Species Status Assessment

Common Name: Synchronous Firefly **Date Updated:** 2024-09-30

Scientific Name: Photinus carolinus **Updated by:** Katie Hietala-Henschell

Class: Insecta

Family: Lampyridae

Species Synopsis

(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):

Photinus carolinus, also known as the Synchronous Firefly, is a habitat specialist of mature deciduous forests and typically occurs near streams. This species is one of two currently known synchronous firefly species in North America. It is known from the Appalachian and Allegheny mountains in the eastern U.S. and most famously from the Great Smoky Mountains. It was suspected to occur in other areas and its presence was confirmed further north in the Allegheny National Forest in Pennsylvania in 2012 (Faust et al. 2012). This species is known from western New York, primarily from Allegany State Park and has been consistently observed over the last 10 years (Wellman 2023). Additional isolated populations are probable in New York, likely occurring in suitable mature forest habitat, likely into the finger lakes region.

Across its range, this species has been assessed as having a stable population trend (Walker and Faust 2021). However, it is a habitat specialist and appears to be restricted to the western part of the state. It may occur in lower numbers in marginal habitats like roadsides and other damp areas (Lloyd 2018). Allegany Park staff continues to host annual evening firefly programs, while there is year-to-year fluctuation, and populations have appeared relatively stable over the last decade (Wellman 2023). In New York, this species is typically active from mid-June through early to mid-July (Faust 2017, Wellman 2023).

In 2021, the International Union for Conservation of Nature (IUCN) Red List conducted baseline conservation assessments for nearly 80% of described firefly species in the United States and Canada. The IUCN Red List found approximately 14% of fireflies are threatened with extinction and more than half of the species (53%) could not be evaluated due to lack of data (Fallon et al. 2021). Future firefly work including monitoring and protecting populations of at-risk species, preserving, and restoring habitat, and gathering data to fill critical information gaps (e.g., population trends) for species suspected to be rare or at risk, like *P. carolinus*, will help inform conservation efforts.

I. Status

a. Current legal protected Status

i. **Federal:** Not listed **Candidate:** No

ii. **New York:** Unprotected

b. Natural Heritage Program

i. **Global:** G4

ii. **New York:** SNR **Tracked by NYNHP?:** No

Other Ranks:

-New York 2025 SGCN status: Species of Greatest Conservation Need
-COSEWIC: Not listed in Canada
-IUCN Red List: Least Concern
-Northeast Regional SGCN: Proposed RSGCN

Status Discussion:

Photinus carolinus is a habitat specialist of mature forests with open understories, and populations are often isolated from one another. It has been assessed by the IUCN Red List Firefly Specialist Group as having a stable population trend (Walker and Faust 2021). However, in New York, this species appears to be restricted to the western part of the state and is currently documented from a single county. West Virginia is the only state with a state conservation rank and *P. carolinus* has been assessed as Vulnerable (S3) (NatureServe 2023). This species can be locally abundant within suitable habitat.

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status or S-Rank	SGCN?
North America	Yes	Unknown	Unknown	Unknown		
Northeastern US	Yes	Unknown	Unknown	Unknown		Proposed RSGCN
New York	Yes	Unknown	Unknown	Unknown		No
Connecticut	No	-	-	-		
Massachusetts	No	-	-	-		
New Jersey	No	-	-	-		
Pennsylvania	Yes	Unknown	Unknown	Unknown	SNR	No
Vermont	No	-	-	-		
Ontario	No	-	-	-		
Quebec	No	-	-	-		

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York

(specify any monitoring activities or regular surveys that are conducted in New York):

The Dark Skies for Fireflies project (2023-2025), a partnership between New York Natural Heritage Program (NYNHP) and the Office of Parks, Recreation, and Historic Preservation (OPRHP), is an effort to survey fireflies in New York State Parks; however, there are no systematic monitoring efforts directed toward this species.

Trends Discussion

(insert map of North American/regional distribution and status):

Photinus carolinus occupies temperate mountain river valley habitat and prefers openings surrounded by rich deciduous forest often near streams or rivers (Faust 2017). Genetic work completed by Faust et al. (2012) determined that *P. carolinus* occurs in isolated populations in the Appalachian Mountains of north Georgia, Tennessee, North Carolina, West Virginia, and Virginia to the forests in the Allegheny Mountains in western Pennsylvania and New York. This species is typically found at higher elevations in the southern part of its range (from 670 to 915 meters) and can be found in suitable habitat at lower elevations (from 300-365 meters) in the northern part of its range (Faust et al. 2019). Fireflies, like *P. carolinus*, that are restricted to specialized habitats tend to be more likely to be threatened by some level of extinction and should be included as SGCN (Fallon et al. 2021).

