USDA United States Department of Agriculture
Natural Resources Conservation Service

Frosted Elfin (Callophrys irus irus)

Field Guide

The frosted elfin (Callophrys irus irus) is a gossamer-wing butterfly with brown forewings and frosted gray with a dark spot and irregular dark line on the underside of the tailed hind wings. The larvae (caterpillars) are pale greenish white with a pale lateral line and oblique dashes along the sides and covered in short whitish hairs. At one time it was found surrounding the Great Lakes and along the east coast from New Hampshire to Florida and west to Texas (USFWS 2018). Habitat alteration, including loss of specific food plants and places to live/grow during critical stages of its life cycle has, over the past 30 years, reduced the species' range and abundance. Frosted elfin now occurs primarily in local colonies of remnant habitats along the eastern coast, Great Lakes, and Texas/ Louisiana borders.

Photo Courtesy of Will Cook

This species is considered critically imperiled in Pennsylvania (Nature Serve 2019) with historic records scattered primarily in the eastern third of the state. The U.S. Fish and Wildlife Service (USFWS) is proactively assessing the conservation status of the frosted elfin to determine whether or not the species may warrant Federal protection under the Endangered Species Act. USFWS has completed Stages 1 and 2 of the Species Status Assessment (SSA; USFWS 2018). Assessing the species viability in light of ongoing conservation efforts (Stage 3) will be performed prior to making a listing determination (USFWS 2018). Through the SSA process, it was evident that data concerning species distribution and habitat were greatly lacking. Surveys were conducted on locations with more recent observations. Survey results will be used to further refine priority restoration areas.

LIFE HISTORY

The entire lifecycle of a frosted elfin is completed within 1 year. This non-migratory butterfly has one flight from late April through mid-June in the north (Williams et al, 2014; NYNHP 2019). Eggs are laid singly on the apical shoot (a small population of stem cells that generates organs and tissues), a flower bud or bud stalks of the host plant (WDNR 2019). Eggs are reported to hatch in 1 week (Albanese et al. 2008). The caterpillars progress through four instars while feeding on both flowers and developing seedpods of host plants. Larvae pupate by late July in the northeast (Albanese et al. 2008), and remain in pupal diapause until the following spring. Hibernation occurs in loose cocoons on or near host plants in litter or beneath the soil surface (Opler and Krizek 1984; NYNHP 2019).

HABITAT

Frosted elfin butterflies require open woods, forest edges, and scrub in which their larval hostplants grow (Wagner et al. 2003; see "Larval Hostplants" section below). Historic habitats included pine barrens, oak savannas, and dry oak forests. Although females lay eggs on hostplants throughout the habitat, hostplants with some canopy shade have higher larval survival (Albanese et al. 2008). In Wisconsin, the majority of occupied habitats (97%) that were observed ranged from 2 to 79 acres (Swengel 1996). Frosted elfin density has also been correlated with higher density of indigo plants (Albanese et al. 2007). Dispersal distances greater than 2 km are considered unlikely across areas without host plants (NatureServe 2019).

As these habitat types have been lost, this butterfly has become increasingly restricted to areas with frequent anthropogenic disturbances such as utility rights-of-way, railroad corridors, recreational trails, and airport buffers (Shepherd 2005), becoming a remnant-dependent species. Frosted elfin was found more often than expected in areas that were disturbed by mowing or natural fires; but less often than expected in areas that received rotational burns (Swengel 1996). This observation could be attributed to the fact that fire-managed sites have more frequent fires, whereas a single wildfire creates new habitat to be colonized over many years (ECCC 2017).

LARVAL HOSTPLANTS

The primary hostplants are yellow wild indigo (Baptisia tinctoria) and wild lupine (Lupinus perennis), which thrive in dry woodland habitats with frequent fires (Anderson 2006; USFS 2018). The adults will occasionally use yellow wild indigo (B. australis) and arrowhead rattlebox (Crotalaria sagittalis) (Shepherd 2005). All known populations in Pennsylvania are associated with yellow, not blue wild indigo (USFWS 2018). Males are territorial, so multiple patches of host plants are needed to accommodate several territories (Swengel 1996). Larvae were more likely to be found on large (greater than 6.5 square feet) indigo plants (Albanese et al. 2008).

