utah	40.21	864	Southeast

Kayenta, Arizona	46.11	5,189	Southeast
Escalante, Utah	59.36	793	Northwest
Mexican Hat, Utah	60.75	31	East

Table 1. Population estimates based on the 2010 United States Census and Glen Canyon National Recreation Area records.

2.3 Assessment of Sky Quality

Measurements of the sky quality at Rainbow Bridge National Monument have been made on four occasions using the Unihedron SQM following the guides outlined by the International Dark-Sky Association's "How to Conduct a Sky Quality Survey." Four measurements were taken at each point on four separate occasions, following the end of astronomical twilight. The first measurement was discarded, as required by the guidelines; the means of the following three measurements at each location are noted in Table 2.

Measurements were taken at points along the Rainbow Bridge trail system, which runs roughly northwest to southeast through the Monument; from the courtesy dock in Bridge Canyon to the boundary of the Navajo Nation.



Figure 10. Satellite view of Rainbow Bridge National Monument. The Rainbow Bridge trail runs along the north-eastern bank of Bridge Creek.

Average Sky Quality Measurement Using the Unihedron SQM (mags/sq. arcsec)		
Waypoint	6/26/17	7/23/17
1	21.85	22.01
2	21.67	21.78
3	21.73	22.03
4	22.17	22.14
5	22.01	22.06
6	22.62	22.03
7	22.49	22.45
8	22.26	22.19
9	22.23	22.26
10	22.18	22.22
11	22.27	22.18
12	22.19	22.09
13	22.24	22.22
14	22.36	22.28

Table 2. Mean Sky Quality Measurements taken at Rainbow Bridge National Monument.

Photographs of the horizon at Rainbow Bridge National Monument (figures 11-14) were also taken from the southern viewing platform, immediately to the north of Rainbow Bridge. The following settings were used:

Camera: Nikon D810

ISO Speed: 4000

Aperture: 3.5

Exposure: 30 seconds

Special Editing: None

Focal Length: 18-55mm

2.3.1 Continued Monitoring of Sky Quality at Rainbow Bridge National Monument

The Glen Canyon National Recreation Area and Rainbow Bridge National Monument Interpretation Division Staff will be responsible for continued monitoring of the sky quality within the Monument. The Division's Standard Operating Procedures for Sky Quality Monitoring is attached in Appendix A.



Figure 11. Northern Horizon.



Figure 12. Eastern Horizon.



Figure 13. Southern Horizon

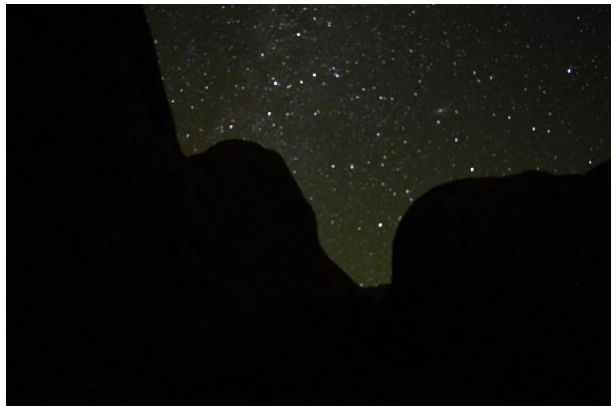


Figure 14. Western Horizon.

2.4 Threats to Sky Quality

The most significant threats to the sky quality at Rainbow Bridge have been identified as the communities around Navajo Mountain on the Navajo Nation, Page, AZ, and the marina communities inside Glen Canyon National Recreation Area at Dangling Rope, Halls Crossing, and Bullfrog.

The National Park Service at Glen Canyon National Recreation Area is currently working to retrofit lighting at all locations within the park in an effort to reduce the amount of light pollution generated by the communities at the Dangling Rope, Halls Crossing and Bullfrog Marinas. A GIS-based lighting survey has been undertaken at Glen Canyon to facilitate this retrofit.

Similarly, the National Park Service is working closely with the City of Page as they initiate an astro-tourism campaign and develop a lighting ordinance with more protection measures for the night sky. Development of tourism-based infrastructure, most notably hotels, is a major contributing factor to the sky glow generated in the city. Recently, the city has moved to adopt <3000k CCT exterior lighting and more stringent shielding requirements. National Park Service staff will continue to work alongside the city, and use the sky quality data generated in both Glen

Canyon National Recreation Area and Rainbow Bridge National Monument to educate area residents about the generation of light pollution and the harm it may cause.

