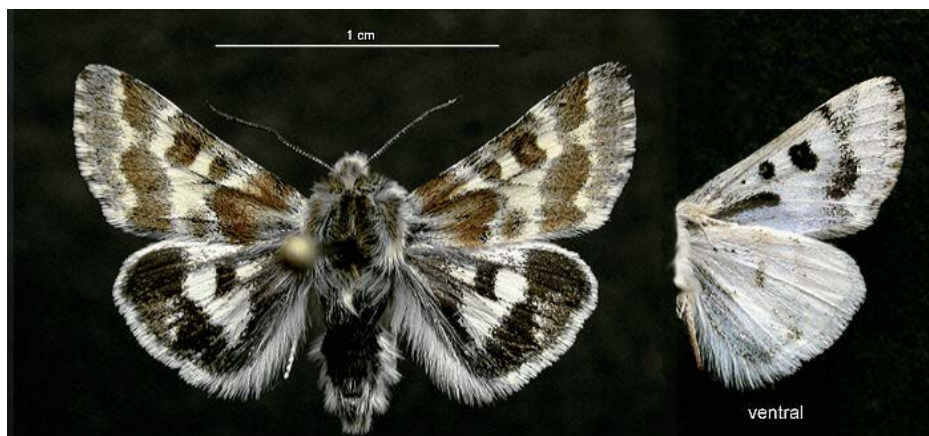


COSEWIC Assessment and Status Report

on the

Verna's Flower Moth *Schinia verna*

in Canada



**THREATENED
2017**

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada



COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Previous report(s):

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Production note:

COSEWIC would like to acknowledge Dr. Cory Sheffield for writing the status report on the Verna's Flower Moth *Schinia verna* in Canada, prepared under contract with Environment and Climate Change Canada. This report was overseen and edited by Dr. Paul Grant, Co-chair of the COSEWIC Arthropods Specialist Subcommittee.

For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment and Climate Change Canada
Ottawa, ON
K1A 0H3

Tel.: 819-938-4125

Fax: 819-938-3984

E-mail: ec.cosepac-cosewic.ec@canada.ca
<http://www.cosewic.gc.ca>

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Verna's Flower Moth — Photo by Gary Anweiler.

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COSEWIC Assessment Summary

Assessment Summary – November 2017

Common name

Verna's Flower Moth

Scientific name

Schinia verna

Status

Threatened

Reason for designation

This moth is endemic to the Canadian prairies. Despite much search effort over the past two decades, it has been found infrequently. This species is believed to be naturally rare within suitable prairie habitat, which is fragmented as a result of agricultural development. The total population is likely small (less than 10,000 adults), divided into smaller subpopulations, based on expert opinion, collection records, and extensive search effort at known localities of this moth.

Occurrence

Alberta, Saskatchewan, Manitoba

Status history

Designated Threatened in May 2005. Status re-examined and confirmed in November 2017.



COSEWIC Executive Summary

Verna's Flower Moth *Schinia verna*

Wildlife Species Description and Significance

Verna's Flower Moth is a small, day-flying sun moth. This species is part of the family of owlet moths, which are one of the most diverse groups of Lepidoptera and have a worldwide distribution.

The forewings of Verna's Flower Moth are marked with contrasting olive-brown and maroon patches on a white background. The hindwings are black and white, giving the moth an overall checkered appearance. Adults are relatively small with a stout body and wingspan of around 20 mm. Verna's Flower Moth depends on one or more species of the genus *Antennaria* for its entire life cycle.

Verna's Flower Moth was described as a species in 1983. Specimens date from 1929 – 2015, although there are few recent specimens, or additional information on its biology. It is suspected that the moth's restricted global range within the highly modified Canadian Prairies ecozone may contribute to its rarity, and partially explain the lack of records.

Distribution

The global and Canadian range for Verna's Flower Moth is restricted to the southern prairie habitats of Alberta (AB), Saskatchewan (SK) and Manitoba (MB). The easternmost locality is from Spruce Woods Provincial Park (MB) and the westernmost localities are from Jenner and Medicine Hat (AB). The species has not been reported outside of Canada and is likely a Canadian endemic.

Habitat

Verna's Flower Moth inhabits sparsely vegetated prairie grasslands where stands of their host plant, *Antennaria*, are common and widespread. However, there are likely other unknown factors which contribute to the presence of Verna's Flower Moth within a given habitat patch.

Biology

Verna's Flower Moth is a day-flying moth which undergoes complete metamorphosis through four life stages: egg, larva (feeding stage with multiple instars), pupa (non-feeding metamorphosis stage) and adult. This species has one generation per year. Although some sun moths are known to stay in the pupal stage for multiple years it is unknown if this occurs in Verna's Flower Moth. Pupae overwinter in shallow underground chambers. In general, adult flower moths are short-lived and may only survive for seven days. Verna's Flower Moth has a brief flight period from late May to mid-June. Their flight period is closely synchronized with the flowering of their larval and nectar food plants, *Antennaria*.

Population Sizes and Trends

No data are currently available on population sizes and trends for Verna's Flower Moth. Most Verna's Flower Moth records are single specimens which are the result of incidental collections. The exception is collections from the type locality, Glenboro (MB) where a total of 52 specimens have been collected. This is a fairly rare species, even within suitable habitats. Based on expert opinion, population densities of closely related species, collection records and search effort, it is inferred that the total Canadian population contains fewer than 10,000 mature individuals.

Threats and Limiting Factors

The primary threats to the species are unclear, but historical loss of prairie grassland habitat, current fragmentation and decline in quality and extent of habitat as a result of agricultural development, and problematic native and non-native species may negatively influence the persistence of this species. Light to moderate levels of grazing may be necessary to maintain larval food plant patches of suitable size and quality within native prairie. The occurrence of Verna's Flower Moth is limited by sufficient abundance of flowering *Antennaria* host plants and other unknown factors.

Protection, Status, and Ranks

Verna's Flower Moth is listed as Threatened under Schedule 1 of the federal *Species at Risk Act* (SARA). Non-legal statuses include: N2N3 (Imperiled to Vulnerable) in Canada, S2S3 (Imperiled to Vulnerable) in AB, S1 (Critically Imperiled) in SK, and S1S2 (Critically Imperiled to Imperiled) in MB. The rangewide rank of GU (Unrankable) is 11 years out of date.

TECHNICAL SUMMARY

Schinia verna

Verna's Flower Moth

Héliotin de Verna

Range of occurrence in Canada: Manitoba, Saskatchewan, Alberta

Demographic Information

Generation time	1 year
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes, inferred based on habitat loss/ degradation
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown.
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown.
Are the causes of the decline a) clearly reversible and b) understood and c) ceased?	a. Unknown. b. No. c. Unknown.
Are there extreme fluctuations in number of mature individuals?	Unknown, but unlikely.

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	157,421 km ²
Index of area of occupancy (IAO)	28 km ²
Is the population "severely fragmented" <i>i.e.</i> , is >50% of its total area of occupancy is in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. Unknown. b. Unknown.
Number of "locations"* (use plausible range to reflect uncertainty if appropriate)	Unknown. This species has a broad geographic range, and the threats to this species remain unclear. Therefore, locations could not be defined. This species occurs within at least 6 sites.

* See Definitions and Abbreviations on [COSEWIC website](#) and [IUCN](#) (Feb 2014) for more information on this term

Is there an [observed, inferred, or projected] decline in extent of occurrence?	Unknown.
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Unknown.
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Unknown.
Is there an [observed, inferred, or projected] decline in number of "locations"?	Unknown.
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Likely - Inferred decline in extent and quality due to agricultural development, invasive non-native species, and problematic native species.
Are there extreme fluctuations in number of subpopulations?	Not likely.
Are there extreme fluctuations in number of "locations"?	Not likely.
Are there extreme fluctuations in extent of occurrence?	Not likely.
Are there extreme fluctuations in index of area of occupancy?	Not likely.

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	N Mature Individuals
Total	< 10,000

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Unknown. No data available to complete analysis.
--	--

Threats

Was a threats calculator completed for this species? Yes. The threat impact was calculated at Medium-Low. However, threats are unclear and mostly historical.

- 2.1 Annual & perennial non-timber crops (medium – low impact).
- 8.1 Invasive non-native/alien species (low impact)
- 8.2 Problematic native species (low impact)

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Not applicable. The species is suspected to be endemic to Canada.
Is immigration known or possible?	Not applicable.
Would immigrants be adapted to survive in Canada?	Not applicable.
Is there sufficient habitat for immigrants in Canada?	Not applicable.
Are conditions deteriorating in Canada? ⁺	Not applicable.

⁺ See [Table 3](#) (Guidelines for modifying status assessment based on rescue effect)

Are conditions for the source population deteriorating? ⁺	Not applicable.
Is the Canadian population considered to be a sink? ⁺	Not applicable.
Is rescue from outside populations likely?	Not applicable.

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC Status History: Designated Threatened in May 2005. Status re-examined and confirmed in November 2017.

Recommended Status and Reasons for Designation:

Recommended Status: Threatened	Alpha-numeric codes: C2a(i)
Reasons for designation: This moth is endemic to the Canadian prairies. Despite much search effort over the past two decades, it has been found infrequently. This species is believed to be naturally rare within suitable prairie habitat, which is fragmented as a result of agricultural development. The total population is likely small (less than 10,000 adults), divided into smaller subpopulations, based on expert opinion, collection records, and extensive search effort at known localities of this moth.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Population trends unknown.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Close to meeting Threatened, B2, as the IAO meets thresholds, there is an observed continuing decline in (iii) area, extent and quality of habitat but it is not severely fragmented or undergo extreme fluctuations. Although at least six extant sites are known, the threats for this species are not clearly defined, and the number of locations is therefore unknown.
Criterion C (Small and Declining Number of Mature Individuals): Meets Threatened, C2a(i), as the total number of mature individuals is estimated at fewer than 10,000 individuals, with no subpopulation containing more than 1,000 mature individuals. It is inferred there is continuing decline in the number of mature individuals based on decline in the area, extent and quality of habitat.
Criterion D (Very Small or Restricted Population): Not applicable. IAO is close to meeting threshold, but it is likely not prone to the effects of human activities or stochastic events, and is thus capable of becoming extinct, extirpated or endangered in a very short period of time.
Criterion E (Quantitative Analysis): Not Applicable. Insufficient Data.

⁺ See [Table 3](#) (Guidelines for modifying status assessment based on rescue effect)

PREFACE

Verna's Flower Moth was first assessed as Threatened in 2005 under B2ab(iii). The species' known range is restricted to the Canadian Prairies with seven recorded sites from across AB, SK and MB. One site is considered historical, six are considered extant with four of these localities confirmed since 1985.

