The Bortle Scale

Pedro RÉ
https://pedroreastrophotography.com/

The **Bortle Scale** (Figure 1) is a **nine-level classification system** used in astronomy to **assess the darkness of the night sky** at a specific location, particularly in relation to **light pollution**. Developed by amateur astronomer John E. Bortle in 2001, it helps observers and astrophotographers evaluate how clearly celestial objects can be seen from a given site.

Overview of the Bortle Scale Classes

Class	Sky Quality	Description
1	*Excellent Dark Sky*	Milky Way casts shadows; zodiacal light and airglow visible; no light pollution
2	*Dark Sky*	Milky Way very prominent; minimal light pollution near horizon
3	*Rural Sky*	Some light pollution: Milky Way still shows structure
4	*Rural/Suburban*	Light domes visible; Milky Way less detailed
5	*Suburban Sky*	Milky Way faint or invisible; skyglow dominates
6	*Bright Suburban*	Milky Way only overhead; sky appears greyish-white
7	*Suburban/Urban*	Milky Way invisible; only brightest stars visible
8	*City Sky*	Sky glows orange/white; few stars visible
9	*Inner City Sky*	Only brightest constellations visible; sky glow reaches zenith

The Bortle Scale can be used to:

1. Choose observing sites with low or no Light pollution
2. Plan astrophotography sessions in a given location
3. Advocate dark-sky preservation

The Bortle scale can be estimated by:

1. Observing which celestial objects are visible (*e.g.,* Milky Way, Messier objects…)
2. Using apps like Dark Sky Finder or a Light Pollution Map
3. Measuring sky brightness with a Sky Quality Meter (SQM)

The original publication of the Bortle Scale appeared in the **February 2001 issue of Sky & Telescope magazine**. The article was authored by John E. Bortle and titled: "**Introducing the Bortle Dark-Sky Scale**" (Figure 2).

John Bortle's goal was to provide a practical and intuitive tool for stargazers to assess sky quality—particularly as light pollution increasingly obscures celestial views. The scale quickly gained traction among both amateur and professional astronomers and continues to be widely used today.