Interpretation Division staff will also continue to engage both the Navajo Nation Tribal Government and the population around Navajo Mountain in a dialogue centered on area night-sky preservation. Park Service staff will continue to attend the Navajo Mountain Chapter's Community Based Land Use meetings, when invited, to help identify opportunities for the Chapter to minimize the community's impact on the quality of the night sky at Rainbow Bridge National Monument. Similarly, all sky quality data collected in the Monument will also be shared with the Chapter, along with the analysis of trends over-time.

2.5 Motivation for Certification

The National Park Service maintains a strong interest in preserving the night skies over National Parks and Monuments and has seen many of the public lands in its charge receive designations from the International Dark-Sky Association. This interest is clearly outlined in the 2015 National Park Service "Director's Call to Action" #27: Starry, Starry Night which requires National Park units to, "Lead the way in protecting natural darkness as a precious resource and create a model for dark sky protection..."

Though Rainbow Bridge is not necessarily a place that attracts astronomical observers, its significance to both the ancient and current Native peoples in the region requires preservation of the landscape as a whole. This Monument also serves as a home for many species of flora and fauna which are fundamental to the ecosystem of the Colorado Plateau, including threatened species.

Rainbow Bridge National Monument and Glen Canyon National Recreation Area are managed jointly by the National Park Service, which has begun the process of retrofitting lighting within the Glen Canyon with the specific intent to apply for International Dark-Sky Association Dark-Sky Park status. It is our intent to decrease the amount of sky glow generated inside the park and work toward preservation of all natural night sky within the boundaries of the land we steward.

2.6 Eligibility for Certification

Rainbow Bridge National Monument meets the requirements for certification as a Dark Sky Sanctuary as outlined by the International Dark-Sky Association. Sanctuaries "must be a public or a private land, accessible to the public in part or whole, that is legally protected for scientific, natural, educational, cultural, heritage and/or public enjoyment purposes. The site must provide an exceptional dark sky resource where the night sky brightness is routinely equal to or darker than 21.5 magnitudes per square arc second."

As illustrated in both the introduction and Section 3 of this application, this National Monument, whose stewardship is the charge of the National Park Service unit at Glen Canyon National Recreation Area and Rainbow Bridge National Monument, is public land preserved and protected through its designation as a National Monument, which is further acknowledged in its designation as a Traditional Cultural Property. It also meets the eligibility requirement concerning regular visitation by the public, although most visitation is not regular night-time

visitation. The general public can visit Rainbow Bridge National Monument during daylight hours; the Monument is staffed April through October by interpretive park rangers.

Similarly, the sky quality measurements taken at Rainbow Bridge National Monument exceed the International Dark-Sky Association's requirement for an average measurement of 21.5, as illustrated in “Table 2. Mean Sky Quality Measurements Taken at Rainbow Bridge National Monument.”

Section 3: Traditional Cultural Property Designation

3.1 Traditional Cultural Property Designation

A Traditional Cultural Property is a property that is eligible for inclusion on the National Register of Historic Places (NRHP) based on its associations with the cultural practices, traditions, beliefs, lifeways, arts, crafts, or social institutions of a living community. TCPs are rooted in a traditional community's history and are important in maintaining the continuing cultural identity of the community.

The cultural practices or beliefs that give a TCP its significance are, in many cases, still observed at the time a TCP is considered for inclusion in the NRHP. Because of this, it is sometimes perceived that the practices or beliefs themselves, not the property, make up the TCP. While the beliefs or practices associated with a TCP are of central importance, the NRHP does not include intangible resources. The TCP must be a physical property or place - that is, a district, site, building, structure, or object.

TCPs are best identified by consulting directly with members of a traditional community. Members often have a special perspective on properties that play important roles in their historically rooted beliefs, customs, and practices. While certain properties may be documented in the historic literature or through previous ethnographic or archaeological studies, information on other properties may have only been passed down through generations by oral history or practice.

For Indian tribes and Native Hawaiians, knowledge of TCP locations may reside with tribal elders or traditional practitioners who may retain specific confidential information regarding the location of properties and the special qualities associated with them. Sensitivity to these issues may be necessary during any identification and documentation process.

3.2 Rainbow Bridge as a Traditional Cultural Property

Eighty-five acres fully contained inside the 160 area Rainbow Bridge National Monument were designated a Traditional Cultural Property in April 2017 to recognizing the site's historic and ongoing cultural significance to at least six American Indian tribes and establish its listing in the National Register of Historic Places. The first site in the State of Utah to receive the designation, Rainbow Bridge has been associated with traditions of the Hopi, Kaibab Paiute, Navajo, San Juan Southern Paiute, Ute Mountain Ute, and Zuni people.

Archeological finds near the bridge include a hearth estimated to be 1,500 years old.



Figure 15. A potsherd of the Glen Canyon design, now housed in the Glen Canyon National Recreation Area archives, ca. 800 C.E.

