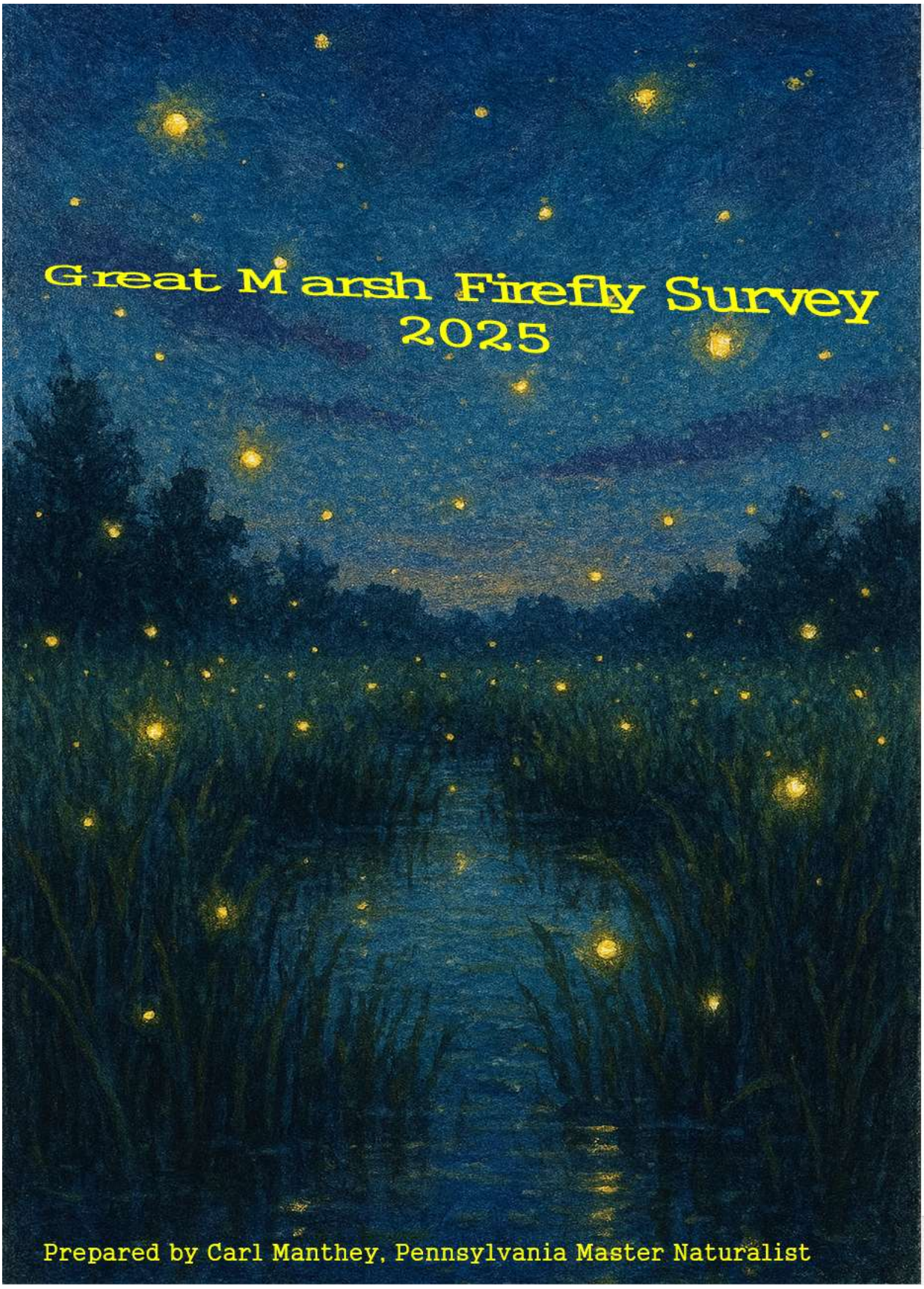
Great Marsh Firefly Survey
2025
Prepared by Carl Manthey, Pennsylvania Master Naturalist

Acknowledgements:

Many thanks to the Moore family who permitted us to roam their marshlands at night, to the Director of the Great Marsh Institute, Bernard (Billy) Brown, for endorsing this project and participating at every level, and to Michele Richards, President of Pennsylvania Master Naturalist, and Marisa Nagele, Southeast Pennsylvania Master Naturalist Coordinator, for providing a framework for volunteer participation. Most importantly, thanks to our cheerful and reliable crew of volunteers who performed these surveys with enthusiasm. These included Myrna Villanueva, Diana Cormack*, Billy Brown, Gilda Brown, Kathy Varaday*, Christa Tyner*, Trip Tyner, Melinda Siegel, Meredith Heffner*, John Lisowski*, Karen Owens*, Jackie Ahlborn* and Carl Manthey* (asterisk indicates Pennsylvania Master Naturalist).

Members of the inaugural nighttime survey on May 18th included (left-to right) Karen Owens, Christa Tyner, Diana Cormack, Jackie Ahlborn, Billy Brown, Kathy Varaday, Carl Manthey, and Myrna Villanueva. Photo by Trip Tyner.

Executive Summary

During the spring and summer of 2025, a group of curious and adventurous citizen-scientists sought to determine if multiple species of fireflies inhabit the Great Marsh in Chester County, Pennsylvania. Over the course of one daytime and 5 nighttime surveys spanning April to August at least eight varieties of fireflies were documented based on flash pattern and morphology. These included the Winter Firefly (*Photinus corruscus*), Marsh Flicker Firefly (*Pyractomena dispersa*), Big Dipper Firefly (*Photinus pyralis*), Yellow-Bellied Firefly (*Photinus scintillans*), Little Grey Firefly (*Photinus marginellis*), Double Cousin Firefly (*Photinus consanguineous*), Ignited Firefly (*Photinus ignitus*) and an undetermined firefly species of the genus *Photuris*. Firefly numbers were most abundant in June and were magical on June 21st but declined rapidly by July 18th and were nearly gone by August 9th. Several other unique flash patterns were seen in June, but the emitting fireflies evaded capture and were not identified. Thus, even more species remain to be documented at the Great Marsh! The remarkable abundance and diversity of fireflies confirm the hypothesis that the Great Marsh is a healthy and important refuge for fireflies and a site well suited for firefly studies and public education.

