

Journal of Lost Species

Extinguished or overlooked? An examination of lost firefly species of the US and Canada

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Abstract: Fireflies (Coleoptera: Lampyridae) are iconic indicators of ecosystem health, yet a significant number of North American species face an uncertain future due to increasing threats from habitat loss, light pollution, climate change, and pesticide use. While the most recent assessments have shed light on the conservation status of some US and Canadian species, a considerable knowledge gap remains for 69 species that are categorized as Data Deficient and a further 48 species that have yet to be evaluated. A number of these have not been reported in many years. This paper investigates 28 firefly species native to the United States and Canada to which we assign the status of ‘lost.’ Herein, we define ‘lost species’ as those with no confirmed observation record within the past decade. Our findings suggest that the lack of recent records is likely due to several factors, including insufficient survey efforts, inadequate identification keys, complex taxonomy, difficulty accessing collections to examine unpublished specimen holdings, and population declines due to environmental stressors. This study underscores an urgent need for targeted field surveys, taxonomic revisions, and updated species keys, as well as expert review and digitization of existing collections; increased funding to support each of these efforts is particularly critical. Furthermore, our findings raise concerns about potential extirpations or even extinctions of some species. In this review, we highlight critical information gaps and rediscovery strategies, profile twelve species that have been successfully rediscovered, and put forward a call to action for researchers, land managers, community scientists, and the broader public to help contribute to the understanding and preservation of a lost and imperiled firefly fauna.

Keywords: Lampyridae, firefly conservation, North America, community science

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Conservation statement: Lost firefly species (those not reported in the last ten or more years) represent 16% of the described native firefly fauna of the United States and Canada. These species may be declining, extirpated, extinct, taxonomically complex, or overlooked due to limited survey effort or difficulties in species identification. In this review, we aim to make the list of lost firefly species publicly available, summarize what is known about these species and recent search efforts, and prompt new efforts to locate them. In particular, targeted surveys and more comprehensive taxonomic work are needed, coupled with life history studies if these species are rediscovered. These actions can help inform extinction risk assessments and prioritize conservation efforts for fireflies.

Resumen: Las luciérnagas (Coleoptera: Lampyridae) son indicadores emblemáticos de la salud de los ecosistemas; sin embargo, varias especies de América del Norte enfrentan un futuro incierto debido a las crecientes amenazas que representan la pérdida de hábitat, la contaminación lumínica, el cambio climático y el uso de pesticidas. Si bien las evaluaciones más recientes han arrojado luz sobre el estado de conservación de algunas especies de Estados Unidos y Canadá, sigue existiendo una laguna de conocimiento respecto a 69 especies en la categoría de Datos Insuficientes y otras 48 especies que aún no han sido evaluadas. Varias de ellas no han sido reportadas en muchos años. Este artículo investiga 28 especies de luciérnagas nativas de Estados Unidos y Canadá a las que asignamos el estado de «perdidas». En este trabajo, definimos «especies perdidas» como aquellas sin registros de observación confirmados en la última década. Nuestros hallazgos sugieren que la falta de registros recientes se debe probablemente a varios factores, entre ellos esfuerzos de muestreo insuficientes, claves de identificación inadecuadas, una taxonomía compleja, la dificultad para acceder a colecciones para examinar especímenes no publicados y la disminución de las poblaciones debido a la degradación del medio ambiente. Este estudio subraya la necesidad urgente de realizar estudios de campo específicos, revisiones taxonómicas y claves de identificación actualizadas, así como la revisión por expertos y la digitalización de las colecciones existentes; es particularmente crítico aumentar el financiamiento para apoyar cada uno de estos esfuerzos. Además, nuestros hallazgos suscitan preocupación por posibles extirpaciones o incluso extinciones de algunas especies. En esta artículo, destacamos las lagunas críticas de información y las estrategias de redescubrimiento, presentamos perfiles de doce especies que han sido redescubiertas con éxito y hacemos un llamado a la acción dirigido a investigadores, gestores de tierras, científicos comunitarios y el público en general para que contribuyan a la comprensión y preservación de una fauna de luciérnagas perdidas y en peligro.

Palabras clave: Lampyridae, conservación de luciérnagas, Norteamérica, ciencia ciudadana

Declaración de conservación: Las especies de luciérnagas «perdidas» (aquellas sin registros en los últimos diez años o más) representan el 16 % de la fauna nativa de luciérnagas descrita en Estados Unidos y Canadá. Estas especies pueden estar en declive, extirpadas, extintas, presentar complejidad taxonómica o haber sido pasadas por alto debido a un esfuerzo de búsqueda limitado o a dificultades en la determinación de ejemplares. En este artículo de revisión, nuestro objetivo es poner a disposición del público la lista de especies de luciérnagas perdidas, resumir lo que se sabe sobre estas especies y los esfuerzos de búsqueda recientes, e impulsar nuevas iniciativas para localizarlas. En particular, se necesitan estudios específicos y trabajos taxonómicos más exhaustivos, junto con estudios sobre el ciclo de vida en caso de que estas especies sean redescubiertas. Estas acciones pueden ayudar a fundamentar las evaluaciones de riesgo de extinción y a priorizar los esfuerzos de conservación de las luciérnagas.

INTRODUCTION

Fireflies (Coleoptera: Lampyridae) are charismatic beetles that serve important ecological roles and can act as indicators of habitat quality, yet they remain understudied beyond

their bioluminescent mating behavior. Anecdotal reports and a small number of monitoring programs (e.g., Gardiner and Didham 2020) suggest global declines, but population trends in the US and Canada are largely unknown (Fallon et al. 2021). International Union

for Conservation of Nature (IUCN) Red List assessments published in 2021 revealed that 18 taxa (16 species and two subspecies) of the US and Canada are threatened with extinction and over half of assessed species are Data Deficient (Fallon et al. 2021); some of these have not been documented for a decade or longer. The conservation status of 48 species remains unevaluated (The Xerces Society for Invertebrate Conservation [hereafter, Xerces Society] 2026), and a number of these species have similarly not been recorded in recent years.

Fireflies face multiple threats, including habitat loss and degradation, light pollution, pesticide use, and climate change, among others (Lewis et al. 2020). Affected populations can diminish to the point of evading detection, or disappearing altogether. However, species can become lost for other reasons, and the absence of recent records does not necessarily indicate extinction or even high extinction risk. Species may have short adult activity periods (both seasonal and diel), highly specific habitat requirements, cryptic morphology, or complex taxonomy, and they may occur in areas that are difficult to access, particularly at night, or on lands that are privately owned. Limited and uneven survey effort, ambiguous historical locality data, inadequate documentation of species-specific flash dialogue for species identification, and difficulties in detection due to life history traits further contribute to species being classified as lost.

The identification of lost species can be a helpful tool for highlighting knowledge gaps and promoting rediscovery efforts of organisms that have not been found in many decades. Global initiatives like Re:wild's Search for Lost Species (Re:wild 2026a) is one example of this; since their launch, over 20 species have moved onto their "Lost Species Found" list (Re:wild 2026b). In 2024, *Pyrrhopyga similis* Green, 1957 (commonly called the 'similar firefly') was added to Re:wild's Top 25 Most Wanted Lost Species, a list highlighting species "with the greatest potential to drive conservation" (Re:wild 2025). Thanks in part to increased attention

and funding for surveys, the similar firefly was rediscovered in 2026 after a 43-year hiatus in observations (aljn 2026a; CMH pers. obs. 2026). However, there are many more lost species of firefly that deserve attention. Identifying and assessing these species is essential for prioritizing conservation efforts and guiding future surveys. Recent calls to highlight lost species by utilizing certain IUCN Red List designations (like Data Deficient or the Possibly Extinct modifier for the Critically Endangered rank) or the 'last seen date' field (e.g., Martin et al. 2023) could help in this regard, although the high proportion of species evaluated as Data Deficient—particularly in invertebrate taxa—may limit their usefulness.

In this review, we go beyond simple categorizations to present a list of firefly species in the US and Canada lacking confirmed records for the last decade or more, with commentary on their status, ecology, and recommended rediscovery strategies. It is our hope that this paper will inspire renewed efforts to find and document these species.

Natural history

Fireflies are beetles that undergo four life stages: egg, pupa, larva, and adult. Eggs are laid on moist soil, duff, leaf litter, or rotting wood. Larvae, which hatch 2–3 weeks later, are long-lived (up to 2 years or more, depending on the species) and predatory, feeding on invertebrates such as snails, slugs, and worms. Pupation takes place under logs, in tree bark, or in the soil, with adults emerging approximately 3 weeks later and living for 2–4 weeks. Adults are generally non-feeding, although multiple species have been observed visiting flowers (Faust and Faust 2014), and adult females in some species of *Photuris* are predatory mimics that feed on fireflies of other genera (Lloyd 1965). While some species are habitat generalists, many have specific habitat associations. At a minimum, moist, undisturbed habitats, adequate food sources, and, for nocturnal species, dark night skies, is needed by most fireflies.

The egg, larval, and pupal stages of fireflies are bioluminescent. However, the adult stages of some species lack this trait. Fireflies can be categorized by their courtship behavior, with three primary groups occurring in the US and Canada: flashing fireflies, glow-worm fireflies, and daytime dark fireflies. Flashing fireflies, also referred to as lightning bugs, are the most well-recognized group, with males using species-specific flash patterns to court females. Flash patterns can vary depending on air temperature, thus requiring careful observation of this factor when attempting to identify species based on their flash pattern (a common approach for surveyors attempting to differentiate flashing species). Adult female glow-worms are flightless and bioluminescent, deploying long-lasting glows to attract winged males that fly overhead in search of them; males of most of these species do not utilize bioluminescence in courtship. Daytime dark fireflies are diurnal and rely on pheromones to signal to potential mates. These three categories may predict a suite of attributes, including susceptibility to threats, detection probability, and recommended survey methods.

Systematics

All of the lost firefly species presented here are considered taxonomically valid entities by the Lampyridae of the World Database (Keller 2024a), and all but one (*Photuris floridana* Barber, 1951) are recognized as valid by the Integrated Taxonomic Information System (ITIS 2025; Table 1). *Photuris floridana* was returned to species status by Lloyd (2018), a treatment we follow here. Despite this recognition of validity, several groups, including *Photinus* species previously classified as *Ellychnia* and some *Photuris* species, are particularly problematic and may benefit from further taxonomic resolution.

Ongoing phylogenetic work, including several large-scale studies, has begun to resolve some long-standing taxonomic questions while complicating others (e.g., Hodson and Branham 2024; Martin et al. 2017; Martin et al.

2019; Stanger-Hall et al. 2007). For example, current phylogenies may not support existing genus-level classifications (e.g., Martin et al. 2019), suggesting frequent evolutionary convergence, historical mixing of lineages, and unknown genetic mechanisms that can cause ancestral traits to reappear unevenly, thereby creating false diagnostic characters for entomologists (Gibson and Dworkin 2004). These findings highlight the need for expanded genetic sampling combined with detailed morphological analyses and biogeographic studies to clarify evolutionary relationships. This need is especially acute for the poorly understood western fauna, which includes many Data Deficient and potentially undescribed species.

The lost species list includes seven species of diurnal *Photinus*. Historically, most of these “daytime dark” fireflies were in the genus *Ellychnia* but are now synonymized under *Photinus* based on similarities in the genitalia (Zaragoza-Caballero et al. 2020; Zaragoza-Caballero et al. 2023). Molecular studies (e.g., Martin 2020; Stanger-Hall and Lloyd 2015) indicate that while the Pacific Northwest *Ellychnia* appear to be monophyletic, the full complement of nomina in the old genus *Ellychnia* includes disjunct species that are questionable members. However, on a strictly taxonomic basis, all species named into *Ellychnia* need to be included in *Photinus* so that *Photinus* does not appear paraphyletic. Yet the name *Ellychnia* remains a useful distinction for many field biologists. One behavioral difference between the genus *Photinus* as it was assembled before the inclusion of *Ellychnia* species, was that most *Photinus* are crepuscular or nocturnal and utilize bioluminescent courtship signals, while all *Ellychnia* species are day active and lantern-less (hence, “daytime dark”), relying on sex pheromones to find potential mates (Lower et al. 2023). Furthermore, morphological characters (e.g., epipleurae, body texture, and color patterns) indicate key differences between the two groups (Fender 1962).

Within the synonymized genus *Ellychnia sensu stricto*, there is at least one large species

Table 1. Lost firefly species in the US and Canada, with synonyms and taxonomic authority.

Species name	Synonym(s)	Common name	Authority
<i>Brachylampis sanguinicollis</i>		red-collared firefly	Van Dyke, 1939
<i>Nelsonphotus aridus</i>		Nelson's desert firefly	Cicero, 2006
<i>Phausis branhami</i>			Hodson, 2024
<i>Phausis marina</i>		seaside ghost	Fender, 1966
<i>Phausis milleri</i>			Hodson, 2024
<i>Phausis skelleyi</i>		Skelley's ghost	Fender, 1962
<i>Photinus alexanderi</i>	<i>Ellychnia alexanderi</i>	Alexander's firefly	(Fender, 1970)
<i>Photinus arizonensis</i>		Arizona dark firefly	Zaragoza-Caballero, 2017
<i>Photinus autumnalis</i>	<i>Ellychnia autumnalis</i>	autumnal firefly	(Melsheimer, 1846)
<i>Photinus captiosus</i>	<i>Ellychnia captiosa</i>	tricky firefly	(Fender, 1970)
<i>Photinus fenderi</i>	<i>Ellychnia obscurevittatus</i> (Fender, 1962)	obscured firefly	Zaragoza-Caballero, Zurita Garcia & Ramírez- Ponce, 2023
<i>Photinus frosti</i>		Frost's firefly	Green, 1956
<i>Photinus granulicollis</i>	<i>Ellychnia granulicollis</i>	granular-necked firefly	(Fender, 1962)
<i>Photinus immaculatus</i>			Green, 1956
<i>Photinus lacustris</i>	<i>Ellychnia lacustris</i>	lake firefly	(LeConte, 1852)
<i>Photuris aureolucens</i>		golden light firefly	Barber, 1951
<i>Photuris cowaselonensis</i>		Creek-Penn firefly, Cowaselon Creek firefly	Lloyd, 2018
<i>Photuris floridana</i>	<i>Photuris brunnipennis</i> var. <i>floridana</i>	Florida firefly	Barber, 1951
<i>Photuris gentrae</i>			Lloyd, 2018
<i>Photuris patriei</i>		Oklawaha	Lloyd, 2018
<i>Photuris polacecae</i>			Lloyd, 2018
<i>Photuris pyralomima</i>	<i>Photuris pyralomimus</i>	common eastern mimic, pyralis-mimicking firefly	Barber, 1951
<i>Photuris tasunkowitcoi</i>		Crazy Horse firefly	Lloyd, 2018
<i>Photuris whistlerae</i>		Whistler's mother	Lloyd, 2018
<i>Pyractomena barberi</i>		Barber's spring firefly	Green, 1957
<i>Pyractomena floridana</i>		Florida spring firefly	Green, 1957
<i>Pyractomena limbicollis</i>		margin-necked firefly	Green, 1957
<i>Pyractomena vexillaria</i>		amber comet firefly	Gorham, 1881

complex, the winter firefly species complex, that is primarily distributed in eastern North America. This complex includes *Photinus corruscus* (Linnaeus, 1767), *Photinus autumnalis* (Melsheimer, 1846), and *Photinus lacustris* (LeConte, 1852), and remains mostly unresolved, although both J. W. Green and K. M. Fender spent a decade trying to reconcile it (Fender 1970). Western species can be split into more or less recognizable species (Fender 1970), though the encroaching winter firefly spe-

cies complex still results in confusion in some places. Furthermore, while Fender (1970) utilizes differences in pronotal vittae (bands of color on the head shield) to distinguish between western species, he suggests that within a species these characteristics can be quite variable, often overlapping with specimens of other species. Therefore, Fender's figures of aedeagi should be used as co-diagnostic features to confirm a species record for any given locality.

The other main group of lost species with unresolved taxonomy are the Division II *Photuris* (Lloyd 2018), referred to here as the *Photuris versicolor* complex. While the Division I *Photuris* are relatively easy to identify based on morphology alone, species within the *Photuris versicolor* complex are often morphologically indistinguishable. Flash patterns are sometimes unreliable for identification, as these species often have a diverse signal repertoire (Lloyd 2018). Each species has one or more primary flash patterns used to locate mates (most of which are species-specific), but these flash patterns are often obscured by flashes used in other behavioral contexts. Within this complex, females are predatory and mimic the female flash patterns of other firefly species to lure in male prey, while males may mimic their females' prey (Lloyd 1975). Furthermore, females of some species are suspected of mimicking male flash patterns to locate responding female prey while dispersing from natal sites (Heckscher 2014). Given the diversity of possible flash patterns within this group, confusion can then arise when species-specific signals are not observed, or if the observer is not familiar with the species-specific signals and focuses instead on one of the many other flash patterns used by individuals in this group. Although careful observation of male-female flash dialogues is fundamental for accurately describing many *Photuris* species, field studies documenting the various flash patterns are lacking or inadequate for some species, further inhibiting species identification.

Before Barber's (1951) work on *Photuris*, the name *Photuris pensylvanica* [or *pennsylvanica*] was given to most *Photuris versicolor* complex specimens in museum collections (Heckscher et al. 2022). Subsequently, Barber (1951), McDermott (1967), Lloyd (2018), and others (e.g., Buschman 2017; Faust 2017; Heckscher 2023; Heckscher and Branham 2024) worked to resolve taxonomic relationships within this species complex by carefully examining behaviors, habitats, and primary flash patterns. Lloyd's (2018) work resulted in the description

of 34 new species in the *Photuris versicolor* complex, many of which may have formerly been referred to as *P. pensylvanica*. Each of these 34 species descriptions are currently recognized as valid based on the latest scientific publications and consensus available. In practice, however, application of these descriptions can be difficult, given the flash diversity discussed above and the lack of comprehensive taxonomic (e.g., dichotomous) keys for this group. Additional field studies and reference collections will be critical for improving our understanding of the *Photuris versicolor* complex and updating keys for species identification. Collecting specimens for genetic analyses may also be helpful for clarifying *Photuris* taxonomy and systematics in the future. However, many *Photuris* have likely experienced recent speciation, possibly since the last glacial maxima, being primarily distinguished by their courtship signals (a reproductive isolating mechanism) rather than morphological divergence. Therefore, absent a full phylogenetic analysis, it is likely that traditional COI barcoding will prove to be an insufficient means for species identification as demonstrated in other recently diverged Coleoptera (cf, Freitag et al. 2021; Hendrich et al. 2010; Meyer and Paulay 2005).

