COSEWIC
Assessment and Status Report

on the

White Flower Moth
Schinia bimatris

in Canada

ENDANGERED
2014

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):

COSEWIC. 2005. COSEWIC assessment and status report on the White Flower Moth *Schinia bimatris* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 20 pp. (www.sararegistry.gc.ca/status./status_e.cfm).

COSEWIC would like to acknowledge Colin Murray and Chris Friesen for writing the status report on the White Flower Moth, *Schinia bimatris*, in Canada, prepared under contract with Environment Canada. This report was overseen and edited by Jennifer Heron, Co-chair of the COSEWIC Arthropods Specialist Subcommittee.

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White Flower Moth — Photo provided by author.

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COSEWIC
Assessment Summary

Assessment Summary – November 2014

Common name
White Flower Moth

Scientific name
Schinia bimatris

Status
Endangered

Reason for designation
In Canada, this moth is restricted to dunes at one site within the Bald Head Hills of southern Manitoba, which is 1000 km north of the nearest site in the United States. The moth's habitat is threatened from natural native vegetation succession into the otherwise open and sparsely vegetated sand. Larval host plants are unknown; however, they are suspected to be in the Aster family. The ongoing vegetation encroachment competes with larval host plant quantity and quality.

Occurrence
Manitoba

Status history
Designated Endangered in May 2005. Status re-examined and confirmed in November 2014.

COSEWIC
Executive Summary

White Flower Moth
Schinia bimatris

Wildlife Species Description and Significance

The White Flower Moth (*Schinia bimatris*) has glossy bright white wings and a bright orange head and body. The wingspan is approximately 31 mm. The eggs and larvae have not been described.

The White Flower Moth is one of several rare obligate sand-dune moths in Canada. There are few areas with active or open sand dune complexes in the country, including the Spirit Sand Dunes within Manitoba. These areas are unique habitats and considered "islands of biodiversity". The Spirit Sand Dunes is culturally and spiritually significant to First Nations in the area. The habitat also represents a unique geomorphological landform which enables unique flora and fauna to reside.

Distribution

The White Flower Moth occurs in central-eastern North America and has a disjunct distribution from Texas east to South Carolina and north to Manitoba. In Canada, White Flower Moth is recorded at one site in southern Manitoba, within the Bald Head Hills, which are southeast of Brandon. The Bald Head Hills includes the Spirit Sand Dunes in Spruce Woods Provincial Park and the sand hills in Canadian Forces Base (CFB) Shilo. Recent search effort within portions of CFB Shilo, which is adjacent to the Spruce Woods Provincial Park, has not recorded the species on this property. However, the species is likely within these areas given the contiguous habitat. The Bald Head Hills has a spatial area of approximately 960 hectares, of which approximately 78 ha is open sand dunes and suitable for White Flower Moth. This area is calculated based on new information since the 2005 status report, which stated the Bald Head Hills contain approximately 5 km^2 of available habitat for White Flower Moth.

Habitat

In Manitoba, the White Flower Moth inhabits exposed open sand dunes and partially vegetated areas between the dunes. In the southeastern United States, it inhabits Longleaf and Shortleaf Pine forests and appears associated with sandy soils. The host plant is unknown.

Biology

There is little data on the biology of the White Flower Moth. Most of its biology is generalized from observations of other flower moths. Adult emergence likely coincides with the emergence of the larval host plant (unknown species). The female mates and lays her eggs on the larval host plant. The eggs hatch after several days and the larva feeds on the flower head. In two to four weeks the larva forms a pupa at or below the soil surface. The adult emerges in about five days in laboratory conditions but likely overwinters in the pupal stage in the wild. In Manitoba there is probably only one generation per year.

Population Sizes and Trends

White Flower Moth populations are expected to decline over the next century based on habitat decline trend projections of 10 – 20% per decade. When the coarse population abundance estimates are projected over the future hundred years the population declines to approximately 35% of its present-day estimate when assuming the moth occupies the entire Bald Head Hills (960 ha) or optimal sand blowout moth habitat (78ha). Overall, White Flower Moth populations likely vary year-to-year based on weather and food availability.

Threats and Limiting Factors

The predominant threat to the White Flower Moth is the natural succession of native vegetation and stabilization of the open dune habitat. A wetter climatic regime appears to be enabling vegetation to grow within these otherwise dry environments. Conversely, the anticipated shift to a more arid climate, due to global climate change, may create more suitable habitat for the moth by increasing sandy areas. This same drier climate may be detrimental to the moth because it would lead to premature senescence of larval host plants. Due to the small and confined population the moth is vulnerable to random (stochastic) events, such as extreme weather, that could eliminate the entire population in one event. Other threats include recreational all-terrain vehicle use within the habitat, and overcollection from research, both specifically targeting the moth and by-catch during other research studies.

