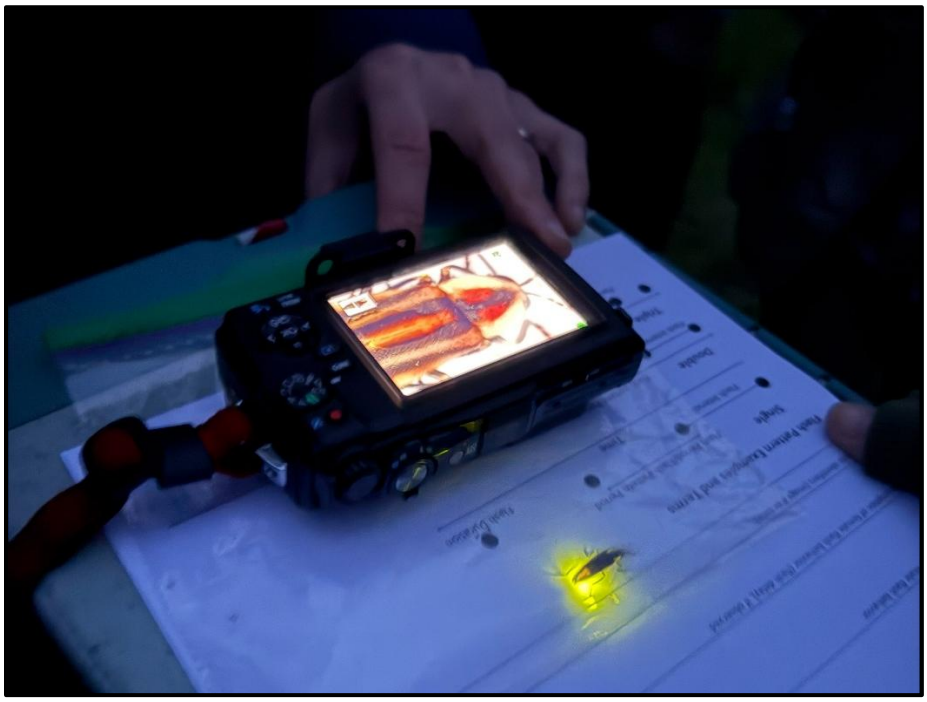
Firefly Atlas

Participant Handbook

Last updated Spring 2026



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- The Xerces Society for Invertebrate Conservation
- New Mexico BioPark Society
- IUCN SSC Firefly Specialist Group

Resources available online at: fireflyatlas.org

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Cover photo: Firefly surveyors documenting a *Photuris* firefly. Photo by North County Land Trust.

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What is the Firefly Atlas?

The Firefly Atlas is a collaborative effort to better understand and conserve the diversity of fireflies in North America. Launched in 2023, the project aims to advance our collective understanding of firefly species' distributions, phenology, and habitat associations, as well as to identify threats to their populations.

This project allows for individuals to:

- Download a species checklist for their state or province of interest;
- Learn to conduct a non-destructive firefly survey;
- Submit survey and observation data, including photos;
- Have observations identified by experts;
- Find detailed information about how to survey for 13 focal species of particular interest for conservation;
- Learn more about fireflies, their ecology, and ongoing conservation efforts;
- Help researchers better understand the distribution of fireflies; and
- Connect with other researchers, land managers, and community scientists.

About Fireflies and the Need for a Firefly Atlas

Fireflies are best known for their showy nighttime displays, but not all fireflies flash at night. The common name "firefly" not only includes familiar flashing species (a.k.a. lightning bugs), but also the more cryptic glow-worms and daytime dark fireflies, whose adults—as their name suggests—are active during the day and rely on chemical pheromones rather than bioluminescence to communicate. Glow-worms, like flashing fireflies, are active during dusk or nighttime and use bioluminescence (by glowing, not flashing) to communicate. While males look like typical fireflies, glow-worm females resemble larvae; they cannot fly because their wings are short or absent. Fireflies face numerous challenges, including increasing light pollution, habitat loss, pesticide use, and climate change. These threats affect firefly species in different ways, depending on each species' life history traits and specific habitat requirements.

Most people are surprised to learn that the United States has more than 170 species of firefly, and new species continue to be discovered and described. It's not uncommon to hear adults lament with nostalgia that they don't see fireflies like they used to. For most species, we simply lack the baseline data and ongoing monitoring to assess whether these anecdotal accounts are true across the board, but assessments published by firefly experts and conservation biologists in 2021 found 18 IUCN threatened firefly species (Near Threatened, Vulnerable, Endangered, Critically Endangered) and up to a third of all species are estimated to be threatened with extinction.

Identifying sites where firefly species occur is important for understanding habitat characteristics and prioritizing which places to protect, restore, and manage with fireflies in mind.

The Firefly Atlas is **community science project to gather data on the distribution of firefly species in the US and Canada**, with a particular interest in imperiled and data deficient species. Join us! We need curious, trained volunteers who can submit survey and observation data on fireflies and their habitats.
We invite professional and amateur scientists to join in the project:

1. Get to know the protocols by carefully reviewing this handbook, watching the recorded trainings on the Firefly Atlas website, and/or attending an in-person training.
2. Visit sites during the firefly season and use the standardized protocols to survey for fireflies.
3. Submit your data and photos via the Firefly Atlas portal.

What you will **need** to participate:

1. Curiosity about fireflies and a readiness to observe closely and record details.
2. Transportation to your survey site (or a site you can easily access).
3. A camera or smartphone to take photos and/or videos.
4. Access to a computer or smartphone to enter data and upload photos.
5. A headlamp with red-colored light or a red filter.

What is helpful to participate:

1. An insect net and transparent containers.
2. A thermometer for air temperature.
3. A phone with a voice memo applications or a digital sound recorder.
4. Firefly field guides

Project Design

In 2019 and 2020, Xerces Society for Invertebrate Conservation, the New Mexico BioPark Society, and the IUCN Species Survival Commission Firefly Specialist Group assessed the conservation status of 132 North American firefly species, and found that eighteen species face the threat of extinction, with the possibility of up to a third of North American species being threatened, if general trends hold with data-deficient species. A central lesson from this assessment was that more data are needed about *all* firefly species in the region.

Firefly Atlas is a targeted inventory project, focusing most on the questions of where (distribution) and when (phenology) for select species, and is less geared toward questions of How many species (diversity/species richness) or How many individuals (abundance, relative abundance).

Intended uses of data

The data generated through Firefly Atlas are intended to be used for more detailed conservation assessments and planning, mapping of ranges and distribution, and improving our understanding of phenology and threats.

Focal species and regions

The Atlas has thirteen focal species whose appearance, behavior, phenology, and/or habitat-specificity make them conducive to study through community science, without the need for specimen collection. These species occur in three focal regions (mid-Atlantic, Southeast, and Southwest), in habitats that include southwest sky islands and desert wetlands, the forested wetlands of the Mississippi River and its tributaries, southern Appalachian middle-elevation wetlands, the Florida peninsula, and mid-Atlantic peninsulas and estuaries.

Lost firefly species

In addition to the thirteen focal species, there are numerous firefly species in the United States that are considered "Lost," meaning that to our knowledge they have not been observed, collected, or otherwise recorded in the past decade. Profiles of six lost firefly species can be found on the Firefly Atlas website.

How is Firefly Atlas different from iNaturalist?

The community science platform iNaturalist has become a significant source of observation data for firefly species, with thousands of georeferenced photo records representing dozens of species. However, many firefly observations on iNaturalist are not verifiable to species level because not enough contextual information is provided or photos fail to capture important features, and there are limitations to what can be inferred from these non-systematically collected data.

Firefly Atlas differs from iNaturalist by:

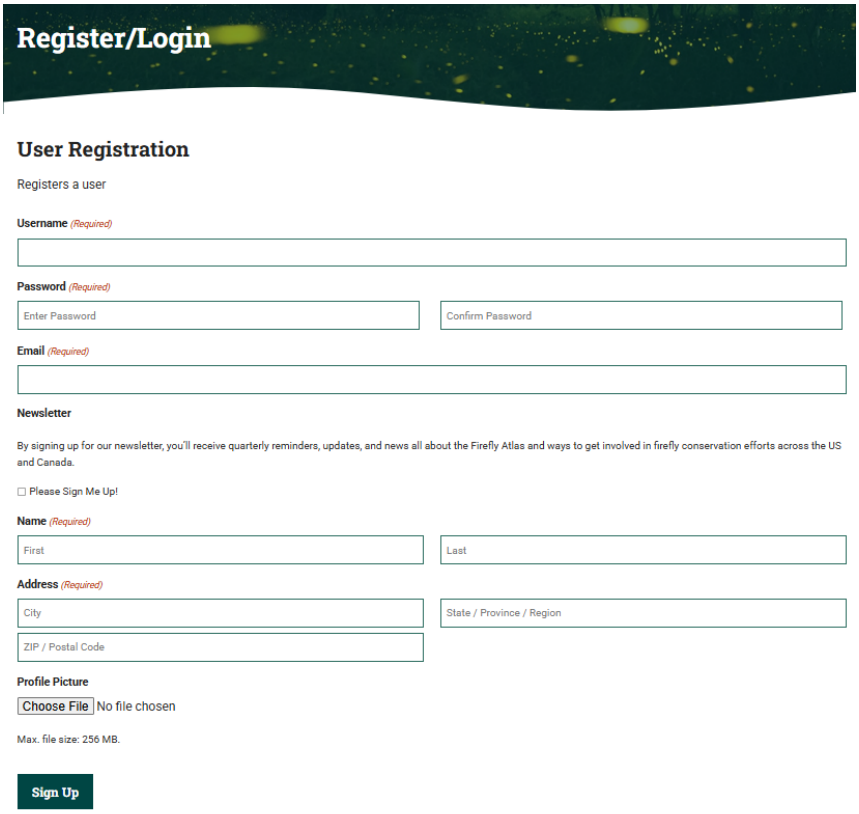
- capturing information related to search effort, weather and habitat conditions;
- accepting non-detection data (cases where fireflies generally or a particular species were searched for but not found);
- providing structured fields for information like estimated abundance;
- guiding participants to generate data and images allowing for a species-level identification.