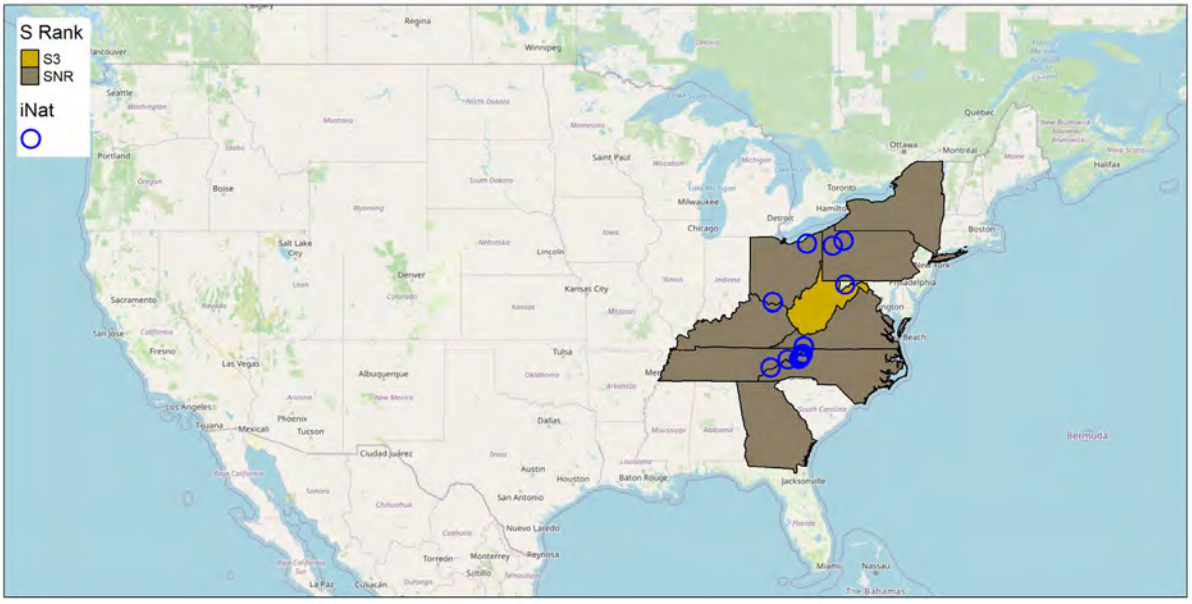

Figure 1: *Photinus carolinus* North American distribution. Points show research-grade iNaturalist observations (iNaturalist 2023, NatureServe 2023).

