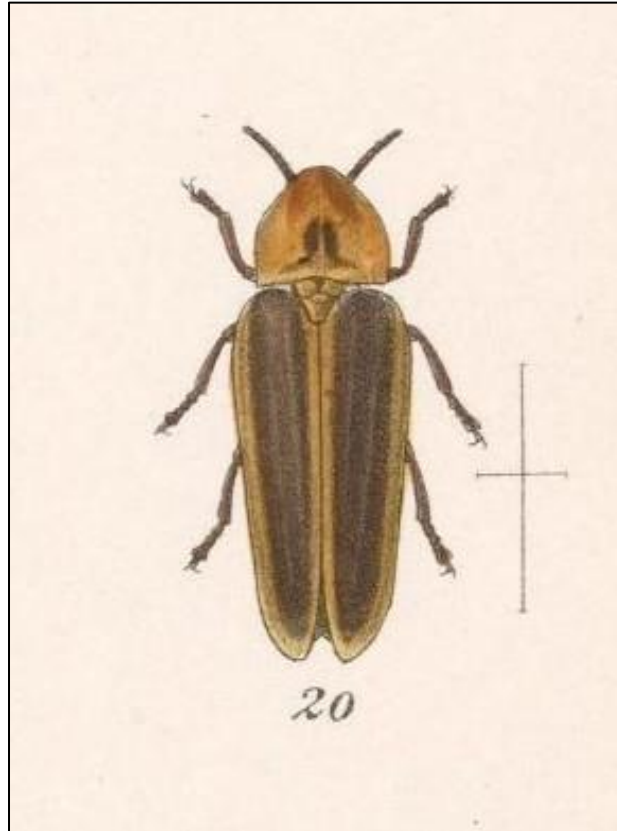


FIREFLY SPECIES FACT SHEET:
Amber comet firefly (*Pyractomena vexillaria*)



An amber comet firefly from Veracruz, Mexico (Gorham 1881).

March 2024

Candace Fallon

Xerces Society for Invertebrate Conservation



Scientific name:

Pyractomena vexillaria Gorham, 1881

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Lampyridae

Subfamily: Lampyrinae

Tribe: Cratomorphini

(ITIS 2023)

Synonyms: *Pyractomena vexillaris* (specific epithet misspelled by Lloyd 2018); *Pyrectomena vexillaria* (genus misspelled by Gorham 1881) (Martin & Powell 2020)

Common name:

Amber comet firefly

Conservation Statuses:

Global Status: G1 – Critically Imperiled (last reviewed 6 January 2022)

National Status (United States): NH – Nation Potentially Extirpated

State Statuses: SH – State Potentially Extirpated (TX)

(Walker et al. 2022a)

Federal Status (United States): None

IUCN Red List: Endangered (Walker et al. 2022b)

Technical Description:

Adult: A key distinguishing feature of *Pyractomena* fireflies is that the median line of their pronotum has a distinct keel. Adult male and female *P. vexillaria* specimens range in length from 9.6-15 mm (Gorham 1881; Green 1957; Lloyd 2018). Diagnostic features include an underside that is generally yellow, a very long and roof-shaped pronotum with a delicate but distinct keel, a reduced pronotal spot that does not reach the apex, and pubescent elytra margined entirely in yellow (Gorham 1881; Green 1957; B. Pfeiffer pers. comm. 2024; Figures 1-3). This species is morphologically similar to the sympatric *Pyractomena punctiventris*, *P. marginalis*, and *P. lucifera*. It most closely resembles *P. punctiventris*, which has very slight differences in characters, although location can help to differentiate the species, and the elytral margin in *P. vexillaria* is wider than that of *P. punctiventris* (B. Pfeiffer pers. comm. 2024). This species is distinguished from *P. marginalis* by black pronotal margins, which are lacking in *P. vexillaria*, and in some cases by location (B. Pfeiffer pers. comm. 2024). *P. lucifera* is distinct in its narrowly elongate shape, black pronotal margins, and uniformly golden pronotal pubescence (B. Pfeiffer pers. comm. 2024). However, external features alone may be insufficient for confidently distinguishing this species from other *Pyractomena* in the area, and examining aedeagi may be needed.