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INTRODUCTION

Who has not at some point in their lives spent an evening catching fireflies and putting them into a bottle? For many, fireflies evoke nostalgia and symbolize the ephemeral nature of time and beauty. However, without further exploration, many come to take fireflies for granted. But did you know that most people who live west of the Rocky Mountains have never seen a firefly while Pennsylvania is in the heart of firefly country? Or that there are over 2000 known species of fireflies globally, and new species are being discovered every year? And did you know that while most fireflies don't eat as adults, one type of firefly eats nothing but other fireflies? The more we look, the more we see that fireflies are far more interesting than we could have imagined.

WHAT INSPIRED THIS SURVEY?

Simple, childlike curiosity was the primary driver of the Great Marsh Firefly Survey. In the Autumn of 2024 staff of the Pennsylvania firefly festival shared with me that fireflies come in many flavors (species). What? Had not all fireflies looked, flashed, and behaved the same? Perhaps it was time to take a second look at fireflies! So, in the spirit of wonder, curiosity, and a pinch of skepticism, a plan was made to survey the Great Marsh in Chester County, Pennsylvania to see what species of fireflies are present. Framed in the scientific method, I proposed to test the hypothesis that more than one species of firefly call the Great Marsh home.

WHY SURVEY THE GREAT MARSH?

Chester County's Great Marsh is the largest periglacial marsh in southeastern Pennsylvania with a landscape that includes approximately 600 acres of marsh, meadows, shrub and forest swamps, floodplain forest, upland forest, and row crop farming. Because firefly larvae need moist environments, and because several species prefer wetland habitats, the Great Marsh was chosen as an ideal site for firefly hunting. Further, much of the land is owned by the Moore family who created the Great Marsh Institute to provide an inviting framework for public education events and citizen science. Therefore, a survey of fireflies at the Great Marsh could pave the way for future scientific studies and for public outreach.

FIREFLY BIOLOGY 101

Fireflies are beetles, and, like all beetles, undergo complete metamorphosis progressing from egg to larva to pupa to adult (Figure 1). Because there are many types of fireflies, there is diversity in the details of the firefly life cycle. However, *most* fireflies begin their life's journey in spring or summer as eggs laid on moist soil and moss or under leaf litter and rotting logs. The eggs soon hatch giving rise to tiny larva that burrow into the soil or patrol leaf litter or rotting logs where, despite their tiny size, they feed on worms, slugs, snails, and soft-bodied insects. The larvae feed through summer and fall, and after a period of winter dormancy, the larvae feed and grow again the following spring. Then, the larvae build mud capsules around themselves and pupate. During pupation, the larva body is broken down and radically transformed into adult structures with wings. The adult firefly emerges when it bursts the capsule, but adult fireflies only live two to three weeks. Many adult fireflies do not eat but rely on metabolic energy banked as larvae. The sole purpose of the adult phase of the lifecycle is to mate and generate the fertile eggs that will give rise to the next generation of fireflies. Reflecting on the life cycle, it comes into sharp focus that more than ninety percent of the life of a firefly is spent in the larva stage on or in the soil. As will be discussed later, this has important implications for firefly conservation!

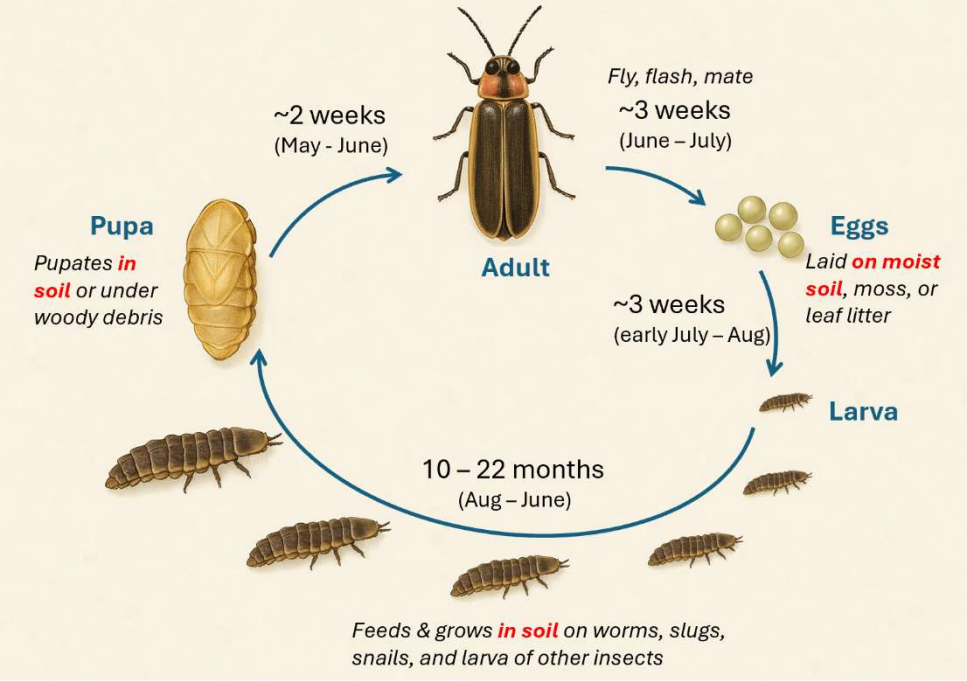

Figure 1. Life cycle of a typical firefly

While the production of light by living organisms (bioluminescence) is common in dark ocean depths, fireflies are unusual among land animals for having light organs. In adult fireflies, these "lanterns", are the familiar yellow segments near the end of the abdomen. Within the lanterns, metabolic energy is mixed with oxygen and a chemical called luciferin. The chemical reaction that ensues releases energy with near perfect efficiency in the form of light.

