

FIREFLY SPECIES FACT SHEET:
Loopy five firefly (*Photuris forresti*)



*Adult loopy five firefly and long exposure of the loopy five firefly flash pattern
(photos: Richard Joyce/Xerces; Allen Grubbs)*

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Richard Joyce
Xerces Society for Invertebrate Conservation



Scientific Name:

Photuris forresti Lloyd, 2018

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Lampyridae

Subfamily: Photurinae

Tribe: Photurini

Synonyms: None

Common Names:

Loopy 5; loopy five firefly

Taxonomic Note:

Photuris forresti was described by James E. Lloyd in 2018 based on specimens collected and observations made in 1986. In Lynn Faust's 2017 firefly, the species is referred to by the common name she coined, "Loopy 5," and by '*Photuris* "F"' which was the placeholder name used by Lloyd.

North American *Photuris* are difficult to identify, with positive ID depending on a combination of morphological characters (not aedeagus) and male courtship flash patterns.

Conservation Status:

Global Status: G1 – Globally Imperiled (Last reviewed 6 January 2022)

National Status (United States): NNR – Nation Not Ranked

State Status: SNR – State Not Ranked (GA, SC, TN)

(Walker & Faust, 2022b)

IUCN Red List: Endangered (Walker & Faust, 2022a)

Federal status (United States): Petitioned for ESA listing, awaiting 90-day finding (Joyce et al., 2023).

Technical Description:

Adult: Loopy five fireflies cannot be definitively identified based on morphology alone, as its diagnostic character is its unique male courtship flash behavior (L. F. Faust, 2017; Lloyd, 2018). However, *Photuris forresti* does have consistent morphologic traits that help to distinguish it from some other southeastern *Photuris* species. The reported length for *Photuris forresti* is 10.3 to 13.1 mm (Lloyd, 2018) but they are typically 11-12 mm (L. F. Faust, 2017). The dark elytra lack mid-elytral vittae (pale diagonal stripes) or

have short, faint mid-elytral vittae (Figure 1). The hind coxae are consistently dark (Faust 2017; Lloyd 2018, Figure 2) in contrast with species with pale hind coxae, such as *Photuris lucicrescens*. Morphologically, *Photuris forresti* does not appear to be distinguishable from *Photuris tremulans* or *Photuris walldoxeyi*, though there are no known sites where *Photuris walldoxeyi* is sympatric (L. Faust & Davis, 2019; Lloyd, 2018).



Figure 1. Dorsal view of an adult *Photuris forresti*, showing the dark elytra lacking mid-elytral stripes and the dark arrow-shaped marking on a red background on the pronotum. (Richard Joyce/Xerces Society).

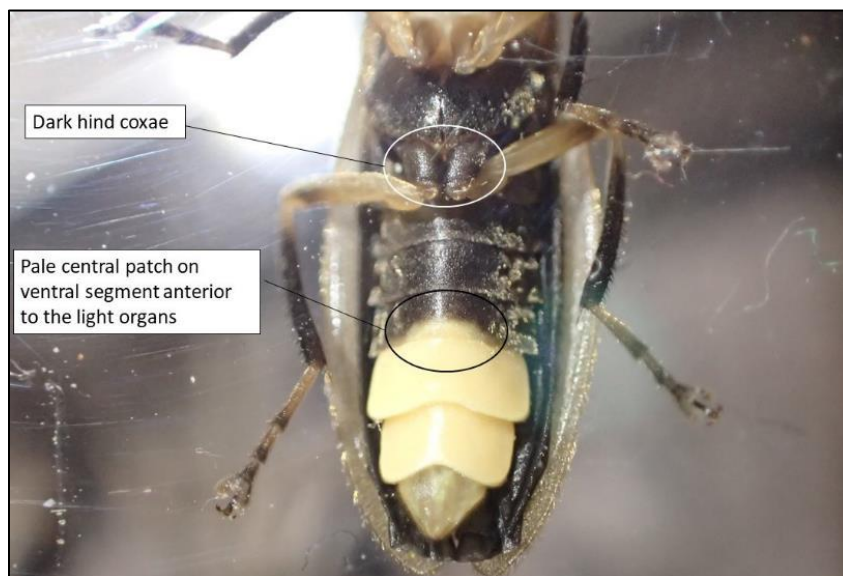


Figure 2. Ventral side of a male *Photuris forresti*, showing dark-colored hind coxae and the pale central patch on the ventral segment anterior to the lanterns. (Richard Joyce/Xerces Society).