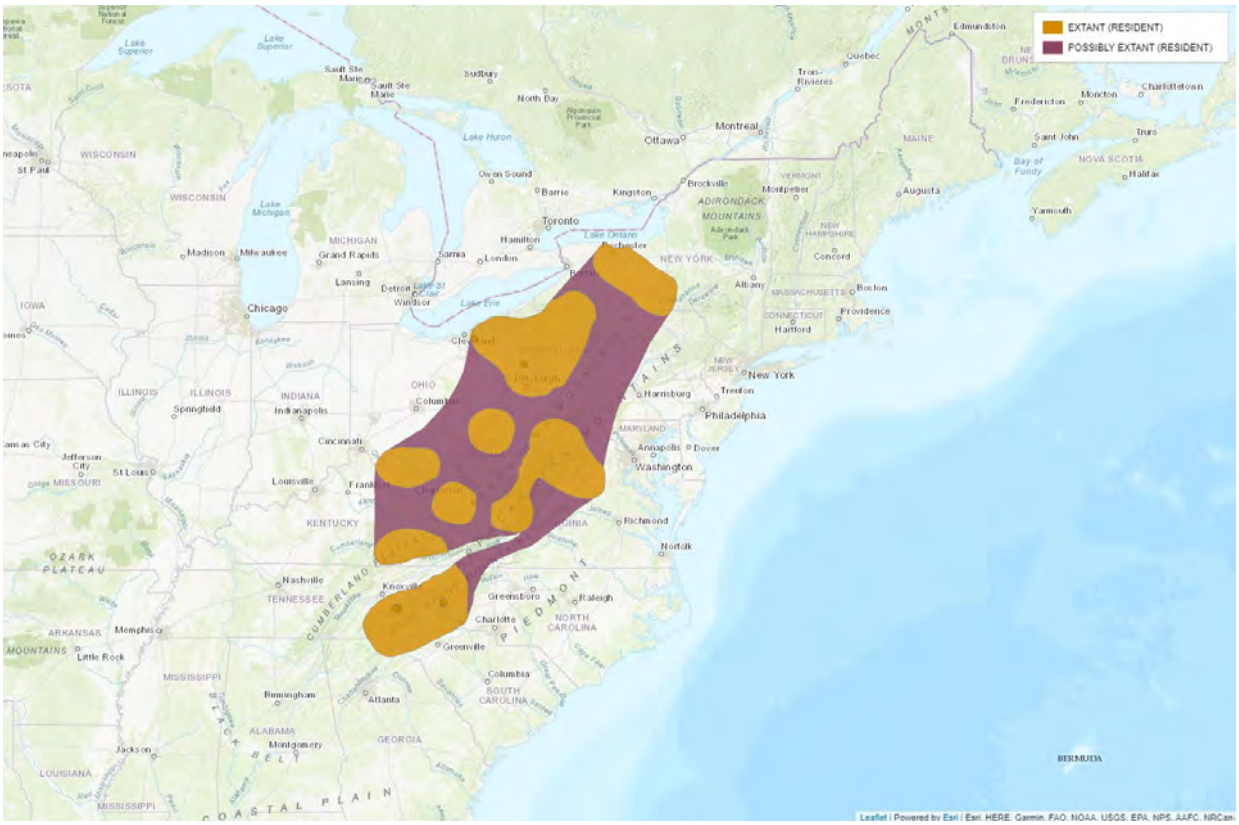

Figure 2: IUCN Red List map of *Photinus carolinus* North American distribution (Walker and Faust 2021).

Figure 3: *Photinus carolinus* regional distribution as reported at https://northeastwildlifediversity.org/rsgcn .

III. New York Rarity

(provide map, numbers, and percent of state occupied)

Currently, there are no records of *P. carolinus* in NYNHP element occurrence database. Recent records have documented *P. carolinus* in Cattaraugus County throughout Allegany State Park. This species has been observed occupying at least 14 sites within the park (Wellman 2023). Available records suggest that this species occurs in less than 2% of New York. Faust et al. (2012) speculates additional isolated populations could occur as far north as Ithaca and Buffalo in New York.