Geography

Lost firefly species presented in this paper are distributed across the continental United States into southern Canada and northern Mexico (Figs. 1–8). Florida has the highest number (seven) of lost species, where overall firefly species richness is highest (Fallon et al. 2022). Five lost species occur in Wisconsin. California, Texas, and New York each have four lost species. Twenty-eight additional states and five Canadian provinces and territories are known or suspected to have one to three lost species.

There is a connection between known occurrences of some of the lost species and geographic survey effort bias. *Photinus autumnalis*, for example, appears to be clustered near human population centers in the northeast and

Great Lakes region; this is very likely reflective of survey effort rather than firefly distribution. Similarly, survey accessibility makes occurrences appear to be more frequent on public land. Nearly all of the occurrences known in Texas, such as for *Photuris gentrae* Lloyd, 2018 and *Photuris polacekae* Lloyd, 2018, are surrounded on all sides for hundreds of miles by privately-managed land. These species may be fairly widespread and/or common but private ownership may make detection more difficult.

However, nine of the 28 lost species are associated with the relatively low diversity regions west of the Rocky Mountains. Because the West is home to a greater proportion of non-flashing species, the association of this region with “lost” species may be a result of lower frequency of detection, instead of low abundance. Additionally, in the western United States, all lost firefly species with distributions outside of the coastal zone are associated with elevation and are restricted to mountainous regions. For example, records of *Photinus alexanderi* (Fender, 1970) are confined to mountain ranges surrounding the Colorado Plateau in Utah, Colorado, Arizona, and New Mexico. Unlike northeastern species, where patchy apparent distributions may reflect patterns of human population density or popular recreation areas, or species in Texas and the Southeast that may be infrequently detected due to limited land access, some of the patchiness observed in the arid West may also reflect ecological suitability. Consequently, search strategies for lost fireflies must be adapted to regional context, reflecting differences in geography, ecology, and land management.

STATUS

For a species to qualify as lost, we use the definition proposed by Long and Rodríguez (2022) and utilized by this journal, whereby a species (represented by a single individual or more) has not been observed in the wild for over 10 years (in our case, since 2015). While some authors

exclude species for which extensive dedicated search effort has occurred (e.g., Lindken et al. 2024), we did not, largely because search efforts for lost firefly species have been sparse or uneven to date.

For this study, we began with a list of lost species we had initially compiled for Re:wild’s master list in January 2024. That list was created based on the results of 132 IUCN Red List assessments published in 2020 and 2021 (see Fallon et al. 2021) and augmented with data from ongoing survey efforts by the authors and other researchers and community scientists. To determine if species on this initial list remained lost, and if others needed to be added, we conducted a literature review as well as an extensive examination of digitized museum collections, genetic sequences, and community science observations (e.g., Global Biodiversity Information Facility (GBIF), Ecdysis, GenBank, Firefly Atlas; access dates for individual uses provided in references). While BugGuide observations and Research Grade iNaturalist observations are included in GBIF data exports, we also searched these platforms independently to determine if any unverified or recent reports might represent one of the lost species. If so, this was verified on the platform and the species removed from our draft list. If a positive species identification could not be made from the photos and information available, but we suspected an observation to be the species in question, we categorized it as “recently reported without confirmation.”

We further refined the list by examining records transcribed from non-digitized museum collections visited in person in recent years: Museum of Southwestern Biology, University of New Mexico in Albuquerque, NM (A.C.W., 2021), New Mexico State University (A.C.W., 2023), University of Florida (including the Smithsonian collection and J.E.L. collection) in Gainesville, FL (R.J., 2024), Southwest Research Station in Portal, AZ (C.E.F. and A.C.W., 2024), Oregon Department of Agriculture in Wilsonville, OR (C.E.F., 2024), University of Arizona in Tucson, AZ (C.E.F., 2024), Sul Ross

State University in Alpine, TX (C.E.F. and R.J., 2024), University of Texas in El Paso, TX (C.E.F., 2024), and C.M.H. Collection in Dover, DE (C.M.H., 2026). (Note that because the original purpose of these visits was not specific to lost species, examinations for such were not comprehensive, and in some cases unsorted materials were not fully inspected.) Species on this list were then shared with other researchers who are familiar with the various species, genera, and/or relevant search efforts to get their review and feedback.

Of the 178 firefly species currently described from the United States and Canada (Xerces Society 2026), 28 species (16% of taxa) have not been verifiably reported for 10 or more years, thus qualifying them as “lost” (Table 2; Fig. 9). Some of these species, for example *Photinus fenderi* Zaragoza-Caballero, Zurita Garcia & Ramírez-Ponce, 2023, have been lost for many decades; this particular firefly was recorded in 1946—nearly 80 years ago—under the name *Ellychnia obscurevittatus*, and is known only from its type locality in south-central Oregon (Fender 1962; Fender 1970; GBIF.org 2026). The conservation status of most of the lost species is uncertain. Nineteen were assessed for the IUCN Red List in 2020; of these, two are categorized as Endangered and the rest are Data Deficient (IUCN 2025). The remaining nine lost species have not yet been evaluated; all were described relatively recently, between 2017 and 2024. None of the lost species have any legal status at state or federal levels. One of the lost species—*Photuris pyralomima* Barber, 1951—is included as a Species of Greatest Conservation Need in Delaware (Delaware Division of Fish and Wildlife 2015), although this does not carry any legal protection.

Lost species accounts

For each of the 28 lost species (see plate of select species in Fig. 10), we provide individual species accounts detailing evidence of lost status, search effort, threats, and rediscovery strategies, as well as relevant details on natural

history and distribution. We have loosely organized the lost species into one of four bins based on their lost species status: those with limited survey efforts (n=13), those with complex taxonomy (n=6), species suspected to be extinct (n=2), and those that have recently been reported but require confirmation (n=7). Here we define limited survey effort as consisting of inadequate, mistimed, or poorly targeted surveys that miss a species even if it is present, lacking the proper frequency, geographic coverage, and ecological knowledge required for a substantial search, thus necessitating further efforts. Species in the last category (reported without confirmation) have been reported in the last ten years, but it is unclear whether the observations are definitively the species in question. While some species could be assigned to multiple status categories, for simplicity we assign the category that we judge to best explain the lost species designation.

Species with limited survey efforts

***Brachylampis sanguinicollis* Van Dyke, 1939.**

The genus *Brachylampis* is represented by just two described species, both of which are endemic to California, and rarely reported. *Brachylampis sanguinicollis* has not been documented since 2003, when a single individual was collected from the mouth of a creek along the beach at the University of California’s Big Creek Reserve in Big Sur, Monterey County (Ecdysis 2026a). Additional specimens were recorded from the same site in 2002 (Ecdysis 2026a). Prior to these, the species had not been reported since June 1929, when numerous individuals were collected from a reservoir near Potwisha, Sequoia National Park and used in the species description (Van Dyke 1939). To date, the species has only been reported from these two locations.

Both male and female adults of these daytime dark fireflies are capable of flight. Although not directly observed, adults likely use pheromones rather than bioluminescence in courtship, based on phylogenetic analyses

Table 2. Lost firefly species of the US and Canada with status, distribution, courtship type, and year of last known observation. For species with a status of “Recently reported without confirmation,” year last observed indicates the year the species was last verifiably collected or seen.

Species name	IUCN RL Category	Global distribution	Courtship type	Year last observed	Reference
Species with limited survey efforts					
<i>Brachylampis sanguini-collis</i>	DD	USA: CA	Daytime dark	2003	Ecdysis 2026a
<i>Nelsonphotus aridus</i>	DD	USA: CA; MEX: SO	Unknown	2005	Gross 2005
<i>Phausis branhami</i>	NE	USA: WI	Glow-worm	2000	Hodson and Branham 2024
<i>Phausis marina</i>	DD	USA: CA	Glow-worm	1976	Hodson and Branham 2024
<i>Phausis milleri</i>	NE	USA: WI	Glow-worm	1999	Hodson and Branham 2024
<i>Phausis skelleyi</i>	DD	USA: OR, WA	Glow-worm	2003	Hodson and Branham 2024
<i>Photinus fenderi</i>	DD	USA: OR	Daytime dark	1946	GBIF.org 2026
<i>Photinus frosti</i>	DD	USA: AL, FL, LA	Flashing	2001	Stanger-Hall & Lloyd 2015
<i>Photinus immaculatus</i>	DD	USA: TX	Flashing	2005	Stanger-Hall and Lloyd 2015
<i>Photuris floridana</i>	DD	USA: FL	Flashing	1969	Lloyd 2018
<i>Photuris polacecae</i>	NE	USA: TX	Flashing	1999	Lloyd 2018
<i>Photuris whistlerae</i>	NE	USA: FL	Flashing	1968	Lloyd 2018
<i>Pyractomena floridana</i>	DD	USA: AL, FL, MS	Flashing	1983	Lloyd 2018
Species with complex taxonomy					
<i>Photinus autumnalis</i>	DD	USA: AK, ID, IN, MN, MT, NC, NJ, NY, OH, PA, RI, WA, WI; CAN: AB, BC, NT, ON, QC	Daytime dark	1951	GBIF.org 2025a
<i>Photinus lacustris</i>	DD	USA: MA, MD, ME, MI, MN, NH, NY, TN, VT, WI	Daytime dark	2001	GBIF.org 2025b
<i>Photuris aureolucens</i>	DD	USA: MI, PA, WI	Flashing	1970	Lloyd 2018
<i>Photuris cowaselonensis</i>	NE	USA: NY	Flashing	1976	Lloyd 2018
<i>Photuris gentrae</i>	NE	USA: TX	Flashing	1992	Lloyd 2018
<i>Photuris tasunkowitcoi</i>	NE	USA: ND	Flashing	1991	Lloyd 2018
Potentially extinct species					
<i>Photuris patriei</i>	NE	USA: FL	Flashing	1975	Lloyd 2018
<i>Photuris pyralomima</i>	EN	USA: DE, NY	Flashing	2007	Heckscher 2010
Species recently reported without confirmation					
<i>Photinus alexanderi</i>	DD	USA: AZ, CO, NM, UT	Daytime dark	1978	A.J. Cook Arthropod Research Collection, Michigan State University, MSUC_ARC_112954

Species name	IUCN RL Category	Global distribution	Courtship type	Year last observed	Reference
<i>Photinus arizonensis</i>	NE	USA: AZ	Daytime dark	1964	Zaragoza-Caballero 2017
<i>Photinus captiosus</i>	DD	USA: CA	Daytime dark	1953	Fender 1970
<i>Photinus granulicollis</i>	DD	USA: MT, OR	Daytime dark	1981	A.J. Cook Arthropod Research Collection, Michigan State University, MSUC_ARC_112957
<i>Pyractomena barberi</i>	DD	USA: FL	Flashing	1960s	Lloyd 2018
<i>Pyractomena limbicollis</i>	DD	USA: FL	Flashing	1983	Lloyd 1997
<i>Pyractomena vexillaria</i>	EN	USA: TX; MEX: TA, VC	Flashing	1980	Lloyd 2018

of morphological traits of worldwide lampyrids (Branham and Wenzel 2003). The diet of this species is unknown, but larvae probably feed on earthworms and snails. Limited habitat information is reported for either of the two described species in this genus, although Van Dyke (1939) reports the 1929 specimens were collected “from amongst the drift debris,” at a site located between 610 and 1,524 m (2,000 and 5,000 ft.) elevation. The drift debris likely references floating or partially submerged plant materials (e.g., branches, leaf litter, and logs) that are transported by flowing water. Specific threats to the species are unknown.

It is suspected that adults may be difficult to trap or may exist in low densities (Caterino 2006), making it likely that the species has been overlooked. Search efforts for this species should occur during the day in June and focus initially on the two known localities to determine if populations remain extant and to learn more about habitat associations. From there, efforts could expand elsewhere. Given the disjunct nature of the two documented localities (separated by approximately 80 km—a distance that spans the western Sierra Nevada, Central Valley, and Central Coast), it is possible the species is more widespread but unreported. However, it could also be that these collections represent two different species, given that the habitats at each locality are quite different (although both are associated with redwoods, albeit of different species—coast redwood, *Sequoia sempervirens* (Lamb. ex D.

Don) Endl., and giant sequoia, *Sequoiadendron giganteum* (Lindl.) J. Buchholz). Sweep netting, beat sampling, and malaise trapping are all recommended techniques for surveys.

***Nelsonphotus aridus* Cicero, 2006.** Not verifiably recorded since 2005, *Nelsonphotus aridus* is known only from a handful of localities in Southern California and one site in the mountains east of Hermosillo, in Sonora, Mexico (Cicero 2006; Gross 2005). *Nelsonphotus* is a monotypic genus with a poorly understood life history, in part because females and larvae are unknown. It is not clear whether this species is diurnal or nocturnal, although at least one individual was observed during the day (Gross 2005). Known records for this species originate in lower reaches of the Sonoran Desert Ecoregion, anywhere from 549 to 1,066 m (1,800 to 3,497 ft.) above sea level (Cicero 2006). Threats to the species are also not well understood.

The lack of recent collection records for *Nelsonphotus aridus* is likely due to a lack of survey efforts, rather than a true absence. The most recent record of this species (February 2005) is from the Anza-Borrego Desert, in San Diego County, California (Gross 2005). Several attempts to confirm the species at this locality were made by J.C. (species authority) since this record was taken, but the species was not located. C.E.F. conducted a visual search at this site over a single evening and morning in March 2026 and did not observe any individuals. These visits may have been unsuccessful due

to asynchrony with appropriate rains, rather than a true lack of the species. This would be the most logical place for rediscovery efforts. Most specimens have been collected in May, though the specimen taken in Mexico was collected in July and the individual observed in Anza-Borrego was seen in February.

Curiously, an observation of a *Nelsonphotus aridus*-like specimen from Yavapai, Arizona

was posted to BugGuide in 2020 (gronbergg 2020). J.C. noted that this species appears very similar to *Nelsonphotus aridus*, but close examination is required. If confirmed, it would be a substantial range expansion for *Nelsonphotus aridus*. However, based on biogeography, it is likely this record represents a new, undescribed species of *Nelsonphotus*. More research is necessary. It is worth noting that this speci-

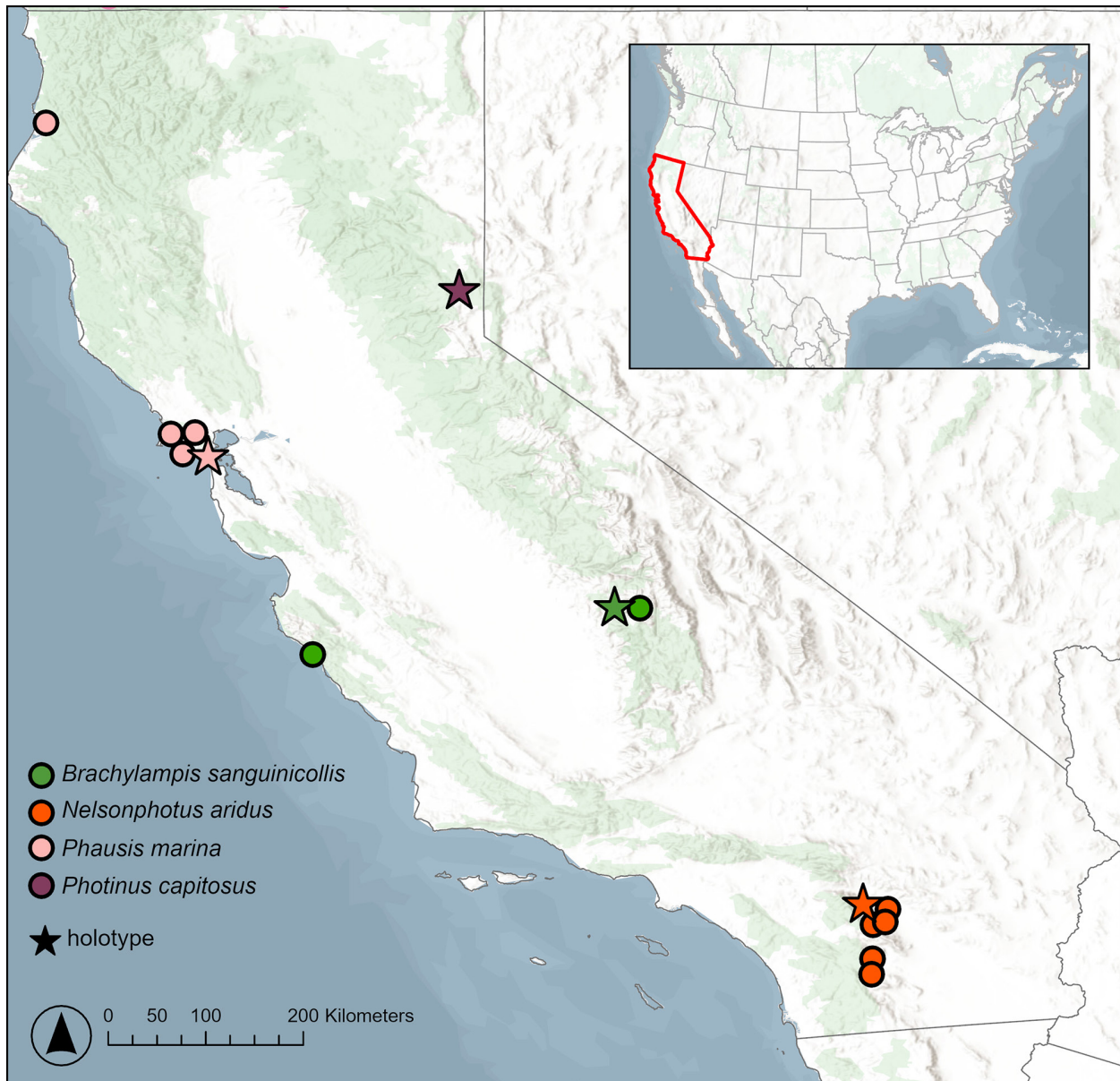


Figure 1. Distribution of lost species in California (Fender 1966; Fender 1970; Gross 2005; Cicero 2006; Hodson and Branham 2024; GBIF.org 2025e). Overlapping points jittered for visualization. In this map and all following, records with vague localities have not been mapped. This map and all following created using ArcGIS Pro 3.4.1 (Esri).

men was collected by a SLAM trap (Sea, Land, Air Malaise Trap), which may prove to be an effective way to survey for *Nelsonphotus aridus* as well.

