FIREFLY SPECIES FACT SHEET:
Florida intertidal firefly (*Micronaspsis floridana*)

An adult male Florida intertidal firefly (Richard Joyce / Xerces Society).

March 2024

Richard Joyce
Xerces Society for Invertebrate Conservation

XERCES SOCIETY
for Invertebrate Conservation

Scientific Name:

Micronaspis floridana Green, 1948

Phylum: Arthropoda
Class: Insecta
Order: Coleoptera
Family: Lampyridae
Subfamily: Lampyrinae
Tribe: Cratomorphini

Synonyms: None

Common Names:

Florida intertidal firefly, Mangrove firefly, Fiddler crab firefly

Conservation Status:

Global Status: G3? – Vulnerable (last reviewed 31 January 2023)
National Status (United States): NNR – Nation Not Ranked
State Status: S3 – Vulnerable (FL) (31 January 2023)
(Almquist et al. 2023)

IUCN Red List: Endangered (Fallon et al. 2021; Fallon and Walker 2021)

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

Taxonomic Note:

For many decades, *Micronaspis floridana* was the only known member of its genus. In 2021, Vaz et al. (2021) described a new species (*M. gabrielae*) from the rocky Atlantic coast of Brazil and reported observations of undescribed *Micronaspis* larvae from a Pacific Panamanian island. There is also a specimen of an undescribed *Micronaspis* larva from Jamaica (Vaz et al. 2021).

Micronaspis is currently placed within the tribe Cratomorphini, along with *Pyractomena* (a genus with a widespread distribution in North America), and the neotropical genera *Aspisoma*, *Aspisomoides*, and *Cratomorphus* (Vaz et al. 2021). However, Cratomorphini may not be a monophyletic group (Luiz Silveira, pers. comm.), so the phylogenetic position of *M. floridana* may shift in the future.

Technical Description:

Adult: Adults are 8-12 millimeters long, oval shaped and fully winged, with convex vitreous spots (clear windows) on the pronotum (head shield) over the eyes (Green 1948; Vaz et al. 2021) (Figure 1). The underside is brown or black except for two pale light organs that fill sternites 4 and 5—two triangular pale spots distal to the light organs. Males have two light organs that are a pale enamel color, each with two stigmatiform pores (Figure 2). In males, the anterior tarsal claw on the front and middle legs have a small tooth (Figure 3). Adult females are similar in appearance to males, but they average larger in size, have smaller eyes, and have a single light organ on sterna 6 (Green 1948; Faust 2017; Vaz et al. 2021) (Figures 4 and 5). This light organ has indentations anteriorly that create the impression of a "cowboy hat" shape (Faust 2017).

Micronaspis floridana could be confused with fireflies in the genus *Photinus* based on superficial appearance, but *Micronaspis floridana* are broader (more oval-shaped), with wider elytral margins, and clear domed windows on the pronotum that are lacking in *Photinus*.

Figure 1. Dorsal views of adult male Florida intertidal fireflies. Note the wide, translucent, pale yellow lateral margins of the elytra, the oval body shape, and the transparent spots on the pronotum over the eyes. In some individuals, the inverted T-shaped marking at the base of the pronotum is faint or reduced. (Richard Joyce/Xerces Society).

Figure 2. Ventral view of an adult male Florida intertidal firefly against a 5-millimeter square grid, showing the proportionately large eyes, dark coloration of the legs and underside, and two pale light organs with stigmatiform pits. (Richard Joyce/Xerces Society).

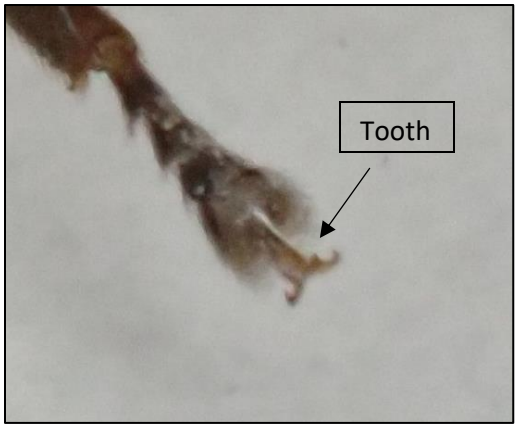

Figure 3. Close-up view of tarsal claws on the front leg of a male Florida intertidal firefly, showing the tooth on the front claw. (Richard Joyce/Xerces Society).

Figure 4. Dorsal view of an adult female Florida intertidal firefly against a 5-millimeter square grid. Note the protrusion of the abdomen beyond the tips of the elytra. Richard Joyce/Xerces Society.

