

ArcGIS Lighting Inventory User Manual for Dark Sky Parks

Glacier National Park



KEEPING THE PARK DARK:

Facilitating Dark Sky Status in Glacier National Park



WPI

ArcGIS Lighting Inventory User Manual for Dark Sky Parks

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LIGHT FIXTURE INVENTORY GLOSSARY

Attribute	Data field used to gather information about a light fixture
Astronomical Twilight	When the geometric center of the sun is 18 degrees below the horizon, the last phase before night
Lamp	A device for giving light: one electrical bulb
Luminaire	A light fixture that contains an electrical lamp and provides illumination
Luminaire Control	How the luminaire is controlled or operated
Luminaire Type	How the luminaire is mounted
Measured CCT	The correlated color temperature of the light measured with an instrument such as a spectrometer
Operating at Night	If the luminaire is emitting light during a night visit
Principle Investigator	Group title of data collector
Rate of Backlight	Light escaping the area of interest behind the light fixture
Rate of Glare	Light escaping the area of interest on the sides of the light fixture
Rate of Uplight	Light escaping the area of interest above the light fixture
Shielding	Physical barriers of the light fixture preventing uplight or sidelight (glare)
Specified CCT	The correlated color temperature of the light determined by labeled bulb specifications or electrical records
Task	The main purpose of the light/what the light is trying to illuminate
Trespass	Light present outside of the designated task area

OVERVIEW OF INVENTORY PROCESS

The overall inventory process includes three main steps:

1. Preliminary planning and preparation
2. Gathering day data
3. Gathering night data

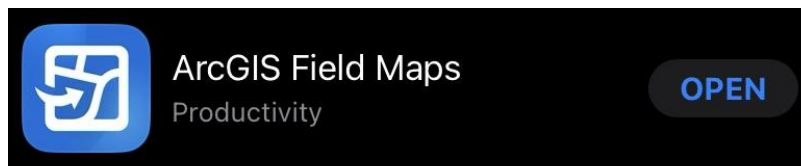
Using ArcGIS for a Lighting Inventory

Geographic Information Systems, or GIS, software overlays layers of geospatial information, such as buildings, terrain, and streets, to be analyzed and shared. These 'layers' can contain many types of information as long as there are GPS coordinates attached to the data. This gathered data can be utilized as an inventory system and can relay important attributes used to determine a park's compliant lighting percentage. ArcGIS utilizes and overlays lighting fixture GPS points over a building layer of Glacier National Park.

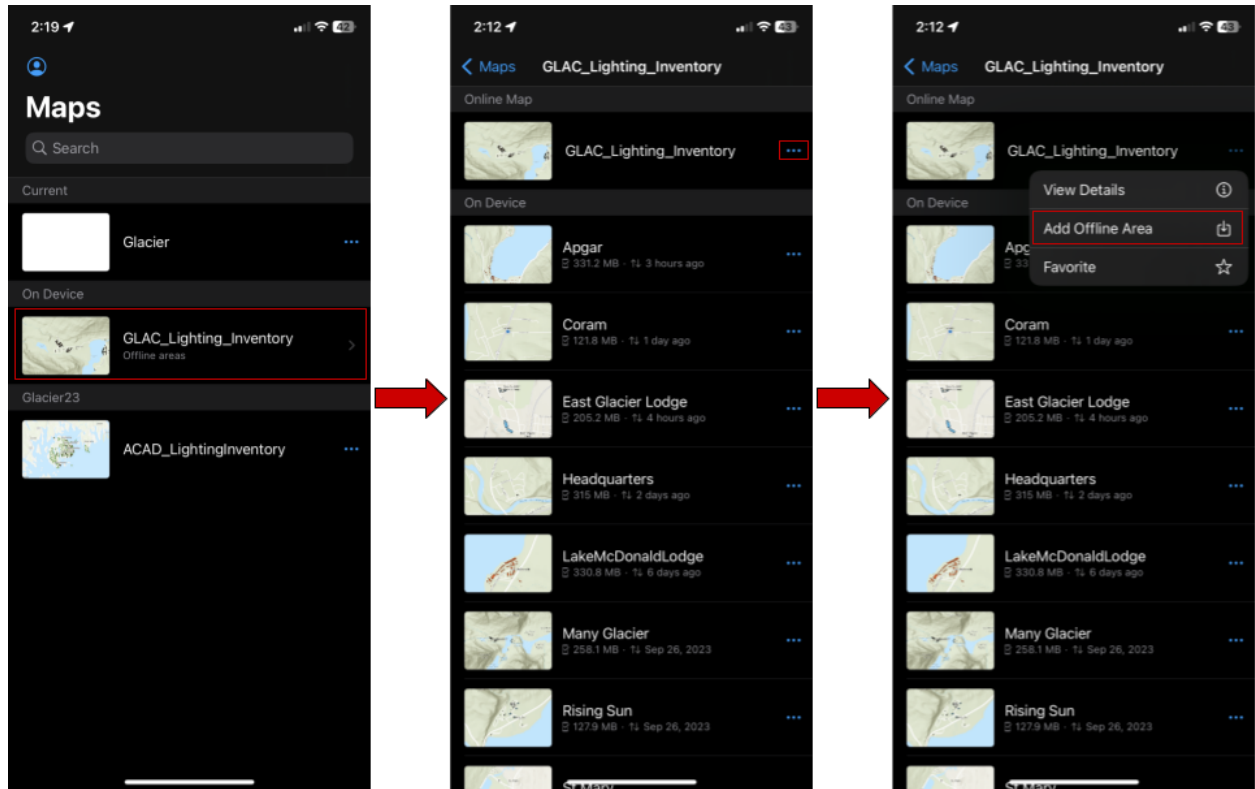
PRELIMINARY PLANNING AND PREPARATION

Download Offline Map Area

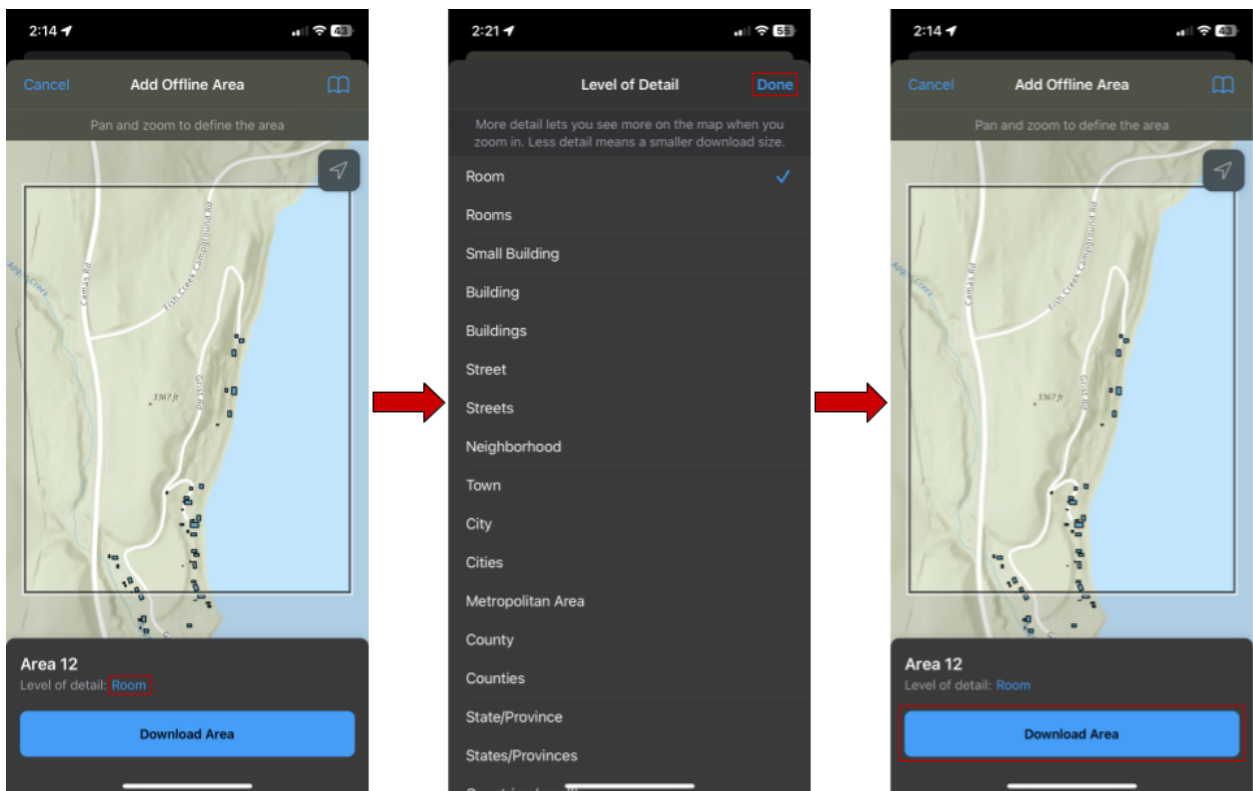
1. Choose a device to use and download the "ArcGIS Field Maps" app. The best devices to use are smartphones or tablets, but a laptop could be used if necessary. Ensure that your device is connected to wifi or cellular data. Open the ArcGIS Field Maps app and log in using your ArcGIS account provided by Glacier National Park.



