SUSTAINABLE US FIREFLY TOURISM

A Guide for Site Managers

XERCES SOCIETY
for Invertebrate Conservation

IUCN SSC
Firefly
Specialist Group

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Acknowledgments

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Our thanks go to the photographers whose photos appear in these pages. All copyrights remain with them. **Cover photos (clockwise from left):** Synchronous fireflies (*Photinus carolinus*) light up the night in Elkmont, Tennessee; an adult flashing firefly perches on a blade of grass before dark; a female glow-worm signals from the forest floor. (Photographs courtesy of Radim Schreiber / fireflyexperience.org.)

US Firefly Tourism Vision Statement:
"We envision a future where firefly tourism inspires natural wonder, dark sky initiatives, and mindful conservation of fireflies and their habitats; promotes nature education; and benefits local communities."
– Participants of the 2021 US Firefly Tourism Charrette

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A female California pink glow-worm (*Microphotus angustus*) displays her glowing lantern to attract males. (Photograph courtesy of Butter / iNaturalist.)

Introduction

Firefly tourism is on the rise in the United States. Of the more than 150 species of fireflies that occur in the US, at least five species—including the synchronous fireflies *Photinus carolinus* and *Photuris frontalis*—are of tourism interest. While this can be a boon to local economies and help more people to experience the wonder of fireflies, it also presents challenges. As a site manager, you will need to carefully balance growing public interest with safeguarding the attraction itself—the fireflies and their habitats.

In 2021, a consortium of site managers, tour operators, event planners, and firefly researchers gathered for a US Firefly Tourism Charrette to discuss these challenges, identify practical solutions, and draft a set of guidelines that could be used to promote sustainable firefly tourism. Those guidelines, which are detailed in the following pages, were adapted from recommendations provided in *Firefly Tourism: Advancing a Global Phenomenon Toward a Brighter Future.* These simple guidelines are intended to help site managers understand the basic needs of fireflies and identify ways to protect fireflies and their habitats while also providing educational and viewing opportunities for visitors. For those who would like to dive a little deeper, additional resources are provided at the end of this document.

What Fireflies Need

In general, fireflies have five basic requirements: food, shelter, moisture, dark nights, and protection from pesticides. Although adults of some species do eat, feeding behavior is primarily associated with larvae. These juvenile predators spend most of their time hunting for soft-bodied invertebrates such as snails, slugs, and worms.

Figure 1—Fireflies spend most of their lives as larvae hunting for soft-bodied prey, like this immature spring firefly (*Pyractomena* sp.) observed killing and eating a snail. (Photo: ssutto / iNaturalist.)

Fireflies require moisture throughout their life cycle. Depending on the species and life stage, different microhabitats offer places for shelter, mating, and overwintering. While adult fireflies tend to steal the show with their brilliant lightworks, it is important to remember that fireflies are present year-round, not just during the brief summer mating season. Fireflies spend most of their lives as larvae—up to two years or more, depending on the species and location. Both larvae and pupae generally seek shelter in moist soil, leaf litter, or rock crevices.

Similarly, adult females will also search out moist soil, rotten logs, and the bases of bunchgrasses to lay eggs; and species with flightless adult females are drawn to small burrows or protected areas under vegetation, rocks, or logs. All of these microhabitats are also attractive to the invertebrates that make up the majority of a larval firefly's diet. At a larger scale, vegetation, from grasses and forbs to shrubs and

trees, provides places for fireflies to perch and signal to potential mates; these plants also play a role in maintaining moisture levels and can help mitigate light pollution.

Because so many species are active at night and use bioluminescent signals to communicate, **dark skies are especially important for fireflies**. Light pollution is a growing threat, known to interfere with firefly courtship and reproductive success. Fireflies need habitats that are free of other types of pollution, as well. Pesticides, which include insecticides and herbicides, have the potential to directly kill fireflies or indirectly affect them by degrading their habitat or reducing prey populations. Broad-spectrum insecticides put fireflies at risk, since these are designed to kill any insects that come into contact with them.