Protection, Status, and Ranks

In 2005, the White Flower Moth was designated as Endangered by COSEWIC, and in 2006 was listed as such under Schedule 1 the federal *Species at Risk Act* (SARA). In 2012 the moth was designated Endangered under the Manitoba *Endangered Species and Ecosystems Act*; this act prohibits destroying, disturbing or interfering with the species or its habitat.

The conservation status rank for White Flower Moth in Manitoba is S1 (Critically Imperiled). The Canadian national rank is N1 (Critically Imperiled) and global rank is G2G4 (Imperiled to Apparently Secure).

White Flower Moth occurs within Spruce Woods Provincial Park and has some protection under Manitoba's *Parks Act*, which prohibits activities that damage or interfere with the environmental features within the park (Manitoba 1993, Manitoba 1996). The moth is protected under the federal *Species at Risk Act* and the CFB Shilo. Training and vehicle use within the sand ecosystem habitat of CFB Shilo that is likely to have a population of White Flower Moth is tightly restricted, as per the CFB Shilo leasehold agreement between the Province of Manitoba and federal government.

TECHNICAL SUMMARY

Schinia bimatris

White Flower Moth — Héliotin blanc satiné

Range of occurrence in Canada: Manitoba

Demographic Information

Generation time	1 year
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes. Inferred decline of 10 – 20% over the next decade based on habitat loss from native vegetation encroachment.
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Yes. 5% to 10% inferred decline in moth population within 5 years based on an estimated 10 – 20% habitat loss per decade from native vegetation encroachment.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Yes. 5% to 10% inferred decline in moth population within 5 years based on an estimated 10 – 20% habitat loss per decade from native vegetation encroachment.
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Yes. 5% to 10% inferred decline in moth population within 5 years based on an estimated 10 – 20% habitat loss per decade from native vegetation encroachment.
[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.	Yes. 5% to 10% inferred decline in moth population within 5 years based on an estimated 10 – 20% habitat loss per decade from native vegetation encroachment.
Are the causes of the decline clearly reversible and understood and ceased?	Partially understood; not ceased and not clearly reversible.
Are there extreme fluctuations in number of mature individuals?	Unknown.

Extent and Occupancy Information

Estimated extent of occurrence o Calculation is less than the previous assessment, which included Aweme and Onah. These two sites are no longer thought to be the accurate collection sites for the associated specimens. o The present assessment only includes the Bald Head Hills habitat in Manitoba.	10 km² (1000 ha)

Index of area of occupancy (IAO)	8 km² (400 ha)
Is the population severely fragmented?	No
Number of locations	1
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	Yes. Observed, inferred and projected decline of 10 – 20% per decade due to habitat loss from natural vegetative succession.
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy?	Yes
Is there an [observed, inferred, or projected] continuing decline in number of populations?	No. The current occurrence is considered one population.
Is there an [observed, inferred, or projected] continuing decline in number of locations*?	No. There is one location.
Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat?	Yes. Observed and projected continuing decline in area, extent, and quality of habitat due to a 10 – 20% loss per decade
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals

Population	**N Mature Individuals**
Bald Head Hills	1308 – 8172
Total	**1308 – 8172**

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not calculated.

Threats (actual or imminent, to populations or habitats)

Problematic native species (i.e. encroachment into the sand dune ecosystem that leads to sand dune stabilization through natural succession causing habitat degradation and elimination); Natural habitat shifting and alteration (i.e. the main driver of native species encroachment); Temperature extremes; Recreational vehicles; Hunting and collecting.

Rescue Effect (immigration from outside Canada)

Status of outside population(s)?	Unknown
Is immigration known or possible?	Not possible
Would immigrants be adapted to survive in Canada?	Unknown
Is there sufficient habitat for immigrants in Canada?	Unknown

Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species?	No

Status History

COSEWIC: Designated Endangered in May 2005. Status re-examined and confirmed in November 2014.