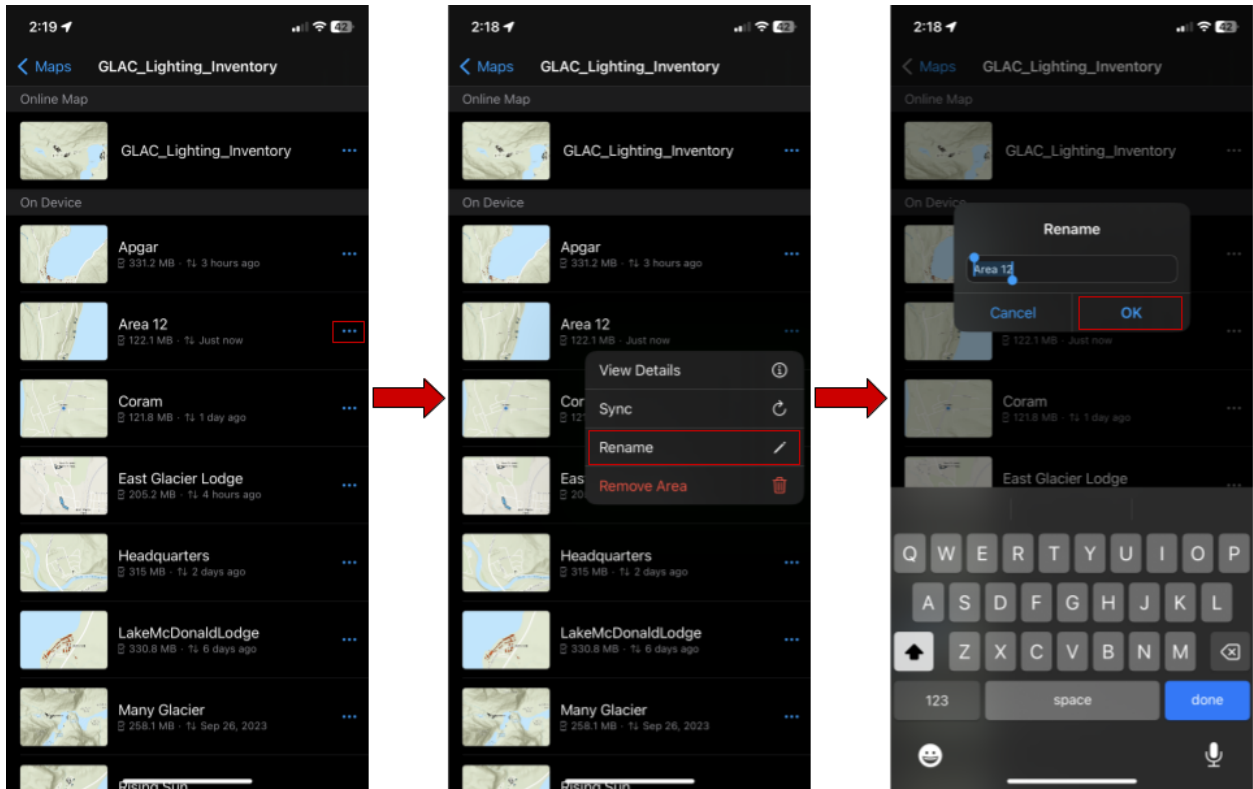
2. After logging in, the "Maps" section will be displayed. Click on the map labeled "GLAC_Lighting_Inventory." This map will show up on your phone automatically as long as you are a member of the ArcGIS group and are authorized to edit.
3. The ArcGIS map of Glacier will be displayed under "Online Map". Click on the three dots next to "GLAC_Lighting_Inventory", and press "Add Offline Area" to load a new area onto your device.



4. Once in the “Add Offline Area” tab, move the displayed box to the planned inventorying location.
5. Click on “Level of detail” and select one of the listed options depending on the size of the area you are inventorying to change the size of the downloaded area. For most of the areas in the Park, the default “Room” option can encompass the entire area.
6. Move the box to encompass the entire area that you are planning to inventory. Once the area to be inventoried is fully encompassed in the box, press “Download area.”



- Once the area to be inventoried has been downloaded, the offline map will be accessible under “On Device” of the GLAC_Lighting_Inventory map.
- To rename the downloaded map, press the three dots next to Area_x (which is the area you just downloaded.) Press “rename”. Finally, type in the name of the location and press “OK.”



GATHERING DAY VISIT DATA

"Day Visit" Equipment

- Data collection devices (smartphone, tablet) with the downloaded offline ArcGIS Field Maps area
- Paper map of inventory area (optional)
- Clipboard and pen/pencil (optional)
- Safety vest
- Bear spray
- Portable battery charger for data collection devices

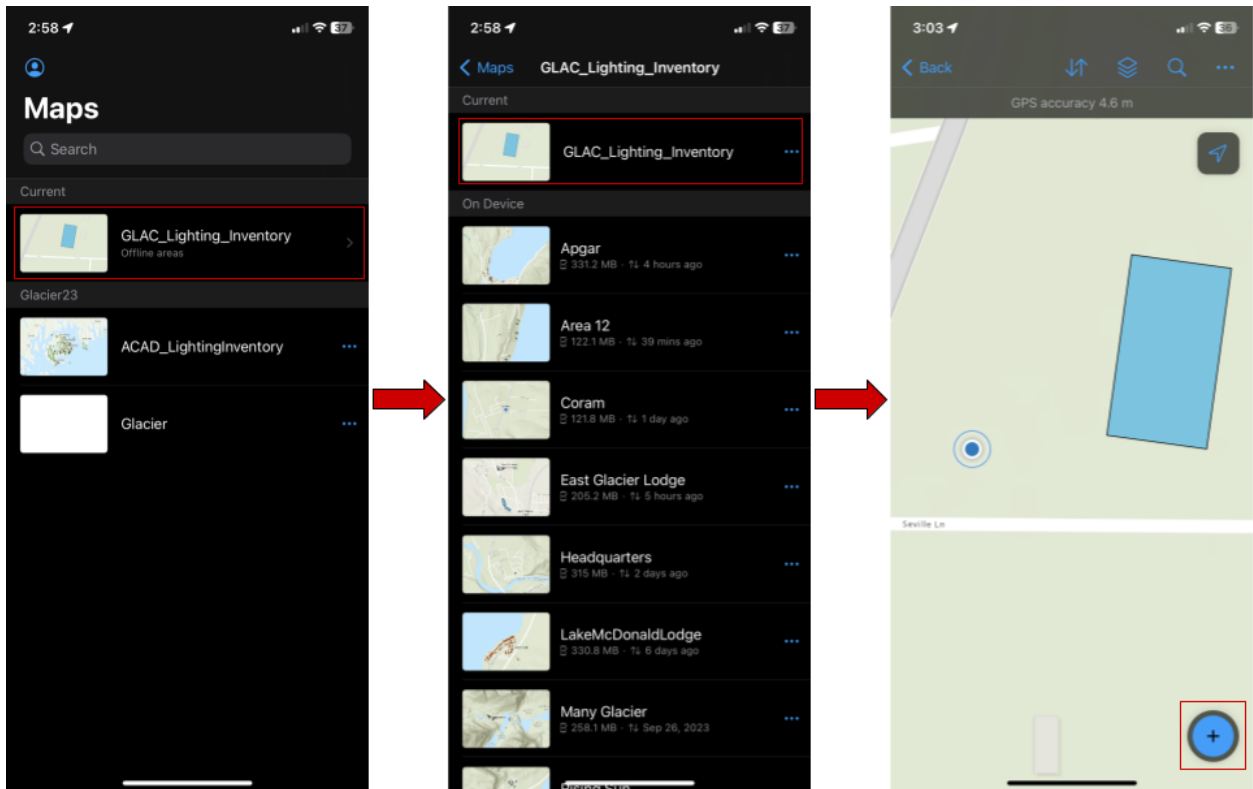
"Day Visit" Attributes

The main light fixture data collected during the day includes:

- The GPS coordinates of the fixture
- Photographs of the light fixture (and bulb if possible)
- The principle investigator
- Time and date of day visit
- Height of light fixture in meters (m)
- Task of the light fixture
- Luminaire type
- Number of lamps
- Type of lamp
- Luminaire control
- Shielding
- Specified CCT
- Recommended Action
- Notes about the light fixture.

