Dark Skies for Everyone!
Citizen Scientist Programs that Shed Light on Light Pollution

by Connie Walker[1]

The arc of the Milky Way seen from a truly dark location is part of our planet's cultural and natural heritage. The ongoing loss of dark night skies for much of the world's population, caused by light pollution, is a serious and growing issue that impacts the economy, ecology, energy conservation, human health, public safety and our shared ability to see the night sky. According to the United Nations, 2008 is the first year in which over half of the world's population (some 3.3 billion people) lives in cities. As urban environments grow, so do their impact on the global environment.

For the International Year of Astronomy (IYA2009) Cornerstone Project on Dark Skies Awareness, partners in dark-sky, astronomy and environmental education have collaborated to promote three main citizen-scientist programs that measure light pollution at a local level. These programs take the form of "star hunts" or "star counts", providing people with a fun and direct way to acquire heightened awareness about light pollution through first-hand observations of the night sky. Together the three programs will span the entire year:

- How Many Stars? (Jan., Feb., April – Sept., Nov., Dec. 2009)
- GLOBE at Night (March 16–28, 2009)
- Great World Wide Star Count (October 9–23, 2009)

In this chapter, the activities to carry out the three star-hunting programs are provided along with background materials on light pollution, a light pollution and shielding demonstration, scaffolding activities to do before the star-hunts and capstone activities to do after. More information about these and other Dark Skies Awareness programs can be found at http://www.darkskiesawareness.org.

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[1] NOAO manager of GLOBE at Night and chair of the IYA2009 Dark Skies Awareness Cornerstone Project. NOAO is the National Optical Astronomy Observatory. NOAO is operated by the Association of Universities for Research in Astronomy (AURA) under cooperative agreement with the National Science Foundation.

How You Can Participate in the Star-Hunting Programs

The three star-hunting or star-counting programs are fun citizen-science activities that encourage everyone — students, educators, amateur astronomers and the general public — to measure the darkness of their local skies and contribute their observations online to a world map. From 2006-2008, these programs successfully conducted campaigns in which more than 35,000 observations were submitted from over 100 countries.

During the IYA2009, citizen-scientists are taking data on light pollution levels by comparing what they see within designated constellations, with star maps showing progressively fainter stars. The idea is that anyone from anywhere in the world at the same time of year can look within the constellation for the faintest stars and match them to one of seven star maps. For more precise measurements, digital sky-brightness meters can be used.

All anyone needs is his/her location, time, date and naked-eye and/or meter measurements. Measurements are submitted online from around the globe, and within a few days to weeks a world map showing the results is available. These measurements can be compared with data from previous years, as well as with satellite data, population densities, and electrical power-usage maps. Measurements are available online via Google Earth or other tools and as downloadable datasets. Data from multiple locations in one city or region are especially interesting, and can be used as the basis of a class project or science fair experiment, or even to inform the development of public policy.

The five simple steps for participating in the programs are listed in this chapter
To learn more about these and to obtain important information on light pollution, stellar magnitudes, the location of the constellation, your location in terms of latitude and longitude, and using a sky brightness meter, see the web pages for the star-hunting programs listed in this chapter. Downloadable activity packets are available as well.

Join tens of thousands of other citizen-scientists around the globe hunting for stars during the International Year of Astronomy 2009! Take part in this international campaign to preserve and observe the nighttime sky! Be part of a local solution to a global problem.

Shown above are 6,800 observations from the 2008 event.
Help us exceed these numbers in 2009!

Five Simple Steps to Naked-Eye Observing with the 3 Star Hunting Programs

Helpful information supporting all of the steps can be found on the websites for the programs listed in the table, as well as observing forms and activity guides.

Program & Website	Time of Year	Constellation
How Many Stars…? http://hms.sternhell.at	Jan., Feb., April–Sept., Nov., Dec.	Little Dipper (north of Casablanca, Cairo, Delhi, Shanghai, L.A. & Atlanta)
	Jan., Feb., April, May, July–Sept., Nov., Dec.	Orion's Belt
GLOBE at Night http://www.globe.gov/GaN	March 16–28, 2009	Orion (best viewed: south of Greenland, Olso, Stockholm, Helsinki, Magadan & Anchorage; north of the Antarctic coast)
Great World Wide Star Count http://www.starcount.org	October 9–23, 2009	Cygnus in the Northern Hemisphere; Sagittarius in the Southern Hemisphere

1. From the table above, determine what time of year, what star hunting program and what constellation to use.

2. Make sure you have a clear, dark and moonless night sky. How long you need to wait for a dark sky depends on your location and time of year. To find out, see *www.sunrisesunset.com/*. For GLOBE at Night and Great World Wide Star Count, measurements can be made until moonrise (e.g., before 10pm).

3. Match the stars you see within the constellation with 1 of 7 "magnitude" charts.

4. Report your choice of magnitude chart (1 – 7) on the program's website along with the date & time of observation and the location you took your observation. The websites help you submit your location in terms of latitude and longitude.

5. View the resulting map from this international event.

Hints:

- Avoid places with nearby direct lighting, such as streetlights.
- If you want to shine light on these instructions or the observing form, use a flashlight with a red balloon, red cellophane, a thin brown bag, or your hand to cover the light.
- Before observing, you should give your eyes time to adapt to the dark.
- Multiple observations are encouraged from different locations.

Star-light, Star-bright, Measure Sky Brightness with a Meter Tonight!

Sky-brightness meters provide a more precise method to measure the night-sky brightness. The GLOBE at Night and the How Many Stars…? programs offer opportunities to use meters to make these more objective measurements.

HOW MANY STARS...?

Newly developed light meters will continuously measure the night sky brightness at 1000 locations around the globe to monitor changes and provide an unbiased reference for the naked-eye measurements within constellations. Adopt a light meter and record the brightness of the night sky in your city, at your school or at your observatory. You need: (1) a computer with USB and Windows XP/NT/2000. (2) A place with a good view of the sky within 20 meters of the computer. (3) About 100 € for the light meter. Contact Verein@Kuffner-Sternwarte.at to adopt a starlight meter! For more information, visit http://wiki.sternhell.at.

GLOBE AT NIGHT

The low-cost, hand-held, digital Sky Quality Meters (SQM) (about 60 to 100 €, depending on how many purchased), manufactured by Unihedron of Canada (www.unihedron.com), are used to make a highly repeatable, direct measurements of night-sky brightness. The SQM model has an almost all sky view for use in rural areas. The second-generation (SQM-L) has a narrower "field of view" for use in city environments, where surrounding lights or buildings may affect the readings. For a project, you can imagine students canvassing a city with SQMs, centered on a How Many Stars meter at their school. For information about the SQM program and suggestions on taking measurements, visit http://www.globe.gov/GaN/learn_SQM.html.

Why Monitor the Night Sky Brightness?

Your help in taking meter and/or naked-eye measurements this year and over the next few years will allow for more in-depth analysis. More measurements within a city or more rural area will provide maps of higher resolution. Comparisons between years would allow people to monitor changes. Monitoring our environment will allow us as citizen-scientists to identify and preserve dark sky oases in cities or catch an area developing too quickly and influence people to make smart choices in lighting. Monitoring our environment might allow us to track the habitats of animals endangered by over-lighting. …If more and more people took a few minutes during any of the three campaigns to measure sky brightness toward one of the designated constellations with the naked-eye or toward zenith with a digital meter (or both!), their measurements will make a world of difference.

…Happy star-hunting!

Demonstrating Light Pollution and Shielding

This demonstration is one of the best illustrations of the effects of light pollution on our view of the night sky and how shielding lights can reduce upward lighting and direct the light to where it is needed. This demonstration is adapted from an activity on the Paper Plate Education website: http://analyzer.depaul.edu/paperplate/lights.htm.

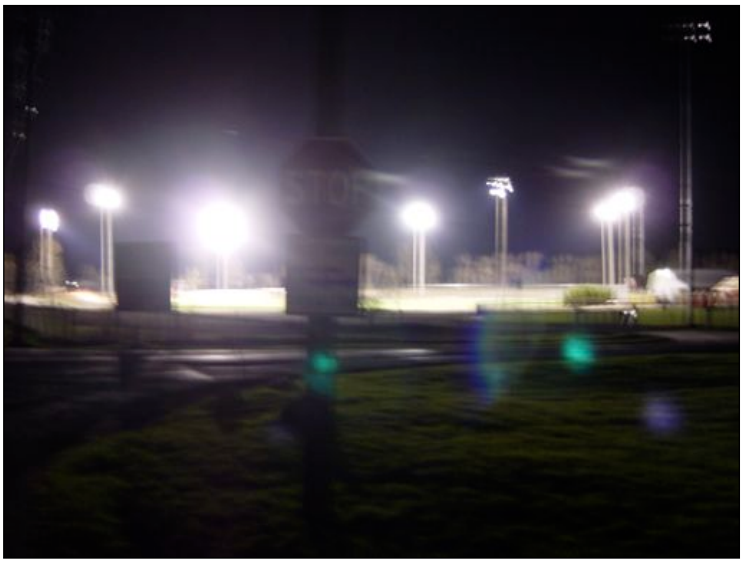
Materials

- Two "Mini-lights" (such as the mini Maglite flashlight)
- A paper cube planetarium (cardboard cube with small hole on one side and pinhole "stars" on the opposite side) – see the template for the paper cube in this chapter.
- PVC cap or other items to act as shields (a black exterior and white interior preferred)
- A map of a town or a white surface
- Optional – figurines and/or matchbox cars
- Optional – picture book with landscapes or city scenes, such as "There Once Was A Sky Full of Stars" by Bob Crelin

Background – Light Pollution

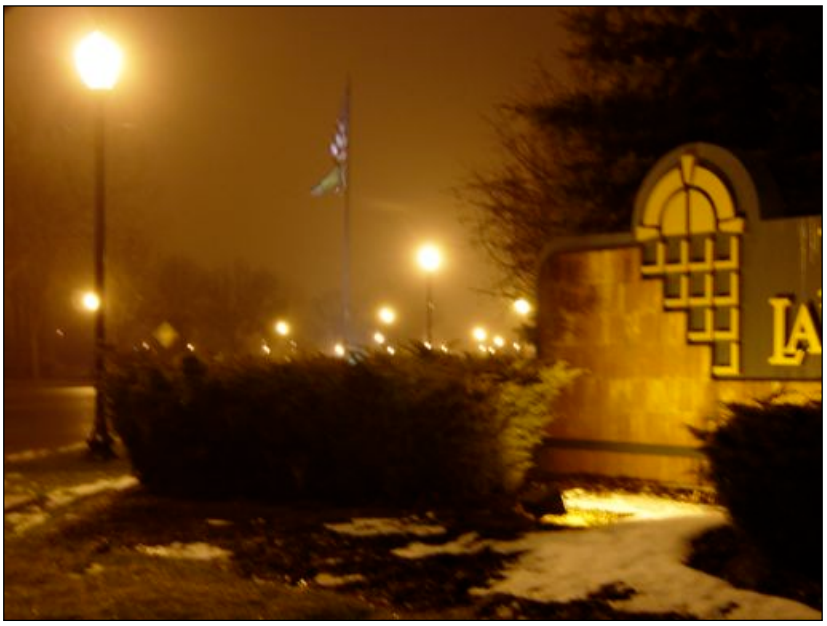
There are three main types of light pollution:

- *Glare* is too much background light. Can you see the stop sign or read the sign below it in this image?



- *Light trespass* is light that spills into an area where it is unwanted. Would you be able to sleep if your bedroom window faced this neighbor's light?

- *Sky glow* is lots of light scattering off particles in the air, giving the appearance of a glowing sky. Do you see any stars in this image?



These images, as well as others illustrating the effects of different types of lighting, can be found on the *Nightwise* website: http://www.nightwise.org/examples.htm
More background on light pollution can be found on the *GLOBE at Night* website: http://www.globe.gov/GaN/learn_light.html.

Background – Lighting

Quality lighting should:

- Maximize the desired effects:
  - Good vision
  - Good night ambiance

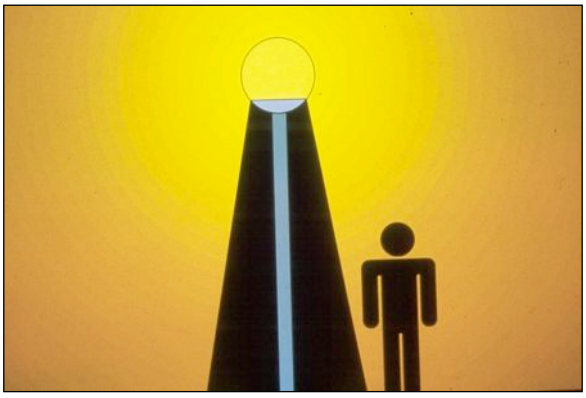
- Minimize the adverse effects:
  - Energy waste
  - Glare
  - Light trespass
  - Sky glow

Keys to quality lighting:

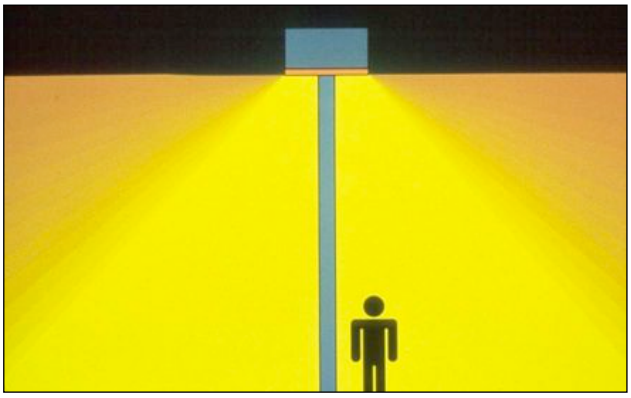
- See the effect, not the source.
- Shine the light down.
- No glare.
- Light only where and when needed.
- Don't over-light.
- Use energy efficient sources.

Shielding can maximize the desired effects of lighting by controlling the light output and minimizing the glare, light trespass, and light that travels straight up, as illustrated below.