The presence of an altar-like structure at the base of the Bridge was noted by most of the members of the 1909 expedition led by Byron Cummings, William B. Douglass and John Wetherill, though there was no accurate analysis of which human group was represented by this shrine. Theodore Roosevelt, who visited Rainbow Bridge National Monument in 1913 via the southern Navajo Mountain-to-Rainbow Bridge route, also noted the presence of an altar-like structure and “the crumbling remains of some cliff dwellings.

Section 4: Rainbow Bridge National Monument Outreach Programs

The staff of Glen Canyon National Recreation Area and Rainbow Bridge National Monument are committed to continued monitoring of night skies in the Monument, as well as continued outreach to surrounding communities aimed at the protection of those night skies. Also collecting data within the boundaries of Glen Canyon National Recreation Area, the sky quality measurements made in both Glen Canyon and Rainbow Bridge have been used in public education programs and dark-sky-focused outreach to neighboring communities. Though the engagement of the Navajo Mountain Chapter of the Navajo Nation is the only outreach currently focused specifically on the preservation of night skies at Rainbow Bridge National Monument, the Dark Skies program conducts a wide variety of education and outreach in and around Glen Canyon National Recreation Area and Rainbow Bridge National Monument.



Figure 16. Light pollution demonstration at the Page Attacks Trash event held annually in observance of Earth Day.

Navajo Mountain Chapter of the Navajo Nation: The Dark Skies Program staff for Glen Canyon National Recreation Area and Rainbow Bridge National Monument have engaged the Navajo Mountain Chapter of the Navajo Nation in a discussion centered on the preservation of the night sky in Rainbow Bridge National Monument. National Park Service staff have been invited to attend several of the Chapter's Community Based Land Use Committee meetings to discuss International Dark-Sky Association designation

for both parks and communities, to identify ways in which the Chapter might reduce the amount of light pollution generated within the community (including lighting retrofit and the use of timers/curfews), discuss area astro-tourism initiatives, and engage in community-based lighting education. National Park Service staff have been invited to attend the September 27, 2017 Chapter's Community Based Land Use Committee meeting to identify specific, non-dark-sky-compliant lighting in the areas of the Chapter House and Navajo Mountain Schools.

The City of Page, Arizona: Dark Skies Program staff have been actively working with the City of Page as they develop a new lighting ordinance in the City. We are also participating in planning efforts to increase dark-sky tourism in the City and surrounding area.

Le Chee Chapter of the Navajo Nation: Dark Sky Program staff have made two presentations to the Le Chee Chapter about dark-sky lighting, the consequences of light pollution and skyglow, and the potential for dark-sky tourism.

Ticaboo Resorts, Ticaboo, Utah: The Ticaboo Resort has expressed interest in retrofitting their outdoor lighting to be more dark-sky friendly. Dark Skies program staff are currently assisting them in the identification of non-compliant luminaires.

Community Outreach and Interpretation: Though these programs do not occur within the borders of Rainbow Bridge National Monument, Dark Skies Program staff engage in a wide variety of community outreach and interpretive programs in and around Glen Canyon National Recreation Area and Rainbow Bridge National Monument.

Section 5: Partnership with Glen Canyon Natural History Association

The Glen Canyon Natural History Association, the Glen Canyon National Recreation Area and Rainbow Bridge National Monument cooperating association, is an advocate for dark skies in both the park and surrounding municipalities and has been an invaluable partner in the work of night-sky preservation. Their specific contributions are outlined below:

- Funded the personnel to conduct lighting inventories, perform dark skies education and outreach, and write and submit applications for certification of both Glen Canyon National Recreation Area and Rainbow Bridge National Monument by the International Dark-Sky Association.
- Helped to develop a volunteer corps of advocates and educators to provide face-to-face interactions with visitors.
- Worked alongside the City of Page, Glen Canyon National Recreation Area and Rainbow Bridge National Monument, and the International Dark-Sky Association to develop a lighting ordinance for the City of Page.
- Hosted dark-sky programming including the Horseshoe Bend and Navajo Bridge Star Parties, Bat Fest, and regular ranger-led programming; all of which support a message of night sky conservation.