The stepwise instruction for gathering day data are as follows:

1. Open the “Field Maps” app on your recording device.
2. Under “Current,” press “GLAC_Lighting_Inventory.”
3. Under “On Device” press the offline map where the light fixture is located
4. Stand directly under the light fixture being gathered (if standing under the fixture is not possible, stand as close as you can) and press the “+” button located in the bottom right corner of the map.

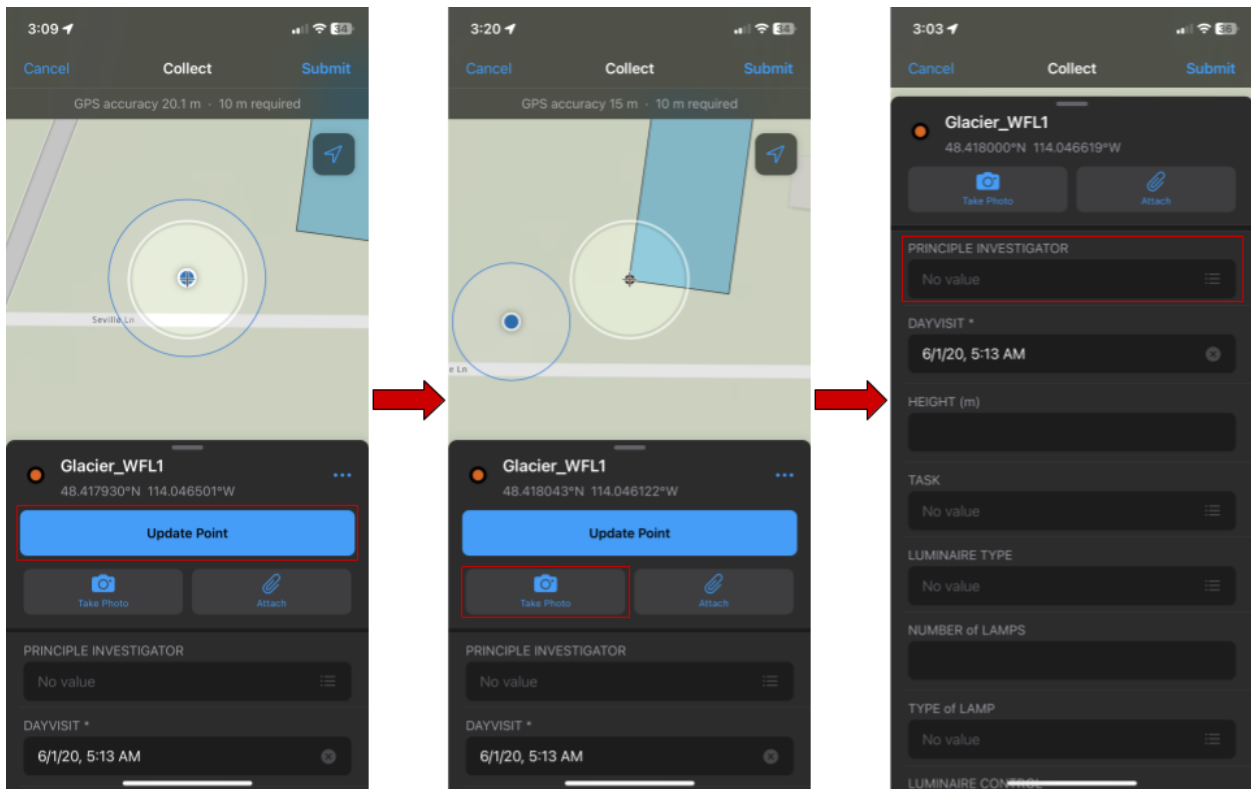


5. If unable to stand directly under the light to get the exact GPS location, move the cursor to the position where the fixture is located on the building layer and press “Update Point.”
6. Press “Take Photo”, and take a close-up picture of the bulb (if possible), a close-up picture of the light fixture, and finally a picture of the light fixture displaying the task of the fixture.

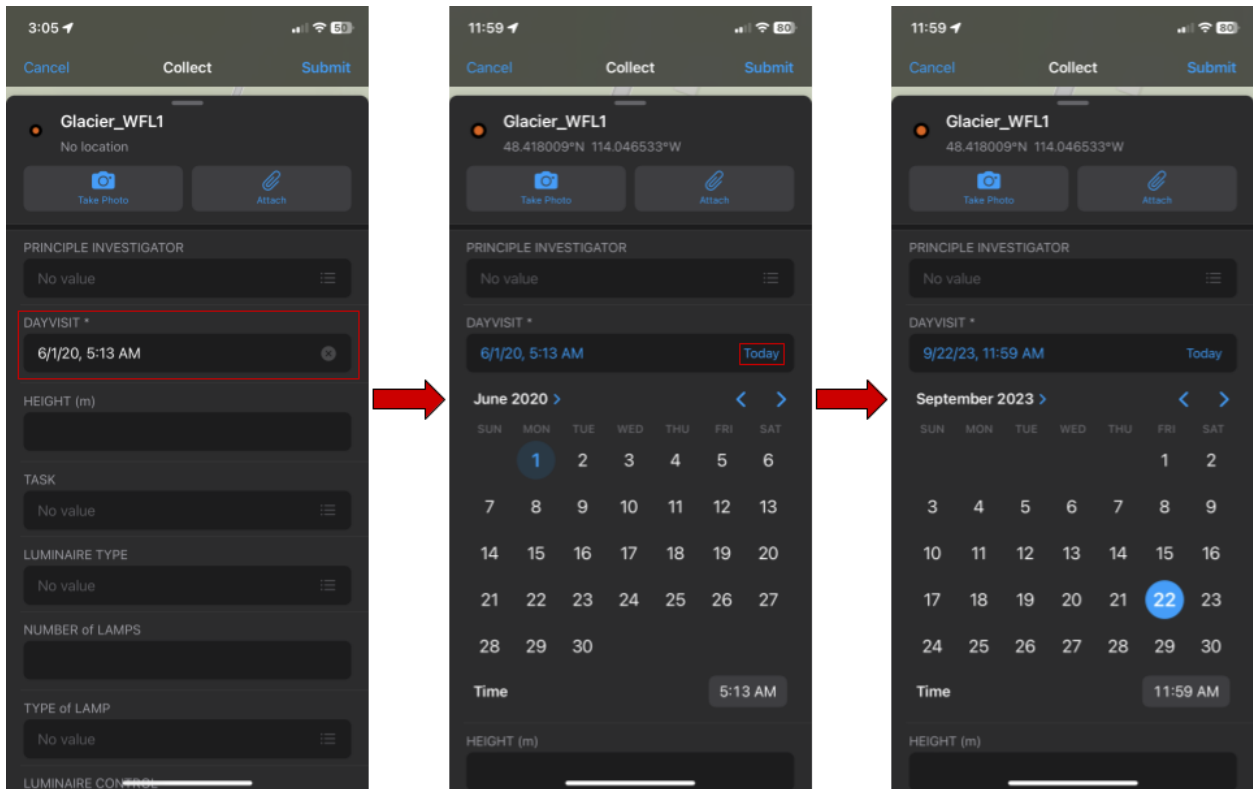


Examples of pictures of light fixtures, displaying a close up of the fixture (left); one a closeup of the bulb (center); and the fixture and its task area (right).

- Under "Principle Investigator" enter the correct value. If you are a National Park Service Employee, select NPS. If you are a student or volunteer, select volunteer.



8. For “DAYVISIT,” press the displayed date and time, then press the blue “Today” text to update the value to the correct time and date.