Immature: The immature life stages of *Photuris forresti* have not been described. *Photuris* larvae can be recognized by their flattened, oval body shape, and are usually detected by the glow that they emit while foraging on the soil or leaf litter surface at night.



Figure 3. A larval *Photuris* feeds on a snail in Tennessee. (Photo by [Will Kuhn CC BY 4.0](#))

Life History:

Larval microhabitats and foraging

Photuris versicolor complex females, such as those of the loopy five firefly, typically lay eggs a few at a time over multiple days or weeks (Lloyd, 2018). Larvae hatch in two or three weeks and go through four to seven instars over a one to two year period, diapausing over the winter (Faust, 2017; Lloyd, 2018). Larvae are likely active spring through fall and hunt along the soil surface, looking for soft bodied organisms such as slugs, snails, earthworms, and other invertebrates to feed on. *Photuris* larvae are also known to forage on berries and to scavenge dead insects (Buschman, 1984). They pupate in chambers just under the soil surface or under logs for one to three weeks and emerge as adults in early summer (Buschman, 1984; Lloyd, 2018).

Flash Behavior

The common name of *Photuris forresti*, loopy five firefly, refers to the firefly's distinctive courtship flash pattern—a series of 4-7 pulses emitted over approximately 3 seconds while rising and falling in space (Faust, 2017) (Figures 4 and 5). The vertical orientation of the flight trajectory while flashing is suspected to be an adaptation for increasing visibility of displaying males to females perched in grassy marsh habitats (Lloyd, 2018). The dark period of the loopy five firefly's flash pattern is relatively long (>10 seconds and up to 26 seconds), which makes it difficult to track individuals for more than one flash

pattern (Faust, 2017; Lloyd, 2018). Unlike many species in its genus, *Photuris forresti* does not appear to have an adjunct (additional) flash pattern (Lloyd, 2018).

Analysis of flash pattern video recorded in Georgia revealed a mean of 6.6 ± 1.8 pulses per flash pattern, with inter-flash gaps of 0.36 ± 0.09 seconds and flash durations of 0.09 ± 0.04 seconds (Martin et al., 2023).

A sympatric species with a superficially similar flash pattern is the cattail flash-train firefly (*Photinus consimilis*), which also emits multi-pulse flash trains over marshy wetlands (see Figures 5 and 6). *Photuris tremulans*, a more broadly distributed species that is presumed to be closely related to *P. forresti* and is morphologically indistinguishable, emits a combination of vibrating flickers and bright single flashes (Figure 7). The firefly with the most similar flash pattern to *Photuris forresti* is the cypress firefly (*Photuris walldoxeyi*) (Faust & Davis, 2019). However, the cypress firefly is currently not known to be sympatric with *Photuris forresti*, and its flash pattern consists of a flash train of short flashes ending in a longer glow, unlike the more erratic mix of flashes and flows in *P. forresti*.

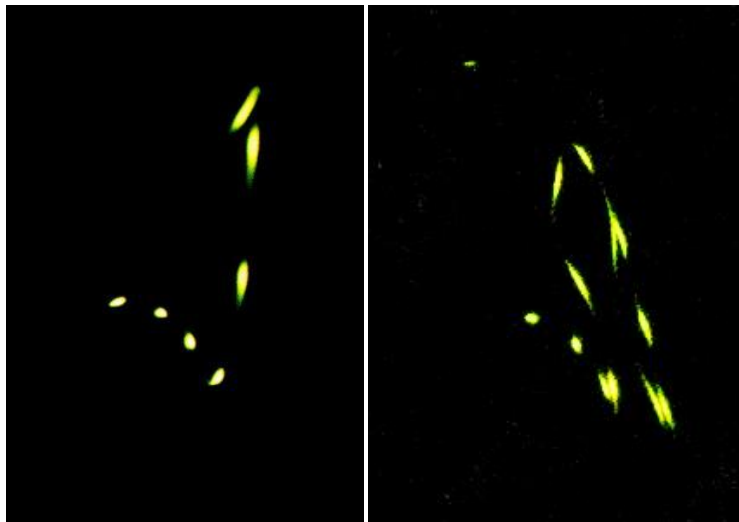


Figure 4. Long exposure images of *Photuris forresti* flash trains. Note that some pulses appear as quick flashes and others as longer glows. (Allen C. W. Grubbs)



Figure 5. A thirty-second long exposure taken in Walton Co., Georgia in May 2023, showing two *Photuris forresti* flash patterns (center and right) and one flash pattern of *Photinus consimilis* (left) (Allen W. C. Grubbs).