Figure 1. (a & b) Dorsal habitus of the *Pyractomena vexillaria* Gorham, 1881 holotype male specimen ([NHMUK015533219](#)) from Mexico (Keita Matsumoto, Michael Geiser, and Max Barclay/Natural History Museum).



Figure 2. Dorsal (a) and ventral (b) habitus *Pyractomena vexillaria* (Gavin Martin, ventral image also depicted in Martin 2020 Figure 1B).

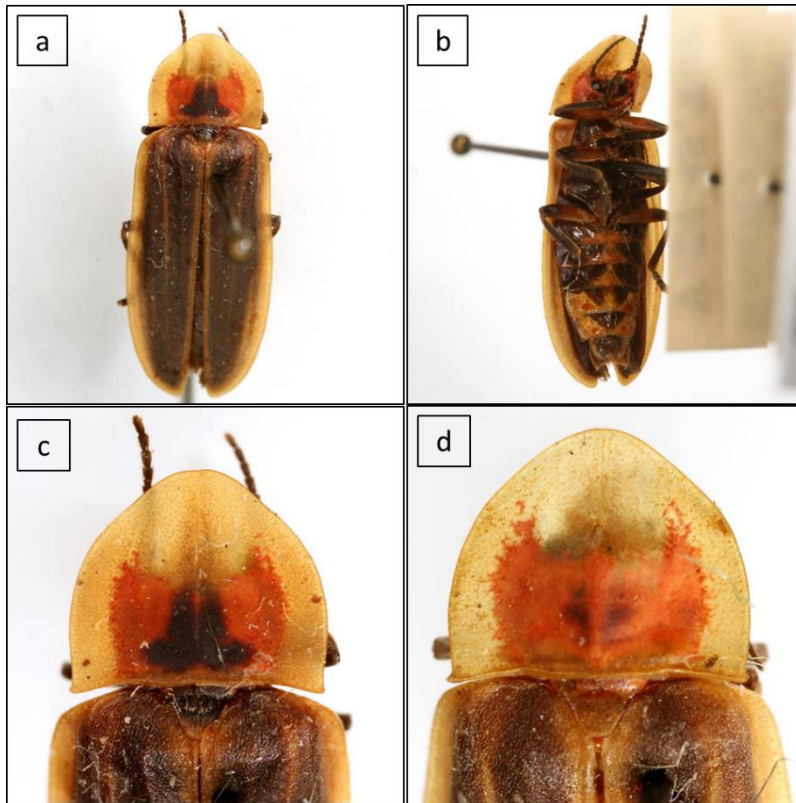


Figure 3. Dorsal, ventral, and pronotal views of adult female amber comet fireflies (©Mike Quinn, BugGuide, used with permission). Figures 3a-3c: specimen collected by D.J. & J.N. Knull on May 24, 1948, from Val Verde County, Texas. Determined by J.W. Green, 1956. C.A. Triplehorn Insect Collection (OSUC 497738). Figure 3d: specimen collected by D.J. & J.N. Knull on August 27, 1947, from Val Verde County, Texas. Determined by J.W. Green, 1956. C.A. Triplehorn Insect Collection (OSUC 497737). Note the difference in the pronotal marking and scutellum color in Figure 3d, which can be variable (Lloyd 2018).

Immature: The immature stages of this particular firefly have not been described. However, its larvae likely look similar to other *Pyractomena* larvae, which have slender heads well-suited for preying on snails (Figure 4).



Figure 4. Larval *Pyractomena lucifera* preying on a snail (extracted from Buschman 2014, used with permission).