Section 6: Management Documents

6.1 NPS Agency Policies

Several federal laws and directives serve as guides for the National Park unit at Glen Canyon National Recreation Area and Rainbow Bridge National Monument in its mission to preserve natural night skies. They are outlined below:

The National Park Service Organic Act (1916): The Organic Act (1916) in order to manage and preserve the nation's national park lands. Specifically, the Act declares that the National Park Service has a dual mission, both to conserve park resources and provide for their use and enjoyment declaring, "The service thus established shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified by such means and measures as conform to the fundamental purpose of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

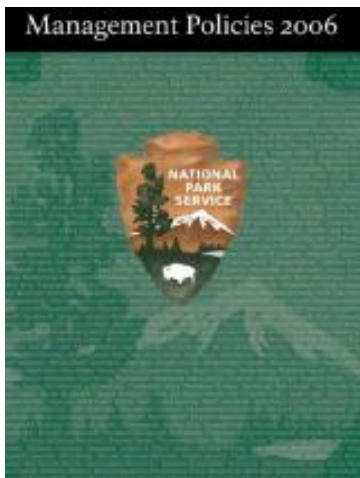


Figure 17. National Park Service Management Policies (2006).

4.10 Lightscape Management (2006): The National Park Service’s Management Policies (2006) specifically outline the service-wide required and recommended actions with regard to lightscape management. The document says, “The Service will preserve, to the greatest extent possible, the natural lightscapes of parks, which are natural resources and values that exist in the absence of human-caused light... To prevent the loss of dark conditions and of natural night skies, the Service will minimize light that emanates from park facilities, and also seek the cooperation of park visitors, neighbors, and local government agencies to prevent or minimize the intrusion of artificial light into the night scene of the ecosystems of parks.”

The document outlines the following service-wide requirements, saying the service will:

- Restrict the use of artificial lighting in parks to those areas where security, basic human safety, and specific cultural resource requirements must be met;
- Use minimal-impact lighting techniques;
- Shield the use of artificial lighting where necessary to prevent the disruption of the night sky, natural cave processes, physiological processes of living organisms, and similar natural processes.

The Green Parks Plan (2012): The Green Parks Plan (GPP) defines a collective vision and a long-term strategic plan for sustainable management of NPS operations. This plan outlines nine specific goals, each supported by action objectives. The “Preserve Outdoor Values” says, “Outdoor experiences can be adversely affected by facility operations. Exterior lighting can reduce dark night sky quality and vehicle traffic can diminish the natural silence and sounds of an ecosystem. Reducing the impact of NPS operations on the environment will improve the visitor experience and protect natural and cultural resources through the preservation of night skies, natural sounds, water quality, ecosystems, and viewsheds,” and is supported by the following objectives:

1. The NPS will reduce light pollution from park facilities with the goal of dark night sky preservation.
2. The NPS will minimize sound pollution in the outdoor environment.

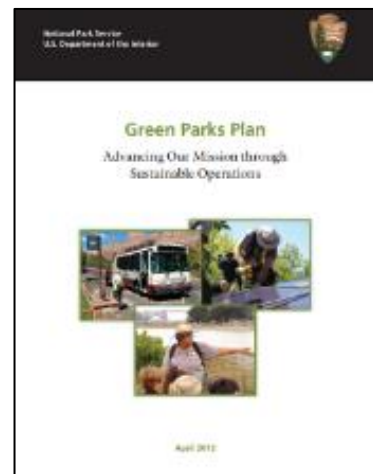


Figure 18. NPS Green Parks Plan (2012)

3. The NPS will ensure that all facilities and operations are sustainably integrated into the park landscape to minimize impact on the natural and cultural environment.”

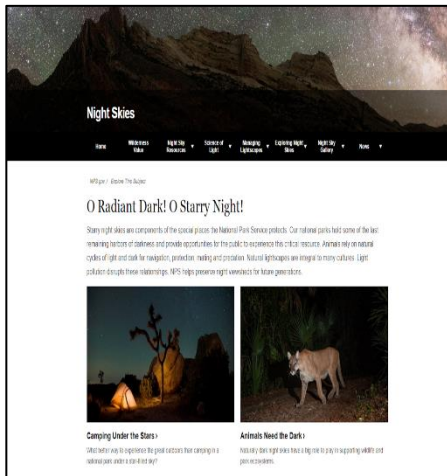


Figure 19. The Natural Sounds and Night Skies Division of the National Park Service promotes the preservation of night skies.
<https://www.nps.gov/subjects/night skies/index.htm>

National Park Service Night Sky Management; Natural Sounds and Night Skies: “America’s national parks contain many cherished treasures; among them are captivating natural sounds and awe-inspiring night skies. The joy of listening to the quiet symphony of nature or the beauty of seeing the Milky Way stretching overhead have become rare experiences in our lifetimes, but they can still be found in many of our national parks. Natural sounds and natural darkness, though often overlooked, are essential in keeping our national treasures whole. They are magnificent in their own right, but also inspirational to the visitors who come to national parks, vital to the protection of wilderness character, fundamental to the historical and cultural context, and critical for park wildlife.”