Figure 6. Flash patterns of the cattail flash-train firefly (*Photinus consimilis*), a firefly species that often overlaps with *Photuris forresti* in habitat and season. The flashes of *Photinus consimilis* are typically less green-tinted and their trajectories are less erratic, often forming an S-shape and having more pulses of more even duration. (Richard Joyce/Xerces Society).



Figure 7. *Photuris tremulans*, a sympatric species that is morphologically very similar to *Photuris forresti*, has two flash patterns, both distinct from *P. forresti*. These include bright single flashes and rapid flickers that appear in long-exposure images as strings of eight or more tightly spaced flashes. (Composite image created by Maina Handmaker, June 2022, Greenville Co., SC.)

Phenology

Adult loopy five firefly flashing displays have been seen from mid-May in Georgia to late-June in Tennessee (see Figure 8).

Modified growing degree days (mGDD) are a measure of heat accumulation on a given date and over the course of the growing season, and are used to take seasonal and geographic variation into account when making phenology timing predictions and characterizations (Faust, 2017; Faust & Weston, 2009). In general, mGDD values of under 1000 correspond to the spring season, while values between 1000 and 1800 are early summer and values above this are summer into early autumn. The accumulated mGDD values for *Photuris forresti* occurrence records range from 1011 to 1690 (Figure 9).

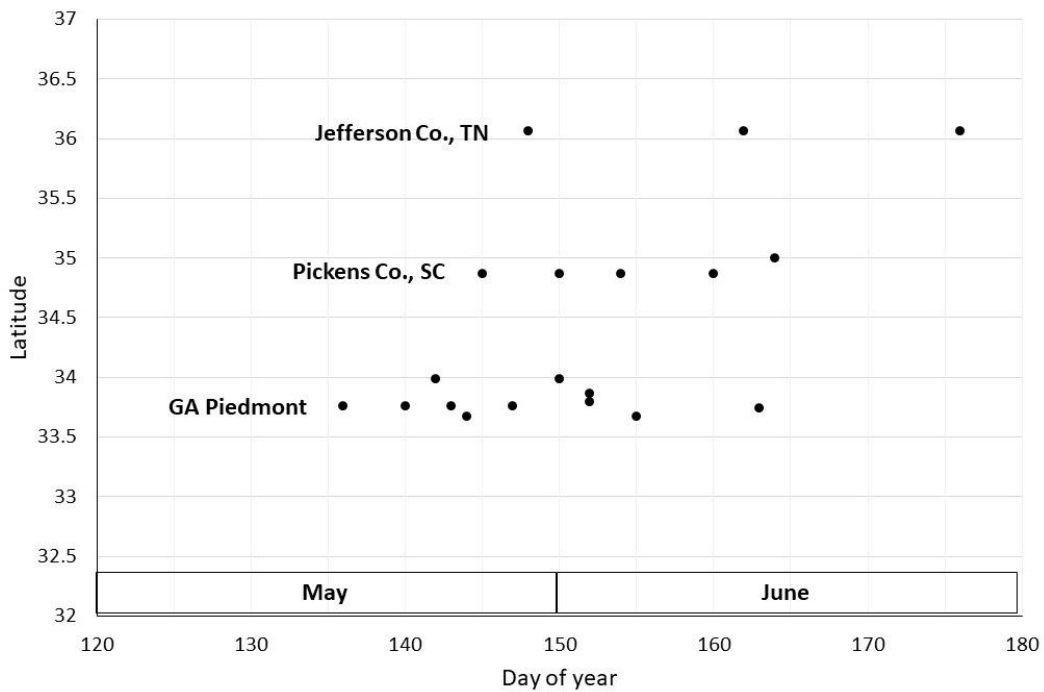


Figure 8. A selection of observation and collection records for *Photuris forresti* by Latitude and Day of Year. Day of year ranged from 136 (16 May) to 176 (25 June). May= 120-150, June= 151-180.