How to Participate

Step 1: Create a Firefly Atlas account and read the Xerces Society Community Science Program Code of Conduct

Create a Firefly Atlas account and Username using the "Register" button in the upper right. Note that address does not include your street address, just city, state/province, and zip code. After signing up, you will need to verify your account using a link sent to the email address associated with your accout. During registration, we encourage you to sign up for the quarterly Firefly Atlas e-newsletter, which will alert you to training events and new website features.

The Community Science Program Code of Conduct can be found on the Firefly Atlas website and in Appendix VI at the end of this handbook.



Step 2: Get to know the possible species in your area, including any focal or data-deficient species

Start by exploring the filterable checklist of firefly species on the Firefly Atlas website (https://www.fireflyatlas.org/firefly-species/firefly-species-checklist), filtering the list to your state or province. It may be helpful to make lists for neighboring states/provinces as well. This will give you a sense of how many types of firefly might be in your area, as well as which ones might be a priority for conservation and study. If you live within one of the regions with focal species, take the time to familiarize yourself with those species and determine whether you might be able to access potential habitat.

Decide whether to do a targeted survey or a general survey

In a targeted survey, you are deliberately trying to find a particular species of firefly and should plan your survey around the seasonal timing and habitat preferences of that species. In contrast, general surveys seek to document whatever species might be present at a given site at a given time. Both types are surveys generate useful data, but targeted surveys are especially useful for focal species and data deficient species.

Take the time to research the firefly species (focal or otherwise) in your area, using resources on the Firefly Atlas website such as species profiles and fact sheets. **Feel free to email fireflyatlas@xerces.org if you'd like suggestions of target species in your area, especially if you live outside of the Firefly Atlas focal regions.**

Step 4: Plan your visit

Where to go

If you are interested in surveying on land that you do not own or manage, take the time to do the following:

- Research the ownership and management of habitats near you.
    - Familiarize yourself with the rules and regulations of the sites, including times are day when it is open to the public and rules on catching insects.
    - Look up the trails, parking lots, and access points.
- **Contact the land manager to request permission for night-time access.** Depending on the land management organization or agency, a written permit might be required. It is crucial to have permission from landowners and land managers prior to being at sites after dusk and conducting firefly surveys.
- Visit your selected site *during the daytime* to familiarize yourself with the habitat, areas that look promising for observation/detection, and hazards such as thorny vegetation, poison ivy, and uneven ground.
- Good potential sites may include:
    - Town or county parks
    - Public boat ramps
    - State wildlife management areas
    - Campgrounds
    - Land owned by friends or family

If you are a biologist or land manager affiliated with a conservation land management agency or organization, you should follow your own organization's policies regarding research and night-time access.

When to go

The timing of your surveys will depend on the species you are looking for and where you live. Use the table below for a general sense of adult firefly survey seasons by state/region. These timeframes exclude larvae and adult winter fireflies (*Photinus corruscus*), which be found nearly year-round in many places. Surveys early or late in the season will usually find fewer fireflies, of fewer species.

Region	Recommended survey timing
Canada	May-August (especially June-July)
Northeast US	April-August (especially May-July)
Florida	Year-round, but especially March-July
Southeast US	March-September (especially May-July)
Arizona and New Mexico	April-October (especially June-September)
Texas	February-October (especially March-June)
Central US and Great Plains	April-August (especially May-July)
California	Year-round, but especially April-June
Intermountain West	May-September (especially June-July)
Pacific Northwest	March-October (especially May-June)

Keep safety in mind

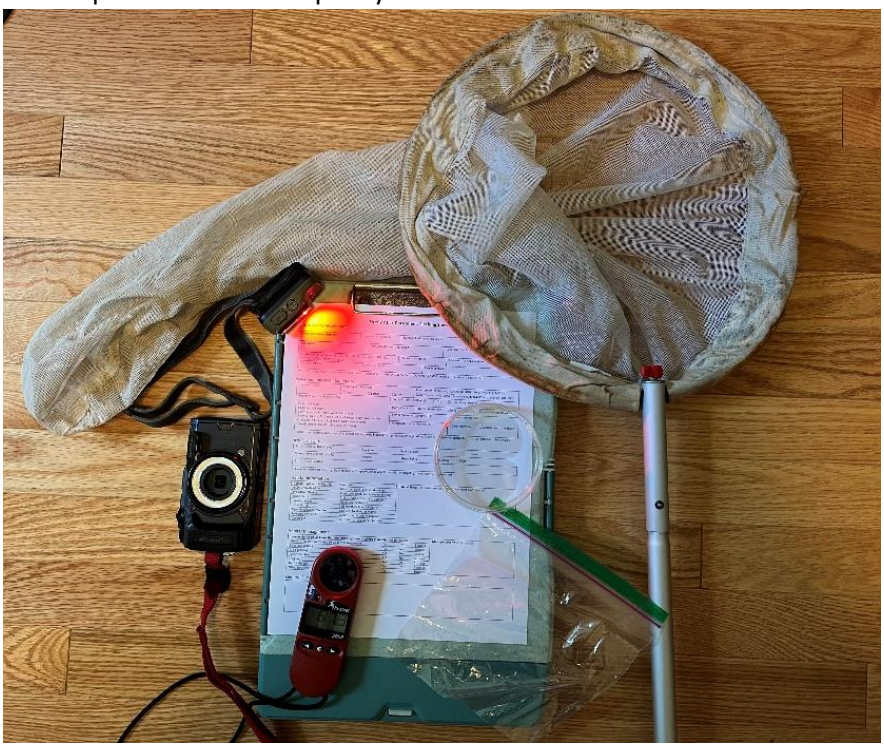
Firefly surveys may take place at night in isolated areas, which can feel unsafe for multiple reasons, including the possibility of being perceived as suspicious or threatening by other people. Ultimately, it will be up to you to determine your comfort level and which sites you are willing to survey.

We strongly recommend that you do the following to have a safe and comfortable experience:

- Survey in pairs or groups!
- Scout out the survey area ahead of time, and let neighbors know that you will be doing surveys.
- Let someone know your plans, including expected return times.
- Check the weather forecast to see if hazardous weather is a possibility.
- Have multiple flashlights available.
- Anticipate hazards such as venomous snakes, biting and stinging insects, alligators, harmful plants, and uneven terrain.
- Monitor your own levels of hydration, nutrition, and energy. Factor in any driving that you will be doing post-survey and the effects of fatigue on your ability to safely drive.
- Consider wearing a reflective vest to be visible to fellow surveyors and signal to bystanders that the survey is a formal activity.

Gather equipment

- flashlights (a red-filtered headlamp is ideal; a small penlight can also be helpful)
- extra flashlight batteries
- clear plastic sandwich bags or petri dishes for temporarily holding and photographing fireflies (if site regulations allow)
- insect net for capturing fireflies (if site regulations allow)
- voice recorder (smart phone or digital recorder)
- thermometer for measuring air temperature
- writing implements and field notebook and/or clipboard
- camera, preferably with macro capability
- mobile phone with GPS capacity or a hand-held GPS



Choose and print the right data sheet(s)

If your survey is targeting flashing firefly species, be sure to download and print the Flashing Firefly Data Sheet. This form has the most questions because it includes variables that are specific to night-time conditions, such moonlight, artificial light, and time of sunset, as well as variables related to flash patterns. The Diurnal Firefly Data Sheet lacks night-time fields and flash pattern details, so it has fewer fields, while the Glow-worm Firefly Data Sheet has an intermediate number of questions. All data sheets are available for download at https://www.fireflyatlas.org/get-involved/data-sheets and are included at the end of this handbook.

These separate data sheets are for your convenience in the field; there is a single online form for entering survey data.

If you think it is possible that you will document both glow-worm species and flashing species on the same survey, use the Flashing Firefly Data Sheet, and simply cross out or leave blank the Flash Pattern Details section for glow-worm observations.

It is possible that you could encounter species of flashing-type fireflies (*Photuris*, *Bicellonycha,* etc.) while conducting a day-time survey targeting a diurnal firefly target species. Since flashing-type fireflies will not actually be flashing during a day-time survey, you can use the *Diurnal Firefly Data Sheet* to record an observation of it in the same way that you would document a diurnal firefly species.

Step 5: Conduct a survey

Phase 1: Explore the site, describe the habitat and pre-fill data sheet fields

1. Arrive at your survey site early enough that you have time to explore a bit, take notes about the habitat and fill out the data-sheet fields that can be prefilled:
    - *Date*
    - *Number of observers*
    - *Names of observers*
    - *Site Name*
    - *Elevation*
    - *Habitat type, management, and notes*
    - *Target Species*
    - *Time of sunset*

    If your survey is mostly stationary, record the location coordinates (*Latitude* and *Longitude* in decimal degrees) by using a GPS or a smartphone.

    Also scan the site for potential hazards—anything ranging from holes or drop-offs to poison ivy, thorny vegetation or alligator slides.

Phase 2: Gather data on weather and artificial light, and begin looking for fireflies

2. Start the firefly survey by recording the *Survey start time*. It often makes sense to start the survey around sunset or slightly after.

3. Record the *Temperature at start time*, either taking a reading from a thermometer or checking a weather app or website, as well as the *Humidity*. Assess the wind speed, and record the *Beaufort Wind Scale* value that matches what you see. Do the same process for *Cloud Cover*, *Moonlight* (if it is a night-time survey) and *Precipitation*. If conditions change dramatically over the course of the survey, choose values that you think are average or representative and include a comment in the survey notes.

