

Frosted Elfin Scoring Methods – Revised 2019 - New information in blue text

1) Data Source

For the 2018 Interim SSA, we requested any available information on current and historic frosted elfin populations from State, Federal, and Tribal partners, as well as species experts. We also obtained observation/voucher data from the Butterflies and Moths of North America database (BAMONA). We can use the BAMONA data to help target additional surveys and better understand the potential range of the species. However, in most cases, insufficient information was provided from BAMONA to assess the status of the site. Moving forward, BAMONA data will only be included in scoring when photographs and additional verification information was available. Data records were assembled in excel tables.

For sites without associated spatial data, spatial point locations were taken from center-points of counties or from Google map searches when more exact locational positions than county were provided. We combined all records into one population for those with the same latitude/longitude or for those within 2 km (1.24 mi) of each other. To do this, we buffered all the point locations by 1 km, and then dissolved the overlapping buffers to generate population polygons using the Buffer and Dissolve tools, respectively, in ArcGIS 10.6 for 2018 and ArcGIS Pro 2.2 in 2019.

We delineated the range for each subspecies by county.

We delineated the range of host plants by county.

In 2019, the U.S. Fish and Wildlife Service (Service) and U.S. Geological Survey (USGS) developed pilot range wide protocols. The survey protocols include three components: preliminary site evaluation, adult counts, and habitat assessment. The Service also provided paper data sheets and Survey123 online forms for standardized data collection.

2) Definition of Population

For the purposes of evaluating the condition of frosted elfin populations, we developed a working definition of “population”. After reviewing the best available information, including input from frosted elfin experts across the range, our working definition of a frosted elfin population includes these core concepts:

1. Frosted elfin populations consist of a group of many male and female butterflies.

2. Frosted elfins generally (but not always) function as metapopulations made up of multiple subpopulations (or individual populations) that interact with each other.
3. Frosted elfins rely on one of two larval host plant types (wild lupine or wild indigo) and do not occur when one of two host plants is not present.
4. Frosted elfins are sedentary (non-migratory); therefore, they are present within suitable habitat (see suitable habitat definition below) year-round.
5. Populations can be distinguished from one another by greater than 2 kilometers (km) (1.24 miles [mi]) of unsuitable habitat between wild lupine or wild indigo patches or by 10 km (6.21 mi) segments of suitable habitat (*i.e.*, rights-of-way) (see NatureServe 2015, p. 9 for additional thoughts).

3) Evaluation of Data by Population for Each Metric

Metrics - We [originally](#) proposed six metrics to assess the current condition of each population: last frosted elfin count, trend in frosted elfin counts, number of host plant patches, acreage of host plant patches, documented stressors, and overall habitat condition. After review of best available data provided, [for the interim SSA Report](#) we removed “trend in frosted elfin count” and “number of host plant patches” as metrics. We found that “trend in frosted elfin count” data were rarely available. For the majority of populations, the status of frosted elfin populations was unknown because last counts were conducted more than 10 years ago; therefore, trend was similarly unknown. We plan to work with species experts to collect additional frosted elfin count and trend data during future surveys, to consider it in our future analysis. We did not find the “number of host plant patches” to be a meaningful metric at this time because it was rarely provided and likely sufficiently addressed with the acreage of host plant patches and overall habitat condition, but we will revisit this concept in the future as more surveys are conducted.

[In 2019](#), we removed “documented stressors” and added the “number of patches” as a new metric.

Frosted elfin last count

Rationale: This is the [peak](#) number of frosted elfins last counted across all transects (or other method) for a given population. The count could be based on one day or multiple days within the same season (if different locations within the population were sampled across multiple days). [We summed the peak counts across all sub-populations within a population to get an overall “peak count” for that population.](#) We assume population counts are correlated with actual population size. For example, Collier *et al.* (2008, p. 21) found a high correlation between Pollard transect

counts and population estimates derived from mark-release-recapture for the bitterbush blue (*Theclinesstes albocincta*), another Lycaenid butterfly.