Life History:

Flash behavior and phenology

Flash pattern and activity period can be used as distinguishing features from other fireflies, such as *Pyrractomena punctiventris*, that may occur in the same area. Both male and female amber comet fireflies flash, and can be found flying from May through August (Green 1957; Lloyd 2018; B. Pfeiffer pers. comm. 2021; Fallon et al. 2022). Male courtship displays begin half an hour after sunset, and consist of a single explosive amber-colored burst, followed by quick one-second upward-trailing flashes emitted at one second intervals (Lloyd 2018; B. Pfeiffer pers. comm. 2021; Fallon et al. 2022; Figure 5). At a site in Cárdenas, Tabasco, Mexico, Lloyd (2018) observed adult males flashing and flying low (less than four feet) over emergent marshy vegetation. However, an individual presumed to be this species was observed flying high, at 15 feet, at a site in Texas (B. Pfeiffer pers. comm. 2024).

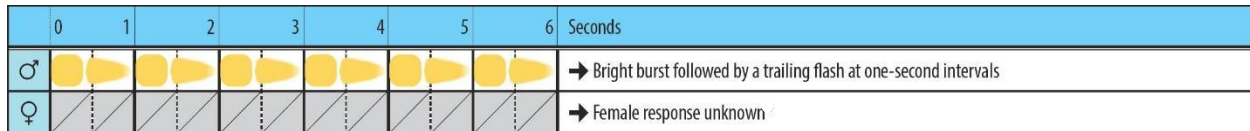


Figure 5. Flash pattern of the amber comet firefly (from Fallon et al. 2022).

Dispersal capacity

The dispersal capacity of the amber comet firefly is unknown. In general, fireflies are thought to be weak fliers that rarely disperse beyond the habitat in which they were born (Lewis 2016), although some species, such as *Photinus signaticollis*, are capable of dispersing across large distances (Koken et al. 2022).

Life cycle

The amber comet firefly is a beetle with a holometabolous life cycle, meaning it undergoes four life stages: egg, larva, pupa, and adult. Specific details about this species' life history are lacking, but may be similar to other closely related *Pyrractomena* fireflies. For example, after mating, female *P. lucifera* lay batches of 20-100 eggs on vegetation over the course of 20-30 days; these hatch into larvae approximately two weeks later (Buschman 1984b). Fireflies spend the majority of their lifetime (1-2 years) as larvae, undergoing 4-7 growth stages called instars (Faust 2017; Lloyd 2018). When fully grown, larvae become sedentary and fasten themselves to vegetation, where they pupate over the course of a week or so before emerging as adults (Buschman 1984b).

Diet

The larval diet of this species is unknown, but all larval *Pyrractomena* are predaceous, feeding on snails and other invertebrates (Buschman 1984a, 1984b; Majka 2012; Lloyd 2018; Figure 4). Some *Pyrractomena* larvae are also semi-aquatic, hunting for snails just below the water surface (Buschman 1984b). Adults are typically not known to feed, although some species have been documented

consuming plant material including berries, milkweed nectar, and apple slices (Buschman 1984a; Faust 2017).

Range, Distribution, and Abundance:

Type Locality: Mexico, Veracruz (Gorham 1881). It is possible that the name Veracruz as it is used here may refer to the Atlantic port and largest city in the state of Veracruz (Selander & Vaurie 1962).

Range: The amber comet firefly occurs in Texas and Mexico (Walker et al. 2022b).

Distribution:

Pyractomena vexillaria is known from just six to seven localities in Texas and Mexico (Table 1). It was originally described from a single specimen collected in Veracruz, Mexico (Gorham 1881). Green (1957) later found five more specimens from U.S. museum collections that were collected from four localities in Val Verde and Comal Counties, Texas (Figure 6). Lloyd (2018) looked for this species in Texas several times but was ultimately unsuccessful in relocating it; however, he did inadvertently collect it from a marsh in Cárdenas, Tabasco, Mexico, increasing the number of known localities in that country to two. The exact year of this collection is unknown, but it is likely that it was 1980, as J. Lloyd was in Cárdenas collecting fireflies at that time (Lloyd & Ballantyne 2003). It has not been verified in Mexico since, although no targeted survey efforts have taken place (Walker et al. 2022b).