***Phausis branhami* Hodson, 2024.** *Phausis branhami* is endemic to Wisconsin and is known from just two localities in Sauk and Jackson Counties. Because the species is morphologically similar to *Phausis inaccensa* LeConte, 1878 (Hodson and Branham 2024), it is possible that this recently described taxon is more widespread but has been overlooked. Known sites are located in mesic hardwood and white pine forests and adults are active from mid-June to early July (Hodson and Branham 2024). Eggs,

larvae, and adult females remain unknown (Hodson and Branham 2024), but it is likely that females are flightless and bioluminescent, similar to other females in the genus. The last known collection was made in July 2000 near Hemlock Draw nature preserve outside of North Freedom, Wisconsin (Hodson and Branham 2024). Surveys should occur during the known adult activity period. Berlese funnels or malaise traps are recommended.

***Phausis marina* Fender, 1966.** *Phausis marina* is endemic to California and known from only a few sites in Marin and Humboldt Counties. Similar to *P. californica*, only adult males, which are non-luminescent, have been de-

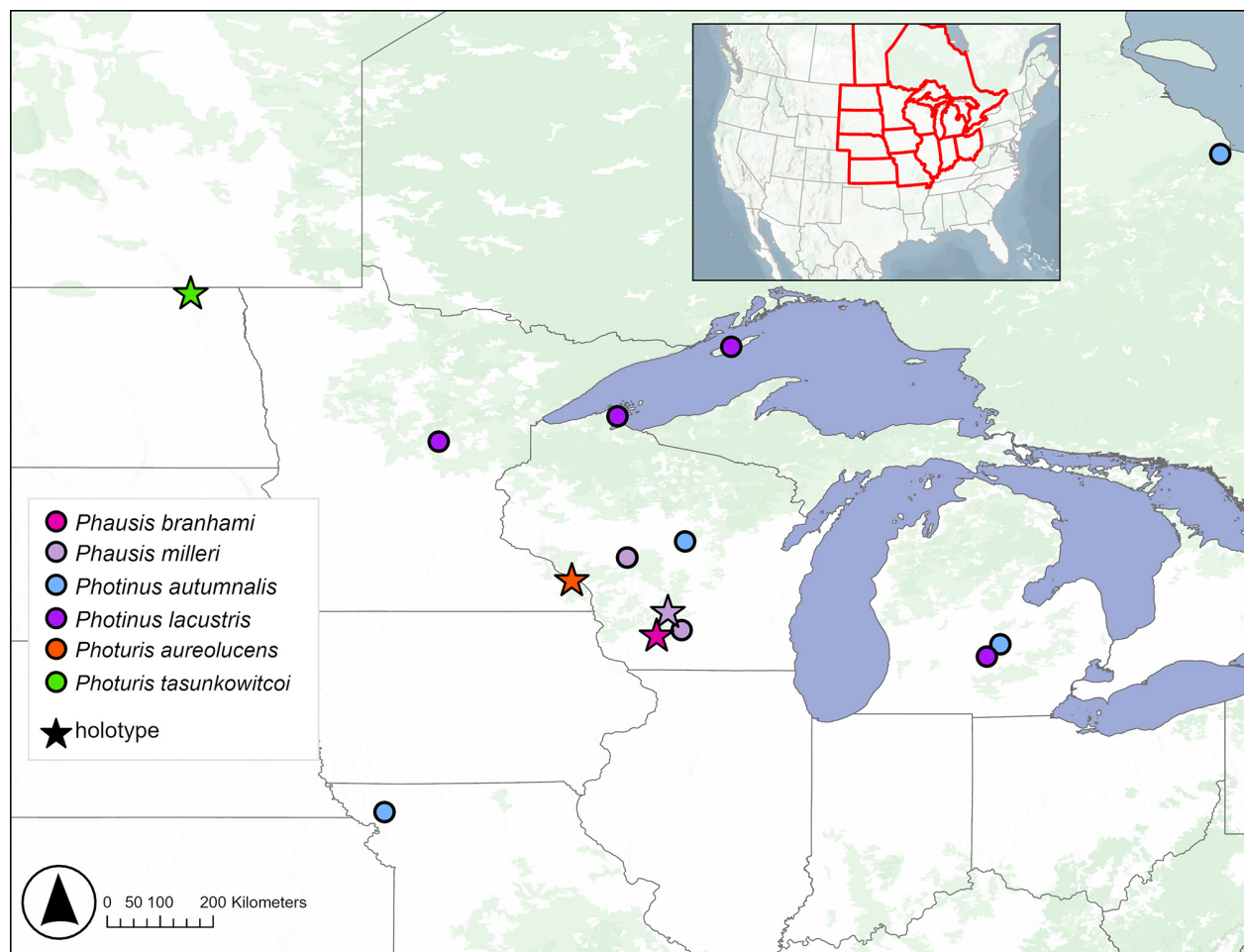


Figure 2. Distribution of lost species in north-central US and south-central Canada (Barber 1951; Gainesville, FL, recorded by R.J. in 2024 [unpub. data]; GBIF.org 2025a; GBIF.org 2025b; Lloyd 2018; Hodson and Branham 2024; James E. Lloyd Collection).

scribed (Fender 1966; Hodson and Branham 2024). Females are unknown but likely flightless and bioluminescent. The larvae of this species are also undescribed. The last known collection occurred in 1976, when a single male was extracted from red alder (*Alnus rubra*) leaf litter in a Berlese funnel (Hodson and Branham 2024). More specific habitat associations for *P. marina* have not been reported. Adult males are active from May through early July (Hodson and Branham 2024). Surveys should occur during the known adult activity period. Berlese funnels or malaise traps are recommended.

***Phausis milleri* Hodson, 2024.** Similar to *Phausis branhami*, *Phausis milleri* is endemic to

Wisconsin and known from just a handful of localities in Sauk and Jackson Counties. Because the species is morphologically similar to *Phausis skelleyi* Fender in Hatch, 1962 (Hodson and Branham 2024), it is possible that this recently described taxon is more widespread but has been overlooked. Adult males are active from mid-June through mid-July (Hodson and Branham 2024). Eggs, larvae, and adult females remain unknown (Hodson and Branham 2024), but it is likely that females are flightless and bioluminescent, similar to other females in the genus. The last known collection was made in July 1999 near Pine Hollow in Sauk County, WI (Hodson and Branham 2024). Surveys should occur in mesic hardwood forests during the known adult activity period. Flight intercept

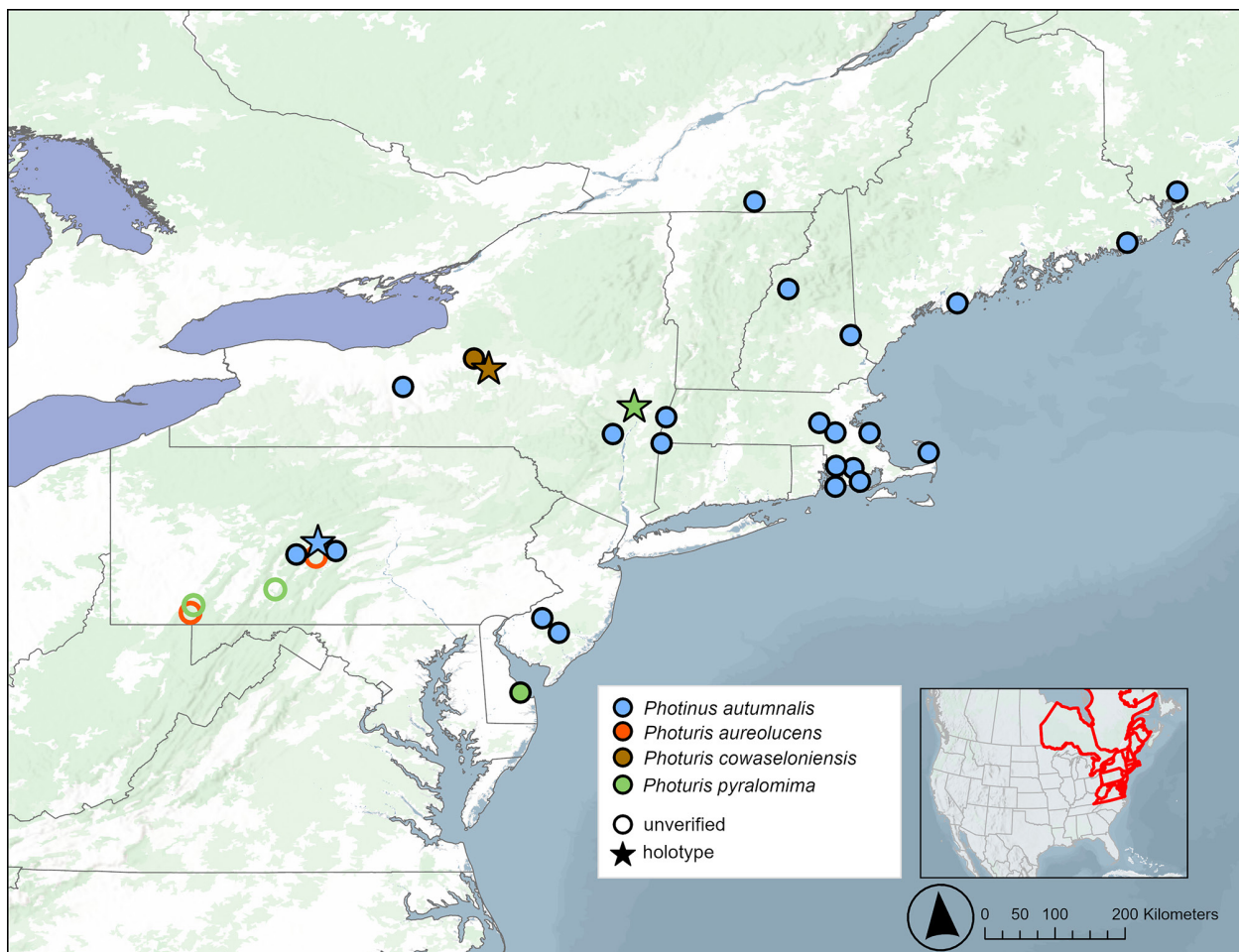


Figure 3. Distribution of lost species in northeast US and southeast Canada (GBIF.org 2025a; GBIF.org 2025f; Ecdysis 2026b; Heckscher 2010; Lloyd 2018). Overlapping points jittered for visualization.

and pitfall traps have successfully been used to collect this species (Hodson and Branham 2024), and are recommended for rediscovery efforts.

***Phausis skelleyi* Fender, 1962.** *Phausis skelleyi* has been recorded only a handful of times from sites in King County, Washington, and Yamhill and Baker Counties, Oregon. Like the other *Phausis* species on this list, only adult males, which are non-luminescent, have been described (Fender 1966; Hodson and Branham 2024). Females are unknown but likely flightless and bioluminescent. The larvae are undescribed. The last known collection occurred in 2003, when two males were recovered from a carrion pitfall trap in a redcedar-maple (*Thuja-Acer*) forest, beside East Issaquah Creek in Washington (Hodson and Branham 2024). Additional information on habitat associations for *Phausis skelleyi* is scarce. Two individuals have been reported from a maple (*Acer* spp.) thicket along a creek in Washington's North Cascade Mountains (LaBonte 1998). The habitat description for this site notes the presence of moist organic or loamy soils with nearly 100% canopy cover and dominant shrubs and trees of vine maple (*Acer circinatum*), red osier dogwood (*Cornus stolonifera* [= *sericea* ssp. *sericea*]), and Pacific crabapple (*Pyrus* [= *Malus*] *fusca*) (LaBonte 1998). Adult males are active from late June through early July (Hodson and Branham 2024). Malaise and pitfall traps, set out during the known adult activity period, are recommended for surveys.

***Photinus fenderi* Zaragoza-Caballero, Zurita Garcia & Ramírez-Ponce, 2023.** *Photinus fenderi* (= *Ellychnia obscurevittatus* Fender, 1962) is a daytime dark firefly described from a single locality in southern Oregon (Fender 1970; GBIF.org 2026). It has not been documented since mid-June 1945, when four specimens (3 males and 1 female) were collected and later used in the species description (Fender 1962). Attempts to relocate this population have been

limited and unsuccessful, largely due to uncertainty surrounding the type locality. Fender (1962; 1970) indicates the specimens used in the species description were collected at "Breast Mountain, Klamath County, Oregon," although the label on the holotype itself does not include the county. Despite extensive attempts to relocate the place name Breast Mountain in Klamath County, there does not appear to be a location by this description in any maps or reports, historical, or current (Lyons 2024). However, there is a location in adjacent Jackson County that was historically labeled as Breast Mountain, now called Sugarloaf Mountain, just south of what is now Dead Indian Memorial Highway (Lyons 2024). The property on which the peak of Sugarloaf Mountain is located is privately owned. Attempts by C.E.F. to contact the owner or arrange site access through a realtor when the land went up for sale in 2024 were unsuccessful. In June 2024, C.E.F. attempted to access a parcel of land managed by the Bureau of Land Management (BLM) adjacent to this location. However, road access was limited and appeared to be privately owned. The BLM parcel itself is completely surrounded by private land, and no viable entry points could be found.

Life history and habitat information for this species is lacking. Like other diurnal *Photinus*, this species may be active near creeks and other water bodies during the day, perching on grasses, forbs, and other plant materials. Search efforts for this species should occur in June near the type locality, including areas of the Cascade-Siskiyou National Monument and other BLM lands in the area. Sweep netting or visual surveys are recommended. Diurnal *Photinus* can often be found on leaf surfaces or grass blades along creeks or trails. There are several observations from southern Oregon on iNaturalist that have poorly defined vittae that could potentially represent this species. Voucher collections would be helpful for dissection and morphological comparison with existing specimen collections.

***Photinus frosti* Green, 1956.** *Photinus frosti* is a flashing crepuscular firefly known from just a handful of specimens and localities: Otter Creek, Florida, where the holotype was collected on 13 April 1954; Ida, Louisiana, where the paratype was collected on 6 June 1951; Mack Landing Campground in Apalachicola National Forest, Wakulla County, Florida, where it was observed on 2 May 1984 and in early May 1986; and Claude D. Kelley State Park (now Little River State Forest) in Monroe or Escambia County, Alabama, where it was seen on 27 May 2001 (Green 1956; Lloyd 1989; Lloyd 2018; Stanger-Hall and Lloyd 2015). Lloyd (1966) visited the Otter Creek locality several times in the 1960s, and one specimen resembling this species was collected during that time. According to Green (1956), the punctate markings on the pronotum of *Photinus frosti* distinguishes it

from all other *Photinus*, except *P. punctulatus*, which is found beyond this species' known range. Habitats in the vicinity of known localities include tree plantations, swamps, mesic flatwoods, and xeric hammock. *Photinus frosti* displays at dusk from April to early June, emitting single yellow flashes at fairly long intervals (8 seconds at 20°C or 68°F) (Stanger-Hall and Lloyd 2015).

The late firefly researcher James E. Lloyd (J.E.L.) was likely the only person actively searching for *Photinus frosti* since the species was described. It is not clear whether he revisited the Apalachicola National Forest and Alabama localities after collecting specimens there in the 1980s and in 2001, respectively. Surveys aiming to rediscover this species should target known localities as well as nearby conservation areas, such as Caddo Black Bayou Preserve

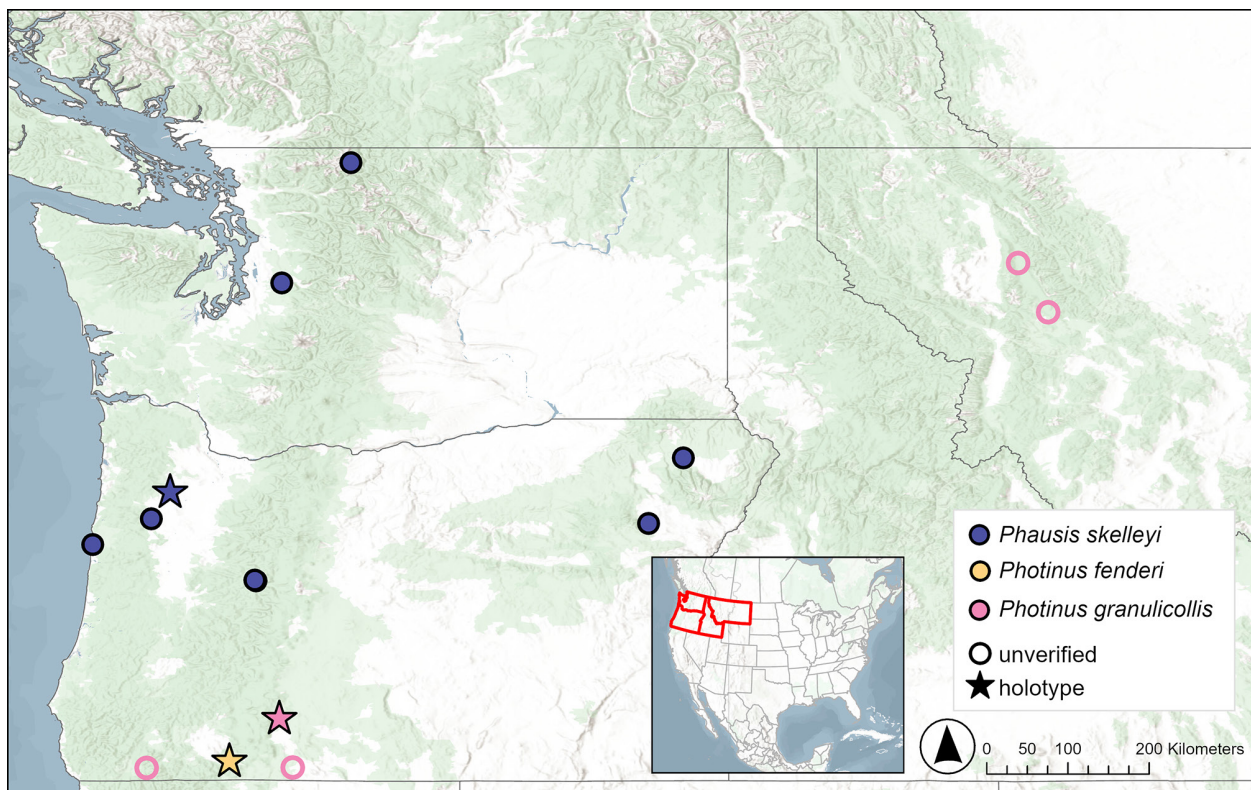


Figure 4. Distribution of lost species in the Pacific Northwest (A.J. Cook Arthropod Research Collection, Michigan State University; Fender 1962; Fender 1966; Fender 1970; GBIF.org 2025c; Hodson and Branham 2024; LaBonte 1998; Parson et al. 1991; *Phausis skelleyi* specimens in the Oregon Department of Agriculture Insect Collection, examined by C.E.F. in 2024 [unpub. data]; Pollock 2025).