Since the initial COSEWIC (2005) status assessment, there have been numerous surveys for Verna's Flower Moth throughout its range. Search effort in 2010 in Spruce Woods Provincial Park (MB); 2012 within the Aspen Parkland and Grassland Eco-regions of AB and SK did not record the species. The survey effort in 2015 confirmed the presence of Verna's Flower Moth at two new sites in Alberta: one adult near the original Alliance site (Alliance 2) and one larva at Kinsella Research Ranch. While only one adult moth was observed and captured, the presence of larvae at sites indicates that there were mature individuals in the area capable of reproduction. In 2015, several larvae were also collected near the original Jenner site in Alberta. In preparation of this status report, several areas in southeastern SK were surveyed for Verna's Flower Moth in 2016 although no specimens were recorded. Based on expert opinion, collection records and increased search effort during the flight season, it is believed this species is naturally rare within suitable habitat.

Threats to this species remain unclear, although they could include natural succession by native plants and competition by non-native plants, which out-compete the host plants. The host plant *Antennaria* appears to grow well under moderate grazing pressure.



COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS (2017)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.



Environment and
Climate Change Canada
Canadian Wildlife Service

Environnement et
Changement climatique Canada
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Canada

The Canadian Wildlife Service, Environment and Climate Change Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Verna's Flower Moth

Schinia verna

in Canada

2017

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Phylum: Arthropoda – the arthropods
Subphylum: Hexapoda – the hexapods
Class: Insecta – the insects
Order: Lepidoptera – the moths and butterflies
Suborder: Glossata – Lepidoptera with a coilable proboscis
Superfamily: Noctuoidea – the noctuoids
Family: Noctuidae – the noctuids or owlet moths
Subfamily: Heliethinae – the sun moths
Genus: *Schinia* – the flower moths
Species: *Schinia verna* Hardwick 1983

English Names: Verna's Flower Moth. This species was first called "Verna Flower Moth" (Hooper 1996), (named after Hardwick's wife Verna (see Hardwick 1983)), but in keeping with the convention of common names honouring people, the common name was amended to the possessive form, Verna's Flower Moth.

French Name: Hélotin de Verna

Taxonomic Background: Verna's Flower Moth, *Schinia verna* was described and named in 1983 by D.F. Hardwick, four years after he discovered it near Glenboro, Manitoba (MB) (Hardwick 1983). However, it had been collected many decades earlier by F.S. Carr in 1929 (Tables 1 and 2). The type materials of Verna's Flower Moth were deposited in the Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa (Hardwick 1983).

Verna's Flower Moth is in the large family Noctuidae (the owlet moths), and more specifically within the subfamily Heliethinae (the day-flying sun moths), which contains over 150 species in North America (Hardwick 1996; Wagner *et al.* 2011). Sun moths are particularly well represented in arid environments, with most of this diversity occurring in southwestern North America (Wagner *et al.* 2011).

The genus *Schinia*, commonly referred to as flower moths, is the most speciose of the sun moth subfamily in North America (Hardwick 1970, 1996). The genus contains about 120 described species north of Mexico, and several other undescribed species (Wagner *et al.* 2011; Schmidt pers. comm. 2016). Like all Heliethinae, *Schinia* is most diverse in the arid grasslands and deserts of the western United States (US).

Verna's Flower Moth is closely related to the Black-spotted Gem (*Schinia honesta* (Grote)), a slightly larger and darker species (Hardwick 1983) that ranges farther westward in Canada from southwestern Alberta (AB) and southern British Columbia (BC), south into California and Colorado (Hardwick 1996; Anweiler 2003). A single specimen similar to both Verna's Flower Moth and Black-spotted Gem was collected in sand-dune habitat of south-central Washington State (WA). Its colouration is more similar to that typical of Verna's Flower Moth, yet its size is more comparable to the Black-spotted Gem (Hardwick 1996). This record has recently been confirmed as the Black-spotted Gem (Schmidt pers. comm. 2017).

More recently, an additional adult specimen from WA tentatively identified as Verna's Flower Moth was posted on BugGuide. This specimen may also represent the unusual form mentioned above (Anweiler pers. comm. 2016). The US records are widely separated from subpopulations documented in Canada and if proven to be Verna's Flower Moth, they may represent a disjunct population that inhabits the inter-montane grasslands of the Columbia basin, possibly ranging into southern BC. However, it is premature to assign the WA population to Verna's Flower Moth as it may likely be another specimen of the Black-spotted Gem.

Morphological Description

Verna's Flower Moth grows via complete metamorphosis, during which there are four life stages: egg, larva, pupa, and adult. The descriptions below are modified from Hardwick (1983, 1996).

Adults:

Verna's Flower Moth is relatively small (wingspan 20-22 mm). The sexes are similar in appearance. The dorsal forewing is olive-brown suffused with dull maroon or red-brown with whitish patches (Figure 1). The forewing fringe is striped white and grey. The dorsal surface of the hindwing is boldly patterned in black and white, the wing margin consists of a broad black band with several faint white spots, and a black median spot adjoins the black inner margin. On the ventral side, the dark markings are greatly reduced and the hindwing is almost entirely white. The underside of the forewing is white with black markings restricted to the mid- and basal areas.

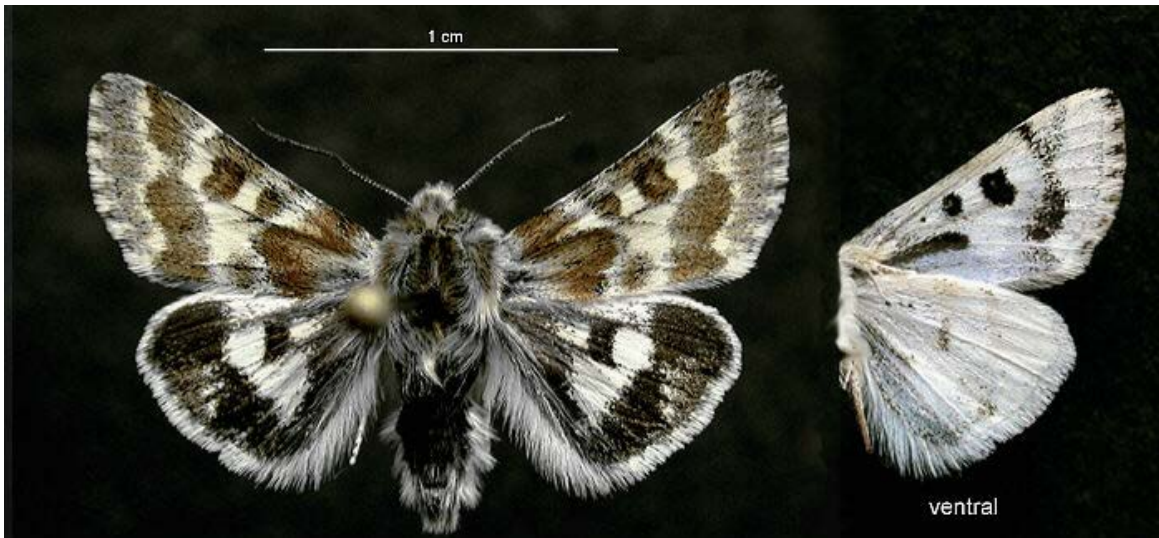


Figure 1. Verna's Flower Moth, dorsal view and ventral view of wings. Photo by Gary Anweiler.

Egg:

The egg is large and translucent-white when first laid, and turns a suffused pink within two days of oviposition.

Larva:

There are five larval stages. The first four stages have a black head capsule, which gradually turns brown by the fifth instar. The earlier instars are pale yellow to white, with black spots (setal bases), that become larger in later stages. The mature larva is pale greenish-white with a yellow-green transverse band across each segment and with rows of prominent black spots along the back and sides. For additional description and photos of larva see Snable *et al.* 2017.

Pupa:

The pupa is light orange-brown.

Verna's Flower Moth has a flight period that coincides with the White-spotted Midget (*Eutricopis nexilis* (Morr.)). However, the latter is smaller and has two white patches on the hindwing (Verna's Flower Moth has three white patches), and is generally more pink in colour. Although the Black-spotted Gem is superficially similar to Verna's Flower Moth, this species occurs farther west, and its known range may only slightly overlap with Verna's Flower Moth in AB.

Persimilis Flower Moth (*Schinia persimilis* (Grote)) is similar in appearance to Verna's Flower Moth, and the flight period for these two species may coincide where their ranges overlap in the Cypress Hills of AB/SK. Persimilis Flower Moth is identified by the evenly curved borders of the forewing postmedian band (jagged in Verna's Flower Moth) and solid black hindwing border.

There are currently no published identification keys to the *Schinia* genus, although one is in preparation for North America (Schmidt pers. comm. 2016). Wagner *et al.* (2011) provide a comprehensive guide to the eastern caterpillars and their food plants. Identification of adults is difficult and should be confirmed by an experienced lepidopterist through comparison to reference specimens or images.

Population Spatial Structure and Variability

The population spatial structure and variability of Verna's Flower Moth has not been studied. The known range of Verna's Flower Moth is restricted to the Canadian Prairies terrestrial ecozone that stretches across southern AB, SK and MB. Within this range, the species has been recorded from seven separate sites (Table 1; Figure 2); one of which is considered historical, six are considered extant with four of these localities confirmed since 1985. The species is considered a Canadian prairie endemic (Schmidt pers. comm. 2016). Only limited genetic studies, including DNA barcoding, have been conducted to determine population variability among known sites, or to clarify relationship with other similar taxa within and outside Canada (*i.e.*, WA specimens).

Table 1. Confirmed localities for Verna's Flower Moth in Canada. See Figure 2 for location of sites.

Site #	Province	Latitude	Longitude	Years recorded	Locality	Ownership
1	MB	49.675	-99.166	1979-80	Spruce Woods Provincial Park	Provincial (Government of Manitoba)
2	SK	52.1	-106.6	1980	Saskatoon*	Unknown
3	AB	50.838	-111.157	2000	Jenner Bridge	Private
4	AB	52.439	-111.822	2007	Alliance	Private
5	AB	52.400	-111.776	2015	Alliance 2**	Unknown
6	AB	53.103	-111.543	2015	Kinsella Research Ranch**	Unknown
7	AB	50.0	-110.6	1929	Medicine Hat*‡	Unknown

* The specific site locality is unknown; Coordinates are for the city named on the specimen label only; there is no other information regarding the actual collection site.

** These records are from Snable *et al.* 2017.

‡ This record is considered historical.

Table 2. Verna's Flower Moth museum specimens.

