The Bortle Scale

Visual Reference for Light Pollution

What you can actually see at each of the 9 Bortle classes — and what to observe at each.

1 2 3 4 5 6 7 8 9

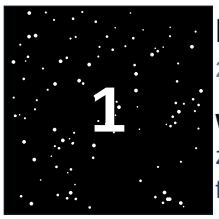
How to use the Bortle scale

John Bortle, an amateur astronomer, published the scale in *Sky & Telescope* in 2001 to give observers a common language for sky quality. It runs from **Bortle 1** (truly dark wilderness skies) to **Bortle 9** (inner-city skies where you can count visible stars on two hands). Every class is defined by what you can actually see — the Milky Way's appearance, the limit of naked-eye stars, how clouds look against the sky.

Use this guide to figure out two things: (1) **what to expect from your home backyard** tonight, and (2) **which targets are realistic** at your sky quality. Galaxies and dark nebulae need Bortle 4 or better to be enjoyable. Bright nebulae and most narrowband targets work down to Bortle 6. Doubles, variables, the Moon, and planets are unaffected by light pollution — those work at any Bortle class.

SQM (Sky Quality Meter) readings in mag/arcsec² are the objective measurement: bigger number = darker sky (each magnitude = 2.5× darker). 22.0 is the natural limit; 16-17 is inner urban. Many smartphone apps now read out an estimate.

The 9 classes



Bortle 1 · Excellent Dark Sky

21.7-22.0 mag/arcsec² · *Observatory class*

What you see The Milky Way casts visible shadows. The zodiacal light, gegenschein, and zodiacal band are all visible. Many constellations are barely recognizable due to overwhelming faint star count. Naked-eye limit ≥ 7.6.

Where to find this Almost extinct in populated parts of any continent. Found in remote desert regions (Atacama in Chile, Namib in Namibia, parts of Outback Australia), high-altitude observatory sites (Mauna Kea, Cerro Paranal), arctic wilderness, and the most remote international Dark Sky Reserves.

Best targets Anything in any catalog. Faint integrated flux nebulae become realistic broadband targets. The Milky Way reveals dust lanes and dark structures with the naked eye.

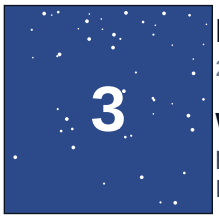
Bortle 2 · Typical Truly Dark Site

21.5-21.9 mag/arcsec² · *Remote rural / dark-sky preserve*

What you see Milky Way still shows complex structure. Zodiacal light bright. Clouds are dark holes against the sky. Most observers think this looks 'as dark as it gets'. Naked-eye limit 7.1-7.5.

Where to find this Internationally recognized dark sky preserves: Cherry Springs (PA), Big Bend (TX), Death Valley (CA), Mont-Mégantic (QC), Jasper (AB), Aoraki/Mackenzie (NZ), NamibRand (Namibia), Pic du Midi (France), Brecon Beacons (Wales), Galloway Forest (Scotland), Westhavelland (Germany). Worth a 3–4 hour drive once a year.

Best targets Faint galaxies (Stephan's Quintet), low-surface-brightness nebulae (Veil with no filter), dark nebulae against the Milky Way. Anything in any catalog.



Bortle 3 · Rural Sky

21.3-21.7 mag/arcsec² · *Rural communities, low light dome*

What you see Milky Way appears bright with detail. Zodiacal light visible in spring/fall. Light pollution domes visible only on the horizon. M33 visible naked-eye with averted vision. Naked-eye limit 6.6-7.0.

Where to find this Small rural towns far from any major metro area. Generally found 50+ km from any town of 5,000+ people. Common in agricultural regions (US Plains, Canadian Prairies, Australian outback fringe, much of rural Europe away from population centers).

Best targets All Messier objects, most NGC galaxies, narrowband nebulae easily, faint emission nebulae with filters. Dark nebulae work but with reduced contrast.

Bortle 4 · Rural / Suburban Transition

20.8-21.3 mag/arcsec² · *Edge of suburbs, small town centers*

What you see Milky Way visible but lacks fine detail above horizon. Light domes evident. M33 a difficult averted-vision target. Clouds in the direction of light sources are noticeably bright. Naked-eye limit 6.1-6.5.

Where to find this Outer-ring suburbs of major cities, small towns (20–50,000 population), rural exurbs. The transition zone where you can still see the Milky Way but light pollution is becoming obvious.

Best targets Most Messier objects, brighter NGC, narrowband emission nebulae, dark nebulae with high opacity (B33, B86, B92). Faint galaxy challenge.

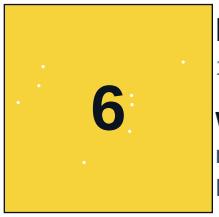
Bortle 5 · Suburban Sky

20.0-20.8 mag/arcsec² · *Average suburban backyard*

What you see Milky Way very weak or invisible near horizon, washed out at zenith. Light pollution evident in most directions. Light clouds anywhere in the sky are noticeably brighter than the dark sky. Naked-eye limit 5.6-6.0.

Where to find this Typical suburban backyard within 10–30 km of any major city. Most North American, European, Australian, and Asian suburbs. Where most amateur astronomers actually observe from.