(near the Ida, Louisiana locality in Caddo Parish). Because of the overlap in range, appearance, and flash pattern with *Photinus umbratus* (a closely related species), specimens should be collected for examination of the punctuation on the pronotum and possibly DNA barcoding. The distinguishing morphological trait is the coarse punctuation of the pronotum (Green 1956), while the flash pattern differs in having a slightly shorter flash duration and a slightly longer flash interval than *Photinus umbratus* (Stanger-Hall and Lloyd 2015).

***Photinus immaculatus* Green, 1956.** *Photinus immaculatus* is known from just two localities in Texas—the type locality, printed only as “Gillespie County” (Green 1956), and Emma Long City Park in Austin, Travis County (Stanger-Hall and Lloyd 2015; K. Stanger-Hall pers. comm. 2025). The latter is based on a specimen that merits further investigation. The type series was collected in May 1940 by entomologists Josef and Dorothy Knull, who spent many summers collecting insects across the American Southwest. Five specimens were collected, two males and three females, though B.P. notes the female specimens have since been lost.

Precise habitat and ecology information for this species remains limited due to the small number of collections and vague type locality data. It is possible the species once occurred within the Llano Uplift, a geologically distinct landscape characterized by exposed igneous and metamorphic rock, shallow soils, and localized aquifers (Hunt 2008). Based on county-level locality data, regional geology, and field observations by B.P. of potential historic localities, *Photinus immaculatus* may be associated with dry upland sites with sloped limestone or granite derived soils that grade into riparian habitats, including seasonal creeks or rivers that flood periodically following rainfall events. Males likely emit single flashes to attract mates, as is known for closely related congeners (Stanger-Hall and Lloyd 2015).

Rediscovery efforts are hampered by the imprecise type locality. It has been hypothesized

that the specimens may have been collected at Enchanted Rock State Natural Area (SNA) in Fredericksburg, a well-known destination at the time, as the collectors were not local to the area (Pfeiffer and Walker 2021). Four nights of surveys over two years at this site by B.P. have not resulted in any detections of *Photinus immaculatus*. Renewed attempts by B.P. to relocate the type locality have identified a historically plausible site within Gillespie County that is currently under private ownership.

Identification of this species cannot be made reliably on external morphology alone. Confirmation requires genitalia examination in combination with morphology; ideally voucher specimens would be collected and dissected to help differentiate *Photinus immaculatus* from the sympatric *Photinus texanus*, which it closely resembles. The Austin record (collected in 2005) should be treated as tentative pending further study of the original specimen. Although it was identified by J.E.L., it is unclear whether genitalia were examined to confirm the determination (K. Stanger-Hall pers. comm. 2025). Targeted surveys at the Austin site are warranted to evaluate this record further, although rediscovery may be unlikely given current levels of recreational disturbance and artificial light at night.

***Photuris floridana* Barber, 1951.** *Photuris floridana* is only known from Everglades National Park in Miami-Dade and Monroe Counties of south Florida (Lloyd 2018; Orrell and Informatics and Data Science Center-Digital Stewardship 2025). While similar in flash pattern, *Photuris floridana* differs from *Photuris congener* in coloration, distribution, and seasonal occurrence (Lloyd 2018).

This species has been collected at sites mapped as pine rockland and rockland hammock, with nearby natural communities including marshes, shrub bog, and marl prairie; males have been observed flying low to the ground among palmettos (Florida Fish and Wildlife Conservation Commission and Florida Natural Areas Inventory 2025; Lloyd 2018).

Males emit short, sharp flashes, often delivered in groups of five, one every half a second (Lloyd 2018). It has been collected in the adult form almost all months of the year (Lloyd 2018). Other than two unsuccessful survey nights by R.J. in April 2026 at historic localities in Everglades National Park, no surveys have occurred for this species since the 1960s (Lloyd 2018).

Rediscovery efforts should focus on known localities (Royal Palm Visitor Center and Lone Pine Key) in Everglades National Park. These precise locations, combined with the distinctive coloration (including lack of red on the pronotum) of *Photuris floridana*, should help facilitate detection of this species if it remains extant. Big Cypress National Preserve contains geographically disjunct rockland hammock areas that could possibly also harbor *Photuris floridana* and warrant investigation.

***Photuris polacecae* Lloyd, 2018.** *Photuris polacecae* is known from a single specimen collected at the Live Oak Creek bridge along Route 16 near Lady Bird Municipal Park in Fredericksburg, Gillespie County, Texas, in 1999 (Lloyd 2018). B.P. relocated this locality outside of the species' adult activity period in 2025 and noted that it is situated approximately 30 m (100 ft.) downstream from a dam that forms a large impoundment lake. The site occurs within a Hill Country landscape characterized by sloping limestone uplands transitioning into a riparian corridor with dense tree canopy, wetland grasses, and periodically flooded creek margins. B.P. has observed that intermittent flooding from dam overflow has produced active erosion and small wetland features along a shaded creek bend near the bridge. This habitat provides a mosaic of dry upland slopes likely used by adults as mating arenas and wetter riparian zones that may support larval foraging and development, while tree-lined sections appear favorable for advertising males. Further habitat associations for the species have not been previously recorded. The single adult male was observed in late May emitting a single flash (Lloyd 2018).

Photuris polacecae is part of the Division I *Photuris* group and most closely resembles *Photuris billbrowni*. Lloyd (2018) characterized *Photuris polacecae* as producing single flashes at variable intervals, whereas *Photuris billbrowni* typically emits paired simple flashes, although both species may produce flash trains during peak mating activity. Complicating identification, B.P. has observed that *Photuris billbrowni* may intermittently emit single flashes and can rapidly alternate between single and paired flashes, sometimes producing paired flashes so closely spaced that they appear nearly continuous. As a result, male mating flash behavior, in combination with morphology (including a lack of red on the pronotum), may be the most reliable means of distinguishing *Photuris polacecae* from closely related congeners. Because no voucher specimens have been collected since the original record, morphological differences between the species remain poorly resolved.

Surveys to relocate this species should focus on the Live Oak Creek bridge type locality from late May through July. Documenting behavioral patterns and habitat use at the site would be particularly valuable if the species is rediscovered and could help guide additional surveys in similar creek systems in the region.

***Photuris whistlerae* Lloyd, 2018.** Known from a few sites in northern Florida and South Carolina, *Photuris whistlerae* is another member of the challenging *Photuris versicolor* group. The last known record is from May 1968 at the holotype location in Florida, though there may be more recent undigitized records in the J.E.L. firefly collection at University of Florida. Lloyd (2018) reported doing field studies at the holotype locality between 1964 and 1985; it is unclear if additional observations or collections were made in later years. Distinguishing features for this species include the pale coloration of the hind coxae, its "delicate" appearance, and the flash pattern, which consists of crescendo flashes that are often emitted while dipping in flight around the tops of vegetation, creating a lace-like effect (Lloyd 2018).

It would be prudent for rediscovery efforts to begin near the type locality, which was a wetland northeast of the Gainesville Regional Airport in Alachua County, Florida. According to Lloyd (2018), this wetland was degraded or destroyed by bulldozing and a dropping water table, but based on aerial imagery, it appears that there continues to be vegetated habitat at the site referred to by Lloyd as the “Gun Club” site. Surveys should take place in May, as the month when Lloyd noted the most observations (though some were seen as late in the year as September). Lloyd’s habitat descriptions are not particularly specific, but they include marshy creeks and areas with shrubs and hardwood trees.

Based on flash pattern and morphology, Lloyd (2018) hypothesized that *Photuris whistlerae* is in a clade with *Photuris cinctipennis* and *Photuris branhami*, both species with distinctive pale coloration on the hind coxae, legs and pronotum.

***Pyractomena floridana* Green, 1957.** *Pyractomena floridana* is restricted to the Gulf coastlines of Mississippi, Alabama, and Florida. Last recorded in 1983, it is a late summer firefly of wet prairies, mesic flatwoods, and Gulf hammock flatwoods (Lloyd 2018). Several of the historic collection localities are within protected areas in Florida, including Mallory Swamp Wildlife Management Area, Hillsborough River State Park, Austin Cary Forest, and Everglades National Park.

Identifying characteristics highlighted by Lloyd (2018) include the tawny (versus pink) coloration of the pronotum, display heights of 1.8–4.6 m (6–15 ft.) off the ground, and an orange flicker flash pattern repeated at intervals of 3–7 seconds when temperatures are 24.4°C (76°F). According to Green (1957), the pale scutellum color of *Pyractomena floridana* distinguishes it from most sympatric congeners with similar genitalia (aka the “*borealis* group”).

A review of iNaturalist records for *Pyractomena* from August and September along the Gulf Coast revealed no adult observations

that possibly matched *P. floridana* in Mississippi, Alabama, or Florida, but there were multiple observations of small *Pyractomena* in these months from the vicinity of New Orleans, Louisiana (iNaturalist 2025). The pronotal coloration of these specimens appears closer to *Pyractomena lucifera* than *Pyractomena floridana*, but these populations may be worth investigating further.

Initial rediscovery efforts should be in the form of nighttime firefly surveys in late summer (August–September) in the vicinity of historic localities, including the type locality (Hillsborough River State Park, Hillsborough County, Florida). Both flash pattern data and voucher specimens should be collected for definitive species identification, as flash pattern and genitalia dissections may help to rule out similar species.

Species with complex taxonomy

***Photinus autumnalis* (Melsheimer, 1846).** *Photinus* (=Ellychnia) *autumnalis* is a daytime dark firefly that has not been definitively reported since 1951 (GBIF.org 2025a). The type locality is listed as simply “Pennsylvania” (Melsheimer 1846). Other confirmed occurrences include localities in Minnesota, Michigan, and Wisconsin (Marvin 1965), although the species has been reported from a number of other states and Canadian provinces. This species is part of a widespread species complex of diurnal fireflies, wherein the division of *Photinus autumnalis*, *Photinus lacustris*, and *Photinus corruscus* is not entirely straightforward (Fender 1970) and has likely led to misidentifications. However, these species can be distinguished by differences in the male genitalia; for *Photinus autumnalis* in particular, Marvin (1965) recommends looking for genitalia that are “oblong with inner margins of lateral lobes deeply notched at base; color black, with grey area near apex of lateral lobes.”

The natural history of *Photinus autumnalis* is not well known, but the related *Photinus corruscus* adults are detectable nearly year-round;

they emerge in late summer, overwinter in tree bark furrows, and mate in the spring (Faust 2012; Rooney and Lewis 2000). Specimens labeled as *P. autumnalis* have been collected from May through November (GBIF.org 2025a), although it is possible some of these represent other *Photinus* in the species complex. Larvae of related species use leaf litter and rotting logs as habitat.

Rediscovery efforts for this species may entail dissections and other diagnostic evaluation of existing museum collections to ascertain whether specimens currently labeled as *P. autumnalis* are in fact this species. Given the confusion surrounding this species complex in general, an overhaul of existing keys would be helpful for future delineation and understanding of the species and its distribution.

***Photinus lacustris* (LeConte, 1852).** Similar to *Photinus autumnalis*, *Photinus* (=Ellychnia) *lacustris* is considered by many to be part of the larger *Photinus corruscus* complex (Faust 2017), which has likely led to misidentifications, despite its validity as a species (ITIS 2025) being supported by distinct differences in genitalia (Marvin 1965). Little is known about the natural history of *Photinus lacustris*, although it is assumed to have a similar life cycle to *Photinus corruscus* and *Photinus autumnalis*. Collections have occurred from April through September.

This species was last verifiably recorded in 2001 at Pilot Butte in Saskatchewan, Canada (GBIF.org 2025b). The vague type locality “Lake Superior” and relative lack of details in the original species description present barriers to definitive rediscovery (LeConte 1852). However, revisiting the collection localities of the 17 specimens from the W.C. Stehr collection that Marvin (1965) examined would be particularly useful, as the genitalia of these specimens were examined. We were unable to locate these specimens in Ecdysis or GBIF (2025b), but other Coleoptera specimens collected by Stehr are spread among Clemson University, Michigan State University, University of Manitoba, and Penn State.

One COI sequence from a specimen identified as *Ellychnia lacustris* and collected in Carlin, British Columbia, on 3 June 1978, appears in the Barcode of Life Data Systems (BOLD) database (BOLD SampleID CNC COLEO 00152834 2012). However, the basis for identification was not specified, so this determination should be treated with caution. Similarly, there are specimens that are labeled as *Ellychnia lacustris* from Washington, Oregon, Montana, New Mexico, and Texas in the Museum of Comparative Zoology, Harvard University, whose identifications should be revisited (GBIF.org 2025b; Fig. 5).

A rediscovery strategy for *Photinus lacustris* should involve collection and close examination (including genitalia dissection) of diurnal fireflies in the winter firefly species complex, with efforts focused in the Great Lakes Region. DNA sequencing may also prove useful for clarifying the taxonomy of this group and confirming new occurrences of this species.

***Photuris aureolucens* Barber, 1951.** *Photuris aureolucens* was described from specimens collected at a tamarack swamp near Bluff Siding in Buffalo County, Wisconsin, in early July 1926 (Barber 1951). It was not collected again at this site until J.E.L. visited the area in 1970 (Lloyd 2018). Other firefly researchers looked for this species at the type locality without success until 2014, when C.M.H. likely observed the species flashing by the hundreds over marsh vegetation. The observation occurred from a distance across impenetrable marsh vegetation and seeps and was viewed through a spotting scope, so it could not be confirmed. In 2020, L.B. found the type locality marsh depicted in Lloyd (2018) some eight miles east of Bluff Siding. This is likely the same location that was observed by C.M.H.. The flashing at this site was extensive, but none matched expectations for *Photuris aureolucens*. However, at Farmers Community Park on 6 July 2020, several miles west of Stockton, Minnesota, L.B. observed a population of *Photuris* emitting short yellow flashes in the grass in the ditch at dusk. Later in the evening they appeared to fly up higher

in the shrubs and trees, eventually flying in the treetops and flashing at longer intervals (3 and 4 seconds). The flash pattern seemed to fit the description *Photuris aureolucens* as implied by Barber and Lloyd who compared the flashing to that of *Photinus castus/marginellus/curtatus* (Lloyd 2018). Specimens labeled as this species can be found in several collections, including individuals from Pennsylvania and Michigan that are housed in the Albert J. Cook Arthropod Research Collection (Michigan State University) and Frost Entomological Museum (Pennsylvania State University), respectively (Ecdysis 2026b). However, it is unknown if flash pattern information was used in the species determinations, and these specimens should be reviewed and their collection sites revisited.

As a member of the *Photuris versicolor* species complex, identification is difficult and relies on flash pattern observation. Identification is further complicated by the similarity to the sympatric species *Photuris caerulucens*, although the duration and color of the male courtship flash differs (Lloyd 2018). Courtship displays of *Photuris aureolucens* start at dusk with males giving off single, short, yellowish flashes as they fly around the tops of tall herbaceous vegetation over marshy ground (Barber 1951). Rediscovery efforts should initially focus on localities where the species is thought to occur; at these sites, detailed flash pattern observations and data on environmental conditions should be collected, as well as voucher specimens, to help confirm that the species is extant.