Unshielded fixture

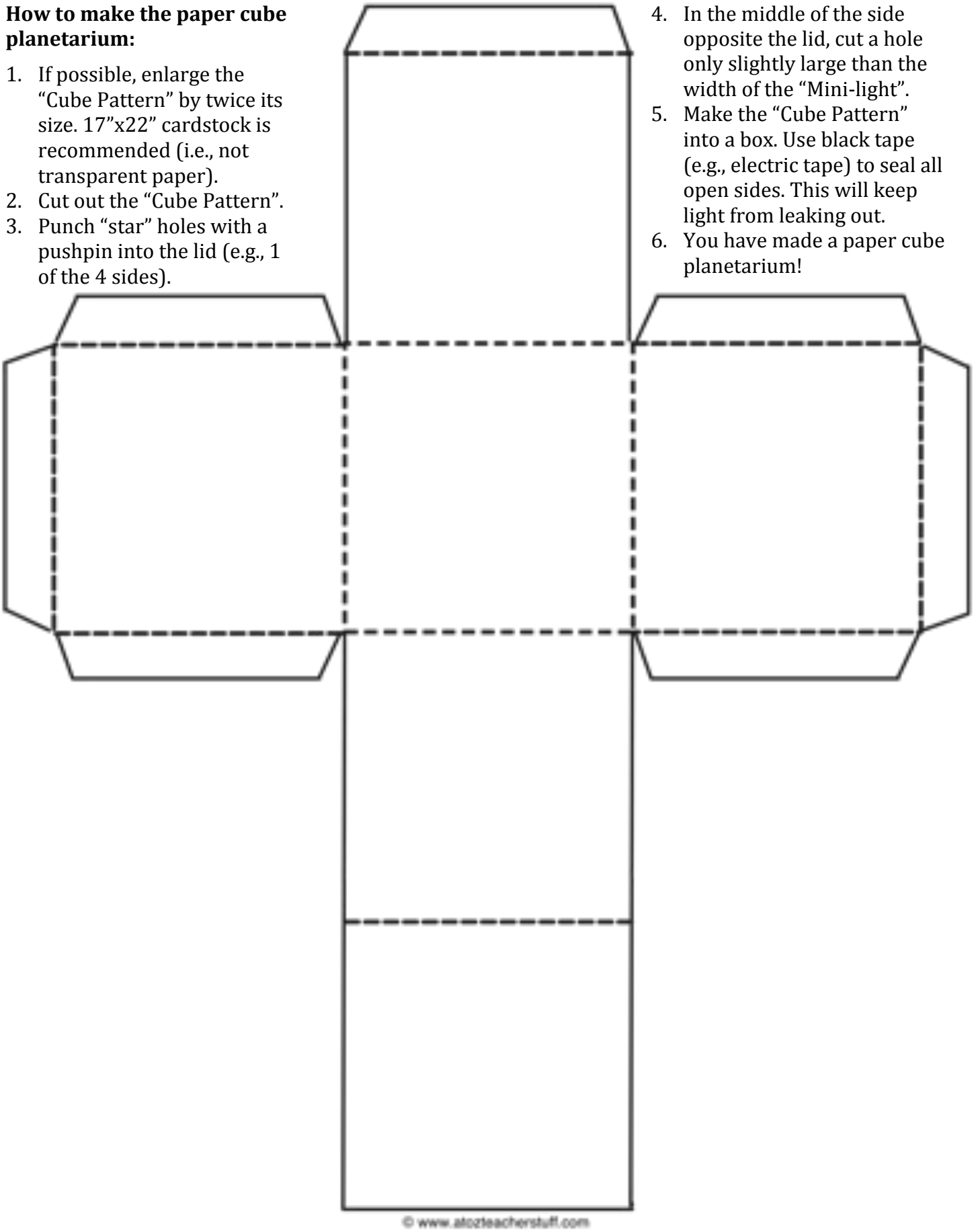


Shielded fixture



How to make the paper cube planetarium:

1. If possible, enlarge the "Cube Pattern" by twice its size. 17"x22" cardstock is recommended (i.e., not transparent paper).
2. Cut out the "Cube Pattern".
3. Punch "star" holes with a pushpin into the lid (e.g., 1 of the 4 sides).
4. In the middle of the side opposite the lid, cut a hole only slightly large than the width of the "Mini-light".
5. Make the "Cube Pattern" into a box. Use black tape (e.g., electric tape) to seal all open sides. This will keep light from leaking out.
6. You have made a paper cube planetarium!



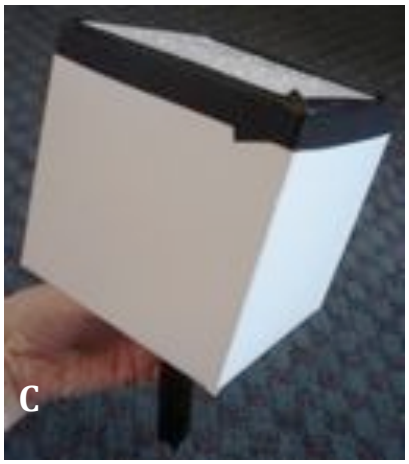
Doing the Light Pollution and Shielding Demo


A

- Make sure you are in a very dark room with a low ceiling. Set up the activity on a table with a white surface.
- If you'd like to include a landscape or city scene as part of the demo, prop open the book to the page with the desired illustration (A).


B

- Unscrew the reflectors from both "Mini-lights" and turn on one of them ("candle mode"). You can use the reflector ends as a base to stand the lights on the table (B).
- Place the bulb top of the "Mini-light" barely into the big hole at the bottom of the paper cube (C).
- With the room lights off, project the "stars" from the white paper cube onto the ceiling. Observe how many stars you can see and how bright they appear. If you are doing this activity outside, use a white surface (e.g., a posterboard) to project the stars onto.


C

- Using the second "Mini-light" as a "street light", place it on the table (in front of the landscape if you are using it) and turn it on (D).
- What do you notice about the number of stars?
- Now place the PVC cap (or another shield) above the 2nd "Mini-light" to represent a shielded streetlight (E).
- What differences do you notice with and without the shield? How is your view of the stars affected? How does the lighting of the area directly under the lamp change?


D


E

Wrap Up

Discuss your observations and the benefits of shielded lighting. Note that shielded lighting improves our view of the stars (reduces sky glow), and is safer and more energy efficient, since it directs light down to the ground, where we want lighting rather than up into the sky. This improves the quality of life for people, animals, and plants; saves money and energy; and preserves our beautiful dark skies.

You may want to encourage participants to take part in citizen science projects to measure light pollution (see resources below) and to write letters to the local newspaper, government, and businesses to encourage the installation of shielded lighting in their community.

Resources

- IYA 2009 Dark Skies Awareness website – http://www.darkskiesawareness.org
- GLOBE at Night - http://www.globe.gov/GaN
- Great Worldwide Star Hunt - http://www.starcount.org
- How Many Stars? - http://www.sternhell.at
- International Dark Sky Association - http://www.darksky.org/
- Nightwise - http://www.nightwise.org/
- Earth Hour - http://www.earthhour.org
- Astronomical League – http://www.astroleague.org
- National Park Service Dark Sky Team - http://www2.nature.nps.gov/air/lightscapes/

Light Pollution

The Heroes

Full cut-off fixtures. These fixtures contain and direct all their light downward. They control the light output with a reflector inside the fixture rather than by a refractor dropped below the fixture, as noted above. No light reaches above or even near the horizontal, so glare is minimized. The fixtures can contain most any kind of lamp but usually are seen with high-pressure sodium or metal halide lamps, both reasonably energy efficient.

These fixtures are easy to recognize because you can't see any glass hanging below the fixture, and you can't see the lamp unless you are relatively close to the fixture and looking directly up at it. They can look like the cobra head fixtures but without the dropped refractor, or they can look like boxes or small opaque cylinders on top of the lighting pole. These fixtures can also be used as wall mounted "wall packs," and they have little or no glare and an excellent distribution of the light output, just as they do when used for street lighting.

Motion sensor lights. These lights are not on all the time from dusk to dawn, but only when their infrared sensor detects motion of people, large animals, or other objects. They then turn on for a few minutes, and go off later when they do not detect any more motion. They don't waste light or energy nor do they create adverse sky glow when well installed to control the light output. Since they come on when a potential burglar approaches, they tend to scare criminals away. They also serve to light walkways or such for the homeowner. They can contain any kind of light that comes on "instantly," but not all lamps do this. Even an energy inefficient incandescent lamp is OK with this type of lighting, as they are so seldom on that little or no energy is wasted.

Timer-controlled lighting. There are many applications where lighting is not needed all night, and this can save a great deal of energy. Some examples are advertising lighting, parking lot lighting, signs of all sorts, decorative lighting, and many others. In some applications, lighting that is still needed can be dimmed when the need for the lighting decreases. Visibility can still remain excellent.

Glare-free lighting. Glare never helps visibility. The eye can see remarkably well even at very low lighting levels in the absence of glare.

Energy-efficient lamps. Naturally, these can help save energy when used in place of energy-inefficient lamps. Here is a list of lamps in order of decreasing energy efficiency: low-pressure sodium, high-pressure sodium, metal halide, and compact fluorescent. Use them whenever possible. Explore your city and your neighborhood, and make a list of the lighting heroes and the villains. Take photographs if you can. Help publicize the heroes. Help others understand the value of heroes and the villainy of villains. Good nighttime lighting has great value.

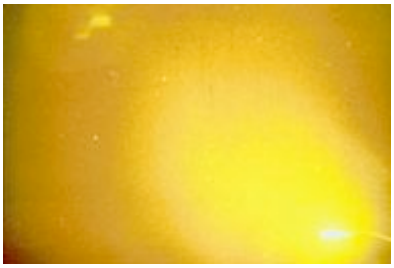
Recognizing the heroes. Photo of a low-pressure sodium fixture.

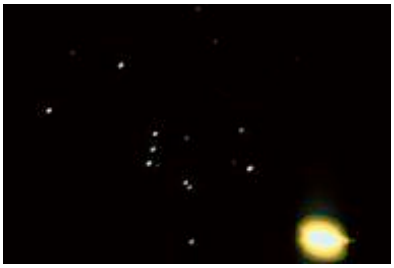
Light Pollution and the U.S. National Science Education Standards

The only good thing about light pollution is that it makes an excellent topic for teaching and learning about science and technology and their relationships to society. And science educators now know that teaching is most effective when an inquiry-based approach is taken. This usually means "hands-on activities," and there are lots of those in the light pollution field. Effective teaching also requires that topics be introduced to students at an age when they can appreciate the concepts and issues involved. As students progress from grades K through 12, the U.S. National Science Education Standards (NSES) gradually introduce them to the scientific, technological, and societal issues with which light pollution connects so well.

The NSES were developed over many years by thousands of teachers, scientists, and other experts across the country. The Standards address not only content issues but exemplary teaching practices, effective professional development, criteria for assessing and analyzing students' attainments, the nature and design of the school and district science program, and the resources and other supports needed.

The content standards include topics to be addressed in the physical, biological, Earth, and space sciences. They also include unifying processes, science as inquiry, science and technology, personal and social perspectives, and the nature and history of science. The study of light pollution touches on virtually every one of these topics. In particular, activities and projects on light pollution relate to two important themes in the content standards. In "science as inquiry," students ask a question, plan and conduct an investigation, employ tools and equipment to extend their senses, use data to construct an explanation or interpretation, and then communicate their results. In the "nature and history of science" thread, an underlying principle is that science is a human endeavor. What better example than the use and misuse of light!





Returning the heavens. In the photograph to the left, few stars in Orion are visible from Flagstaff, AZ, because of sky glow from low-pressure sodium lamps, but astronomers can easily work around this monochromatic problem by placing a sodium filter in their telescope. In the image to the right, see the return of Orion's stars by the use of such a filter.

At the grade K-4 level in the physical science stream, students are introduced to light. In the biological science stream, they are introduced to the concept of the environment. In the Earth and space science stream, the sky becomes part of the environment. But there may be changes in the environment: "changes... can be natural or influenced by humans. Some changes are good, some are bad, and some are neither... Pollution is a change in the environment that can influence the... activities of... humans." Students learn to recognize that science and technology produce local challenges; the effects may be good or bad.

At the grade 5-8 level, the science and technology stream deals with the development, implementation, and evaluation of technological designs and products (lighting!). The social perspectives include environmental degradation and the concept of risks and benefits; students must think critically about

the positive and negative aspects of technological activity. Again, light pollution is an example which can be understood at a very basic level.

At the grade 9-12 level, in the physical science stream, light and spectra are introduced. Astronomy topics center on the origin and evolution of the universe - questions which inspire so many people (including astronomers) to look at the sky and lament the gradual disappearance of its beauty. The topics in the science and technology stream - technological design and the complex nature of science and technology, their motivations and interactions - are tailor-made to be illustrated through a study of light pollution. And the social perspectives include natural resource consumption, environmental quality, and the role of science and technology in local, national, and global challenges.

[Note: All illustrations are from the ASP slide set "Light Pollution: Problems and Solutions."]

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GLOBE at Night

Teacher Activity Packet: Observation Guide

www.globe.gov/globeatnight

March 16 - March 28, 2009

Encourage your students to participate in a world-wide citizen science campaign to observe and record the magnitude of visible stars as a means of measuring light pollution in a given location. Because the data collection occurs in the evening, this is an excellent opportunity to get parents involved in a learning activity with their child. Participants will learn how to locate the constellation Orion. They will learn stars have different magnitudes of brightness in the night sky and that this information is of interest to scientists studying light pollution. Using the information provided your students will collect data and report their findings to the GLOBE at Night online database. The data will then be analyzed and mapped for participants to see the results of this global campaign.

You may choose to have GLOBE at Night be a part of your planned curricula or a completely independent extracurricular activity. Note that an activity packet has been designed for parents and families to help them successfully participate with their child.

Learning Objectives - Students will be able to:
- Use latitude and longitude coordinates to report the location of their observation
- Locate the constellation Orion using stellar maps
- Determine the magnitude of the faintest visible stars in their location
- Analyze the spatial data collected
- Draw conclusions from studying the mapped observations

Materials Needed:
- GLOBE at Night Teacher or Family Activity Packet
- Something to write on (clipboard or cardboard)
- Something to write with (pencil or pen)
- Red light to preserve night vision (A red light can be made by covering a flashlight with a brown paper bag or red cellophane and securing the covering with a rubber band to be sure it doesn't slip while making the observation.)
- Optional: GPS unit, Maporama Web site (www.maporama.com) or topographic map to determine your latitude and longitude

Participation is open to anyone who lives or works in one of the 110 GLOBE countries listed on:
www.globe.gov/globeatnight/countries.html

Five Easy Star-Hunting Steps:
(*www.globe.gov/globeatnight/observe.html*)

1) Find your latitude and longitude by using any of the following methods:
a. Use a GPS unit where you take a measurement. Report as many decimal places as the unit provides.
b. Visit *http://eo.ucar.edu/geocode/* on-line. Input your location. Or input your city; zoom in/out and pan around until you find your location. Double-click and the latitude and longitude will be displayed.
c. Use topographic map of your area.
d. Determine your latitude and longitude with the interactive tool when reporting observations on the GLOBE at Night Web site.

2) Find Orion by going outside an hour after sunset (approximately between 8-10 pm local time)
a. Determine the darkest area by moving to where the most stars are visible in the sky toward Orion. If you have outside lights, be sure they are all off.
b. Wait outside for at least 10 minutes for your eyes to adapt to the darkness. This is called becoming "dark-adapted."
c. Locate Orion in the sky. For help use the appropriate Orion Finder Chart (*www.globe.gov/globeatnight/observe_finder.html*) for your latitude.

3) Match your nighttime sky to one of our magnitude charts (pages 3-4)
a. Select the chart that most closely resembles what you are seeing.
b. Estimate the cloud cover in the sky.
c. Fill out the Observation Sheet (page 5).

4) Report your observation online at:
www.globe.gov/globeatnight/report.html
a. Your observation can be recorded any time between March 16 - April 7, 2009.
b. From March 16-28, do it again from a different location!

5) Compare your observation to thousands around the world at:
www.globe.gov/globeatnight/analyze.html

GLOBE at Night

Teacher Activity Packet: Observation Guide

www.globe.gov/globeatnight

March 16 - March 28, 2009

U.S. Education Standards:
This activity meets the following U.S. educational standards:

National Science Education Standards
Earth and Space Science Standards-
• K-4: Objects in the sky
Science in Personal and Social Perspectives-
• K-4: Changes in environments
• 5-8: Populations, resources, and environments,
Science and technology in society
• 9-12: Environmental quality, Science and technology in local, national, and global challenges

Mathematics Standards
Numbers and Operations: Understand numbers, ways of representing numbers, relationships among numbers, and number systems
• Pre-K-2: Count with understanding and recognize "how many" in sets of objects; Understand and represent commonly used fractions, such as 1/4, 1/3 and 1/2
• 3-5: Develop understanding of fractions as parts of unit wholes, as parts of a collection, as locations on number lines, and as divisions of whole numbers
• 6-8: Work flexibly with fractions, decimals, and percents to solve problems
Geometry: Use visualization, spatial reasoning, and geometric modeling to solve problems
• Pre-K-2: Recognize geometric shapes and structures in the environment and specify their location
• 3-5: Recognize geometric ideas and relationships and apply them to other disciplines and to problems that arise in the classroom of in everyday life
• 6-8: Recognize and apply geometric ideas and relationships in areas outside of the mathematics classroom, such as art, science, and everyday life

Geography for Life: The National Geography Standards
Essential Element 1: The World in Spatial Terms
• How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information.
• How to analyze the spatial organization of people, places, and environments on Earth's surface.
Essential Element 5: Environment and Society
• How human actions modify the physical environment.