Locality	Date	Collector	Collection ¹	Number of specimens
CAN: MB; Spruce Woods Prov. Park, N of Glenboro	Jun 1980	D. & V. Hardwick	CNCI	16
CAN: MB, Spruce Woods Prov. Park, N of Glenboro	6 Jun 1979	D. & V. Hardwick	CNCI	2
CAN: MB, Spruce Woods Prov. Park, N of Glenboro	9 Jun 1979	D. & V. Hardwick	CNCI	20
CAN: MB, Spruce Woods Prov. Park, N of Glenboro	10 Jun 1979	D. & V. Hardwick	CNCI	2
CAN: MB, Spruce Woods Prov. Park, N of Glenboro	11 Jun 1979	D. & V. Hardwick	CNCI	9
CAN: MB, Spruce Woods Prov. Park, N of Glenboro	12 Jun 1979	D. & V. Hardwick	CNCI	3
CAN: SK, Saskatoon	23 May 1980	Unknown	CNCI	1
CAN: AB, Medicine Hat	1 Jun 1929	F.S. Carr	USNM	1
CAN: AB, Red Deer R. N of Jenner	19 May 2000	G.G. Anweiler	UASM	1
CAN: AB, Alliance	2007	G.G. Anweiler	UASM	1
CAN: AB, Alliance	2015	Canadian Wildlife Service	Anweiler, private collection	1
CAN: AB, Jenner	2015	Canadian Wildlife Service	UASM	1
CAN: AB, Jenner	2015	Canadian Wildlife Service	UASM	1

¹Museum acronyms: UASM - University of Alberta Strickland Entomological Museum, CNCI - Canadian National Collection of Insects, RSKM - Royal Saskatchewan Museum, USNM - United States National Museum

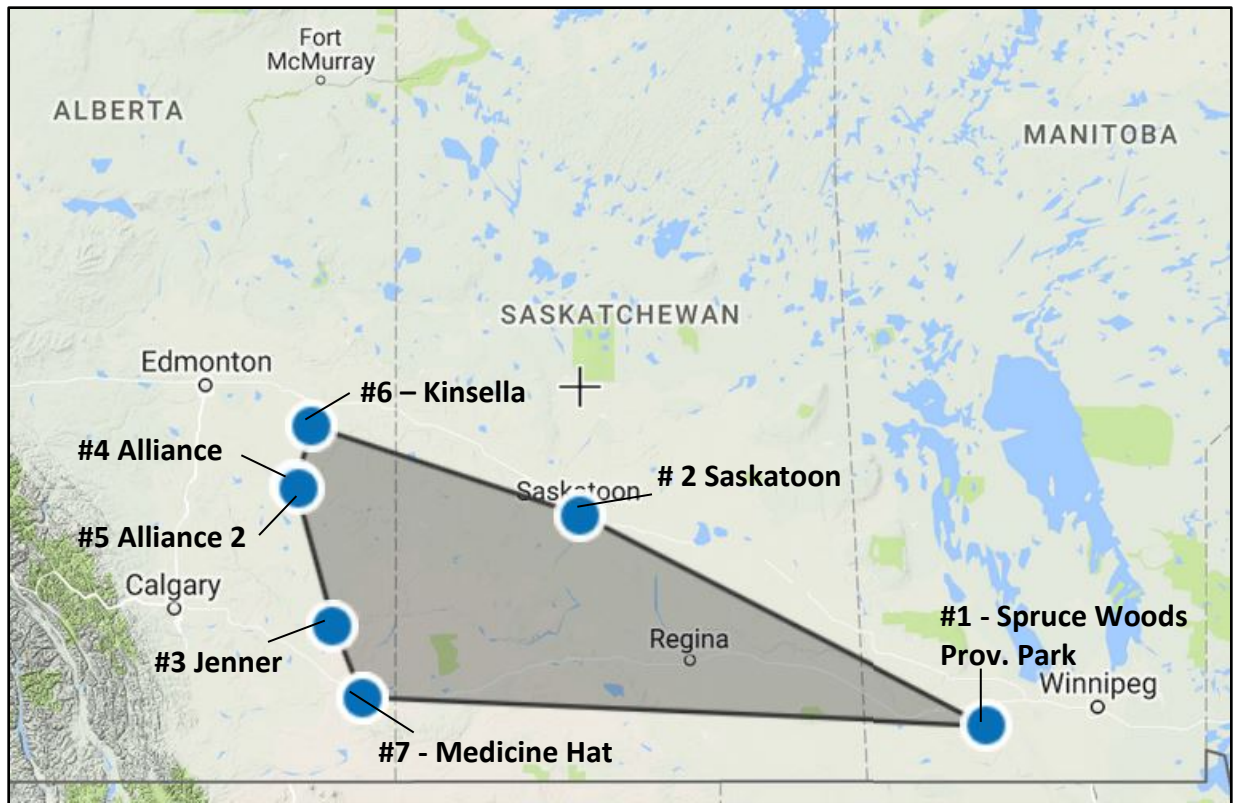


Figure 2. Global collection localities of Verna's Flower Moth (1929 – 2015).

Designatable Units

Verna's Flower Moth is being assessed as one designatable unit. There is no information on discreteness or evolutionary significance among the six known extant sites in Canada. The species occurs within the Prairie COSEWIC National Ecological Area.

Special Significance

Verna's Flower Moth is considered a Canadian prairie endemic. The loss of this moth from Canada would represent a loss to the unique biodiversity of these endangered prairie ecosystems.

DISTRIBUTION

Global and Canadian Range

The global and Canadian range for Verna's Flower Moth is restricted to the southern prairie habitats of AB, SK and MB. The easternmost locality is from Spruce Woods Provincial Park (MB) and the westernmost localities are from Alliance (AB) (Table 1, Figure 2).

Verna's Flower Moth is known from seven sites (Table 1, Figure 2). Six of these sites are considered extant because records are within the past 50 years and habitat is still present within these general areas: 1) Spruce Woods Provincial Park (Glenboro), MB (1979 – 1980); 2) Saskatoon, SK (1980); 3) Jenner Bridge, AB (2000); 4) Alliance, AB (2007); 5) Alliance-2, AB (2015); and 6) Kinsella Research Ranch, AB (2016) (Table 1; Figure 2). One locality is considered historical: 7) Medicine Hat, AB (1929).

The larval host plants for Verna's Flower Moth are various species of Pussytoes (*Antennaria* spp.) (see **Habitat**). Based on the distribution of these plants, their area of occupancy is likely less than 16,000 km². However, the low number of records for this day moth suggests there are other habitat factors that likely determine the moth's presence within a habitat patch. These habitat factors, combined with the cumulative ongoing and historical threats to these habitats (see **Habitat Trends and Threats**), make it difficult to determine the potential historical range for the species.

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EO) for Verna's Flower Moth (all records; Table 1, Figure 2) is 157,421 km² and the index of area of occupancy (IAO) is 28 km².

Removal of pre-1975 records (Medicine Hat, AB) lowers the EO to 118,508 km², and IAO to 24 km².

Search Effort

Museum specimens and observations of Verna's Flower Moth date from 1929 – 2015 (Table 1 and 2). The earliest record of Verna's Flower Moth is one specimen from the Medicine Hat area (AB) in 1929. Most of the type series (16 specimens) and other collections (36 additional specimens) were collected from Spruce Woods Park north of Glenboro, MB in 1979-1980. One specimen was collected in the vicinity of Saskatoon, SK (collector unknown) in 1980 (Hardwick 1983, and see Tables 1 and 2). An additional AB specimen was collected in the Red Deer River valley north of Jenner, AB in late May 2000, and near Alliance, AB in 2007 (Alberta Sustainable Resource Development and Alberta Conservation Association 2008). The most recent records are from the Kinsella Research Ranch, AB and a locality near Alliance, AB in 2015 (Table 1; Snable *et al.* 2017).

During the preparation of the first COSEWIC (2005) status report, two localities (Glenboro, MB and Jenner, AB) were surveyed in 2003 and one (Jenner) in 2004 (Figures 3 and 4). Habitats surveyed in 2003 were selected based on the presence of *Antennaria* host plant patches. Numerous *Antennaria* patches in southern AB have been surveyed while searching for and collecting the White-spotted Midget Moth (*Eutricopis nexilis*). This moth is also dependent on *Antennaria* as its larval host plant. Although these habitats often supported large patches of flowering *Antennaria* plants and/or White-spotted Midget moths (see **Morphological Description**), Verna's Flower Moth was not recorded from these areas.

There have been numerous surveys for Verna's Flower Moth throughout its AB, SK and MB range (Table 3) since the initial COSEWIC (2005) status assessment (e.g., M. Curteanu unpublished data; Murray 2014; Snable *et al.* 2017). Search efforts in 2010 in Spruce Woods Provincial Park (MB) and in 2012 within the Aspen Parkland and Grassland Eco-regions of AB and SK did not record the species (Table 3).



Figure 3. Habitat of Verna's Flower Moth, 8 km NNE of Glenboro, MB. Photo by Chris Schmidt 2005.



Figure 4. Habitat of Verna's Flower Moth, 10 km N of Jenner, AB. Photo by Chris Schmidt 2005.

Table 3. Sites surveyed for Verna's Flower Moth from 2003 – 2016 for preparation of this status report. All sites surveyed did not record the species. Additional search effort can be found in Snable *et al.* 2017 and Murray 2014.