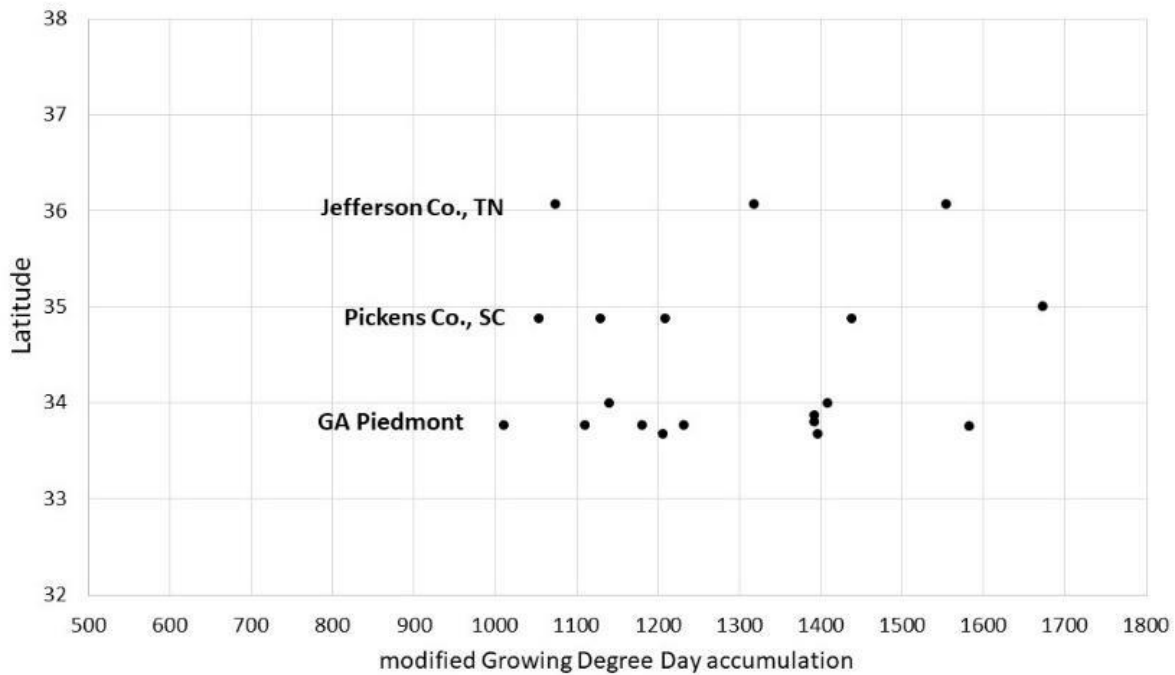


Figure 9. Observation or collection records for *Photuris forresti* by Latitude and accumulated modified Growing Degree Days (86°/50° F, 1 March start date). Cumulative mGDD (a measure of seasonal temperature trends, based on daily high and low temperatures) range was 1011 to 1674, with the minimum corresponding to May 16th and the maximum corresponding to June 13th. Sites labeled “GA Piedmont” are located in Walton, Clarke, Oconee, and Morgan counties in Georgia.

Co-occurring firefly species

Photuris forresti has been known to co-occur in time and site with *Photinus acuminatus*, *Photinus consimilis*, *Photinus macdermotti*, *Photuris frontalis*, *Photuris tremulans*, and *Phausis reticulata* (Lloyd 2018; L. Faust pers. comm.; R. Joyce pers. obs.).

Range, Distribution, and Abundance:

Type locality: USA: South Carolina, Pickens County, near Route 178 and the Oolenoy River. The type locality population was extirpated due to habitat destruction.

Range: *Photuris forresti* is known to occur South Carolina, Georgia, and Tennessee (Figure 11).

Distribution: The loopy five firefly has been documented from six sites in Georgia (Clarke, Morgan, Oconee, and Walton Counties), two sites in Pickens County, South Carolina (only one of which is extant), and one site in Tennessee (Jefferson County) (Figure 10). The level IV Ecoregions in which the species has been found include the Southern Outer Piedmont, the Southern Inner Piedmont, Southern Limestone/Dolomite Valleys and Low Rolling Hills. The known elevation range is from 600 ft (180 m) in Georgia to over 1,1040 ft (315 m) in Tennessee.