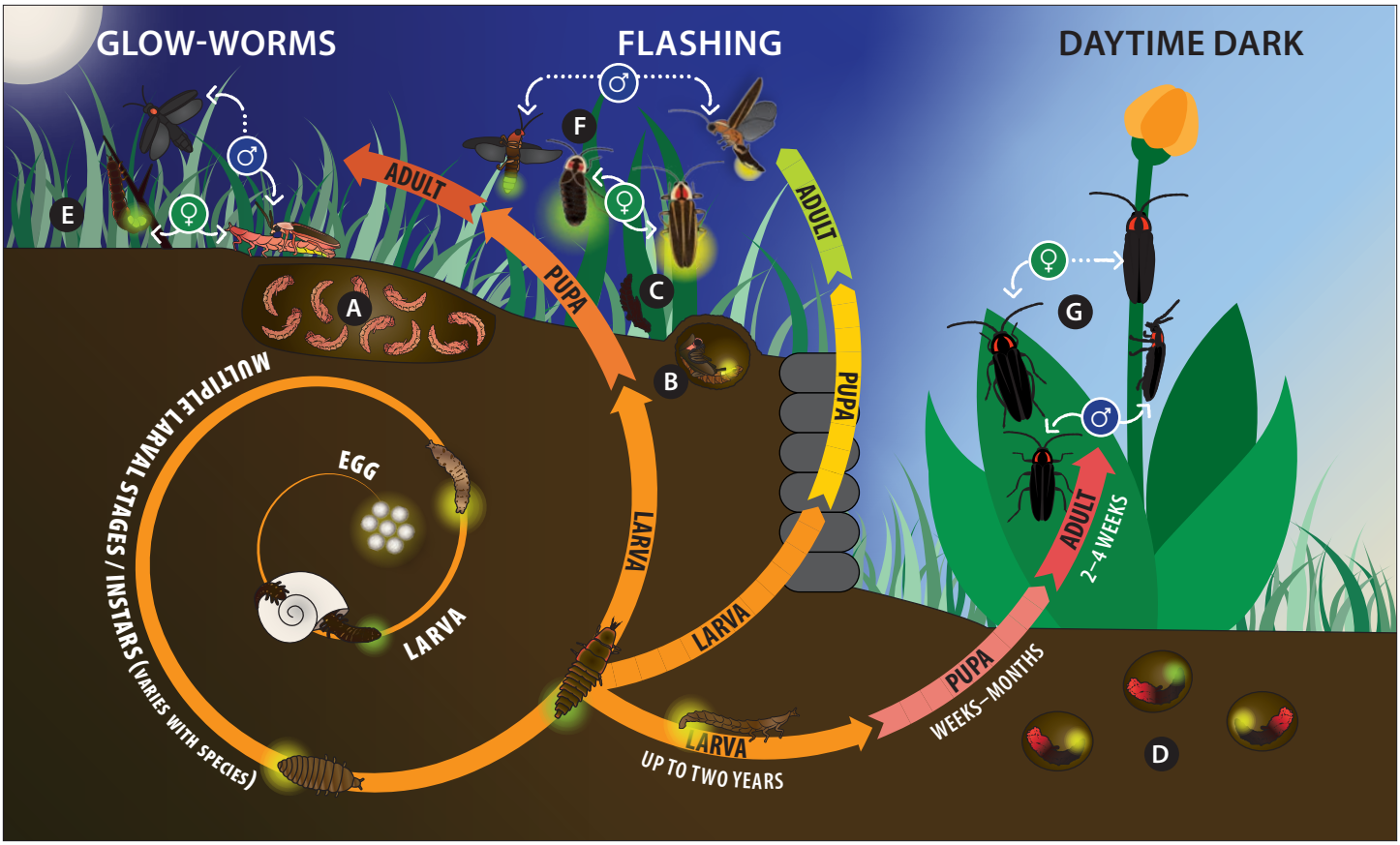
What Are Dark Sky Initiatives?

Dark sky initiatives are part of a global movement to reduce light pollution by eliminating or restricting artificial light at night.

Some of the most common initiatives include promoting the use of lighting fixtures that direct light only where it is needed, campaigning for communities to adopt lighting regulations, and encouraging friends and neighbors to turn off unnecessary outdoor lighting after dark.

You can find more information about firefly-friendly lighting practices and other dark sky initiatives in the Conservation Guidance section on page 10.