Prov	Site Name	Date	Search effort (min)	Survey method	<i>Antennaria</i> plants	Reference
MB	NNE of Glenboro	26-27 May 2003	600	sweep net	common	COSEWIC 2005
MB	Spruce Woods Provincial Park, North of Glenboro Park	26 May 2003	120	sweep net	none found	COSEWIC 2005
MB	North of Glenboro	26 May 2003	120	sweep net	common	COSEWIC 2005
MB	North of Glenboro, Spirit Dunes, Spruce Woods Prov. Park Site B	26 May 2003	180	sweep net	none found	COSEWIC 2005
SK	Cypress Hills, NNE Eastend	29 May 2003	150	sweep net	abundant	COSEWIC 2005
SK	Cypress Hills, SSW Maple Creek	30 May 2003	240	sweep net	common	COSEWIC 2005

Prov	Site Name	Date	Search effort (min)	Survey method	<i>Antennaria</i> plants	Reference
SK	ESE Guernsay	22 May 2003	60	sweep net	common	COSEWIC 2005
AB	Red Deer R North of Jenner	4 Jun 2004	360	sweep net	common	COSEWIC 2005
AB	Red Deer R North of Jenner	31 May 2003	420	sweep net	common	COSEWIC 2005
AB	North of Big Stone	1 Jun 2003	30	sweep net	common	COSEWIC 2005
MB	Road 46 North South side Glenboro Site 1	18 May 2010	20	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 1	20 May 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 1	25 May 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 1	26 May 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 1	2 June 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 1	4 Jun 2010	30	sweep net	Abundant	Westwood 2010
MB	Park Road West side Glenboro Site 2	18 May 2010	20	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 2	20 May 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 2	25 May 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 2	26 May 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 2	2 June 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 2	4 Jun 2010	30	sweep net	Abundant	Westwood 2010
MB	Hogsback Glenboro Site 3	18 May 2010	20	sweep net	None	Westwood 2010
MB	Steel Ferry Rd South of Rd 45 N Glenboro Site 4	18 May 2010	20	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 4	20 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 4	25 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 4	26 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 4	2 June 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 4	4 Jun 2010	30	sweep net	Scarce	Westwood 2010

Prov	Site Name	Date	Search effort (min)	Survey method	Antennaria plants	Reference
MB	Epinette Prairie Glenboro Site 5	18 May 2010	20	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 5	20 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 5	25 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 5	26 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 5	2 June 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 5	4 Jun 2010	30	sweep net	Scarce	Westwood 2010
MB	Northwest corner Glenboro Site 6	18 May 2010	20	sweep net	None	Westwood 2010
MB	SE corner east of HWY Glenboro Site 7	18 May 2010	20	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 7	20 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 7	25 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Steel Ferry Rd West side between Rd 40 and 41 North Glenboro Site 8	18 May 2010	20	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 8	20 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 8	25 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 8	26 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 8	2 June 2010	30	sweep net	Scarce	Westwood 2010
MB	Steel Ferry Rd West side north of Rd 41 North Glenboro Site 9	18 May 2010	20	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 9	20 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 9	25 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 9	26 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 9	2 June 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 9	4 Jun 2010	30	sweep net	Scarce	Westwood 2010
MB	Steel Ferry Rd West side South of Rd 42 North Glenboro Site 10	18 May 2010	20	sweep net	Medium	Westwood 2010
MB	Glenboro Site 10	20 May 2010	30	sweep net	Medium	Westwood 2010

Prov	Site Name	Date	Search effort (min)	Survey method	Antennaria plants	Reference
MB	Glenboro Site 10	25 May 2010	30	sweep net	Medium	Westwood 2010
MB	Glenboro Site 10	26 May 2010	30	sweep net	Medium	Westwood 2010
MB	Glenboro Site 10	2 June 2010	30	sweep net	Medium	Westwood 2010
MB	Glenboro Site 10	4 Jun 2010	30	sweep net	Medium	Westwood 2010
MB	Steel Ferry Rd West side North of Rd 42 Glenboro Site 11	18 May 2010	20	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 11	20 May 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 11	25 May 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 11	26 May 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 11	2 June 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 11	4 Jun 2010	30	sweep net	Abundant	Westwood 2010
MB	Steel Ferry Rd West side North of Rd 45 Glenboro Site 12	18 May 2010	20	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 12	20 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 12	25 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 12	26 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 12	2 June 2010	30	sweep net	Scarce	Westwood 2010
MB	Road 46 North North side Glenboro Site 13	18 May 2010	20	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 13	20 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 13	25 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 13	26 May 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 13	2 June 2010	30	sweep net	Scarce	Westwood 2010
MB	Glenboro Site 13	4 Jun 2010	30	sweep net	Scarce	Westwood 2010
MB	Steel Ferry Rd West side Glenboro Site 14	18 May 2010	20	sweep net	None	Westwood 2010
MB	Sand dunes Glenboro Site 15	18 May 2010	20	sweep net	Sparse	Westwood 2010
MB	Glenboro Site 15	20 May 2010	30	sweep net	Sparse	Westwood 2010

Prov	Site Name	Date	Search effort (min)	Survey method	<i>Antennaria</i> plants	Reference
MB	Glenboro Site 15	25 May 2010	30	sweep net	Sparse	Westwood 2010
MB	East of Hogsback Glenboro site 16	18 May 2010	20	sweep net	None	Westwood 2010
MB	Park Rd West side Glenboro Site 17	18 May 2010	20	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 17	20 May 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 17	25 May 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 17	26 May 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 17	2 June 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 17	4 Jun 2010	30	sweep net	Abundant	Westwood 2010
MB	North of Assiniboine River Glenboro Site 18	18 May 2010	20	sweep net	Sparse	Westwood 2010
MB	Glenboro Site 18	20 May 2010	30	sweep net	Sparse	Westwood 2010
MB	Glenboro Site 18	25 May 2010	30	sweep net	Sparse	Westwood 2010
MB	Glenboro Site 18	26 May 2010	30	sweep net	Sparse	Westwood 2010
MB	Glenboro Site 18	2 June 2010	30	sweep net	Sparse	Westwood 2010
MB	Glenboro Site 18	4 Jun 2010	30	sweep net	Sparse	Westwood 2010
MB	North of Assiniboine River Glenboro Site 19	18 May 2010	20	sweep net	None	Westwood 2010
MB	West corner Rd 73 W & Rd41 N Glenboro Site 20	18 May 2010	20	sweep net	Medium	Westwood 2010
MB	Glenboro Site 20	20 May 2010	30	sweep net	Medium	Westwood 2010
MB	Glenboro Site 20	25 May 2010	30	sweep net	Medium	Westwood 2010
MB	Glenboro Site 20	26 May 2010	30	sweep net	Medium	Westwood 2010
MB	Glenboro Site 20	2 June 2010	30	sweep net	Medium	Westwood 2010
MB	Glenboro Site 20	4 Jun 2010	30	sweep net	Medium	Westwood 2010
MB	Park Rd West side Glenboro Site 21	18 May 2010	20	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 21	20 May 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 21	25 May 2010	30	sweep net	Abundant	Westwood 2010

Prov	Site Name	Date	Search effort (min)	Survey method	<i>Antennaria</i> plants	Reference
MB	Glenboro Site 21	26 May 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 21	2 June 2010	30	sweep net	Abundant	Westwood 2010
MB	Glenboro Site 21	4 Jun 2010	30	sweep net	Abundant	Westwood 2010
AB	Suffield NWA T1	30 May 2012	29	sweep net	none	Westworth 2012
AB	Suffield NWA T2	30 May 2012	38	sweep net	present	Westworth 2012
AB	Suffield NWA VFM3	31 May 2012	12	sweep net	none	Westworth 2012
AB	Suffield NWA VFM4	31 May 2012	2	sweep net	none	Westworth 2012
SK	Coteau CP T3	1 June 2012	137	sweep net	present	Westworth 2012
SK	Coteau CP T4	1 June 2012	109	sweep net	present	Westworth 2012
SK	Coteau CP C3	1 June 2012	133	sweep net	present	Westworth 2012
SK	Coteau CP C4	1 June 2012	108	sweep net	present	Westworth 2012
SK	Coteau CP T5	2 June 2012	70	sweep net	present	Westworth 2012
SK	Coteau CP C5	2 June 2012	109	sweep net	present	Westworth 2012
SK	Battle River-Cutknife CP T6	4 June 2012	26	sweep net	present	Westworth 2012
SK	Battle River-Cutknife CP T7	4 June 2012	284	sweep net	present	Westworth 2012
SK	Battle River-Cutknife CP BR6, 6b	4 June 2012	34	sweep net	present	Westworth 2012
SK	Battle River-Cutknife CP BR7	4 June 2012	271	sweep net	present	Westworth 2012
AB	CFB Wainwright T10	8 June 2012	74	sweep net	present	Westworth 2012
AB	CFB Wainwright T11	8 June 2012	35	sweep net	present	Westworth 2012
AB	CFB Wainwright T12	8 June 2012	22	sweep net	none	Westworth 2012
AB	CFB Wainwright W10	8 June 2012	55	sweep net	present	Westworth 2012
AB	CFB Wainwright W11	8 June 2012	22	sweep net	present	Westworth 2012
SK	Coteau CP	1 June 2012	311	malaise trap	present	Westworth 2012
SK	Coteau CP	1 June 2012	122	malaise trap	present	Westworth 2012
SK	Coteau CP	2 June 2012	178	malaise trap	present	Westworth 2012
AB	CFB Wainwright	8 June 2012	136	malaise trap	present	Westworth 2012
AB	CFB Wainwright	8 June 2012	166	malaise trap	present	Westworth 2012
SK	Buffalo Pound PP	May 2016	180	sweep net	present	C. Sheffield
SK	Qu'appelle River Valley, near Lumsden	May 2016	240	sweep net	present	C. Sheffield
SK	Weyburn - Estevan	May 2016	240	sweep net	present	C. Sheffield
SK	"Irish Spring" near Eastend	May 2016	60	sweepnet	present	R. Poulin

In preparation of this status report, several areas in southeastern SK were surveyed for Verna's Flower Moth in 2016 although no specimens were recorded. Examination of uncatalogued moths at the Royal Saskatchewan Museum yielded two historical specimens labelled Verna's Flower Moth from SK: one from Buffalo Pound Provincial Park and other from the Qu'Appelle River Valley (Figures 5-7). Further taxonomic identification of these specimens confirmed they were mislabelled and in fact an undescribed *Schinia* species (Schmidt pers. comm. 2016). Further search effort in 2016 (during preparation of this status report) in these geographic areas did not record Verna's Flower Moth.



Figure 5. Potential Verna's Flower Moth habitat with abundant *Antennaria* flowering in a bison grazed compound at Buffalo Pound Provincial Park, SK in May 2016. No specimens of Verna's Flower Moth were detected. Photo by Cory Sheffield.



Figure 6. Potential Verna's Flower Moth habitat with abundant *Antennaria* flowering in a bison grazed compound (left side of fence) and non-grazed area (right side) at Buffalo Pound Provincial Park, SK, in May 2016. No specimens of Verna's Flower Moth were detected. Photo by Cory Sheffield.



Figure 7. Potential Verna's Flower Moth habitat with abundant *Antennaria* flowering in the Qu'appelle River Valley near Lumsden, SK in May 2016. No specimens of Verna's Flower Moth were detected. Photo by Cory Sheffield.

The lack of information on the specific historical collection localities from the Medicine Hat and Saskatoon areas makes it difficult to specifically resurvey these areas. However, suitable native grassland habitat remains in the general vicinity of all the historical and the more recent collection localities. Approximately 324,000 ha of prairie grasslands are under management for military training (Bailey *et al.* 2010). Several military bases (*i.e.*, Canadian Forces Base Suffield, Moose Jaw and Shilo) exist within the range of this species, and likely contain suitable habitat. Most of the habitats with the highest potential to support Verna's Flower Moths are on private land (Westwood 2010) (Table 1).