4. Look around and **assess** the *Types* (sky glow, light trespass, glare) and *Sources* (vehicles, street lights, buildings) of *Artificial Light*. Record what you find, and give more details in the *Artificial Light Notes.*

5. Turn off headlamps or keep them on a dim red setting, and watch closely and patiently for firefly activity, keeping in mind the search image and/or flash-pattern of your target species, if you have one.

6. **When you see firefly flashes, observe them until you get a feel for the different flash patterns**. There will likely be some variation within what appears to be the same species, so try to get a

general impression of the number of flashes in the pattern, number of seconds between flashes, color, and flash height/location. Focus on the flash patterns that match target species, but try to be aware of all the flash behaviors at the site.

7. **Record the *Time of first observed flash* and the *Air temperature* at this time**.

8. **Record flash pattern time measurements** (*Period of Flash Pattern*, *Flash duration*, and *Flash Interval*) by using a stopwatch or by counting flashes into a voice recorder to be timed later. Count out loud as you see each flash in a series of flashes, and note when you switch to observing a different individual. (Saying "new bug" into the microphone is a quick way to do this!) The Flashing Firefly Data Sheet only has one space per variable per species observation, but it's best to record multiple measurements of flash patterns of each species, choosing the numbers that fit best with your general impression. If you have the ability to take video of flash patterns, consider recording some clips that you can analyze later, but don't rely on video for flash pattern details.

   If you suspect that the same species was doing multiple types of flash patterns, make a note of this in the *Description of male flash behavior*.

9. Once you are satisfied with the flash pattern details you have recorded, use an insect net (or a container or plastic bag) to **catch a displaying firefly**, being careful not to harm it. Be sure that the firefly you catch was one giving the flash pattern that you recorded! Put the firefly in a clear plastic bag or petri dish, and **photograph it**, taking shots of both the upper side and the underside. Document the firefly's size by photographing it against the millimeter scale on the back of the data sheet (a plastic bag usually works better than a petri dish for doing this).

   If you have all the necessary collection and research permits and you are equipped to collect a specimen, it may be appropriate to do so. Otherwise, **release the firefly** after you have photographed it.

10. **Repeat steps 6-8 for additional species** for which you are able to record flash pattern details and/or take photographs.

    For each species, record *Approximate number observed during the survey*, choosing between one, two to ten, 11 to 50, or more than 50.

11. To wrap up the survey: record the *Time of last observed flash* for the target species (and any additional species) and the *Air temperature* at that time, then record the *Survey end time* and *Temperature at end time*. Since many species of flashing fireflies will display fairly late into the night, *Time of last observed flash* and its associated temperature will often be the same as for the *Survey end time* and *Temperature at end time*.

    Approximate Area Searched in hectares is often easiest to estimate using Google Maps once you are back from the field (a demo video is available here), but take the time to record relevant

information (such as start and end locations or approximate distance that was searchable from trails).

Jot down any optional *General Survey Notes* that are not captured by other fields on the form.

12. **Double-check that you have recorded all necessary information** (either on the data sheet, in a voice recording, or in a field notebook) and check the site to make sure you are not leaving anything behind (thermometers, petri dishes, nets, notebooks, etc.)

13. **Get home safely!** Drive carefully and stay alert.

Phase 3: Process your field notes and recordings, follow up day-time visit

14. Analyze, summarize, and process your notes and raw data. If you relied on a voice recorder for much of the survey, you will likely fill in most of your data sheet after the fact. Post-survey data-processing might include the following:
    - Transcribing voice recordings;
    - Using a stopwatch, sound software, or a video player to measure flash pattern details from voice recordings;
    - Calculating *Approximate Area Searched* using the Measure Distance/Area tool on Google Maps and converting area units to hectares;
    - Using Google Maps to determine *latitude* and *longitude* for the approximate middle of the survey site;
    - Looking up the *Elevation* in meters of your survey site;
    - Identifying plants in photos taken at the survey site.
15. An optional but often helpful step after a survey is to re-visit the site during the daylight in order to take photos or gather better information about where fireflies were in relation to the vegetation or other habitat components.

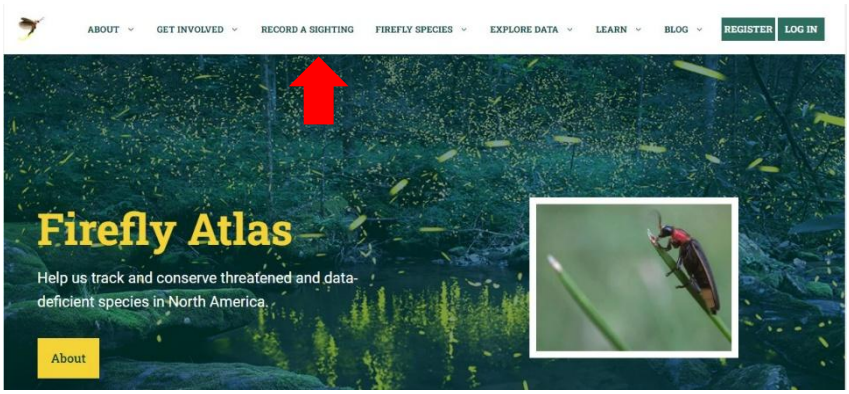
Step 6: Submit Your Data

All data will be submitted to the Firefly Atlas website: fireflyatlas.org.

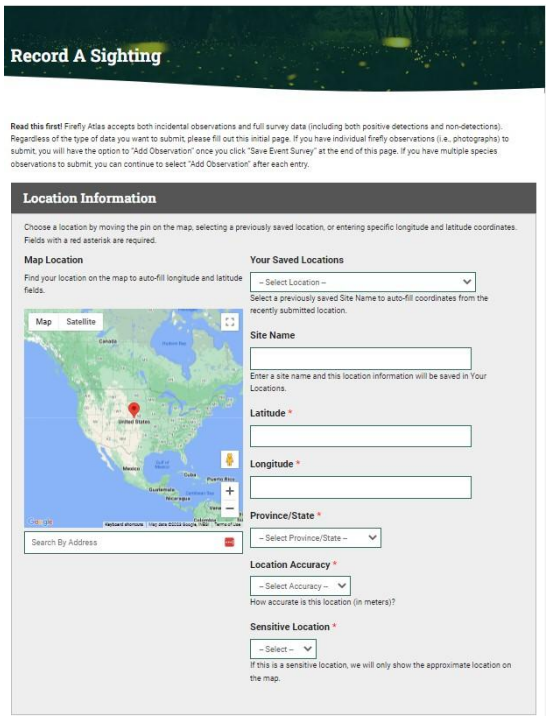
1. Curate your photos. Decide which three you are going to submit for each species on your data sheet. Use the images that are most clear and close-up. You may choose to use a habitat photo or a night-time long exposure as one of your three photos, but you should prioritize images of the firefly's morphology. Resize the images to 2 megabytes or less to ensure successful upload.

2. Log in to Firefly Atlas.

4. Click on *Record a Sighting*.

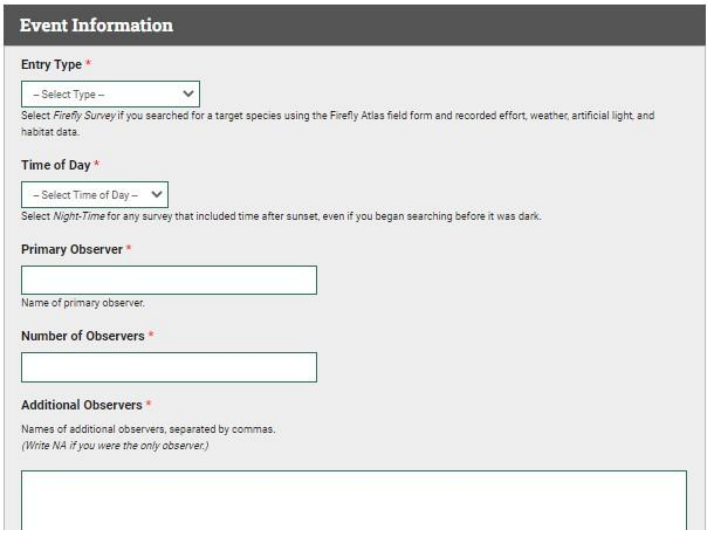


5. Enter your location information.
    a. Either enter the *Latitude* and *Longitude* fields manually (making sure to include at least 5 decimal places and that the Longitude value is negative) or drag the red pin on the map until it aligns with your sight. You survey may have two sets of coordinates: the center of the survey area and the location that is specific to a firefly observation. Find a balance between the accuracy of both these locations, but prioritize the location of observed target species.

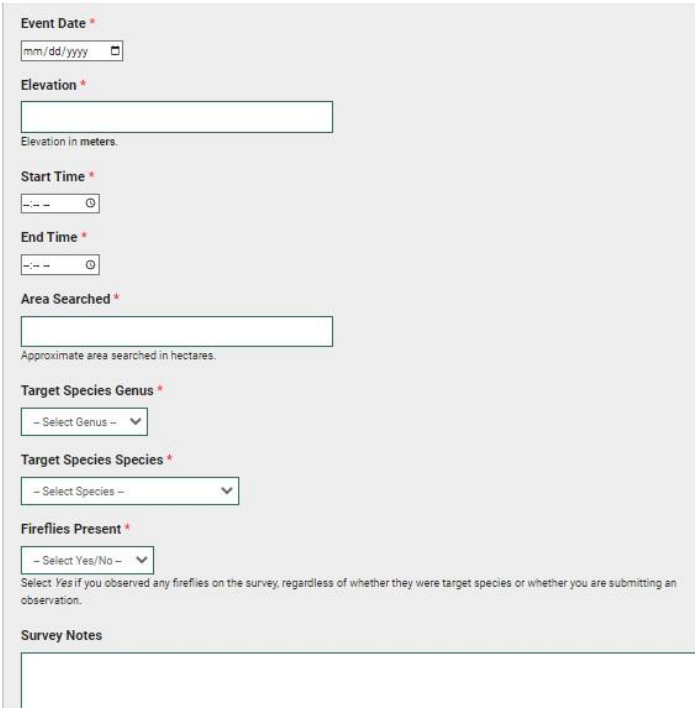


    b. Give your survey location a *Site Name* that is meaningful and would help someone re-find the survey location 50 years from now, and select the US state or Canadian province of the site.
    c. Enter the *Location Accuracy*, meaning how close your actual survey location is to the selected map point. If you covered a relatively large area, select a *Location Accuracy* that reflects that.
    d. If you would like to hide the exact location of the site because of landowner preference or other considerations, respond "Yes" to the *Sensitive Location* question.