Yet, to what purpose does the firefly produce light? The balance sheet of life demands that any use of metabolic energy must be used to advantage. Does it not seem almost a miracle that male and female insects, tiny as they are, can find each other in this huge world? For fireflies, flashing is an elegant solution to this problem. Numerous male fireflies take to the air every night and flash to call out to the fewer females that are stationary on vegetation and that flash to call back in return.

The overwhelming characteristic of life on earth is diversification to exploit every niche. Scientists have documented over 2000 distinct species of fireflies globally and new species are still being discovered! Approximately 170 species reside in North America and at least thirty species are native to Pennsylvania. All this diversity creates a dilemma; if many species of fireflies are flashing simultaneously to find mates, how do fireflies know which flashes are from mates of their own species? Incredibly, each species has its own unique *flash pattern* with a specific duration of flash and interval between flashes. These patterns are determined by a pacemaker neural circuit that is unique for each species; the flash patterns are genetically hardwired! Indeed, careful observation of flash patterns is the easiest way for fireflies *and* humans to identify fireflies to the species level.

In Pennsylvania, the species of fireflies that flash can be grouped into three "genera", i.e., *Photinus*, *Photuris*, and *Pyractomena*. Photinus is the most commonly encountered genus. *Photuris* fly higher in trees, later in the night and often have noticeably long legs and a diagonal stripe across the wing covers. Meanwhile, *Pyractomena* favor wetlands and have distinctive pointed and ridged headshields.

Might bioluminescence increase visibility and make fireflies easy targets for predators? To protect themselves, most fireflies make bitter toxins known as lucibufagins. It only takes one experience to teach a young bird, bat, or frog to stay away from fireflies. Curiously, fireflies of the genus *Photuris* lack the ability to produce lucibufagins and female *Photuris* obtain lucibufagins by a surprising method. Female *Photuris* fireflies mimic the female flash patterns of *Photinus* and *Pyractomena* species. When an unsuspecting *Photinus* or *Pyractomena* male arrives for courtship, he is ambushed and eaten for his lucibufagins! This predation of one bioluminescent firefly by another may have had remarkable impacts on firefly evolution. Some scientists speculate that predatory *Photuris* drove the loss of lanterns in some fireflies. Indeed, nearly one in four firefly species have lost adult-stage bioluminescence. These species, active only in the daytime, are adapted to avoid *Photuris* predation!

Read the fascinating books written by Sarah Lewis and Lynn Faust to learn more about fireflies.[1, 2]

FIREFLY CONSERVATION

Many older people have the impression there are fewer fireflies now than in the past. Looking at the big picture, why should we care about fireflies? While it is easy to care about fireflies because they are enchanting, we should care because they are reliable bioindicators of the health of the environment. The factors that stress fireflies (*e.g.*, habitat loss, pesticide use, and air, water and light pollution) are the same factors that stress whole ecosystems.

To conserve fireflies, recall that the vast majority of the firefly lifecycle occurs on or in moist soil. It follows that fireflies are best supported by taking steps that ensure clean, undisturbed and well hydrated soils. These steps may include eliminating pesticide use and conserving soil moisture by mowing less (or at a greater height), allowing areas of leaf-litter and woody debris, and protecting streams and wetlands. Also, consider that the tiny larvae spend their entire life within a few feet of where they hatched. Moreover, while males can fly some distance, female fireflies minimize flying to focus their precious metabolic energy on producing eggs. In some species the females don't even have wings! Fireflies and the land they live on are intimately linked. Disruption of soils for development has extirpated many otherwise robust firefly populations.

Studies show that female fireflies do not respond to males flashing against a backlit sky and firefly reproduction is reduced dramatically when humans add light to the night (light pollution). Firefly biologists recommend adherence to the "Five Principles for Responsible Outdoor Lighting" of Dark Skies International, *viz.,* limit light to that which is useful, minimally necessary, directed (shielded), timed, and warm colored.

While conducted in a spirit of fun, the survey also had a rationale rooted in environmental concern. To determine the status of firefly populations, the International Union for Conservation of Nature (IUCN) and the Xerces Society have launched citizen science initiatives such as The Firefly Atlas to collect data on the occurrence and range of various firefly species across North America. Creating an inventory of what is present and where is a first step on the road to firefly conservation. Finding vulnerable populations is key to identifying land for preservation. The results of our Great Marsh surveys were entered into the Firefly Altas database and will contribute to establishing the range and prevalence of the fireflies we observed.

METHODS

Surveys were performed using methods recommended by the Firefly Atlas.[3] Fireflies were identified by a combination of morphology and flash patterns. Flash patterns of individual fireflies were recorded using the Voice Memos utility on cell phones. With the Voice Memos utility turned on, an observer tracking an individual firefly spoke the word "flash" each time a firefly flashed until three to five consecutive flash cycles were accumulated. The utility had a stopwatch display. The recording was replayed and the time between first and last recorded flash was noted. This value (seconds) was divided by the number of recorded flashes minus one to calculate the average flash interval. The determination of flash duration was qualitative. Short, "snappy" flashes were estimated to be less than 0.5 seconds in duration. Long, "lazy" flashes were estimated to be >0.5 seconds in duration. Flash color, height and habitat were also recorded using the Voice Memos utility.

Morphology was documented by photography. Fireflies with recorded flash patterns were caught using standard butterfly nets with telescoping poles. The fireflies were placed in 100 mm petri dishes with lids and photographed with supplemental light from a standard flashlight. Photographs were taken of the dorsal and ventral surfaces using cell phone cameras set at maximum magnification or with attached magnification lenses. Photographed fireflies were released.

Identification to the genus level was by morphology, *i.e., Pyractomena* were identified by headshields with a pointed front edge and a central longitudinal raised keel, *Photuris* by long legs and stripes running diagonally across the wing covers, and *Photinus* were indicated by rounded head-shields and lack of diagonal wing cover stripes.