In an effort to represent additional collection effort for Verna's Flower Moth, collection events for *Eutricopis nexilis*, another *Antennaria* specialist, were recorded from specimens in the University of Alberta, Strickland Museum, the Royal Saskatchewan, and the Canadian National Collection of Insects, Arachnids and Nematods (145 specimens with GIS data collected between 1897-2005). It is assumed that as both species require similar habitat within the Canadian Prairies and share a larval host plant, then if present at these sites, Verna's Flower Moth also would have been collected. Collection events for *E. nexilis* in North America (Figure 8a) suggest the species and its larval food plants are widespread. Verna's Flower Moth and *E. nexilis* co-existed in the past (and likely still do in some parts of their shared range in the Canadian Prairies (Figure 8b). It is assumed that Verna's Flower Moth, if present, would have been collected concurrently with *E. nexilis* specimens in the Canadian Prairies (Figure 8b) throughout the 108 year sampling period, though with the exceptions discussed above, this was not the case.

The Manitoba Conservation Data Centre conducted extensive field surveys in 2013 (Murray 2014). Eight sites were surveyed in and around Spruce Woods Provincial Park, most of which were cattle grazed and contained *Antennaria* spp. Potentially due to cool wet weather during the survey (early to mid-June) the flight season may have been missed, and no Verna's Flower Moths were observed (Murray 2014).

Canadian Wildlife Service Surveys: In 2010, 2015 and 2016 surveys for Verna's Flower Moth were conducted in AB and SK by the Canadian Wildlife Service (M. Curteanu unpublished data; Snable *et al.* 2017). A combination of survey techniques including sweep netting, Malaise traps and larval searches were utilized where Verna's Flower Moth was previously recorded to confirm occupancy or absence, in addition to new suitable locations (Snable *et al.* 2017). In total 17 sites were surveyed, where flowering *Antennaria* spp. were present.

The survey effort in 2015 confirmed the presence of Verna's Flower Moth at two new sites in Alberta: one adult near the original Alliance site (Alliance 2) and one larva at Kinsella Research Ranch (Table 1, Figure 2). While only one adult moth was observed and captured, the presence of larvae at sites indicates that there were mature individuals in the area capable of reproduction. In 2015, several larvae were also collected near the original Jenner site in Alberta. These larvae matched the description of later instar larvae of Verna's Flower Moth provided by Hardwick (1983) and matched in appearance the larva collected from the Kinsella Research Ranch that were confirmed as a Verna's Flower Moth through DNA barcoding (Snable *et al.* 2017). Of these larvae, one was confirmed to the *Schinia* genus through DNA barcoding and the remainder were reared. Identification of the two adults, successfully reared at the Royal Alberta Museum, were confirmed as Verna's Flower Moth by Gary Anweiler and deposited in the Strickland Museum at University of Alberta.

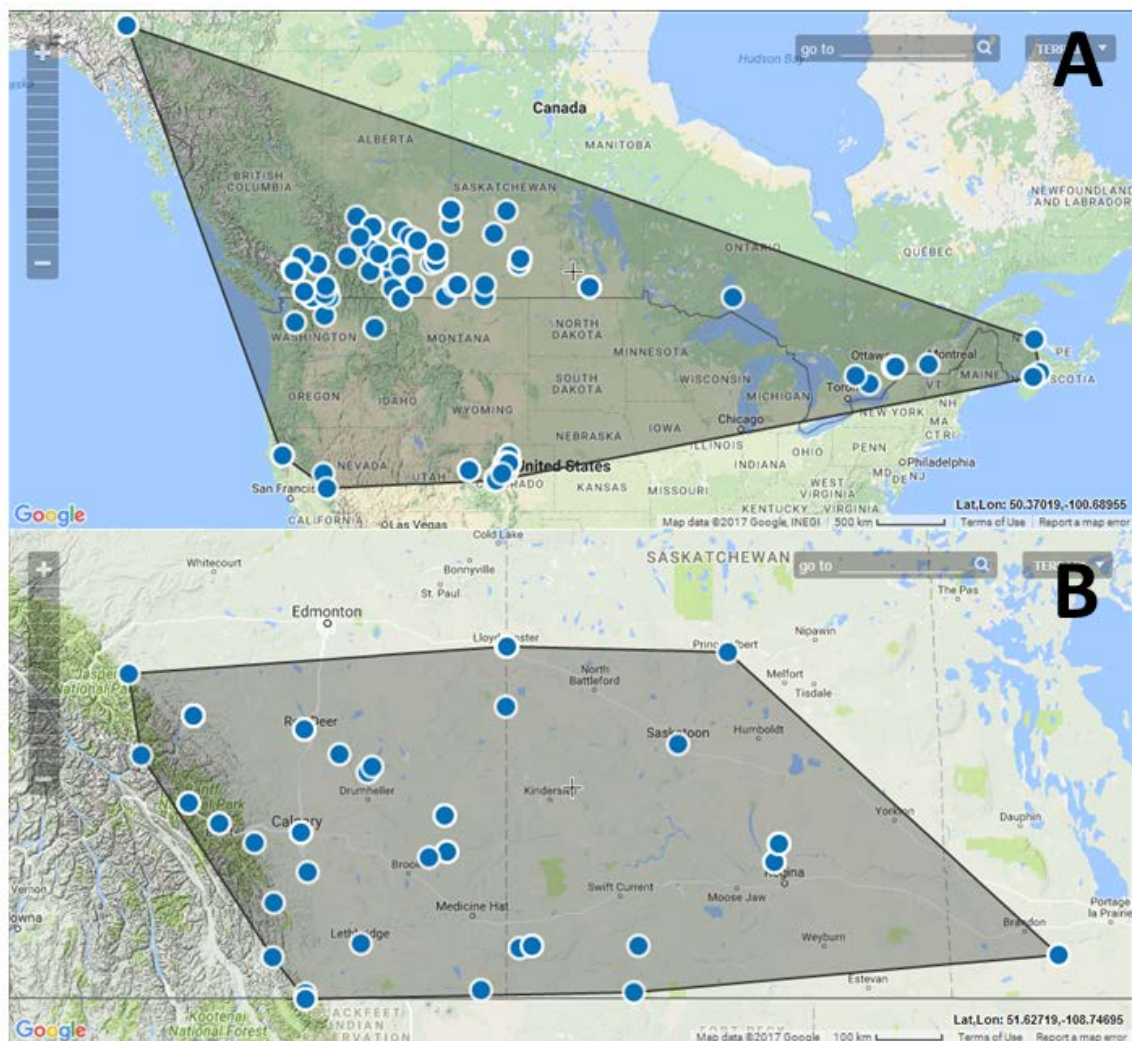


Figure 8. Distribution map of *Eutricopis nexilis* (Noctuidae) within North America (A), and in the Prairie Provinces of Canada (B) collected between 1897-2005. Like Verna's Flower Moth, this species uses *Antennaria* (*Antennaria* spp.) as its larval food plant. It is assumed for the Canadian Prairies that collectors would have collected both species in these sites if both were present.

In 2016, a total of 32 larvae were collected from 7 sites and sent for DNA barcoding (Snable *et al.* 2017). Four specimens from Beaver Creek Conservation Area, SK were confirmed to the *Schinia* genus, with one matching closer to Verna's Flower Moth and three matching closer to Black-spotted Gem. Although all specimens were within a 1% match to both species, given the low number of specimens in the BOLD system currently, it is not possible at this time to confirm a species level identification. Larvae were also collected from additional new sites, including Chaplin Lake-North Shore, SK from the *Schinia* genus, but DNA barcoding was not able to confirm species level identification.

Verna's Flower Moth occurs at minimum of six extant sites. The species appears to persist in low abundance and there are likely additional new sites where suitable habitat is present (see **Habitat Requirements**).

HABITAT

Habitat Requirements

At a broad geographic scale, Verna's Flower Moth is restricted to grassland habitats of the Canadian Prairies terrestrial ecozone. The Glenboro (MB) and Saskatoon (SK) localities are within the Aspen Parkland Ecoregion, while the Medicine Hat and Jenner (AB) localities are characterized as Mixed Grassland (Gauthier *et al.* 2001). The Aspen Parkland habitats are likely at the northern periphery of Verna's Flower Moth's range, and suitable habitat should also occur throughout the Moist Mixed Grassland Ecoregion situated between the Parkland and Mixed Grassland regions.

In general, Verna's Flower Moth occurs in sparsely vegetated prairie grassland with stands of the moths' larval food plant, *Antennaria* (*Antennaria* spp.) (Figures 3 and 4). *Antennaria* must be present as flowering plants because the larvae consume the flowers and seeds of the plant. Adult sun moths are highly dependent on flowers for nectar.

Specific habitat descriptions for Verna's Flower Moth are not fully known due to the lack of notes taken by collectors. At the Glenboro (MB) locality female Verna's Flower Moths were observed ovipositing into the flower heads of Broad-leaved *Antennaria* (*Antennaria neglecta* Greene) and Low *Antennaria* (*A. parviflora* Nutt. (= *A. aprica* Greene)) (Hardwick 1983, 1996). Low *Antennaria* is also present at the Jenner, (AB) locality. Both Broad-leaved *Antennaria* and Low *Antennaria* are widely distributed, although often localized, over most of North America (Scoggan 1979). Because both these *Antennaria* species have such a broad range and occur in several ecoregions outside of the prairies, the presence of Verna's Flower Moth is likely limited by factors other than the distribution of the host plant. The close synchrony of the adult's flight period with the flowering of *Antennaria*, and the close host plant specificity of other *Schinia* species (Hardwick 1996; Wagner *et al.* 2011) makes it highly unlikely that plants other than *Antennaria* are used as larval hosts. However, while it is unknown what other *Antennaria* spp. are utilized as hosts, it is likely that not all species of *Antennaria* are suitable host plants.

Habitat in the Glenboro region (surveyed in 2003) consisted of native, sandy pastures supporting *Antennaria*, in addition to Three-flowered Aven (*Geum triflorum*), Chickweed (*Cerastium* spp.), Puccoon (*Lithospermum* spp.), and various sedges (*Carex* spp.) (see Figure 3).

The Verna's Flower Moth specimen collected from near Jenner, AB (collected in 2000) was recorded from a north-facing grassland valley slope. Subsequent surveying of this site in 2003 showed that *Antennaria* were common on vegetated, north-facing valley sites and growing in association with Three-flowered Aven and June Grass (*Koeleria macrantha*) (see Figure 4).

At both the Glenboro (MB) and Jenner (AB) localities, Verna's Flower Moth flight period coincides with the White-spotted Midget, which is a more common and widespread *Antennaria*-feeding feeding flower moth (Hardwick 1983; Schmidt unpubl. data). At one time, the presence of this moth was thought to be a potential indicator of Verna's Flower Moth habitat. The abundance of White-spotted Midget at these sites (Jenner and Big Stone, AB) suggests this moth has broader or slightly different *Antennaria* feeding preferences and its presence may not be a good indicator of suitable Verna's Flower Moth habitat.