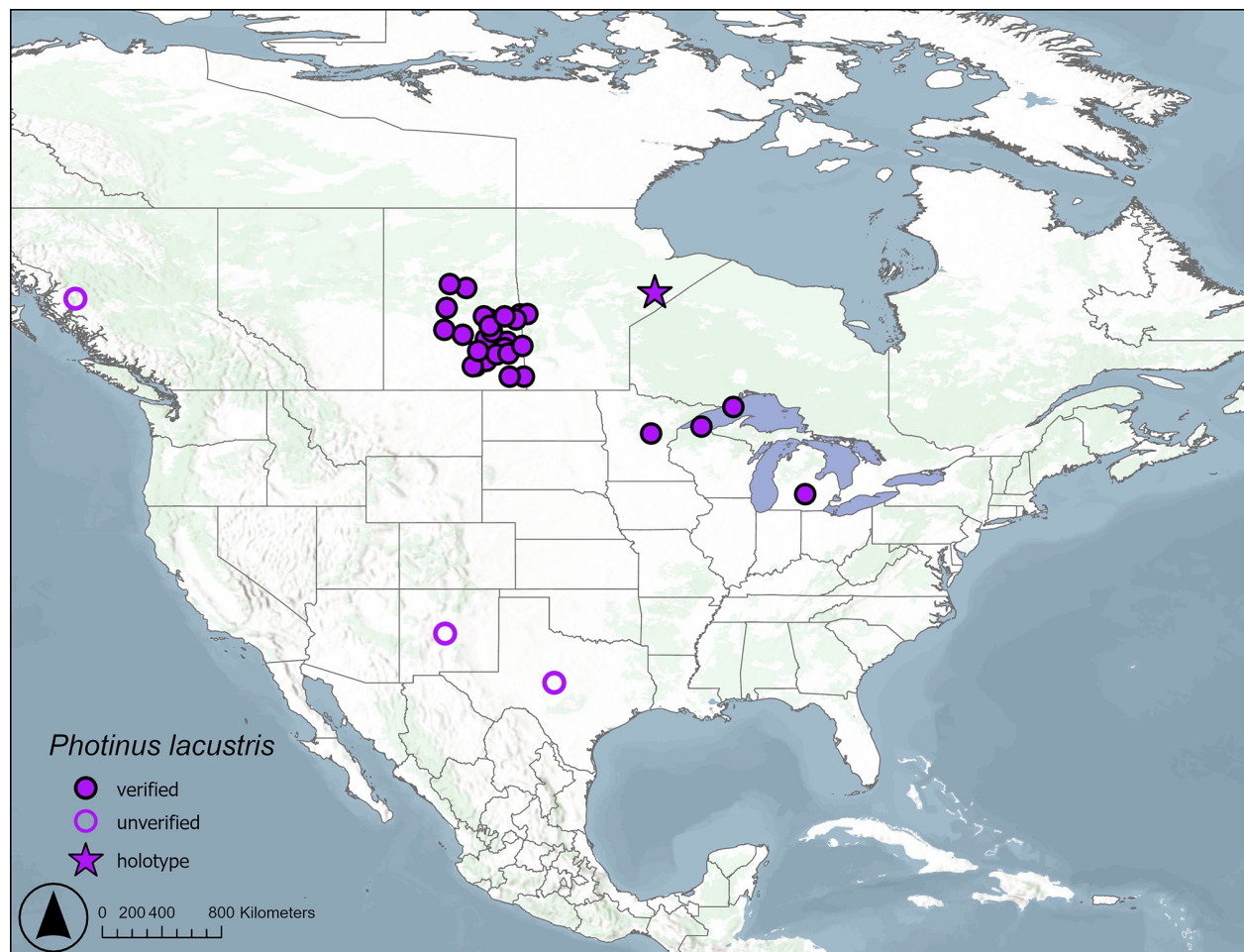


Figure 5. Distribution of the lost species *Photinus lacustris* across the US and Canada (GBIF.org 2025b).

***Photuris cowaselonensis* Lloyd, 2018.** *Photuris cowaselonensis* is a nocturnal, flashing firefly in the *Photuris versicolor* complex that was studied by J.E.L. in the 1970s in the Cowaselon Creek valley of Central New York and later described in his *Photuris* monograph (Lloyd 2018). Because identification of species based on flash behavior can be challenging, rediscovery efforts should focus on bottomlands in the Cowaselon Creek valley in Central New York in June and early July. The Cowaselon Creek valley is under private ownership, with very little conservation land, so survey efforts would likely require landowner outreach and permission.

Surveyors should look for medium-sized (~12–14 mm) *Photuris* with dark hind coxae that

emit dot-dash flash patterns (that is, a quick flash followed by a longer pulse or glow). This species also emits single, short flashes early in the evening, so flash patterns should be observed carefully and over the course of an evening. Heckscher (2021) noted that all *P. cowaselonensis* specimens examined in the J.E.L. collection showed slim basal segments of the antennae which sweep outward in an arc-like shape. This feature, in part, was helpful in separating the species from *P. sellicki* Heckscher, 2021, a species recently described from the nearby Adirondack Mountains that has a similar flash pattern (Heckscher 2021). When studied by Lloyd in the 1970s, *P. cowaselonensis* overlapped in habitat with *P. bridgeniensis* and

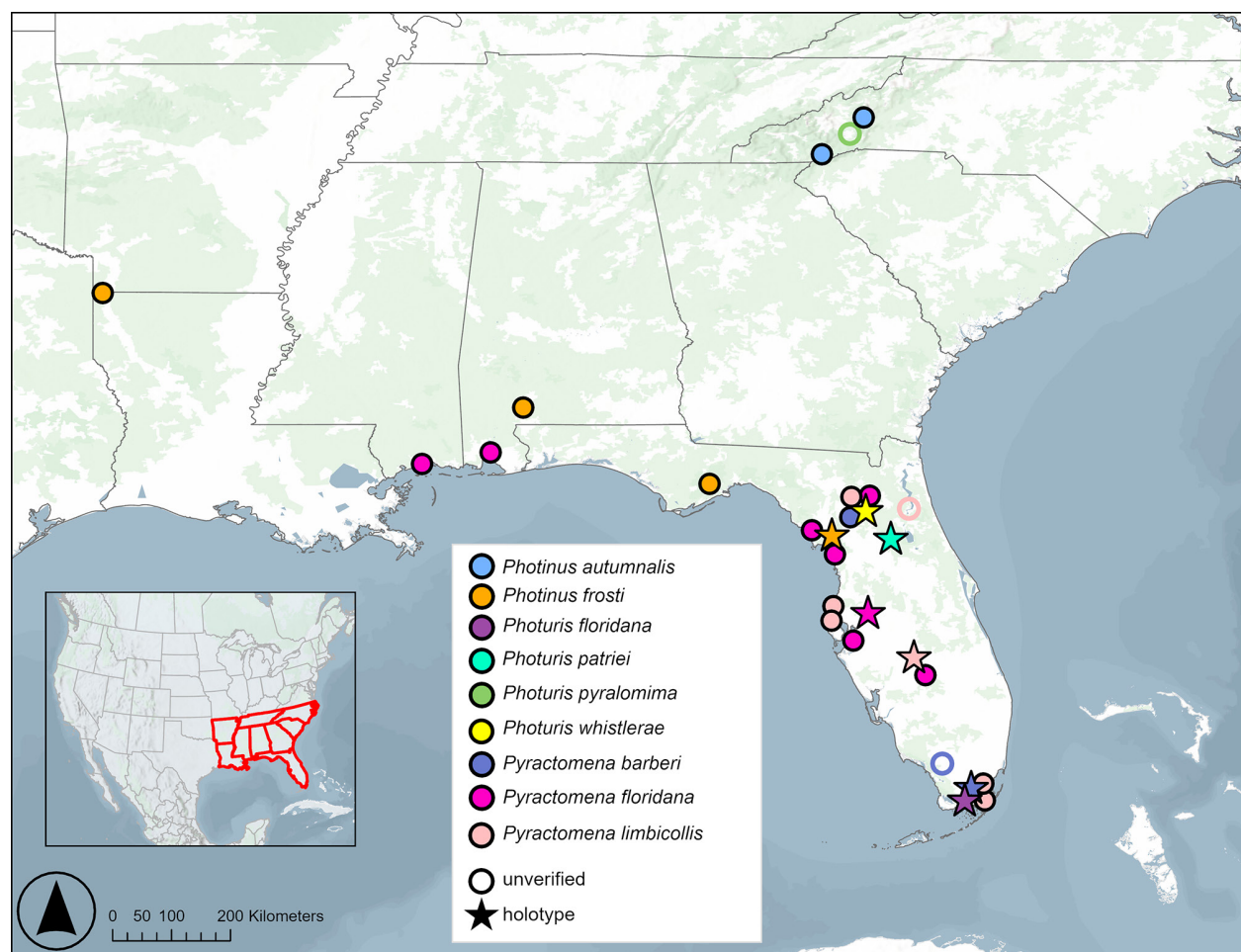


Figure 6. Distribution of lost species in the southeastern US (GBIF.org 2025a; GBIF.org 2025f; GBIF.org 2025g; GBIF.org 2025h; Green 1957; James E. Lloyd Collection 2024 [unpub. data]; Lloyd 2018; Orrell and Informatics and Data Science Center-Digital Stewardship 2025). Overlapping points jittered for visualization.

Photinus complex *marginellus* (Lloyd 2018), so surveyors should be aware of and familiar with these other species. Based on flash pattern and superficial appearance, Lloyd (2018) hypothesized that *Photuris cowaselonensis* might be in a clade with *P. pensylvanica*, *P. appalachianensis*, and *Photuris hiawasseensis*.

***Photuris gentrae* Lloyd, 2018.** *Photuris gentrae* is another recently described member of the *Photuris versicolor* species complex. It is documented from only two localities along the Nueces and Sabinal Rivers in the Hill Country of Texas, and no observations have been reported since 1992 (Lloyd 2018). Relatively little is known about its habitat and ecology, although it appears to be associated with riparian areas (Lloyd 2018). Adult females have not been described (Lloyd 2018).

Interpretation of flash patterns within this group is particularly challenging, as *P. gentrae* and the related *P. katrinae* exhibit highly similar male flash behaviors. The primary distinguishing feature described for *P. katrinae* is a bimodal flash that may appear “hitched” or uneven, but B.P. has found that to most observers the hitched flash patterns of these species appear effectively identical, making it difficult to determine whether one or multiple species are present, or whether observed variation represents intraspecific signaling diversity rather than distinct taxa, based on flash pattern alone.

Targeted survey efforts for the species have been scarce in the Uvalde region of the Nueces and Sabinal Rivers. Search efforts for this species should focus on this region during June and July. Males have been observed flying from grass height to 3–3.6 m (10–12 ft.) above ground level, emitting a single flash at an average of 1.8–2.8 second intervals at 26°C (79°F) (Lloyd 2018). The flash pattern description is based on observations of 5 males observed in July, but Lloyd (2018) states that “the main season of adult appearance may be June, since the few individuals observed in July appeared to have been stragglers (?)”. Co-occurring species may include *P. katrinae*, which appears to occasionally emit

a subtle hitched flash pattern (Lloyd 2018), although Lloyd (2018) notes that this species is much larger (15 mm) than *P. gentrae* (13 mm).

***Photuris tasunkowitcoi* Lloyd, 2018.** The last known record of *Photuris tasunkowitcoi* was likely on 14 June 1991, when J.E.L. stumbled upon this firefly in a deep valley in the north-eastern corner of North Dakota. Males of this species were seen flying along the shrubby and tree lined banks “upslope from a bridge across the Pembina River near Walhalla” (Lloyd 2018). Cutting through the surrounding prairies, the deep river channel and adjacent pockets of permanently damp and wooded areas were created by glacier meltwater bursting from ice-impounded lakes thousands of years ago. Lloyd (2018) describes seeing a short flash, similar in duration to early short flashes of other *Photuris*, until about 10:30 pm local time; later in the evening, long flashes (at least a second in duration at about 21°C, or 70°F) were observed. Long flashes had varying character, including little change in intensity, slow decreases in intensity, rapid decreases in intensity, or a slight increase in intensity (Lloyd 2018).

This firefly is distinguished by the variability of its flashes as well as a distinct flicker flash pattern, which is rarely seen in other similar fireflies. Several *Pyrractomena angulata* were observed flying in the same habitat and are likely the reason for this distinct flicker; *P. angulata* are likely preyed upon by *Photuris tasunkowitcoi* (Lloyd 2018).

It is likely this species has been overlooked. It is subject to the same difficulties in identification as many *Photuris* in the *versicolor* complex, though on the night the species was observed, there were no other *Photuris* reportedly co-occurring (Lloyd 2018). However, as the distinct flicker flash was the primary distinguishing factor, revisiting the population and closely examining flash patterns would be helpful. It is possible this flash was misinterpreted as a mating flash, when it may not have been, and the observed long flash may align this population with species such as *P. caerulucens* or

P. lucicrescens. Rediscovery is probable at the type locality, as the habitat appears to remain intact. Targeted surveys were conducted for this species at the type locality, near the Route 55 bridge where it crosses the Pembina River, and at nearby sites along the Pembina River in June 2026 (K. Hietala-Henschell pers. comm. 2026). While a *Photuris* population was observed flashing alongside *Pyrractomena angulata*, it is unclear if it represents Lloyd's species. Flash pattern data are under review, but more research is likely needed.

Potentially extinct species

***Photuris patriei* Lloyd, 2018.** Notable for its small size (8.9 mm), this *Photuris* firefly is known just from the type specimen, collected from a site in Ocala National Forest, Marion County, Florida, by J.E.L. in mid-July 1975 (Lloyd 2018). The habitats at the type locality are classified as "Basin Swamp and Freshwater Forested Wetlands" (Florida Fish and Wildlife Conservation Commission and Florida Natural Areas Inventory 2025). Adult males emit a single flash pattern at intervals of three seconds at 20°C (68°F) (Lloyd 2018).

J.E.L. indicated to C.M.H. that he revisited the type locality multiple times but never re-located the species. Nonetheless, rediscovery efforts should focus on the Eaton Creek type locality in Ocala National Forest in July before expanding out to similar nearby habitat. Lloyd (2018) recommended identifying potential roadside survey sites by the presence of cabbage palms (*Sabal palmetto*) and wetland-associated hardwoods. At the type locality, Lloyd (2018) described also observing *Photuris lamarcki*, a medium-sized (11.3 mm on average) species that emits characteristic flicker flashes and has pale hind coxae (versus moderate darkness in *P. patriei*). Hind coxae color can be variable and is not a diagnostic trait, but in some species is useful for identifying conspecifics. Given the small size of *P. patriei*, this would be a helpful feature for surveyors looking to distinguish it from other *Photuris*.

***Photuris pyralomima* Barber, 1951.** *Photuris pyralomima* was first recorded in Selkirk, New York, in 1924 (Barber 1951). Lloyd (2018) spent years conducting firefly survey work in Central New York, including near the type locality, but never came across the species. Limited efforts by C.M.H. in 2024 to find the species in appropriate habitat at Allegany State Park in Cattaraugus County, New York, were also unsuccessful. It is possible the species is extirpated in the state.

In 2004, *P. pyralomima* was found at Prime Hook National Wildlife Refuge (NWR) in Sussex County, Delaware (Heckscher 2010). Although once thought to occupy three additional sites in New Castle and Kent Counties, Delaware (Heckscher 2010), reassessment of specimens by C.M.H. in light of growing *Photuris* knowledge has since led to different identifications. This species has been recorded in open habitats including moist meadows and fields, especially those that have been left to fallow (Heckscher 2010). Males emit a single, yellowish, half second flash every 6 seconds (Barber 1951), which has the characteristic J-shape of *Photinus pyralis*; this characteristic gives this firefly its name, as 'pyralomima' means pyralis-like (Lloyd 2018).

Surveys for this species in Delaware in recent years have been unsuccessful. In 2013, C.M.H. checked a fallow field at Prime Hook NWR while conducting surveys for other fireflies nearby. In 2023, limited surveys targeting this species in meadows near the vicinity of the refuge headquarters did not result in any detections (J. Davis pers. comm. 2026). The species is thought to be threatened by practices that diminish old field and scrub habitat along the edges of farm fields (Heckscher and Walker 2021), and some of the fields at Prime Hook NWR where the species was previously found have matured into young forest, eliminating the previous open habitat. Even so, the refuge might be the most fruitful location to look to rediscover this species, at least initially, as that is where the species has most recently been recorded. Specimens from Pennsylvania

and North Carolina identified as this species may represent additional historic localities to revisit (Ecdysis 2026c); because no flash pattern data are associated with these records, and it is unknown who determined them, they remain tentative.

*Species recently reported without
confirmation*

***Photinus alexanderi* (Fender, 1970).** The daytime dark firefly *Photinus* (=Ellychnia) *alexanderi* has been recorded in Oak Creek Canyon, Arizona, Pike National Forest and Boulder, Colorado, and Liberty, Utah (Fender 1970). The last known collection occurred in October 1978 in Lincoln County, New Mexico (A. I. Cognato, A.J. Cook Arthropod Research Collection, Michigan State University, pers. comm. 14 January 2026). This species may have been observed in the last few years. However, it is retained on this list because most recent records are observations lacking specimen vouchers needed for close examination. Given the unreliability of pronotal vittae to ensure the identity of these individuals (especially from photos), a series of specimens should be collected and examined, with dissection of the male genitalia (Fender 1970). Several individuals that appear to be this species were collected from Arizona's White Mountains in June 2026 (Killingsworth 2026a, 2026b); these have yet to be closely examined.

Rediscovery efforts should focus on the type locality, Oak Creek Canyon, in Yavapai County, Arizona, or one of the other confirmed localities (Fender 1970; A.I. Cognato, pers. comm. 2026). Specimens with the morphological characters of *Photinus alexanderi*, as described by Fender (1970), were observed at this locality in 2025 (Fallon 2025a), so successful rediscovery is very likely. A series of specimens should be collected at recent unconfirmed locations to better understand the distribution of this species. Hand collection and direct searching/visual surveys may be the best method. Fallon (2025a) observed nearly 30 individuals of what

may be this species perched on riparian vegetation (grasses, sedges, and horsetails) and rocks in Oak Creek Canyon; hand collection of these individuals would be straightforward.

Unconfirmed occurrences are found across mountainous regions of Arizona, Colorado, Utah, and New Mexico. Very little is known about the habitats and ecology of *Photinus alexanderi* because there are few confirmed records of the species. Adults likely use pheromones rather than bioluminescent light signals to communicate with potential mates, and the larvae likely feed on other invertebrates at or below the soil surface (Lewis 2016). This species has only been recorded in lower montane areas, from about 1,402 to 2,073 m (4,600 to 6,800 ft.). One specimen in Utah was found on a willow (*Salix* sp.) and many of the other occurrences are in canyons, so proximity to permanent water sources may be important for this species. Where it has been confirmed, it has been collected in June, September, and October (Fender 1970).

***Photinus arizonensis* Zaragoza-Caballero, 2017.** The daytime dark firefly *Photinus arizonensis* is known from just three sites in the Chiricahua Mountains of Arizona—the Southwest Research Station, Rustlers Park, and Chiricahua Mountain—where it has been collected in July (Zaragoza-Caballero 2017). Little information is available about this species beyond its original description. Life history and habitat details are lacking. Search efforts for this species should occur in July near known localities in the Chiricahua Mountains. Similar to other diurnal *Photinus*, the species may be found perching on grasses and other plants during the day. Survey techniques could include visual surveys and sweep netting. It is possible this species occurs on other sky islands in southern Arizona. For example, a recent iNaturalist observation of an all-black *Photinus* from the Santa Rita Mountains could potentially be this species (Meeds 2025); however, voucher specimens and dissection of genitalia are needed for verification.