Identification to the species level was accomplished by matching the observed flash pattern to flash pattern guides specific to each genus.[1,2] Identification was confirmed by noting definitive morphological traits (if any), *e.g.*, unique headshield markings, leg color, abdomen markings, shape of pygidium, etc., as described.[2]

A core of great volunteers was essential to this project (see acknowledgements). Two to three volunteers worked together as a team. Depending on the number of volunteers in attendance, two to three teams were formed for each survey. Teams were assigned to walk one of three observation routes (see **Appendix I**).

Following each survey, observations were uploaded into iNaturalist[4] and the Firefly Atlas[3].

RESULTS

SUMMARY AND CHRONOLOGY

Indeed! The Great Marsh proved to be an exciting location to learn about fireflies. Over the course of the spring and summer of 2025 at least eight types of fireflies were documented comprising all three North American genera of flashing fireflies (Table 1). The season started with the treat of seeing a mating pair of the Winter Firefly (*Photinus corruscus*) during a daytime reconnaissance visit on April 14. Then, on our inaugural nighttime survey (May 18th) we witnessed Marsh Flicker Fireflies (*Pyractomena dispersa*) flashing after full darkness. Until then, none of us had seen flashes near our homes, underscoring that the Great Marsh was indeed a special place!

TABLE 1: Summary of 2025 Great Marsh Firefly Survey by Date and Species

	April 14	May 18	June 7	June 21	July 19	August 9
Photinus consanguineous /Double Cousin			✓			
Photinus ignitus/ Ignited Firefly			✓			
Photinus marginellis /Little Grey			✓			
Photuris (species undetermined)			✓		✓	
Photinus scintillans /Yellow Bellied Firefly			✓	✓	✓	
Photinus pyralis /Big Dipper			✓	✓	✓	✓
Pyractomena dispersa /Marsh Flicker		✓				
Photinus corruscus /Winter Firefly	✓					
Estimated relative flash abundance (% peak)		5	25	100	10	1
Modified growing degree days (base 86/50)*	166	568	787	1048	1770	2241
Sunset	7:41 PM	8:15 PM	8:30 PM	8:36 PM	8:28 PM	8:07 PM
Survey time (start/end)	3 - 5 PM	8-9:45 PM	8:30-10 PM	8:30-10 PM	8:30-10 PM	8-9:30 PM
Temp (start/end)	65°F	65°F	70-68°F	78-77°F	77-74°F	73-71°F
Moon		none	bright	none	none	bright
Wind	light	breezy	still	light	light	light
Number of volunteers (teams)	2 (1)	9 (3)	5 (2)	4 (2)	8 (3)	5 (2)
Humidity		60%	>90%	67%	85%	35%
Other			ground wet	damp/Mosquitoes!		

*(https://climatesmartfarming.org/tools/csf-growing-degree-day-calculator/) used a start date of 03/01/2025.

Remarkably, Marsh Flickers had already departed the scene by June 7th. Yet, this night featured a dizzying variety of other flash patterns, and we documented at least 6 distinct species. The action began promptly at dusk with iconic Big Dipper Fireflies (*Photinus pyralis*) drifting up out of mowed lawn. Next, tiny Yellow-Bellied Fireflies with snappy flashes nearly every 2 seconds were observed just above uncut grass adjacent to the bass pond. As dusk progressed to full darkness, a chorus of flash patterns emerged that varied not only in flash interval but in both height and habitat. The teams successfully photographed three additional species within the genus *Photinus*. One member of the genus *Photuris* was also photographed, but we were unable to identify this specimen to the species level.

The yellow stars in Table 1 (and the numbers above the stars) provide a qualitative estimate of the relative flash abundance across the survey dates. June 21st was clearly the height of firefly season; on this night fireflies started out strong and ended as a spectacle.

Initiating our survey at dusk on June 21st, we immediately tracked dozens of the iconic Big Dipper Fireflies rising out of mowed grass and Yellow-Bellied Fireflies by the bass pond. Then, as darkness intensified, firefly abundance grew and grew. Soon the confusion created by the abundant flashes made it virtually impossible to track individual fireflies as was necessary for documentation. Also, many unique fireflies were out of our reach, high in trees or at a distance over the marsh. Even so, it was clear we were seeing a rich diversity of flash patterns and species. By 9:45 PM the fields, meadows and tree lines were a spectacle of lights. The abundance was no longer limited to prime habitat. Even areas that were previously dark such as the soybean fields and sheep pasture were now awash in fireflies. This night at the height of firefly season was truly magical.

Four weeks later (July 19th) the early summer surge of fireflies was well past. Flash abundance was reduced by about ninety percent compared to the peak on June 21st. Every firefly was either a Big Dipper or a Yellow-Bellied Firefly or an occasional member of the genus, *Photuris*. August 9th saw a continuation of this decline. By this date, a few Big Dippers continued to rise out of the grass at sunset, but by nightfall, the flashes of summer were nearly extinguished. Yet, looking over the marshy area along Moores Road between the house and Marsh Creek, we saw about a dozen yellow-orange flashes that were snappy, unlike the slow Big Dipper flashes. Unfortunately, the fireflies were fifty yards over the marsh and out of our reach. The identity of these fireflies remained unresolved, and the summer survey ended with a mystery.

DETAILED DESCRIPTION OF OBSERVED SPECIES

Two Winter Fireflies were observed mating on the sunny side of a black willow near Catfish Pond (Figure 2). The female was noticeably larger than the male and lighter in color. These fireflies lack lanterns and are active during the day. Winter Fireflies are unusual because they pupate in the fall and overwinter *as adults* sheltering in the rough bark of trees where they can survive temperatures below minus 10 degrees! Mating occurs in March and April and eggs are laid in the spring. Larvae may require two summers to fully mature. This species is well known to maple sugarers because adults frequent the sap flows during the sugaring season. Long considered to represent a distinct genus (*viz., Ellychnia*), recent DNA analysis revealed Winter Fireflies to be members of the genus *Photinus*. Winter Fireflies are wide-bodied and the ridged elytra (wing covers) lack yellow borders. They inhabit diverse wooded habitats over a large geographic area extending from the east coast to Montana and from Canada to Mexico (see Appendix II). Although it is not a well-known firefly, it has an IUCN conservation status of “Least concern”.