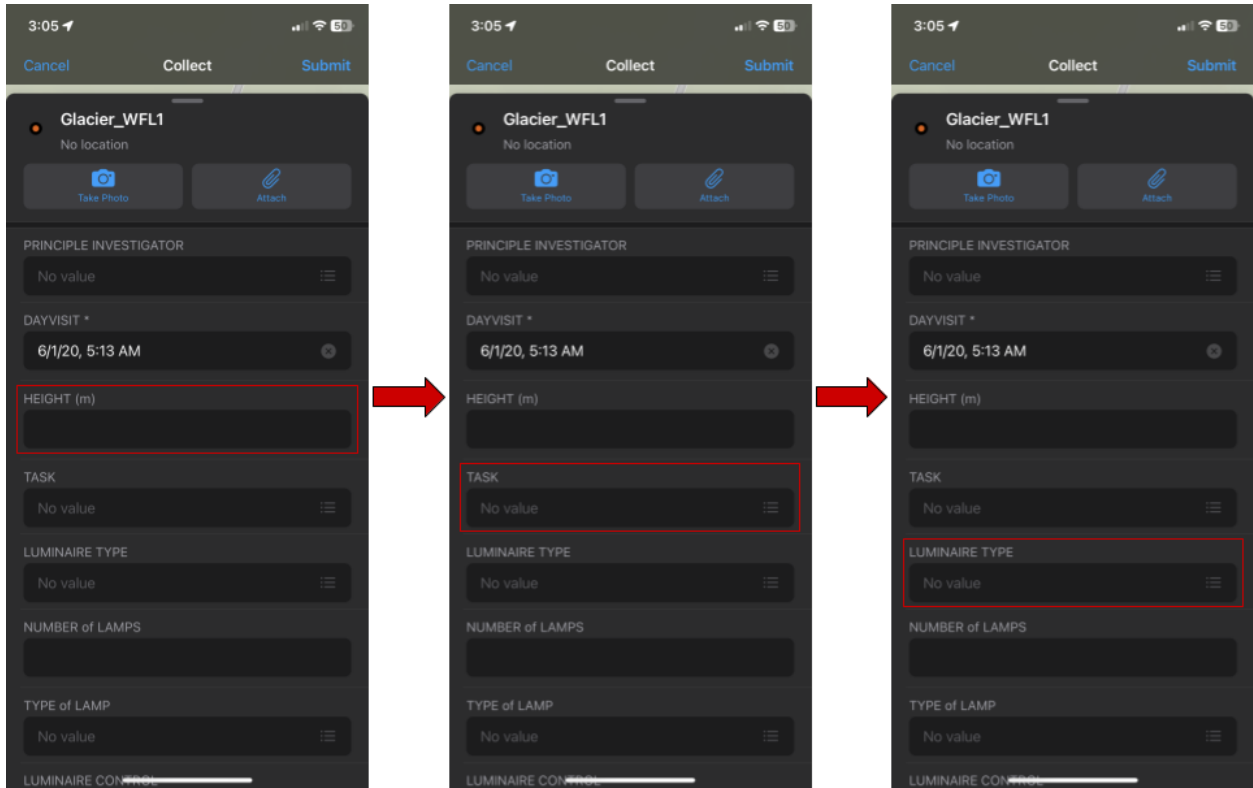
9. Press “Height (m)” and estimate the height to the nearest half meter value. If the light fixture is above a porch or set of stairs, estimate the height from the base of the porch or stairs, not the ground.

10. Enter the task, or the light fixture’s purpose, under “Task.”

Option	Example	Option	Example
Decorative	Holiday lights	Other	
Roadway	Road without sidewalks	Monument	Lighting up a monument
Wayfinding	Lights at end of docks, buoy	Signage	Lighting up a sign
Area	Lighting up a seating area, or sport court	EntranceEgress	Lighting up a doorway for Safety (prevent tripping)
Unknown		Interpretive	
Parking	Parking lot	Pathway	Lighting up a pathway (not connected to a road)
Hazard	OSHA required lighting (fueling stations, propane tank storage)	StreetLighting	Lighting with pedestrian focus (streets with sidewalks or crosswalks)
Flag	Illuminating a flag		

Note. Table depicting the different options under the “Task” attribute and examples of when to select each.

11. Under “Luminaire Type” enter the type of light fixture.

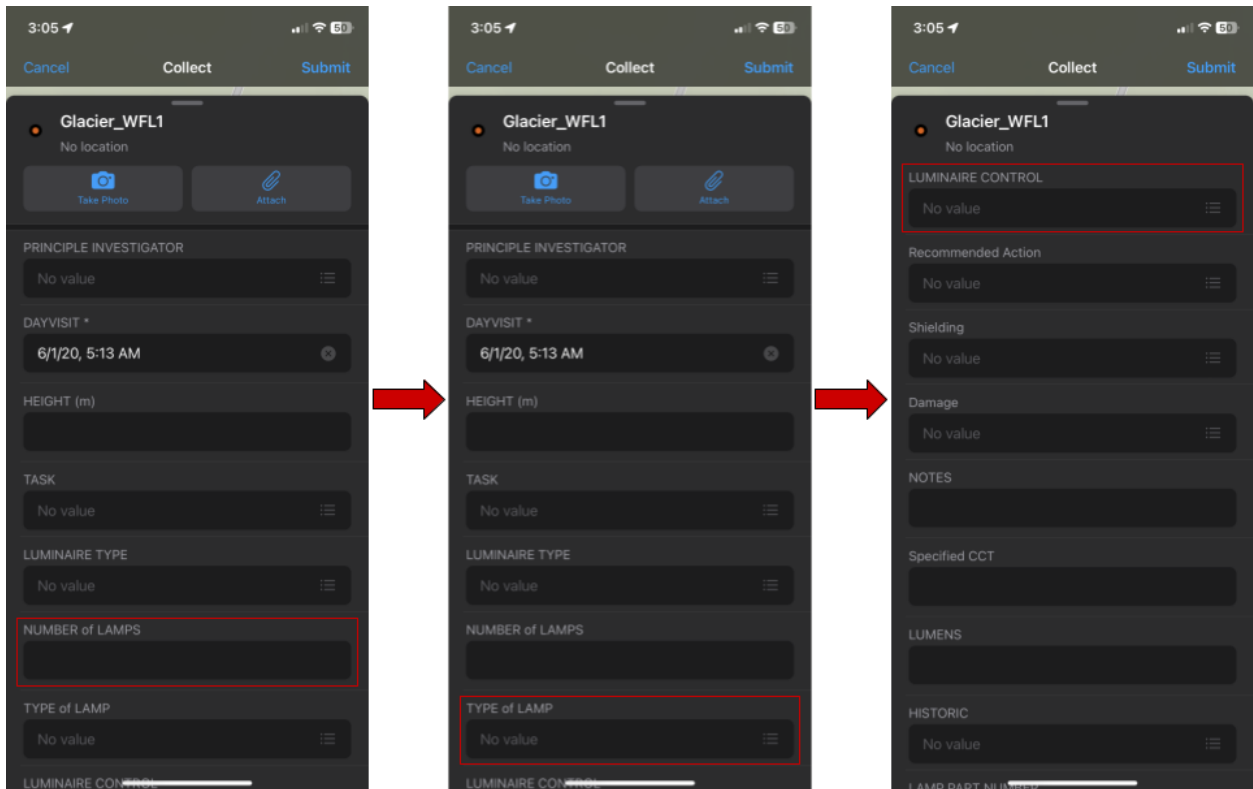


12. Enter the number of bulbs under “Number of Lamps.”
13. Under “Type of Lamp” enter the correct bulb type. If unsure, select “Unknown.”