Table 1. All known localities of the amber comet firefly (*P. vexillaria*), with dates of collection.

Country	State	County	Locality	Month(s)	Year	Reference
Mexico	Veracruz			Unknown	Unknown	Gorham 1881
Mexico	Tabasco		Cárdenas marsh	Unknown	1980?	Lloyd 2018
USA	Texas	Val Verde		August	Unknown	Green 1957
USA	Texas	Comal	New Braunfels	June to July	1902	Green 1957
USA	Texas	Val Verde	Del Rio	August	1912	Green 1957
USA	Texas	Val Verde		August	1947	Green 1957
USA	Texas	Val Verde		May	1948	Green 1957

The current distribution of the species in Texas is similarly uncertain, and it may be extirpated (Walker et al. 2022a). Targeted surveys in Val Verde and Comal Counties have been largely unsuccessful (B. Pfeiffer pers. obs.), although there was a potential sighting of the species in Comal County on May 10, 2018, when Pfeiffer observed a brilliant amber flash while conducting firefly surveys in a field near the Guadalupe River. Because he was unable to capture the firefly, the record remains unverified, although it is within the known range of the species. Not counting this 2018 observation, the species has not been seen in Texas since 1948 (Green 1957).

Documented

Because the locality descriptions for this species in Texas are vague, it is unclear whether it has been documented from any public lands in the state.

