



## Light Pollution Project and Lab-Activities

### Activity I: The Globe at Night Program and Citizen Science<sup>1</sup>

Quantifying light pollution is the first step towards addressing the problem. A common metric used to quantify light pollution is “sky brightness” and it means exactly that – how bright is the sky? Astronomers measure brightness in funny units called “magnitudes”, and the unit for sky brightness is “mag/arcsec” – how much light is the sky emitting per square arc-second?

*(Note: A full circle has 360 degrees; each degree is divided into 60 arc-minutes; and each arc-min is further divided into 60 arc-second)*

The most popular device used to measure ‘sky brightness’ is manufactured by *Unihedron*<sup>2</sup> and is called a “Sky Quality Meter”. The handheld version is relatively easy to use and costs about \$140 (though they are available at a discounted rate of about \$100 through IDA-Missouri). Not everyone has a handheld SQM though, and so dark sky advocates have come up with other means of estimating and measuring the sky brightness.

#### **Aims:**

- a) Estimating the limiting magnitude at your location to quantify the level of light pollution using the faintest visible stars in the sky and,
- b) Learning how to use the Globe at Night (GaN) website to submit your data and participate in Citizen Science.

#### **Materials:**

1. Access to internet on desktop computer or smartphone,
2. Headlamp (red lights)
3. Warm clothes, hand-warmer

#### **Safety:**

1. **Always scout out a location during the day before venturing there at night.**
2. **Always be aware of your surroundings and be safe whilst doing nighttime measurements.**
3. **Make sure someone knows where you are at any given time. Have a protocol about periodic check-ins (text message or phone call every 15 minutes etc., especially if you are going to a relatively new location).**

#### **Procedure:**

Go to the GaN website (<https://www.globeatnight.org/6-steps.php>), and read the “6-steps”.

The first few steps below are best done on a desktop or laptop computer (tablets might be okay, but smartphone screens are too small for efficient use of the resources).

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<sup>1</sup> Adapted from [https://www.globeatnight.org/resources/GaN2021\\_ActivityGuides\\_English\\_N/GaN2021\\_ActivityGuide\\_Cygnus\\_English.pdf](https://www.globeatnight.org/resources/GaN2021_ActivityGuides_English_N/GaN2021_ActivityGuide_Cygnus_English.pdf)

<sup>2</sup> <http://www.unihedron.com/projects/darksky/>

- We will identify particular constellations that are listed on the webpage for this time of the year (for example, for August, September, and October: Cygnus and/or Pegasus).
- The “magnitude chart” for Cygnus is provided later in this handout. Print his out (you should be able to use the printer at the local county library).
- Now head out to your chosen location at the appropriate time. Check the weather and decide if it is worth making an observation, or if you need additional warm clothing etc. Make sure you have your phone, headlamp, sky-chart, and other supplies you might need (SAFETY FIRST!).
- From your location, identify the directions (North, South etc.). Orient yourself in a manner that is most comfortable for you, preferably looking away from the “bright side” of the sky.
- Take some time to settle down (let your eyes get adjusted to the sky), avoid looking at any bright lights, and then look at the sky.
- Identify some of the prominent constellations, and make sure you have identified your target constellation (say, Cygnus or Hercules) correctly.
- Identify prominent stars like Arcturus (Bootes), Deneb (Cygnus), Vega (Lyra) etc. If you are not familiar with the night sky, it might be a good idea to first attend a local star party, or consult with the local astronomer at a nearby school.
- Choose which of the pictures from Fig II best match the sky around Hercules from your location.
- Note down the sky conditions (clear, partly cloudy etc.) and note down your location, date and time.
- Click on the ‘Globe at Night Report page’ in step 3 – open it in a new tab (<https://www.globeatnight.org/webapp/>, see Figure I).
- Finally, enter in your observations into the GaN website (see Figure I below).