Best targets Bright Messier objects, narrowband emission, planetary nebulae, double stars, variables, the Moon and planets. Galaxies and dark nebulae become difficult.



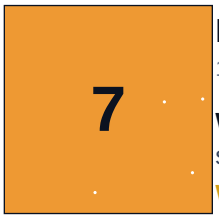
Bortle 6 · Bright Suburban Sky

19.1-20.0 mag/arcsec² · *Inner suburbs*

What you see Milky Way invisible from anywhere except possibly near the zenith on the best nights. Sky within 35° of horizon glows grayish-white. Reading paper without aux light is possible. Naked-eye limit 5.1-5.5.

Where to find this Inner suburbs and smaller cities — denser residential areas with significant local lighting. Examples: outer boroughs of NYC, the M25 ring around London, central Sydney suburbs, mid-sized European cities.

Best targets Brightest Messier (M31, M42, M45), planetary nebulae with OIII filter, narrowband emission with a dual filter, doubles, variables, lunar/planetary. Forget galaxies and dark nebulae.



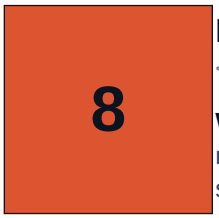
Bortle 7 · Suburban / Urban Transition

18.0-19.1 mag/arcsec² · *Outer city / dense suburb*

What you see Sky background appears grey/orange/yellow over much of the sky. Strong light sources evident in all directions. The Milky Way is invisible. Naked-eye limit 4.6-5.0.

Where to find this Outer urban areas — dense neighborhoods within major metropolitan regions but not the central core. Examples: Brooklyn or Queens in NYC, outer London zones, Berlin outskirts, Greater Tokyo periphery.

Best targets Moon and planets, bright doubles, brighter variables. M42 and M45 still rewarding. Narrowband imaging still works for bright targets like the North America Nebula. Dual-narrowband filters extend OSC reach.



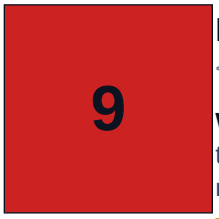
Bortle 8 · City Sky

<18.0 mag/arcsec² · *Inner city*

What you see Sky background bright orange-grey throughout. Even bright constellations missing many of their stars. Major asterisms (Big Dipper, Orion's belt) are obvious but the surrounding stars are washed out. Naked-eye limit 4.1-4.5.

Where to find this Inner-city neighborhoods of major metropolitan areas worldwide. Manhattan residential districts, central London, downtown Tokyo, Paris within the périphérique, downtown Sydney, downtown Toronto, central Mexico City.

Best targets Moon, planets (especially good detail with stable seeing), brightest doubles (Albireo, Mizar, Castor). The Pleiades. Narrowband imaging still possible for very bright Hα targets if you can put up with bright background.



Bortle 9 · Inner City Sky

<17.5 mag/arcsec² · *Heart of major metropolis*

What you see Most of the night sky is bluish-orange. Only the brightest planets, the Moon, and the brightest stars (about 50 total) are visible. Many people have never seen the Milky Way and never will from where they live. Naked-eye limit < 4.0.

Where to find this The most light-polluted entertainment and commercial districts on Earth. Times Square (NYC), Las Vegas Strip, Shibuya/Shinjuku (Tokyo), Piccadilly Circus (London), Hong Kong Central, Dubai downtown. Anywhere with billboards and intense local lighting.

Best targets Moon, planets, the very brightest stars and one or two bright doubles. This is when you observe the Sun in white light or chase the ISS.

Practical advice

Travel pays off

Each Bortle level is a 2.5× darkening of the sky background — moving from Bortle 6 to Bortle 4 means objects appear roughly 6× higher contrast. A 90-minute to 2-hour drive from a typical metropolitan suburb (B6/7) to a designated dark sky preserve (B2) is the difference between 'I can see M31's core' and 'I can see M33 with averted vision' — the impact is dramatic and worth the trip.

Filters extend reach

An OIII filter brings planetary nebulae and emission nebulae back to life under suburban skies. A dual-narrowband filter (Hα + OIII) extends one-shot color cameras into B6 territory for emission targets. Light pollution filters (broadband UHC) help narrowband visual but won't recover galaxies.

Time of night matters

Light pollution is worst before midnight when commercial lighting is at full brightness. After 1 AM, many cities reduce street lighting. The 2-4 AM window often reads 0.3-0.5 magnitudes darker than 9 PM at the same site.

Moon phase matters more than you think

Even a Bortle 2 site looks like Bortle 5 when the Moon is up. A 50% moon adds about 1 Bortle class of skyglow. Plan deep-sky imaging for the moonless 10 days each month around new moon.

Apps and websites for sky quality

Light pollution maps: **lightpollutionmap.info** (clickable VIIRS satellite data), **darkskymap.com**. SQM apps: **Loss of the Night** (citizen science), **Dark Sky Meter** (iOS). Trip planning: any of the dark-sky-preserve directories.

Bortle 4 is the sweet spot

If you can find a Bortle 4 site within driving distance, you've solved 90% of the light pollution problem. Galaxies and dark nebulae become accessible, narrowband works for everything, and the Milky Way returns. The jump from 4 to 2 is incremental; the jump from 6 to 4 is transformative.