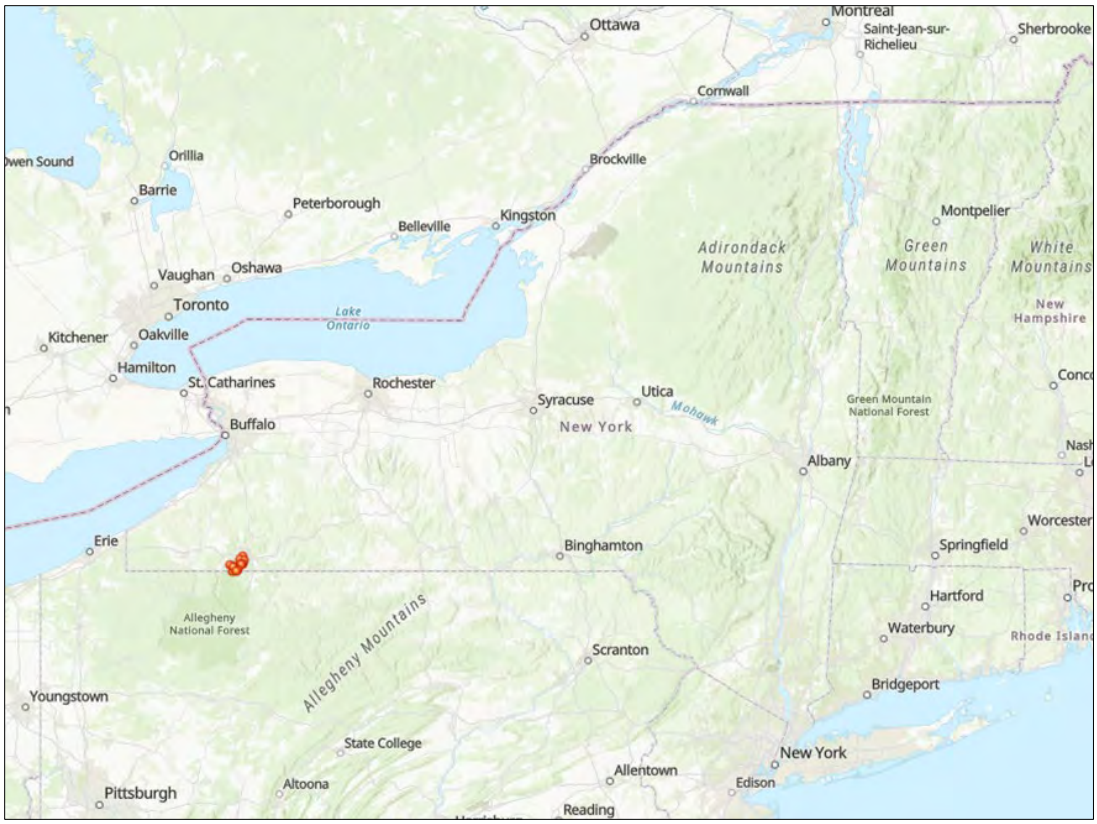

Figure 4: NYS distribution for *Photinus carolinus* based on unpublished records from Wellman 2023 (NYNHP 2024).

Table 1. Number of observations of *Photinus carolinus* grouped by the dates known to be extant (repeat observations (element occurrences) include the years spanning first observation to last observation) and the number and percent of total of counties these observations fall within for New York State.

Years	# of records	# of Counties	% of counties in State
Pre-1999	NA	NA	NA
2000-present	14	1	1.6

Details of historic and current occurrence:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
26-50%	Peripheral	

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%' 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type

(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):

NatureServe (2023): Woodland – Hardwood, Woodland- Mixed, Forest – mixed, Forest – Conifer, Woodland – Conifer, Forest – Hardwood, Subterrestrial

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/ Increase
Yes	Unknown	Unknown	Unknown

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing: Unknown; (blank) or Choose an item

Habitat Discussion:

IUCN Red List (Walker and Faust 2021):

Photinus carolinus is found in mature second growth hardwood forests in temperate mountain river valleys (Faust 2010). Mating displays take place in open woodland areas, usually within 100 metres of streams or rivers (Faust 2010). Individuals have been found from 430 to 1,830 metres, although the highest densities are found from 670 to 915 metres (Faust 2017). In northern latitudes, such as in Pennsylvania and New York, this species can be found at lower elevations, from 300-365 metres, in slightly drier forest habitats (Faust et al. 2019).

V. Species Demographics and Life History

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	Yes	No	Yes	Yes	No

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion

(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):

IUCN Red List (Walker and Faust 2021):

The display flashes of this firefly are typically emitted in near synchrony, with thousands of males flashing and then going dark simultaneously (Faust 2010). Mating displays generally take place from late May to early July, peaking around mid-June (Faust 2010). Flash trains of 4-8 flashes at intervals of half a second, are followed by 6-9 seconds of darkness, depending on temperature (Faust 2010). Flash activity typically begins 37-43 minutes after sunset (Lloyd 1966) and lasts up to three hours (Faust 2010).

Females respond with a double flash, which often becomes a single flash as a male approaches closer (Faust 2010). Adult males have been observed guarding pupal females for up to 6 days before eclosion (Faust 2010). Captive females lay an average of 24 eggs, sometimes singly, but often in a mass just before death (Faust 2010). Typically, *Photinus* larvae are suspected to be subterranean, likely feeding on earthworms and other soft bodied invertebrates at or below the soil surface (Buschman and Faust 2014).

Harvestmen (Phalangiidae) and Orb-weaver (Araneidae) spiders have been observed preying on this species. Additionally, predatory *Photuris* fireflies have been observed eating *P. carolinus* in captivity, and while they are present during the flight season of *P. carolinus*, they have yet to be observed feeding on *P. carolinus* in the wild (Faust 2010).