6. Use your data sheet to enter details about the survey and/or observation data you are entering, such as *Entry Type* (firefly survey or incidental observation), *Time of Day* (whether your survey or observation involved any night-time activity), the *Primary Observer* (your name), the total *Number of Observers*, and the names of *Additional Observers*.

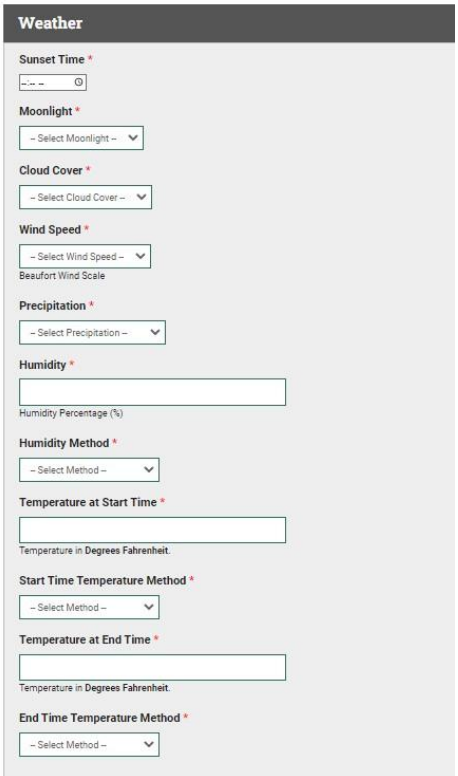


Also enter the *Event Date* (date of the survey or incidental observation), *Elevation* in meters, survey *Start Time*, survey *End Time*, the approximate *Area Searched* (in hectares), the scientific name of your *Target Species* (entering unknown for Genus and Species if you did not have a target species), and whether there were *Fireflies Present* on your survey (this includes *both* target species and non-target species for which you obtained photos and flash pattern details, and fireflies that you were unable to photograph or record flash pattern details for.

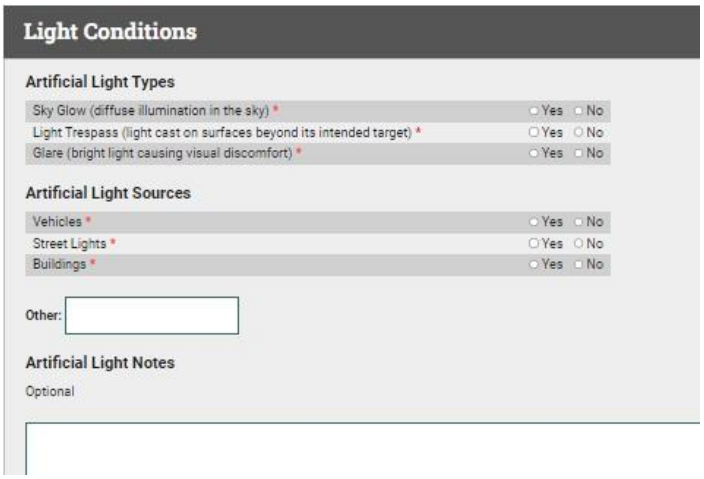


You may include *Survey Notes* to add context or details about the survey that are not captured by other fields.

7. Enter the weather and moonlight information that you gathered in the using visual assessment and instruments and/or local weather data sources. Enter the *Sunset Time* for the survey or incidental observation date, which can be found at various websites and applications based on date and location. Select between categories for *Moonlight* conditions, *Cloud Cover*, *Wind Speed* and *Precipitation*, and enter the values for *Humidity*, *Temperature at Start Time*, and *Temperature at End Time*, indicating whether *Temperature Method* and *Humidity Method* involved measurements on site with instruments or sourcing weather data from sources such as weather apps or websites.

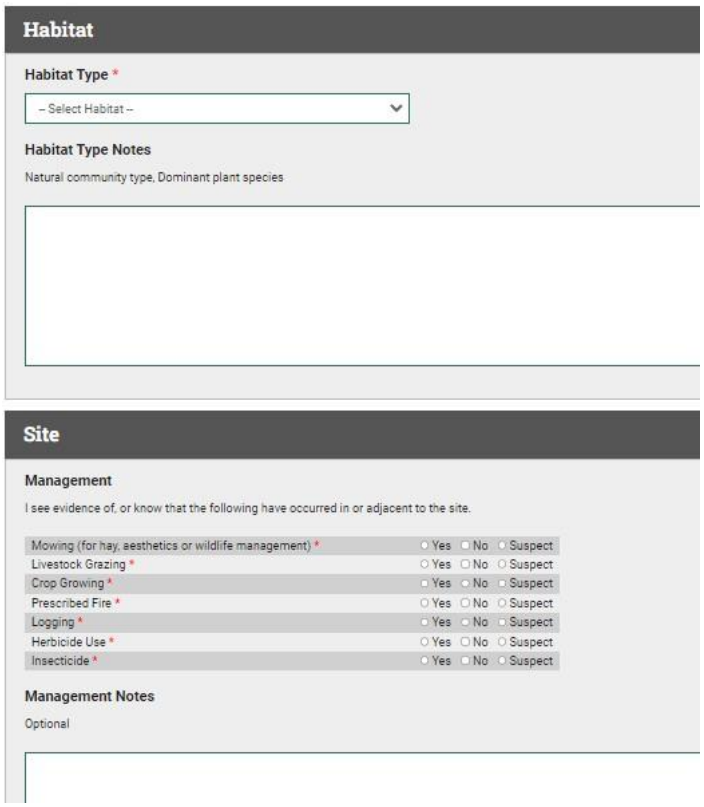


8. Select the *Artificial Light Types* and *Artificial Light Sources* that affected your survey site. These are Yes/No options and it's likely that you have some uncertainty about what to mark, but don't overthink it, and include more details (such as proximity of light trespass or frequency of vehicle

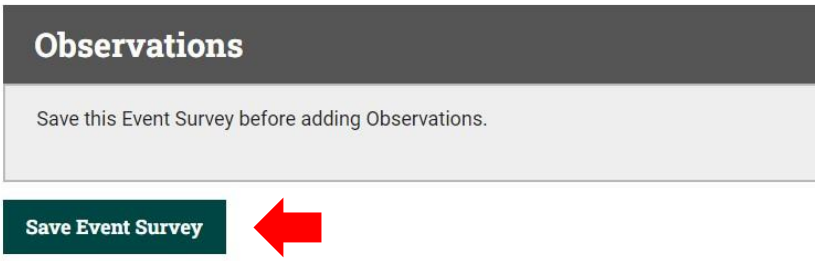


headlight glare) in the optional *Artificial Light Notes* section.

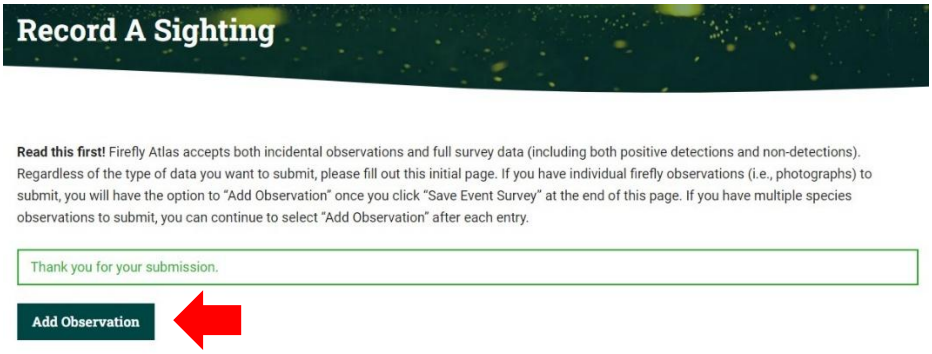
9. Select the broad *Habitat Type* from the drop-down menu that best fits your survey site, and include details such as plant species or other descriptions under *Habitat Type Notes*. Click *Yes*, *No*, or *Suspect*, for each of the seven land *Management* practices and enter any optional *Habitat Management Notes*, elaborating on your knowledge of how the site is managed.



10. IMPORTANT! Click *Save Event Survey* to save all the data you've just entered. If this was a survey (as opposed to an incidental firefly observation,) and you do not have any observation data to submit, you can navigate away from the page after saving.



11. If this was a survey and you have observations to submit, click on *Add Observation*. This step is important!



12. Upload up to three photos of the species you documented. One photo should be of the upper side (dorsal) and another should show the underside of the firefly (ventral). The third photo may be a day-time habitat photo or a long-exposure image that captures aspects of the firefly's flash pattern.
13. Under *Observation Type*, select either *Flashing* or *Non-Flashing*. This is not about whether the firefly you observed is capable of flashing, but rather whether you were able to record flash pattern details. For example, you might select *non-flashing* if you found a flashing firefly but were unable to measure or record details of flash behavior.
14. Identify your firefly to the best of your knowledge by making selections in the *Genus* and *Species* fields. If you are unsure of the species or the genus and species, you can select *unknown*. It is okay to be imprecise or to be wrong, as Firefly Atlas verifiers will confirm

identifications and correct them if need be. Note that *Genus* and *Species* may be different from *Target species genus* and *Target species species*.