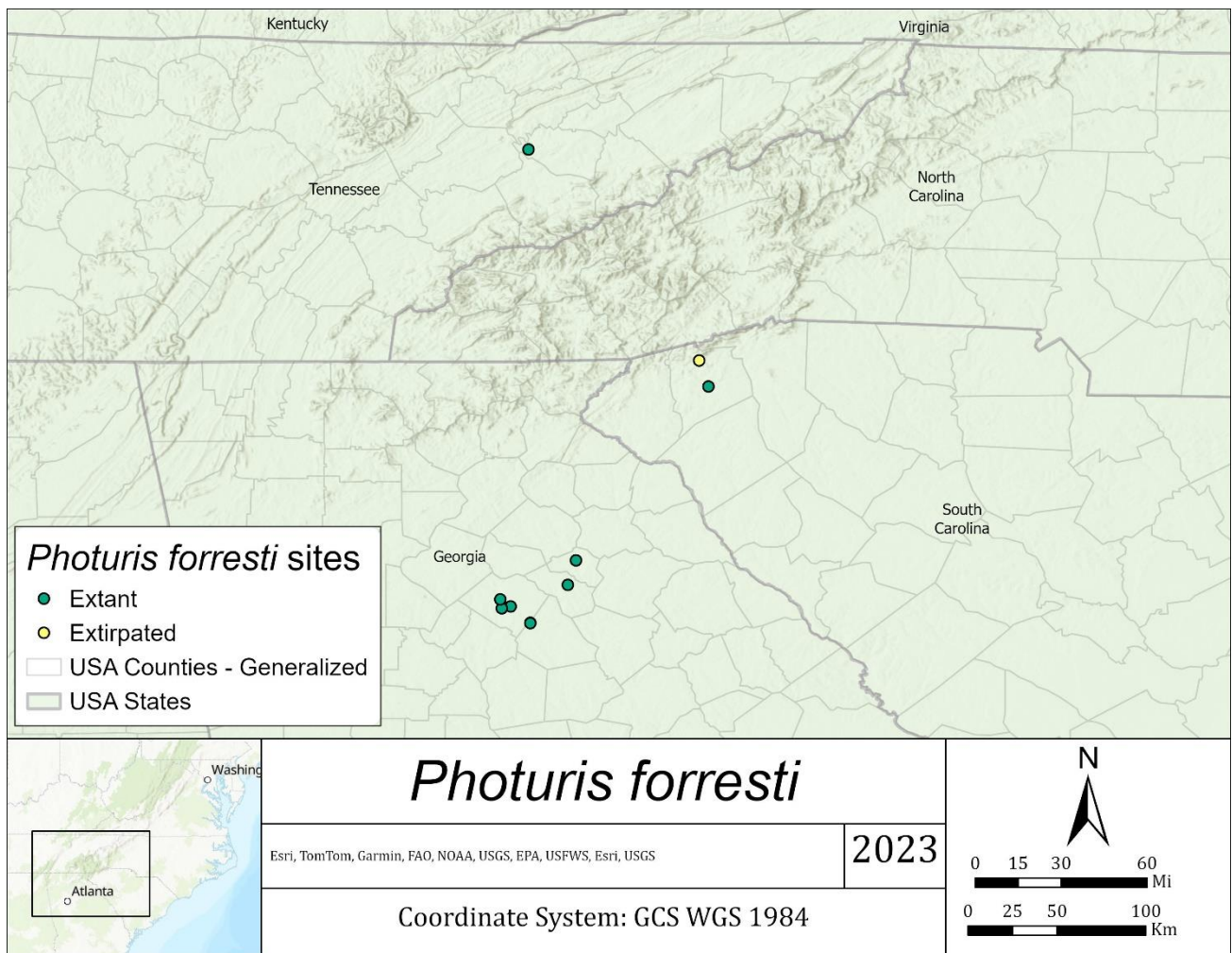


Figure 10. Distribution of the loopy five firefly as of 2023, showing confirmed localities (green dots) and an extirpated site (yellow dot).

Documented

As of 2023, *Photuris forresti* has been recorded on the following public lands:

- Sandy Creek Nature Center, Clarke County, GA
- Harris Shoals Park, Oconee County, GA
- Hard Labor Creek State Park, Morgan County, GA

Suspected

It is possible that *Photuris forresti* also occurs in Alabama, North Carolina, or Virginia which contain the same ecoregions and similar habitats.