VI. Threats

Threat Level 1	Threat Level 2	Threat Level 3	Spatial Extent*	Severity*	Immediacy*	Trend	Certainty
6. Human Intrusions & Disturbance	6.1 Recreational Activities	6.1.8 Wildlife observation/photography	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.
7. Natural System Modifications	7.3 Other Ecosystem Modifications	Choose an item. (habitat loss/degradation)	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.
9. Pollution	9.3 Agricultural & Forestry Effluents	9.3.1 Nutrient loads	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.
9. Pollution	9.3 Agricultural & Forestry Effluents	9.3.3 Herbicides & pesticides (runoff)	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.
9. Pollution	9.6 Excess Energy	9.6.1 Light pollution	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.
11. Climate Change	11.1 Habitat Shifting & Alteration	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.
11. Climate Change	11.4 Changes in Precipitation & Hydrological Regimes	11.4.2 Droughts	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.

Table 2. Threats to *Photinus carolinus.*

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes:	No:	✓	Unknown:

If yes, describe mechanism and whether adequate to protect species/habitat:

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

Threats to *Photinus carolinus* include light pollution, soil and air pollution, pesticides, habitat fragmentation and destruction, climate change, and overtourism (Faust et al. 2012, Lewis et al. 2024). Minimizing these key threats are needed to conserve at-risk firefly species. In addition, Reed et al. (2020) found that fireflies have numerous risk factors that can contribute and make them more susceptible to various threats, including specialized diets, poor dispersal abilities, and unique mating signals and behaviors.

Artificial lights can impair communication resulting in reduced courtship and mating (Faust et al. 2012). *Photinus carolinus* thrives in mature second growth forests with open understory, while younger forests with dense underbrush make it difficult for males of this species to synchronize (Faust et al. 2012). Even low levels of light pollution can reduce reproductive success (Owens et al. 2022). Light pollution can be managed by turning off unnecessary lights and planting hedgerows or trees around occupied sites to block trespassing light. Pesticide exposure can reduce fitness and cause mortality, especially in the long-lived, ground-dwelling larval life stage. Runoff or direct exposure of insecticides, herbicides, and fertilizers may degrade firefly habitat and can have lethal and sublethal effects on fireflies (Lewis et al. 2024). Sublethal effects can include changes in the midgut, body convulsions, persistent glow, and other physiological changes (Wang et al. 2022). Indirect effects include contaminating and reducing available prey.

Habitat loss and degradation is another leading threat to firefly populations. While some fireflies are generalists, like the common *Photinus pyralis* (Big Dipper Firefly), others are habitat specialists and are restricted to specific conditions. Once unique habitats – such as wetlands and mature forests – are lost, fireflies may experience direct mortality or may be unable to recolonize an area that has been converted or developed. Climate Change can result in more droughts, wildfires, floods, sea-level rise, etc. all of which can potentially negatively impact fireflies in all life stages. Maintaining the natural hydrology of a site will benefit firefly populations. Overtourism can lead to development and trampling. Globally synchronizing fireflies (e.g., *P. carolinus*) face the greatest risk from overtourism. Their impressive light shows bring crowds that may increase onsite light pollution or trample individuals and habitat (Lewis et al. 2024). While programing and education/outreach surrounding these species can increase insect conservation and awareness, care should be taken at known sites to limit access areas and light use during breeding.

Additional conservation actions to support at-risk firefly populations include reducing light pollution that spills into parks or other sensitive areas, eliminate the use of broad-spectrum insecticides, modify mosquito control programs to minimize risk to fireflies, and protect wetland and riparian habitat from recreational activities (Lewis et al. 2024).

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Action Category	Action	Description
A.1 Direct Habitat Management	A.1.0.0.0 Direct Habitat Management	Site/Area management
A.2 Direct Species Management	A.2.0.0.0 Direct Species Management	Invasive/problematic species control
B.3 Outreach	B.3.1.0.0 Outreach, communication, and distribution	Awareness & Communications
C.6 Design and Plan Conservation	C.6.0.0.0 Design and plan conservation.	Site/Area protection
C.6 Design and Plan Conservation	C.6.0.0.0 Design and plan conservation.	Resource/Habitat protection
C.6 Design and Plan Conservation	C.6.5.1.3 Develop a conservation, management, or restoration plan for protected private lands	Habitat and natural process restoration
C.7 Legislative and Regulatory Framework or Tools	C.7.1.3.0 Create, amend, or influence regulation	Regulations
C.7 Legislative and Regulatory Framework or Tools	C.7.2.1.0 Create or amend policies	Policies
C.9 Education and Training	C.9.2.0.0 Training and individual skill development	Training

Table 3. Recommended conservation actions for *Photinus carolinus*.

VII. References

This SSA drew heavily from these resources:

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