Moderate grazing may be required to maintain the large patches of flowering *Antennaria* host plants needed to support Verna's Flower Moth. The moth was recorded from Spruce Woods Provincial Park, and the habitat near Glenboro (MB) was described as a grazed meadow supporting various spring blooming flowers in a region partially wooded with spruce and aspen (Hardwick 1983). The Jenner (AB) locality experienced some grazing pressure (Anweiler unpubl. data; Schmidt unpubl. data). Some grazing and wildfire may allow for the maintenance of flowering and seeding *Antennaria* plants, which is required for larval presence. Without these natural processes, the plants may be present as non-blooming mats within a thick overstory of high grasses (see **Habitat Trends**).

Much of the arable land on the prairies is privately owned, and the majority of remaining suitable habitat for Verna's Flower Moth is within these areas (e.g., the Jenner, AB site is privately owned). Suitable habitat in AB likely occurs upstream along the Red Deer River valley within Dinosaur Provincial Park, 15 km to the southwest. The habitat for the Glenboro subpopulation, if still extant, is also on private land. Surveys of accessible sites within Spruce Woods Provincial Park suggest conditions are too dry and sandy to support substantial *Antennaria* patches, but further inventory work is needed in other parts of the park to determine the extent of the slightly more mesic meadows that could potentially support the host plants. Suitable habitat also likely occurs within the Qu'appelle River Valley, Beaver Creek Conservation Area and Chaplin Lake-North Shore in SK (Snable *et al.* 2017; Sheffield pers. data).

Habitat Trends

Since the 1850s over 99% of the native prairie across North America has been converted to agricultural crops or hay fields, or severely degraded by overgrazing. Historically, there were approximately 340,000 km² of tall-grass prairie in North America although today approximately 5,000 km² remain (Samson and Knopf 1994). Much of this habitat was lost between 1850 and 1920. Mixed-grass prairies have experienced similar losses (Samson and Knopf 1994). In Manitoba, 6,000 km² of tall-grass prairie once existed (Samson and Knopf 1994) and the most recent calculations estimate a decline of 99.5% with only about 50 km² remaining. In SK, approximately 82% of the mixed-grass prairie habitat has been lost (Samson and Knopf 1994). Although dependent on *Antennaria* spp., other specific habitat requirements for Verna's Flower Moth are unknown, the extensive loss of prairie habitat likely had an impact on the distribution, connectivity and maintenance of subpopulations throughout the moth's range.

Most of the Canadian prairies were modified decades ago (Javorek and Grant 2011). Because Verna's Flower Moth was only described in 1983, it is possible that the species declined significantly in abundance and distribution long before it was formally described, and/or it was always uncommon due to lack of suitable habitat following the extensive agricultural development of the prairies.

Historical grazing by native Plains Bison (*Bison bison*) may have played a significant role in the maintenance of *Antennaria* host plant patches needed to sustain populations of Verna's Flower Moth. Moderate grazing appears to enable the continued flowering and seed-set of *Antennaria* host plants, both of which are required for larval consumption and growth. Without these natural processes, the plants may be present as non-blooming mats and a thick overstory of high grasses and other plants grows and out-competes the *Antennaria* plants.

Approximately 2,430 km² are currently grazed by wildlife within provincial and national parks in the Canadian Prairies terrestrial ecozone (Bailey *et al.* 2010). This ecozone is approximately 610,000 km², though habitat conversions to agriculture since the late 1800s have resulted in < 20% of this area remaining as grasslands; there are about 114,000 km² of natural grasslands remaining in AB, SK and MB, most of this (109,000 km²) is grazed by domestic livestock and wildlife (Bailey *et al.* 2010).

Like other moth floral specialists, Verna's Flower Moth may be susceptible to increased habitat fragmentation (Thomas 2016). Much suitable habitat was lost and/or isolated during 1850 – 1920 and continues to be fragmented.

BIOLOGY

Information on the biology and natural history of Verna's Flower Moth is summarized from Hardwick (1983, 1996), the previous COSEWIC (2005) status report and general moth references (Wagner *et al.* 2011).

Life Cycle and Reproduction

Verna's Flower Moth, like all Lepidoptera, undergoes complete metamorphosis, from egg to larva (5-6 instars), pupa and adult. The species reproduces during the adult flight period which occurs between late May and mid-June. Females oviposit eggs within the flower heads of the *Antennaria* host plants. Females are also known to lay eggs while nectaring (Wagner *et al.* 2011). The larvae hatch in three days and grow through five (occasionally six) instars over a mean period of 17 days (Hardwick 1983, 1996). First instar (3 days) and second-instar (2.6 days) larvae live within an individual flower head, while the larger third- (2.5 days) and fourth-instar (3.3 days) larvae weave together adjacent flower heads. Mature (fifth-instar) (5-6 days) larvae feed externally on the flower head, resting on the plant stem (Hardwick 1996). Mature larvae drop and burrow into the ground, construct a shallow chamber in which they overwinter and pupate in the spring (Hardwick 1983). Generation time is suspected to be one year; however, some flower moths can remain in pupal stage for a number of years before emerging (Alberta Sustainable Resource Development and Alberta Conservation Association 2008). Individual adult flower moths live less than seven days (Hardwick 1996).

Schinia species lay eggs that are relatively large compared to their body size (Hardwick 1996), so a female likely produces fewer eggs than other owl moths. The reported maximum number of eggs laid by female *Schinia* varies from 89 in the Phlox Moth (*S. indiana*) to 356 in *S. sueta* (no English common name) (Hardwick 1958). Because Verna's Flower Moth produces large eggs compared to other species of *Schinia* (Hardwick 1996), fecundity is likely low for the genus, perhaps ranging from 100 to 200 eggs laid per female.

Physiology and Adaptability

There is no information available on the physiology or adaptability for Verna's Flower Moth. Verna's Flower Moth may be tolerant of moderate disturbance through cattle grazing, a crucial process through which high-quality host plant patches are maintained. More data on grazing pressures in relation to moth and its *Antennaria* host plant presence and abundance are needed. Nieminen (1996) indicates that the risk of extinction of moths is significantly affected by the host plant characteristics rather than by the characteristics of the moths themselves.

Dispersal and Migration

There are no data available on the dispersal of Verna's Flower Moth. Most *Schinia* species are strong fliers and have a rapid, buzzing flight (Schmidt unpubl. data). The ability for strong flight would facilitate colonization of host plant patches separated by unsuitable habitat. *Schinia* species seem to have the ability for rapid and relatively widespread dispersal; however, many species exhibit high site and host plant fidelity and are rarely observed outside of the immediate vicinity of host plants (Hardwick 1996; Swengel and Swengel 1999). Verna's Flower Moth is not migratory.

Interspecific Interactions

The larvae of Verna's Flower Moth (Hardwick 1983) and other sun moths (Wagner *et al.* 2011) can be cannibalistic, and typically there is only one larva inhabiting a single *Antennaria* flower head. Larvae of the White-spotted Midget are also attacked and consumed by Verna's Flower Moth larvae (Hardwick 1983), a behaviour which is unusual for most Lepidoptera. However, this behaviour may confer a competitive advantage to Verna's Flower Moth over the more common White-spotted Midget, particularly if the quantity or quality of food is a limiting factor. It is unknown if the reverse is true (*i.e.*, White-spotted Midget larvae consuming Verna's Flower Moth larvae) though Wagner *et al.* (2011) indicate that cannibalism and/or interspecies larval consumption occurs in the Heliothinae.

A large range of predators (vertebrate and arthropod), parasites and pathogens are known for Lepidoptera, including owlet moths (Wagner *et al.* 2011). Although specific parasites of Verna's Flower Moth have not been confirmed, tachinid flies (Diptera: Tachinidae) and hymenopteran wasps (Hymenoptera: Ichneumonidae, Braconidae) have been reported for other *Schinia* species (Peigler and Vinson 1988). Concealment in flower heads during feeding may be a predator/parasitoid avoidance strategy in flower moths (Hardwick 1996).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Sampling effort for Verna's Flower Moth has focused on surveying potential habitat and recording the species presence (Table 3, Snable *et al.* 2017). There have been no systematic studies developed to measure the population sizes or trends for the species. Trend information can be inferred from trends in habitat loss (see **Habitat Trends and Threats**).

Abundance

Despite much search effort over the past two decades this species has been detected infrequently and it is believed this species is naturally rare within suitable habitat. It is likely that Verna's Flower Moth, similar to other closely related species, occurs at low densities and may experience high larval mortality. There are less than 60 adult specimens of the moth (Table 2). Given the rarity of this species, in addition to expert opinion, collection records and search effort at known sites (Table 3, Snable *et al.* 2017), it is estimated that the total number of mature individuals is confidently less than 10,000 with no subpopulation containing more than 1,000 mature individuals (Schmidt pers. comm. 2017).

Low population numbers are also known to occur in other closely related species. A daily mark recapture study conducted on the Primrose Moth (*Schinia florida*) at one site found a total of 53 individuals across the entire flight season (Handel 1976). Many of these closely related species are short lived and relatively rare within suitable habitat patches (Handel 1976).

Fluctuations and Trends

Insufficient data exist to establish whether population fluctuations and trends exist for this species. However, some species of sun moths are known to exhibit potential population fluctuations due to multi-year pupation periods (Wagner *et al.* 2011) but it is unknown if Verna's Flower Moth exhibits population fluctuations similar to other *Schinia* species. For example, population levels of the Phlox Moth varies over a five-year period (Swengel and Swengel 1999). Search effort should therefore have sequential sampling over multiple years (*i.e.*, 3 years) to detect adult moths (Schweitzer *et al.* 2011), although this has not been completed at Verna's Flower Moth localities. However, it is unknown and potentially unlikely that this species exhibits extreme population fluctuations where changes in distribution or in the total number of mature individuals occur rapidly and frequently, and are typically of more than one order of magnitude.

Rescue Effect

Verna's Flower Moth is considered endemic to Canada, occurring within the Canadian Prairies terrestrial ecozone of AB, SK and MB. Rescue from the United States is not applicable.

THREATS AND LIMITING FACTORS

The threats classification for Verna's Flower Moth is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system (see Salafsky *et al.* 2008; Master *et al.* 2012). Details are discussed below under the IUCN-CMP headings and numbering scheme (Table 4).

There is little information on the specific threats to Verna's Flower Moth and localities. The primary threats to Verna's Flower Moth are the conversion and intensification of agricultural crops (2.1 Annual & perennial non-timber crops, medium – low impact); the slow spread and encroachment of non-native plants (8.1 Invasive non-native/alien species – low impact) and native shrub species (8.2 Problematic native species – low impact).