“The Natural Sounds and Night Skies Division uses science, engineering, and technology to understand and better manage these spectacular resources. We pioneer innovative techniques to measure the impact of noise and light pollution, develop new approaches to safeguard natural sounds and natural darkness, and identify management solutions to restore these public resources.”

“The Natural Sounds and Night Skies Division works to protect, maintain, or restore acoustical and dark night sky environments throughout the National Park System. We work in partnership with parks and others to increase scientific understanding and inspire public appreciation of the value and 60 character of soundscapes and star-filled skies. We welcome your interest in learning about these sublime resources of our national parks and the efforts you can take to help us preserve them for future generations. Whether it’s simply talking a little softer or turning off an outdoor light, you too can make a difference in the protection of these vital resources. Most of all, we encourage you to experience for yourself the natural soundscapes and lightscapes of your national parks.”

Director’s Call to Action (2015): The National Park Service Director’s Call Action provides guidance for National Park Service employees and partners and provides specific, service-wide goals. The National Park Service’s commitment to night sky preservation is outlined in #27 Starry, Starry Night. “Lead the way in protecting natural darkness as a precious resource and create a model for dark sky protection by establishing America’s first Dark Sky Cooperative on the Colorado Plateau in collaboration with other federal agencies, partners, and local communities.”

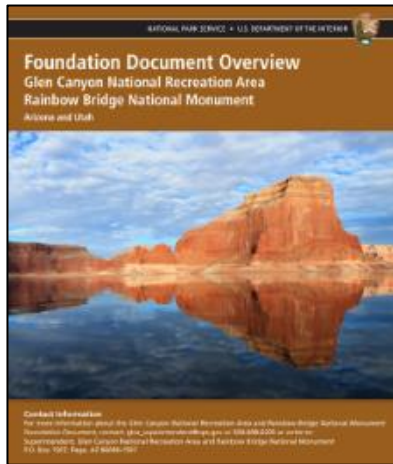


Figure 20. Foundation Document for Glen Canyon National Recreation Area and Rainbow Bridge National Monument (2014).

6.2 Management Actions

The Foundation Document for each monument functions as a “formal statement of its core mission that will provide basic guidance for all planning and management decisions.” This document (2014) describes, “protection of night sky resources as development outside proposed wilderness increases over time” as both a challenge for engagement for National Park Service employees, while opportunities are identified as, “incredible visitor opportunities to experience solitude, primitive recreation, undeveloped desert landscapes, night skies, and open vistas within wilderness areas.” This document also notes the necessity for developing partnerships to promote wilderness stewardship and education, as well as developing partnerships for monitoring and restoring wilderness resources -- such as those present within Rainbow Bridge National Monument.

6.3 Lighting Inventory

There are currently no artificial lights at Rainbow Bridge National Monument and no capacity to generate electricity within the Monument.

6.4 Lightscape Management Plan

The entirety of Rainbow Bridge National Monument has been designated LZ00, which is outlined as “A dark ambient environment with absolute minimal level of lighting. Permanent artificial light fixtures exist only where critical for human safety or where mandated by codes, and are for discrete tasks only. Nighttime activities in this zone are oriented to darkness at night. There is minimal impact to human dark adaptation and enjoyment of a natural lightscape. There is minimal disruption of nocturnal wildlife habitat.” Outdoor lighting will only be added within the monument in the event that such conditions exist in which nighttime public safety is demonstrably threatened. In such a case, the use of outdoor lighting will only be employed to mitigate the hazard.

Neither San Juan County, Utah nor the Navajo Nation have an existing lighting ordinance, and as such are not considered here. NPS Management Policies direct parks to use artificial light on an “only as needed” basis and to minimize impact whenever possible. Merely shielding a light does not necessarily constitute lightscape, wildlife, or night-sky friendliness; especially if that light is initially unnecessary. When a light is necessary, the incorporation of a timer, motion sensor, or switch can greatly reduce its impact. The mitigation of outdoor lighting impacts upon the environment is best accomplished by addressing six parameters of lighting. Should the need arise

to install lighting at Rainbow Bridge National Monument, it will conform to the following guides:

1) Warranting- Light only **WHERE** you need it.

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

2) Controls- Light only **WHEN** you need it.

- a. Rather than defaulting to a dusk-till-dawn operational cycle, lighting controls should be designed to minimize the amount of time the light is on while still fulfilling the need met by installing the light at that spot in the first place.

3) Shielding- Direct light **DOWNWARD**.

- a. No fixture should emit light above the horizontal. In most cases, beams of light should be restricted even further.

4) Spectrum- Select **LAMPS** that minimize negative impacts.