Current Status and Reasons for Designation:

Status:	**Criteria:**
Endangered	B1ab(i,ii,iii)+2ab(i,ii,iii)
Reasons for designation: In Canada, this moth is restricted to dunes at one site within the Bald Head Hills of southern Manitoba, which is 1000 km north of the nearest site in the United States. The moth's habitat is threatened from natural native vegetation succession into the otherwise open and sparsely vegetated sand. Larval host plants are unknown; however, they are suspected to be in the Aster family. The ongoing vegetation encroachment competes with larval host plant quantity and quality.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Data available is not sufficient to use these criteria with confidence.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered B1ab(i,ii,iii)+2ab(i,ii,iii) since the EO is less than 5,000 km² (10 km²), the IAO is less than 500 km² (8 km²), it is known to exist at fewer than 5 locations (1), and there is an observed continuing decline in (i) the EO, (ii) the IAO, and (iii) the area, extent and quality of habitat.
Criterion C (Small and Declining Number of Mature Individuals): Does not meet criteria.
Criterion D (Very Small or Restricted Population): Meets Threatened D2 since it is known to exist at one location, the IAO is 8 km^2 and it is prone to stochastic events within a short period of time.
Criterion E (Quantitative Analysis): Not applicable. No analysis completed.

PREFACE

The White Flower Moth (*Schinia bimatris*) was initially assessed as Endangered in 2005. Since the initial status assessment new information from field observations and surveys has been gathered on the threats, biology and population of the moth.

The only known White Flower Moth occurrence in Canada is within the Bald Head Hills of the Brandon/Spirit Sand dune complex, Manitoba. Surveys between 2000 and 2013 in other sand hill complexes in Alberta, Saskatchewan, and Manitoba have not recorded new sites.

The White Flower Moth has been observed flying in partially stabilized dunes and semi-vegetated areas between dunes when previously it was only documented in exposed sand dunes. Recent search effort has shown the species is primarily diurnal and observed and captured in the day; when previously it was only documented flying at night.

Elsewhere in the species' global range, in the southeastern United States, the moth occurs in Longleaf Pine forest but has also now been documented in Shortleaf Pine forests. There is now some evidence that it prefers pine forests that grow on sandy soils that appear similar to the Bald Head Hills. Within the United States, the closest known (disjunct) occurrence is in Omaha, Nebraska, approximately 1000 km to the south.

The current (2013) and previous (2005) population size estimates are different. The population is projected to trend downward. The primary threat to White Flower Moth continues to be dune stabilization from native plant succession leading to sand mixed-grass prairie and forest. Other threats include natural habitat shifting and alteration and extreme temperatures (e.g. early or late season frost) which cause mortality to foraging caterpillars or active adults. Some threats initially identified in the recovery strategy (Environment Canada 2011) have since been assessed negligible

The extent of occurrence and the area of occupancy have declined since the initial COSEWIC (2005) assessment, although this is partially due to incorrect specimen locality information. Specimens collected in Aweme, Onah, and Treesbank were likely general locations with incorrect labelling and in fact collected in the Bald Head Hills area.

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
(2014)

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 Canada / Environnement Canada
Canadian Wildlife Service / Service canadien de la faune
Canada

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

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Phylum Arthropoda – arthropods

Class Insecta – insects

Subclass Pterygota – winged insects

Order Lepidoptera – butterflies, moths

Superfamily Noctuoidea

Family Noctuidae – Owlet Moths

Subfamily Heliothinae

Genus *Schinia*

Species *bimatris* (Harvey 1875)

Synonyms: *Pippona bimatris* Harvey 1875.

English common name: White Flower Moth

French common name: héliotin blanc satiné

White Flower Moth (*Schinia bimatris)* was first described as *Pippona bimatris* from a specimen captured in Bosque County, Texas (Harvey 1875). The common name, White Flower Moth, was first used by Hooper (1996).

White Flower Moth is one of 154 documented flower moth species (Heliothinae) in North America and a subfamily of the owlet moths (Noctuidae) (Lafontaine and Schmidt 2010). There are approximately 123 *Schinia* species documented in North America (Lafontaine and Schmidt 2010) and 28 species in Canada (Troubridge and Lafontaine 2004a; Troubridge and Lafontaine 2004b).

Morphological Description

White Flower Moth (Figures 1 and 2) has a wingspan of 30 - 32 mm (Harvey 1875; Hardwick 1996). The unique colouration of this species distinguishes it from other moths collected in its Canadian habitat. The wings are glossy white, the abdomen and upper thorax are white, both contrasting with the head and collar, which are bright orange. Most specimens from Manitoba have white hindwings while some have a small area of grey scales overlaying the white scaling on the outer margin of the apex of the hindwing and that after pinning the scales may look brownish (Westwood pers. com. 2014).

Elsewhere in the species global range White Flower Moth may appear to have different colouration than the Manitoba populations. The forewings can be faintly yellow in coastal regions of its global range (Harvey 1875) and have light brown scales on the outer margin of the hindwing (Harvey 1875; Brou 2003). Southern individuals tend to be slightly smaller than northern populations. White Flower Moth eggs and larvae have not been described.