Remember Safety First!
Please remind students of the following safety guidelines:
• Be sure you ask for permission from your parent(s) or guardian to go outside after dark to do this activity. This is designed to be a family activity, invite all your family members to do the activity with you.
• Depending on your location, be sure to wear suitable clothing for the weather and for being outside at night (light colored and/or with reflective
colors).
• Remember safety first! When choosing the darkest area in your location, be sure the location is not close to traffic, the edge of a balcony, or near any other type of danger.

Multiple Observations:
You can enter more than one observation by moving to a new location at least 1 km away from your original location. Don't forget to get new latitude and longitude coordinates. This can be done on the same night or on another night any time during March 16 - March 28, 2009.

Note for higher latitudes (>45 N or S): astronomical twilight will occur later and Orion will be low on the horizon; so you may need to do your observation closer to 9:00 pm rather than 8:00 pm or 10:00 pm.

GLOBE at Night

Teacher Activity Packet: Magnitude Charts

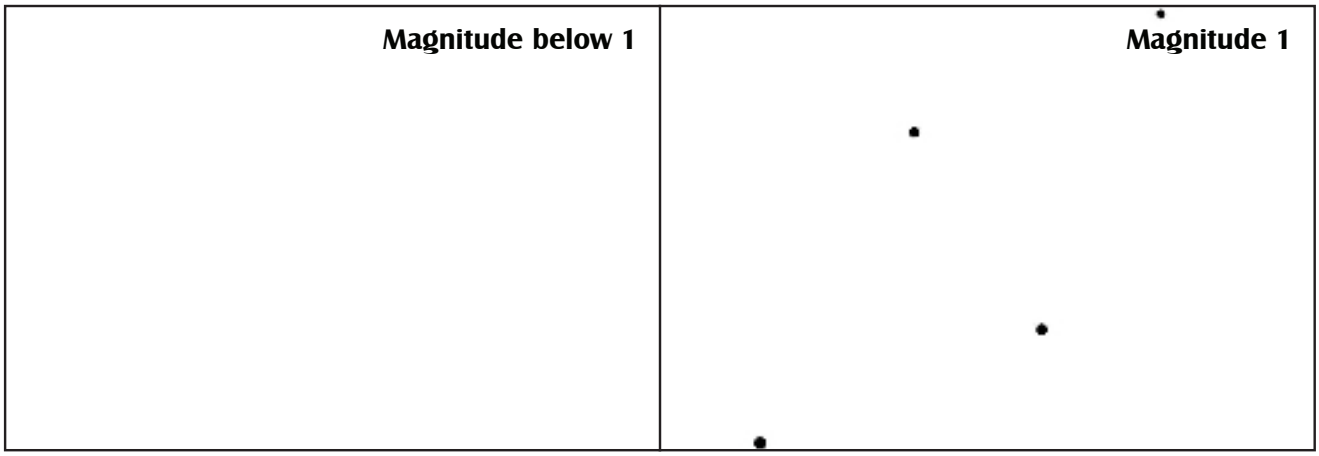
www.globe.gov/globeatnight

March 16 - March 28, 2009

The following charts were generated with celestial North straight up.
Please orient this page according to your location.

Northern Hemisphere View

Magnitude below 1



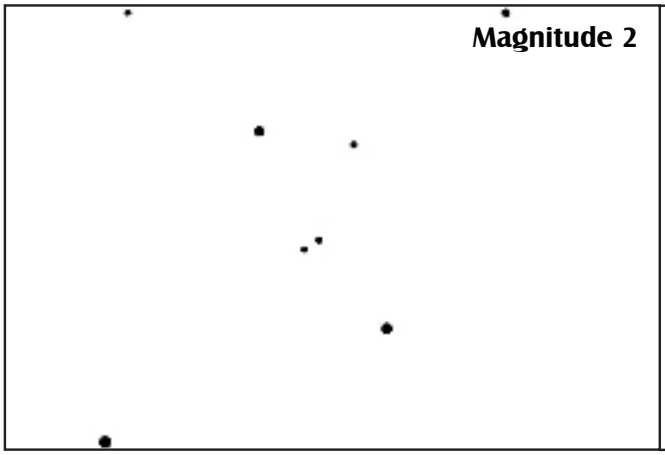
Hint: You can't see Orion because he is hidden behind clouds.

Magnitude 1

Hint: You can only see a couple of the brightest stars in Orion.

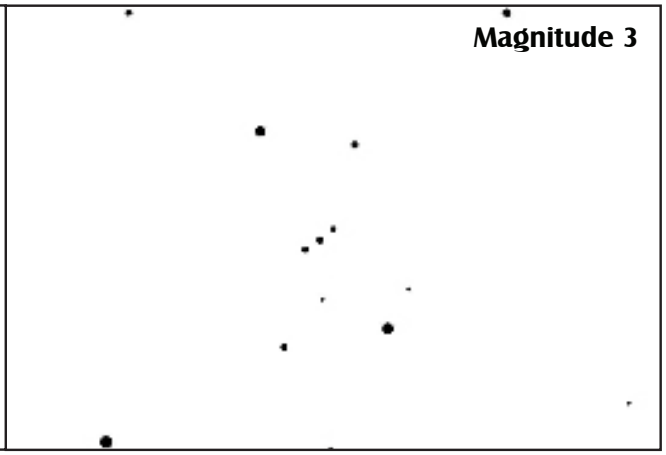
Near Equator View

Magnitude 2



Hint: You can see two stars in Orion's belt.

Magnitude 3



Hint: You can see three stars in Orion's belt.

Southern Hemisphere View

GLOBE at Night

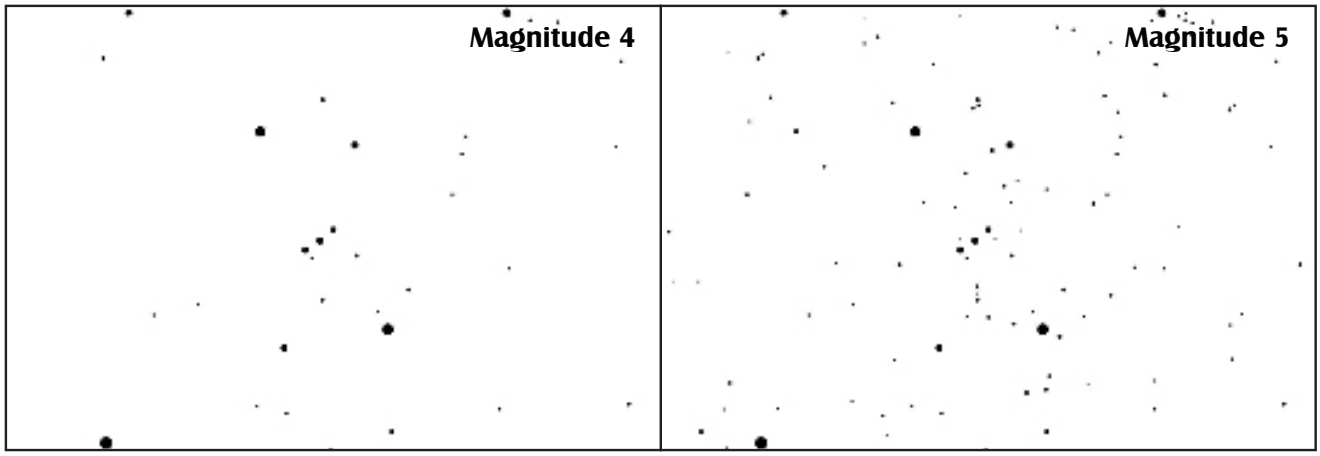
Teacher Activity Packet: Magnitude Charts

www.globe.gov/globeatnight

March 16 - March 28, 2009

The following charts were generated with celestial North straight up.
Please orient this page according to your location.

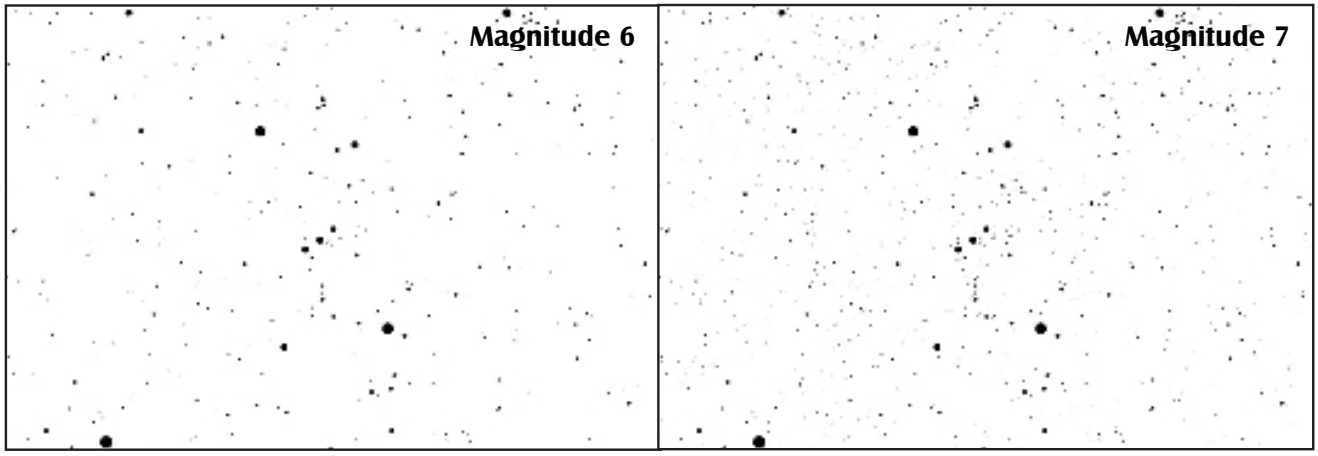
Northern Hemisphere View



Hint: You can see four stars in Orion's belt.

Hint: You can see six stars in Orion's belt, and also you might be able to see his sword.

Near Equator View



Hint: You can see many stars in Orion's belt, and his sword is clearly visible.

Hint: You can't count that many stars!

Southern Hemisphere View

GLOBE at Night

Teacher Activity Packet: Observation Sheet

www.globe.gov/globeatnight

March 16 - March 28, 2009

Only fields marked by * are required.

*Date: March _____, 2009

*Observation Time: ____:____ PM local time (HH:MM)

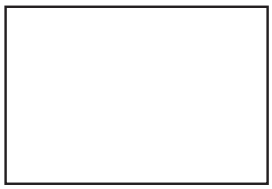
*Country: _____

*Latitude (in deg/min/sec or decimal degrees): _____ deg ____min_____sec _____ decimal degrees (North / South)

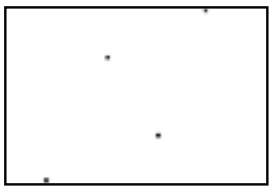
*Longitude (in deg/min/sec or decimal degrees): _____ deg ____min_____sec _____ decimal degrees (East / West)

Comments on location: (e.g. There is one street light within 50 m that is shielded from my view.)

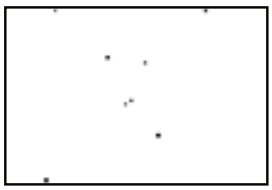
***Match your nighttime sky to one of our magnitude charts :**



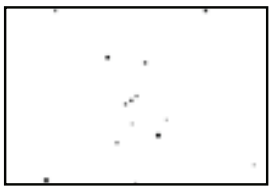
◯ **Stars in Orion not visible**



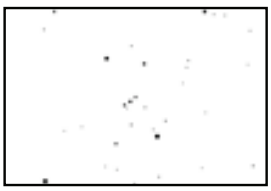
◯ **Magnitude 1 Chart**



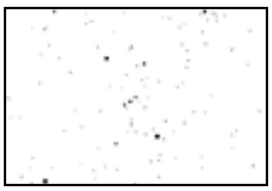
◯ **Magnitude 2 Chart**



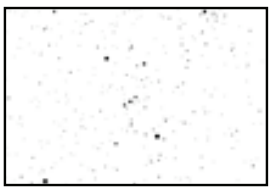
◯ **Magnitude 3 Chart**



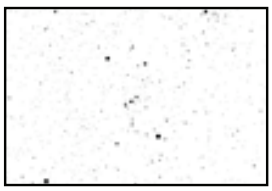
◯ **Magnitude 4 Chart**



◯ **Magnitude 5 Chart**



◯ **Magnitude 6 Chart**



◯ **Magnitude 7 Chart**

Reading from the Unihedron Sky Quality Meter (if applicable): _____

Serial number from the Unihedron Sky Quality Meter (if applicable): _____

*Estimate the cloud cover in the sky:

◯ Clear ◯ Clouds cover ¼ of sky ◯ Clouds cover ½ of sky ◯ Clouds cover > ½ of sky

Comments on sky conditions: (e.g. a little haze to the north)

Report online at www.globe.gov/globeatnight/report.html

GREAT World Wide STAR COUNT

A Windows to the Universe Citizen Science Event

www.windows.ucar.edu/starcount

October 20 – November 3, 2008

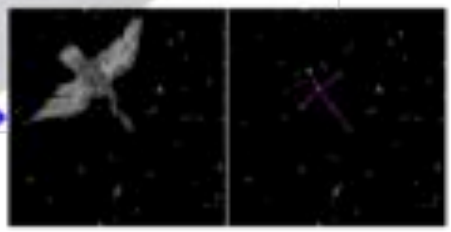
Steps:

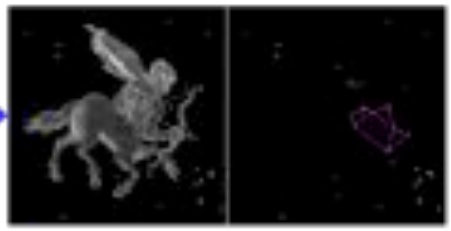
WHAT do I need?
- Pen or pencil
- Red-light or "night-vision" flashlight
- GPS unit, access to the Internet or topographic map
- Printed Activity Guide with report form

HOW do I make a "night-vision" flashlight?
- Cover the end (lens) of a flashlight with red cellophane or a brown paper bag
- Secure it with tape or a rubber band

WHEN do I observe?
- Any night(s) between Oct. 20 – Nov. 3, 2008
- About an hour after sunset (usually between 7:00 and 9:00 pm local time)

WHAT do I observe?
- Find your constellation:
  - If you live in the Northern Hemisphere, you will observe the stars in Cygnus, the Swan, which includes the Northern Cross asterism
  - If you live in the Southern Hemisphere, you will observe the stars in Sagittarius, the Archer, which includes the Teapot asterism
- Match your nighttime sky to the magnitude charts on pages 2 & 3



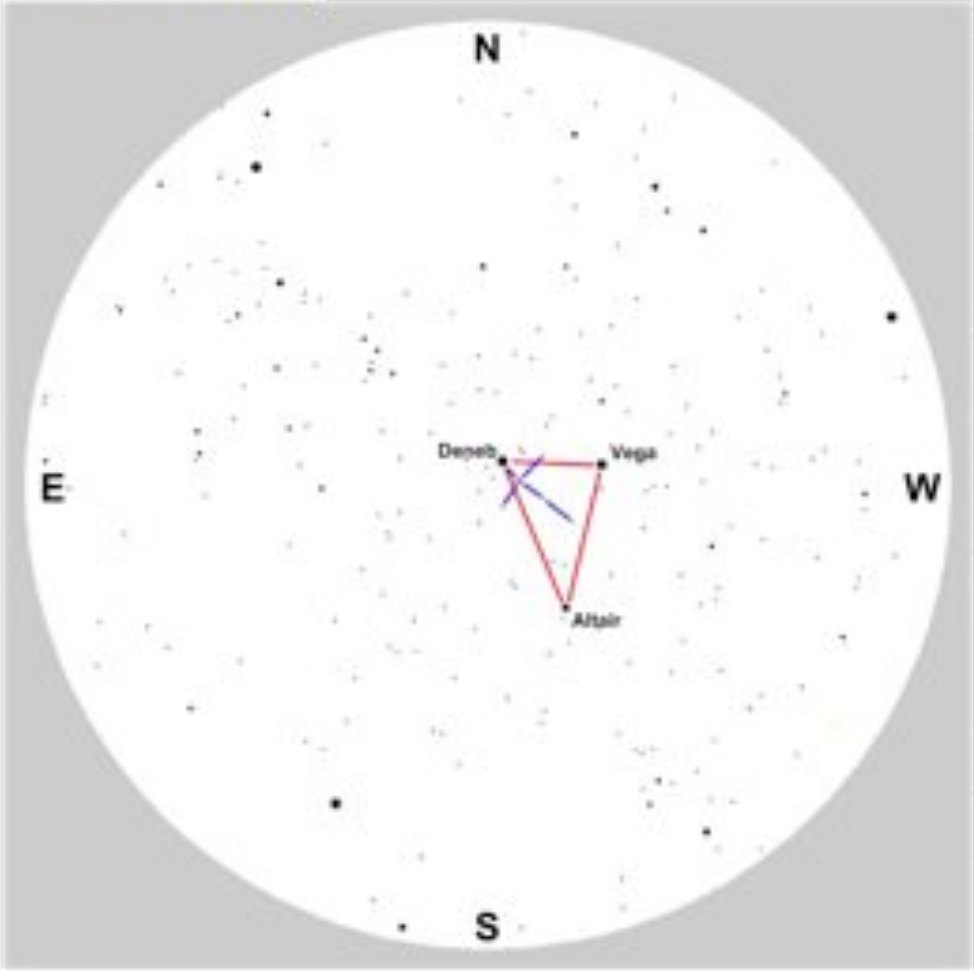


WHERE do I observe?
- Anywhere outside where you can determine the latitude and longitude (for help visit www.windows.ucar.edu/starcount/latlon.html)
- Optional: Report more than one observation by moving to a new location at least 1 km

Don't Forget!
Give your eyes about 15 minutes to adapt to the nighttime darkness.