Photo Courtesy of Sara Bright

ADULT NECTAR PLANTS

Adult frosted elfin are nectarivores. The adult frosted elfin is a flower generalist, primarily requiring only successional blooming from early spring through mid-summer. As adults are almost always found within 50 feet of one of the larval hostplants (NYNHP 2019), the nectar supply is needed in the same habitat. They have been observed feeding on a variety of flowers including wild lupine and bird-foot violet (Viola pedata) (Swengel 1996), blueberry (Vaccinium spp.) and huckleberry (Gaylussacia spp.) (Thom 2013), pin cherry (Prunus pensylvanica), sweetbells (Leucothoe racemosa), and staggerbush (Lyonia mariana) (Schweitzer et al. 2011), and Rubus spp. (Allen 1997). Adult frosted elfins were also reported to feed on moist sand (Swengel 1996), likely a source for salts and minerals.

HABITAT RESTORATION RECOMMENDATIONS

Priority areas in Pennsylvania

Note: Please do not share the information below regarding locations of frosted elfin populations, as they may be the last in Pennsylvania, thus they are very vunerable for collection.

Primary - Dry, open wooded areas, particularly near utility corridors, in Centre County surrounding State Game Land (SGL) 176 and State Forest land in Huntingdon County. If populations become established near State College, then expand into neighboring counties with suitable habitat characteristics, focusing on corridors such as utility rights-of way.

Secondary - Dry, open wooded areas surrounding Goat Hill Preserve in Chester and Lancaster Counties and surrounding Fort Indiantown Gap in Lebanon County with expansion into non-urban areas of York, Dauphin, Schuylkill, and Berks Counties

Secondary - Dry, open wooded areas in Monroe County surrounding SGL 038 and Big Pocono State Park and non-urban habitat surrounding Stafford Bald Natural Area in Lackawanna County.

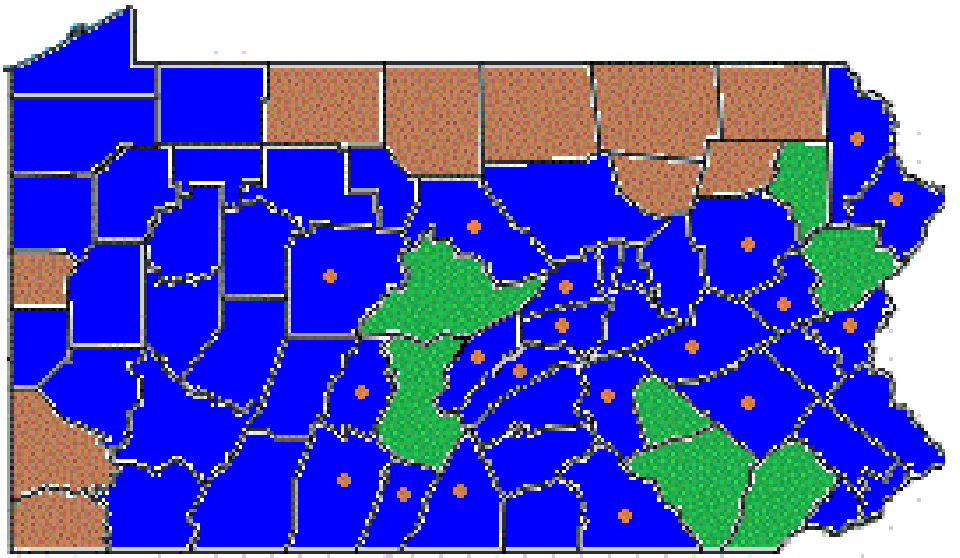

Figure 1. Historic (blue) distribution and priority areas (green) of frosted elfin in Pennsylvania. Counties with orange markers are targeted expansion areas. Counties not known to support hostplants (brown) are lowest priority.

Habitat Sub-Types and Target Species

1) Dry open pine-oak woods, forest edges, and scrub; disturbance dependent
   a. Larval host plants – limiting factor for reproduction
      i. Yellow Wild Indigo (Baptisia tinctoria) –
         1. only hostplant known to be used by frosted elfin in Pennsylvania
         2. hostplant for other butterfly and moth larvae
         3. grows in coarse to medium soils with pH 5.8 to 7.0
         4. throughout PA except Lawrence, Washington, Greene, McKean, Potter, Tioga, Bradford, Sullivan, Susquehanna, and Wyoming Counties

      ii. Wild Lupine (Lupinus perennis) –
         1. Known to be used by frosted elfin in NY, DE, MA, and VA
         2. Lake Erie Basin, Western Allegheny Mountains, Ridge and Valley, and Piedmont Counties except for urban zones

      iii. Blue Wild Indigo (B. australis) –
         1. Rare observances of frosted elfin larvae, but used by other butterflies
         2. Erie, Warren, Forest, Venango, Clarion, Armstrong, Beaver, Allegheny, Washington, Luzerne, and Montgomery Counties

      iv. Arrowhead Rattlebox (Crotalaria sagittalis) –
         1. Rare observances of frosted elfin larvae, but used by other butterflies and moths
         2. Piedmont and Huntingdon, Bedford, Franklin and likely Fulton Counties.