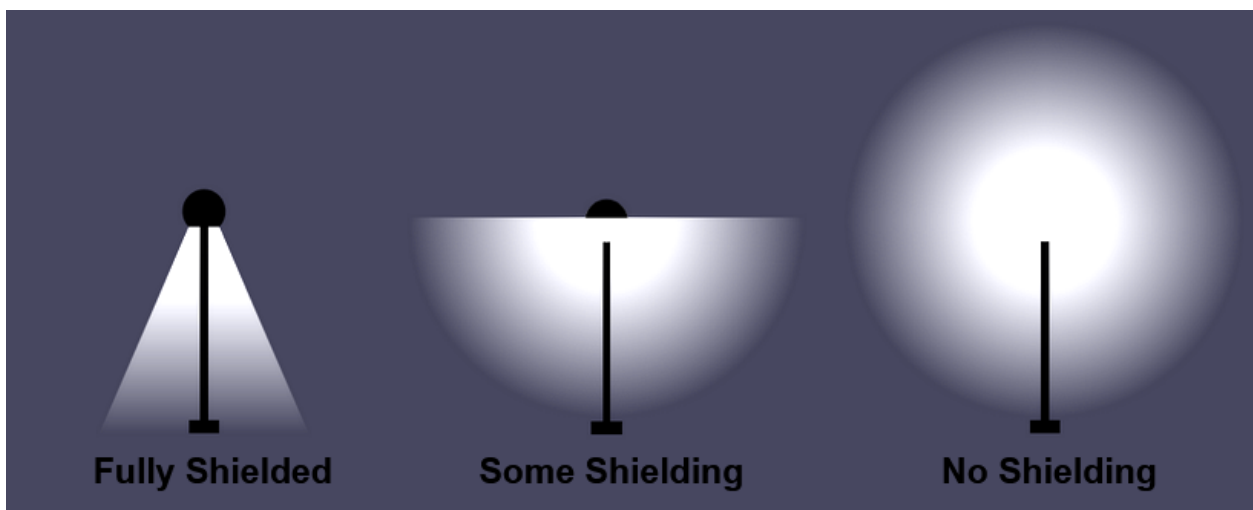


Note. Examples of different bulb types (Types of Lightbulbs, 2023).

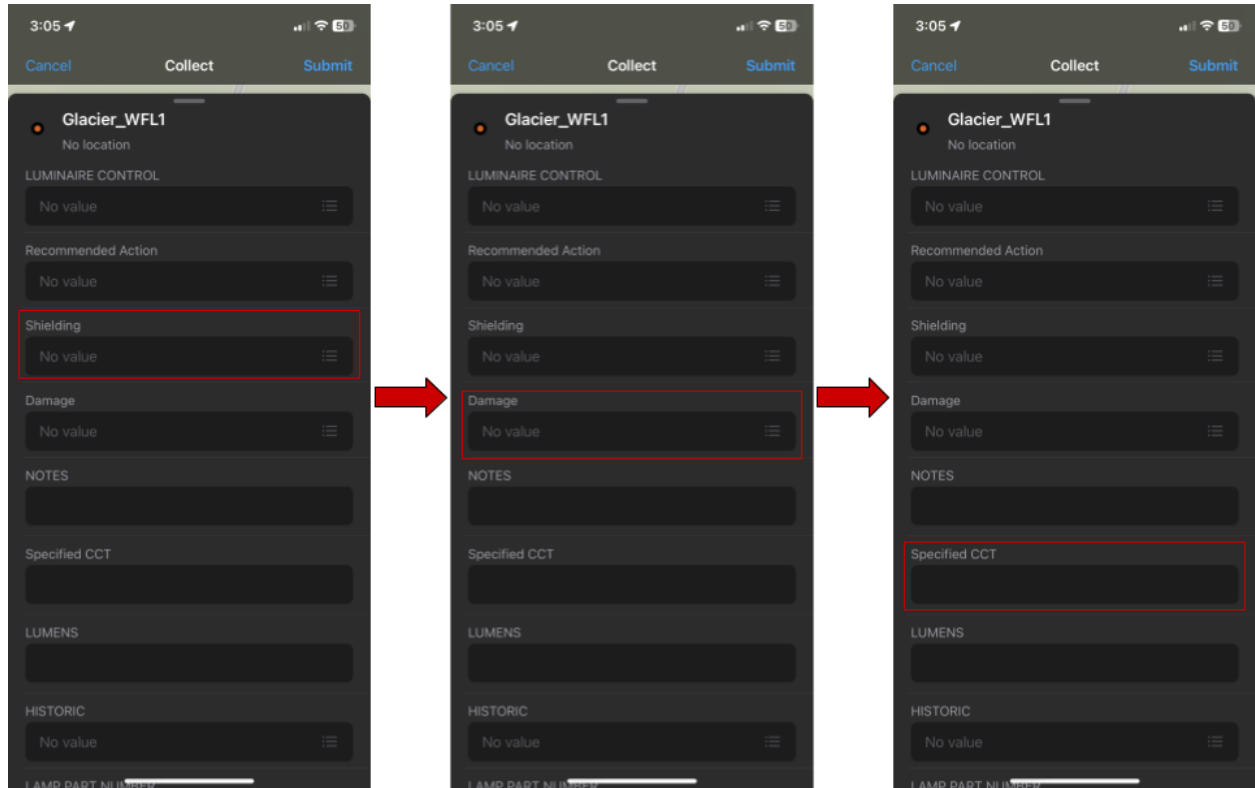
14. Enter how the light fixture is controlled: either by a motion sensor, a solar (photo) sensor (commonly on light posts), a switch (if it's on a house), or another control listed under "Luminaire Control". If you are unsure, select "Unknown."



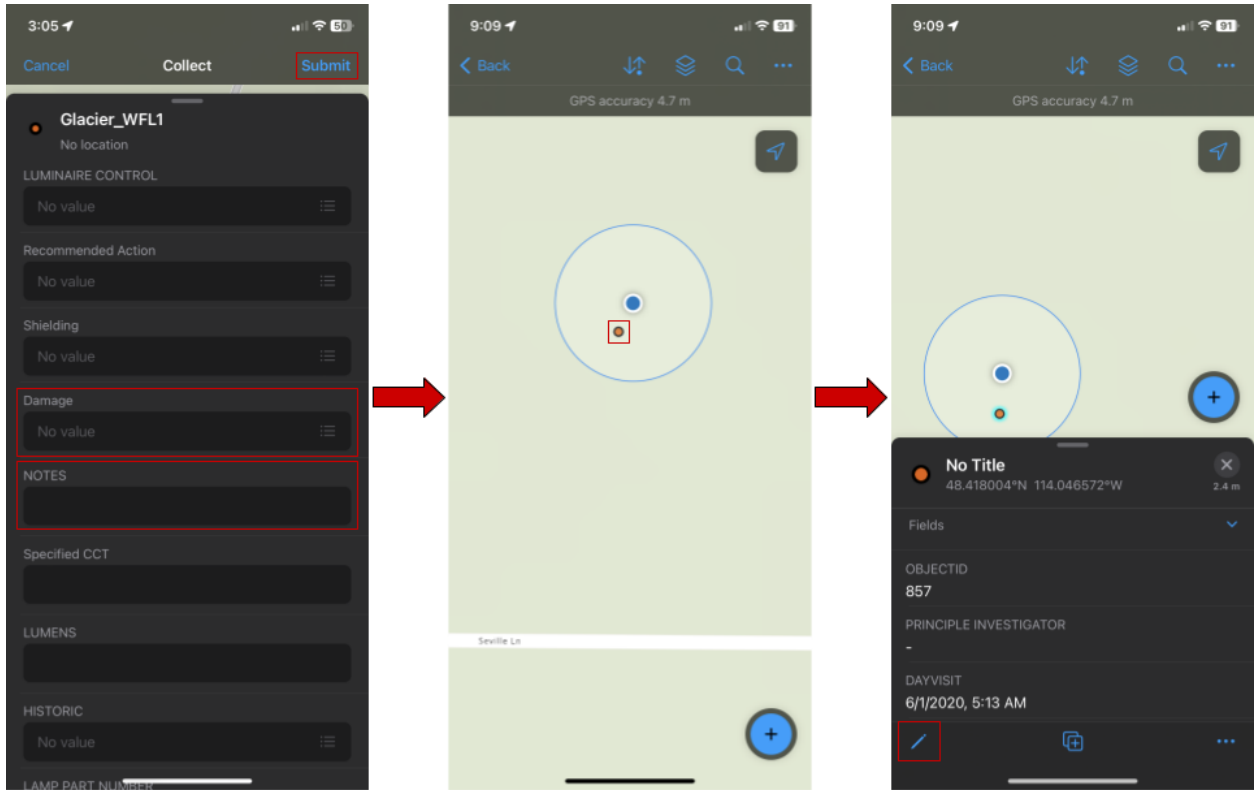
15. Enter the shielding status of the light fixture. A shielded light is a bulb that is not visible at eye level of the light fixture.



16. Enter the correct value under “Damage.”
17. Enter the CCT value labeled on the bulb under “Specified CCT.” If you cannot reach the bulb or cannot find the CCT on it, leave this attribute blank.



18. If necessary, enter other important observations into “Notes.” If you have a recommendation for the fixture, select “retrofit”, “replace”, or “remove.” If you have no recommendation, select “no action.”
19. Press “Submit” to add the data point to the offline map.
20. If necessary, click on the data point, and then click on the pencil symbol “ ” to edit.