Stay Safe!
- Use good judgment when outside at night and wear appropriate clothing
- Young children should be supervised

Northern Hemisphere Observing Guide



How to Find Cygnus and Use the Magnitude Charts

The illustration above represents the night sky as seen from the Northern Hemisphere about an hour after sunset in early October and should help you find the Northern Cross in Cygnus. Hold this page above your head so that the compass directions around the edge point in the right direction. Your sky view should roughly match the illustration. You may see more stars or fewer, depending on the quality of your night sky and how long you've been outside. You will see more stars if you stay outside for 15 minutes!

The three brightest stars above you are Vega, Altair, & Deneb, known as the Summer Triangle (marked in red above). Deneb is the dimmest of the three and will be almost directly overhead. Remember that constellations usually look larger than you might expect! If you extend your arm straight up and stretch your thumb and little finger as wide as possible, they should almost reach from the top of the Northern Cross (Deneb) to the bottom (Alberio). Once you have found the Northern Cross, use the seven magnitude charts on the right to determine the limiting magnitude at your location. Each chart includes a hint to help you decide.

Mag 1: No stars in the cross are visible, but you can see Vega.

Mag 2: Deneb is the only star visible the cross.

Mag 3: Only four stars visible at the top of the cross.

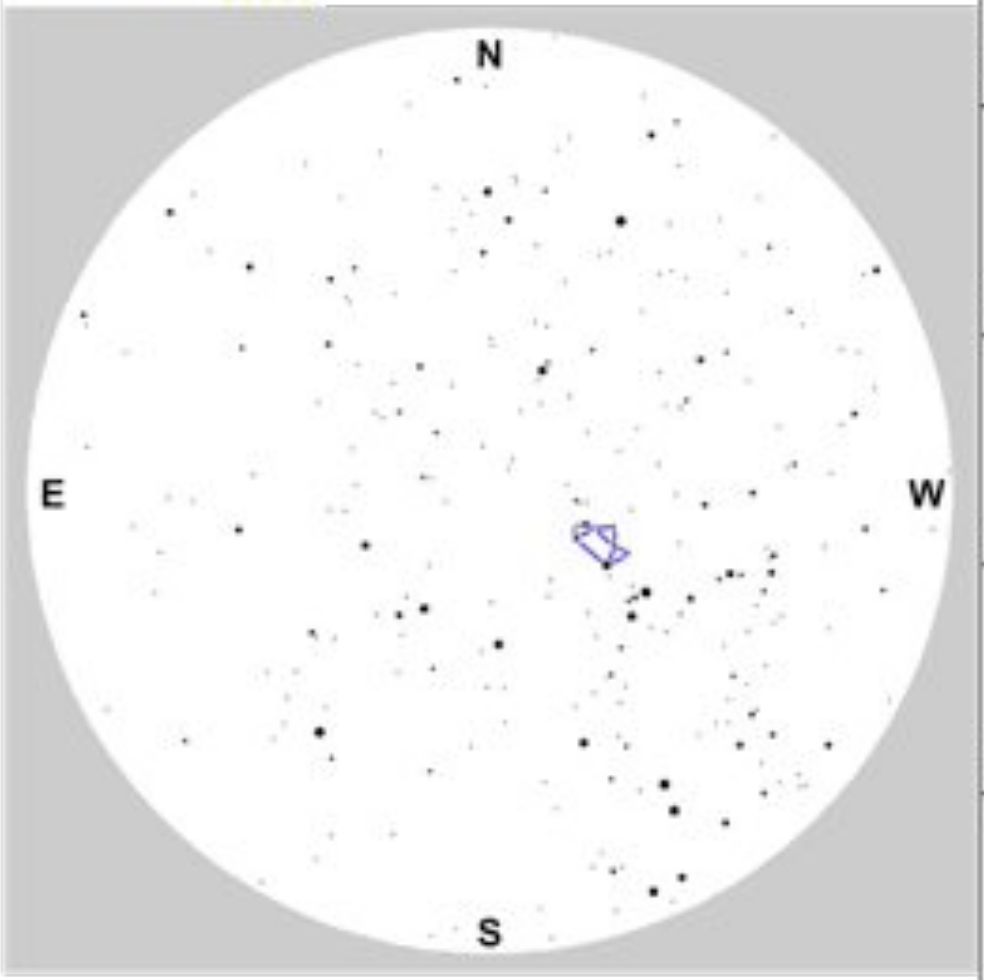
Mag 4: All six main stars visible in the cross.

Mag 5: Six stars in a "V" at the top of the cross.

Mag 6: "S"-shaped curve of stars visible.

Mag 7: Too many stars to count!

Southern Hemisphere Observing Guide

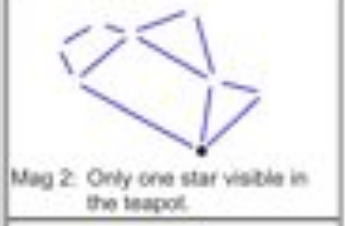


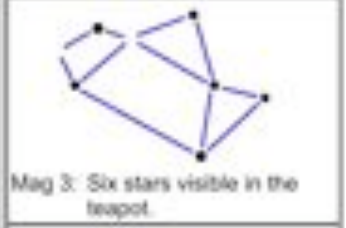
How to Find Sagittarius and Use the Magnitude Charts

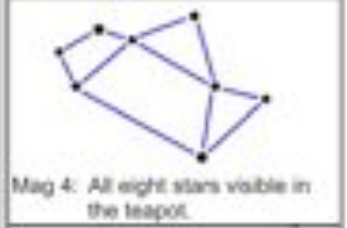
The illustration above represents the night sky as seen from the Southern Hemisphere about an hour after sunset in early October and will help you find the Teapot in Sagittarius. Hold this page above your head so that the compass directions around the edge point in the right direction. Your sky view should roughly match the illustration. You may see more stars or fewer, depending on the quality of your night sky and how long you've been outside. You will see more stars if you stay outside for 15 minutes!

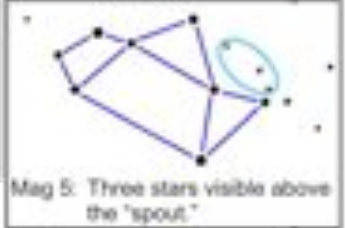
The Teapot is easy to find. If you are facing west, look up about half way to the zenith (straight overhead). If you are lucky enough to live where you can see the Milky Way, it runs right through the Teapot, and looks like steam pouring out of the spout! Remember that constellations usually look larger than you might expect! If you extend your arm and make a loose fist, the Teapot asterism will be slightly wider than the width of your hand. Once you have found the Teapot, use the seven magnitude charts on the right to determine the limiting magnitude at your location. Each chart includes a hint to help you decide.

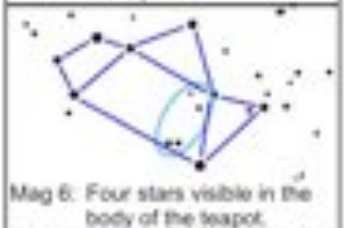

Mag 1: No stars in visible in the teapot.

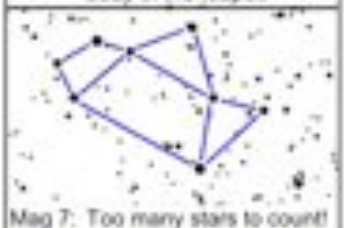

Mag 2: Only one star visible in the teapot.


Mag 3: Six stars visible in the teapot.


Mag 4: All eight stars visible in the teapot.


Mag 5: Three stars visible above the "spout."


Mag 6: Four stars visible in the body of the teapot.


Mag 7: Too many stars to count!

GREAT World Wide STAR COUNT

A Windows to the Universe Citizen Science Event
www.windows.ucar.edu/starcount

October 20 – November 3, 2008

Report Form: Complete this form for each observation made.

WHEN did you observe?
***Date:** October / November ____ , 2008

***Local Time:** ___ : ___ PM (suggested times are between 7:00-9:00 pm local time)

WHAT did you observe?
***Constellation:**

o Northern Hemisphere – Cygnus

o Southern Hemisphere – Sagittarius

***Nighttime Sky:** For help see pages 2 & 3

- oToo cloudy to see
- o Limiting Magnitude 1
- o Limiting Magnitude 2
- o Limiting Magnitude 3
- o Limiting Magnitude 4
- o Limiting Magnitude 5
- o Limiting Magnitude 6
- o Limiting Magnitude 7

Comments:

WHERE did you observe? For help visit www.windows.ucar.edu/starcount/lation.html

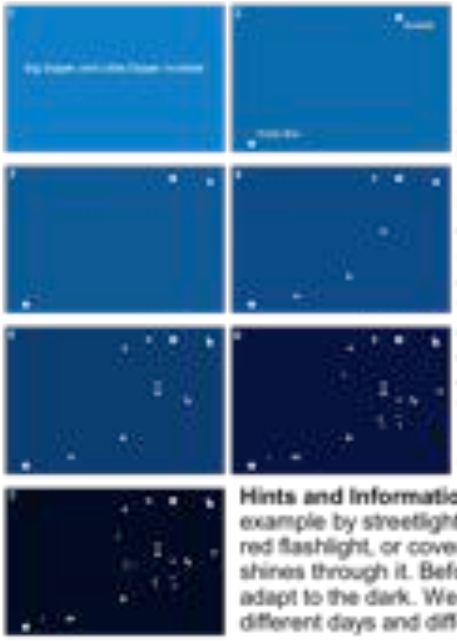
***Lat:** _____ decimal degrees (remember that North is positive (+) and South is negative (-))

***Lon:** _____ decimal degrees (remember that East is positive (+) and West is negative (-))

***Country:** _____

Report your observation online at www.windows.ucar.edu/starcount/report.html

How many stars...? Look at your sky and report to sternhell.at



How to help and participate

1. *Look* for an observing site under clear and moonless skies.
2. *Locate* the constellation of the little dipper by first locating the Polar Star and Kochab, the brightest stars of the little dipper (with the help of the large image and the big dipper) or look for Orion and its three belt stars.
3. *Compare* the stars that you can see with the naked eye, (without binoculars or a telescope, but using your glasses) either in the Little Dipper or in the constellation of Orion to the respective small reference images on this page.
4. *Kindly report* the image number (1 to 7) of the constellation-image that matches most closely to what you actually see together with date, clock-time (that is local legal time) observing location by using the observation form at the ***How many stars?*- website** http://sternhell.at where you can see all results immediately.

Hints and Information: Avoid places with nearby direct lighting, for example by streetlights. If you want to illuminate the instructions use a red flashlight, or cover the flashlight with your hand so that it dimly shines through it. Before observing you should give your eyes time to adapt to the dark. We encourage you to repeat your observation at different days and different times even at the same spot.

North of the line Casablanca-Cairo-Delhi-Shanghai-Los Angeles-Atlanta you can always use the Little Dipper

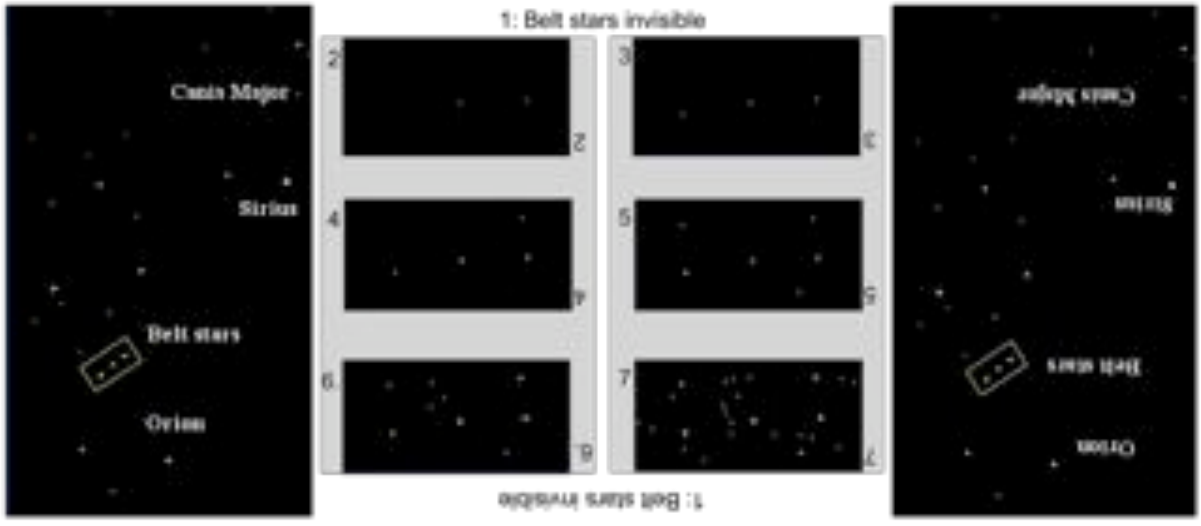
Adopt a light meter and measure the brightness of your sky

Our goal is to record the state of the world's night skies for the first time during 2009. Newly developed light meters at 1000 places around the globe shall continuously measure the brightness of the night to determine the brightening of the night sky and provide a reference for the sightings of Orion and the Little Dipper. Help us, adopt a light meter and record the brightness of the night sky in your city, at your school or at your observatory. You need (1) a computer with USB and Windows XP/NT/2000. (2) A place with good view of the sky within 20m of the computer. (3) About 100 € for the light meter that might be funded by the IYA. Contact Verein@Kuffner-Sternwarte.at for more information and to adopt a starlight-meter. http://wiki.sternhell.at

Orion

Observers in the South use the three *Belt Stars of* Orion, also known as the *Trés Marias* for their observations. Orion is visible during almost the entire night during the southern hemisphere summer (the northern winter). Orion is visible in the evening until May and reappears in July, in the morning, about an hour before sunrise .

Southern observers use Orion: this side up



Northern observers may use Orion in Winter: this side up

Activities to Support the Star-Hunting Programs

On the next few pages, 6 activities are included that provide scaffolding for the star-hunting programs. Where they originated is also provided. Here is a summary of the activities:

- **How Light Pollution Affects the Stars**: To help students determine how light pollution affects the visibility of the stars by using a magnitude reader. (Contributed by the International Dark-Sky Association; from http://data.nextrionet.com/site/idsa/How Light Pollution Affects the Stars.pdf.)