Figure 5. Underside of an adult female Florida intertidal firefly, showing the single "cowboy hat-shaped" light organ (Faust 2017). (Richard Joyce/Xerces Society).

Larvae: The larva of *Micronaspis floridana* was first described by McDermott (1954), with additional morphological descriptions provided by Vaz et al. (2021). Larvae have four tubercles or spikes on the posterior edge of each tergite (dorsal plate) (Figure 6a). The underside and soft parts are whitish or pink. The pronotum (most anterior dorsal plate) has 2 pale or translucent spots at the front edge and two at the back, while segments 2 and 3 each have 2 pale spots on the rear edge. Larvae have two small light organs on the underside of the "tail," which produce a prolonged greenish glow (Figures 6 and 7). This nighttime bioluminescence is how most larvae are detected by surveyors.

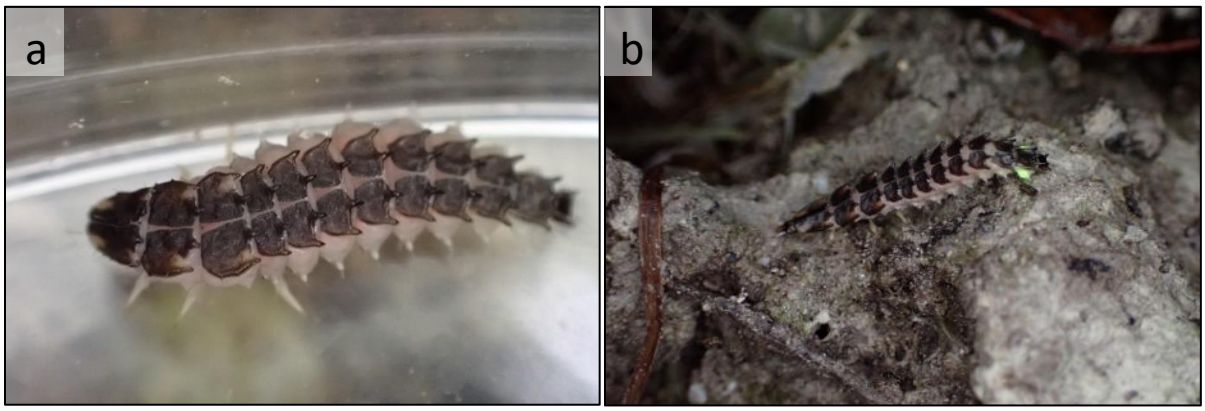

Figure 6. (a) Dorsal view of a Florida intertidal firefly larva, showing four tubercles on each tergite (b) A larva crawling over a damp substrate while emitting a greenish glow. (photos: Richard Joyce/Xerces Society).

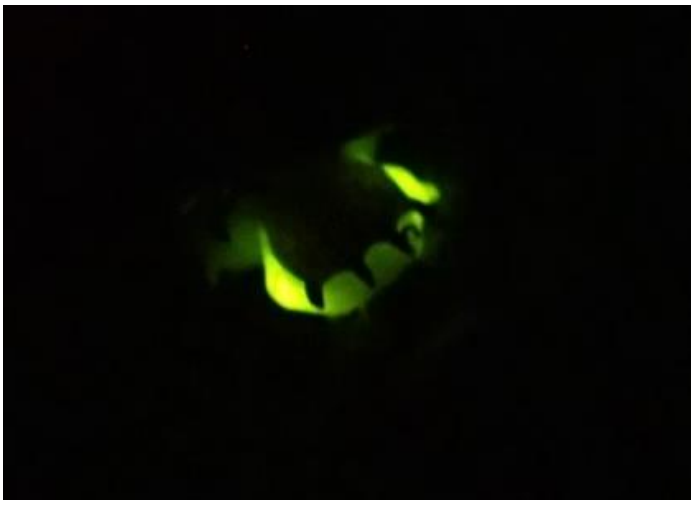

Figure 7. Greenish glow against the final spiked dorsal plate of a larval Florida intertidal firefly. (Richard Joyce/Xerces Society).

Pupae: Pupae are pale yellow with a pink tint and emit a faint glow from small light organs on the abdomen (Figure 8).