Frosted elfin appear to have a naturally patchy or low level of abundance. Frosted elfins were never considered abundant in Canada (ECCC 2017, p. vi) and are currently not considered abundant anywhere in the range (NatureServe 2015, p. 2 “G3” Rank and all S ranks at or below S3; also see, Appendix B). Pfitsch and Williams (2009, p. 231) found that frosted elfin populations are never highly abundant and considered their transect counts of approximately 30 individuals to be large for the species.

There is uncertainty around accuracy of frosted elfin butterfly counts. We recognize that counts may not have been conducted during the peak flight period and would, therefore, be a lower count than the possible maximum for a given year. In addition, in captive and wild settings, a unique evasive behavior has been documented that may limit observations. When disturbed, adult butterflies may suddenly drop into leaf litter and “play dead”. Over time, we anticipate that more populations will be counted during peak flight period to obtain more accurate reflections of population health. Weather can influence butterfly flight; however, we designed protocols to address this as much as possible. Surveyor expertise may also factor into counts.

For the 2018 Interim SSA Report, we ranked this metric as follows: last count of less than 15 frosted elfin as low, 15 to 30 frosted elfin as moderate, and greater than 30 frosted elfin as high. Multiple surveys (e.g., 3 surveys within a 5-year period) with zero butterflies within suitable habitat would be considered extirpated.

In 2019, we modified scoring as follows: last count of less than or equal to 5 frosted elfin as low, 6 to 30 frosted elfin as moderate, and greater than 30 frosted elfin as high. Multiple surveys (e.g., 3 surveys within a 5-year period) with zero butterflies within suitable habitat would be considered extirpated.

Acreage of host plant patches

Rationale: Larger acreages should provide more habitat for larger populations. In addition, if parts of a patch are impacted by a stressor, if the patch is large enough, there may be some suitable habitat remaining.

In central Wisconsin, frosted elfin units typically contained a large patch or multiple smaller patches of high-density lupine (Swengel 1996, p. 56) with 50 percent of observed individuals occurring within patches greater than or equal to 5.93 acre (2.4 ha). Only 3 percent (5/149) were observed in lupine patches less than or equal to 0.99 ac (0.4 ha) with the remaining 97 percent observed in patches ranging from 1.98 to 79.07 ac (0.8 to 32 ha). Lupine occurs in dense patches in a dune area of less than 2.47 ac (1 ha) in central New York where a “large” population of

frosted elfin occurs (Pfitsch and Williams 2009, p. 227, 231). Similarly, in Florida, a seemingly healthy population of frosted elfin occurs within approximately 3.15 acres of suitable habitat spread across multiple patches (D. Jue, personal communication, 8/14/2019).

We summed the total acreage across subpopulations within a population for this metric.

We ranked **host plant** acreage of less than 0.99 ac (0.4 ha) as low, 1 to 2.47 ac (0.41 to 1 ha) as good, and greater than 2.47 ac (1 ha) as high.

Number of sub-populations – new metric in 2019

Rationale: Multiple patches (and sub-populations) should provide opportunities for recolonization of sub-populations within a metapopulation.

We ranked each population for this metric as follows: multiple sub-populations (2 or more sub-populations) as high and no sub-populations (1 patch) as low.

Documented stressors

Rationale: We assume that the more stressors affecting a population, the lower the population's resilience.

We are focusing on stressors that are considered likely to influence population viability. These include: human mediated causes of development, invasive plant species, natural causes of succession, and herbivory.

For the 2018 SSA, we ranked this metric as follows: 3 or more stressors as low, 1 to 2 stressors as moderate, and 0 stressors as high.

In 2019, we removed this metric for assessing current condition. We will consider stressor ranking in the future condition assessment. Stressor information will be retained for planning and prioritizing management.