Figure 1. Dorsal view of White Flower Moth (*Schinia bimatris*), female. Specimen from Louisiana: St. Tammany Parish, 4.2 mi. NE Abita Springs. Housed at Brou Collection, Louisiana. Photograph Vernon Brou Jr.

Figure 2. Dorsal view of White Flower Moth (*Schinia bimatris*), female, showing light brown scaling on hindwings. Specimen from Louisiana: St. Tammany Parish, 4.2 mi. NE Abita Springs. Housed at Brou Collection, Louisiana. Photograph Vernon Brou Jr.

Figure 3. White Flower Moth (*Schinia bimatris*) adult. Note the distinctive orange colouration of the head, ventral thorax and legs. Photo taken at Bald Head Hills, Spruce Woods Provincial Park, Manitoba in 2007. Photograph Chris Friesen.

Population Spatial Structure and Variability

Geographic barriers exist that could create genetic structure and demographic isolation but the extent of this isolation has not been studied. The Manitoba site has a small area of occupancy and is geographically isolated from the closest site in Omaha, Nebraska, approximately 1000 km to the south. Specimens from Manitoba and southern United States exhibit slight morphological differences externally (COSEWIC 2005). Molecular variation (DNA barcode fragment of the COI gene) between four Manitoba and three Mississippi specimens does not indicate that these populations are separate species (C. Schmidt pers. comm. 2014).

Designatable Units

The White Flower Moth is being assessed as one designatable unit, in the absence of information on discreteness or evolutionary significance among populations. The species occurs within the COSEWIC (2011) Prairie National Ecological Area.

Special Significance

The White Flower Moth is known from one population in southern Manitoba and represents the northern extent of the species' global range. The White Flower Moth is one of many rare, sand-dune obligate species in Canada several of which are protected by provincial and federal species-at-risk legislation. Only a few small areas exist in Canada with active or open sand dune complexes. These areas are considered "islands of biodiversity" surrounded by agriculture (Hugenholtz *et al.* 2010).

The Spirit Sand Dunes is culturally and spiritually significant to First Nations and represents a unique geomorphological landform containing unique fauna and flora (Manitoba Conservation 1983, 1985, 1998, 2013)

DISTRIBUTION

Global Range

The White Flower Moth has a fragmented range, which jumps from southern Manitoba 1000 km to Nebraska, and then south to eastern Texas and east to southern Alabama. Another disjunct population occurs on the eastern seaboard of South Carolina, approximately 900 km east of the southern Alabama site (Figure 4; COSWIC 2005, Environment Canada 2011, Opler *et al.* 2013, NatureServe 2013, Pogue pers. comm. 2013).