Table 4. The International Union of Conservation Networks – Conservation Measures Partnership (IUCN-CMP) threats calculator outputs for Verna's Flower Moth. The calculated impact was Medium.

Species English and Scientific Name:		Verna's Flower Moth, <i>Schinia verna</i>		
Date:		2016-05-09		
Assessor(s):		Cory Sheffield (report author and SSC member), Paul Grant and Jenny Heron (Arthropods SSC Co-chairs), Jessica Linton and John Klymko (SSC members), Angèle Cyr (Secretariat) with further input from Syd Cannings (Canadian Wildlife Service) and Victoria Snable (Canadian Wildlife Service).		
		Level 1 Threat Impact Counts		
		Threat Impact	high range	low range
	A	Very High	0	0
	B	High	0	0
	C	Medium	1	0
	D	Low	1	2
Calculated Overall Threat Impact:		Medium		

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Report Author's Comments
1	Residential & commercial development		Negligible	Negligible (<1%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs)	
1.1	Housing & urban areas		Unknown	Small (1-10%)	Unknown	High (Continuing)	The threats from housing and urban areas are historical and currently likely minimal and/or confined to relatively small areas with the range.
1.2	Commercial & industrial areas		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Likely similar to 1.1, though likely fewer of these types of development over time.
1.3	Tourism & recreation areas		Negligible	Negligible (<1%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs)	Tourism and recreational activities may be minor and non-disturbing to the active moth populations.
2	Agriculture & aquaculture	CD	Medium - Low	Restricted - Small (1-30%)	Extreme (71-100%)	High (Continuing)	
2.1	Annual & perennial non-timber crops	CD	Medium - Low	Restricted - Small (1-30%)	Extreme (71-100%)	High (Continuing)	(See Threats Section)
2.2	Wood & pulp plantations						Not applicable.

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Report Author's Comments
2.3	Livestock farming & ranching	Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	High (Continuing)	<p>2.3 Livestock farming and ranching. Historical grazing likely contributed to the abundance, distribution and maintenance of <i>Antennaria</i> host plant patches throughout the Canadian prairies. Light to moderate grazing may be required to promote blossoming of <i>Antennaria</i> (Environment Canada 2015).</p> <p>Conversely, livestock overgrazing can result in a change in plant species composition and the permanent loss of native plants. During extended periods of drought, impacts from overgrazing are amplified. Overgrazing can also lead to an increase in the scope and spread of non-native invasive plants such as Crested Wheat Grass (<i>Agropyron cristatum</i>), Baby's Breath (<i>Gypsophila</i> spp.), Sweet Clover (<i>Melilotus officinalis</i>), Leafy Spurge (<i>Euphorbia esula</i>) and others. Because the pupae spend about 10-11 months (or longer) in a shallow underground chamber, soil trampling by livestock in heavily grazed pastures may also result in mortality, particularly in heavy or overgrazed situations.</p> <p>There is approximately 11.4 million ha of natural grasslands remaining in AB, SK and MB and most of these areas (10.9 million ha) is grazed by domestic livestock and wildlife (Bailey <i>et al.</i> 2010). Four of the five extant Verna's Flower Moth localities are susceptible to some form of grazing. Observations at Buffalo Pound Provincial Park (SK) during the completion of this status report suggest the bison range area had a greater abundance of flowering <i>Antennaria</i> plants than adjacent non-grazed areas in the park. This observation supports the idea that light to moderate grazing could important to maintain flowering <i>Antennaria</i> plants needed for larval development and adult nectar.</p>
2.4	Marine & freshwater aquaculture					Not applicable.
3	Energy production & mining	Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	
3.1	Oil & gas drilling	Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	This threat is likely negligible, and is associated with the small footprint likely associated with infra-structure associated with existing, expanding, and/or new energy production and mining activities.
3.2	Mining & quarrying	Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	Likely similar to Threat 3.1.

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Report Author's Comments
3.3	Renewable energy	Negligible	Negligible (<1%)	Extreme (71-100%)	Unknown	The footprints for wind farms and other renewable energy sources (<i>i.e.</i> , concrete slabs) are likely negligible, though could have some impact if sites are developed in areas containing native prairie and/or large populations of <i>Antennaria</i> .
4	Transportation & service corridors	Negligible	Negligible (<1%)	Extreme (71-100%)	Moderate (Possibly in the short term, < 10 yrs)	
4.1	Roads & railroads	Negligible	Negligible (<1%)	Extreme (71-100%)	Moderate (Possibly in the short term, < 10 yrs)	This threat is likely negligible.
4.2	Utility & service lines	Negligible	Negligible (<1%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs)	This threat is likely negligible.
4.3	Shipping lanes					Not applicable.
4.4	Flight paths					Not applicable.
5	Biological resource use					
5.1	Hunting & collecting terrestrial animals					Not applicable.
5.2	Gathering terrestrial plants					Not applicable.
5.3	Logging & wood harvesting					Not applicable.
5.4	Fishing & harvesting aquatic resources					Not applicable.
6	Human intrusions & disturbance	Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	High (Continuing)	
6.1	Recreational activities	Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	High (Continuing)	Recreational activities and use of all-terrain vehicles may have the potential to destroy or significantly alter stands of <i>Antennaria</i> , compact the soil and passively disperse non-native plants. However, these threats are largely unknown and/or unsubstantiated, and in some cases light disturbances may create habitat.
6.2	War, civil unrest & military exercises	Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	High (Continuing)	It is likely that routine military exercises causing light disturbance may promote habitat creation and could be beneficial.
6.3	Work & other activities	Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	High (Continuing)	Ranchers using ATVs throughout suitable habitat would be an ongoing activity and cause minor disturbance which could be beneficial.
7	Natural system modifications	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Report Author's Comments
7.1	Fire & fire suppression		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	7.1 Fire & Fire Suppression. Wildfires are considered part of the natural ecosystem processes of Canada's grasslands, and historically wildfires were important in maintaining native grasslands. At present, native grasslands areas are confined to very small areas, many of which are highly isolated from one another, and usually with only sporadic wildfire events. Verna's Flower Moth is recorded from localities where wildfires in these and potential habitats have the potential to directly and severely impact local moth populations (e.g., Swengel 1996). Here the direct impact of fire at a temporal level is considered, as it is likely that wildfires occurring only at critical times in the life history of the moth (i.e., adult flight and larval feeding; May-July) would have negative consequences to moth populations; it is during this time when the host plant is flowering and may contain the feeding larva. Once the larvae finish feeding, they drop to the soil and burrow, likely offering protection from fire except under extreme intensities.
7.2	Dams & water management/usage						Not applicable.
7.3	Other ecosystem modifications		Not a Threat	Pervasive (71-100%)	Neutral or Potential Benefit	High (Continuing)	Other ecosystem modifications that serve to create light to moderate disturbance and/or disrupt natural ecological succession are likely beneficial to <i>Antennaria</i> populations and may serve to create habitat for the moth. This would include both natural and prescribed burning during times when the moth is not flying or feeding. Hotter fires would likely impact populations of mature plants, but seed banks would likely survive. In general, light fire would be beneficial. Again, timing is the main issue; if fire or other ecosystem modifications occur when host plants are flowering and the larva are feeding, then the impact would be negative.
8	Invasive & other problematic species & genes	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Took the non-native as the highest threats 8.1.
8.1	Invasive non-native/alien species	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	(See Threats Section)
8.2	Problematic native species	D	Low	Restricted - Small (1-30%)	Moderate (11-30%)	High (Continuing)	(See Threats Section)
8.3	Introduced genetic material						Not applicable.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Report Author's Comments
9	Pollution		Unknown	Restricted (11-30%)	Unknown	High (Continuing)	
9.1	Household sewage & urban waste water						Not applicable.
9.2	Industrial & military effluents						Not applicable.
9.3	Agricultural & forestry effluents		Unknown	Restricted (11-30%)	Unknown	High (Continuing)	Most of the prairies are under agricultural production, and thus agricultural effluents are routinely applied to crops. Numerous crop pests are lepidoptera larva. Pesticide drift is a potential threat to larvae and adults and herbicides could potentially affect the larval host plant as well if sites exist close to the area of pesticide application. The threat is not applicable to the locality at Spruce Woods Provincial Park. The scope and severity are unknown for the remaining localities.
9.4	Garbage & solid waste						Not applicable.
9.5	Air-borne pollutants						Not applicable.
9.6	Excess energy						Not applicable. Although light pollution can have impacts on nocturnal moths, this is a day flying moth species.
10	Geological events						
10.1	Volcanoes						Not applicable.
10.2	Earthquakes/tsunamis						Not applicable.
10.3	Avalanches/land slides						Not applicable.
11	Climate change & severe weather		Unknown	Unknown	Unknown	High (Continuing)	

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Report Author's Comments
11.1	Habitat shifting & alteration	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	<i>11.1 Habitat Shifting & Alteration.</i> Verna's Flower Moth appears to have several specialized habitat requirements, a likely dependence on specific climatic and habitat cues which may impact emergence times, and a dependence on specific host plants (<i>Antennaria</i>) that will likely contribute to its decline with a rapidly changing climate (Foden <i>et al.</i> 2008; Thomas <i>et al.</i> 2011). For other early-emerging lycaenid species advanced emergence dates in response to climate warming have been observed (Polgar <i>et al.</i> 2013; Swengel and Swengel 2014), so synchrony of emergence of Verna's Flower Moth with its host plant(s) may also be affected. A longer-term threat is the anticipated change to a warmer and drier climate in southern parts of the Canadian prairies (Sauchyn and Kulshreshtha 2008).
11.2	Droughts	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	<i>11.2 Droughts.</i> An increase in the frequency and severity of extreme droughts could be a long-term threat to Verna's Flower Moth and may have synergistic negative effects with overgrazing. Hot and arid conditions may also impact host plants, potentially reduce larval survival.
11.3	Temperature extremes	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	<i>11.3 Temperature Extremes.</i> Although this species is a prairie specialist, exceptionally cold winters with little snow cover may affect this species ability to tolerate cold temperatures in the wintering stage.
11.4	Storms & flooding	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	<i>11.4 Storms and flooding.</i> The frequency and severity of weather events increases due to climate change. Small, isolated populations of Verna's Flower Moth may be vulnerable to stochastic events such as hailstorms and flooding. During extreme events in the prairies, flooding can be extensive in the spring.

Threat 2. Agriculture & aquaculture (medium – low impact).

2.1 Annual and perennial non-timber crops (medium – low impact).

The highest threat impact to Verna's Flower Moth are agricultural activities including ongoing crop intensification or cultivation, that result in loss or degradation of flowering populations of the *Antennaria* larval host plants (Environment and Climate Change Canada 2016). Three of the extant populations are adjacent to agricultural areas, and although these areas have not been extensively surveyed for the moth, agricultural development

would limit the population size at the site. The loss and/or fragmentation of prairie grassland habitat from agricultural development is considered the highest threat impact to prairie butterflies (Thomas 2016).