- a. Humans and many other animals are most sensitive to blue/white light. Most evening lighting goals can be achieved using warmer temperature lighting, which decreases the disruption to wildlife (including insects), maintains the human ability to adapt to low light conditions, and decreases sky glow.

b. The color tint of white light is measured in Kelvins (K), a scale in which warm-toned white light has smaller values (1800-3000K) and cold-toned light has larger values (5000K and higher). Between 3000 and 5000K, light is said to be “neutral” in tone. The common incandescent lamp is 2700K.

c. Traditional incandescent lighting is about 2700K, a warm toned light considered normal for residential and hospitality lighting in North America. For reasons of consistency and appearance, light sources should be 2700-3000K with a minimum Color Rendering Index of 70. Amber or yellow light sources are preferable, both to limit attraction by insects and to reduce sky glow. Light sources should be chosen for energy efficiency, long life and low maintenance. Because locations in the Monument are exposed to extreme heat, light sources must be suitable for all expected operating conditions.

The following light sources are acceptable for outside use:

- i. LED 2700K “warm” white lamps, yellow, or amber colored, 1, 3, or 7 watt. Use with caution in hot climates. Use amber LEDs in most environmentally sensitive areas.
- ii. Compact fluorescent, 9 watt, twin tube and 13 watt double twin tube or Edison base spiral 3, 7, 10, 13 or 26 watt (2700K only or yellow “bug lamps”). Because of low starting temperature and low cost components, this light source can be used for many basic outdoor lighting applications.
- iii. Halogen IR, 20 watt, 12 volt MR16 lamp. Uses are generally limited to temporary (motion detector activated) lighting applications. Because of

their low luminous efficacy they should not be used in continuous duty applications.

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

5) Intensity- Use the minimum **AMOUNT** of light necessary.

6) Efficiency- Select the most energy **EFFICIENT** lamp and fixture.

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September 1, 2017

Board of Directors
International Dark-Sky Association
3223 North First Ave.
Tucson, AZ 85719

Dear IDA Board of Directors,

As an IDA member in good standing, it is my pleasure to nominate Rainbow Bridge National Monument for Dark Sky Sanctuary status. On my many trips to the Monument, it has become clear there are few places which possess both the deep cultural significance and the pristine night skies of Rainbow Bridge. Located among some of the United States' premier Dark Sky Parks, Rainbow Bridge's remote location – even by Colorado Plateau Standards – has allowed the site to remain, essentially, free from artificial light at night and the pollution domes generated by such.

The beauty of the night sky at Rainbow Bridge cannot be overstated. Having spent several nights there taking sky quality measurements, I am always thrilled by the untarnished brilliance of its skies which are matched only by the immensity of the Monument's stone bridge. Known to native peoples for centuries, the Monument was recently designated a Traditional Cultural Property, acknowledging its continued significance to many of the region's Native American tribes. Though night-time visitation of the Monument is not encouraged, preservation of the entirety of this sacred landscape is of the highest importance.

The certifying of Rainbow Bridge National Monument as a Dark Sky Sanctuary – the first in the National Park Service system – would continue to expand and cement the culture of night sky protection the National Park Services has already demonstrated at many of the Colorado Plateau National Parks and Monuments. As such, I appreciate the attention you will give this application package and ask for your favorable consideration.

Regards,



Sarah Stannard



United States Department of the Interior

NATIONAL PARK SERVICE

Glen Canyon National Recreation Area

Rainbow Bridge National Monument

P.O. Box 1507

Page, Arizona 86040



August 3, 2017

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

Dear Board of Directors:

I am writing to express my strong support for the designation of Rainbow Bridge National Monument as an International Dark-Sky Association (IDA) Dark Sky Sanctuary. As outlined in the requirements for Dark Sky Sanctuary designation, this spectacular site has been protected for both its scientific and educational value, as well as cultural heritage and public enjoyment. Articulated by President William Howard Taft upon the designation of Rainbow Bridge as a National Monument in 1910, this site is an, "extraordinary natural bridge, having an arch which is in form and appearance much like a rainbow, and which... is of great scientific interest as an example of eccentric stream erosion." Long before its designation as a National Monument, however, the Rainbow Bridge has been a sacred place to the Native American tribes who have frequented it throughout history. In recognition of these cultural values, the National Park Service relies heavily on the Rainbow Bridge Native American Consultation Committee which includes tribal representatives from the Navajo, Hopi, Zuni, San Juan Southern Paiute, Kaibab Paiute, and White Mesa Ute.

This year, Rainbow Bridge National Monument was designated as a Traditional Cultural Property and listed in the National Register of Historic Places. This designation, in partnership with an IDA Dark Sky Sanctuary designation, will help to preserve the entirety of this magnificent landscape for the Monument's 80,000 annual visitors and future generations.