15. Indicate the approximate number of individuals of this species that you saw during your survey, selecting between 1, 2-10, 11-50, and 50+.
16. Enter *Observation Notes*. This will include pieces of information that don't fit within the responses to other questions, and might include things like body length, particular microhabitats, the sex of the firefly photographed, and details that led you to the *Genus* and *Species* that you selected.
17. If you collected one or more specimens (with all necessary permits and permissions from land managers), enter the *Specimen Voucher Numbers* so that the physical specimens can be linked to the observation.
18. Enter Flash Pattern Observation Details, including *First Flash Time*, *Last Flash Time*, *Temperature at First Flash*, *Temperature at Last Flash*, *Number of flashes in flash pattern*, *Flash Color*, *Flash Pattern Period*, *Flash Duration*, *Flash Interval*, *Male Height Zone*, *Flash Location*, *Male Flash Behavior*, and *Female Flash Behavior*. While all these fields are required, you can enter "Did not measure" or "Did not observe" if you do not have data to submit for those fields. You can review flash pattern terminology using the diagrams on the back of the data sheet.

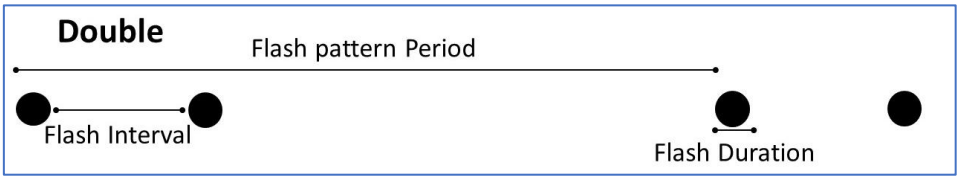
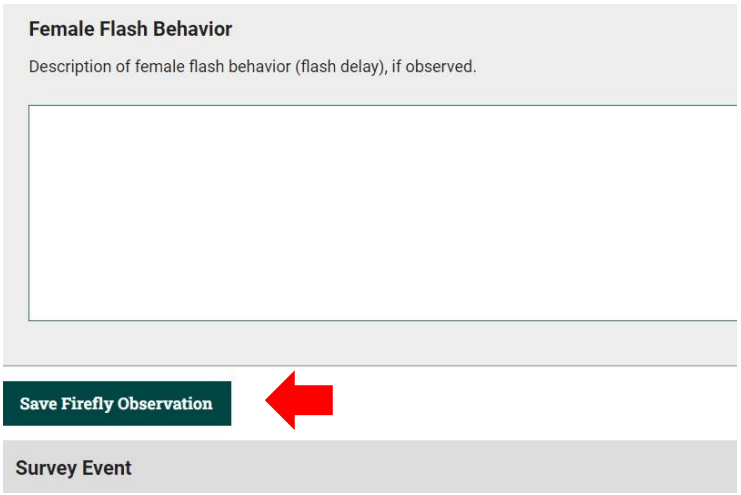
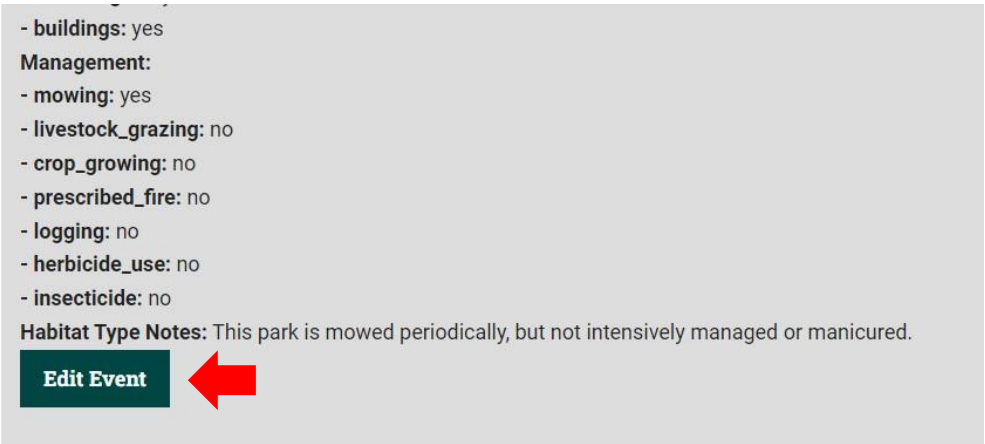


Diagram of a firefly flash pattern consisting of paired flashes, illustrating flash pattern terms.

19. Save the observation by clicking on the *Save Firefly Observation* button.



20. To submit another observation from this survey, click on *Edit Event* and then click on *Add Observation*.



Diurnal Firefly Survey Considerations

Because daytime fireflies can be spotted at shorter distances compared to flashing fireflies at night, diurnal firefly surveys will likely entail traveling further than night-time flashing firefly surveys.

Walk slowly along a trail or through an open area that does not have sensitive vegetation or wildlife, taking appropriate precautions against hazardous wildlife, vegetation, and terrain. Search the area on either side of the trail. Pay particular attention to nooks and crannies in tree bark, tips of foliage, and flowers (especially milkweeds).

Estimate how far on either side of the trail you are able to search, as you'll use this to calculate *Approximate area searched* in hectares. It will likely not be more than two or three meters on each side.

If you hike a 1 km-long stretch of trail and you were able to search about two meters on each side of the trail, the *Approximate area searched* would be 1,000 meters x 4 meters= 4,000 square meters or 0.4 hectares.

When you find a diurnal firefly**, photograph it, ideally capturing dorsal (back) and ventral (underside) views that show the size of the firefly**, and record the latitude and longitude of the observation. Depending on the species, you may not need to capture it in order take photos for species verification. Take notes on behaviors, microhabitats and sexes found, as well as an estimate of how many you saw.

If you encounter a flashing species of firefly (such as a *Photuris*, *Photinus*, *Pyractomena* or *Bicellonycha*) during a day-time survey targeting a diurnal focal species, feel free to photograph it and add it as an observation—it's okay that it's missing flash pattern data. Verifiers will try to identify it as best we can.

Only capture or handle fireflies if the site regulations allow it. If you are a researcher or land manager and you use a sweep net to sample rather than just an active visual search, make a note of this in the *General Survey Notes* field on the data sheet.

Glow-worm Firefly Survey Considerations

Glow-worm firefly surveys will likely be traveling rather than stationary, as glow-worm detectability drops off steeply with distance. Walk slowly along a trail or through an open area. If safety allows, walk in the dark so that you can better see the light of glow-worms. If safety requires some amount of illumination, use a dim, red-filtered light and pause periodically to turn it off. Scan the ground, low vegetation and leaf litter for glows.

When you see a glow-worm, photograph it, ideally capturing dorsal and ventral features, and make a note of its behavior, sex, and life-stage. **Only capture or handle the glow-worm if site regulations allow it.** Gently scooping the glow-worm and some soil or detritus into a plastic petri dish may be helpful for temporarily containing it while taking photos.

Contributing an Incidental Observation

You may come across fireflies when you are not conducting a full survey– while camping, in a friend's yard, at your porch light, or while hiking. These **incidental observations** can still be very useful, especially if photographs or flash pattern descriptions and measurements still capture diagnostic details. Even if the observation cannot be definitively identified to species level, your finding may point to a promising site for follow-up surveys.

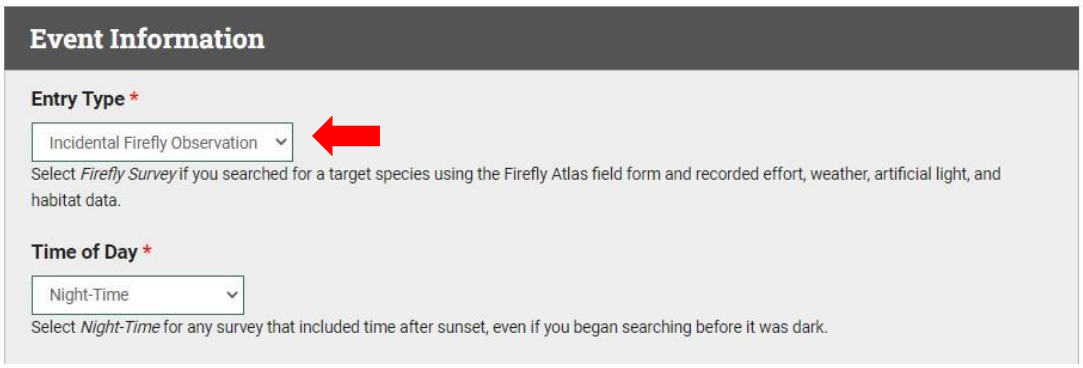
The focal species that are most conducive to incidental observations include the following:

- Florida intertidal firefly- *Micronaspis floridana*
- Florida scrub dark firefly- *Lucidota luteicollis*
- Keel-necked Firefly- *Pyractomena ecostata*
- Ant-loving scrub firefly- *Pleotomodes needhami*
- Sky island firefly- *Photuris falli*
- Twice-wounded firefly- *Photinus bivulnerus*
- Southwest spring firefly- *Bicellonycha wickershamorum*
- Southwest synchronous firefly- *Photinus knulli*

Because of the similarity between species and the amount of variability within species, many incidental observations of *Photuris* and *Photinus* will not be able to be confirmed to species-level without flash pattern and air temperature details.

Unlike formal surveys, incidental observations do not have a protocol or a data sheet. However, when submitting incidental observations to the Firefly Atlas data portal, include as much event and observation data as you are able. For example, you may not have temperature data to submit, but you might be able to fill out moonlight, habitat type and artificial light sources. You may not have flash pattern measurements, but you might be able to indicate the *number of flashes in the flash pattern*.

When submitting your data make sure that the *Entry Type* under "Event Information" is set to "Incidental Firefly Observation."



Appendix I: Species-specific Survey Guidance for Focal Target Species

Flashing Species

Bicellonycha wickershamorum- southwest spring firefly

Photo: Candace Fallon / Xerces Society.