Threat 8. Invasive & other problematic species, genes & diseases (low impact)

8.1 Invasive Non-Native/Alien Species (low impact).

Many non-native plant species are found throughout the prairie grassland ecosystems. Invasive plants such as Leafy Spurge (*Euphorbia esula*), Smooth Brome (*Bromus inermis*) and Kentucky Blue Grass (*Poa pratensis*) are threats to prairie grassland habitats. The distribution and abundance of these plants specifically within Verna's Flower Moth habitat is unknown; however, these plants would compete with the larval host plant. In most of the prairie habitats, the spread and growth of non-native plants may be slow due to the hot and dry climate.

8.2 Problematic native species (low impact).

Potential successional ingrowth of native grassland plants may reduce *Antennaria* populations in the absence of light/beneficial herbivore grazing. Observation in Buffalo Pound Provincial Park found that host plant populations were significantly larger within bison grazing enclosures than areas outside where surrounding grasses were longer (Figure 6). In the absence of grazers, native grasses can out-compete and/or shade *Antennaria*, reducing stand size.

Natural succession and the expansion of woody plant species and the growth of shrubs and grasses contribute to the decline of *Antennaria* host plant patches. Periodic disturbance is needed to sustain the early seral conditions needed for these host plants. The lack of long-term natural (e.g., fires) or anthropogenic (e.g., livestock grazing, mowing, or prescribed burns) disturbance will lead to further natural succession.

Habitat within Spruce Woods Provincial Park is declining due to the ingrowth of native plants such as White Spruce (*Picea glauca*), Trembling Aspen (*Populus tremuloides*), Creeping Juniper (*Juniperus horizontalis*), Sand Bluestem (*Andropogon hallii*), Prairie Sunflower (*Helianthus petiolaris*) and Silverberry (*Elaeagnus commutata*). Natural succession is likely driven by the current natural wetter climatic regime, which is projected to continue within the coming decades (Wolfe *et al.* 2000, 2001; Hugenholtz and Wolfe 2005; Hugenholtz *et al.* 2010; Environment Canada 2011, 2013). Additional factors that contribute to native plant encroachment include wildfire suppression (threat 7.1), lack of adequate ungulate disturbance (e.g., Plains Bison), large-scale tree planting, and agricultural practices that promote soil conservation (e.g., wind shelter belts) (Environment Canada 2011, 2013).

Limiting Factors

Little is known about the limiting factors applicable to Verna's Flower Moth. The species is entirely dependent on *Antennaria* as its larval host plant, and this specificity combined with the large distances between known host plant populations makes the species more vulnerable to localized extinction risk. Bailey *et al.* (2010) estimates that approximately 2,430 km² are grazed by wildlife within provincial and national parks in the Canadian Prairies terrestrial ecozone, and grazing is likely needed to maintain flowering host plant patches.

Intraspecific cannibalism has been documented for feeding larva of Verna's Flower Moth (Hardwick 1983, 1996), and cannibalism larval predation has been reported for other sun moths (Wagner *et al.* 2011). First-instar larvae of Verna's Flower Moth abandon flower heads that are already occupied, so survival of these wandering larvae may be very low and limited because of their small size and observed inability to penetrate a new flower head (Hardwick 1983).

Number of Locations

The term 'location' defines a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present. This species has a broad geographic range, and the threats to this species remain unclear. Therefore, in absence of clearly defined threats over its range, the number of locations is unknown.

At least six extant sites are known for Verna's Flower Moth; however, it is likely a small number of additional areas could still be documented and potential habitat has been identified in other areas (e.g., Qu'appelle River Valley, Beaver Creek Conservation Area and Chaplin Lake-North Shore in SK) (Snable *et al.* 2017; Sheffield pers. data).

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Verna's Flower Moth is listed as Threatened under Schedule 1 of the federal *Species at Risk Act* (SARA) (Canada Gazette 2009; Environment Canada 2015). It was last assessed as Threatened by COSEWIC in May 2005 and was returned by the Minister for further information and consideration based on several factors including few data on the species' distribution, abundance, range, threats and suitable habitat (Canada Gazette 2006). COSEWIC reconfirmed a Threatened status designation in 2007 and it was listed on Schedule 1 of SARA in 2009 (SARA Registry). A federal species recovery strategy was published in 2016 (Environment and Climate Change Canada 2016).

Non-Legal Status and Ranks

The conservation status ranks for Verna's Flower Moth are: N2N3 (Imperiled to Vulnerable) in Canada, S2S3 (Imperiled to Vulnerable) in Alberta, S1 (Critically Imperiled) in Saskatchewan, and S1S2 (Critically Imperiled to Imperiled) in Manitoba (Canadian Endangered Species Conservation Council 2016).

Habitat Protection and Ownership

One locality in Manitoba is on Provincial Crown land (Spruce Woods Provincial Park), the other two known localities are on privately owned land (Environment Canada 2015). The habitat protection and ownership at the other two localities (Saskatoon and Medicine Hat) are unknown.

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AUTHORITIES CONTACTED

Anweiler, G.G. December 2013. Moth specialist. 7212-103rd Avenue, Edmonton, Alberta, T6A 0V1

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Court, G. December 2013. Provincial Wildlife Status Biologist, Government of Alberta, 2nd floor, Great West Life Building, 9920 - 108 Street, Edmonton, Alberta, T5K 2M4.

Dombroskie, J. December 2013. Collections Manager. Department of Entomology. Cornell University. Comstock Hall, Ithaca, New York, 14853-2601, USA

Duncan, D. December 2013. Manager, Population Conservation Section. Prairie and Northern Region. Canadian Wildlife Service, Environment Canada, 9250 49th Street NW, Edmonton, Alberta, T6B 1K5

Dunford, W. December 2013. Recovery Science Officer. Recovery Program. Species at Risk Management, Canadian Wildlife Service, Environment Canada, 351 St. Joseph Blvd., Hull, Quebec K1A 0H3.

Eberhardt, E. December 2013. Manager. Recovery Program. Species at Risk Management, Canadian Wildlife Service, Environment Canada, 351 St. Joseph Blvd., Hull, Quebec K1A 0H3.

Greenwald, N. December 2013. Endangered Species Director. Centre for Biological Diversity, PO Box 11374, Portland, Oregon, 97211-0374.

Hassan, A. January 2014. Recovery Biologist. Canadian Wildlife Service. Prairie and Northern Region. Environment Canada. 115 Perimeter Road, Saskatoon, Saskatchewan, S7N 0X4.

Howes, B. December 2013. Science Support. Species at Risk Program. Natural Resource Conservation Branch. Protected Areas Establishment and Conservation Directorate. Parks Canada. 30 Victoria Street, Gatineau, Quebec, J8X 0B3.

Hurlburt, D. December 2013. COSEWIC Aboriginal Traditional Knowledge Subcommittee Co-chair, PO Box 114, 9 Circle Drive, Annapolis Royal, Nova Scotia, B0S 1A0.

Nantel, P. December 2013. Office of the Chief Ecosystem Scientist. Protected Areas Establishment and Conservation Directorate. Parks Canada. 30 Victoria Street, Gatineau, Quebec, J8X 0B3.

Saigeon, L. December 2013. Executive Director. Saskatchewan Fish and Wildlife Branch. Resource Management and Compliance Division. 3211 Alberta Street, Regina, Saskatchewan, S4S 5W6.

Schmidt, C. December 2016. Entomologist. National Collections of Insects, Arachnids and Nematodes. Canadian Food Inspection Agency. 960 Carling Avenue, K. W. Neatby Building, Ottawa, Ontario, K1A 0C6.

Snable, V. April 2017. Wildlife Biologist, Canadian Wildlife Service, Environment and Climate Change Canada, Ottawa, ON.

Song, S. December 2013. Head. Population Assessment Unit. Population Conservation Section. Canadian Wildlife Service. Prairie and Northern Region. Canadian Wildlife Service. Environment Canada. 9250 49th Street, Edmonton, Alberta, T6B 1K5

Watkins, B. December 2013. Zoologist. Ecosystem Protection Branch. Manitoba Department of Conservation, Box 24, 200 Saulteaux Crescent, Winnipeg, Manitoba, R3J 3W3.

Wayland, M. January 2014. Head, Species at Risk Recovery Unit. Canadian Wildlife Service. Prairie and Northern Region. Environment Canada. 115 Perimeter Road, Saskatoon, Saskatchewan, S7N 0X4.

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BIOGRAPHICAL SUMMARY OF REPORT WRITER(S)

Cory S. Sheffield has been studying bees and pollination since 1993, as part of undergraduate honours studies at Acadia University, Wolfville, Nova Scotia. He continued graduate studies (MSc) of insect-plant interactions at Acadia, and at Agriculture and Agri-Food Canada (AAFC), Kentville, Nova Scotia from 1994 – 2006. Cory did graduate studies (PhD) at the University of Guelph, Ontario, while continuing to work at the AAFC. These studies focused on the bee fauna of Nova Scotia, including their diversity and contributions to crop pollination. During this time, Cory and several co-authors published on the re-discovery of *Epeoloides pilosulus* in Nova Scotia, which was thought extinct. Cory then worked on post-doctoral studies at York University, ON in bee taxonomy and DNA barcoding, followed by a research associate position in bee taxonomy with the Canadian Pollination Initiative (CANPOLIN). He is now research scientist and curator of invertebrate zoology at the Royal Saskatchewan Museum in Regina, SK. His research continues to focus on bees: he has published on the taxonomy of Canadian/North American bees, the utility of DNA barcoding for bees, bee physiology, pollination contributions and diversity of the Canadian bee fauna.

COLLECTIONS EXAMINED

In preparation for the first status assessment (COSEWIC 2005): Strickland Entomological Museum (University of Alberta, Edmonton, AB), Northern Forestry Centre (Edmonton, AB), Canadian National Collection of Insects (Ottawa, ON), Buffalo Museum of Science (Buffalo, NY), University of Guelph Entomology Collection (Guelph, ON), British Museum of Natural History (London, UK), Illinois State Natural History Survey (Urbana, IL), Natural History Museum of Los Angeles County (Los Angeles, CA), Michigan State University (East Lansing, MI), Great Lakes Forestry Centre (Sault Ste. Marie, ON), University of Manitoba (Winnipeg, MB), University of Michigan (Ann Arbor, MI), University of Minnesota (St. Paul, MN), New York State Museum (Albany, NY), Jim Troubridge personal collection, Chuck Harp personal collection.

In preparation of this status assessment (post 2005): Royal Saskatchewan Museum, Regina, SK.