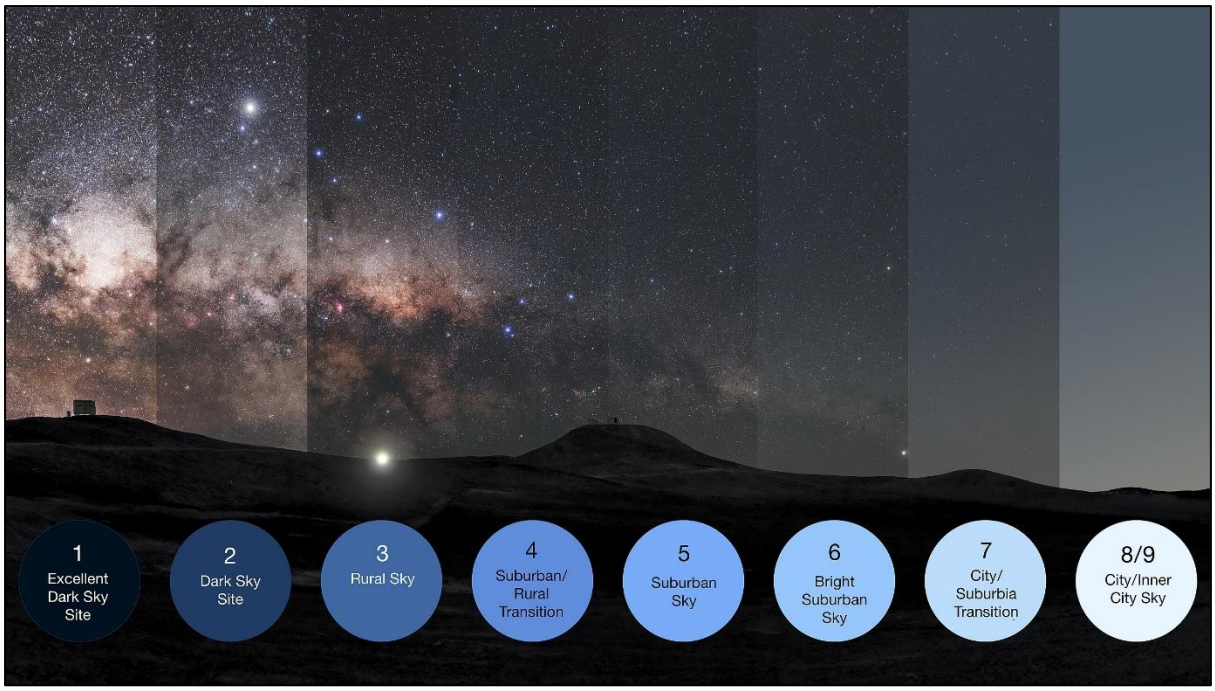

Figure 1 – Bortle Scale, a nine-level classification system used in astronomy to measure the darkness of the night sky.

The Bortle Scale and the Sky Quality Meter (SQM)[1] are two complementary tools used to assess night sky brightness and light pollution levels.

Sky Quality Meters (SQMs) (Figure 3) vary based on field of view, connectivity, and data logging capabilities. All are designed to measure **night sky brightness** in magnitudes per square arcsecond (mag/arcsec²), but they serve different needs—from casual stargazing to professional monitoring.

Main Models by Unihedron[2]

Model	Field of View	Features	Best For
SQM	~84° (wide)	Basic handheld model	General sky brightness checks
SQM-L	~20° (narrow)	Integrated lens for zenith-only readings	Precision measurements at zenith
SQM-LU	~20°	USB connection for real-time data logging	Research, automated setups
SQM-LE	~20°	Ethernet-enabled for remote monitoring	Permanent observatories, networks
SQM-DL	~20°	Data logger with internal memory	Long-term field campaigns

[1] The **Sky Quality Meter (SQM)** is a handheld or mountable device used to **quantify the brightness of the night sky**, especially for assessing **light pollution**. It's widely used by amateur astronomers, astrophotographers, researchers, and dark-sky advocates to measure how dark the sky is at a specific location.

[2] https://unihedron.com/

Introducing the Bortle Dark-Sky Scale

Excellent? Typical? Urban? Use this nine-step scale to rate the sky conditions at any observing site. | **By John E. Bortle**

ILLUSTRATIONS BY JOHN BANCHI (FROM "EXPLORING THE NIGHT SKY" BY TERENCE DICKINSON)

How dark is your sky? A precise answer to this question is useful for comparing observing sites and, more important, for determining whether a site is dark enough to let you push your eyes, telescope, or camera to their theoretical limits. Likewise, you need accurate criteria for judging sky conditions when documenting unusual or borderline observations, such as an extremely long comet tail, a faint aurora, or subtle features in galaxies.

On Internet bulletin boards and newsgroups I see many postings from beginners (and sometimes more experienced observers) wondering how to evaluate the quality of their skies. Unfortunately, most of today's stargazers have never observed under a truly dark sky, so they lack a frame of reference for gauging local conditions. Many describe observations made at "very dark" sites, but from the descriptions it's clear that the sky must have been only moderately dark. Most amateurs today cannot get to a truly dark location within reasonable driving distance. Thus, upon finding a semirural observing site where stars of magnitude 6.0 to 6.3 are marginally apparent to the unaided eye, they believe they have located an observing Nirvana!

Thirty years ago one could find truly dark skies within an hour's drive of major population centers. Today you often need to travel 150 miles or more. In my own observing career I have watched the extent to which ever-growing light pollution has sullied the heavens. In years long past I witnessed nearly pristine skies from parts of the highly urbanized northeastern United States. This is no longer possible.

Limiting Magnitude Isn't Enough

Amateur astronomers usually judge their skies by noting the magnitude of the faintest star visible to the naked eye. However, naked-eye limiting magnitude is a poor criterion. It depends too much on a person's visual acuity (sharpness of eyesight), as well as on the time and effort expended to see the faintest possible stars. One person's "5.5-magnitude sky" is another's "6.3-magnitude sky." Moreover, deep-sky observers need to assess the visibility of both stellar and nonstellar objects. A modest amount of light pollution degrades diffuse objects such as comets, nebulae, and galaxies far more than stars.