Figure 2. Winter Fireflies (*Photinus curruscus*)

Marsh Flicker Fireflies (*Pyractomena dispersa*) provided excitement on our inaugural nighttime survey, May 18th (Figure 3). They appeared in full darkness after 9 PM over the wet meadow between the duck blind and the turnpike plaza and were also sighted along Marsh Creek and at about head height over the marsh along Moores Road. Some flashed while perched in tall grass. These produced single flashes or occasional quick double or triple flashes. Other Marsh Flickers flashed single flashes while flying just over the top of the vegetation. Flash intervals were variable with some showing single flashes followed by indeterminant long dark intervals while others flashed with a 4 to 5 second flash interval. The flashes were eye catching because they were bright yellow-orange and substantial (~0.5 sec duration).

Figure 3. Marsh Flicker (*Pyractomena dispersa*)

These fireflies were identified as members of the genus *Pyractomena* due to distinct features of the head shield (pronotum), *i.e.,* head shields were slightly pointed at the front and sported a central longitudinal raised keel (hard to see in Figure 3). They were identified as the species *dispersa* based on the flash pattern, *viz.,* single bright flash every 4 to 5 seconds and based on head shields that lack the black side markings characteristic of other species of *Pyractomena*.

Marsh Flicker fireflies have a wide distribution across North America (**Appendix II**), but their requirement for marshy habitats makes their distribution patchy. Although Marsh Flickers were known to exist in Pennsylvania, ours was the first Pennsylvania entree in iNaturalist for this species. These early season Marsh Flickers were not observed in later surveys.

Our third observation was the common but extraordinary Big Dipper Firefly (*Photinus pyralis*). Big Dippers (Figure 4) are named for the ladle shaped J-stroke they draw with their lazy ~0.75 second flash that starts low above cropped grass and rises like a campfire spark at five to six second intervals. Characteristic of the genus *Photinus*, Big Dippers have a head shield that is round across the front and smooth across the top (not pointed and keeled like a *Pyractomena*). This firefly has classic black, red and yellow aposematic coloration. The first four abdominal segments of the abdomen are uniformly dark while the fifth segment has a pale lower border that blends into the lanterns (segments six and seven). The last segment (pygidium) is pale and narrowly rounded but reveals an iconic “tornado-tail” geometric pattern when viewed from the dorsal surface.

Big Dipper fireflies were observed throughout the Great Marsh, but were most frequently documented near the house, guest house and nature center because these are the first fireflies to flash at dusk and they thrive in areas of mowed grass.

Figure 4. Big Dipper (*Photinus pyralis*)

The Big Dipper "all-American" firefly is the most abundant North American firefly and is the firefly most likely to be caught by curious children. In our surveys, Big Dippers had the longest season; they were observed on each survey from June 7th to August 9th. Even so, their abundance peaked along with total firefly numbers on the June 21st survey.

Why has this firefly been so successful? Big Dippers are most active at sunset when there is still enough light to read. Perhaps their success reflects a tolerance of light pollution. Success may also be a function of their tolerance of human modified landscapes. However, the underlying reasons for Big Dipper tolerance of human-modified landscapes remain unknown. Despite the abundance of Big Dippers, very little is known about the prey and lives of Big Dipper larvae. Indeed, there is a general lack of knowledge about larvae of any species of the genus *Photinus*.

Figure 5. Yellow-Bellied Firefly (*Photinus scintillans*)

Another early evening firefly observed on multiple surveys was the Yellow-Bellied Firefly (*Photinus scintillans)*. Yellow-Bellied Fireflies (Figure 5) were consistently seen in large numbers flying just over the tops of tall grass/perennials or in shrubs adjacent to the bass pond and other locations. These snappy fireflies flashed like tiny firecrackers once every 1.75 to 2.5 seconds while flying in a line. They were the smallest fireflies observed in our surveys, and captured Yellow-Bellied Fireflies were frenetic and hard to photograph. Even so, the diminutive size, tawny belly, clear, wavy tail (pygidium)

and short flash interval yielded an unambiguous identification.

Yellow-Bellied Fireflies are quite exotic. They are the only common species in our state with brachypterous females, meaning the females have shortened wings and are flightless. Without the ability to disperse eggs through flight, the spread of brachypterous insects occurs at glacial pace and populations can be wiped out by soil disturbance. This may account for the fact that although Yellow-Bellied Fireflies can be abundant locally, they have a small geographic range, being virtually unknown outside of Pennsylvania, Delaware, New Jersey and New York. The only other Pennsylvania firefly with flightless females is the rarely seen Blue Ghost (*Phausis reticulata*) whose females lack wings altogether.

Mixed with the Yellow-Bellied Fireflies flying low (0-3 ft) among shrubs surrounding the catfish pond were a smaller number of fireflies with brief orange flashes every four seconds. Capture revealed a small *Photinus* with a tawny belly that was difficult to distinguish from the Yellow-Bellied Firefly. However, the four second flash interval suggested these could be Little Grey Fireflies (*Photinus marginellus*). While Little Grey Fireflies have pale grey wing covers in the southern part of its range, they have darker wing covers in the Mid-Atlantic region making them a close match with Yellow-Bellied Fireflies. Had we found a mating pair, identification would have been easy because Little Grey females have normal wings and can fly.

Flying later in the evening and higher in the tree canopy, small numbers of fireflies emitted short yellow flashes every four seconds. Capture revealed a *Photinus* firefly with a black belly without mottling and black wing covers (Figure 6). The combination of color, flash pattern, and behavior (higher flight during full darkness) identified these fireflies as the Ignited Firefly (*Photinus ignitus*).

Figure 6. Ignited Firefly (*Photinus ignitus*)

Another late evening firefly observed in full darkness exhibited exciting quick double flashes every six to eight seconds along the east causeway a few feet above cattails. Capture yielded a small firefly with a black scutellum (small plate behind the headshield) and black belly including the entire fifth segment (Figure 7). These features suggested identification as a Double Cousin Firefly (*Photinus consanguineous*). However, the pale wing covers were unusual.