Figure 2—The three firefly groups—flashing, daytime dark, and glow-worms—have similar life cycles that mostly differ in their adult stages. Shown below: After spending approximately two years as larvae, some species pupate together (A) or alone (B) in shallow cavities at or slightly above soil level, aboveground on vegetation (C), or in shallow chambers an inch or two belowground (D). Flightless adult females (♀) are found in all three groups, varying from wingless (E) to different levels of short-winged (F), a.k.a. brachypterous, the most extreme of which are functionally wingless. While all three groups are bioluminescent as larvae and pupae, not all adults have functioning light organs, a.k.a. lanterns. Daytime dark fireflies and many adult male (♂) glow-worms do not produce light; in both groups females may signal/attract males using light (glow-worms) or pheromones (G).



1 Know Your Species, Their Life Cycles, and Their Needs

Figure 3—U.S. Fish and Wildlife Service at-risk conservation fellows & Delaware Division of Fish and Wildlife staff (above) survey and process fireflies (below) as part of an effort to learn more about the Bethany Beach firefly (Photo: Kayt Jonsson, USFWS / flickr.)

It is likely you already know the main species attractions at your site; after all, this is probably what led to your site gaining popularity with firefly tourists. Successfully managing your site to welcome visitors while protecting popular species requires an understanding of each firefly's life cycle, habitat needs, and relevant life history traits. It is also important to keep in mind that other firefly species likely co-occur at your site and should also be considered in any management or conservation activities that take place.

Recommendations

- Create a species checklist for your site. If you are not familiar with fireflies, consult regional guidebooks, local species experts, and/ or community science websites like iNaturalist to determine what might occur in your area.
- If possible, conduct surveys to confirm species presence or fill in information gaps.
- Document each species' life cycle and determine how each stage's activity period might be affected by management activities and visitor traffic.
- Take time to understand your species' specific habitat requirements and other life history traits so that you are better equipped to put practices in place that will protect them. For example, adult female blue ghosts (*Phausis reticulata*) are flightless, so trampling is a major concern for this species.

State of the Fireflies of the United States and Canada

Researchers and firefly experts with the Xerces Society, Albuquerque BioPark, Tufts University, and the International Union for Conservation of Nature Species Survival Commission Firefly Specialist Group completed Red List assessments for 132 firefly species and subspecies (77% of described taxa in the US and Canada). Their report, *State of the Fireflies of the United States and Canada*, summarizes the extinction risk and conservation status of these species, highlights major threats, and offers an action plan for protecting fireflies. Download the report at: xerces.org/publications/reports/state-of-the-fireflies/

2 Protect Adult and Larval Habitat

Habitat loss and degradation have been identified as the leading **perceived threats to fireflies worldwide**. Degradation occurs in many forms, from light pollution and pesticide use to modification of waterways and invasive plants. If not managed well, firefly tourism can degrade adult and larval habitat through soil compaction, vegetation removal, water and light pollution, and loss of prey populations. Certain species, like habitat specialists and those with flightless adult females, are especially vulnerable to such habitat degradation. To safeguard the star attractions, you will need to protect not only adult display areas, but also larval habitats.

Figure 4—Boardwalks like this one in Congaree National Park, South Carolina, help ensure visitor safety while protecting fireflies and their fragile wetland habitats. (Photo: Congaree National Park).

Recommendations

- Set limits on visitor capacity at your site:
  - Cap the number of visitors per night or per showing.
  - At sites where interest exceeds capacity, consider implementing a lottery system.
  - Minimize tour group sizes and the number of tours per night.
  - Designate one-way trails to keep people moving and reduce congestion.
- Restrict visitors to designated viewing areas or trails:
  - Announce sensitive habitat with appropriate signage.
  - Install fences, raised walkways, or observation platforms to constrain visitor traffic.
  - Consider bleachers or other designated seating areas to limit disturbance to surrounding habitat.
  - Use dim rope lights to direct people to the designated area, and then turn them off during viewing periods.
  - If your site has accessible still water (e.g., pond, lake), consider a night paddle by kayak or canoe, which allows observation without trampling on flightless adult female fireflies or larval territory.

Figure 5—Dim red rope lighting is used to direct visitors to designated bleachers at the Pennsylvania Firefly Festival in Allegheny National Forest. Once settled in, the lights are turned off so that everyone can enjoy the show. (Photo: Peggy Butler / Pennsylvania Firefly Festival.)