- **How Many Stars are You Missing?** Based on the unaided-eye observations from star-hunting programs like GLOBE at Night and the Great World Wide Star Count, calculate how many stars you are missing at your location. (Based on "Calculating Stars Lost" by Fred Schaaf in *Seeing the Sky*, John Wiley & Sons, 1990; from page 5 of http://www.windows.ucar.edu/citizen_science/starcount/GWWSC2008_ActivityGuide.pdf).

- **Orion at Your Fingertips:** This arts and crafts activity introduces the novice constellation hunter to a method for spotting the main stars in the constellation, Orion, the Great Hunter. (Courtesy of the National Optical Astronomy Observatory Education and Public Outreach Group; from http://www.globe.gov/GaN/GaN2009OrionAtFingertips.pdf.)

- **Turtle Hatching:** Demonstration shows the survival challenges of turtles (simulated by large group of kids) hatching on a beach at night. (Courtesy of the Let There Be Night program; from http://www.lettherebenight.org/turtles.html.)

- **Light Pollution Workbook:** 6 one-page puzzlers (a crossword puzzle, word search, connect the dots, Venn diagram, etc) that help students discover the effects of light pollution on astronomy. (Contributed by the International Dark-Sky Association; from http://docs.darksky.org/education/JTTSS2/LightPollutionWorkbook.pdf.)

- **Outdoor Lighting Activity:** Students observe the design of outdoor lighting, discuss how efficient and effective the light and fixture at hand are and determine the degree to which light pollution occurs. More advanced students may also observe and describe the spectrum of the outdoor lighting. (Courtesy of the Astronomical Society of the Pacific's "Universe in the Classroom"; from http://www.astrosociety.org/education/publications/tnl/44/lightpoll5.html#6.)

How Light Pollution Affects the Stars: Magnitude Reader

Objective: To help students determine how light pollution affects the visibility of the stars by using a magnitude reader.

Materials:

- Cellophane (clear plastic wrap)
- A penny
- Scissors
- A piece of thin cardboard about 1 x 5 inches (cereal box, shoe box, cardstock, etc…)
- Tape or glue

Procedure:

1. Use the penny to trace five circles on the cardboard. The circles should make a straight line and be evenly spaced apart.

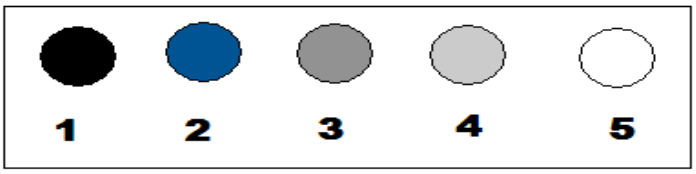
2. Tape or glue a piece of cellophane across the back of your cardboard, covering all holes. Make sure not to get glue or tape on any of the holes. It will obstruct your view later.

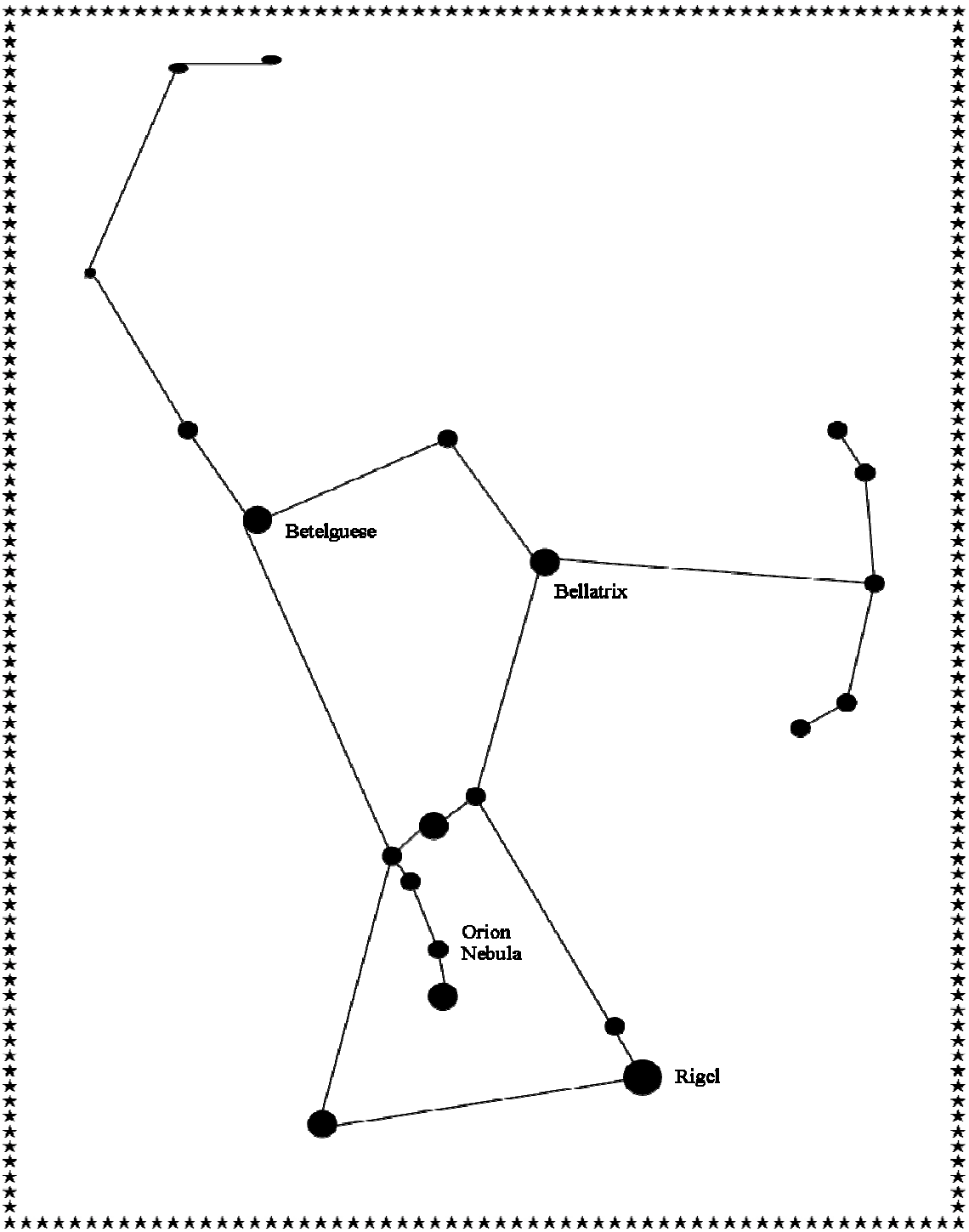
2. Next tape or glue a piece of cellophane over the last four holes, again being careful not to get glue or tape on any of the holes. Repeat this step by covering the last three holes, the last two, and then the last hole. The result should be that each hole has one more piece of cellophane than the previous hole. You now have a tool for measuring the magnitude of stars. Label the hole with only one piece of cellophane 5, the second one 4, and so forth, until you get to 1.

3. Find the constellation Orion in the night sky. Now, look at the sky and use your magnitude reader view each star in Orion. On the drawing of Orion, write down which number you can see the star faintest through (i.e. you can't see the star in hole 4, but you can see it faintly in hole 3, you would write down 3 for that star). Do this for each star in the drawing. You now have a list of the magnitude of each star in the constellation Orion.

4. Record the lighting situation where you recorded your data about Orion. Are the lights bright? Are they dim?

Class Discussion: Compare your results to the rest of the class. Remember that lower magnitudes are brighter stars and higher magnitudes are dimmer stars. How did each star compare to the other students data in each of their lighting situations? In brighter lights were the stars dimmer or brighter? How accurate is this data?




Betelguese
Bellatrix
Orion
Nebula
Rigel

Activity: How Many Stars Are You Missing?

Based on "Calculating Stars Lost" by Fred Schaaf in *Seeing the Sky*, John Wiley & Sons, 1990

> *In order to complete this activity you will need to determine your local limiting magnitude by observing Cygnus or Sagittarius as described in the prior pages.*

By now you know that the number of stars visible is affected by the quality of the night sky. The Moon, atmospheric conditions, and light pollution can make it hard or impossible to see the fainter stars. You have also probably discovered that astronomers use the **magnitude scale** to measure the brightness of stars. Remember that magnitude 1 stars are brighter than magnitude 2 stars, which are bright than magnitude 3 stars, and so on.

As part of the Great World Wide Star Count, you have learned to measure the **limiting magnitude** of your night sky, that is, what are the dimmest stars that can be seen? Under perfect conditions—no Moon, clear skies, and far, far away from any lights, the human eye can see stars down to about 6th or 7th magnitude. According to the table below, that's about 14,000 stars!

Limiting Magnitude	Approximate Number of Stars Visible
1	6
2	45
3	150
4	540
5	1,700
6	4,900
7	14,000

Now you are ready to calculate how many stars you are missing at your location. All you have to do is subtract the approximate number of stars visible from your location from 14,000. For example, if you measured your limiting magnitude to be 3, you can see about 150 stars with the naked eye, but you are missing around 13,850 stars (14,000-150 = 13,850)!

Questions:

1. What do you think the result would be if you took a measurement closer to the nearest town or city? How about farther away?

2. Try taking a measurement as soon as stepping outside, followed by another in 15 minutes—using the table above, how many more stars can you see after your eyes adapt to the dark?

GLOBE at Night

Orion at Your Fingertips

www.globe.gov/globeatnight

March 16 - March 28, 2009

Overview:

This activity introduces the novice constellation hunter to a method for spotting the main stars in the constellation, Orion, the Great Hunter. Simple materials are used to make an outline of the constellation which, when put under a strong light (or a long wavelength ultraviolet light) for at least 10 minutes, will glow in the dark for 5 minutes, just long enough to locate the stars in Orion and imagine his appearance.

You will be amazed how imaginative and engaged children and first-time night sky viewers will be after spotting Orion, and hearing his story. It is an excellent way to tie together history, Greek mythology, literature, and astronomy. It is also one of the most inexpensive and creative ways to encourage children and first-time viewers to learn the constellations.

What You Will Learn:

- The fascinating mythology of Orion, the Great Hunter, dating back to ancient Greece. Visit www.globe.gov/globeatnight/learn_orionmyth.html
- How to spot the stars and pattern that make up the constellation of Orion.

What You Need:

- 2 different colored tubes of GLOW Tulip brand fabric paint (or another brand that glows in the dark)
- 1 transparency (the thicker the better, but make sure you can still see through them)
- The Orion-at-Your-Fingertips tracing pattern
- 1 flashlight
- A couple of Q-tips

Getting Ready:

1) First, place the Orion-at-Your-Fingertips tracing pattern with the transparency on top, so the transparency covers the constellation in its entirety.

2) After placing these on the flat surface, trace the inner constellation pattern with the first color tube of glow-in-the-dark fabric paint, and follow the pattern by creating lines and circles on the transparency where indicated. The inner pattern is the constellation of stars connected by straight lines and circles.

3) When you're finished with the inner constellation, it is time to trace the outer more imaginative outline of the constellation with the second, different-colored tube of glow-in-the-dark fabric paint.

4) If you blur some lines or make a minor mess while tracing, try using Q-tips to fix them.

5) When you are finished - DO NOT SKIP THIS - allow the transparency to dry for AT LEAST 45 minutes in a brightly lit area before attempting to do the activity.

GLOBE at Night

Orion at Your Fingertips

www.globe.gov/globeatnight

March 16 - March 28, 2009

Doing the Activity:

1) After the glow-in-the-dark fabric paint on the transparency has completely dried for at least 45 minutes and been under strong light for at least 10 minutes, you are ready to take the transparency outside to find Orion.

2) During March 16 - 28, 2009, between 8:00 pm and 10:00 pm (local time), the easiest way to find Orion in the night sky is to go outside and look in the southwest sky, if you are in the northern hemisphere, or the northwestern sky, if you are in the southern hemisphere. If you live on or near the equator, Orion will be visible in the western sky. You are looking for three bright stars close together in an almost-straight line. These three stars represent Orion's belt. The two bright stars to the north are his shoulders and the two to the south are his knees or feet.

3) The Orion Finder Charts from the GLOBE at Night Web site will also help locate the general area in which to find Orion. (http://www.globe.gov/GaN/observe_finder.html)

4) When you have found the general area, hold up the transparency with the constellation pattern on it at arm's length. Match the pattern you have drawn with the stars in the constellation Orion. You may have to tilt or turn the transparency to align the pattern correctly with the stars.

5) The constellation pattern has been drawn so the stars in the constellation will be visible within the circles drawn on the transparency itself, allowing the constellation pattern to be recognizable to even the most novice night-sky observers.

6) The transparency with the glow-in-the-dark constellation pattern should glow for approximately 5 minutes. Be sure to take a flashlight with you so that you can "recharge" the transparency for continuous use. However, be careful not to loose your eyes' adaptation to the dark sky.

Credits:

This activity was created by Natasha Kopsie and Connie Walker at the National Optical Astronomy Observatory (NOAO) for the GLOBE at Night program. NOAO is operated by the Association of Universities for Research in Astronomy Inc. (AURA), under a cooperative agreement with the National Science Foundation.

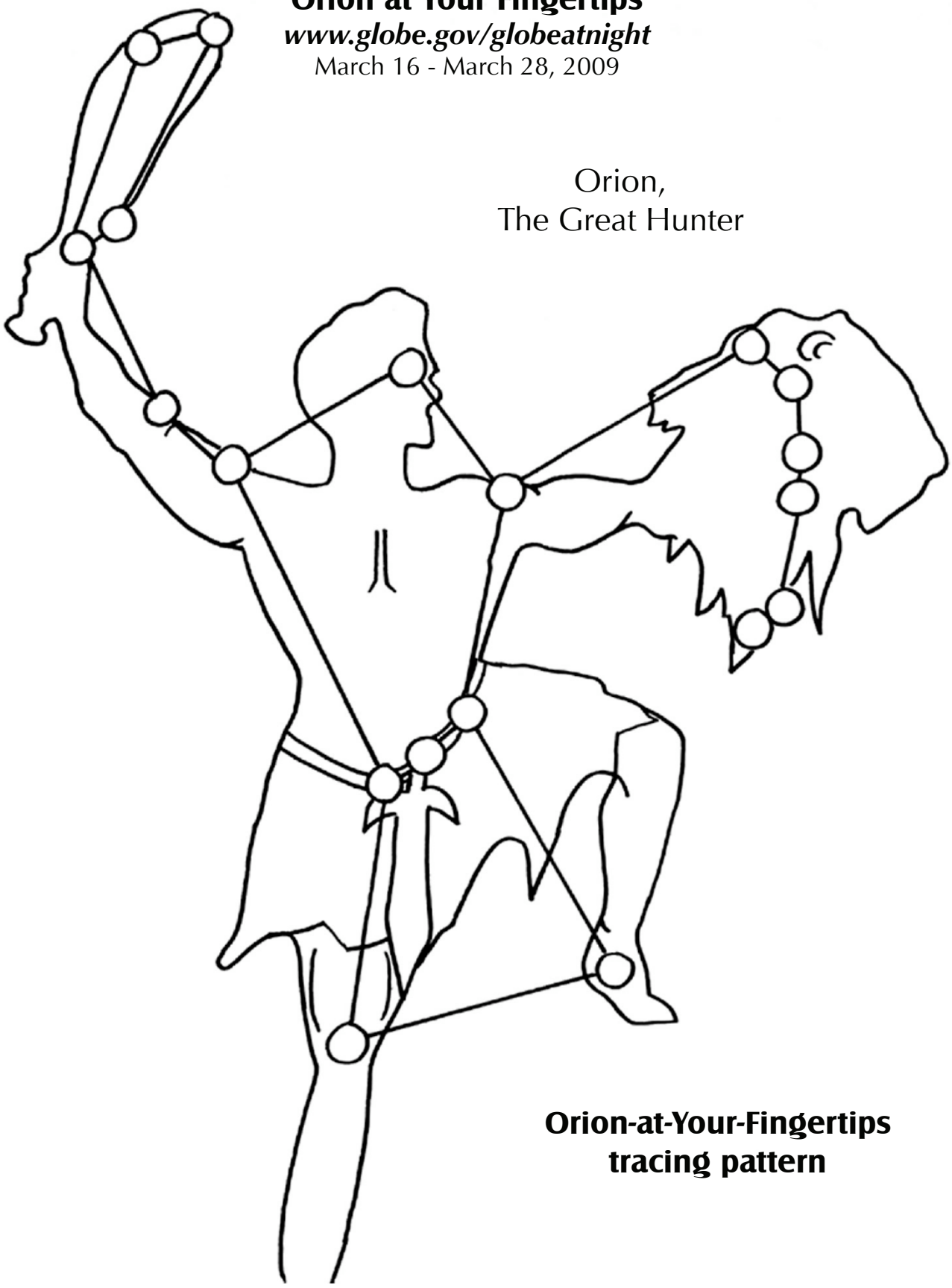
GLOBE at Night is a collaboration between The GLOBE Program; the National Optical Astronomy Observatory (NOAO); the International Dark-Sky Association (IDA), Centro de Apoyo a la Didactica de la Astronomia (CADIAS), and Environmental Systems Research Institute, Inc. (ESRI).