21. Refer to **SYNCING OFFLINE MAPS TO ONLINE MAPS** to sync the offline data.

GATHERING NIGHT DATA

"Night Visit" Equipment

- Data collection device with downloaded offline map
- Fully charged UPRtek MK350 N Premium Spectrometer
- Printed out map of planned and sectioned route (Optional)
- Headlamp/Flashlight
- Clipboard (Optional)
- Safety vest
- Bear spray
- Portable charger

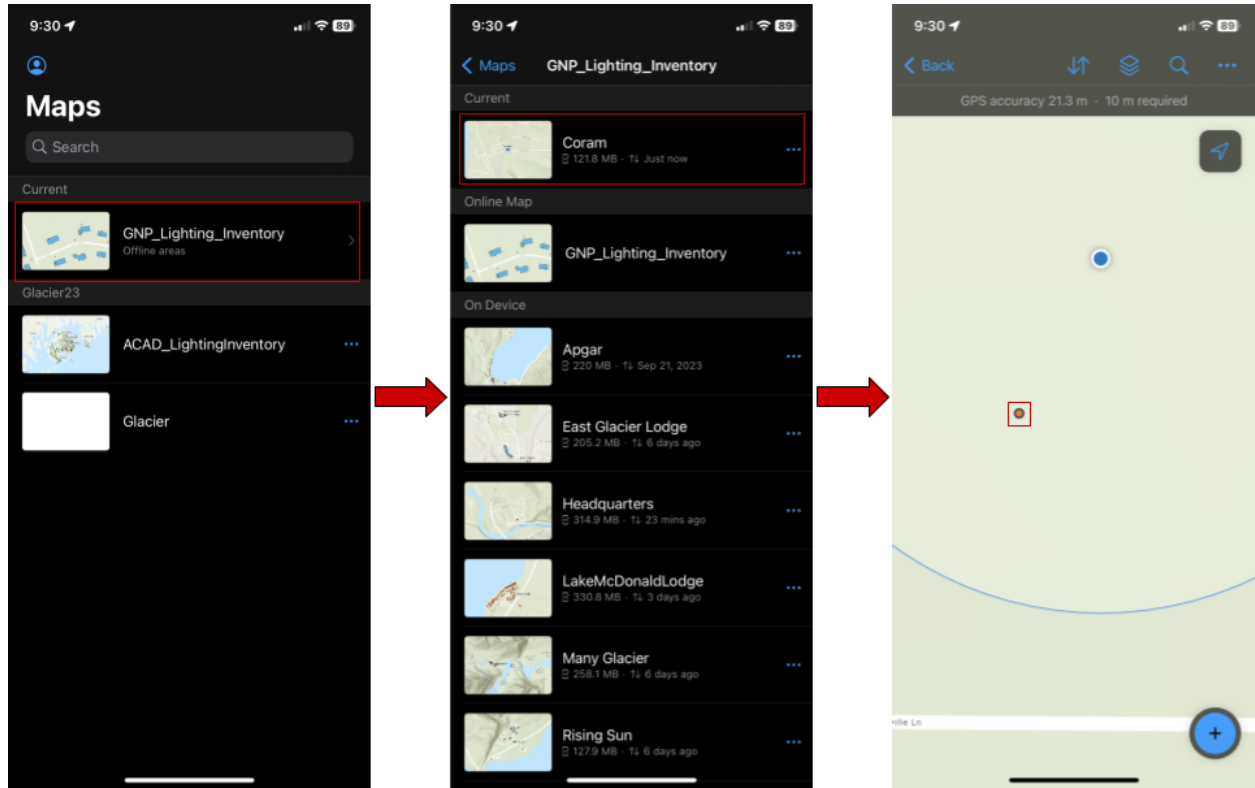
"Night Visit" Attributes

The main lighting attributes collected during the night include:

- Determining if the light operates at night
- Rate of glare
- Rate of backlight
- Rate of uplight
- Trespass
- Measured CCT of the light fixture

The stepwise instruction for gathering night data are as follows:

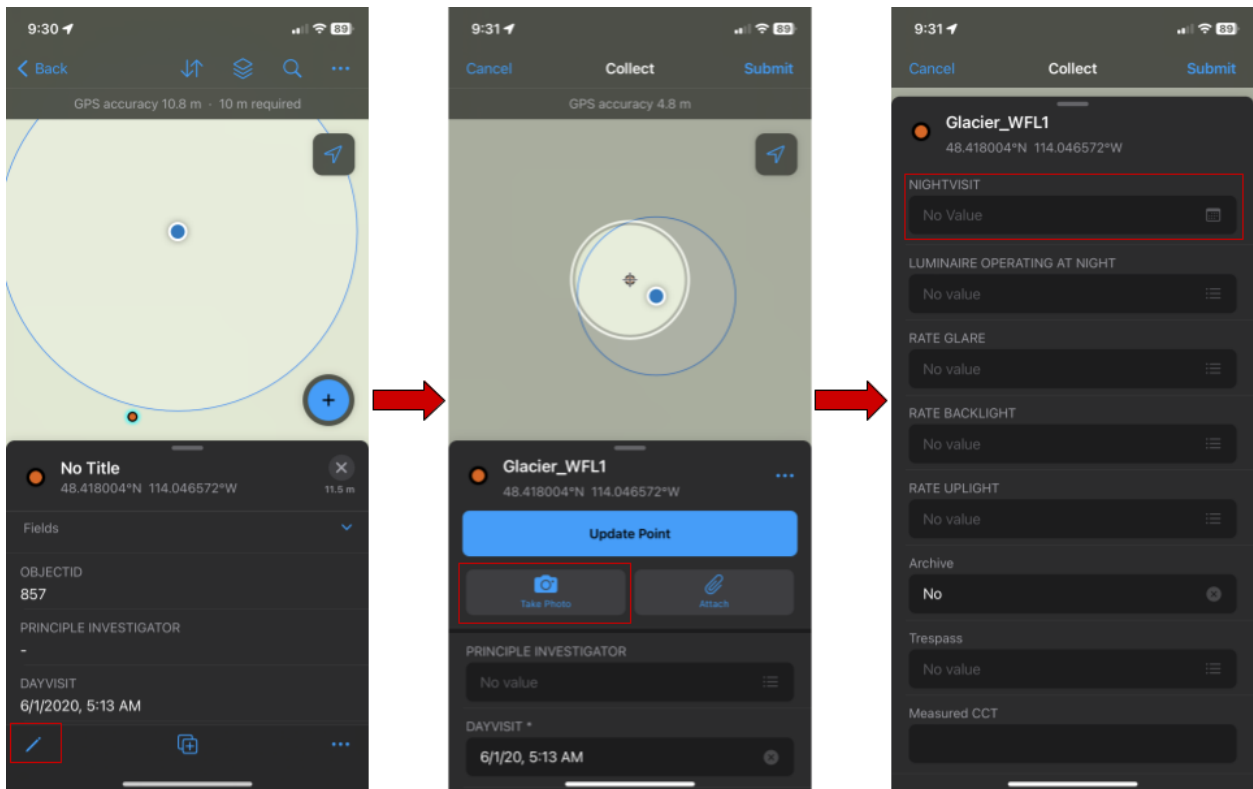
1. Open the "ArcGIS Field Maps" application once in the field on the data collection device.
2. Press "GLAC_Lighting_Inventory."
3. Under "On Device" press the offline map where data is being collected in the park.
4. Once you are near the light fixture being inventoried, press the data point of the light fixture on the map.



5. Once the attributes of the data point are on the screen, press the “ ” icon located in the bottom left of the screen to edit the data point.
6. Take a photo displaying the light fixture completing or failing its task.



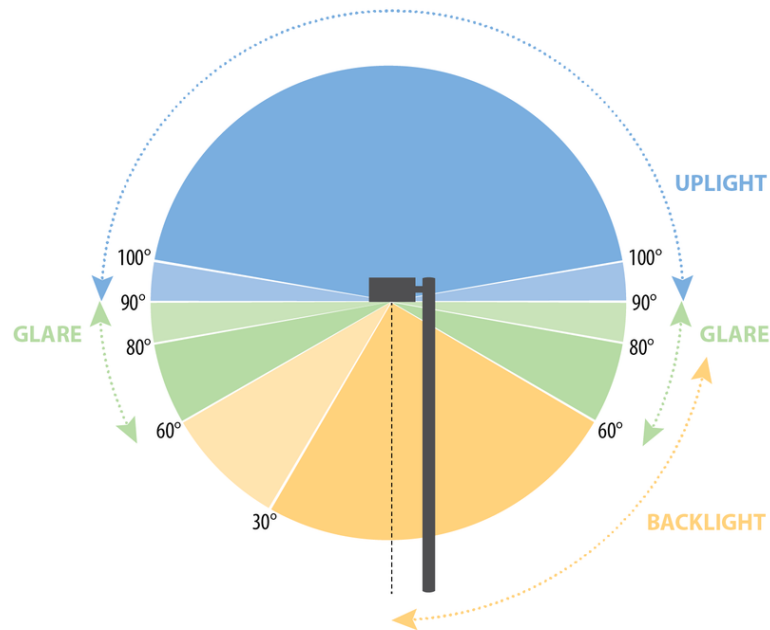
- Once a photo is taken, edit the "NIGHTVISIT" value by pressing the attribute. The date and time should update automatically.