2) Adult nectar sources (documented and likely based on habitat and bloom time) –
   a. critical to span period from early April to early July; flower generalists
   b. includes early blooming trees and shrubs

COMMON NAME	SPECIES	RANGE IN PA
Forbs		
Blue Wild Indigo	*Baptisia australis*	See larval hostplants
Yellow Wild Indigo	*Baptisia tinctoria*	See larval hostplants
Wild Lupine	*Lupinus perennis*	See larval hostplants
Wild Bergamot	*Monarda fistulosa*	Throughout
Appalachian Beardtongue	*Penstemon canescens*	South Central
Smooth Penstemon	*Penstemon digitalis*	Throughout
Hoary Mountainmint	*Pycnanthemum incanum*	All but Allegheny Watershed
Bigleaf Mountainmint	*Pycnanthemum muticum*	Southeast
Virginia Mountainmint	*Pycnanthemum virginianum*	All but Northern Tier
Violets (blue/purple)	*Viola spp.*	Throughout
Shrubs		
New Jersey Tea	*Ceanothus americanus*	Throughout
Black Huckleberry	*Gaylussacia baccata*	Throughout
Staggerbush	*Lyonia mariana*	Southeast
Sand Cherry	*Prunus pumila*	Counties surrounding Pittsburgh, Erie, Centre, Clearfield, Franklin, Perry, and all eastern counties
Carolina Rose	*Rosa carolina*	All but Northern Tier
Berry Canes	*Rubus spp*	Throughout
Lowbush Blueberry[1]	*Vaccinium angustifolium*	Throughout
Hillside Blueberry[1]	*Vaccinium pallidum*	Throughout
Trees		
Eastern Redbud	*Cercis Canadensis*	All Southern Counties
Pin Cherry	*Prunus pensylvanica*	All Except Washington, Greene, Adams, and York Counties

[1] Observations indicate that Vaccinium spp. are preferred nectar plants.

Restoration Approaches

Objective: The preferred habitat is semi-open canopy (6 to 50 percent cover) with a mosaic of canopy cover and vegetation types (e.g., thickets, open glades, forest patches, herbaceous openings). It must contain diverse nectar species for frosted elfin adults and abundant host plants [primarily yellow wild indigo in PA] (USFWS 2018).

Yellow wild indigo prefers growing in dry, sunny locations in gravel, sandy or well-drained loamy soils and tolerates highly acidic soils. It occurs on sand hills, pine woods, xeric woodlands, ridges and road banks (Belt 2012) that undergo frequent disturbance (e.g., utility rights-of-way, railway corridors). Priority areas

for introduction of hostplants are open and denuded forest edges where competition will be minimal. Providing hostplants with a diverse range of microhabitat conditions may be vital to the long-term persistence of colonies (Albanese et al. 2008). Host plants should cover at least 6 acres (USFWS 2018), but can be as small as 2.5 acres if the hostplants are planted densely (Pfitsch and Williams 2009).

Multiple patches of habitat for a given population may be important to provide varying canopy cover and a range of microhabitat characteristics that will support suitable habitat conditions despite annual variation in weather (USFWS 2018). This species nearly always occurs in clusters of populations that function as metapopulations and small habitat patches may be unoccupied in some years. Females will disperse within the habitat and larvae can turn up in appropriate patches where adults are not usually seen. (NYNHP 2019).

As the habitat requires a sparse canopy cover or adjacent forest edge, restoration projects should be chosen where these wooded habitats already exist. Restoration effort should focus on creating hostplant patches interspersed with adult nectar sources.