Habitat condition

Rationale: Presence of suitable habitat is the primary driver affecting frosted elfin population status. Individual sites generally lack quantitative measurements for many habitat metrics and so we asked a simple yes/no for managers to assess whether habitat for the population is currently suitable using the description below. The 2019 survey protocols (SOP 3) included habitat metrics designed to provide more objective information about a site.

For the 2018 SSA Report, we considered habitat as suitable for frosted elfin when:

- The overall site condition is considered semi-open canopy (6 to 50 percent cover)
- There is a mosaic of canopy cover and vegetation types (*e.g.*, thickets, open glades, forest patches, herbaceous openings)
- There is presence of relatively abundant nectar species for frosted elfin adults
- There is presence of relatively abundant host plants (wild blue lupine/wild indigo)

In 2019, we began collecting information designed to test that description of suitability. Based on initial results, the qualitative assessment was validated. Therefore, we modified our scoring methods to incorporate the additional detailed information when available. However, qualitative assessments will still be incorporated for sites without additional habitat metrics.

Habitat is considered suitable for frosted elfin when:

- The overall site condition is considered **semi-open canopy** (6 to 50 percent cover)
 - 2019 binning:
 - 11-30% and 31-60% were considered suitable for a patch
 - 0-10% and >61% were considered as unsuitable for a patch
- There is a **mosaic** of canopy cover and vegetation types (*e.g.*, thickets, open glades, forest patches, herbaceous openings)
 - 2019 binning:
 - If any patch is >60% (Bin D) for grass or shrub or bare ground cover bins – we consider this unsuitable – dominance of any of these reduces suitability.
 - 0-10%, 11-30%, 31-60% – can all be suitable – it all depends on the mix.
- There is presence of relatively abundant nectar species for frosted elfin adults
 - In 2019, we did not collect information on nectar plants because there is debate about how much nectar is needed for adult frosted elfins
- There is presence of relatively **abundant host plants** (wild blue lupine/wild indigo)
 - In 2019, we collected information on host plant density in three ways (visual estimate, walking density estimate, and host plant counts)

The initial scoring appears similar regardless of use of visual density or walking density methods. We ranked populations using walking density scores this year.

- 2019 binning
 - Suitable – A, B, or C
 - Unsuitable – D, E

To score populations with multiple patches (sub-populations) we considered the following:

- Goal is for the majority of patches to have suitable habitat

- However, there are degrees of suitability

Therefore, we ranked the degree of suitability with a focus on host plant abundance

In 2018, we ranked populations with unsuitable habitat as low and suitable habitat as high.

In 2019, we used patch count and habitat assessment data to determine habitat suitability scores (see Figure A-1). For each patch, we applied our suitability rules to assign a suitability score (0 or 1) for canopy, mosaic/heterogeneity, and host plant abundance. We then multiplied these suitability scores by a population-proportional weight (1 / total # patches in population) so each patch contributed equally at the population level. We also multiplied the host plant abundance metric by two, to give it twice the weight of the other metrics. Finally, we summed the three metrics for each patch to determine the patch-level habitat suitability score, and then summed all of the patch scores within a population to calculate the population-level habitat suitability score (0-4).

Figure A-1. A demonstration of the 2019 Frosted Elfin habitat suitability scoring system using two example populations (Alpha and Beta, consisting of 3 and 4 patches, respectively). The patch-level survey data is used to determine the habitat suitability scores, which are then multiplied by the weights to calculate the patch metrics, and finally the metrics are summed to get the final patch-level habitat score. All of the patch suitability scores within a population are then summed to calculate a population-level score from 0 (no suitability at any level) to 4 (all measures within and among patches were suitable). Populations with a score between 0 and 2 are considered to have ‘unsuitable’ habitat and populations with scores greater than 2 are considered to have ‘suitable’ habitat.