To help observers judge the true darkness of a site, I have created a nine-level scale. It is based on nearly 50 years of observing experience. I hope it will prove both enlightening and useful to observers — though it may stun or even horrify some! Should it come into wide use, it would provide a consistent standard for comparing observations. Researchers would also be better able to assess the plausibility of an unusual or marginal observation. All around, it could be a boon to those of us who regularly scan the heavens.

Rate Your Skies

Class 1: Excellent dark-sky site. The zodiacal light, gegenschein, and zodiacal band (*S&T:* October 2000, page 116) are all visible — the zodiacal light to a striking degree, and the zodiacal band spanning the entire sky. Even with direct vision, the galaxy M33 is an obvious naked-eye object. The Scorpius and Sagittarius region of the Milky Way casts obvious diffuse shadows on the ground. To the unaided eye the limiting magnitude is 7.6 to 8.0 (with effort); the presence of Jupiter or Venus in the sky seems to degrade dark adaptation. Airglow (a very faint, naturally occurring glow most evident within about 15 of the horizon) is readily apparent. With a 32-centimeter (12½-inch) scope, stars to magnitude 17.5 can be detected with effort, while a 50-cm (20-inch) instrument used with moderate magnification will reach 19th magnitude. If you are observing on a grass-covered field bordered by trees, your telescope, companions, and vehicle are almost total-

Figure 2 - Introducing the Bortle Dark-Sky Scale, by John Bortle, published in the February issue of Sky & Telescope magazine.

The Bortle Scale and the SQM

Bortle Class	SQM Reading (mag/arcsec²)	Limiting Magnitude	Sky Description
1	21.7–22.0+	7.6–8.0+	Milky Way casts shadows; airglow visible
3	21.3–21.5	6.6–7.0	Milky Way prominent; some light pollution
5	20.0–20.5	5.6–6.0	Milky Way faint; skyglow dominates
7	18.0–19.0	~5.0	Milky Way invisible; only bright stars seen
9	<15.5	<4.0	Sky brightly lit; only planets visible

Figure 3 – Sky quality meters: SQM (left) SQM-L (right).

Bortle Dark Sky Scale Reference

Class 1 - Excellent Dark Sky
SQM: 21.7-22.0+ mag/arcsec²
Limiting Magnitude: 7.6-8.0+
Zodiacal light visible, Milky Way casts shadows, airglow visible on horizon

Class 2 - Typical Dark Sky
SQM: 21.5-21.7 mag/arcsec²
Limiting Magnitude: 7.1-7.5
Milky Way structure visible, zodiacal light evident, M31 visible to naked eye

Class 3 - Rural Sky
SQM: 21.3-21.5 mag/arcsec²
Limiting Magnitude: 6.6-7.0
Milky Way still prominent, some light pollution on horizon

Class 4 - Rural/Suburban Transition
SQM: 20.4-21.3 mag/arcsec²
Limiting Magnitude: 6.1-6.5
Milky Way visible overhead, light domes on horizon

Class 5 - Suburban Sky
SQM: 19.1-20.4 mag/arcsec²
Limiting Magnitude: 5.6-6.0
Milky Way washed out except overhead, clouds brighter than sky

Class 6 - Bright Suburban Sky
SQM: 18.0-19.1 mag/arcsec²
Limiting Magnitude: 5.1-5.5
Milky Way invisible, M31 requires effort, sky grayish

Class 7 - Suburban/Urban Transition
SQM: 16.8-18.0 mag/arcsec²
Limiting Magnitude: 4.6-5.0
Sky noticeably bright, entire sky has grayish cast

Class 8 - City Sky
SQM: 15.5-16.8 mag/arcsec²
Limiting Magnitude: 4.1-4.5
Sky *bright gray/orange, only brightest stars visible*