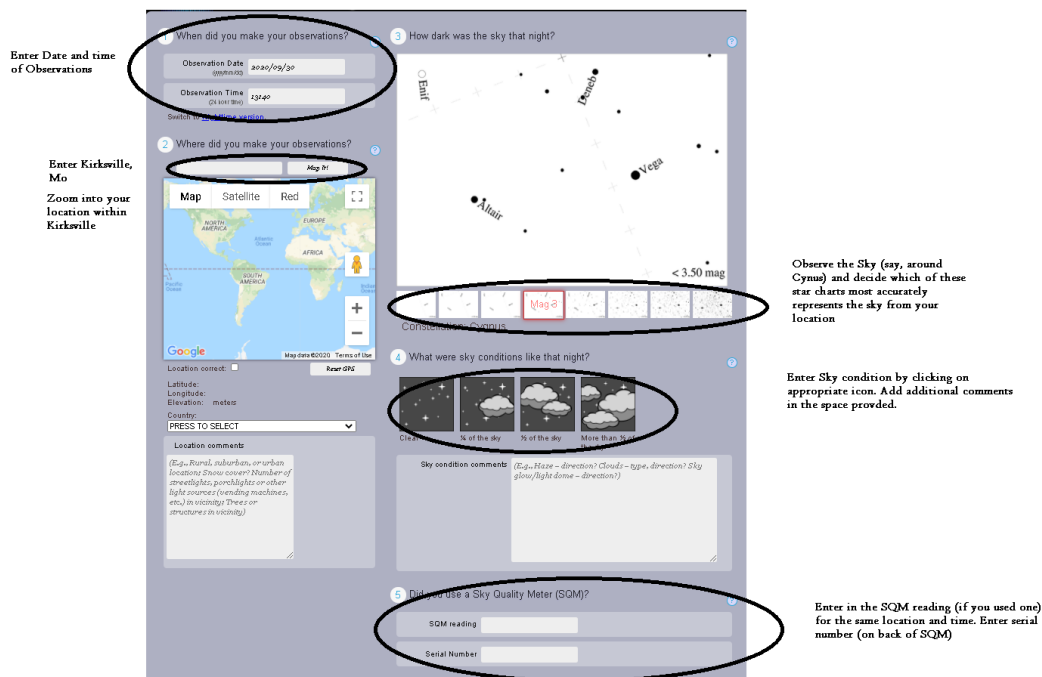


Figure I: The web interface for entering observations on the GaN website.

## Observations

Determine the “limiting magnitude” based on your GaN measurements. That is, if you decide that the third sky-chart in Figure II below best represents the sky you are seeing from a particular location at a particular time, then the limiting magnitude is 2.50. That is, stars brighter than magnitude 2.50 are visible from that location.

Notes:

- a. It is advisable to make these measurements after your eyes have “dark adapted”. Wait about 5 minutes (at least, preferably 10 minutes) in the dark to let your eyes get dark adapted.
- b. We also recommend that, if possible, have a friend or family member accompany you and have them do these same measurements independently. This will serve as a reality check, and if you disagree, you can average your “readings” and submit the average on the GaN app or website.
- c. If you have access to a hand-held SQM (see Activity V in the “Extra Activities” document), then enter your SQM reading in the appropriate space (handheld SQMs do not have a serial number so you can ignore that entry).