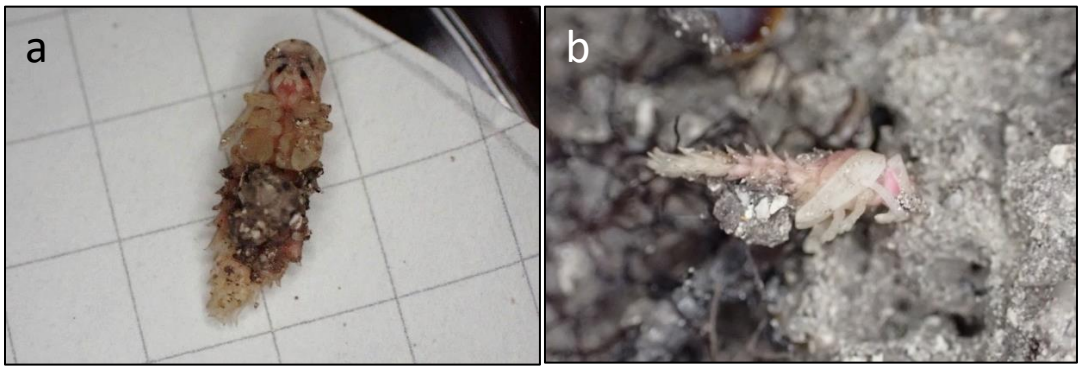

Figure 8. Ventral view (a) and lateral view (b) of a *Micronaspis floridana* pupa found in damp sand below the hide tide line. Grid in left image is made of 5 mm squares. (photos: Richard Joyce/Xerces Society)

Eggs: Eggs are less than 1 mm in diameter and round and orange when first laid. They fade in color over the course of development (Faust 2017). Two glowing insect eggs that were possibly of *M. floridana* were found glowing in intertidal habitat also occupied by *M. floridana* larvae were ovoid with a concave dimple and pearly colored with a small black spot (Figure 9).

Figure 9. A beetle egg found by its dim glow floating on a leaf in a mangrove swamp occupied by *Micronaspis floridana* in April 2023. (Richard Joyce/Xerces Society)

Life History:

Eggs

When held in captivity, female *Micronaspis floridana* lay broods of about 15 orangish eggs in viscous clusters (Faust 2017; Vaz et al. 2021). However, in the wild it is more typical for fireflies with winged females to lay eggs singly or dispersed across multiple sites (Buschman 1984). During a survey in April 2023 in mangroves with an abundance of *Micronaspis floridana* larvae at Hugh Taylor Birch State Park in Broward County, Florida, two single insect eggs were detected by their very faint glow. One egg was on a dead red mangrove (*Rhizophora mangle*) leaf floating in shallow water below the high tide line (Joyce 2023a) (Figure 9). The identity of these eggs as *M. floridana* was suspected but not confirmed. Eggs laid and kept in captivity lasted 21 days but did not eclose because they were killed by a fungus (Vaz et al. 2021).

Larval foraging and microhabitats

Larvae of *Micronaspis floridana* are active year-round when temperatures are suitable (at least 68° F/20° C). They can be found on the surface of damp sand or mud, crawling in leaf litter near the high tide line, climbing on red mangrove (*Rhizophora mangle*) stilt roots and black mangrove (*Avicennia germinans*) pneumatophores, in crevices of cobble above and below the high tide line, and at the margins of black needlerush (*Juncus roemerianus*) marshes (Faust 2017; Joyce 2022, 2023c; Lloyd 2018).

Micronaspis floridana larvae are predators of intertidal snails, but will also eat a range of other animal and plant foods when kept in captivity, perhaps suggesting opportunistic scavenging (Faust 2017; Lloyd 2018; McDermott 1954). While specific taxonomic information about the snails consumed by *Micronaspis floridana* larvae is lacking, larvae have been found in the same microhabitats as the coffee bean snail (*Melampus* sp.), a species that eats decomposing leaves above the high tide line (R. Joyce pers. obs.)

Pupation

Relatively little is known about the pupal stage of this firefly. In captivity, last instar larvae will burrow into sand or soil at shallow depths (1-2 cm or less) and form cells to pupate (McDermott 1954). These emerge as adults after 12-14 days (McDermott 1954; Vaz et al. 2021). Field observations are scarce. A pupa was found in the wild at Bill Baggs Cape Florida State Park in Miami-Dade County, Florida, on 19 April 2023 by its dim green glow (Figure 8). It was located in the damp sand below the high tide line and was covered with a thin layer of sand that still allowed its dim glow to be visible (R. Joyce pers. obs.).