Class 9 - Inner City Sky
SQM: <15.5 mag/arcsec²
Limiting Magnitude: <4.0
Sky brilliantly lit, only planets and brightest stars visible

Class	Color Key	Naked-eye Limiting Magnitude	Sky Description	Milky Way	Astronomical Objects	Zodiacal Light / Constellations	Airglow and Clouds	Night Time Scene
1		7.6 - 8.0	Excellent, truly dark-skies.	MW shows great detail and light from the Scorpio / Sagittarius region casts obvious shadows on the ground.	M33 (the Pinwheel Galaxy) is a obvious object.	Zodiacal light has an obvious color and can stretch across the entire sky.	Bluish airglow is visible near the horizon and clouds appear as dark blobs againt the backdrop of the stars.	The brightness of Jupiter and Venus is annoying to night vision. Ground objects are barely lit and trees and hills are dark.
2		7.1 - 7.5	Typical, truly dark skies.	Summer MW shouws great detail and has veined appearance.	M33 is visible with direct vision, as are many globular clusters.	Zodiacal light bright enough to cast weak shadows after dusk and has an apparent color.	Airglow may be weakly apparent and clouds still appear as dark blobs.	Ground is mostly dark, but objects projecting into the sky are discernible.
3		6.6 - 7.0	Rural sky.	MW still appears complex, dark voids and bright patches and meandering outline are all visible.	Brightest Globular Clusters are distinct, but M33 is only visible with averted vision. M31 (the Andromeda Galaxy) is obviously visible.	Zodical light is striking in Spring and Autumn, extending 60 degrees above the horizon.	Airglow is not visible and clouds are faintly illuminated, except at the zenith.	Some light pollution eveidnet along the horizon. Ground objects are vaguely apparent.
4		6.1 - 6.5	Rural / suburban transition.	Only well above the horizon does the MW reveal any structure. Fine details are lost.	M33 is a difficult object, even with averted vision. M31 is still readily visible.	Zodiacal light is clearly evident, but extends less than 45 degrees after dusk.	Clouds are faintly illuminated except at the zenith.	Light pollution domes are obviouse in several directions. Sky is noticeably brighter than the terrain.
5		5.6 - 6.0	Suburban sky.	MW appears washed out overhead and is lost completely near the horizon.	The oval of M31 is detectable, as is the glow in the Orion Nebula.	Only nints of zodiacal light in Spring and Autumn.	Clouds are noticibly brighter than the sky, even at the zenith.	Light pollution domes are obviouse to casual observers. Ground objects are partly lit.
6		5.1 - 5.5	Bright, suburban sky.	MW only apparent overhead and appears broken as fianter parts are lost to sky glow.	M31 is detectable only as a faint smudge; Orion Nebula is seldom glimpsed.	Zodiacal light is not visible. Constellations are seen and not lost against a starry sky.	Clouds anywhere in the sky appear fairly bright as they reflect back light.	Sky from horizon to 35 degrees glows with grayish color. Ground is well lit.
7		4.6 - 5.0	Suburban / urban transition.	MW is totally invisible or nearly so.	M31 and the Beehive Cluster are rarely glimpsed.	The brighter constellations are easily recognizable.	Clouds are brilliantly lit.	Entire sky background appears washed out, with a grayish or yellowish color.
8		4.1 - 4.5	City sky.	Not visible at all.	The Pleiades Cluster is visible, but very few other objects can be detected.	Dimmer constellations lack key stars.	Clouds are brilliantly lit.	Entire sky background has an orangish glow and it is bright enough to read at night.
9		4.0 at best	Inner city sky.	Not visible at all.	Only the Pleiades Cluster is visible to all but the most experienced observers.	Only the brightest constellations are discernable and they are missing stars.	Clouds are brilliantly lit.	Entire sky background has a broight glow, even at the zenith.

Figure 5 - Bortle Dark Sky Classification Reference Chart

Sources

- **Bortle, J. E. (2001).** *Introducing the Bortle Dark-Sky Scale*. Sky & Telescope, **101**(2), 126–129. Sky & Telescope
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