Photinus captiosus (Fender, 1970). *Photinus* (=Ellychnia) *captiosus* is a daytime dark firefly described from a single locality in California.

Fourteen specimens were collected from 10–12 July 1953, at Sage Hen Creek (referred to as Sagehen Creek in current maps) near Hobart

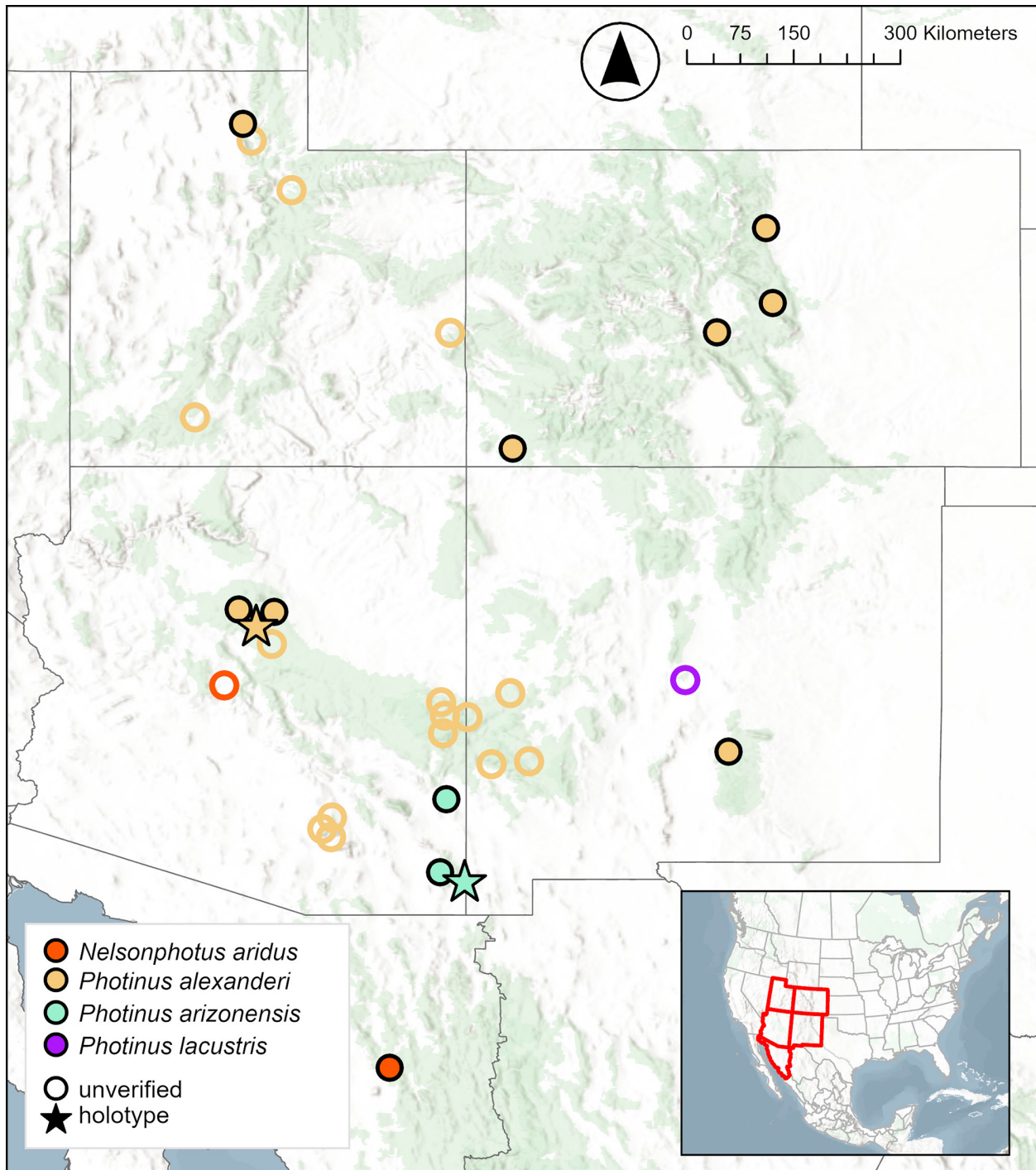


Figure 7. Distribution of lost species in the southwestern US (Cicero 2006; Ecdysis 2026e; Fallon 2025a; Fallon 2025e; Fallon 2025f; Fallon 2025g; Fallon 2025h; Fender 1970; GBIF.org 2023; Harrison 2020; Irvin 2025; Pieluszyński 2022; Pipkin 2025; Pollom 2022; Thaxton 2022; Vitanza 2024; Verde 2021; Zaragoza-Caballero 2017). Overlapping points jittered for visualization.

Mills in Nevada County, California (Fender 1970). Very little is published about this species. Adults of both sexes are winged, lantern-less, and likely use chemical pheromones to communicate. The dietary preferences of the larvae are unknown, but like other firefly species, they are likely carnivorous, feeding on soft bodied invertebrates such as snails, slugs, and earthworms. The Sagehen Creek Basin, which is located on the eastern slope of the northern Sierra Nevada, is described as being dominated by pine and fir forest with grassy meadows along its main channel (Mast and Clow 2000).

The type locality should be revisited in early to mid-July to determine if the species remains extant. The area around Sagehen Creek has a long history of entomological field studies, many of which have been based out of the nearby Sagehen Creek Field Station. This field station could prove to be a helpful base for future studies on this species. Other surveys for the species in surrounding areas are recommended, as are visits to entomological collections to determine if additional specimens are in museum holdings. Several observations on iNaturalist resemble this species (e.g., Ueda 2018), so the lack of records may be a result of difficulty in identification, rather than true absence. These iNaturalist localities should also be revisited to determine if the populations represent *Photinus captiosus*.

***Photinus granulicollis* (Fender, 1962).** The last confirmed collection of *Photinus* (=Ellychnia) *granulicollis* occurred in Klamath County, Oregon, in 1981 (A.I. Cognato, pers. comm. 2026). The species was described from Klamath County, Oregon, at three different localities: Fort Klamath, Klamath Falls, and Upper Klamath Lake (Fender 1970; GBIF.org 2025c). Additional specimens from Grayback Forest Camp in the Siskiyou National Forest (now the Rogue River-Siskiyou NF), Oregon, and Lake and Missoula Counties, Montana, are also thought to represent this species (Fender 1970). Given the disjunct nature of these populations and the similarity some Montana specimens

have to *Photinus faculus* (Fallon 2021), further examination and comparison are needed.

Little is known about the life history or ecology of this daytime dark firefly. Both males and females are winged, and it is likely that they use chemical pheromones to communicate. The habitat associated with *Photinus granulicollis* has not been described, but similar to other diurnal *Photinus*, it is likely that the species can be found perching on riparian vegetation during the day.

Targeted survey attempts for this species have been limited. C.E.F. conducted a single survey for *Photinus granulicollis* at Wood River Day Use Area in Fort Klamath, Klamath County, Oregon, in June 2024 and did not detect it or any of its congeners (Xerces Society 2025). Follow-up surveys at this site by C.E.F. in June 2026 yielded several *Photinus* observations; voucher specimens have yet to be closely examined but could represent this species. It is possible this firefly was recently rediscovered on Miller Island, Oregon, based on an observation posted to iNaturalist on 15 June 2025 (Pollock 2025). This site was revisited by C.E.F. in June 2026, when several adults were observed that may be this species. Voucher samples were collected for dissection and DNA barcoding.

More extensive surveys are needed. In Oregon, attempts to relocate this species should occur from June through August near known sites, including Fort Klamath, Klamath Falls, Upper Klamath Lake, and Grayback Forest Camp in the Rogue River-Siskiyou National Forest. In addition, further study of daytime dark *Photinus* specimens from Klamath County housed in the Southern Oregon University Insect Collection and Oregon State Arthropod Collection could shed light on this species' distribution in Oregon, as would revisiting these historic collection sites. Several recent iNaturalist records of daytime dark *Photinus* species from the Fort Bidwell area in adjacent Modoc County, California, suggest the species may be found further south as well (R. Lyons pers. comm. 2026).

Documented sites in Montana should be revisited in June and vouchers collected and compared to Oregon specimens to determine if these populations represent this species. Fender (1970) describes material from the following Montana locations: 14 miles south of Swan Lake, Lake County, 3,200 ft., 14 June 1967, and Seeley Lake, Missoula County, 3,500 ft., 15 June 1967. Confirming the validity and presence of this species at recorded sites in Montana would be especially helpful in distinguishing this species' range.

***Pyractomena barberi* Green, 1957.** *Pyractomena barberi* is a flashing firefly endemic to Florida, where it has a disjunct distribution in South Florida and the Big Bend region near the state's panhandle. Details regarding its last detection date are vague, but likely occurred west of Gainesville sometime in the 1960s by J.E.L. (Lloyd 2018). The species was originally described from four specimens collected in February and March 1919 in what is now Everglades National Park (Royal Palm/Paradise Key) (Green 1957; Lloyd 2018). This species has an adult activity period that spans late winter and early spring (February–April). It is associated with habitats such as wet prairies, pine flatwoods, and possibly other wetland types. Displaying after dark, *Pyractomena barberi*'s low-flying flickering amber flash pattern is distinctive and its long, narrow form should also preclude confusion with other species like *Pyractomena angustata* and *Photuris eureka*, which overlap in display season and habitat. *Pyractomena floridana* overlaps in range and habitat, but is active later in the season than *Pyractomena barberi*.

Rediscovery efforts should focus on collection sites mentioned by Lloyd (2018), including Hines, Dixie County, Florida, and Mallory Swamp, Lafayette County, Florida. The species can be locally abundant, but unlikely to be seen unless specifically sought out; Lloyd (2018) notes that “sub-firefly temperatures” of 11°C (52°F) or less, which are common early in the season, can hamper survey efforts. It is possible that this species has been seen recently.

An iNaturalist observation from Gator Hook Trail in Big Cypress National Preserve, Collier County, on 20 February 2022, closely matches the physical appearance of this species (Hall 2022). The habitat of this observation appears to be a cypress swamp bordering wet prairie. Documentation of flash pattern and species behavior from this site would be helpful, as would photographs taken with a scale to establish body length. Surveys should begin about 40 minutes after sunset and should take place when temperatures are at least 11°C (52°F), although ideally higher.

***Pyractomena limbicollis* Green, 1957.** *Pyractomena limbicollis* is another early-season (February–April) flashing firefly of forested habitats in Florida. It was last documented in an urban park in Gainesville, Florida, in 1983 (Lloyd 1997). However, because it appears to occur at low densities and flashes out of reach in the treetops, the lack of recent records of this species is likely not an indication of true absence.

Definitive identification of *Pyractomena limbicollis* will likely require the collection of specimens. While no genitalia differences are noted by Green (1957), the elytral pubescence may be instructive. The species resembles *Pyractomena marginalis*, at least superficially, and overlaps in habitat with *Pyractomena borealis* at some sites. At the Gainesville locality, *Pyractomena limbicollis* overlapped in season with *Photuris harranorum*, which emits a similar flash pattern, but is distinctive morphologically.

Rediscovery efforts should occur in late winter and early spring (February to April) in forested habitats at or near historic localities in Florida, such as Highlands Hammock State Park (the type locality), Lloyd's study site at Possum Creek (now within Loblolly Woods Nature Park) in Gainesville, and the vicinity of Royal Palm visitor center in Everglades National Park. Given the difficulty of catching adults displaying in the treetops, an additional approach to surveys would be to do daytime searches for pupae or recently eclosed adults on the north side of tree trunk bases,

or to search for active larvae. On rainy days in October and November in the 1970s, L.B. observed larvae crawling up to 3 m (10 ft.) above ground on vines and small twigs and branches at a site east of Gainesville on the west shore of Newnans Lake.

Another potentially useful sampling method for adults could be the use of blacklighting. There are two iNaturalist observations of fireflies at moth lights that may represent recent detections of this species, reported on 28 February and 4 March 2023, along the St. Johns River in Putnam County, Florida (kcthetc1 2023a; kcthetc1 2023b). Voucher specimens and flash pattern behavior, if observed, could help to confirm the validity of these populations.

***Pyractomena vexillaria* Gorham, 1881.** *Pyractomena vexillaria* was originally described from a single specimen collected in Veracruz, Mexico (Gorham 1881). In the archive collections of three US museums, Green (1957) found five more specimens from localities within Val Verde and Comal Counties, Texas. Green did not examine the *Pyractomena vexillaria* type specimen, so his determination of Texas specimens as this species was based largely on similarities in general appearance and coloration. Lloyd (2018) looked for this species in Texas several times without success, before finally encountering it in Cárdenas, Tabasco, Mexico, likely in 1980. Differences in the habitat between the Texas and Mexico localities are reported; Lloyd (2018) found this species flying low over a marsh in Cárdenas, whereas the areas where the species has been observed in Texas are limestone river basins among semi-arid cenizo and guajillo brushland (Walker et al. 2022). Given the discrepancies in habitat and Green's lack of examination of Gorham's Mexico specimens, it may be helpful to retain a distinction between *vexillaria sensu* Green (a South Texas plains/Texas-Tamaulipas semi-arid plain ecoregion firefly with *lucifera*-like genitalia) and *vexillaria sensu* Gorham (a coastal Mexico species, genitalia undescribed), at least until specimens can be compared.

Adults of this species have been reported from May through October (Green 1957; Lloyd 2018). In Cárdenas, male courtship displays began half an hour after sunset, and consisted of a single, short, amber colored flash, emitted at about two second intervals, while flying low over marshy vegetation (Lloyd 2018). Specific threats to this species in Texas include extensive habitat loss resulting from urban and agricultural development, light pollution, and major alteration of groundwater dependent ecosystems.

B.P. has conducted targeted surveys for *Pyractomena vexillaria sensu* Green in Val Verde and Comal Counties since 2016, including extensive efforts along the Devils River on Pfeiffer River Ranch and adjacent riparian areas, as well as surveys in the Blue Sage area and at Dolan Falls in June 2021 and June 2023 on property owned by The Nature Conservancy. Additional surveys have been conducted by B.P. in multiple locations in Comal County, including relatively undisturbed riparian habitat along the Guadalupe River on the Ingram Ranch, south of Canyon Lake, where wider riparian buffers remain intact and the area has not yet been heavily developed or dominated by invasive vegetation. The species has not been detected during any of these efforts, although a flash, which could have been the distinct amber courtship display of this species, was observed by B.P. along River Road on the Guadalupe River in Comal County, Texas, on 10 May 2018 (Walker et al. 2022). However, the individual emitting the flash was not caught, so the record cannot be confirmed.

In 2021, a photograph posted by a birding photographer depicted a living adult consistent with *Pyractomena vexillaria sensu* Green (Curtis 2021). After B.P. contacted the photographer, it was determined that the image was taken at the Amistad Reservoir Visitor Center in Val Verde County, Texas. While several diagnostic morphological features visible in the photograph are consistent with *Pyractomena vexillaria*, the absence of behavioral data, particularly flash pattern information, precludes definitive

identification and prevents confirmation of the species based on this record alone.

In Texas, the species appears to be parapatric with the more common and similar looking *Pyractomena punctiventris*, with little to no overlap observed. It is possible that *Pyractomena vexillaria* is associated with drier limestone habitats of the Edwards Plateau, whereas *Pyractomena punctiventris* is more frequently encountered in more humid environments with deeper soils extending eastward and southward from the Balcones

Escarpment toward the coastal plains. B.P. has observed that for several decades, entomologists working in the Edwards Plateau region of Texas routinely assigned *Pyractomena* specimens to *P. punctiventris*, largely due to lack of awareness that additional *Pyractomena* species occurred in the region. As a result, many historical records attributed to *Pyractomena punctiventris* (e.g., Quinn 2013; Quinn 2016) may warrant reevaluation, particularly given the greater abundance of that species relative to *Pyractomena vexillaria*.

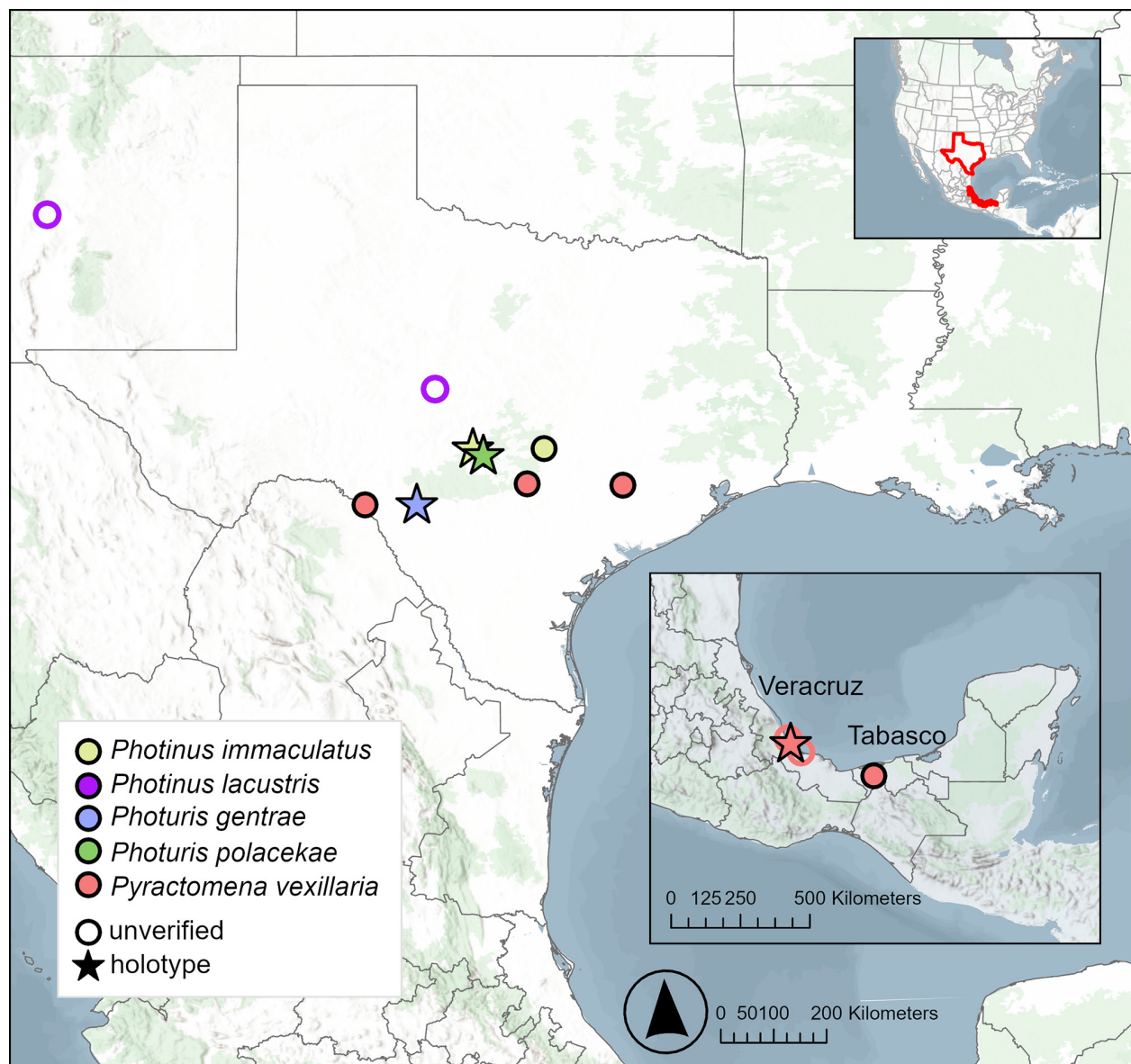


Figure 8. Distribution of lost firefly species in Texas (Axel-f-m 2021; Green 1956; Green 1957; James E. Loyd Collection 2024 [unpub. data]; Palacios 2016).