The National Park Service protects the quality of the night sky around Rainbow Bridge, across the Colorado Plateau, and nationwide. We are actively working to adopt night-sky-friendly, energy-efficient lighting in Glen Canyon National Recreation Area - the National Park Unit immediately surrounding Rainbow Bridge National Monument - and use night sky preservation as a central theme in our public messaging and outreach. We are also working alongside the Colorado Plateau Dark Sky Cooperative, adjoining federal land-management agencies, our local municipal partners, and tribal governments to fulfill the mission of the agency's service-wide Call to Action #27, *Starry Starry Night*.

For these reasons, Rainbow Bridge National Monument is a prime candidate for designation as an International Dark-Sky Association Dark Sky Sanctuary. I am pleased to present the enclosed nomination package, and I ask for your favorable consideration.

Sincerely,

A handwritten signature in black ink, appearing to read "Wm Shott". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

William Shott
Superintendent, Rainbow Bridge National Monument
Glen Canyon National Recreation Area



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MISSION
We are a cooperating
association that supports and
funds education, research,
interpretation, and visitor
services within the public lands
on the Colorado Plateau.
Working in partnership with
Glen Canyon National
Recreation Area, Rainbow
Bridge National Monument,
and Grand Staircase-Escalante
National Monument, we
promote and inspire the
preservation and stewardship
of cultural and natural
resources.

July 12, 2017

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

Dear Board of Directors,

The Glen Canyon Natural History Association is pleased to support the Rainbow Bridge National Monument's Dark Sky Sanctuary nomination. We have been a cooperating association and close partner of the National Park Service unit at Glen Canyon National Recreation Area and Rainbow Bridge National Monument for over 30 years and strongly believe in the preservation of the entirety of our natural landscape - including natural, dark night skies. This monument is located in one of the most remote regions of the Continental United States and provides visitors with a visually stunning landscape, largely unchanged for thousands of years.

We appreciate the commitment of the National Park Service to the preservation of our public lands and nightscapes and have echoed that commitment in the funding of a position dedicated to night sky preservation at Glen Canyon National Recreation Area and Rainbow Bridge National Monument. This position has allowed the unit to undertake the significant work of International Dark-Sky Association compliance and application, public education, and outreach. We work side-by-side to inform local public policy, make substantive changes to the parks' lightscapes, coordinate robust dark-sky centric programming, and develop astro-tourism opportunities in the local area. In fact, several members of our board and staff have become active volunteers in the Glen Canyon and Rainbow Bridge Dark Skies Program and provide boots-on-the-ground support for this initiative in public programs.

The Glen Canyon Natural History Association encourages you to consider naming Rainbow Bridge National Monument a Dark Sky Sanctuary. This designation will only serve to strengthen the current preservation efforts being undertaken at this special and significant site.

Sincerely,

Frank Talbot
President, Glen Canyon Natural History Association



Colorado Plateau Dark Sky Cooperative

June 13, 2017

Board of Directors
International Dark Sky Association
3223 North First Avenue
Tucson, Arizona 85710-2103

To the International Dark Sky Association (IDA) Board of Directors:

The Colorado Plateau Dark Sky Cooperative and Consortium for Dark Sky Studies are enthusiastic to announce their support to designate Rainbow Bridge as an International Dark Sky Sanctuary.

Rainbow Bridge is a place that needs protecting, not only for its darkness, but for its cultural importance. The National Park Service has designated Rainbow Bridge a Traditional Cultural Property (TCP), recognizing the site's historic and ongoing cultural significance to at least six American Indian tribes, and establishing its listing in the National Register of Historic Places. Additionally, Rainbow Bridge is the first site in Utah to gain a TCP designation. It only follows that if the site is important during the daytime to cultures of native peoples, that the night time aspects of the area should also be conserved.

Connections with the night sky have been integral to civilizations historically. The original wide screen- the night sky has inspired peoples for millennia. As an important part of history and culture, Rainbow Bridge's incredibly dark skies are an asset worth preserving for the future.

As one of the darkest places in the United States, and the world, the Rainbow Bridge sanctuary would provide a much needed level of protection for the area's night skies. A dark sky sanctuary designation would add protections to the sensitive night time habitat of the area, and inspire other public land areas to take measure to protect their night skies as well.

Thank you.

Bettymaya Foott

Coordinator, Colorado Plateau Dark Sky Cooperative
darkskycooperative@gmail.com
cpdarkskies.org



July 12, 2017

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

Dear Board of Directors,

The Aramark Corporation is pleased to support the nomination of Rainbow Bridge National Monument for the International Dark-Sky Association's Dark Sky Sanctuary designation. As a major concessionaire inside Glen Canyon National Recreation Area and a tour operator at Rainbow Bridge National Monument, we see obvious benefit in both the protection of the natural landscape and Rainbow Bridge and the preservation of the nightscape adjacent to both our lodging and houseboat rental operations.