Figure 7. Double Cousin (*Photinus consanguineous*)

In addition to the several species of *Photinus* described above, members of the genus *Photuris* were active throughout much of the season and were caught during the June 7th and July 19th surveys (Figure 8). *Photuris* were easily identified based on their distinctly long legs and hunched posture. Further, among Pennsylvania fireflies, only *Photuris* have diagonal yellow stripes across the wing covers (although not all *Photuris* species have this feature).

The many species of *Photuris* that inhabit Pennsylvania are difficult to distinguish by appearance. Precise documentation of flash patterns is essential for species level identification, and microscopic examination of genitalia or DNA analysis is sometimes needed. Our specimens were caught later in the evenings in full darkness at or above eye level with single green flashes about every four seconds. Unfortunately, this generic flash pattern did not provide an unambiguous identification at the species level.

Figure 8. *Photuris* (unknown species)

DISCUSSION AND FUTURE DIRECTIONS

Over the course of surveys spanning April through August, eight varieties of fireflies were documented at the Great Marsh based on flash pattern and morphology. All three genera of flashing North American fireflies were observed, *viz.*, *Pyractomena*, *Photinus*, and *Photuris*. June 21st sported a show of outstanding firefly abundance. The large numbers and species diversity of fireflies confirmed the hypothesis that the Great Marsh is an important refuge for multiple firefly species and a site well-suited for further firefly studies and public education.

Might *even more* species make the Great Marsh home? The teams certainly saw fireflies with unique flash patterns that they were unable to catch and photograph. In some cases, fireflies of interest were out of reach high in trees or over the marsh. In other cases (particularly on June 21st) the shear abundance of fireflies frustrated our ability to track individual fireflies.

It is likely that several *Photuris* species contributed to the impressive flash displays observed in June. For example, fireflies with quick triple flashes at five second intervals were observed at tree level, and these were likely *Photuris versicolor*. Other tree-level fireflies emitted quick flashes every second like the strobe lights of tiny aircraft; these may have been *Photuris hebes*. Yet other *Photuris* species may have produced the long, eerie flashes observed drifting over the marsh.

Also, while the Great Marsh is within the geographic range of six species of marsh loving *Pyractomena*, we documented only one, *viz.*, *Pyractomena dispersa*. The presence of other *Pyractomena* species seems likely. The nighttime surveys may have begun too late in May for early season *Pyractomena borealis*. Conversely, could the mysterious yellow-orange flashes observed closing out the August 9th survey have been a late season *Pyractomena*?

Thus, despite the success of the 2025 surveys, exciting discoveries await future firefly hunters at the Great Marsh. Surveys earlier in the season or later into the night would likely reveal additional species. Canoes could be used to explore Marsh Creek and areas of marsh and ponds that were previously out-of-reach, and it would be interesting to explore the mature forest habitat contiguous with the Templin Woods Preserve. Trail cameras or other technology might provide the means for more extensive and continuous monitoring.

Agricultural, commercial, and residential land practices have placed pressure on wildlife including insects. The IUCN conservation status of the observed species is provided in Appendix III. The six *Photinus* species are of "least concern" while *Pyractomena dispersa* is considered "data deficient" with a declining population. Loss and fragmentation of wetlands is a threat to *Pyractomena dispersa*. Because courtship of this species occurs well after sunset, light pollution is another threat. Meanwhile the small range of *Photinus scintillans* is a notable risk that may reflect loss of female flight. Our survey results were entered into the Firefly Atlas[3] and will contribute to the efforts of the IUCN and The Xerces Society to track firefly populations. These surveys, together with future surveys at the Great Marsh, will help assess firefly populations over time.

Fireflies have been described as "charismatic" insects that open our eyes to the wonders of the natural world. The groundswell of interest in fireflies globally is helping to enliven environmental consciousness. A public that cares about fireflies is a public that is receptive to reducing light pollution and pesticide use, "leaving-the-leaves", planting native, and protecting watersheds. The 2025 surveys identify the Great Marsh as an ideal site for public education about these beloved insects.

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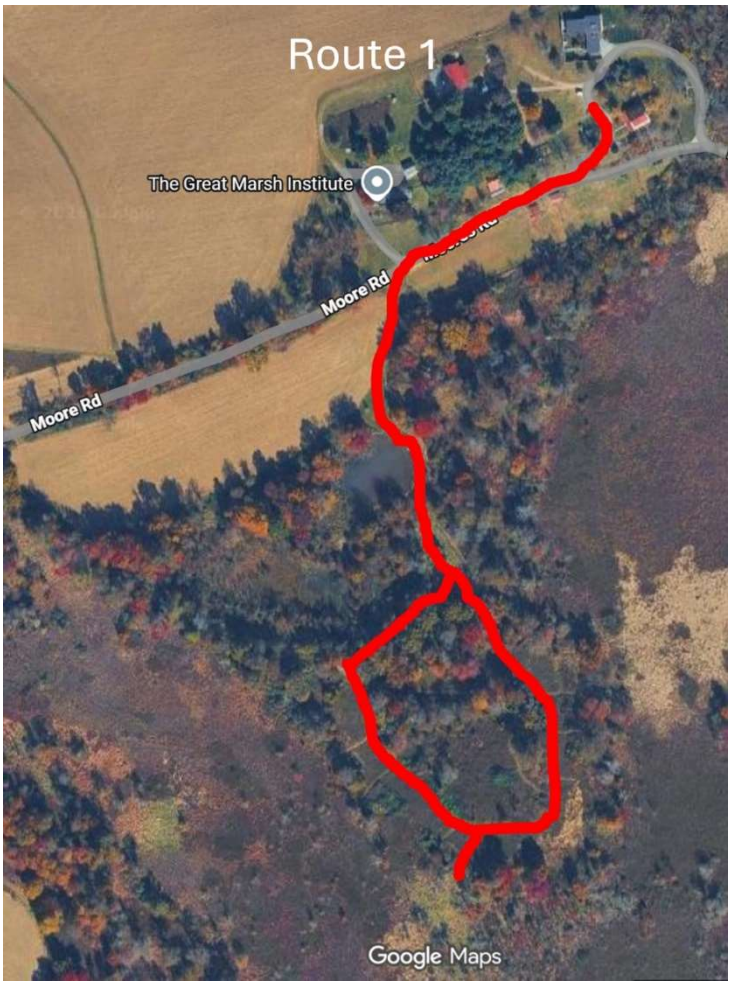
APPENDIX I: DESCRIPTION OF ROUTES AND CONDITIONS