**Congratulations! You are a citizen-scientist and you just submitted your first science observations!!**

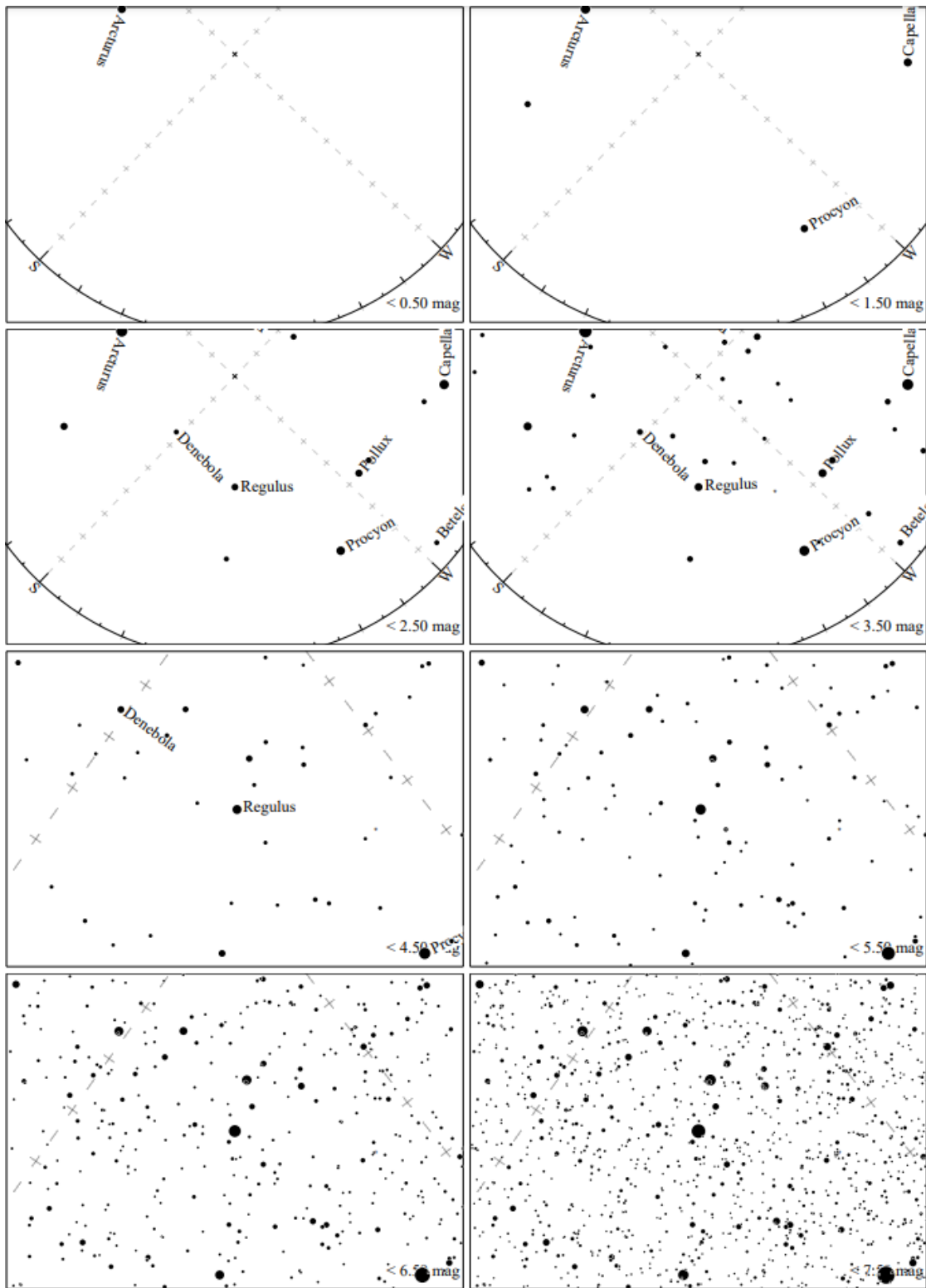


Figure II: Map of Leo for the Globe at Night measurement for latitude  $40^\circ$ . Maps are freely available here: <http://amper.pcd.muni.cz/jenik/astro/maps/GaNight/2024/> [Make sure you select the appropriate latitude,  $40^\circ$  degrees is appropriate for most of Missouri].

## Activity II: Dark Sky Home Assessment<sup>3</sup>

The first step towards doing something about outdoor lighting is to look at your own habits and behaviors and see if there is room for improvement. The International Dark-Sky Association has developed a program called "Dark Sky Friendly Home Lighting Program" which walks you through the steps of assessing your own home (or park building or business office) in terms of the outdoor fixtures you have, and whether these need to be replaced or modified to be "dark sky friendly". It is good first step, and it is an intuitive, straight-forward process that you can easily involve your spouse or child and even your neighbors in.

There are the steps to the process of getting your home certified as "dark sky friendly":

- a. Take an inventory of all your outdoor lighting and answer the five questions below for each light.
- b. Use the DSFH inventory form on the next page to keep a record of your inventory.
- c. Submit your results via the self-certification form at:  
<https://idsw.darksky.org/activities/nightskyathome/dark-sky-friendly-home-lighting-program-self-certification-form/>
- d. Download and display a free Dark Sky Friendly Home certificate!