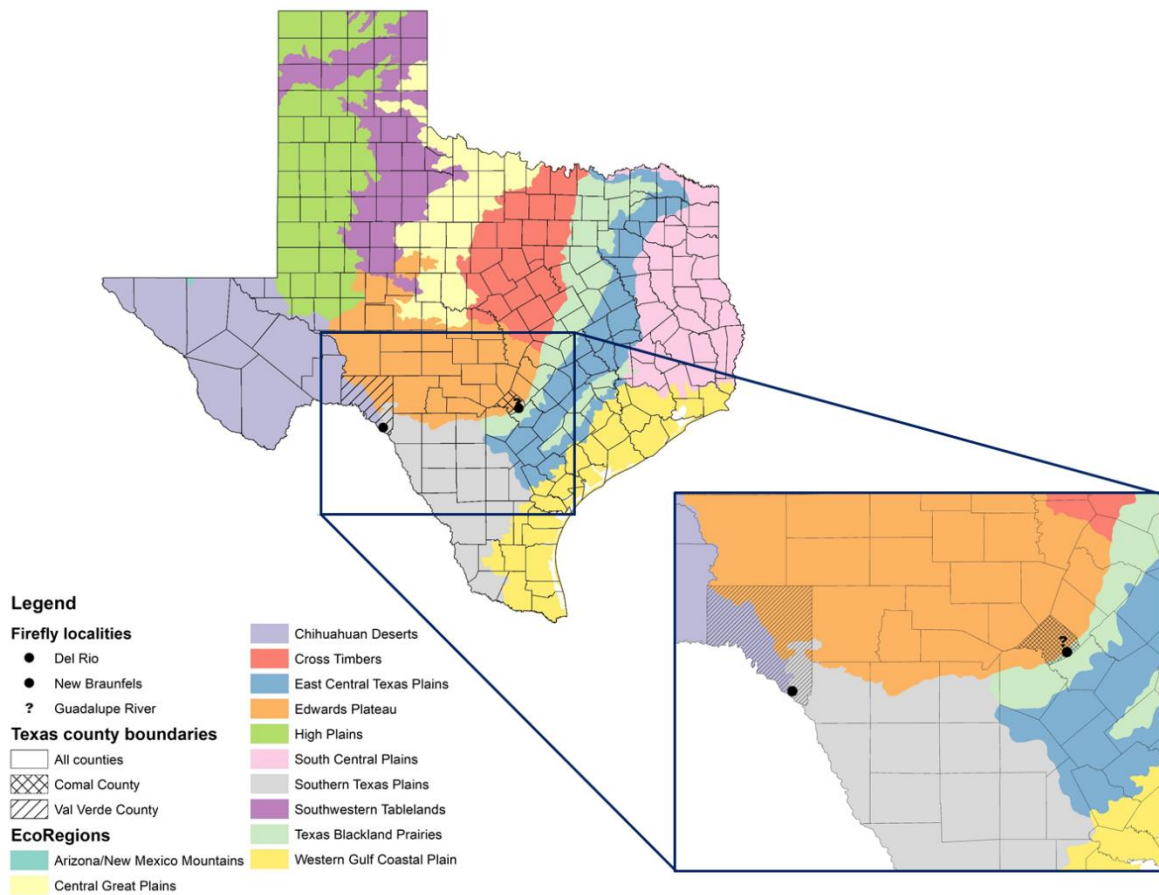


Figure 6. Distribution of the amber comet firefly in Texas. Note that two of the Val Verde County localities are only described to the county level, so these lack points on the map.

Suspected

The amber comet firefly may occur in marshy areas on the following publicly accessible and non-governmental conservation lands in Val Verde, Comal, and adjacent counties in Texas:

- Devil's River State Natural Area, Val Verde County
- Guadalupe River State Park, Kendall and Comal Counties
- Honey Creek State Natural Area, Comal County
- Amistad National Recreation Area, Val Verde County
- Seminole Canyon State Park and Historic Site, Val Verde County
- Upper Cibolo Creek Conservation Area, The Nature Conservancy, Comal County
- Chaparral Wildlife Management Area, Dimmit and La Salle Counties
- Lower Rio Grande Valley National Wildlife Refuge

It is possible the species could also occur in Laguna Atascosa National Wildlife Refuge, although this overlaps *P. punctiventris*' range, and could make species identification difficult. It remains unclear how far *P. vexillaria* dips into South Texas, and where it overlaps with *P. punctiventris* (B. Pfeiffer pers. comm. 2024).

Abundance:

Detailed data on abundance are not available, and all known observations consist of just one to a handful of individuals, suggesting that the species is not abundant. Given how few records are available for the species, and the fact that it has not been recorded since 1948, it is likely extremely rare.

Habitat Associations:

Habitat details for this species are extremely limited, but within Texas, the amber comet firefly appears to be a habitat specialist associated with spring complexes and river basins in semi-arid shrublands (Fallon et al. 2021; Figure 7). In Tabasco, Mexico, Lloyd (2018) observed adult males flying low over a marsh. In places where it has been recorded in Val Verde County, Texas, the habitat is mixed semi-arid cenizo and guajillo brushland with limestone river basins, whereas in the Comal County hill country the dominant plants are oak and cedar brush (B. Pfeiffer pers. obs.).