Orion at Your Fingertips

www.globe.gov/globeatnight

March 16 - March 28, 2009

Orion,
The Great Hunter



Orion-at-Your-Fingertips tracing pattern

Author: Chuck Bueter from LetThereBeNight.com; color photos courtesy of Kurt Kruggel.

Gather the kids close together with their arms around their knees as you describe this night.

Six months ago their mother deposited them into a hole in the sand on the shore of the ocean. Tonight they hatch.

Sea turtles generally hatch only at night. What are the benefits of hatching at night? How does the turtle hatchling, in an egg while buried under the sand, know that it's nighttime?

When a sea turtle emerges, it looks around the horizon, moves away from the dark silhouette of the dunes and vegetation, and scurries toward light.

In this demonstration, several parents equidistant from the group encircle the kids from afar while holding lights. On the count of three, the students have to look around the horizon, and then crawl on their elbows and knees to a source of light.

One caveat: the teachers are predators. The kids will not become prey if they first reach someone holding a light. If a predatory teacher does get them, the victim has to lie on his/her back while kicking feet and arms in the air.

Remember, you have to look all around first.

One, two, three, go! They're off, scattering in every direction toward the lights all around.

Predators descend.

Hear the kids as they rush to the lights. (See the video at http://uk.youtube.com/watch?v=-adYa8zrKCo.)

Clusters of turtles are at the feet of people holding lights.

In the middle of the field are turtles who did not escape the clutches of the predators. While seemingly unfortunate, it reflects the natural order.

Survey the scene with the kids.

When the giggling and screaming abates, take inventory of the turtles that reached the lights and of turtles in the middle of the field. Specifically count aloud how many turtles reached each light. On a paper plate, plot the positions of the turtles outward from the nest. Then note what the respective lights might represent in the real world.

For example, this pair of lights held by two parents represents the stars and moon reflecting off the water. Under a pristine sky with no light pollution, sea turtle hatchlings naturally move away from a dark shore and toward the starlight and moonlight reflecting off the water.

In this trial run, only 7 of 89 turtles reached the relative safety of the water, for they scrambled toward two lights randomly deemed the natural light.

What about the rest of the turtles? Those of you gathered by that light over there--that's a streetlight, so you might have gotten run over crossing the road while heading in the wrong direction. And the turtles by the light over there? That's a retail development; so those half dozen turtles were overheated in the sun the next day. And what about the turtles by that other beachside light? They got disoriented by the unshielded condominium lights, and they won't have enough energy to finish life's jumpstart journey to sea. Sorry.

Discuss the results and propose solutions.

Bring all of the kids back into a central group and describe how sea turtles emerge and head for light. What can people do to improve the survival rate of these sea turtles? This group of kids proposed turning shore side lights off. Be sure to note that we need outdoor lighting in our modern society. Yes, some lights can be turned off. But what can we do about other necessary lighting? Guide the students to propose better lighting options.
Shield the lights. Aim lights downward. Lessen the wattage of existing bulbs. Put lights on motion detectors or timers. Turn off unnecessary lights.

Rerun the turtle hatch.

After adjusting some of the lighting held by parents to reflect the suggestions above, rerun the turtle hatch. So that the kids are not preconditioned to run toward the same "seaward" direction, move the parents around. The "reflected moonlight and starlight" will then be in a new spot. The "shore side" lights are not all turned off, just altered per the kids' recommendations.

Remind the kids that they have to scan the horizon before they can take off, stay on their elbows and knees, and head for light.

One, two, three, go!

When the giggling and piling on stops, re-survey the scene. There are still many who got nabbed by the predators. That's nature. However, now how many ended up at the shore side lights and how many made it to the safety of the water? Again have someone plot the positions of the turtles outward from the nest. Compare results and summarize with the students.

Links:

http://research.myfwc.com/features/view_article.asp?id=2156 - Artificial Lighting and Sea Turtle Hatchling Behavior ("Artificial lighting on marine turtle nesting beaches disrupts the ability of hatchlings to find the sea from their nest") from the Fish and Wildlife Research Institute.

http://www.urbanwildlands.org/Resources/LongcoreRich2004.pdf - Ecological Light Pollution Travis Longcore and Catherine Rich paper summarizes ecological consequences of night lighting. See also their book Ecological Consequences of Artificial Night Lighting.

A Silent Cry for Dark Skies (http://www.astrosociety.org/education/publications/tnl/74/74.html) from the Universe in the Classroom series (No. 74-Winter 2008) presents examples of how the natural world is impacted by excessive outdoor lights.

http://uk.youtube.com/watch?v=Tl3yYd-4Rw*s* - A real turtle hatch on a beach.

Astronomy Word Search

G L A R E T U T E L E S C O P E H J B N B F J L
K I H U B B L E S P A C E T E L E S C O P E R O
X G A L A X Y E Q V J I L U R I P F S C B M V V
E H E E Y I P D L A P L E G O D I A M E T E R T
H T E D X O I F A S R A M X S W V H Y E N Q G E
A P L U T O P K R A D W E A I A M H I U P S F M
S O R R T Y X J F T Z L N P O R G F S R C O H O
T L L A D W Y U L U F G T I N F I H W T V L M C
E L S N L F A P A R C X S K C P P T S X D A I N
R U J U R N S U R N K J F L H L J D E U B R C G
O T X S L O T L E G E U B D U A K I Y C C S B N
I I T C N D R F J K D W Q H B N M S C A L Y B I
D O F I Y U O F B M D J R T I E O K D T E S Y T
S N E P T U N E C X S F J R U T I I A M L T B H
P T J H M A O K Q P Y I F A N P A V S O M E S G
W P A O V J M O A M E U O E S N K S F S H M T I
I E W T I O Y R U C R E M Q R P A Y U P C X B L
L P Y O U F D J M I Y N S H E M I S P H E R E L
D P E S K Y G L O W O G Y D S W J V J E P F N A
L C Z P Q K H C B R M T J U I S X K M R W G O I
I F R H O L J C I B H D T J O O B J R E T A R C
F W T E G J F V N M L J T Y J G R K O H F U B I
E C H R T Y N F X B J I O E H B F O U I X N P F
G R W E I E J O H Q A J M N D R E Y E P A B J I
H T L E B R E P I U K S R H N V I S R T G R U T
P G D R R M U J B E W A R E T I P U J B E P U R
R E T R O G R A D E R O T A T I O N P T Y M D A

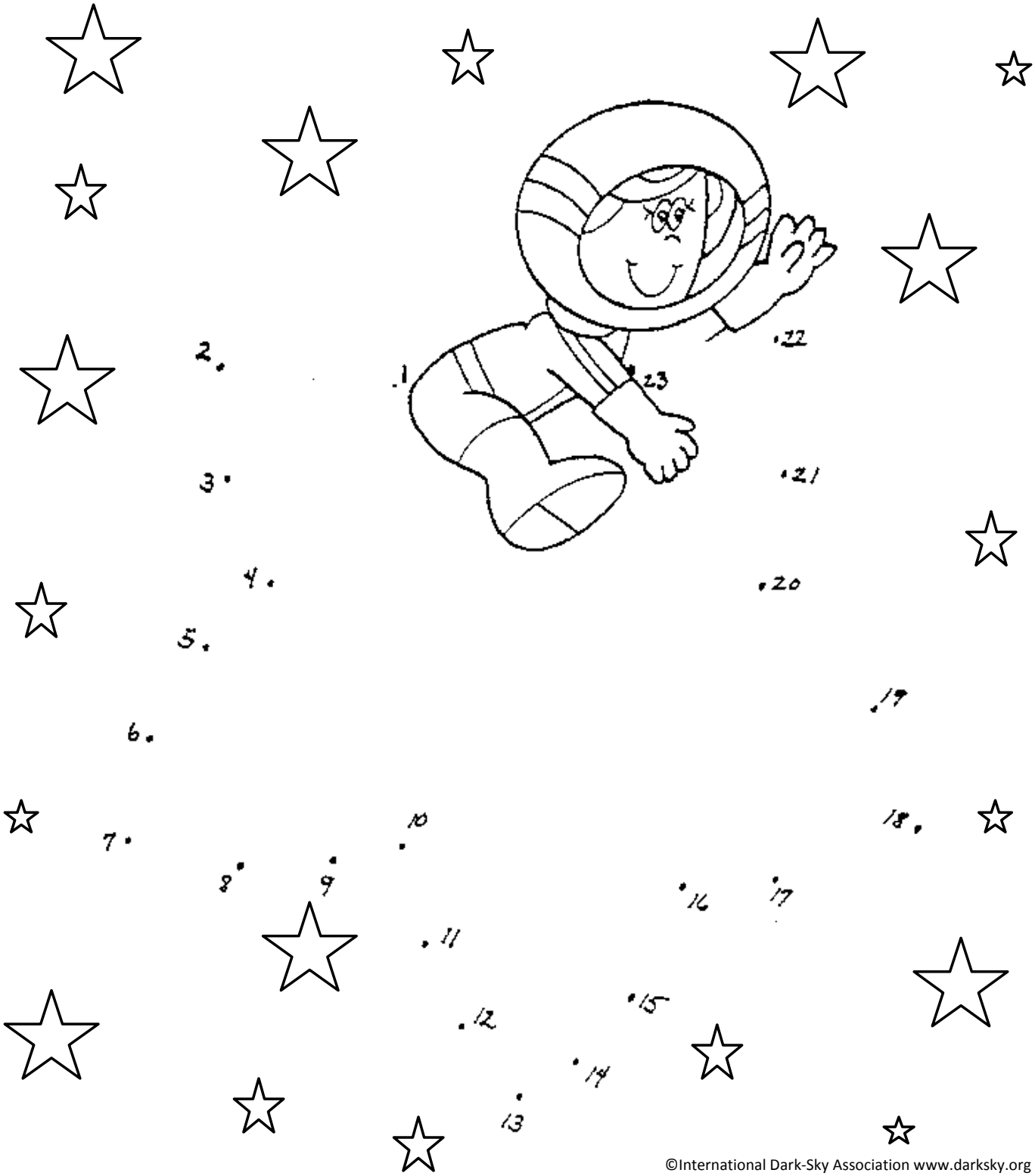
Astronomy
Pluto
Earth
Uranus
Neptune
Dwarf planet
Venus
Mercury
Mars
Jupiter
Saturn
Hubble Space
Telescope

Sun
Solar System
Light Pollution
Glare
Kuiper Belt
Asteroids
Comet
Meteoroids
Atmosphere
Mass
Diameter
Photosphere
Elements

Erosion
Orbit
Telescope
Crater
Hemisphere
Galaxy
Sky glow
Artificial Lighting
Environment
Wildlife
Circadian rhythm
Solar flare
Retrograde rotation

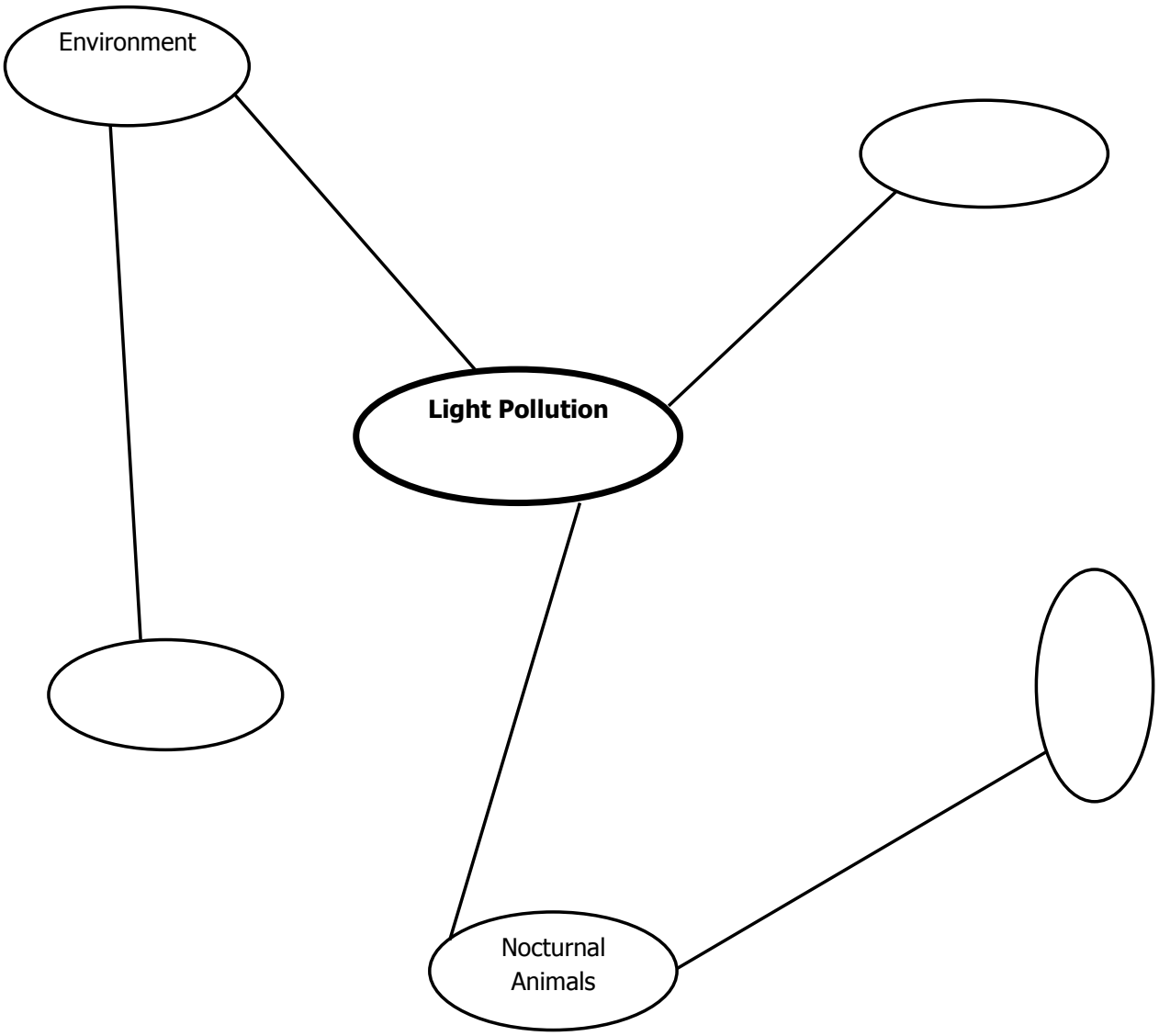
Connect The Dots!