Many of our guests come to visit this area specifically for unimpeded views of a natural and dark night sky. While it is unlikely that our guests will be inside the Monument after nightfall, we do partner with the National Park Service to host dark skies programming on the grounds of our lodge in the Wahweap District of Glen Canyon National Recreation Area - the most popular ranger-led programming in the park. Along with the Park Service unit at Glen Canyon, we are actively working to retrofitting our lighting inside park borders in support of the park's dark skies initiative and support the work they are doing to inspire visitors to participate in preservation efforts of their own.

The staff of Aramark Corporation at Lake Powell Resort and Marinas work alongside our park-partners to ensure our National Parks and Monuments are protected for future generations. We encourage the board to consider the work that has been done to preserve the nightscape at Rainbow Bridge National Monument and grant the Monument Dark Sky Sanctuary status.

Sincerely,

A handwritten signature in black ink, appearing to read 'Scott McGinn'.

Scott McGinn | Aramark | Regional Vice President - East | Leisure
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United States Department of the Interior

NATIONAL PARK SERVICE

Rainbow Bridge National Monument

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Page, Arizona 86040

(928) 608-6200



Appendix A: Standard Operating Procedure Sky Quality Monitoring at Rainbow Bridge National Monument

This SOP covers the continued monitoring of the sky quality over Rainbow Bridge National Monument, as required by the International Dark-Sky Association for the Monument's certification as a Dark Sky Sanctuary.

Glen Canyon National Recreation Area and Rainbow Bridge National Monument Interpretation Division staff will conduct a sky quality survey and photograph the Monument's horizon at least twice per year; preferably once in the Spring and once in the Fall. The method for each is outlined below.

Conduct a Sky Quality Survey

Using the enclosed worksheet, the surveyor will measure the sky brightness at 14 previously established locations within the Monument using a Unihedron Sky Quality Meter (SQM). The surveyor will hold the device overhead, pointing the photometer at zenith, and click the button. The surveyor will collect four measurements at each waypoint and record them in the grid. The Surveyor will calculate the mean of measurements 2-4 at each location, disregarding measurement 1 as outlined by International Dark-Sky Association's Sky Quality Measurement Guidelines, as the first measurement is often unreliable.

Sky quality measurements will only be taken on a clear night when no moon is present, as light from the moon will deter the accuracy of the Unihedron Sky Quality Meter.

Photograph the Horizon

Each time sky quality measurements are recorded, the surveyor will also take four images of the horizon at Rainbow Bridge National Monument, facing each of North, East, South, and West using a DSLR digital camera. All photographs must be taken on the same settings which will be recorded on the enclosed worksheet. Photographs will be taken from the southern (main) viewing platform directly north of Rainbow Bridge.

Images will be named with the following conventions and stored with a digital copy of the horizon photograph worksheet: RABR_Horizon_Month_Year_Direction_Photographer Last Name

Ex. RABR_Horizon_April_2017_West_Smith

All sky quality measurements and horizon photographs will be maintained for use in annual reporting to the International Dark-Sky Association.

Rainbow Bridge National Monument Sky Quality Survey

Date:

Surveyor Name:

Weather Conditions:

Time Start:

Time Complete:

Waypoint	Lat./Long.	M. 1	M. 2	M. 3	M. 4	Mean of M. 2 through M. 4 (M2+M3+M4)/3=mean
1	N37°04.530' W110°57.598'					
2	N37°04.559' W110°57.644'					
3	N37°04.589' W110°57.670'					
4	N37°04.581' W110°57.710'					
5	N37°04.628' W110°57.798'					
6	N37°04.658' W110°57.786'					
7	N37°04.693' W110°57.827'					
8	N37°04.696' W110°57.861'					
9	N37°04.725' W110°57.959'					
10	N37°04.701' W110°58.000'					
11	N37°04.771' W110°58.093'					
12	N37°04.827' W110°58.105'					
13	N37°04.825' W110°58.141'					
14	N37°04.907' W110°58.259'					

Remember! When calculating measurement mean, disregard M. 1 and calculate the mean of M. 2, M. 3 and M. 4.

Rainbow Bridge National Monument Horizon Photographs

Date:

Weather Conditions:

Time Start:

Time Complete:

Surveyor Name:

Camera Type	
Exposure Time	
Aperture	
Focal Length	
ISO Speed	
Special Editing	

Remember! All photographs must be taken on the same camera settings!