Survey region: Arizona, New Mexico

Habitats to survey: Springs, seeps, wet pastures, wetlands in canyons, and riverbeds in and around Madrean Sky Islands and the Gila River watershed

Time of year to survey: June, July and August

Time of day/night to survey: Dusk to dark.

What to look for: Greenish flashes that rise higher above the ground as the evening progresses. Black elytra with yellow borders. Acute back corners of the pronotum, creating a head shield that is shaped like a shovel head. Dark, upside-down T shaped marking on the pronotum.

Special considerations: Studying maps of perennial water sources may be helpful for identifying potential survey sites. This species has two subspecies: the *Bicellonycha wickershamorum piceum* subspecies (Gila southwest spring firefly) distinguished by the dark brown (piceous) color of the antennae and back of head, versus black in the *Bicellonycha wickershamorum wickershamorum* subspecies.

Photinus knulli- southwest synchronous firefly

Survey region: Southern Arizona

Habitats to survey: Permanently wet habitats, such as seeps and springs.

Time of year to survey: From early July into early September, during the summer monsoon rain season.

Time of day/night to survey: 35 to 120 minutes after sunset

What to look for: Three quick yellow flashes over about a second, repeated every six seconds.

Photo: James Bailey / iNaturalist CC BY-NC

Special considerations: Its synchronizing displays may make this species attractive for viewing, and thus sensitive to trampling and other negative impacts from excessive visitation to sites. It is especially important to model responsible firefly viewing etiquette when surveying for *Photinus knulli*.

Photuris falli- sky island firefly

Photo: Oscar Johnson/iNaturalist CC BY-NC

Survey region: Davis Mountains in Texas and other sky islands in Texas, Arizona and New Mexico.

Habitats to survey: grasslands, creek bottoms, and spring complexes in Sky Islands.

Time of year to survey: Early May to late August.

Time of day/night to survey: After sunset, once it is dark.

What to look for: Quick rhythmic, single, green flashes. Dark-winged firefly with rounded posture and yellow pronotum with a central orange marking.

Special considerations: This species has a long flight season, which may vary from year to year depending on temperature and rainfall. It can also be found at UV/moth lights.

Photuris bethaniensis- Bethany Beach firefly

Photo: Xerces Society/Richard Joyce

Survey region: Eastern shore of Delaware and Maryland, as well as barrier island beaches in Virginia and northern North Carolina.

Habitats to survey: Freshwater interdunal swales. Wet areas behind sand dunes with bayberry and *Baccharis* shrubs and/or rushes.

Time of year to survey: Late June to early August.

Time of night to survey: After dark.

What to look for: Two green flashes, ¾ of a second apart, repeated every 5 seconds or so. Dark marking on pronotum (head shield) widens toward the tip.

Special considerations: Sites will likely be within protected areas and may contain sensitive plant species, so permission to access for surveys is very important.

Photuris mysticalampas- mysterious lantern firefly

Survey region: Delaware and Maryland, as well as in New Jersey, eastern Virginia and eastern North Carolina.

Habitats to survey: Peatland forests in freshwater river floodplains, particularly in the Nanticoke River, Mispillion River, and Cedar Creek watersheds. Headwaters of mill ponds. Atlantic white cedar and sphagnum moss are good vegetation indicators.

Time of year to survey: Mid-June to late-July, peaking between 1500-1800 modified Growing Degree Days (mGDD).

Time of night to survey: After dark.

What to look for: Single, yellowish green glow. Hairy elytra; pale scutellum, coxae, and thorax. Oval shape when viewed from above.

Special considerations: Sites will likely be within protected areas, so permission to access them for surveys is especially important.

Photo: Candace Fallon / Xerces Society

Photo: Radim Schreiber/ FireflyExperience.org

Photuris salina- salt marsh firefly

Photo: Richard Joyce/Xerces Society

Survey region: coastal New Jersey, Delaware, Maryland, and Virginia.

Habitats to survey: Upper edges of salt marshes, where high marsh meets salt-tolerant shrubs such as bayberry, groundsel (*Baccharis*) and marsh elder (*Iva*).

Time of year to survey: Late May to mid-July.

Time of night to survey: After dark.

What to look for: Single yellowish flash every 1-2 seconds, low over vegetation in drier areas of salt or brackish marshes. Pronotum (head shield) marking is often hourglass-shaped. Hind coxae are pale or moderate in coloration. Length is 9-12 mm.

Special considerations: Also keep an eye out for *Pyractomena ecostata*, which overlaps in habitat. Be careful to avoid disturbing salt marsh-nesting birds.

Pyractomena ecostata- keel-necked firefly

Photo: Richard Joyce/Xerces Society

Survey regions: Coasts of New Jersey, Delaware, and Maryland. Coasts and inland wetlands of Alabama and Florida.

Habitats to survey: In the mid-Atlantic: high marsh; wet pastures and roadside ditches. In Florida and Alabama: salt marsh, black-needle rush marsh, mangrove swamp, freshwater marshes; and wet flatwoods

Time of year to survey: In the mid-Atlantic: mid-June to early August. In Florida and Alabama: year-round.

Time of day/night to survey: After dark. Flashes activity beginning about 50 minutes after sunset.

What to look for: Pale stripes down the middle of the elytra (superficially like a *Photuris*), large body (11.5-16 mm); Single bright greenish yellow explosive flash (~1-second-long) repeated at relatively long intervals while flying at moderate heights over marsh.

Special considerations:

- In the mid-Atlantic, also keep an eye out for *Photuris salina*.
- In Florida, also keep an eye out for *Micronaspis floridana*, as the two species occupy overlapping habitats.
- Checking porch lights in coastal areas may also yield incidental observations.

Micronaspis floridana- Florida intertidal firefly

Survey region: coastal Florida, including the Florida Keys. Northern edge of range is uncertain.

Habitats to survey: Salt marshes, mudflats, mangroves, and upland areas closes to the intertidal zone

Time of year to survey: Year-round, but March to May for highest numbers of adults.

Time of day/night to survey: About thirty minutes after sunset, going as late as ~11:30 PM.

Florida intertidal firefly larva, showing distinctive dorsal plates. Photo: Xerces Society/Richard Joyce

What to look for: Yellowish-green flash, every 2-3 seconds, of low-flying males. Flashes begin brighter and fade at the end. Glowing armored larvae around the high-tide line. Females sometimes gather in groups and perch on vegetation or rubble emitting a prolonged, modulated flash-glow combination.

Adult male Florida intertidal firefly. Photo: Richard Joyce/Xerces Society

Special considerations:

- Activity is lower on nights with wind, bright moonlight, or temperatures below 65° F.
- There is significant overlap in habitat with *Pyractomena ecostata* in Florida, so keep an eye out.
- Checking porch lights in coastal areas with nearby intertidal wetlands may yield incidental observations.
- To survey for larvae rather than adults, simply disregard the flash-pattern questions on the Flashing Firefly Data Sheet.

Photuris forresti- loopy five firefly

Photo: Xerces Society/Richard Joyce

Survey region: Middle elevations of Georgia, South Carolina, Tennessee, Alabama, and North Carolina.

Habitats to survey: Edges and inlets of ponds or open riparian wetlands (often beaver-influenced) with emergent and floating plants, such as broadleaf arrowhead and arrow arum. Other common vegetation components include grasses, sedges, willows, alders, and red maples. Elevations of known sites range from 600 to 1040 feet (~183-315 meters).

Time of year to survey: Mid-May through late June, lasting 3-4 weeks; earliest at southern sites and lower elevations.

Loopy five firefly flash pattern. Photo: Radim Schreiber/ FireflyExperience.org

Time of day/night to survey: Flashes may be detectable in marsh vegetation as soon as 25 minutes after sunset, but surveys should run through at least an hour after sunset.

What to look for: A flash-train of 5-7 flashes that rise and fall vertically over marshy vegetation over the course of about 3 seconds. A relatively small *Photuris* with dark wing covers and no elytral vittae (pale stripes down middle of each wing cover).

Special considerations:

- Wear rubber boots or waders when surveying for Loopy Fives. It will be difficult to capture a displaying male without wading a bit into their wetland habitat.
- If you are able to get close enough, a smartphone camera may be able to capture video of Loopy Five's distinctive flash-pattern.
- *Photuris tremulans* looks very similar and can be found in the same vicinity and time of year, so be sure that your photographs correspond to individuals that were giving the characteristic Loopy Five flash-pattern.

Photuris walldoxeyi- cypress firefly

Survey region: States in the South and Midwest on either side of the Mississippi and Ohio Rivers: Mississippi, Tennessee, Arkansas, Missouri, Kentucky, Illinois, and Indiana. Elevations at known sites range from ~300-600 ft.

Habitats to survey: Bald cypress swamps, bald cypress-tupelo swamps, and other forested and shrubby floodplain wetlands.

Time of year to survey: Early May to mid-to-late June, depending on latitude and warmth of spring.

Time of day/night to survey: 35-45 minutes after sunset, peaking 65-155 minutes after sunset). Flashing when temperatures are between the low 60s and high-80s Fahrenheit.

What to look for: Flash pattern consisting of 4-9 blinks followed by ~1 second glow.

Cypress firefly flash patterns. Photo: Radim Schreiber/ FireflyExperience.org

Special considerations:

- The northernmost site where this species has been found is beyond the native range of bald cypress, so non-cypress forested wetlands with gum trees (*Nyssa* sp.) in Indiana and Illinois are worth checking.
- This species is very similar to *Photuris forresti* and the two are thought to be closely related. It is possible that they intergrade in places like Alabama.