The Great Marsh is the largest remaining periglacial marsh in SE Pennsylvania. Part of the land was once drained for use as a dairy farm. After 1950 these lands were allowed to revert to marshland, although two ponds were dug, *viz.*, bass pond and catfish pond, and berms were built that later served as walking trails. Currently, the area includes marshes with cattails, ponds with spatterdock, swamp with black willow, wet meadows with native perennials, mowed grassy paths, and higher ground with red maple, black cherry, spicebush, and oak. There are also a couple of crop fields and a sheep pasture.

While the land is managed for conservation, a few human interventions can be noted. All meadows are mowed at least once per year. A small plot of land east of Route 401 was logged about 12 years ago. Adjacent crop fields are presumably treated with herbicides and insecticides.

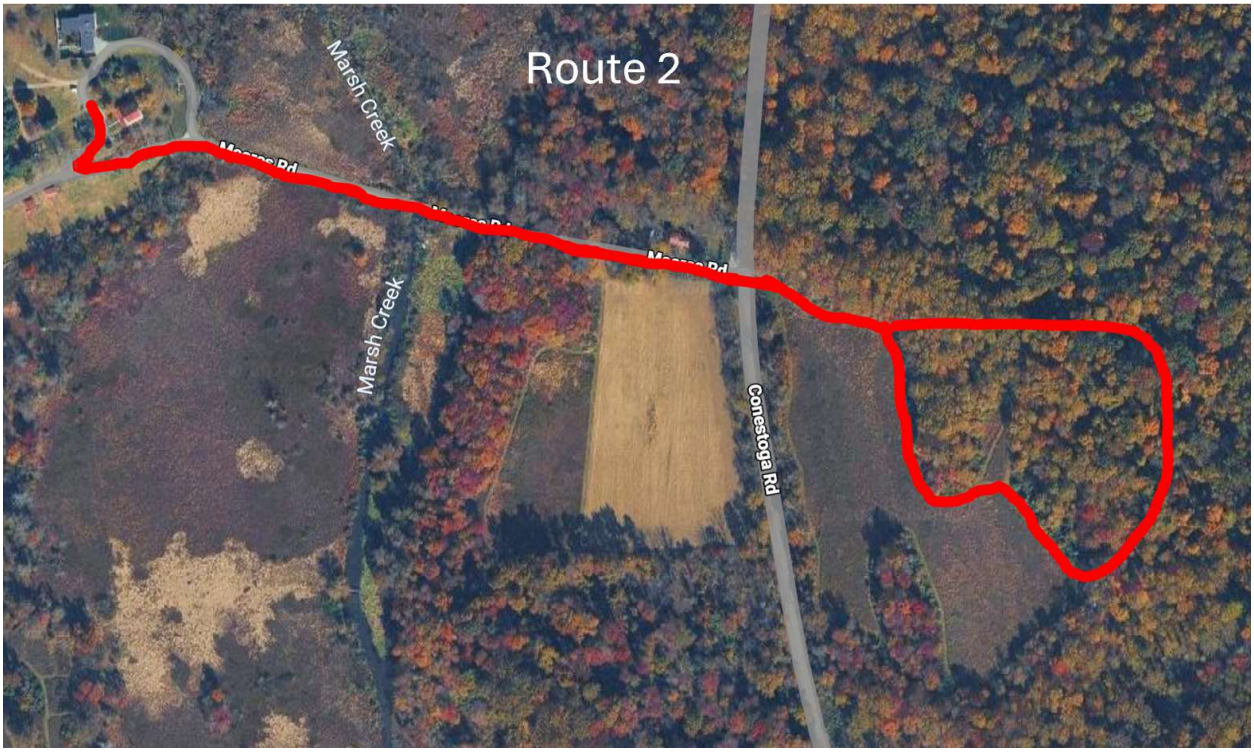
Light pollution is minimal. There is a minor amount of regional sky glow and some nominal light trespass escapes the residence and associated buildings on Moores Road. The closest severe light pollution is the Peter J Camiel Travel Plaza on the Pennsylvania turnpike.

Teams performed surveys by walking one of three routes.



Route 1: Beginning at the parking area, route 1 took Moores Road WSW past a sheep pasture on the left after which the route turned south onto a mown walking path along the east side of a soybean field and Bass Pond. The path continued past a wet meadow and woods until it opened again into meadow and reached a duck blind that overlooked a spacious wet meadow extending about a quarter mile to the turnpike and the Peter J Camiel Travel Plaza. Route 1 continued in a loop through a small, wooded area and rejoined the path from the Bass Pond to the parking area.

Route 2: From the parking area, route 2 headed ESE along Moores Road past a large cattail marsh followed by Marsh Creek, a line of shrubs and trees and an agricultural field prior to crossing Route 401/Conestoga Road. The route continued about 150 yards into a mature forested area contiguous with the Templin Woods Preserve before looping back west along the edge of a cleared meadow and retracing the route along Moores Road.