The following is a non-exhaustive list of public lands could potentially host *P. forresti* populations because of their proximity to known localities or their location within watersheds and regions where the species has been documented:

Tennessee: Seven Islands State Birding Park; Henderson Island Refuge; Rankin Bottom Wildlife Management Area; Lick Creek Bottoms Wildlife Management Area

South Carolina: Tall Pines Wildlife Management Area; Clemson Forest; Oconee Station State Historic Site; Belvue Springs Heritage Preserve; Croft State Park; Sumter National Forest; Kings Mountain State Park

Georgia: Oconee National Forest, Panola Mountain State Park, Charlie Elliot Wildlife Center, Piedmont National Wildlife Refuge

Habitat Associations:

Loopy five fireflies are found in and adjacent to palustrine wetlands, including freshwater ponds, freshwater emergent wetlands, and freshwater shrub swamps in middle elevations of the southern Appalachian region (Figure 12). Common vegetation components include broadleaf arrowhead (*Sagittaria latifolia*), arrow arum (*Peltandra virginica*), yellow pond lily (*Nuphar lutea*), cattails (*Typha* spp.), jewelweed (*Impatiens capensis*), sedges (Cyperaceae), cutgrass (*Leersia* sp.), sensitive fern (*Onoclea sensibilis*), willows (*Salix* spp.), red maple (*Acer rubrum*), and smooth alder (*Alnus serrulata*). Sites typically occur along streams with low slope and annual mean velocity (Joyce et al., 2023).

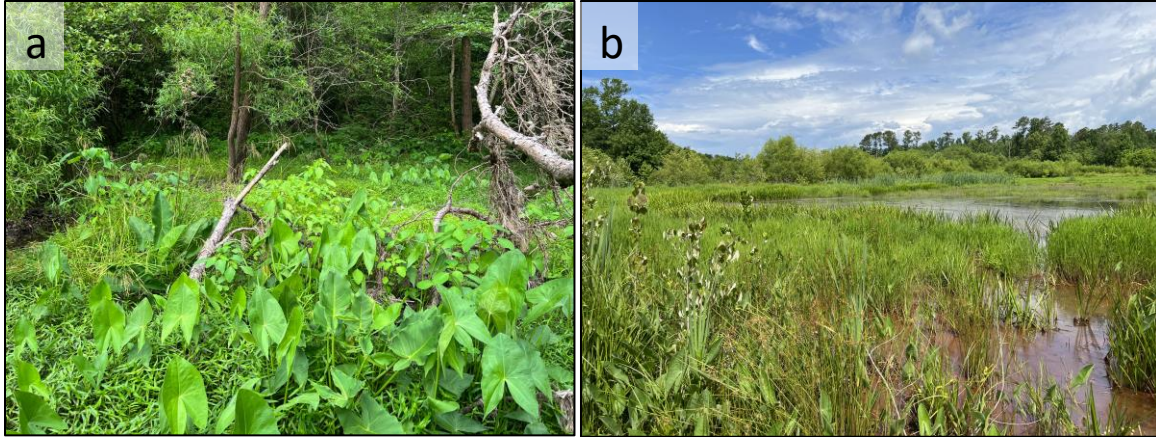


Figure 11. (a) Loopy five firefly habitat at the inlet of a small pond in Walton County, Georgia, with arrow arum (*Peltandra virginica*), broadleaf arrowhead (*Sagittaria latifolia*), jewelweed (*Impatiens capensis*) and willow (*Salix* sp.). (b) Pond and marsh habitat of *Photuris forresti* in Pickens, South Carolina. (photos: Richard Joyce/Xerces Society).

Co-occurring wildlife

Several of the known loopy five firefly localities have signs of beaver activity. Given that beavers (*Castor canadensis*) create similar open wetlands, it is likely that *Photuris forresti* occurrence has historically been associated with beaver-influenced wetlands. Green tree frogs (*Hyla cinerea*) and cricket frogs (*Acris* sp.) are often heard in the vicinity of *Photuris forresti* adult courtship display areas (R. Joyce, pers. obs.).

Threats:

Development and habitat loss

While several of the known localities for *Photuris forresti* are from within conservation lands, the type locality in South Carolina was extirpated when the riparian ecosystem was cleared and bulldozed to build a golf course (Lloyd, 2018). Golf courses are often built in the flat river bottoms of the southeast, replacing or shrinking the riparian edge habitat used this species. Localities in Georgia and South Carolina both have golf courses along streams in their watersheds. Agriculture in valley bottoms may also replace or degrade these habitats.