As we learn about light pollution, we need to take the time to appreciate the stars and think about what the world would be like if we could no longer see them!



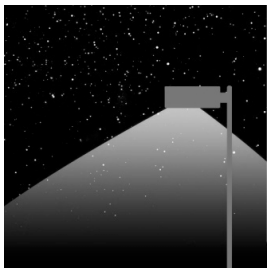
What a Waste of Light!

When people talk about the effects of light pollution, what are they talking about? Are they talking about the effects on the environment and animals? Are they talking about people's health? What about astronomy and being able to see the stars? Or is it all of these things plus more? Brainstorm some ideas about what light pollution is, and what we can do to prevent it. I've started some ideas for you. Fill in the blanks and create your own!

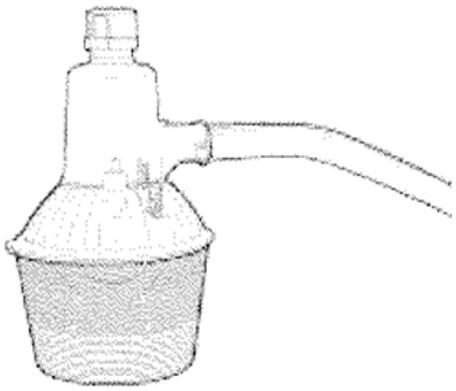


Good Light or Bad Light?

The best kind of lighting fixture is called fully-shielded. This means it cuts off any light from shining up into the sky. It does this by creating a solid barrier that only allows the light to shine onto the ground where it is needed. The picture to the right is a great example of a good lighting fixture! Look at figures A, B, and C below. Check "YES" if it is a good lighting fixture, or check "NO" if it is not.



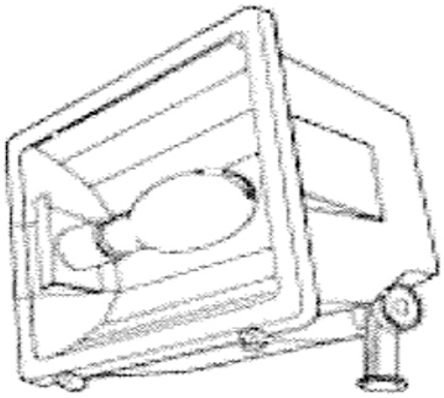
A.



☐ **YES**

☐ **NO**

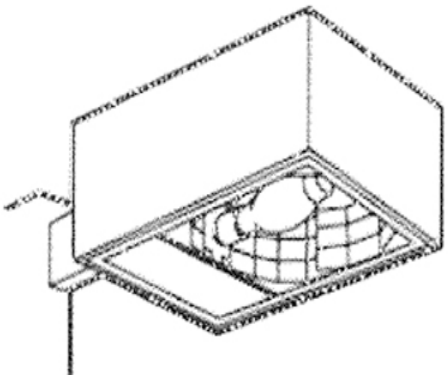
B.



☐ **YES**

☐ **NO**

C.

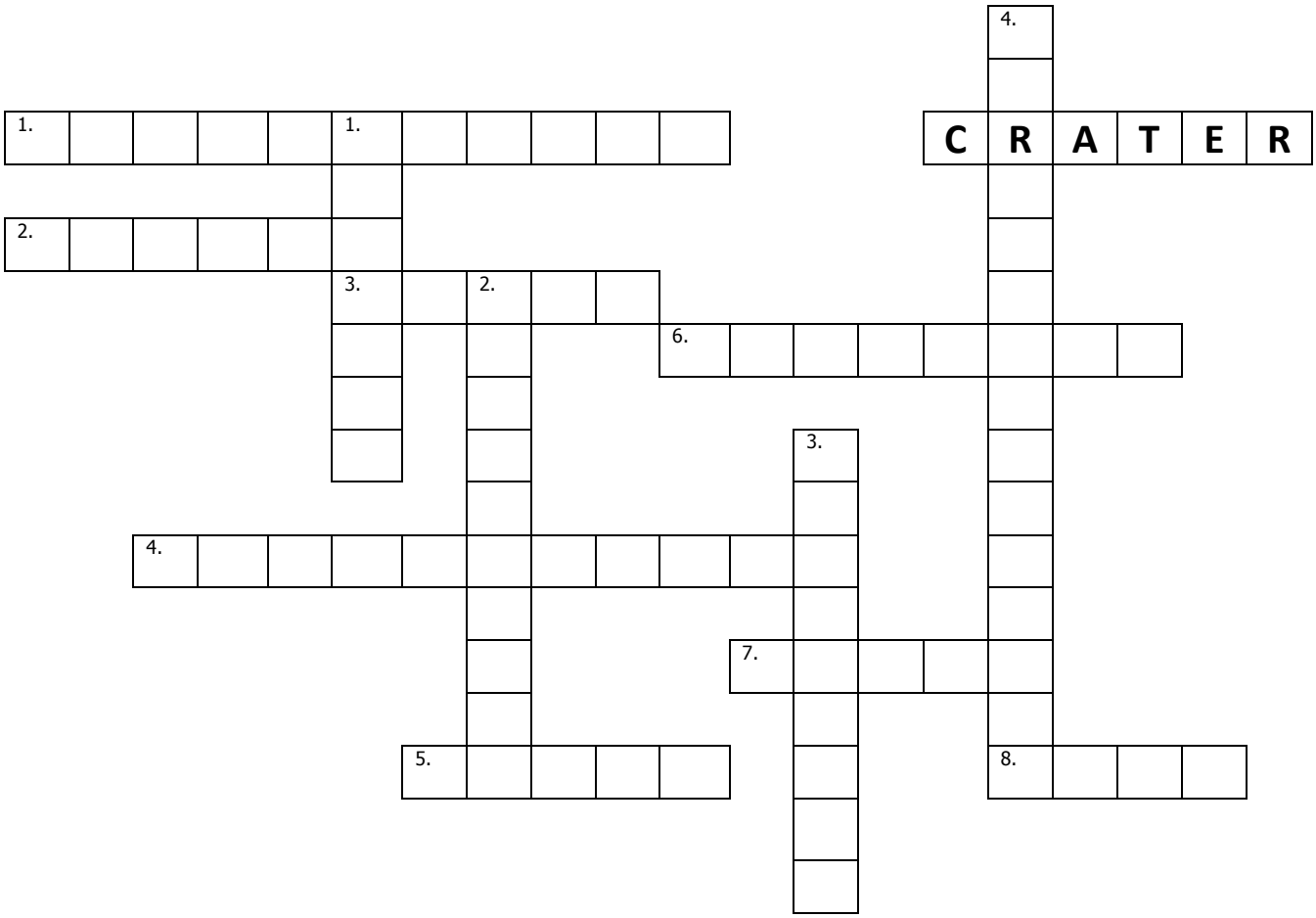


☐ **YES**

☐ **NO**

Hint: Good lighting protects our night environment from light pollution by using fixtures that shine light onto the ground because they are full cutoff or shielded fixtures.

Crossword Puzzle



Across:

1. The _____ includes the sun, planets, comets, meteoroids, asteroids, and dwarf planets, which are all in proximity to the sun. (two words)
2. A collection of stars that orbit around a common center point.
3. An intense and blinding halo of light that causes you to squint.
4. This is the new classification of Pluto. (two words)
5. The second planet from the sun.
6. All _____ need both daylight and darkness for normal functioning.
7. The path that an object in space follows around another object.
8. The red planet.

Word List:
Solar system, Venus, circadian rhythm, galaxy, glare, sky glow, dwarf planet, orbit, asteroids, Mars, atmosphere

Down:

1. A brightening of the night sky by manmade outdoor lighting that blocks the view of the stars.
2. The gases surrounding an object in space, such as the air surrounding Earth.
3. A rock that orbits the sun in the solar system but is too small to be considered a planet.
4. The natural internal, 24 hour clock that human and other creatures have. (two words)

That is Astronomical!

If you could live on any planet, which would it be and why? Why do you think this is a good planet to live on? How would you help prevent light pollution on your new planet?_____

_____

_____

_____

_____

List 5 other animals that are influenced by light pollution:

1.

2.

3.

4.

5.

Why do you think it is important we help keep these animals healthy?

_____
_____
_____
_____
_____
_____
_____

What can you do to help keep all animals safe and healthy?

_____
_____
_____
_____
_____
_____
_____
_____

Light Pollution

ACTIVITY 3

[This activity is based on one developed by Jerry Reed and extensively edited and amended by Dave Crawford.]

Objective

In this activity, students observe the design of outdoor lighting and discuss how this affects the efficiency and effectiveness of the job which the lighting is intended to do and the degree of light

pollution which occurs. More advanced students may also observe and describe the spectrum of the outdoor lighting and how that is related to the effectiveness of the lighting and to the degree of light pollution.

General Information

This activity can be done at the grade 6-12 level. Students at the grade 9-12 level may have been introduced to light and spectra in their science courses, and this activity is a good application. It is safer and more interesting and effective if students work in small groups. The activity can be completed in one or two evenings, plus a class period for discussion. It effectively integrates science and technology.

Background Information

Most of us are vaguely aware of lighting in our environment, but how often have we looked closely at lighting fixtures (even those in our own back yard)? We may have noticed deficiencies in lighting, but not investigated their cause.

Research has shown that many students have deep-seated misconceptions about light and lighting. What happens when yellow light shines on a blue car in a dark parking lot? Can you see a mirror or a bicycle reflector in a completely darkened room? Does light from a given source travel further at night than during the daytime? This activity is useful for dealing with such questions.

What the Students Will Do

- make a study of outdoor light fixtures as scientific, technological, and societal devices
- answer the question: How efficiently and effectively do the lights they observe do their job?

Doing the Activity

1. Go outdoors in front of your house during the evening, and look at your block or the area visible from your home. Make a diagram of your block (or area).

2. Observe all the lights — the lights at your house, at your neighbors' houses, on the street, and any others visible to you. Note *every* one of the them by recording each light's approximate location on your diagram, record what kind of light it is (porch light, security light, street light, decorative yard light, flood light illuminating a tree, etc.), and try to identify the type of lamp. Mercury vapor lamps are a

coldish white. High-pressure sodium lamps are pinkish or amber. Low-pressure sodium lamps are bright yellow. Incandescent lamps are a yellowish white.

3. *[Optional]* Use a spectroscope or diffraction grating to analyze the spectrum and identify the type of lamps you observe ~~(as in Activity 2)~~.

4. Note the following about the lights you observe:

- what kind of fixture the lamp is in (if easily apparent)
- observe how street lights are mounted (on their own pole or on a utility pole...are they "cobra head" or "full cut-off"?)
- estimate the amount of glare (on a scale of 1 to 5, for instance, where 1 is "no glare at all" and 5 is "very glary")
- estimate qualitatively how well the lights do their job by considering their contributions to glare, energy waste, and light pollution

Evaluation

The evaluation should be based on the reports kept by the students, including their ability to record and fully describe the light sources in their neighborhoods.

Closure

The students will become aware of the different types of lighting in their neighborhoods and how well each type of light does its job.

Koyaanisqatsi — Life Out of Balance

The Hopi Indians have a fine word, one that does not exist in English or any other language. It expresses a concept that is so evident in the modern world. It is *koyaanisqatsi*. One translation is "life out of balance." Others are "crazy life," or "life in turmoil," or "life disintegrating," or "a state of life that calls for another way of living."

Descriptions often make better definitions. One such is "A Los Angeles freeway at 4:00 p.m. on a Friday afternoon." Light pollution is another. The environmental problems we all live with, and which are growing daily, are all excellent examples of *koyaanisqatsi*.

An Example: *The Light Pollution Project in the Schools in Greece*

Margarita Metaxa

Arsakeio School of Athens and National Observatory of Athens

The light pollution project in the schools of Greece has been organized through the Greek Ministry of Education and Religion, with funding and support from the "Action III" initiative of the European Community. It began in 1997 and will culminate with a major symposium in Athens on 7-9 May 1999. The project was proposed by the Astrolaboratory of the Second Lyceum of the Arsakeio School of Athens (one of a family of high schools operated by a non-profit organization in Greece), in partnership with two other schools — one in Ioannina, Greece, and one in Manchester, U.K.

The objectives of the project are: (1) to familiarize students (and teachers!) with the scientific and technical aspects of light pollution through a study of astronomy, physics, computer science, and related topics; (2) to expose the students to the cultural and social dimensions of light pollution; and (3) to encourage students to understand and appreciate the effects of light pollution on their heritage and environment.

For maximum effectiveness, the students work in four groups:

- the "astronomical group" studies the astronomical aspects of the problem of light pollution;
- the "lighting group" investigates the nature and design of different types of lighting fixtures and their impact on the problem;
- the "social group" explores the social dimensions of light pollution— the psychological aspects, the effects on ecosystems, and the legal and political channels which can be used to deal with the problem;
- the "public relations group," a team which includes members of the other three groups and who are directed to inform the local authorities, the media, and society, about the problem by organizing special events. The group's ultimate goal is to inform, educate, and influence planning authorities to produce and install efficient, effective lighting systems.

The students who participate in this project receive valuable experience working and collaborating in groups and in taking initiatives, which will enable them to become active decision-makers in the future.

In addition to the three partner schools, a total of 40 schools — 32 in Greece and 8 from abroad, with 76 teachers and 690 students — have joined the project. In 18 Greek cities, local light pollution centers have been organized. These promote efficient, effective lighting in their local areas. In the city of Tarrega, Spain, a light pollution by-law has been passed as a result of the project. Many other organizations and individuals have contributed to the success of the project: the scientific advisory committee, the International Dark-Sky Association, the lighting companies Siemens and Philips Hellas SA, the municipalities in Greece which co-operated with the project, and the individuals who prepared scientific information for the project's web pages.

Much has been learned from the project already. Obviously, light and air pollution have robbed our towns and cities, both large and small, of the beauty of the night sky. Even so, most students, teachers, and the general public are totally unaware of the important and impressive environmental issue of light pollution. The strategy of having students work in four groups has proven to be very effective, as demonstrated by the excellent presentations and posters which were given at meetings held in Athens, Crete, and Manchester at the end of the project's first year.

Links to Other Dark Skies Activities

Activities are from the Let There Be Night program, Paper Plate Education, the International Dark Sky Association, and the 1999 Toshiba/NSTA Laptop Learning Challenge. Web links are given within each activity description.

- **Globe at Night Paper Plate Activity:** Students use a star field of Orion (drilled into a stack of paper plates) to help students find and count the stars of Orion for Globe at Night. See http://analyzer.depaul.edu/paperplate/globe.htm.
- **Heavens Above: Students Activity:** Students draw their impression of night sky highlights to show what's at risk of being lost because of light pollution. See http://www.lettherebenight.com/heavens.html.
- More **Light Shielding Demonstrations:** Students use toy cars, dolls, and a Maglite® flashlight on a town mat to show how common lights create glare, light trespass, and sky glow, all of which can be lessened with simple shields around the lights. There are also a couple of videos. See http://www.lettherebenight.com/maglite.html.
- **LEGO® Block Model Activity:** Using data gathered across the school district, the Student Leadership Teams will make a model out of LEGO® blocks to convey visually how much of the night sky has already been lost. See http://www.lettherebenight.com/blocks.html.
- **Tools for Teachers:** The International Dark-Sky Association (IDA) offers a collection of tools to assist teachers, with activities, lesson plans, learning resources, brochures, and project ideas. See http://www.darksky.org/mc/page.do?sitePageId=59509.
- **At Issue: Light Pollution:** This lesson investigates light pollution in the night sky. Students conduct the investigation using local resources, the Internet, digital cameras, computer-based sensing probeware, and laptop computers. Analysis of the data and synthesis of their discoveries by student investigation teams lead to recommendations for modifications to lighting practices and uses. Student groups make presentations to a panel of city planners and community members. At Issue: Light Pollution is designed for seventh and eighth graders, but could be modified for younger or older students. See http://www.nsta.org/publications/interactive/laptop/lessons/light.pdf.