- Enter whether the luminaire is on or off under the attribute "Luminaire Operating at Night". If the luminaire isn't operating at night, skip to step 11.
- Enter a value for "Rate Glare", "Rate Backlight", and "Rate Uplight" as observed.
 - The options for "Rate Glare" are "None," "Task Area," or "Beyond Task Area." Glare is defined as light shining between 60 and 90 degrees up from the point on the ground directly below a light. Select "None" if there is no glare, "Task Area" if glare is limited to the task area, and "Beyond Task Area" if glare goes further than the light's task area.
 - The options for "Rate Backlight" are "Unknown," "Negligible," "Moderate," and "Severe." Backlight is defined as light falling behind the task area. Select "Unknown" if you are unsure of the rate backlight. Select "Negligible" if there is no backlight or if backlight is blocked by

an object such as a building. Select “Moderate” if backlight is present but not extreme. Select “Severe” if backlight is extreme.

- 9.3. The options for “Rate Uplight” are “Unknown,” “Negligible,” “Moderate,” and “Severe.” Uplight is light that falls above the task area. Select “Unknown” if you are unsure of the rate uplift. Select “Negligible” if there is no uplift. Select “Moderate” if uplift is present but there is some shielding. Select “Severe” if uplift is extreme and there is no shielding.

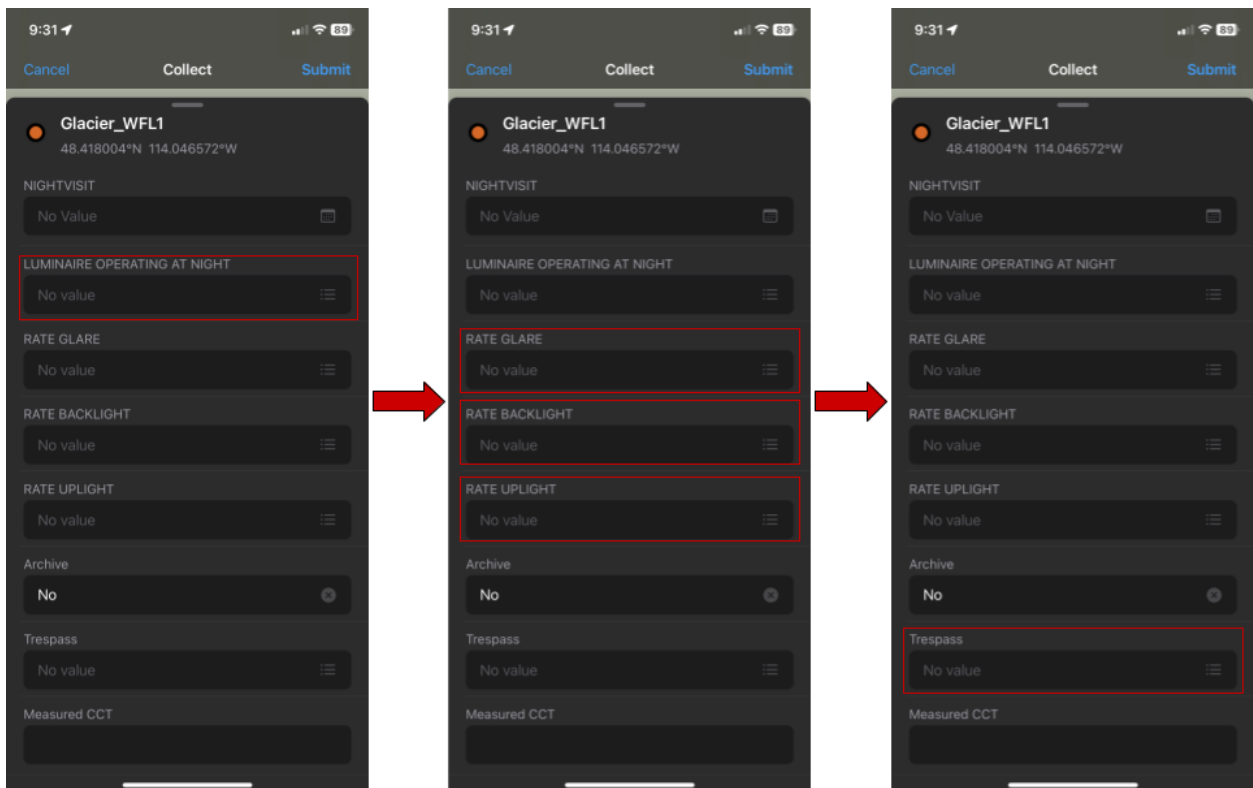


Note. Diagram displaying three attributes of the ArcGIS system, the backlight, glare, and uplift (Sullivan, 2023).

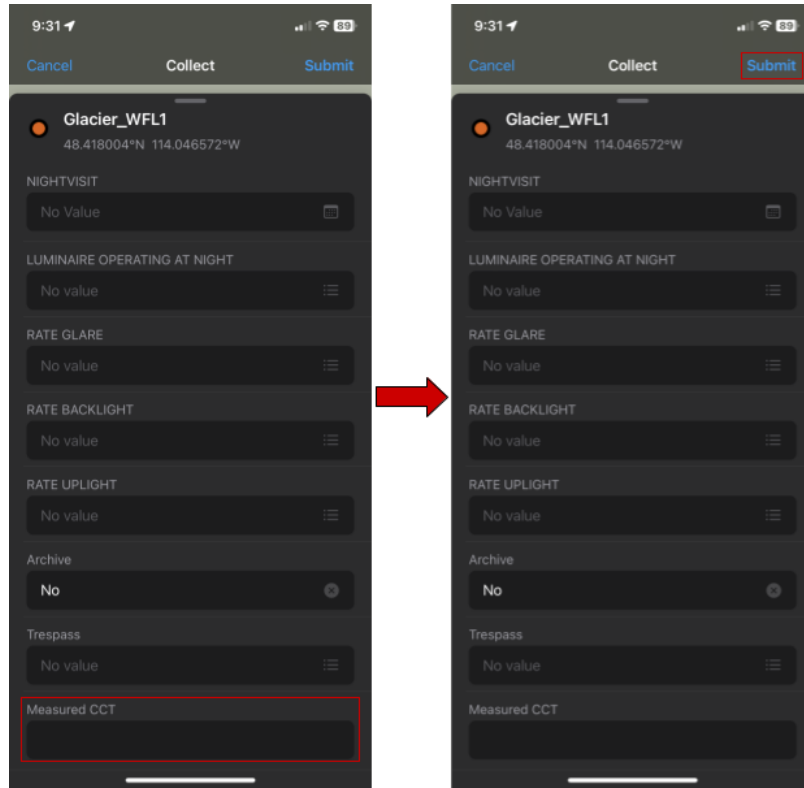
10. Enter a value for “Trespass”, referring to the area the light is illuminating, and if it is on task or not.



Note. Diagram displaying an “off task” trespass value, as the main task of the light is to illuminate the roadway and walkway, however it also illuminates the surrounding environment, not required by its task.



11. Measure the CCT of the light fixture, entering the value gathered into the attribute labeled “Measured CCT”. For instructions on using the spectrometer, refer to **Measuring CCT** below.
12. Press “Submit.” The night attributes are now added to the offline map data point.