Dispersal capacity

The flight range of *M. floridana* has not been studied, but fireflies are generally not strong fliers and have limited dispersal capacity (S. Lewis 2016). Despite these limitations, *M. floridana* has nonetheless been able to reestablish populations on mangrove islands that had been fogged with insecticide as part of an island biogeography study (Simberloff 1976). They have also recently been documented in a restored mangrove area that had previously been filled with dredge spoils and surrounded with a concrete bulkhead seawall (Joyce 2023b). This suggests that *M. floridana* individuals are able to disperse to unoccupied habitats, and may have greater dispersal capacity than other firefly species. Furthermore,

the ability of larvae to float on the surface of the water has been speculated to allow for dispersal as well (Faust 2017; Vaz et al. 2021).

Adult phenology and feeding

At the northern edge of its known range (Levy and Volusia Counties in Florida), adult *Micronaspis floridana* have been observed from late April to early October (Lloyd 2018). In more subtropical areas within its range, adult *Micronaspis floridana* can be found year-round, but are found in greatest abundance from March to May, and adult and larval activity may only be detectable when temperatures are at least 20° C/68°F (Faust 2017; Vaz et al. 2021).

Like most adult non-*Photuris* fireflies, adult *Micronaspis floridana* are generally thought not to feed, but an individual was observed perched on an inflorescences of sea grape (*Coccoloba uvifera*) (Abreu 2021), suggesting that it may have been seeking nectar.

Adult flash behavior

Flashing fireflies use species-specific patterns in their emissions of light to communicate with potential mates. The courtship flash pattern of the Florida intertidal firefly consists of a single or bimodal flash lasting 0.14 seconds and repeated at intervals ranging from 1.5-4 seconds, (Faust 2017; Lloyd 2018). Males flash while flying at low to moderate heights and females respond from low vegetation or rocky substrates with a distinctive modulated flash-glow (Faust 2017). Figure 10 illustrates a generalized male flash pattern at 75 degrees Fahrenheit.

Figure 10. Diagram showing a typical male courtship flash pattern for *M. floridana*, a single flash repeated about every 1.5 seconds when the air temperature is 75° F.

Range, Distribution, and Abundance:

Type locality: Cedar Key, Levy County, Florida

Range: The Florida intertidal firefly has been documented on the coast of Florida from Cedar Key in Levy County on the Gulf Coast to Volusia County on the Atlantic Coast and throughout the Florida Keys in Monroe County (Figure 11). It is also found on Deep Water Cay in the Bahamas.

Distribution: In Florida, it is documented from the following counties: Dixie, Levy, Citrus, Hernando, Pasco, Pinellas, Hillsborough, Manatee, Charlotte, Collier, Monroe, Miami-Dade, Broward, Saint Lucie, Indian River, and Volusia (Faust 2017; Joyce, Selvaggio, and Fallon 2023). Various sources have erroneously listed Seminole County, a land-locked county, as part of the distribution.