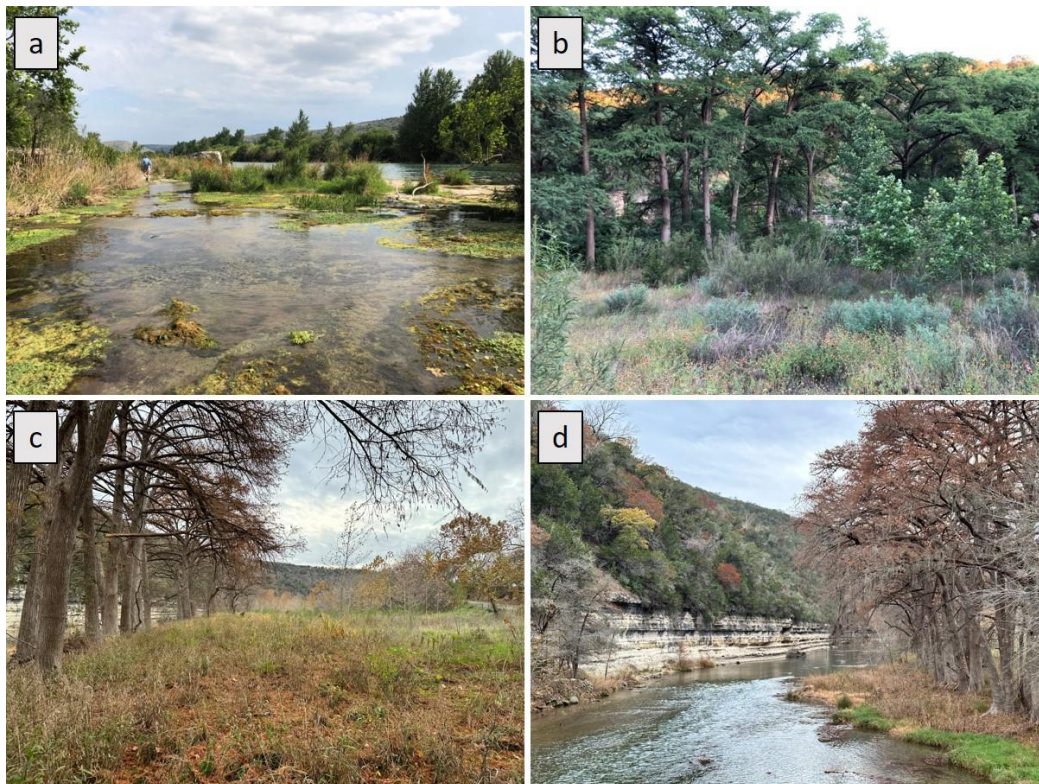


Figure 7. Potential *Pyractomena vexillaria* habitat in Texas: (a) the Devil's River in Val Verde County, (b-d) riparian habitat along the Guadalupe River in Comal County, where B. Pfeiffer observed a bright amber flash in 2018 (Ben Pfeiffer). The photo in Figure 1c was taken in winter, offering a clearer view of potential larval habitat along the river.

Threats:

Habitat loss and degradation are likely the greatest threats to this species. Human populations have grown substantially in urban areas of Texas where the amber comet firefly was once found. For example, in Comal County, populations grew an estimated 64% from 2010 to 2023 (World Population Review 2023). Urban and agricultural development associated with this growth can affect this firefly via direct habitat loss as well as indirect effects such as increased demands on water resources, increased light pollution, and encroachment from invasive plant species.

The manipulation of surface waters to support increased resource demands may have driven past declines of this species by leading to the disappearance of spring complexes and surrounding riparian habitats. For example, based on historic collection localities, this species may once have occurred in marshy habitats where the Devils River Delta meets the Rio Grande; this section of river was dammed to create the Amistad Reservoir, which now covers the marsh and associated springs (Walker et al. 2022b).

Artificial light at night (also known as light pollution or ALAN) negatively affects the reproductive success of nocturnal firefly species that require darkness for their courtship displays (Owens & Lewis 2018; Lewis et al. 2020). Artificial light at night can interfere with the behavior of nocturnal fireflies in a multitude of ways, including temporal disorientation (courtship behavior failure to be triggered because the ambient light levels never reach necessary thresholds), phototaxis (fireflies being drawn to lights), and disruption of light signal reception (fireflies failing to respond to the signaling of potential mates because the signal is drowned by artificial light, or because sudden exposure to artificial light saturates their dark-adapted photoreceptors, effectively blinding them to other signals) (Owens & Lewis 2018, 2022). Since amber comet fireflies are active after full darkness, it is likely they are more vulnerable to light pollution than species that are active at dusk.