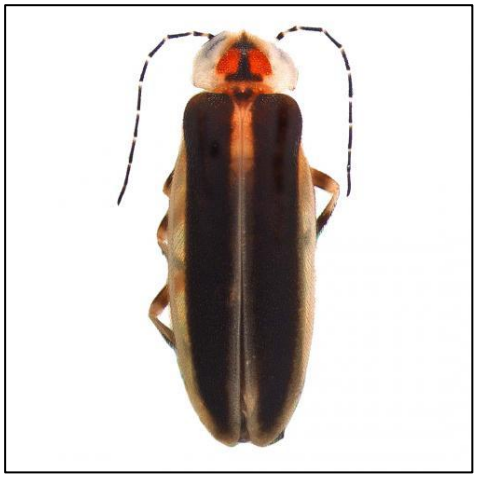


Photo: Luiz Felipe Lima da Silveira.

Diurnal Species

Lucidota luteicollis- Florida scrub dark firefly

Adult male Florida scrub dark firefly. Photo: Richard Joyce/Xerces Society

Survey region: The Central Ridges and Uplands ecoregion of Florida, as well as dry habitats in southern Georgia.

Habitats to survey: Dry scrub, sandhill, and longleaf pine with sandy soils.

Time of year to survey: March to September, but especially April.

Time of day/night to survey: Daytime.

What to look for: Small black firefly with an orange headshield (pronotum) and tip of abdomen, and prominent, flattened, serrated antennae. Males fly relatively low along trails and rest on vegetation.

Special considerations:

- At certain times, the adult males of this species can be relatively abundant.
- Flightless adult females mate with males through the sand.
- Multiple other insect species that share habitats with Florida scrub dark fireflies have similar warning coloration of an orange head or thorax and a black body, including soldier beetles, net-winged beetles, leaf beetles, lovebug flies, and false blister beetles.

Photinus bivulnerus- twice-wounded firefly

Survey region: Madrean Sky Islands in southern Arizona

Habitats to survey: Oak-pine woodlands especially, but all habitats in sky islands.

Time of year to survey: June through August.

Time of day/night to survey: Daytime.

What to look for: A black firefly with red markings on either side of the midline of the pronotum and tiny light organs on the second to last abdominal segment.

Special considerations: This species was previously known under the name *Ellychnia bivulnerus.*

Photo: Mike Quinn/iNaturalist CC BY-NC

Glow-worm Species

Pleotomodes needhami- ant-loving scrub firefly

Survey region: The Central Ridges and Uplands ecoregion of Florida, which stretches from Gainesville to Venus, as well as nearby areas that are dry and sandy.

Habitats to survey: Oak scrub and woodlands with dry, sandy soil.

Time of year to survey: Late March through July, especially April and May.

Time of day/night to survey: Shortly after dark.

Flightless female.
Photo: Xerces Society/Richard Joyce

What to look for: Flightless females glow near the entrance of ant mounds in sandy areas. *Pleotomodes needhami* have been found in nests of northern fungus-growing ant (*Trachymyrmex septentrionalis*), trap-jaw ants (*Odontomachus clarus*), and pyramid or cone ants (*Dorymyrmex* spp.).

Pleotomodes male at a UVlight.
Photo: Tom Palmer/ iNaturalist CC BY-NC

Special considerations:

- While *Pleotomodes needhami* and *Lucidota luteicollis* can be found in the same places, they are unlikely to be detected on the same survey because they differ in times of activity.
- *Pleotomodes knulli* records are also of interest, as the species is assessed as Data Deficient.
- It is assumed that *Pleotomodes needhami* does not co-occur with its close relative *Pleotomodes knulli*, but it may still be helpful to know how to distinguish adult male *needhami* from *knulli*:
    - body shape: parallel sides versus narrowing at the back
    - eyes separated underneath versus contiguous/touching
    - long, sparse, nearly erect pubescence (hairs) on the elytra versus shorter, denser and flat
- Adult males are attracted to blacklights, and checking porch lights in the spring and summer could yield incidental observations of adult males.

Northern Fungus-growing Ant (*Trachymyrmex septentrionalis) nest*.
Photo: amyvak18/iNaturalist CC

Appendix II: Beaufort Windscale Table and Indicators

Scale	MPH	Description	Indicators in the Field
0	0-1	Calm	Calm. Smoke would rise vertically.
1	1-3	Light air	A weather vane would not move.
2	4-6	Light breeze	Wind felt on face; leaves rustle; ordinary vanes moved by wind.
3	7-10	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag.
4	11-16	Moderate Breeze	Raises dust and loose paper; small branches are moved.
5	19-24	Fresh Breeze	Small trees in leaf begin to sway.

Appendix III: Indicators of Habitat Management

Activity	Examples of signs or evidence
Mowing	Short, open vegetation; cut stems; abrupt changes in vegetation height.
Livestock grazing	Manure, tracks or other signs of cattle, sheep, goats or horses.
Crop growing	Crops, cover crops or crop remnants.
Prescribed fire	Fire control lines, blackened bases of trees, soot on ground or charred sticks in a fire adapted ecosystem (longleaf pine savannah, prairie)
Logging	Stumps, slash, or tracks from logging machinery.
Herbicide use	Posted signs; withered vegetation in agricultural or developed area
Insecticide use	Posted signs (“don’t let pets on grass,” yard pest control signs).

Appendix IV: Explanation and detailed instructions for Flashing Firefly Survey Data Sheet

Site and Survey Information Fields

Name of primary observer: Your name.

Number of observers: The number of individuals who are actively participating in the survey.

Names of additional observers: List the names of other individuals who are actively participating in the survey.

Date: Write the date in such a way that you will be able to distinguish day from month when entering it into the Firefly Atlas Portal. The Firefly Atlas database isn't able to accommodate surveys that straddle two calendar dates, so end your survey no later than midnight (23:59).

Site Name: Try to be as specific as possible, while keeping the name recognizable and standard.

Latitude and *Longitude*: Latitude is your North-South position relative to the Equator. In North America, **latitude should always be a positive number**.

Longitude is your East-West position relative to the central meridian. In North America**, longitude should always be a negative number**.

The number of decimal places is important for the precision of the location data; try to include at least five decimal places.

Latitude and longitude can be determined using a handheld GPS, map applications on smartphones, or even after the fact using Google Maps.

You may choose to fill in the coordinates *after* the survey in order to enter more accurate locations of fireflies found or to choose a point that is roughly at the center of the survey area rather than at one end of it.

Location Precision: Select the precision range of your site's coordinates. This will determine the scale at which your data can be used for certain types of analyses, such as habitat modeling.

Elevation (meters): Get this number using a GPS, topographic maps, or online tools that derive elevation from location.

Approximate area searched (hectares): One hectare is equal to 10,000 square meters or ~2.47 acres. You can picture it as the length of a football field, squared. If your survey involved walking a linear distance (along a road or trail, for example), you can estimate the area surveyed by multiplying the one-way distance that you walked in meters by the total width of the area you were able to observe on either side of you. For example, if you hiked 1 mile (1,600 meters), and you had a view of 5 meters (~16 ft) on either side of you, the area searched would be 1.6 hectares (1,600x10/10,000).

Survey start time: This indicates the beginning of when you started searching for fireflies, as well as the window of time to which the Weather, Moon, and Artificial Light values apply.

Survey end time: This indicates when you stopped searching for/observing fireflies, as well as the end of the period of time to which the Weather, Moon, and Artificial Light values apply.

Weather, Moon and Artificial Light Conditions Fields

Time of sunset: You will want to know this information before conducting your survey, so you may want to write it in on your data-sheet before traveling to your site. There are various online sources for sunset time based on location such as weather apps, timeanddate.com, and the National Weather Service.

Moonlight (for flashing firefly and glow-worm surveys)*:* **Choose between "none," "partial," and "bright"** for the moonlight conditions at your survey site. Moonlight at your survey site will depend on factors such as moon-phase, rise time, set time, cloud cover, and the shade cast by vegetation or topography at your site.

Select *none* when the moon phase is new or when the moon is not above the horizon during the survey (this is likely between the third quarter and waning crescent phases).

Select *partial* when the moon is above the horizon, but factors such as the forest canopy, cloud cover, topography or a crescent moon phase are limiting the amount of moonlight reaching the survey site.

Select *bright* moonlight when moonlight is unobstructed and noticeably brightens the survey site (likely casting shadows). Factors that contribute to this category include moon phases between first quarter and third quarter, clear skies, and open habitats and terrain.

The distinction between partial and bright may feel somewhat subjective. For example, a crescent moon may still shine brightly enough to cast shadows. Don't overthink it!

Cloud cover: Choose between *clear*, *mostly clear*, *partly cloudy*, *mostly cloudy*, and *overcast*. In terms of percentages: clear= 0-20% of sky is cloudy; mostly clear= 20-40% of sky is cloudy; partly cloudy= 40-60% of sky is cloudy; mostly cloudy= 60-80% of sky is cloudy; and overcast= 80-100% of the sky is cloudy.

If cloud conditions change over the course of the survey, choose a middle category that you feel best represents the conditions observed.

Beaufort Wind Scale: Use sensory cues in the environment to select the Beaufort Wind Scale. (See Appendix I.) Depending on the species in your area, the chances of observing fireflies may be low when the wind scale is above a given threshold. For your safety and in the interest of conducting surveys when detecting fireflies is more probable, **do not survey when the wind scale is above 5 (Fresh Breeze, 19-24 mph). If your site is wooded, it is advised that you not survey when the scale is above 3 (Gentle Breeze, 7-10 mph).**

If your survey site is relatively close to a weather station that provides real-time, accessible data, you may wish to cross-check your Beaufort Wind Scale estimate with the measured wind speed.

Temperature at start time and *Temperature at end time*: If using a thermometer, make sure that it is reading the temperature of the air, not the ground or your body. The best way to do this is often to hang it from a branch or hold it away from your body and other sources of heat, such as pavement or vehicles.

For convenience, the data sheet and online portal use degrees Fahrenheit as the unit.

Temperature method: Select *thermometer* if you used an instrument to measure the temperature onsite. Select "Weather Station" if the temperature was determined by checking a weather app on a mobile device or sourced from a local weather station. It is preferable to have on-site temperature data, because temperature can vary dramatically with topography and other factors, even in a small area. However, temperature data from a weather app is much preferable to no data at all.