Figure 6—Lottery winners of tickets to the Great Smoky Mountains National Park synchronous firefly event line up in advance; attendees are brought to the site by trolley to limit the visitors' impact on the fireflies. (Photos: Warren Bielenberg, Great Smoky Mountains National Park / flickr.)

- Minimize artificial lighting:
  - Encourage visitors to arrive prior to dark and limit headlight/flashlight use when walking around the site.
  - If a light must be used, remind people to use a dim red light and aim it only at the path.
  - Prohibit the use of flash photography and limit cell phone use.
  - If possible, switch off infrastructure and building lights or cover them with red filters.
  - Install barriers along roads and parking areas to protect firefly display areas from vehicle headlights.
  - Encourage drivers to use running lights instead of their vehicle's headlights as they leave the site.
- Don't apply pesticides within or around firefly habitat:
  - Pesticides, which include insecticides and herbicides, have the potential to kill fireflies or indirectly affect them by degrading their habitat or killing their food sources.
- Conduct management activities with the firefly life cycle in mind:
  - Any activity that involves ground disturbance could potentially harm fireflies.
  - Limit and/or rotate mowing and other maintenance activities so that no more than one-third of the habitat is impacted in any given year.
  - Avoid using heavy machinery, which can physically crush juvenile fireflies (off season) and flightless adult females (in season).

3 Provide Training for Guides

Trained guides familiar with the basics of firefly biology will enrich the visitor experience while ensuring that visitor guidelines are followed to help protect fireflies and their habitat. Guides can help provide context for what visitors are seeing and explain why certain guidelines are in place. They can also help foster a deeper appreciation for fireflies, their life cycle, and their conservation needs, and may even inspire visitors to take action to help protect fireflies following their visit.

Recommendations

- Establish training programs for tour guides and volunteers:
  - Provide annual training for staff and volunteers before firefly season begins—if possible, include any staff who will interact with visitors.
  - Include information on the focal firefly species: its behavior, life cycle, phenology, and conservation issues.
- Develop a script for new guides to use, and give guides and volunteers a FAQ sheet with information specific to your site.
- Ensure that guides are familiar with basic visitor etiquette at the site, and provide tools and resources that will help them promote visitor compliance.

Figure 7—Above: A volunteer explains the firefly life cycle to attendees of the annual High Bridge Trail Firefly Festival. Below: Attendees arrive before dark at the annual High Bridge Trail Firefly Festival (left), before hearing a ranger give a talk about fireflies (right). (Photos: Virginia State Parks / flickr.)

Educate Visitors 4

Education can improve visitor engagement, create a deeper sense of connection, and foster long-term conservation efforts. Simple measures taken to educate visitors can help them understand the reasons behind the site guidelines and visitor etiquette, identify the elements fireflies need to thrive, and inspire deeper thinking about conservation and habitat protection. In turn, informed visitors share what they have learned with others, apply lessons to their personal lives (e.g., by turning off their outdoor lights when they're not needed), and gain a deeper appreciation for the natural world.

Recommendations

- Send visitors information about firefly-watching etiquette **before** they visit (e.g., through tour websites, email confirmations, etc.):
  - Consider a verbal or written pledge where visitors agree to follow these guidelines.
- Display this information at the site entrance, and then reinforce it through tour guides.
- Display accurate, attractive signs and exhibits to illustrate firefly life cycles, focal species identification, habitat requirements, and conservation needs:
  - Post these at the viewing area and wherever people park or board shuttles.
  - If permanent signage is a concern, consider temporary banners that can be displayed just during the firefly season.
- Encourage visitors to let their eyes adjust to the darkness and educate them on the importance of dark skies (light pollution affects people, too, not just fireflies and other animals).
- If possible, provide each tourist group with a trained guide who can answer basic questions about the focal species' biology, life cycles, habitat requirements, and conservation.
- Use brief pre-tour videos or live presentations to describe firefly life cycles, habitat requirements, and conservation.
- Videos can be shared via email, websites, social media, and at on-site kiosks.
- Offer educational programs for community groups and schools during the off season.
- Educate visitors about what they can do to help protect fireflies where they live, including conservation information and community science opportunities like **Firefly Watch**.