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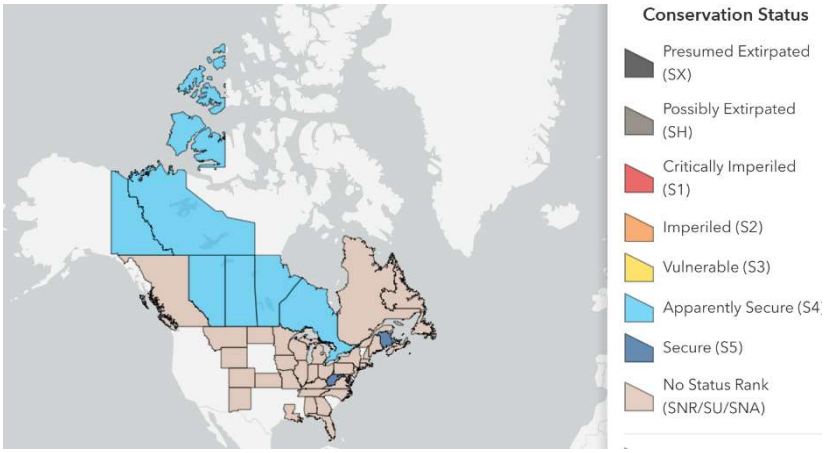
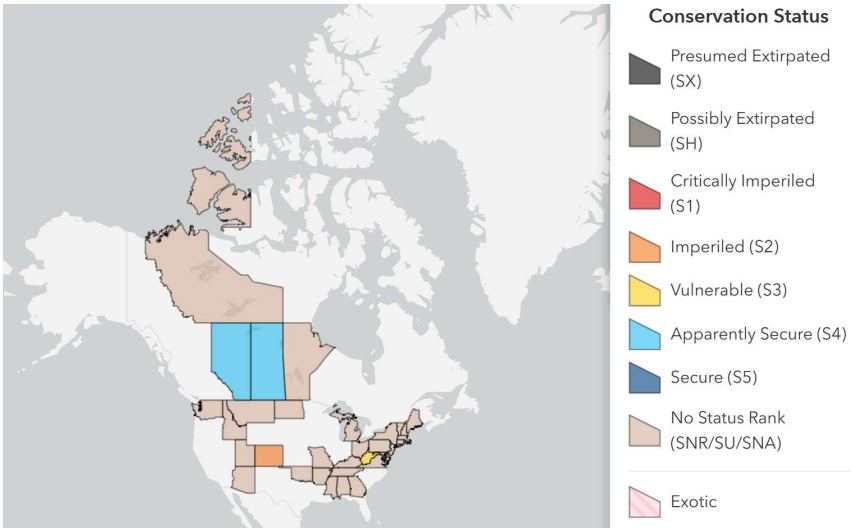
Route 3: From the parking area, route 3 headed NW to a trail running ENE along an agricultural field on the left and a wooded area on the right. The trail crossed Marsh Creek and turned NNW on a raised path along Catfish Pond, a large area of marshy open water home to spatterdock and cattails. A wooden pier extends about 20 feet over open water offering a good view of the shoreline and any activity over the water. Route 3 continued NNW before bending west over Marsh Creek and through marshy woodland until turning SE between a tree line and a meadow.

APPENDIX II: RANGES OF FIREFLIES (FROM SEARCH RESULTS | NATURESERVE EXPLORER)

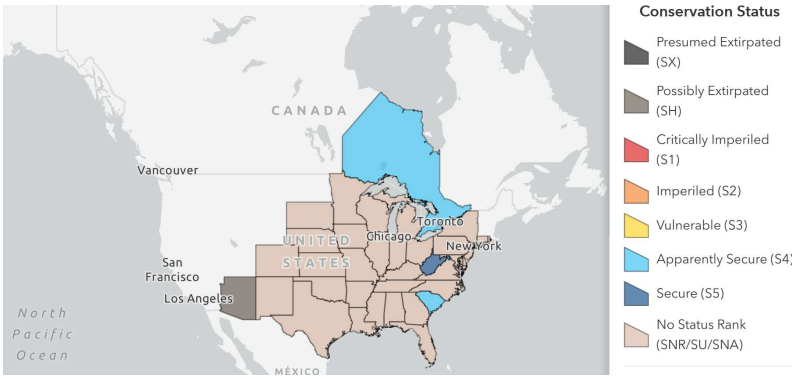
Photinus corruscus



Pyractomena dispersa



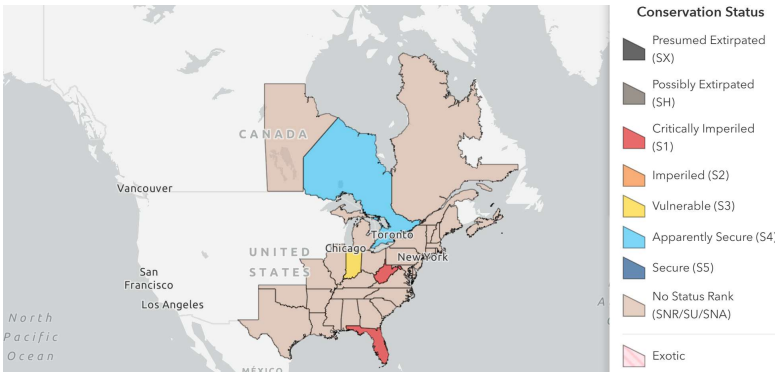
Photinus pyralis



Photinus scintillans

Photinus marginellis

Photinus consanguineous



Photinus ignites

APPENDIX III: IUCN STATUS OF OBSERVED SPECIES

	Conservation status[1]	Preferred habitat[1]	Size of Range[2] million km[2]	Population trend[1]
Photinus consanguineous/Double Cousin	Least Concern	Forrest/Shrub	4	Unknown
Photinus ignites/Ignited Firefly	Least Concern	Grassland	>2.5	Unknown
Photinus marginellis/Little Grey	Least Concern	Forest/Shrub	2.5	Unknown
Photinus scintillans/Yellow Bellied Firefly	Least Concern	Grassland	0.15	Unknown
Photinus pyralis/Big Dipper	Least Concern	generalist	>2.5	Unknown
Pyractomena dispersa/Marsh Flicker	Data Deficient	inland wetlands	7	Decreasing
Photinus corruscus/Winter Firefly	Least Concern	Forest/Grass	15	Unknown

[1]https://www.iucnredlist.org/search?searchType=species

[2]https://explorer.natureserve.org/Search