Humidity and Humidity Method: If you have access to a Kestrel Weather Meter, you can measure the humidity in the field at the beginning of the survey. Otherwise, look this number up on a weather app or website.

Precipitation and moisture: Select one of three options.

> *Dry* - No rain during the survey and the ground (leaf litter and ground plants) is dry.
>
> *Ground wet (recent rain)* - It is not raining during the survey, but it has rained recently and the ground is wet. (If the survey site is a wetland or intertidal area, focus on moisture on the vegetation, not the ground.)
>
> *Rain* - Rain of any intensity or duration during the survey. **If it is raining hard, you may want to stop the survey or not start it to begin with.**

Artificial Light Type: For each type of Artificial Light at Night (also known as "light pollution"), answer Yes or No about its presence at the site.

> *Sky Glow:* Diffuse light in the sky, often appearing yellowish or orange. Common in and around cities and suburban areas and often still visible in rural areas.
>
> *Light trespass*: Light illuminating surfaces beyond its intended target. For example, a streetlight casting light beyond the street and onto a forest or field.
>
> *Glare*: Bright, direct light that is visually uncomfortable. Examples: vehicle headlights or stadium lighting. If glare is in the distance, it may not create trespass.

Artificial Light Sources: Circle yes or no to indicate whether each source of artificial light is present at or near your site.

> *Vehicles*: May be relevant for survey sites near roads.
>
> *Street lights*: This might include municipal lighting or private lighting in places like parking lots.
>
> *Buildings:* This might could entail both exterior and interior lights of residential, commercial other types of buildings.
>
> *Other* sources might include telecommunication towers, signage, planes or even fireworks.

Habitat Information Fields

Habitat Type: Choose the broad habitat type that best fits your survey site. It is possible, or even likely, that your survey site will be at a transition area between two types. If you don't think your site fits within one of the given types, circle the closest fit and provide a better description under habitat notes.

Habitat Notes: Provide a more detailed description of your survey site. It is especially helpful to include notes about plant species and vegetation structure. If you are familiar with natural community classifications (groups of plants that tend to grow together because of the environmental conditions), this is a great note to include.

> Examples: Transition between an upland loblolly forest with pawpaw and American holly in the understory and a tupelo/red maple swamp.
>
> Wet roadside meadow with grasses and wildflowers. Vegetation knee-high.
>
> Suburban backyard with 4-inch grass, leaf-litter and native ornamental shrubs.

Habitat Management: Circle "yes," "no" or "suspected" indicating whether you see evidence of the listed management activities. See Appendix II: Habitat Management for examples of evidence for each type.

Only circle "yes" if you observe clear evidence of the activity. Circle "suspect" if you have reason to believe that the activity is practiced, but you don't observe direct evidence, for example if you suspect herbicide use in a tree plantation.

Observation Fields

For the purposes of Firefly Atlas, an observation is the documented occurrence of a given species at a given site on a given date. Note that while you may and photograph multiple individuals, the Firefly Atlas protocol is such that you would only record and submit one observation per species. This differs from other protocols where an observation is the documented occurrence of an *individual* of a given species at a given place at a given time.

Firefly Species: This is the preliminary identification or the scientific name (Genus + species) that you are assigning to your observed firefly species. If you are unsure of the species, you just enter the genus, followed by "unknown" or simply Genus unknown and species unknown.

Approximate number observed during the survey: This is your best guess of the total number of *individuals* that you saw over the course of the survey period. If your survey was stationary, this might be the maximum number of individuals seen flashing in a short period. If your survey was traveling, this might be a rough tally of how many individuals you saw. These are coarse bins, so don't over think it. Remember that this is the approximate number of *individuals*, not number of flashes!

Observation notes (not related to flash pattern): This is a space where you may wish to include information such as the sexes of individuals observed or photographed, body length, microhabitats used, or any other pieces of information that are not captured in the flash pattern details.

Flash Pattern Details

Time of first observed flash: This is not necessarily the time when a given species began flashing at a site, but it is an upper bound of how late the species began flashing. If this number coincides with the survey start time, you probably should have arrived at the site a little earlier!

Time of last observed flash: In the moment, it's hard to know whether a flash will be the last one you see for the evening, so it's fine to estimate when the last observed flash was. Depending on the species, this time will often coincide with the end survey, because flashes will still be going when you leave the site.

Temperature of last observed flash: The rate at which fireflies flash is temperature dependent, so this is important to record.

Number of flashes in Flash Pattern (FP): Select between 1, 2, 3, 4 and more than 4. The number should be apparent after observing for a minute or two. Note that single-flashers may sometimes emit strings of 2, 3 or 4 flashes, but these will not be repeated in a regular or predictable way. If the observed species had a number of flashes in its flash pattern greater than four, include this number or range of numbers in the *Description of male flash behavior field*.

Flash Color: Flash color often helps to narrow down the likely genera, particularly when viewed up close. This is a somewhat subjective impression that will vary based on conditions and the age and eyesight of the observer.

Period of Flash Pattern (seconds): This is the time between the start of the flash pattern and when the flash pattern repeats. Use a stopwatch, voice recorder, or camera with video capability to measure the period. When using a voice recorder, count the flashes out loud as you see them. For quick, single-flashing species, this will often be basically the same as "flash interval."

Flash duration (seconds): This is how long the individual flash or pulse is, for species with regular-length flashes. You can either use a stopwatch while observing an individual adult male or use a video to get a more precise estimate after your survey. Even if you do record video, we recommend taking a stopwatch measurement in the field in case the video is not clear enough. While stopwatches can read to hundredths of a second, it's fine to round to the closest tenths (0.1) or twentieths (0.05) of a second.

Flash Interval (seconds): This is the "pause" or amount of time in between flashes in a flash pattern. Use the same method(s) as for flash duration.

Height zones at which males displayed (check all that apply): Low (0-3 ft), Moderate (3-8 ft), and High (over 8 ft). You can disregard stray individuals that appear to be outliers.

Male flash description: Use this space to describe the male display behavior. Helpful things to note include where males are flying in relation to habitat features, the distance they fly in between flashes, the speed at which they fly, shape of flashes and flight paths (J-shaped, sideways hook, flashbulb) and any qualitative descriptors (warm, flickery, erratic, rhythmic, explosive).

Female flash description: If you observe a female flashing, include details such as delay between male flash and female flash, position in the habitat, and air temperature when flashing. With some species, it may be unlikely that you will find a female.

Photo identifiers (images # or time): This field is on the data sheet but not on the online form, and its purpose is to ensure that you can associate photos on your camera with flash pattern details on the data sheet.

Appendix V: Vehicle Dash Placard

Cut out the placard on the following page and place it in the window of your vehicle when surveying. This may help to address any concerns from local individuals.

VOLUNTEER SURVEYOR

I am conducting fieldwork to document fireflies/lightning bugs. Sampling is non-lethal and there is no collection of fireflies/lightning bugs. See fireflyatlas.org for more information.

Name:_____

Phone: _____

Project Coordinator: Richard Joyce
Conservation Biologist,
The Xerces Society for Invertebrate Conservation
(864) 668-5598
fireflyatlas@xerces.org

FIREFLY ATLAS

fireflyatlas.org

Appendix VI: Community Science Program Code of Conduct

Thank you so much for agreeing to volunteer with The Xerces Society. Your commitment provides critical information to further the conservation of animals that are so often overlooked. The Xerces Society is committed to promoting and maintaining an environment in which all volunteers are treated with respect and dignity. To achieve this, we ask that volunteers and employees conduct themselves in a civil and cooperative manner and avoid behavior that interferes with the ability of others to volunteer and to feel comfortable while volunteering.

WHAT WE ASK:

While volunteering in any capacity such as with other volunteers, Xerces staff, organizational partners, or with the public, we ask that volunteers do the following:

- Please feel free to answer questions about your specific volunteer activity but direct people to the Xerces' website for questions about Xerces' mission, research, values, and position on conservation issues.
- Please act in a manner that will increase public trust in our conservation efforts.
- Please do not use a volunteer position with the Xerces Society for personal gain, nor claim or imply that you represent Xerces or represent your personal views as those of Xerces.
- Please represent that you are a Xerces' volunteer only when engaged in an approved Xerces' volunteer activity.
- Please direct the public to the Xerces' website if they ask about making a donation and explain that you are not allowed to accept donations on behalf of the Xerces Society.
- If approached by the media while participating in a Xerces activity as a volunteer, only answer those questions that are directly related to volunteer participation in the specific activity, speaking only as a volunteer. Any questions beyond that limited scope, including but not limited to any questions about Xerces' public policies, should be directed to the Director of Communications at communications@xerces.org.

UNACCEPTABLE BEHAVIOR:

In order to protect volunteers and members of the public they interact with, we consider the following behavior unacceptable:

- Trespass in any form or manner on private property including, but not limited to, by

entering lands under cultivation or enclosed by a fence, climbing fences, pushing through fences or hedges that define property boundaries or tampering with locks on gates, entering uncultivated or unenclosed lands by ignoring signs forbidding trespass, refusing to reasonably look for signs forbidding trespass or destroying signs forbidding trespass, or refusing to leave the property when told. If you are uncertain as to whether property is public or private, assume it is private, stay on the public roads adjoining the property when performing the activity, and DO NOT ENTER THE PROPERTY ITSELF WITHOUT PRIOR WRITTEN PERMISSION OF THE OWNER.

- Damage of any public or private property, whether deliberately or through negligence, reckless or improper conduct, including Xerces Society-owned property.
- Fraudulent, illegal, or improper conduct or activities.
- Volunteering under the influence of, possessing, distributing, selling, or using drugs that are illegal under state or federal law while volunteering.
- Volunteering under the influence of, possessing, distributing, or selling alcohol.
- Bullying, abusive, intimidating, discriminatory or harassing conduct while volunteering.
- Violation of safety or health rules.

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