1) Barren or fallow area conversion adjacent to forest edge
   - Herbicide – One application to control weeds
   - Dry Meadow seed mixes for nectar areas -
     - fall with winter rye or spring without
     - include blue lupine and blue wild indigo as secondary hostplants
   - Yellow wild indigo seeds (fall or spring) or plugs (spring only) for 2 acres of larval patches
     - Do not mix seeds or interplant with other species
     - Seed at 2 lbs/ac (13 seeds/ ft^2) to achieve one seedling/ft^2 to create dense patches
     - Plant dense patches using a 3' spacing for plugs for at least 4,000/acre

2) Scrub conversion within dry open woods (less than 50% canopy)
   - Stump treat and/or grub – Fall or Spring to create openings (5-6 acres)
   - Dry Meadow seed mixes for nectar areas –
     - fall with winter rye or spring without
     - include blue lupine and blue wild indigo as secondary hostplants
   - Yellow wild indigo seeds (fall or spring) or plugs (spring only) for 2 acres of larval patches
     - Do not mix seeds or interplant with other species
     - Seed at 2 lbs/ac (13 seeds/ ft^2) to achieve 1 seedling/ft^2 to create dense patches
     - Plant plugs in dense patches using a 3' spacing for at least 4,000/acre

3) Warm-season grass plantings or native meadow enhancement with more than 6% canopy (spring only)
   - Mowing patches to create openings (sufficient to create 5-6 acres overall)
   - Forb plugs for nectar areas
     - sufficient to create or supplement adult habitat
     - include some blue lupine and blue wild indigo as secondary hostplants
   - Yellow wild indigo plugs for 2 acres of larval patches
     - Do not interplant with other species
     - Plant plugs in dense patches using a 3' spacing for at least 4,000/acre

LONG-TERM MAINTENANCE

Frosted elfin habitat requires periodic disturbance to impede succession and retain openings.

1) Existing Habitat
   - The species presence must be documented. Local naturalists should be queried to document their observations. Surveys should be conducted using the methods and schedule from (USFWS 2019, McElveen, 2018). Given the rarity of this species, vouchers are not necessary. Detailed photo documentation is warranted.
   - If present, evaluate the existing disturbance regime (e.g., burning, mowing, herbicides). Disturbances should be used on small proportions (≤ 1/4) of the occupied habitat in any 1 year and in scattered patches to create a mosaic of post-disturbance successional stage habitats. Management activities should be done during the dormant season to avoid destroying eggs or larvae. Intervals of 4 to 6 years should be used to accommodate nectar areas and hostplants. Shrub control cycle can be longer depending on species' growth rates. Measures (e.g., washing equipment, managing borders) should be implemented to control the spread of non-native plants into habitat as yellow wild indigo is intolerant of competition.
   - Mowing is more conductive to maintaining mosaics on divergent schedules than burning. Unlike burning, mowing can be used to improve select areas while providing refugia for pupae in the leaf litter. If mowing is currently practiced, ensure that cutting occurs before March 31 or after September 16 (WDNR 2019). Mowing the hostplants from May to July could eradicate or reduce occurrence (NYNHP 2019). Blade height should be 6 to 8 inches above ground surface to protect overwintering pupae.
   - Where an existing population has been maintained without fire, do not introduce fire. Sites currently managed with prescribed burning should be divided into several units with less than one-quarter of the habitat burned in each year (WDNR 2019) using a 4 - 6 year rotation (Swengel 1996).
   - Frosted elfin could be exposed during gypsy moth (Lymantria dispar) spraying given the canopy requirement. Spraying of Bt (Bacillus thuringiensis) likely poses a serious hazard to frosted elfin larvae (Shepherd 2005), although larvae of this species have not been tested (NYNHP 2019). Plan for spraying in adjacent forested habitats to occur prior to egg hatching or after pupation.
   - Limit herbicide use to spot and stump treatments to prevent loss of hostplants. If adjacent to crops, implement an adequate buffer to prevent effects from pesticide drift, including biocides.

2) Restored Habitat
   - Disturbances should be used on small proportions (no more than one-quarter) of the occupied habitat in any 1 year and in scattered patches to create a mosaic of post-disturbance successional stage habitats. Measures (e.g., washing equipment, managing borders) should be implemented to control spread of non-native plants into habitat as yellow wild indigo is intolerant of competition.
   - Winter mowing (September 1 to March 31) is the preferred management tool. The footprint of the machinery should be minimized in order to avoid crushing the pupae (NYNHP 2019) and blade height of 6 to 8 inches to provide pupae cover.
   - Maintain connectivity of colonies where they are clustered (less than 2 km separation) as it is likely to be critical for long-term persistence of populations (USFWS 2018).
   - Maintain hostplants and nectar areas on 3 to 5 year mowing cycle.
   - Maintain tree and shrub canopy at 6-50%
   - Maintain an adequate buffer to prevent effects from pesticide drift, including biocides. Limit herbicide use to stump or injection treatments.
   - Conduct surveys and/or use citizen scientists to monitor butterfly occupancy and adjust management based on occupancy

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