Conservation Considerations:

The amber comet firefly is a rare habitat specialist documented from only six or seven sites in Texas and Mexico. This firefly is vulnerable to extinction because it is not known from very many localities, its population size is suspected to be small, and the species faces numerous threats to its persistence including habitat loss due to urban and agricultural development, light pollution, and invasive plants. The species may be extirpated from Texas, where it has not been recorded since the 1940s (Walker et al. 2022b). Small population sizes make this species particularly vulnerable to site-disturbing activities and stochastic events such as drought, fire, or flooding. It is unclear if the species occurs in any protected areas, and 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, most critical of which are increased survey efforts and research to better understand the species' distribution, life history, and habitat associations. If discovered to be extant in Texas, site protection will be critical to this species' persistence, and long-term monitoring can help managers better understand the species' abundance and population trends, particularly in response to threats and management actions.

Research needs

Despite recent work to assess the amber comet firefly's conservation status and compile a comprehensive database of known occurrence records, our understanding of this species' distribution, abundance, and population trends is poor, which hinders our ability to effectively conserve the species (Walker et al. 2022b). Basic details regarding this firefly's life history, microhabitat requirements, and vulnerability to various threats are also largely unknown, further impeding conservation efforts. Critical information gaps must be addressed to inform conservation efforts for the amber comet firefly, including:

Natural history

- Are the larvae snail specialists? If so, what species are important to them?
- What microhabitat features are important to adults? To the larvae?
- What habitat associations and factors affect the persistence of *P. vexillaria* populations?
- Is *P. vexillaria* a relict species from a time when the Texas Hill Country was wetter and more temperate?

Species range and distribution

- What is the full extent of this species' range?
- Is this species still extant in Texas? In Mexico?
- Can we use species distribution models to better inform future survey efforts?
- Can we use occupancy modeling to determine the survey- and site-level variables that influence the detection and presence of fireflies 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 drought and other climate change impacts on their populations? What about the impacts of increasing development, water drawdowns, and light pollution?

Conservation impacts

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

Inventory and monitoring

In addition to addressing data gaps, continued surveys of marshy habitats are needed to determine the full extent of this species' range. This firefly has not been observed in the US in over 75 years.

Inventorying is needed at both historic localities to determine if the species remains extant, and in appropriate habitat elsewhere in Texas. As core sites for this species are discovered, land managers could work to establish long-term monitoring programs to better understand population size, dynamics, and trends. Engaging volunteers or leveraging biologists who are already in the field for nocturnal survey work (such as for bats, owls, or amphibians) may help build extra capacity for survey and inventory work.

Management actions

The amber comet firefly has only been documented from one site in the US, and it is unclear if the population remains extant. If confirmed as extant, or found elsewhere in Texas, 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 disturbed by development, cattle grazing, harmful pesticide applications, light pollution, or other management activities.

To do this, land managers could start by identifying potential sites that need preferential treatment and special management. Identify the riparian areas such as creeks, rivers, bottomlands, and marshes that could support fireflies. Evaluate the condition they are in. The following questions can help to evaluate the condition of the land around riparian and wetland habitats.

1. Healthy riparian areas supports dense stands of densely rooted vegetation. Healthy, well-vegetated areas will appear overgrown, untrimmed, and shaggy. Is the habitat dense, bushy, and scruffy, with dead trees, logs, brush piles, or boulders? If so, your habitat is healthy, and you should take action to address the threats to this healthy habitat.
2. Dysfunctional riparian areas lack sufficient vegetation to slow floodwaters and catch sediment. Is there any bare ground between the sparse or unhealthy plants? Is the woody debris being removed or burned to help clean up the habitat? Does it look manicured, park-like, and open? If this is the case, you should take the steps listed below to help restore your riparian habitat, such as fencing and plant re-vegetation.

Key actions to take if you have healthy riparian habitat might include:

- Meeting with key stakeholders to discuss priorities for protecting firefly habitat by preserving natural buffers around riparian and spring complex habitats.