Patch Level Data

Patch ID	Survey Data							Suitability			Weight	Metric			Score
	FE Count Max	Habitat Area	Canopy Cover	Bare Ground Cover	Grass/Herb Cover	Shrub Cover	Walking Density	Canopy Suit	Mosaic Suit	HP Abund Suit		Equal	Canopy Metric	Mosaic Metric	
Alpha-01	0	.2	0-10	61-100	11-30	11-30	D	0	0	0	.33	0	0	0	0
Alpha-02	3	1.5	31-60	11-30	11-30	0-10	B	1	1	1	.33	.33	.33	.66	1.33
Alpha-03	1	.3	11-30	11-30	61-100	0-10	D	1	0	0	.33	.33	0	0	.33
Bravo-01	0	.2	31-60	61-100	0-10	0-10	D	1	0	0	.25	.25	0	0	.25
Bravo-02	15	.2	31-60	11-30	0-10	0-10	B	1	1	1	.25	.25	.25	.50	1.25
Bravo-03	3	.1	0-10	0-10	11-30	31-60	C	0	1	1	.25	0	.25	.50	.75
Bravo-04	0	.1	0-10	0-10	0-10	61-100	D	0	0	0	.25	0	0	0	0

Scoring System - We developed a scoring system for each metric using existing available information (Table A-1). We then solicited expert review of the proposed metrics and thresholds. We assigned scores for each population and then normalized those scores. We modified the scoring system in 2019 (Table A-2).

Table A-1. 2018 scoring system for frosted elfin population metrics.

	Condition Class				
Metric	Unknown	Extirpated	Low	Moderate	High
FE last count	Unknown	NA	<15	15 to 30	>30
<i>Score</i>	0		-1	1	2
<i>Normalized score</i>	0.33		0	0.67	1.0
Acreage of host plant patches	Unknown	NA	≤0.99 ac (0.4 ha)	1 to 5.9 ac (0.41 to 2.4 ha)	>5.9 ac (>2.4 ha)
<i>Score</i>	0		-1	1	2
<i>Normalized score</i>	0.33		0	0.67	1.0
Documented stressors	unknown	NA	3+	1 to 2	0
<i>Score</i>	0		-1	1	2
<i>Normalized score</i>	0.33		0	0.67	1.0
Habitat condition	Unknown	NA	Unsuitable	NA	Suitable
<i>Score</i>	0		-1		1
<i>Normalized score</i>	0.5		0		1.0

Table A-2. 2019 scoring system for frosted elfin population metrics.

Population Metric	Metric Value	Condition Class	Condition Score
Frosted Elfin Last Count (Peak # Adults)	N/A	Unknown	0.33
	< 5	Low	0
	6-30	Moderate	0.67
	>30	High	1
Host Plant Area (Total Hectares)	N/A	Unknown	0.33
	<0.99	Low	0
	1 - 2.47	Moderate	0.67
	>1	High	1
Subpopulations (# Patches)	N/A	Unknown	0.33
	1	Low	0
	≥ 2	High	1
Habitat Condition (Suitability)	N/A	Unknown	0.33
	Suitable	Low	0
	Unsuitable	Moderate	1

4) Evaluation of Overall Population Condition

The following definitions were used to describe overall population condition.

Presumed Extirpated - Historical records indicate the presence of frosted elfin during at least one survey AND currently:

- Habitat is no longer suitable for frosted elfin; or
- Habitat is suitable for frosted elfin, but no butterflies were observed during multiple subsequent surveys (*e.g.*, 3 surveys within a 5-year period).

Unknown - At least one survey has indicated presence of frosted elfin AND currently:

- Habitat appears suitable for frosted elfin, but no butterfly surveys have been conducted in recent (10) years (*i.e.*, since 2009); or

- Habitat appears suitable, no butterflies have been observed during recent (10) years, but survey effort is considered insufficient to suggest “presumed extirpated”; or
- There is no information to indicate habitat condition or number of frosted elfin butterflies observed during last count.

For the remaining populations, we calculated the overall condition for each population based on the sum of the normalized scores.

Low Condition – 0 – 1.33 (up to 1 moderate metric)

Moderate Condition – 1.34 – 3.01 (up to 1 high metric)

High Condition – Greater than 3.01 (three or more high metrics)

Literature Cited

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