"Going Further" Dark Skies Projects

These capstone activities take the star-hunting campaigns a step further. Ideas have been brainstormed by the staff at the National Optical Astronomy Observatory, the Let There Be Night program and the International Dark-Sky Association and Drs. Fabio Falchi and Ferdinando Patat.

- The Good, the Bad, the Ugly Lighting Activity: Students critique light designs and describe which light fixtures contribute to light pollution and which are night friendly. This activity can be done on either small or large scales:
  - Conduct a lighting inventory on your school grounds. What lights are necessary, and what could be altered? Justify your recommendations. What would be your proposed savings to the school district?
  - Conduct a lighting inventory in town. For instance, inventory a playing field to see if proper lighting is used and/or monitor when lights are turned off as town ordinances decree.

- Design a facility that will incorporate sustainable design and construction strategies to meet the silver level of certification as designated by the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) program. Report on what it takes for an organization to make the proposed level of commitment to night friendly design. (See the bottom of https://leedonline.usgbc.org/for certification information.)

- Interested citizen-scientists may choose to expand the Sky Quality Meter (SQM) measurements beyond the GLOBE at Night campaign period. There are different types of SQM measurements one can take during the rest of the year — from grid surveys of one's town on one night (repeatable every month), to seasonal surveys, to surveys every hour over a night at one or more location, to surveys of 8 cardinal directions along ones horizon (concurrent with regular SQM measurements or measurements at different angles along one's meridian). One can also use SQMs to monitor places within town like playing fields to determine when lights are turned off or use SQMs to seek out "dark sky oases" within one's town.

- Astronomer Ferdinando Patat of the European Southern Observatory suggests using a Sky Quality Meter to parallel what professional astronomers are doing. "Record the brightness values as the sun goes down, taking note of the time each measurement is done. Keep doing this into the astronomical twilight. Then, you will be able to produce plots like ours and you will be in the condition of judging when the sun contribution becomes negligible." See www.nightwise.org/twilight.htm for details.

- Dr. Fabio Falchi of the Dept. of Astronomy at the University of Padua in Italy writes, "One of the most discussed issue in light pollution is the direct vs. indirect light in producing sky glow. In order to understand better this, I need a number of measures taken with and without snow coverage in the 100 km surrounding the site. Sites far from sources will be affected less by the indirect light while sites near cities or inside cities will be more affected by the indirect. With the SQM reading I'll need also the transparency of the night (at least in a qualitative way: extremely clear, very clear) [and] the snow coverage at the moment of the measure (for example, main streets (10% of total) clean but sidewalks and surrounding covered, secondary streets half covered, countryside and roofs covered). All in a radius of 80 km. Other example: all streets clean, sidewalks still half covered, surrounding in the country covered…. Who would help me in this … can contact me directly..." at falchi at lightpollution.it. [Replace the " and " with "@".]

- Another type of capstone activity encompasses the analysis of the maps. Analysis of the maps could include a comparison with other data sets such as the last couple of years of SQM data and the limiting-magnitude unaided-eye observations, population density, satellite data on nighttime lights (top view looking down versus the SQMs bottom view looking up) and regional environmental concerns (e.g., sea turtles in Florida). Using Google Earth on the GLOBE at Night results webpage enables the citizen-scientist to zoom into an area of interest using these data sets.

- Other capstone activities involve citizen-scientists meeting with their local officials to increase their awareness of dark skies preservation issues and to promote the use of compliant fixtures and shielding. Or involve citizen-scientists in writing letters to the local newspaper, government, and businesses to encourage the installation of shielded lighting in their community. For more information on these types of activities, visit the International Dark-Sky Association at http://www.darksky.org.

"Let There Be Night" Resources to Support Dark Skies Awareness

The *Let There Be Night* introduces light pollution issues with a compilation of a show for small planetariums or classrooms, activities, presentations, stories, videos, songs, images, and ideas that are bundled onto two DVDs with permission of the respective copyright holders. Some of the content is linked from the Web page: http://www.lettherebenight.com/dvd.html. Other content is available only on the 2-disc DVD set, which can be purchased for the cost of duplication and shipping through the Great Lakes Planetarium Association at the GLPA Online Store: http://www.glpaweb.org/zencart5/index.php?main_page=product_info&cPath=2&products_id=29. The content of the 2-disc DVD set includes:

- Let There Be Night original planetarium program (or a stand-alone video as well);
- Saving the Night, written and narrated by David Levy, and re-distributed courtesy of the Southeastern Planetarium Association;
- There Once Was a Sky Full of Stars, written by Bob Crelin and illustrated by Amie Ziner; includes complete narrated video as well as individual components;
- "Ant Dances for Light", a Pacific Northwest Nations story told by Dovie Thomason (Kiowa Apache/Lakota). The Day and Night audio recording, excerpted from the Lunar and Planetary Institute's SkyTellers series, is used with permission of LPI, Thomason, and Lynn Moroney;
- Stars Above, Earth Below, a video capturing the magnificence of the night from Tyler Nordgren's tour of US National Parks; images and narration courtesy of Nordgren;
- Dark Matters, an introduction (~15 minutes) to outdoor lighting issues; video written by John McMahon and produced by Danl DuRall;
- Perpetual Twilight, a PowerPoint presentation for dark sky advocacy; courtesy of the Illinois Coalition for Responsible Outdoor Lighting;
- Stellarium planetarium script on magnitudes and the respective diminishing star fields, courtesy of Karrie Berglund of Digitalis;
- DarkSkies, an animated video segment conveying the impact of light pollution on sidewalk astronomy (right); courtesy of Tim Brothers (astrobrothers at gmail.com);
- Globe at Night teacher and family activity packets, and resources from the National Optical Astronomy Observatory.
- GEMS Observing the Jupiter System activity that simulates the positions of Jupiter's moons as observed by Galileo; courtesy of Alan Gould and Regents of UC.
- Using a Sky Quality Meter (SQM), a student video about using an SQM for Globe at Night; courtesy of Patrick Eme.
- In This Light song; performed by John Kaufmann & Dan Dennis; courtesy of Starball.
- Shoulders of Giants song; courtesy of ©Johannes Kepler Project. Words and Music by Padi Boyd. Performed by The Chromatics.
- Lucifer's Bait song; courtesy of Bandazian.

INTERNATIONAL YEAR OF ASTRONOMY 2009

Dark Skies Awareness Programs for the U.S. International Year of Astronomy

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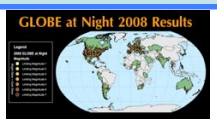
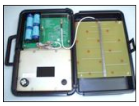
Overview

"Dark Skies Awareness" is one of 11 Global Cornerstone Projects and one of 7 major U.S. themes during the 2009 International Year of Astronomy (IYA2009). The goal of "Dark Skies" is to raise the level of public knowledge about adverse impacts of excess artificial lighting on local environments and help more people appreciate the ongoing loss of a dark night sky for much of the world's population. Toward this end, partners in dark-sky and environmental education worldwide are promoting a range of programs and resource materials developed by the "Dark Skies Working Group" (DSWG). Everyone is invited to use any of these materials as local solutions to a global problem. Information about the programs, resources and DSWG members is at ***www.darkskiesawareness.org.***



3 Citizen-Science, Star-Hunting Programs Year-Round

The three star-hunting programs are fun citizen-science activities that encourage everyone — students, educators, astronomers and the general public — to measure the darkness of their local skies and contribute their observations online to a world map. In the last few years these programs successfully conducted campaigns in which more than 35,000 observations were submitted from over 100 countries. During the IYA2009, citizen-scientists will take data on light pollution levels by comparing and matching what they see toward certain constellations with one of 7 star maps showing progressively fainter stars. For more precise measurements, digital sky-brightness meters can be used. With the location, time, date, measurements are submitted on-line from around the globe, and within weeks a world map showing the results is available. Together the three programs span the entire year: **GLOBE at Night** (March 16-28, 2009), **Great World Wide Star Count** (Oct. 9-23, 2009), **How Many Stars** (January, February, April through September, November and December), with websites at *www.globe.gov/GaN/, www.starcount.org,* and *www.sternhell.at/,* respectively.



Quiet Skies

Radio Frequency Interference, or RFI, is the radio equivalent of light pollution. RFI effectively blinds radio telescopes at certain frequencies, making it impossible to study the Universe at those frequencies. The Quiet Skies project (led by the National Radio Astronomy Observatory) introduces radio astronomy and the need for quiet skies to the public through 2 activities: one with an AM radio and the second with a kit loan program to schools, clubs and museums. Participants measure the RFI levels and with the second activity, enter their measurements into a database. The RFI results will be graphically displayed similar to the striking "Earth at Night" light pollution image. To learn more, visit *www.quietskies.org*.

The Great Switch Out

The Great Switch Out program encourages homeowners to remove and replace their residential light fixtures with ones that are energy efficient and dark sky friendly. The International Dark-Sky Association (IDA) provides a Homeowner's Guide to Outdoor Lighting on fixture recommendations and suggestions for retail outlets at which to purchase these fixtures. For further information, visit *www.darksky.org*, select "Best Choice Lighting" and then select "Homeowners Guide".

On-line Interactions

MySpace and Facebook web pages introduce new audiences to dark-sky issues. The MySpace page on dark-sky preservation is *www.myspace.com/turndownthelight*. With a Second Life® (SL), adults can visit a recreation of Galileo's villa in Arcetri at *slurl.com/secondlife/NASA%20CoLab/151/100/702*. Above this platform in SL is an urban street scene (*slurl.com/secondlife/NASA%20CoLab/161/97/760*) that allows visitors to switch between good and bad lighting to see the impact of their actions. These interim sites, hosted by NASA CoLab, will move to the IYA Island for 2009.

Podcasts

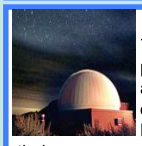
People advocating dark skies preservation are invited to promote their dark skies programs, events, and resources by creating a 5-10 minute audio podcast to submit to the IYA "365 Days of Astronomy" podcasts. Sign up at *365DaysOfAstronomy.org/*.

Displays, Posters and Brochures

These are wonderful ways for disseminating light pollution education to communities during public events. Topics covered are on good and bad lighting and on the effects of light pollution on wildlife, energy, astronomy, safety and glare control. The displays are available through the IDA at *www.darksky.org;* select "Educators/Kids" and then select "IDA Displays". The posters and brochures are downloadable at home or local office supply stores for large scale versions and can be found off of the IDA home page at "Events" and then "IYA2009".

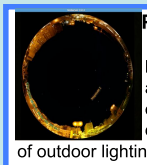
Nights in the (National) Parks

Throughout 2009, many national parks will be holding special programs in celebration of the International Year of Astronomy. Some of the last dark skies in the country can be found in our national parks, and the National Park Service is proud to share the beauty and wonder of the night sky. While the starry canopy will take center stage, event activities are as diverse as the parks. Activities may include meteor watching, telescope viewing, solar viewing, instructional workshops, evening programs, night hikes, nocturnal wildlife watching, tips for protecting dark skies, & storytelling. Visit parks at *www.nps.gov* for more information.



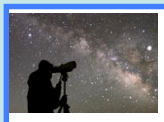
Dark Skies Discovery Sites

The Dark Skies Discovery Sites (DSDS) program seeks to establish permanent relatively dark locations where the public can be educated about light pollution while being introduced to the wonders of a fairly dark night sky. Astronomy clubs or individuals can earn the official DSDS designation for their location by agreeing to present, mostly at their own pace and schedule, an ongoing series of programs about light pollution. More information is at *www.darkskiesawareness.org* and/or *www.astroleague.org*.



Planetarium Program

Let There Be Night (LTBN) introduces students and adults to outdoor lighting issues in conjunction with IYA2009. The planetarium program allows them to experience the starry night that likely inspired the story of Day & Night from the Pacific Northwest Nations. With a dynamic demonstration in the dome, they will also witness how three aspects of outdoor lighting--glare, sky glow, and light trespass--degrade the night. They will describe the trade-offs of outdoor lighting and decide whether and how to act. The planetarium program segues to Orion and supports student participation in the GLOBE at Night star hunt. The LBTN 2-DVD set is also a collection of resources—videos, activities, songs, images, a website, and more—for dark sky advocates and anyone who would like to use the resources. Visit *www.LetThereBeNight.com/*.



Earth and Sky Photo Contest

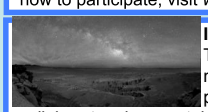
The photography contest is open to any amateur photographer of any age, anywhere in the world. Photographs should focus on elements of the night sky (e.g., stars, planets, moon or celestial events) set against the backdrop of a beautiful, historic, or notable location or landmark. The special theme of this contest is "Dark Skies Importance"; so the image should try to impress people about how important and amazing the starry sky is, how it affects our life, and how bad the problem of light pollution has become. See *www.darkskiesawareness.org* or *www.TWANight.org* for more on the contest.

Earth Hour

Millions of people in cities across the U.S. and around the globe turned their lights off for 1 hour on Saturday, March 29, 2008 to make an unprecedented and highly visible global statement in support for action on climate change, energy conservation & light pollution. The organizer, the World Wildlife Fund, is gearing up for next year's Earth Hour on March 28, 2009 from 8:30-9:30pm, on the last night of GLOBE at Night. More info at *www.EarthHour.org*.

International Dark Sky Week & the World Night

National Dark-Sky Week (NDSW) is an event usually occurring in April in the U.S., during which people are encouraged to turn out unnecessary outdoor lights to reduce light pollution. NDSW and the Starlight Initiative are collaborating in the launch of the "World Night in Defence of Starlight" as the first night of the International Dark Sky Week, April 20-26, 2009. For more information on how to participate, visit *www.starlight2007.net/20April2009.html* and *www.ndsw.org/*.



International Dark Sky Communities, Parks & Reserves

To promote the establishment of special protection areas for natural night skies and to honor exceptional commitment to preservation of darkness, IDA with a number of international collaborators have established a certification program. See *www.darksky.org;* select "Policy/Programs" and then IDS Communities, Parks and Reserves.

The National Optical Astronomy Observatory is operated by the Association of Universities for Research in Astronomy (AURA) under cooperative agreement with the National Science Foundation.

Other Resources on the GLOBE at Night Web Site

- Find out what *light pollution* is all about. Visit the GLOBE at Night Web page: http://www.globe.gov/GaN/learn_light.html.
- What is the *magnitude* or brightness of a star? Visit the GLOBE at Night Web page: http://www.globe.gov/GaN/learn.html.
- Find out how *latitude* and *longitude* gives you your location on Earth. Visit http://www.globe.gov/GaN/observe_latlong.html. Find out how you can determine your latitude and longitude when you are ready to observe.
- How do you *find Orion* in the night sky? Visit the Web page: http://www.globe.gov/GaN/observe_finder.html.
- To help you observe during GLOBE at Night, *magnitude charts* can be found on the Web page: http://www.globe.gov/GaN/observe_magnitudeEqu.html.
- The following games and interactives *for students* can be found at http://www.globe.gov/GaN/student.html:

What does light pollution look like? What does your nighttime sky look like? Try this fun interactive game to see how light pollution effects the stars you see at night: http://www.globe.gov/GaN/learn_orionsky.html		**Can you find Orion?** Try this quick game to see whether you can pick out the great hunter Orion in a starry sky: http://www.globe.gov/GaN/learn_findorion.html	
Making a Red Light How can you make a red light from a flashlight to observe stars at night? http://www.globe.gov/GaN/redlight.html		**Orion Mythology** The ancient Greeks saw the figure of the Greek myth Orion in the nighttime sky. Learn more about his story at http://www.globe.gov/GaN/learn_orionmyth.html	
GLOBE at Night Observation Practice Test your knowledge of the magnitude charts with this 5 question quiz: http://www.globe.gov/GaN/observe_practice.html (Adobe Flash Player required)		**Report your observations!** Report your observation along with others from across the globe: http://www.globe.gov/GaN/report.html