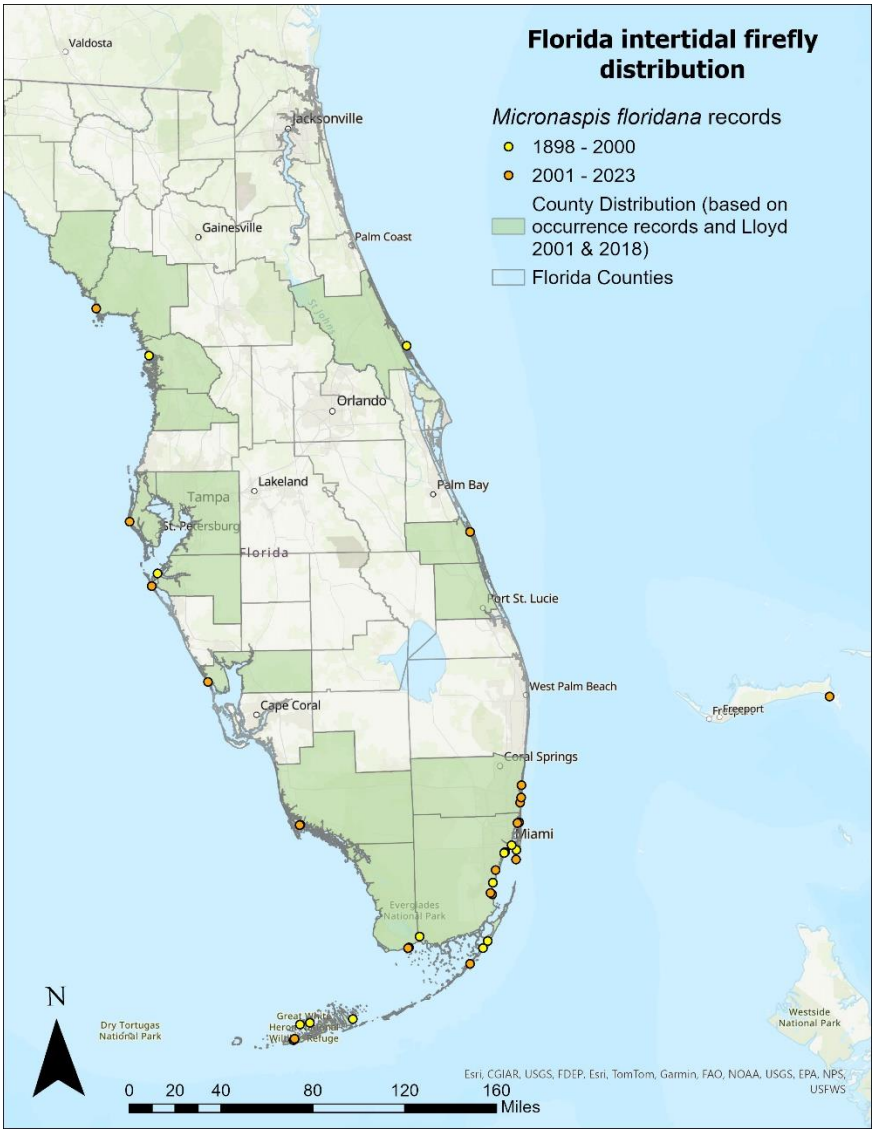

Figure 11. Map of counties and localities where Micronaspis floridana has been documented as of 2023.

Documented

As of 2023, *Micronaspis floridana* has been recorded in the public lands listed in Table 1.

Table 1. Public lands where *M. floridana* has been documented as of 2023.

Public Land	County	Managing entity
Everglades National Park	Collier, Monroe	National Park Service
Biscayne National Park	Miami-Dade	National Park Service
Canaveral National Sea Shore	Volusia	National Park Service
Great White Heron National Wildlife Refuge	Monroe	United States Fish and Wildlife Service
Bill Baggs Cape Florida State Park	Miami-Dade	Florida DEP
Oleta River State Park	Miami-Dade	Florida DEP
Dr. Von D. Mizell- Eula Johnson State Park	Broward	Florida DEP
Hugh Taylor Birch State Park	Broward	Florida DEP
Florida Keys Wildlife and Environmental Area	Monroe	Florida Fish and Wildlife Conservation Commission
Rookery Bay National Estuarine Research Reserve	Collier	Florida DEP, NOAA, Florida International University
West Lake Park	Broward	Broward County
Deering Estate	Miami-Dade	Miami-Dade County
Leffis Key Preserve	Manatee	Manatee County

Suspected

The following public lands contain the habitat types used by the Florida intertidal firefly, are within or adjacent to the species' known range in Florida, and may support populations of the species:

- *National Park Service*: Dry Tortugas National Park
- *US Fish and Wildlife Service*: J. N. Ding Darling National Wildlife Refuge, Ten Thousand Islands National Wildlife Refuge, Merritt Island National Wildlife Refuge, Pelican Island National Wildlife Refuge, Crocodile Lake National Wildlife Refuge, National Key Deer Refuge, Key West National Wildlife Refuge
- *Florida State Parks*: Delnor-Wiggins Pass State Park, Lovers Key State Park, Estero Bay Preserve State Park, Cayo Costa State Park, Charlotte Harbor Preserve State Park, Avalon State Park, Fort Pierce Inlet State Park, St. Lucie Inlet Preserve State Park, Seabranch Preserve State Park, McArthur Beach State Park, John Pennekamp Coral Reef State Park, Lignumvitae Key Botanical State Park, Long Key State Park, Curry Hammock State Park, North Peninsula State Park, Bulow Creek State Park
- *Florida Fish and Wildlife Conservation Commission*: Big Bend Wildlife Management Area

Abundance: Long-term population monitoring has not been conducted at any *Micronaspis floridana* sites. However, detections of *Micronaspis floridana* adults during Firefly Atlas surveys have ranged from one or two adults (Joyce 2023b) to estimates of over 50 adults. Similarly, firefly expert Lynn Faust reports that in the Bahamas, Florida intertidal fireflies "are never exceptionally abundant even under

ideal conditions and habitat. On peak nights I might see fifty males in a half-mile walk. On other nights I might see one or two" (Faust 2017).

Habitat Associations:

Florida intertidal fireflies are coastal habitat specialists found in mangroves, salt marshes, and tidal mudflats (Figure 12). Adults may also be found displaying in upland habitats adjacent to intertidal areas such as coastal strands, maritime hammocks, and grassy roadsides (Joyce 2022, 2023c). Larvae are typically found at ground level in mangroves and salt marshes, habitats often shared with fiddler crabs (family Ocypodidae) (Faust 2017; Lloyd 2018).