Dams and Modification of waterways

Dams create significant changes to riparian systems, often permanently inundating upstream habitats (Nilsson & Berggren, 2000). Unlike beaver dams (which have existed on the landscape for thousands of years), human-built dams are usually larger and permanent. Depending on topography, the damming of streams and rivers may inundate and reduce the extent of the wetland vegetation types used by loopy five fireflies.

Pesticides

Pesticides pose a threat to fireflies generally through lethal and sublethal effects resulting from various exposure routes: aerial spraying, contaminated soil, runoff in waterways, and consumption of contaminated prey. Pesticide uses that are of particular concern for *Photuris forresti* include aerial spraying of mosquito adulticides (often pyrethroids) and the use of neonicotinoids in soil for agricultural, landscaping, and silvicultural purposes (Joyce et al., 2023).

Applications of herbicides in ponds to treat nuisance aquatic vegetation has anecdotally been observed to suppress or eliminate resident populations of *Photuris forresti* (L. Faust pers. comm.) In addition to affecting the availability of cover and microhabitats for larvae by killing aquatic vegetation, the decomposition of killed vegetation can lower dissolved oxygen in ponds (Steckel et al., 2022). This likely impacts the survival and availability of *Photuris forresti* prey species, such as gastropods and other invertebrates.

Light Pollution

Artificial light at night (ALAN, also known as light pollution) has been shown to have wide range of negative effects on insects generally (Owens et al., 2020) and fireflies specifically (Owens et al., 2022; Owens & Lewis, 2022), causing interference with courtship communication and lowering reproductive success. Because loopy five fireflies do not begin their courtship displays until it is dark and well after sunset, they are vulnerable to disturbance from artificial light at night.

Conservation Considerations:

The loopy five firefly is a rare wetland habitat specialist known from fewer than 10 localities in South Carolina, Tennessee, and Georgia. This firefly is vulnerable to extinction because of it has a limited distribution, its population size is suspected to be small, and it faces multiple threats to its persistence. The population at the type locality was extirpated due to habitat destruction. Furthermore, there are no specific conservation measures in place to protect this species or the habitats upon which it relies. Conservation measures are needed on multiple fronts, from answering basic research questions to continued inventorying, long-term monitoring, and species-specific management actions.

Research Needs

Despite recent survey efforts in South Carolina, Georgia, and Tennessee, our understanding of this species' distribution, abundance, and population trends is incomplete or lacking, which hinders our ability to effectively conserve the species. Basic details regarding this firefly's life history, microhabitat requirements, and vulnerability to various threats are also largely unknown, further impeding conservation efforts. Critical data gaps that must be addressed to inform conservation of the loopy five firefly include:

Natural history

- What is the larval diet? (Both feeding trials in captivity and field observations could help answer this question.)
- What microhabitat features are important to adults? To the larvae?
- What factors affect the persistence of *P. forresti* within its wetland habitats?

Species range and distribution

- What is the full extent of this species' range?
- Does it occur in Alabama, North Carolina, or Virginia?
- Does the species intergrade with the similar *Photuris walldoxeyi*?
- What can species distribution modeling tell us about focusing future survey efforts?
- Can we use occupancy modeling to determine the survey- and site-level variables that influence the detection and presence of *P. forresti* at known sites?
- What is the dispersal capacity of this species?

Population size, trends, and abundance

- What are the global and local population sizes and trends for this species?
- What monitoring protocols and/or programs do we need to develop to answer this question?
- What is the most reliable index of abundance for this species?
- What is the geographic pattern of genetic differentiation?

Threats

- To what extent do known threats impact the species?
- Can we model the impacts of climate change impacts on their populations? What about the impacts of increasing development and light pollution?

Conservation Impacts

- How do different management activities impact firefly populations?
- How can we use this information to guide conservation and restoration activities?

Inventory and Monitoring

In addition to addressing the data gaps above, continued surveys of ponds, marshes, and riparian floodplains in middle elevations of the southeastern US are needed to determine the full extent of this species' range. If there is limited capacity among staff or volunteers to conduct surveys, we recommend doing one or two surveys in late May at more southern localities and in mid-June at sites further north (~1100-1400 mGDD).