- Evaluating vehicle traffic in creek areas and riparian buffer zones. Consider rerouting roads and trails around these sensitive habitat areas.
- Eliminating excessive recreational activity and foot traffic.
- Identifying invasive species whose excessive growth inhibits the ability of native riparian plants to establish and making plans to remove them.
- Fencing off sensitive habitats and maintaining these fences to ensure cattle and excessive populations of deer, exotic ungulates, and feral hogs do not find their way through.
- Eliminating any prolonged grazing by cattle in riparian areas. Consider rotational grazing to give areas adjacent to riparian corridors a long time to recover.
- Investigating the effects of proposed dams and other water changes that could negatively impact firefly habitat. Will some land be lost, and will adjacent riparian buffers be subjected to excessive erosion from flood waters?
- Protecting occupied sites from excessive or unnecessary pesticide application.
- Setting up long-term monitoring programs at extant sites to gather baseline population data to better understand population trends and conservation status of this species over time, as well as gain insights into the impacts that various management activities have on firefly health and abundance.
- Placing educational materials or signs in the firefly habitat to educate others about the habitat's importance to fireflies and why it is protected.

Key actions to take if you have dysfunctional riparian habitat include:

- Identifying land management techniques that have become hindrances affecting the health of riparian habitats.
- Speaking with everyone who is involved in using the land closest to the firefly habitat. How do they use it on a regular basis?
- Determining the nature of new growth. Are new plants colonizing trapped sediment on the banks? Look for new plants and runners from existing plants in deposited sediment. What is hindering new plant colonization?
- Identifying the plants that currently occupy the banks. Are banks covered with strong rooted vegetation that can withstand the energy of floodwaters? What is their age? Is a diversity of young, middle-aged, and mature riparian plants present?
- Reducing disturbance by heavy equipment (such as during construction) along floodplain banks, which can contribute large sediment deposits.
- Eliminating mowing or spraying of weeds or brush too close to creek and river banks.
- Avoiding any timber harvesting or logging activities near the waterway.
- Discontinue burning brush piles in riparian areas that remove large dead wood or downed trees.
- Eliminating excessive recreational activity and foot traffic. Consider allowing access only seasonally to give areas a chance to rest in-between.

- Fencing off sensitive habitats and maintaining these fences to ensure cattle and excessive populations of deer, non-native ungulates, and feral hogs do not find their way through. Look for browse lines underneath vegetation to indicate a serious deer or goat problem.
- Providing educational material or installing signs to describe the reasons why certain practices are being carried to protect the riparian area.
- Removing or modifying artificial light sources, such as streetlights, that may have a negative impact on populations (e.g., using motion sensors on existing lights or replacing bright LEDs with dim red bulbs that do not interfere with firefly flash communication).

Survey Protocol:

Where:

- Mixed semi-arid cenizo and guajillo brushland in limestone river basins
- Creeks, rivers, bottomlands, and marshy habitats with a dominant mix of grasses like eastern gamagrass, sawgrass, switchgrass, inland sea oats, native cane (*Phragmites* sp.), and woody riparian species like sycamore and cypress trees
- Oak and cedar brushland in the Texas Hill Country

When:

- Surveys should begin just after dusk from May through August
- Air temperature should be at least 65° Fahrenheit (18° Celsius)
- Wind speed should be at Beaufort scale 2 or lower (0-7 mph) if adults are being targeted
- Moon phase should ideally be last quarter, waning crescent, new moon, or waxing crescent

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
- Walk slowly along riparian and marsh habitats looking for explosive amber flashes
- Diagnostic morphologic features to look for include a very long and roof-shaped pronotum with a delicate but distinct keel, and pubescent elytra margined entirely in yellow
- Consider recording observations using a voice memo app on a cell phone or a voice recorder, using the data sheet as a guide
- 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 species expert.
- Use artificial light sparingly to maintain night vision and avoid disturbing fireflies; a dim red headlamp or a flashlight wrapped in red cellophane can be used as needed to navigate the site
- Submit survey data and photographs to the Firefly Atlas (regardless of whether fireflies were observed)

Additional Resources:

- 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>
- Firefly Habitat Sign certification program: <https://www.firefly.org/certify>

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