Plant species that are found in *M. floridana* habitats include red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*), green buttonwood (*Conocarpus erectus*), sea grapes (*Coccoloba uvifera*), coin vine (*Dalbergia ecastaphyllum*), and black needlerush (*Juncus roemerianus*).

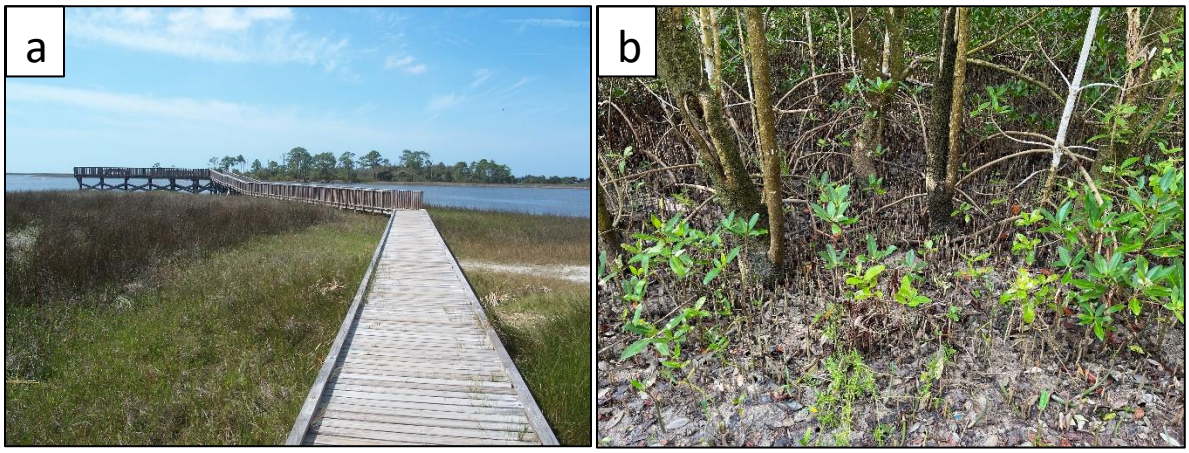

Figure 12. Florida intertidal firefly habitats: (a) black-needle rush salt marsh at the Cedar Key Shell Mound, Levy County (photo: Ebyabe CC BY-SA and (b) mangroves in the Flamingo district of Everglades National Park, Monroe County (photo: Richard Joyce/Xerces Society).

Co-occurring bioluminescent beetles

Co-occurring firefly species may include the keel-necked firefly (*Pyractomena ecostata*), Dixon's striped firefly (*Aspisoma ignitum*), and single-flashing *Photuris* similar to *Photuris salina*. Other bioluminescent beetles that may overlap in habitat include the click beetle *Ignelater havaniensis*, which are known by the common names headlight beetles, fire beetles, and *cocuyos* (Spanish). These click beetles can be quickly distinguished by the presence of two circular light organs on the top of the thorax that stay lit for longer periods (see Figure 13). Click beetles in flight appear as long glowing streaks rather than as quick flashes.

Figure 13. The glows of the bioluminescent click beetle *Ignelater havaniensis*, with two round light organs on the dorsal side of the thorax, may be confused with the flashes of *Micronaspis floridana*. (*Ignelater havaniensis* by A Rector, licensed CC BY-NC 4.0)

Threats:

Documented threats to the Florida intertidal firefly include habitat loss, climate change, pesticide use, artificial light, and entomopathogenic nematodes (Fallon and Walker 2021; Joyce, Selvaggio, and Fallon 2023).

With Florida's rapid population growth has come the rapid expansion of urban development along the state's coasts and the loss of coastal wetlands. Steep declines in the acreage of non-vegetated intertidal wetland (sand and mudflats) and estuarine emergent wetland (salt marsh) occurred during the 1950s and 1970s (Dahl 2005) as dredge and fill operations replaced wetlands with housing developments. During the second half of the 20th century, the Upper Florida Keys lost 15 percent of their original (mid 1900s) mangrove cover (Strong and Bancroft 1994). Lewis et al. (1985) estimated that 23% of Florida's historical mangrove cover was destroyed by development by the 1980s. This loss of coastal wetlands has meant a reduction in the extent and connectivity of habitat for the Florida intertidal firefly.