At sites with more capacity and interest among staff or volunteers, surveys once a week or more than once a week between mid-May and early July would produce a more complete picture of the seasonal cycle and phenology of the loopy five firefly at the local scale. As core sites for this species are identified, land managers could work to establish long-term monitoring programs to better understand population size, dynamics, and trends. Because of the relatively long pause between repetitions of *Photuris forresti* flash patterns, tracking individual trajectories and counting individual fireflies is difficult, but long-exposure photographs and associated metadata (camera settings, air temperature) may help measure index of abundance.

In addition, researchers and land managers present at night near wetland habitats could be notified of the possible presence and appearance of *Photuris forresti* to facilitate opportunistic incidental observations of the species.

Management actions

Although some of the sites where this species occurs are considered protected areas, the passive protection afforded by such designations are inadequate to protect the species from extinction. Therefore, targeted protection and restoration of known habitats is crucial. Land managers can play a key role in ensuring that known and potential habitat is not negatively impacted by management activities. Key actions that could help this firefly include:

- establishing and maintaining buffers around palustrine wetlands such as ponds, marshes, and beaver-dammed streams
- rerouting roads and trails around sensitive habitat areas
- installing boardwalks or bridges if passage through the site is required
- removing or modifying artificial light sources such as streetlights that may be negatively impacting populations (e.g., using motion sensors on existing lights, or replacing bright LEDs with dim red bulbs that don't interfere with firefly flash communication)
- protecting occupied sites from excessive or unnecessary pesticide application
- removing invasive plants, which may alter native plant communities and make them uninhabitable for fireflies
- setting up long-term monitoring programs at a subset of occupied sites to gather baseline population data to better understand population trends and conservation status of this species over time, as well as insights into the impacts that various management activities have on firefly health and abundance.

Survey Protocol:

Where:

- Ponds, marshes, beaver flowages, and other freshwater palustrine wetlands in middle elevations of southeastern states (Alabama, Georgia, South Carolina, Tennessee, North Carolina, Virginia).

When:

- Mid-May to late June, between 1000 and 1700 modified Growing Degree Days (see Figure 9).
- Surveys should begin about 50 minutes after sunset.
- Air temperature should be at least 60° Fahrenheit (15.5° Celsius)
- Beaufort wind scale should be Force 2 or lower (0-7 mph)

How:

- Review survey protocols and print data sheets from the Firefly Atlas (www.fireflyatlas.org).
- If needed, secure the appropriate permits and/or site access permissions prior to conducting surveys.
- Wait near open wetland habitats, looking for erratic, rising and falling flash patterns of 4-7 flashes and glows, repeated by individuals at relatively long intervals.
- Consider recording observation data using a voice memo app or a voice recorder, using the data sheet as a guide.
- Use artificial light sparingly to maintain your night vision and avoid disturbing fireflies; a dim red headlamp or a flashlight wrapped in red cellophane can be used to navigate the site.
- If permitted, net several individuals and take high quality dorsal and ventral photos, including a scale to show the length of the firefly. Photos will enable validation of species identification by a Firefly Atlas administrator or relevant expert.
- Supporting morphological features to look for include dark elytra with absent or minimal elytral vittae, a body length of about 11-12 mm, and dark-colored hind coxae.
- While *Photuris forresti* cannot be definitively identified by morphology alone, it may be helpful to collect a small number of voucher specimens. **All necessary permits should be obtained before doing any collecting.** Specimens can be put into a vial and frozen or collected into ethanol (70-95%).

Additional Resources:

Species-specific

- Fireflies, Glow-worms, and Lightning Bugs: Identification and Natural History of the Fireflies of the Eastern and Central United States, by Lynn Faust, (species account under Loopy 5/ *Photuris* "F"): <https://ugapress.org/book/9780820348728/fireflies-glow-worms-and-lightning-bugs/>
- Petition to list the loopy five firefly as an endangered species under the US Endangered Species Act: <https://xerces.org/publications/policyposition-statements/petition-for-protection-of-loopy-five-firefly-under-us>

Firefly conservation

- Conserving the Jewels of the Night: Firefly-Friendly Lighting Practices : <https://xerces.org/publications/fact-sheets/firefly-friendly-lighting>
- Conserving the Jewels of the Night: Guidelines for Protecting Fireflies in the United States and Canada: <https://xerces.org/publications/guidelines/conserving-jewels-of-night>
- State of the Fireflies of the United States and Canada: Distributions, Threats, and Conservation Recommendations: <https://xerces.org/publications/scientific-reports/state-of-fireflies-of-united-states-and-canada>

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