13. Refer to **SYNCING OFFLINE MAPS TO ONLINE MAPS** to sync the offline data.

Measuring CCT

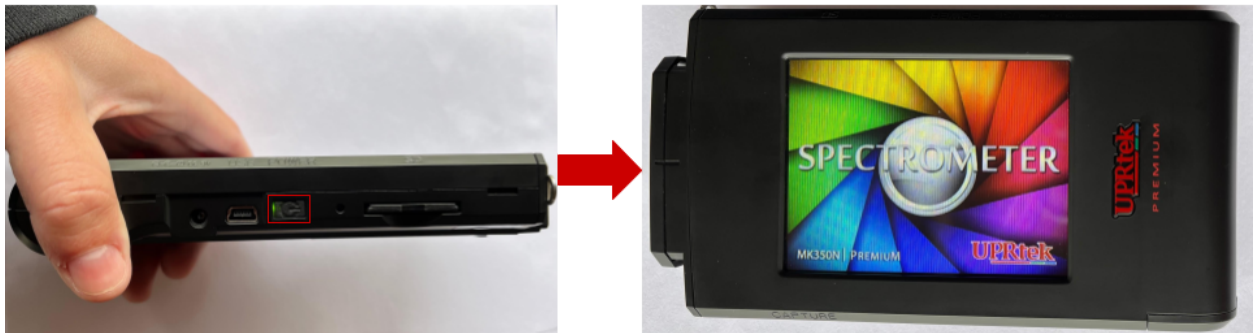
You'll need to charge the spectrometer, and ensure an SD is in the device (located in the right side of the unit). The spectrometer can only gather accurate data after astronomical twilight to ensure the most accurate measurement. To determine when astronomical twilight is, refer to meteogram.org.

Anatomy of the UPRtek MK350 N Premium Spectrometer



To measure the CCT of a light fixture:

1. Power on the spectrometer device by holding the small rectangular power button on the right side. A screen that says "Spectrometer" with colors around it will appear. Wait for a Dark Calibration prompt.



2. Complete the Dark Calibration:
 - 2.1. Ensure the top cap is securely fastened over the sensor and hit "OK."
 - 2.2. Hit "OK" again, resulting in two audible clicks.
 - 2.3. Hit "OK" when the dark frame is complete, then remove the top cover and store the cover in a secure place.



3. Check the Date and Time

3.1. From the home screen click the “page turn” image twice at the bottom right of the screen.



4. Select the “option” icon, check and update the time and date accordingly.

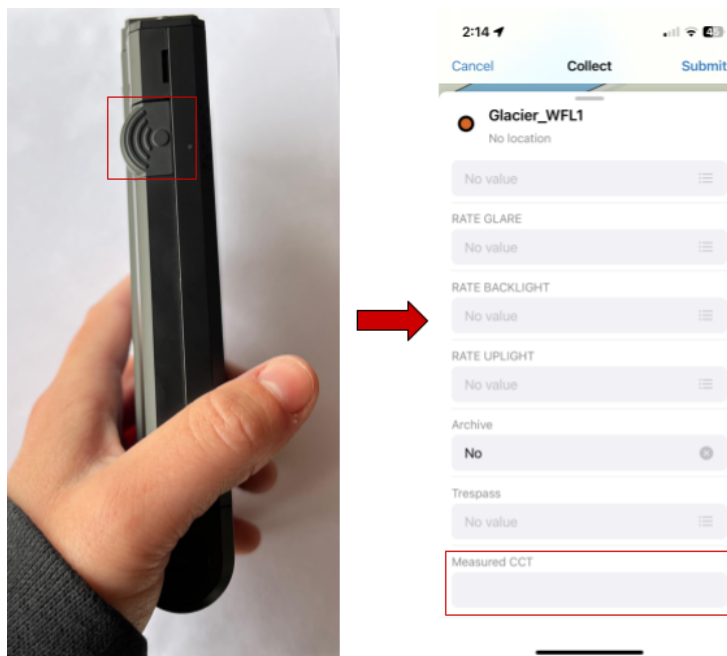
1. Take a CCT measurement:

1.1. Select the “BASIC” option from the home screen.

1.1.1. A list of measurements including LUX, CCT, S/P and IRR with zeros next to them will be displayed.



- 1.2. Point the spectrometer such that the light sensor (the white disk) on top of the unit is facing the light source and is as close to touching the bulb as possible while standing.
- 1.3. Ensure that the light source being measured is the dominant light source with no other/few lights contributing to the measurement.
- 1.4. Hit the large shutter button on the left hand side of the unit: values should populate the CCT row.
- 1.5. Manually enter the CCT value into the “Measured CCT” attribute for that light on ArcGIS Field Maps.



SYNCING OFFLINE MAPS TO ONLINE MAPS

After collecting light fixture data points, make sure the offline map successfully syncs to the online map once a stable wifi or cellular connection is found.

1. While on the offline map, press the “↕” symbol located at the top of the screen.
2. Press “Sync Now” located to the left of the last time the data was synced.
3. Toggling “Auto-Sync” to on will automatically upload offline data to the online map without manual syncing.
4. Ensure that the data was successfully synced. If the sync was completed successfully, next to “Sync Now” will be a label that says “Just now.”

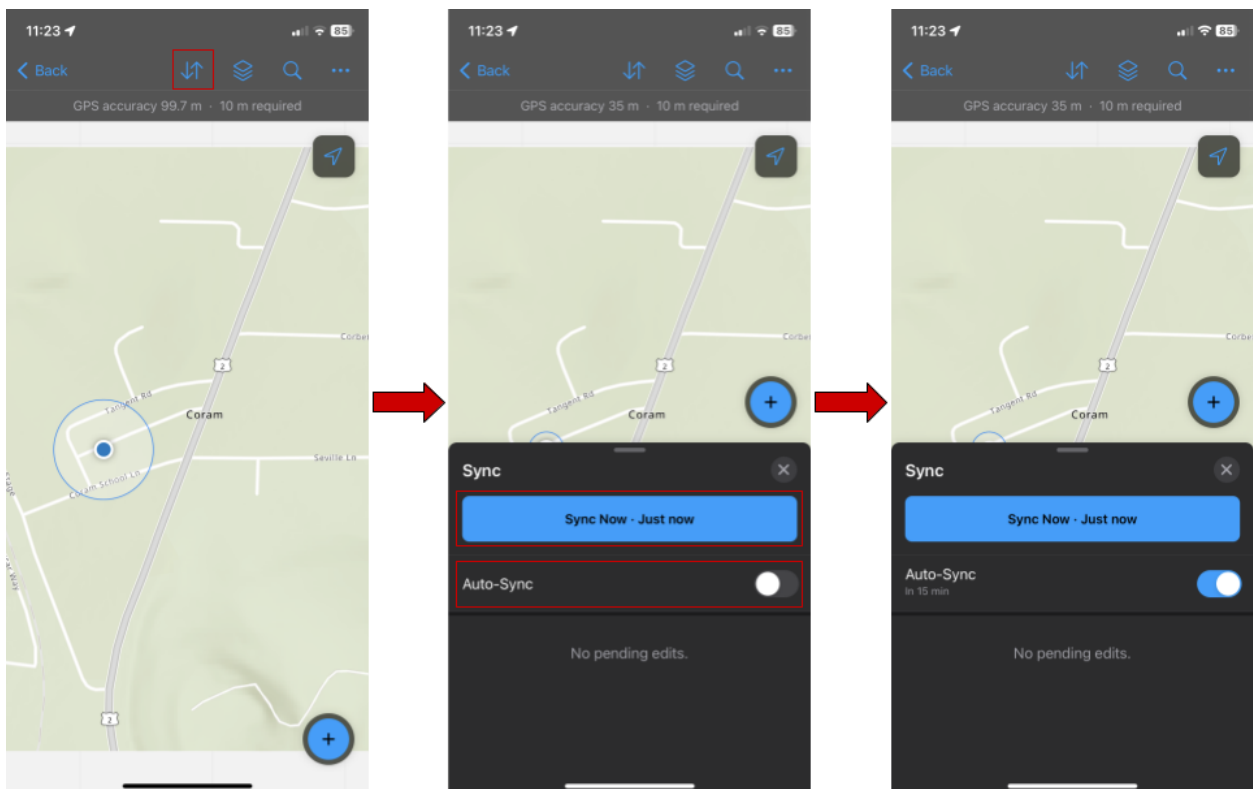


Image Credits

Sullivan, R.G. (2023). *Diagram of the backlight, upright, and glare (BUG) rating system*. ResearchGate.

https://www.researchgate.net/figure/Diagram-of-the-backlight-uplight-and-glare-BUG-rating-system_fig1_372574389

Types of Lightbulbs. (2023). Wayfair.

<https://www.wayfair.com/sca/ideas-and-advice/renovation/types-of-lightbulbs-how-to-choose-the-right-one-T5256>.