Global climate change threatens the Florida intertidal firefly through multiple mechanisms, including rising sea levels, increased temperatures, and increased frequency and severity of storms. Global sea levels are rising increasingly quickly (Hayhoe et al. 2018), and it is estimated that the relative sea level rise from 2005-2060 will be over 0.5 meters (Sweet et al. 2022). Because the Florida intertidal firefly occupies the upper intertidal area during its larval stage (and presumably egg and pupal stages), even modest amounts of sea level rise will permanently flood the lower elevations of the areas that it currently occupies, likely resulting in a significant loss of this firefly's habitat. While it may be possible for some coastal wetlands to persist despite sea level rise through vertical accretion and horizontal migration, the ability of mangroves and salt marshes to migrate and adapt to rising sea levels is greatly constrained by coastal development and infrastructure (Osland et al. 2022) and coastal wetland migration is not a given. The collapse of freshwater wetland peat soils and accretion rates that do not keep pace with sea level rise are two factors that could lead to wetlands being submerged rather than migrating or transitioning from freshwater or brackish to saline (Chambers, Steinmuller, and Breithaupt 2019; Parkinson and Wdowinski 2022).

Climate change is also expected to affect Florida intertidal fireflies and their prey through higher and more extreme temperatures. Thermal stress is known to negatively impact beetle survival, reproductive

development, and fertility (Sales, Vasudeva, and Gage 2021). High temperatures affect firefly reproduction (Bauer et al. 2013) and survival of eggs and larvae (Evans et al. 2019). While many intertidal gastropods have physiological and behavioral adaptations to temperature extremes (Leung, Russell, and Connell 2019), these organisms may already be close to their thermal limits (Tomanek and Zuzow 2010), and embryonic intertidal gastropods are particularly susceptible to high temperatures (Sippo et al. 2018). Furthermore, heat waves are a source of mangrove mortality, with temperatures over 38-40 °C (100.4-104 °F) causing stress to mangrove trees by inhibiting photosynthesis (Sippo et al. 2018). Mangrove mortality likely increases heat stress to fireflies and their prey by reducing the shade and habitat structure that provide thermal refugia. Conversely, cold snaps due to polar vortexes may restrict the ability of *Micronaspis floridana* to expand its range northward as mean temperatures rise, even if climate conditions are suitable during the remainder of the year.

As the ocean and atmosphere warm due to anthropogenic climate change, tropical cyclones are projected to have deeper storm surge, more intense winds and precipitation, a greater proportion of category 4 and 5 storms, and slower translation speeds (Knutson et al. 2020). Hurricanes are a natural part of the region where the Florida intertidal firefly is endemic, and the species appears to have adaptations that allow it to persist in areas struck by hurricanes (Vaz et al. 2021). However, we know that hurricanes can dramatically affect the habitats that the firefly relies upon. For example, Hurricane Irma in 2017 led to 10,760 hectares of complete mangrove dieback within the range of *Micronaspis floridana* in Southwest Florida, with low-lying black mangrove areas especially affected by ponding and hyper salinization in the aftermath of the storm surge (Lagomasino et al. 2021) Other mechanisms for mangrove degradation by storms include sulfide soil toxicity, peat collapse, soil compression, and soil erosion (Gilman et al. 2008).

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 *Micronaspis floridana* include aerial spraying of mosquito adulticides (often pyrethroids or the organophosphate naled), the use of neonicotinoids in soil for agricultural and landscaping purposes, and the use of molluscicides (Joyce, Selvaggio, and Fallon 2023).

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 and Lewis 2022), causing interference with courtship communication and lowering reproductive success. Because the Florida intertidal firefly begins its courtship displays about 40 minutes after sunset, once it is dark, artificial light can interfere with its behavior. Even the illumination from a full moon appears seems to reduce Florida intertidal firefly activity, and artificial light can far exceed this level. The illuminance of a full moon is generally less than 0.3 lux (Kyba, Mojar, and Posch 2017), and illuminance measurements taken at the edge of lit parking lots in state parks in Florida in April 2023 were as high as 20 lux (Joyce unpublished data). Sources of artificial light observed to be illuminating *Micronaspis floridana* habitat include vehicle headlights, buildings, port infrastructure, and light posts (Figure 14).

Figure 14. Artificial light in and near *M. floridana* habitats can come from various sources and take the form of sky glow, light trespass and glare. (Richard Joyce/Xerces Society).

Nematodes in the genus *Steinernema*, a group that is used to control agricultural and turf pests in Florida, have been found to infect and kill larvae of *Micronaspis floridana* in mangroves along Sarasota Bay (Faust 2017). More research is needed about the extent and severity of this threat, as well as the origin of these nematodes in firefly habitats.