This species has not been confirmed in Mexico in decades, although, to our knowledge, no targeted survey efforts have taken place. The type locality reported by Gorham (1881), “Vera Cruz, Mexico,” is vague. There are several unconfirmed iNaturalist records from Veracruz which may turn out to be this species (Axelf-m 2021, Ramírez-Palacios 2015). The region where this species has been recorded in Veracruz and Tabasco has experienced substantial agricultural and urban growth (Walker et al. 2022), suggesting habitat for this species may be limited. Ideally, new material from Veracruz could be compared with Green’s Texas specimens, Lloyd’s Cárdenas specimens, and Gorham’s Veracruz holotype to determine whether they are all conspecific.

In both Texas and Mexico, voucher collections are recommended for comparison against the type specimen. Other rediscovery efforts should focus on collection of *Pyractomena* specimens near the vague localities cited by Green (1957) and Lloyd (2018), including New Braunfels and Del Rio, Texas, and Cárdenas, Tabasco, possibly near the Colegio Superior de Agricultura Tropical, where Lloyd was visiting when he encountered the species.

Rediscoveries

Our initial lost species list, compiled for Re:wild in 2024, included nine firefly species that have since been rediscovered, thanks to expert review of iNaturalist observations or targeted surveys by community scientists and researchers. Three additional species had previously been lost for many years before similarly being rediscovered via targeted survey efforts. These rediscoveries point to the power of focused search efforts, community science submissions, and expert review of such observations. Utilizing these approaches may well lead to more lost species being rediscovered. While the following list is not comprehensive, it provides an overview of twelve previously lost species and the circumstances leading to their rediscoveries.

***Chespirito milleri* Ferreira, Keller & Ivie, 2022.** Formally described in 2022, this species was initially known only from the type locality in the Huachuca Mountains of southeast Arizona (Ferreira et al. 2022). Type specimens were collected at 1,737 m (5,700 ft.) in Ramsey Canyon, a Nature Conservancy preserve, in the Huachuca Mountains on 7 August 1993. No other specimens or localities were known for this species until a specimen collected in July 2025 from the Southwest Research Station in the Chiricahua Mountains near Portal, Arizona, was determined to be this species. It was caught along with several *Paraphausis eximius* individuals via a V-form flight intercept trap (VFIT), at an elevation of 1,645 m (5,397 ft.) (O. Keller pers. comm. 2026).

Little is known about the habitat and ecology of this species. Females are undescribed. Adult males lack light organs, suggesting this may be a daytime dark firefly. The type locality at Ramsey Canyon is characterized by high walls and a spring-fed, sycamore and maple-lined stream that keeps the environment cool and moist. Plant communities in this vicinity range from semi-desert grassland to pine-fir forest (The Nature Conservancy 2026). Similarly, the Southwest Research Station is located in a riparian desert canyon lined with sycamores and cottonwoods, surrounded by pinyon pine, juniper, and oak woodlands (Southwestern Research Station 2026).

The relative absence of collection records is puzzling, particularly given the species’ occurrence at the Southwest Research Station, which is a well-known and popular area for entomological field research. Additional surveys in these two mountain ranges and other sky islands in southern Arizona are recommended to better delineate the species’ distribution and habitat associations. Surveys should take place in July and August. Flight intercept traps are recommended, as are visual searches, beat sampling, and sweep netting. A related species, *Chespirito zaragozai*, was found in sifted leaf litter (Ferreira et al. 2020), which may be a helpful survey approach for this species as well.

***Microphotus chiricahuae* Green, 1959.** Prior to two iNaturalist observations from 2021 (jimeckert49 2021) and 2023 (Coin 2023), the Chiricahua glow-worm *Microphotus chiricahuae* had not been verifiably recorded since J.C. collected two specimens from a blacklight at Rustlers Park in the Chiricahua Mountains of Arizona on 27 June 2003. When some of the authors (A.C.W. and J.C.) became aware of the iNaturalist records in 2024, they contacted the observers for additional information and to ensure that the specimens, one male and one female, were both in fact *Microphotus chiricahuae*. The confirmation came on the heels of unsuccessful attempts by A.C.W. and C.E.F. to locate the glow-worm at multiple sites in the Chiricahuas in 2024 (Xerces Society 2025). Of the ten species currently recognized in the genus, *Microphotus chiricahuae* is likely the most range restricted, so far being recorded only from the Chiricahua Mountains of southern Arizona (Usener and Cognato 2006; Green 1959). It is somewhat surprising that more records have

not been reported from these mountains, considering that the Southwest Research Station is located on the east side of the range, which regularly attracts entomologists and other researchers from around the world.

***Phausis californica* Fender, 1966.** *Phausis californica* is endemic to California and known from Calaveras, El Dorado, Lake, Placer, Tulare, and Tuolumne Counties (Forister 2019; GBIF.org 2025d; Hodson and Branham 2024). Only adult males, which are non-luminescent, have been described (Fender 1962; Hodson and Branham 2024). Although the adult females are unknown, it is likely they are flightless and bioluminescent, similar to others in the genus. The larvae of this species are also undescribed. Adult males are known to be active from April through July (Forister 2019; Hodson and Branham 2024).

Prior to rediscovery, the last known collection of this species had occurred via sweepnetting a trail along the North Fork American Riv-

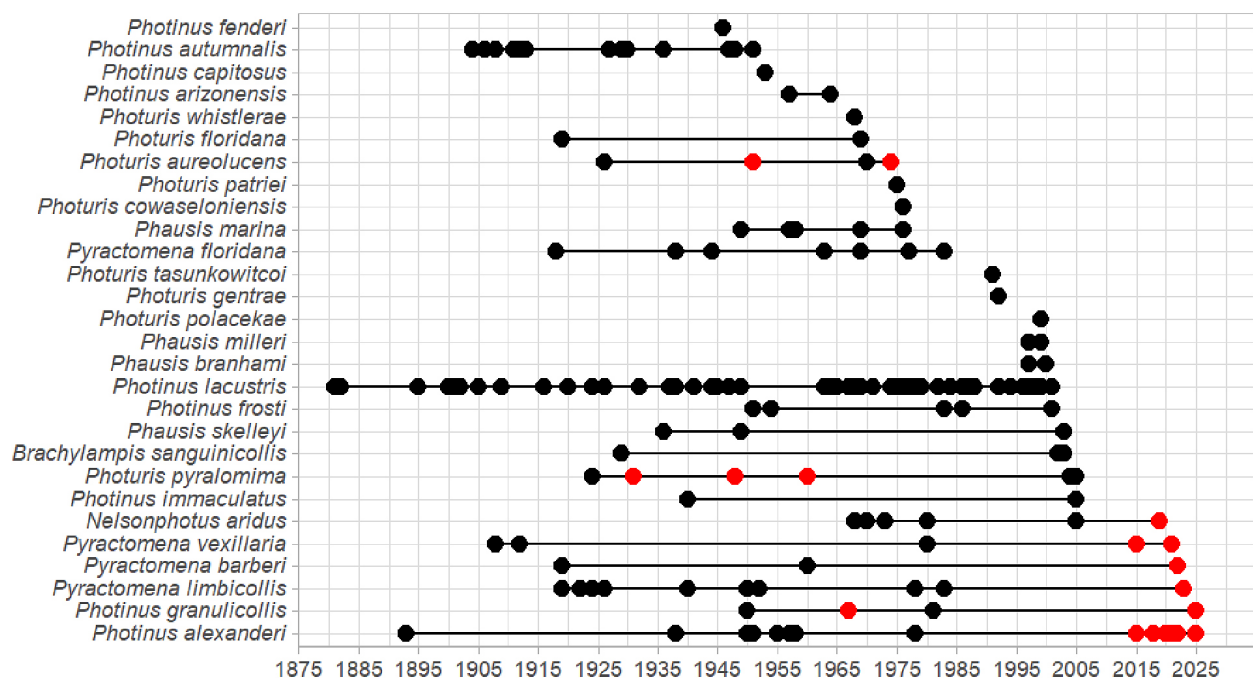


Figure 9. Timeline of observation records for each lost firefly species, from time of first description to most recent occurrence. Species are presented in order of least to most recently recorded. Points in black represent confirmed records; those in red require confirmation. Data sourced from references listed by region in maps (Figs. 1–8).

er in Placer County, California, in April 2013 (Forister 2019; G.W. Forister unpub. data). In 2020, another specimen was collected via a light trap in an oak woodland within a rural residential area (G.W. Forister unpub. data). Several other individuals have been collected nearly every year since using light traps, malaise traps, and vertical flight intercept traps (G.W. Forister unpub. data). The success of these methods, in addition to a sieving flume and beating vegetation (specifically *Ceanothus*) (Hodson and Branham 2024), suggests the species may have been overlooked previously.

***Photinus acuminatus* Green, 1956.** Described from just two specimens collected from Pisgah Mt., North Carolina, and Newberry, Florida (Green 1956), this species has been recorded infrequently and at scattered locations across multiple states (Joyce 2024). J.E.L. collected numerous specimens at sites near the Suwannee River in Dixie County, Florida, in the 1960s and 1970s. He documented an additional population in 1986 in Pickens County, South Carolina, although the site was destroyed three days later for the development of a golf course (Lloyd 2018). After a long period with no records, three individuals were collected from Delaware Seashore State Park by C.M.H. and Karen Bennett in 1998. Nearly two decades later, in 2017, another individual was discovered in southern Ohio (Faust et al. 2019; L. Hughes pers. comm. 2017). The species has never been found again in Ohio, despite annual attempts by L. Hughes. Subsequent survey efforts in South Carolina from 2022–2024 led to additional records. It has most recently been observed along the Nanticoke River in Maryland in 2025 (A. Reb pers. comm. 2026).

While the scarcity of *Photinus acuminatus* records may be in part due to identification challenges (genitalia dissection is required for definitive identification), the species appears to be rare. Adult males typically fly over or near shrubby wetlands in June and July, displaying single bright flashes at dusk (Joyce 2024; Lloyd 1969).

***Photinus aquilonius* Lloyd, 1969.** *Photinus aquilonius* is a flashing firefly found in open wetlands and fields in the northeastern US and southeast Canada, with historic records from Michigan, Maine, South Dakota, Manitoba, Ontario, Quebec, and Nova Scotia (Lloyd 1969; Luk et al. 2011). Documentation of this species has been sparse over the last several decades. *Photinus aquilonius* was studied by Lewis and Wang (1991) in an open field at Case Estates in Weston, Middlesex County, Massachusetts, in the late 1980s, on property that is now town-owned conservation land. C.M.H. collected it from an emergent herbaceous wetland along Stud Mill Road in northern Maine on 26 June 2010. In 2021, a study was published that examined the fluorescence of firefly specimens collected in Boston suburbs and included some identified as *Photinus aquilonius* (Wilcox 2021), although based on photos in the paper, this record requires confirmation. A return trip to the northern Maine site by C.M.H. in the 2020s did not result in any detections of the species, nor did a survey at the type locality (Warren Road, Washtenaw County, Michigan) on 16 June 2024, though marsh habitat is extant (Keller 2024b). However, the species was rediscovered at two wetland sites at 1,036 m (3,400 ft.) elevation in eastern West Virginia in late May 2023 (M. Franz, K. Noe, and V. Spaid pers. comm. 2026), suggesting it may persist at additional as-yet un-surveyed locations throughout the region.

***Photinus irroratus* (Fender, 1970).** Until a confirmed sighting from Scotia Canyon in the Huachuca Mountains, Arizona, by J.C. in 2024 (verified via examination of genitalia), the daytime dark firefly *Photinus irroratus* had not been verifiably observed since 1956 (Fender 1970). Like several other lost daytime dark *Photinus*, *Photinus irroratus* likely remained unrecorded for so long merely due to the unreliability of morphological features for identification and the need for dissection of the genitalia for species confirmation. Endemic to Arizona, this firefly may have been recorded in the Santa

Catalina Mountains in 2020 (Taraborelli 2020) as well as multiple sites in the White Mountains in 2025 (Fallon 2025b; Fallon 2025c; Fallon 2025d). However, these records and several others (e.g., Vitanza 2024) are based on visual observations that lack voucher specimens needed for close examination and species confirmation.

***Photinus tenuicinctus* Green, 1956.** *Photinus tenuicinctus* had not been documented since a specimen was collected by J.E.L. at Devil's Den State Park, Arkansas, in 2002 (Stanger-Hall and Lloyd 2015; K. Stanger-Hall pers. comm. 2025). In June 2025, a Firefly Atlas participant surveyed a site in Arkansas where J.E.L. collected the species in 1964 and found a thriving population (Morgan 2025); specimens were collected at additional Arkansas sites in 2024 and 2025 (iNaturalist 2026a). In recognition of this firefly's limited geographic range and to help garner enthusiasm from others in the area, the surveyor furthermore suggested an evocative common name, which was previously lacking: the Ozark spark.

***Photuris lineatocollis* (Motschulsky, 1854).** *Photuris lineatocollis* is a member of the *Photuris versicolor* species complex with a tangled taxonomic history, with multiple spellings (e.g., *Photuris lineaticollis*) and author attributions used over the years. Lloyd (2018) designated what he reasoned was the likely taxon representing *Photuris lineatocollis* [*Photuris lineaticollis*, sic]; we follow Lloyd to help maintain taxonomic stability. Currently, an epitype that represents Lloyd's decision is in the process of being designated. The taxon represented by Lloyd (2018) as *Photuris lineatocollis* [*Photuris lineaticollis*, sic] was collected in Alachua County, Florida, and is a member of Lloyd's "Red Group," in which the elytral border and pronotal coloration are distinctively redder in color than most other *Photuris*. In addition to this reddish coloration, the large size, interrupted pronotal vitta, and faint or absent elytral vittae may be helpful (but not diagnostic) morpho-

logical traits. The flash pattern consists of short single flashes at intervals of 4–6 seconds (Lloyd 2018). Collection months according to Barber (1951) and Lloyd (2018) include March, April, May, and June. Prior to observations of this taxon by C.M.H. in April 2015 and 2016, when it occupied a large portion of St. Vincent Island National Wildlife Refuge, Franklin County, Florida, the species had not been reported since 1970 (Ecdysis 2026d).

***Photuris potomaca* Barber, 1951.** Prior to rediscovery, the last confirmed record of *Photuris potomaca* was in 1978, although it is possible L.F.F. observed a healthy population at Swartswood State Park in New Jersey in early July 2014 (Faust 2017). It was suspected by some to be extinct until 2022, when extensive search efforts by biologists with the West Virginia Natural Heritage Program led to the discovery of nine occupied sites within the species' historical Potomac River watershed in West Virginia and Maryland, as well as four sites in the Monongahela River basin of West Virginia, where it had not previously been reported (Frantz et al. 2024). Furthermore, the authors were able to collect detailed habitat information for each of the sites, characterizing them as distinct riverscours ecosystems (Estes et al. 2023) and described as "early successional riverside habitat containing cobblestone beaches, driftwood, and sapling American sycamores (*Platanus occidentalis* L.; Platanaceae)," which may help guide future survey efforts for this species in the area. Additional surveys throughout the rest of its historic range could lead to additional detections of the species; for example, it is suspected to occur along a tributary to the Ohio River in southeast Ohio, based on flash pattern observations, seasonality, and habitat (L. Hughes pers. comm. 2024),

***Pterotus curticornis* Chemsak, 1978.** Prior to rediscovery, the last known collection of *Pterotus curticornis* was in 1963, and the species was confirmed only from its type locality at the Boyd Deep Canyon Research Center in Riv-

erside County, southern California (Chemsak and Chemsak 1978). The Center encompasses a major drainage system at the foot of the Santa Rosa Mountains, with habitat types ranging from montane forest and pinyon-juniper chaparral to sandy washes across a broad alluvial fan where the canyon meets the valley (University of California Riverside 2025). Unfortunately, it is unknown where the species was found within the Center, as locality information is imprecise.

In February 2026, two iNaturalist observations of a single male were posted for this species from Borrego Palm Canyon in Anza Borrego Desert State Park approximately 25 miles south of the type locality (Bailey 2026; nmoorhatch 2026). The individual was observed in the early morning on an immature flowerhead of Newberry's velvet mallow (*Horsfordia newberryi*).