The FIVE principle Questions to help you make your assessment are:

### **1. Does the Light Serve a Clear and Necessary Purpose?**

If you find that lights on your property are not necessary or useful, remove or disable them so that they are not accidentally turned on

### **2. Does the Light Fall Only Where it is Needed?**

Direct the light down, not up into the sky. Target fixtures so light does not spill beyond where it is needed. The light source should not be visible from beyond your property.

### **3. Is the amount of light appropriate for the intended task?**

Use the lowest lighting level needed to perform the task. Light levels are measured in lumens, so check your light source and use the lowest lumens possible.

### **4. Is the light connected to active controls?**

All outdoor lighting should be connected to a light switch, timer, and/or motion sensor so they are used only when needed.

### **5. Is the light source warm in color?**

Most light bulbs manufactured today have a Kelvin rating printed on the bulb. Kelvin ratings 3000<sup>+</sup> or less are considered warm and generally emit less harmful blue light than high Kelvin. For home lighting, there are good options at 2700 Kelvin or less.

### Notes:

- *Take the recommended action below each question for any "no" response.*
- *After the appropriate actions are taken and you can answer "yes" to all the questions, record the date any necessary actions were taken.*
- *Submit your results via the self-certification form at [idsw.darksky.org/activities/nightskyathome/dark-sky-friendly-home-lighting-program-self-certification-form/](https://idsw.darksky.org/activities/nightskyathome/dark-sky-friendly-home-lighting-program-self-certification-form/)*
- *Download and display a free Dark Sky Friendly Home certificate!*

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<sup>3</sup> <https://idsw.darksky.org/activities/dark-sky-friendly-home/>

<sup>4</sup> IDA has updated this requirement, based on latest research by scientists in the field: a Kelvin rating of about 2200 K or lower is to be preferred. Of course 3000 K is better than, say, 5000 K but we recommend you aim for close to 2200 K.



Fixture Description	Principle					5 Notes	Action Needed	Date Action Completed
	1	2	3	4	5			
example Front Porch	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Spills into neighbors yard	Need to re-aim light to fall only on stairs	
1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
9	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			

**PRINCIPLES:** 1. Does the light serve a clear purpose? 2. Does the light fall only where it is needed? 3. Is the amount of light appropriate for the intended task? 4. Is the light connected to active controls? 5. Is the light source warm in color?

Produced by The International Dark-Sky Association. April 2020. www.DarkSky.org

Note: Low-level lighting solar pathway lights do not need to be included in this inventory

*Table I: Inventory form to record your observations of outdoor lights and light fixtures for your home assessment.*

## The International Dark Sky Places Program<sup>5</sup>

The International Dark Sky Places (IDSP) Program was founded in 2001 to encourage communities, parks and protected areas around the world to preserve and protect dark sites through responsible lighting policies and public education.

The International Dark Sky Places Program offers five types of designations:

1. **International Dark Sky Communities:** Communities are legally organized cities and towns that adopt quality outdoor lighting ordinances and undertake efforts to educate residents about the importance of dark skies.
2. **International Dark Sky Parks:** Parks are publicly- or privately-owned spaces protected for natural conservation that implement good outdoor lighting and provide dark sky programs for visitors.
3. **International Dark Sky Reserves:** Reserves consist of a dark “core” zone surrounded by a populated periphery where policy controls are enacted to protect the darkness of the core.
4. **International Dark Sky Sanctuaries:** Sanctuaries are the most remote (and often darkest) places in the world whose conservation state is most fragile.
5. **Urban Night Sky Places:** UNSPs are sites near or surrounded by large urban environs whose planning and design actively promote an authentic nighttime experience in the midst of significant artificial light at night, and that otherwise do not qualify for designation within any other International Dark Sky Places category.

Details about each of these programs can be found here: <https://www.darksky.org/our-work/conservation/idsp/>  
We will focus on the “Dark Sky Parks” and the “Urban Dark Sky Community” programs in our workshop.

<sup>5</sup> <https://www.darksky.org/our-work/conservation/idsp/>