Conservation Considerations:

The Florida intertidal firefly is a habitat specialist found in Florida and the Bahamas. This species is vulnerable to extinction because it has a limited distribution, its population size is suspected to be small, and it faces numerous threats to its persistence, including habitat loss, climate change, pesticides, light pollution, and entomopathogenic nematodes. There are no specific conservation measures in place to protect this species. 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 work to assess the Florida intertidal firefly's conservation status and to compile a comprehensive database of known occurrence records, our understanding of this species' distribution, abundance, and population trends is incomplete or lacking, which hinders our ability to effectively conserve the species. There remain critical data gaps that must be addressed to inform conservation efforts for the Florida intertidal firefly, including:

Natural History

- In the wild, are larvae specialists or generalists? Do they have food sources other than snails? Which species of snails are important prey?
- What microhabitat features are important to adults? To the larvae?

Species range and distribution

- What is the full extent of this species' range? Surveys on the northwest coast and in the Big Bend region are especially needed to determine the northern range limit.
- 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 fireflies at known sites?
- What is the dispersal capacity of this species during the larval and adult life stages?

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

- What are the threshold levels of artificial light at which behavior and reproductive fitness of Florida intertidal fireflies are affected?
- What is the incidence of *Steinernema* nematodes in larvae? How widespread geographically are *Steinernema* infections in Florida intertidal firefly larvae?
- What are the thermal tolerance thresholds of adults and larvae?
- What is the toxicity of naled, permethrin, and other commonly used mosquito adulticides to adults and larvae? Are sublethal effects observed from ULV (ultra-low volume) spraying?
- Can we model the impacts of sea level rise and other climate change impacts on their populations? What about the impacts of increasing development 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 intertidal habitats are needed to determine the full extent of this species' range. Nighttime visual surveys are recommended in managed areas in Florida with salt marshes and mangroves (see Suspected Distribution section) to gather baseline data about the presence, habitat use, baseline abundance, and site-specific activity patterns. If there is

limited capacity among staff or volunteers to conduct surveys, we recommend doing one or two surveys in the spring (April-May) when conditions are favorable (see Survey Protocol). 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.

Management actions

Land managers can play a key role in ensuring that known and potential habitat for Florida intertidal fireflies is not disturbed by recreation, development, harmful pesticide applications, light pollution, or other management activities. Key actions that could help this firefly include:

- establishing and maintaining vegetated shoreline buffers
- rerouting roads and trails around sensitive habitat areas
- removing tidal barriers and restrictions such as undersized culverts, levees, or berms
- 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
- using *Bacillus thuringiensis israelensis* (Bti) larvicides rather than adulticides in cases where mosquito control is deemed necessary
- restoring more natural tidal hydrology to mosquito impoundments in salt marsh or mangrove
- using living shorelines rather than seawalls or revetments
- 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: Throughout coastal Florida, from Taylor and Flagler Counties south through the Florida Keys, in the following habitats:

- salt marshes (including black needle rush marsh)
- mangrove swamps
- mudflats
- upland areas within about 50 meters of the high-water line

When:

- Surveys should begin 30-40 minutes after the time of sunset. April and May appear to be peak season for adults, but the species is detectable year-round in the southern portion of its range.
- Air temperature should be at least 68° Fahrenheit (20° Celsius)
- Beaufort wind scale should be Force 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.
- Survey duration is flexible, but we recommend a minimum duration of 30 minutes for stationary or small patch surveys and at least **6 minutes** per **100 meters** of route, which can be achieved by walking slowly at 1 km/hr or walking the route twice at 2 km/hr.

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 near the high tide line looking for bioluminescent flashes and glows.
- Consider recording observation data using a voice memo app or a voice recorder, using the data sheet as a guide.
- Photograph any glowing larvae encountered, as the spiked dorsal plates are diagnostic.
- 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 your 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 (including from surveys where fireflies were not detected).

Additional Resources:

Species-specific

- Fireflies, Glow-worms, and Lighting Bugs: Identification and Natural History of the Fireflies of the Eastern and Central United States, by Lynn Faust: https://ugapress.org/book/9780820348728/fireflies-glow-worms-and-lightning-bugs/
- Petition to list the Florida intertidal firefly as an endangered species under the US Endangered Species Act: https://www.xerces.org/blog/esa-petition-filed-to-protect-florida-intertidal-firefly-micronaspis-floridana
- 'Wanted' poster: Have seen this rare firefly? https://www.fireflyatlas.org/firefly-posters

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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