There are but two species in this genus. The other species, *Pterotus obscuripennis*, is more common and widespread, being found along the Pacific coast from southern Washington to Baja California, Mexico. While little is known about the ecology of *Pterotus curticornis* in particular, female *Pterotus obscuripennis* are grub-like, large, and soft-bodied, and give off luminous glows, while adult males are winged and non-luminous (Dean 1979). It is likely that *Pterotus curticornis* adult females are similar. *Pterotus* larvae feed primarily on snails and, in *Pterotus obscuripennis*, are found in well-drained, moist areas, often in field or meadows surrounded by forests of spruce, redwood, or fir (Dean 1979). Given the two known locations for *Pterotus curticornis*, larval habitat for this species is likely quite different.

Based on the antennae of males, females may employ pheromone cues to attract males to their vicinity, then guide the males further by emitting a glow. Further details on the life history of *Pterotus curticornis* are unknown. However, if the larvae of this species are similar to *Pterotus obscuripennis*, they may be active and detectable outside of the summer months, when conditions are damp (e.g., Dean 1979;

iNaturalist 2026b). Because the type specimen reportedly came to a light trap (GBIF.org 2023), additional surveys for adults should focus on using this method (UV and mercury vapor lights) across various habitat types at the Boyd Deep Canyon Research Center and Anza Borrego Desert State Park from February through April. Because there is some debate as to whether *Pterotus curticornis* and *Pterotus obscuripennis* are conspecific variations (J.C. in Bailey 2026), DNA barcoding may provide useful insights.

***Pyractomena palustris* Green, 1957.** The known range of this wetland specialist includes Arkansas, Delaware, Maryland, Mississippi, Tennessee, and Virginia. Adult males emit a long, flare-like yellow flash, often as their flight paths descend into or just above the vegetation.

Prior to rediscovery, *Pyractomena palustris* had last been documented by J.E.L. sometime in the 1980s near the Hiwassee River in Tennessee (Faust 2017). Decades later, in May 2022, it was discovered extant at a site in Delaware by C.M.H., followed by another documented location in Delaware by a state biologist in 2025 (J. Davis pers. comm. 2025). In 2026, L.F.F. found a population less than ten miles from J.E.L.'s original Hiwassee site in Polk County, Tennessee, in addition to populations in Hamilton and Knox Counties, Tennessee. Genetic analyses of individuals from these sites are forthcoming.

Other sightings of this species have been reported in recent decades. L.F.F. and several other firefly researchers may have found this species while conducting surveys in the Allegheny National Forest in 2012 (Faust 2017); however, given the difficulties in identifying this species, the identifications remain tentative. Several specimens collected at Thayer Farm, Otsego County, New York, in the summers of 2017 and 2018 and identified as *Pyractomena palustris* were COI DNA-barcoded as part of a master's thesis (Cassata 2019). While possibly identified correctly, these sequences and specimens should be treated with caution, given the possibility of misidentification. In the analyses reported by Cassata (2019), the *Pyractomena*

palustris specimens appear on a branch shared with samples identified as *Pyractomena borealis* and *Pyractomena linearis* (BOLD v4 2025). An additional COI barcode sequence from a specimen collected by J.E.L. may be a more reliable reference, but the date and locality of collection are not currently available (Stanger-Hall et al. 2007, GenBank accession EU009309.1). Ideally, these sites, as well as Kenilworth Aquatic Park and Gardens (the type locality) could be revisited to search for the species and record flash pattern details. L.F.F. visited Kenilworth 10–11 June 2026 and was unable to confirm the species' presence, although it may have been too late in the season. *Pyractomena palustris* is difficult to identify unless flash patterns are observed (Faust 2017), and even then, identification is complicated by its alignment with the *Pyractomena linearis/dispersa/palustris* species complex, which requires additional work to resolve taxonomic relationships (Lloyd 2018).

***Pyractomena similis* Green, 1957.** *Pyractomena similis* was historically found in Washington D.C., Maryland, Virginia, South Carolina, Alabama, and Mississippi (Lloyd 2018). Until its rediscovery, it had not been recorded since 1983 (Lloyd 2018). Increased search efforts, bolstered by Re:wild's 2024 listing of the species, led to two new observations in 2026. On 15 May, several males were observed displaying over a large meadow on the Janelia Research Campus in Leesburg, Virginia (aljnrn 2026a). Just two weeks later, on 28 May, an additional population was observed in a nearby meadow (aljnrn 2026b). Then on 3 June, C.M.H. observed this species in a managed Piedmont meadow at Brandywine Creek State Park north of Wilmington, Delaware—a new state record. In all three cases, careful documentation of flash pattern details and collection of voucher samples helped to confirm species identification, which requires examination of the male genitalia and pubescence patterns on the elytra.

It appears the distribution remains disjunct, as ample survey effort in North Carolina and

Georgia failed to find the species (Lloyd 2018). Much of the historic locality information for this species is imprecise, which may have contributed to the limited number of recent records. However, Lloyd (2018) gives precise locality information for a site in Virginia: "*Py. similis* was seen on an old field slope about 50 yards east of the Appomattox River, at Appomattox Courthouse, Virginia, a half mile below the Courthouse and a dozen yards from the spot that tradition says General Robert E. Lee waited under an apple tree for word from General Grant regarding plans for ending the Civil War. It also occurred near the Confederate cemetery a quarter of a mile above the Courthouse, in a mowed field next to the Raine monument." These Appomattox Courthouse sites were surveyed on 11 May 2024, but the species was not detected (Moskwik 2024). However, the survey was only about 30 minutes long, and temperatures were low (~13–14°C, or 55–57°F). Additional surveys at this site are warranted.

Specific habitat for this firefly is not well understood, though the species has been recorded in open fields in proximity to riparian areas and ponds. Adults are active in May and June in the northern portions of their range, and mid-April through May in the southern portions of their range. Male courtship displays consist mostly of strings of quick, amber flashes emitted at short intervals. Though it is most easily confused with *Pyractomena angulata*, pinned specimens of the firefly can be reliably identified by dissection of the male genitalia. The flashes of these two species are also distinct, and the early seasonal timing of *Pyractomena similis* should make it easy to identify in the field (Lloyd 2018).

Threats

While the rarity of observations of many of the lost species may be a result of limited survey effort or difficulties in detection or identification, others may be lost due to decline of abundance or range, and therefore at risk of extinction (Fallon et al. 2022). The majority of species on

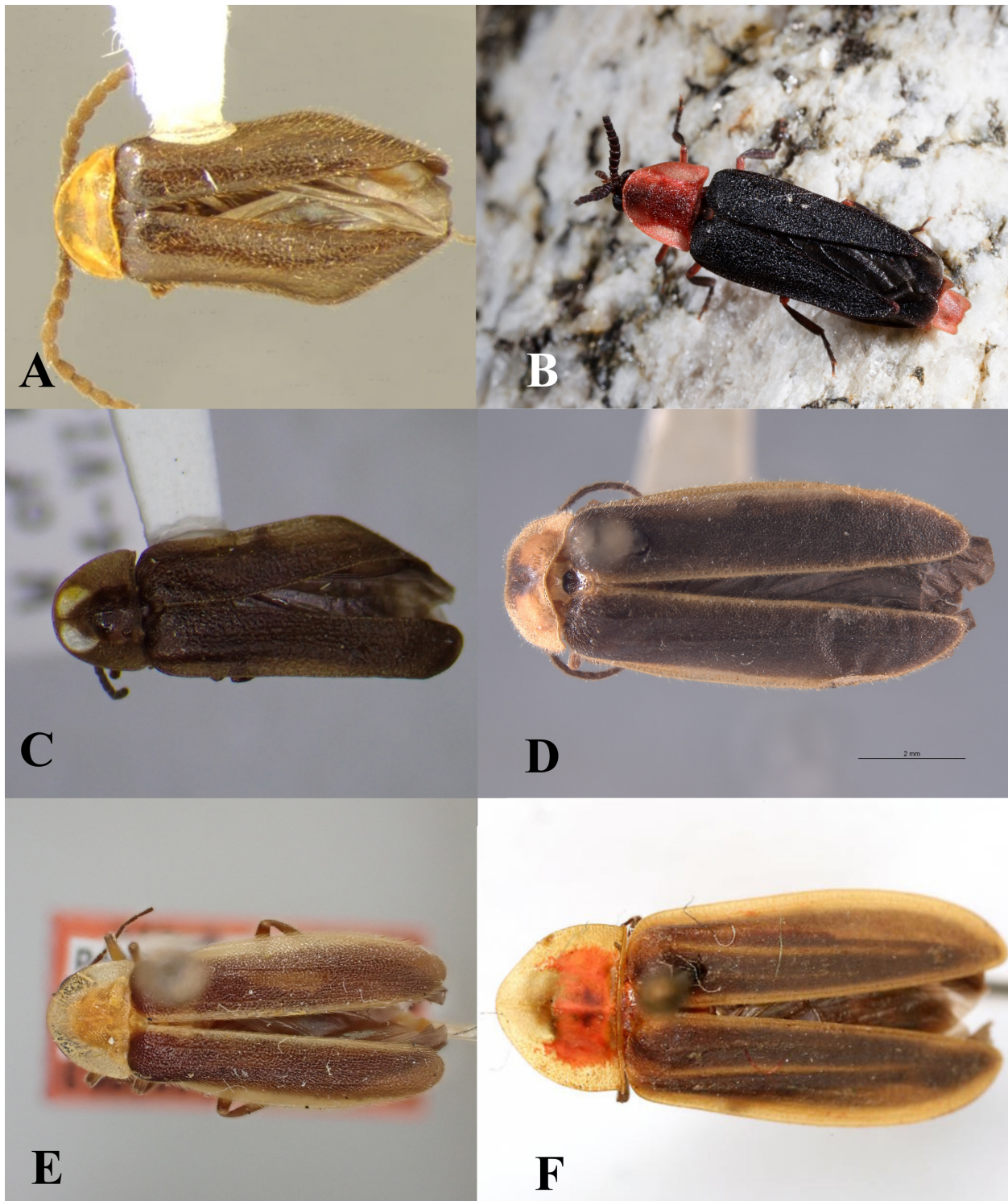


Figure 10. A selection of lost fireflies of the US and Canada: (a) *Brachylampis sanguinicollis* Van Dyke, 1939, Santa Barbara Museum of Natural History Entomology Collection, CC0-Public Domain, (b) *Nelsonphotus aridus* Cicero, 2006, by Joyce Gross (used with permission), (c) *Phausis skelleyi* Fender, 1962, Oregon Department of Agriculture Insect Collection, by Candace Fallon/Xerces Society, (d) *Photinus frosti* Green, 1956, California Academy of Sciences, CC0 Public-Domain, (e) *Photuris floridana* Barber, 1951, J.E.L. Collection at the University of Florida/Marc Branham, by Richard Joyce/Xerces Society, and (f) *Pyractomena vexillaria* Gorham, 1881, C.A. Triplehorn Insect Collection, OSUC 497738, by Mike Quinn (used with permission).

this lost list are likely both under-surveyed and threatened. Lost species ecologies are poorly understood, and therefore there is an extreme paucity of data documenting species-specific threats (Fallon et al. 2021). However, because of shared biological attributes and geographical characteristics, we can infer shared drivers of decline that should be prioritized in research on lost fireflies. These drivers, which have been more comprehensively characterized in previous work (Fallon et al. 2021; Lewis et al. 2020, 2024) generally fall into one of four primary threat types: (1) habitat loss, (2) light pollution, (3) pesticide use, and (4) climate change.

Habitat loss—from agriculture, ranching, commercial and residential development, and surface water diversion—has been identified as the largest threat to fireflies (Lewis et al. 2020). Aquifer depletion by surface water diversion and groundwater pumping, wastewater discharge, invasive plant species, and large water-management projects such as dams degrade riparian and wetland habitats critical for larval development. Both aquifer depletion and invasive plants have been recognized as threats to the Bethany Beach firefly, *Photuris bethaniensis* McDermott, 1953 (Heckscher and Bartlett 2004), which has been proposed for Endangered Species Act listing (U.S. Fish and Wildlife Service 2024). Fireflies typically depend on moist soils, leaf litter, wetlands, and riparian corridors, making them particularly vulnerable to land-use change, fragmentation, and altered microclimates—all threats that disproportionately affect small-ranged species (Staude et al. 2020). Numerous assessed species, including *Photuris pyralomima*, *Pyractomena vexillaria*, and *Photinus immaculatus* are threatened by agricultural conversion, urban expansion, and loss of early successional or marsh habitats (Heckscher and Walker 2021; Pfeiffer and Walker 2021; Walker et al. 2022).

Light pollution is another major threat that disrupts courtship signaling, predator defense, circadian rhythms, visual sensitivity, and mate recognition (Firebaugh and Haynes 2016; Firebaugh and Haynes 2019; Horridge 1969; Lall

1993; Oba and Kainuma 2009; Owens and Lewis 2018; Owens and Lewis 2021; Saunders 2009). Artificial light at night (ALAN) reduces signal contrast, inhibits dark adaptation of the eye, and in some species attracts adult males towards artificial light sources, reducing chances for mating success and thereby lowering reproductive output (Owens and Lewis 2018).

Pesticides are not always identified as a direct threat to fireflies, unfortunately due to a lack of information as opposed to documented resiliency (Fallon et al. 2022; Lewis et al. 2020). Available evidence indicates that fireflies exhibit toxicity thresholds similar to other arthropods and that sub-lethal exposure can impair larval behavior, metabolism, and survivorship (Disque et al. 2019; Lee et al. 2008; Pearsons et al. 2021). More research is necessary to determine how pesticide exposure through the environment, not only through soil but via prey invertebrates, plants, water, and air may have lasting impacts on the health and resilience of firefly populations.

Climate change further compounds habitat loss, as warmer and drier conditions reduce soil moisture, alter hydrology, and shorten surface-water availability, particularly affecting aquatic and riparian species such as *Pyractomena barberi*, *Pyractomena floridana*, and *Pyractomena limbicollis*, which are subject to predicted increases in drought conditions in Florida in coming years (Khattar et al. 2022; Lewis et al. 2020; Walker 2021a; Walker 2021b; Walker 2021c).

All the above stressors are particularly threatening to species that are limited in their ability to colonize new areas of habitat. Many of the lost species appear to be endemic at the state level (as inferred by state-level records), and therefore are probably highly locally adapted to environmental conditions (Kawecki and Ebert 2004). An endemic species like *Brachylampis sanguinicollis* likely does not have the adaptive capacity to move to a new site when existing habitat is degraded by pollutants or development, even if the degradation occurs slowly and similar habitat is nearby (Manes et

al. 2021; Staude et al. 2020). This limitation is more severe when habitat is highly geographically restricted, and may be the reason many of the lost species are associated with the arid West, where water sources required for development are small and/or discontinuous (Sosa et al. 2020). Some fireflies are also physiologically dispersal limited; species with apterous females cannot disperse by flight, and species with winged females are generally thought to be very weak fliers that rarely move beyond their natal habitat (Faust 2017; Lewis et al. 2020), leaving the critical role of species dispersal to ambulation of the larvae.

CONCLUSION

While our study reveals that 16% of the described firefly fauna of the US and Canada has not been documented in over a decade, it is likely that at least some of these species remain extant, and have not been reported due a lack of survey effort and species-specific knowledge or confusion over species identity due to unresolved taxonomic relationships. Nearly half the region's firefly species are categorized as Data Deficient, and populations of many of these species remain overlooked due to specialized habitat requirements, nocturnal or diurnal behaviors that evade casual observation, and complex taxonomic histories and flash displays that complicate species identification. This gap in knowledge creates a conservation quandary: we cannot protect what we have not found. To bridge this divide and ensure that lost species are not lost forever to these issues and the growing threats of habitat loss, light pollution, climate change, and pesticide use, focused scientific and public intervention is essential.

Our findings highlight the need for more surveys and studies of data deficient firefly species, in addition to taxonomic revisions to solidify species relationships. That said, two species (*Photuris patriei* and *Photuris pyralomima*) on the list do appear to potentially be

extinct, or extremely rare. These species in particular should be sought out at their type localities and other known historic locations to determine if their populations remain extant. If so, safeguarding their habitat, restoring it as needed, and surveying nearby sites where the species may occur are important next steps.

Regional efforts to learn more about firefly populations may be especially important for developing updated keys, species checklists, and field guides. In particular, community science has proven helpful in not only documenting species distributions but also rediscovering previously lost species. This includes observations on platforms like iNaturalist, BugGuide, and Firefly Atlas. Community scientists can help researchers map the distribution of lost and data deficient species by continuing to post to these platforms; some, like Firefly Atlas, also document search effort for species that are not detected and prompt participants to enter environmental and flash pattern data that can help with identification. Clear photographs showing dorsal and ventral details and body length would further help firefly experts with species confirmations. In some cases, where close inspection of internal and external morphology is needed, voucher specimens collected and deposited with regional institutions could be appropriate if collected with necessary permits and permissions.

Review of existing collections at universities, colleges, and museums may lead to additional discoveries. In addition to organized collections that have yet to be digitized (and thus made widely available to researchers), many institutions hold drawers of unsorted material that is worthy of examination; these reviews could lead to the discovery of additional localities and collection dates for lost species, or even to formal descriptions of new species that warrant survey efforts (e.g., Ferreira 2024; Ferreira et al. 2022).

Support for taxonomic and phylogenetic research is also needed, particularly for understudied western species. While rediscovering lost species fills critical data gaps, it also has

the potential to disrupt established taxonomic classifications, underscoring the need for increased attention, infrastructure, and funding to accurately document and manage these findings.

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Data accessibility

No new data were generated or analyzed in this study. With the exception of personal observations and personal communications, data used are publicly available from the published literature and online platforms including iNaturalist, Firefly Atlas, GBIF, Ecdysis, BugGuide, GenBank, and from voucher collections referenced herein.

Author contributions

C.E.F., A.C.W., R.J., and Q.B. conceived the study. A.C.W. compiled the initial list for Re:wild upon which we built this study. C.E.F. wrote the first draft of this manuscript with significant contributions from A.C.W., R.J., and Q.B.. All authors contributed information for species statuses and reviewed and edited subsequent versions. C.E.F., A.C.W., R.J., and Q.B. compiled and curated data. Q.B. created Figs. 1–9. C.E.F. created Fig. 10. All authors read and approved the final manuscript.

Ethical standards and competing interests

Findings from this study were based on publicly available specimen records, author observations, and personal communications. No permits were required to compile the information contained herein. The authors declare no competing interests.

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