Figure 8—Well-designed exhibits like this one at the Utah Natural History Museum in Salt Lake City engage visitors while educating them about local species. The one-of-a-kind firefly model, named Franklin, was sculpted by museum artist Emily Szalay. The habitat display has been converted into a traveling mini-diorama. (Photos: Utah Museum of Natural History.)

For More Information

Conservation Guidance

Conserving the Jewels of the Night: Guidelines for Protecting Fireflies in the United States and Canada
xerces.org/publications/guidelines/conserving-jewels-of-night

Conserving the Jewels of the Night: Firefly-Friendly Lighting Practices (available in English and Spanish)
[…]/fact-sheets/firefly-friendly-lighting

Firefly Conservation: A Guide to Protecting the Jewels of the Night
[…]/brochures/firefly-conservation

International Dark-Sky Association
www.darksky.org

The Xerces Society's Firefly Conservation Campaign
xerces.org/fireflies

ID Guides & General Information

Silent Sparks: The Wondrous World of Fireflies by Sara Lewis:
silentsparks.com

Fireflies, Glow-worms, and Lightning bugs: Identification and Natural History of the Fireflies of the Eastern and Central United States and Canada by Lynn Faust:
ugapress.org/book/9780820348728/fireflies-glow-worms-and-lightning-bugs/

Field Guide to Western North American Fireflies by Larry Buschman:
entomology.k-state.edu/doc/Kansas%20Fireflies%20May%202015.pdf

Figure 9—This educational interactive display taught attendees of the Capilano Suspension Bridge Park holiday lights festival about firefly communication using reactive lights that flashed in response to signals from a special flashlight. (Photo: Tom Magliery / flickr.)

US Firefly Tourism Resources

Visit xerces.org/fireflies to download additional resources for sustainable firefly tourism, including an easy-print Visitor's Etiquette Guide that can be displayed or distributed before events and the most recent report on the State of the Fireflies, which includes a checklist of the known species in the United States and Canada.

Figure 10—Three copies of the Visitor's Etiquette Guide can be printed on on letter paper using a small office printer, making it easy to share with participants before and during events.

Community Science Projects & Opportunities

In addition to field guides, community science projects are a great way to learn more about the species that might occur at your site. You can peruse other users' observations or submit your own sightings and get assistance with species ID. Species inventories and bioblitzes can be run through platforms like iNaturalist, and you can even start your own project to collate observations associated with your site. BugGuide, another online community of naturalists and specialists, offers a more curated approach to species ID. Together, the two platforms can be a useful tool for learning more about your resident firefly fauna, although there are limitations to a photo-only approach. Accurate species IDs often require flash pattern descriptions, activity period data, and even voucher samples. Firefly-specific projects, like Xerces' Firefly Atlas, can provide more guidance and support to site managers interested in conducting these types of surveys. Additional firefly community science projects can be found at **xerces.org/endangered-species/fireflies/community-science**.

North America

Firefly Atlas

fireflyatlas.org

The Firefly Atlas is a new initiative by the Xerces Society and partners that seeks to engage land managers, researchers, and community scientists in filling data gaps that can then help inform firefly conservation efforts. With guidance and training support provided through the project, site managers are encouraged to conduct surveys for threatened and data deficient species and report their sightings to the Atlas.

iNaturalist

www.inaturalist.org

iNaturalist is an online community dedicated to cataloging biodiversity data and bringing people together to learn more about the natural world. By submitting your sightings, your records can be vetted by the community and integrated into other projects like the one run by the Fireflyers International Network, whose members work together to review and curate firefly report and improve the accuracy of these datasets.

BugGuide

bugguide.net

Hosted by Iowa State University, BugGuide is an online community of naturalists who share observations of arthropods such as insects, spiders, and other related creatures. Registered users can post photos for identification by specialists and experienced naturalists.

Figure 11—Species like the synchronous firefly (above left), the snappy sync firefly (above right), and the blue ghost firefly (below) tend to be the stars of the show, but they likely represent just a part of your resident firefly fauna. When making management decisions that could impact these species, don't forget to consider the rest of the firefly community at your site. (Photos: Mike Quinn / BugGuide [above left, above right]; John Abbott [below].)

Blue ghost fireflies (*Phausis reticulata*) light up the forest floor.

Cover photos courtesy of Radim Schreiber / fireflyexperience.org.

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