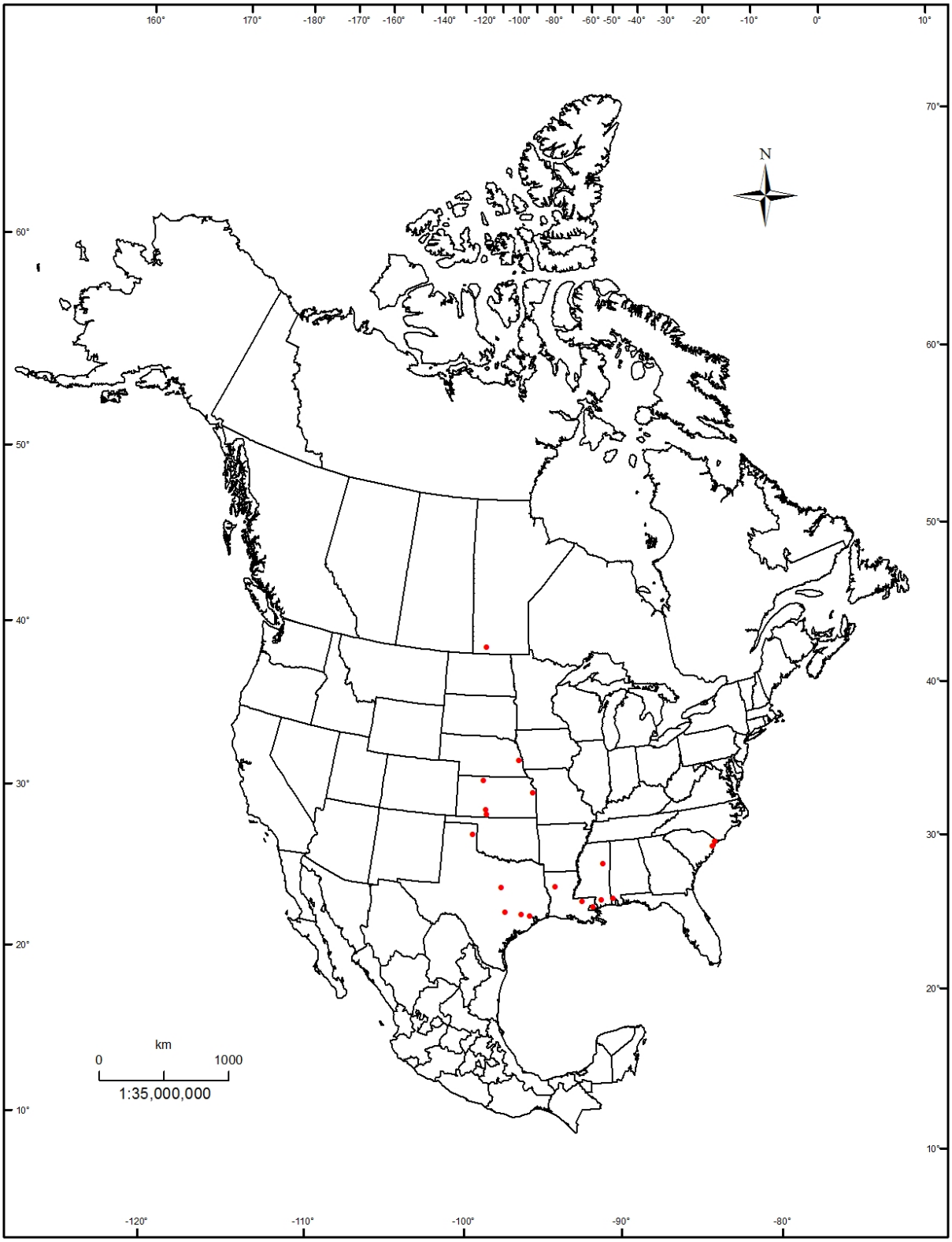

Figure 4. Global range of White Flower Moth (*Schinia bimatris*). Records and habitat are disjunct. Red dots indicate a collection site (Table 1).

Table 1. Summary of specimen data for the White Flower Moth.

Site	Collection Date	Collector	Museum Collection[1]	Number of specimens
Canadian Sites				
CAN MB: Aweme	ca. 1900	J. Fletcher	CNCI	1
CAN MB: Aweme	?	?	LACM	?
CAN MB: Aweme	20-Jul-1910	N. Criddle	UMWM	?
CAN MB: Aweme	20-Aug-1911	Unknown	RSM	1
CAN MB: Aweme	09-Jul-1916	N. Criddle	CNCI	1
CAN MB: Aweme	08-Jul-1920	N. Criddle	CNCI	1
CAN MB: Aweme	07-Jul-1920	N. Criddle	CNCI	1
CAN MB: Aweme	19-Jul-1921	J.B. Wallis	RSM	1
CAN MB: Aweme	15-Jul-1923	J.B. Wallis	RSM	1
CAN MB: Aweme	17-Jul-1923	J.B. Wallis	RSM	1
CAN MB: Aweme	18-Jul-1923	N. Criddle	LACM	?
CAN MB: Aweme	19-Jul-1923	J.B. Wallis	RSM	1
CAN MB: Aweme	31-Jul-1924	N. Criddle	CNCI	1
CAN MB: Aweme	09-Jul-1925	N. Criddle	AMNH (fide C. Harp)	?
CAN MB: Onah	18-Jul-1921	N. Criddle	CNCI	1
CAN MB: Onah	16-Jul-1927	N. Criddle	CNCI	2
CAN MB: Treesbank	20-Jul-1910	J.B. Wallis	RSM	1
CAN MB: Spirit Dunes, Spruce Woods P.P.	20-Jul-2003	J.D. Lafontaine and J. Troubridge	J. Troubridge	2
CAN MB: Spirit Dunes, Spruce Woods P.P.	21-Jul-2003	J.D. Lafontaine and J. Troubridge	CNCI and J. Troubridge	7
CAN MB: Spirit Dunes, Spruce Woods P.P.	28-Jul-2003	J.D. Lafontaine and J. Troubridge	J. Troubridge	2
CAN MB: Spirit Dunes, Spruce Woods P.P.	23-Jul-2007	C. Friesen and R. Westwood	UMWM	4
CAN MB: Spirit Dunes, Spruce Woods P.P.	31-Jul-2007	C. Friesen and R. Westwood	UMWM	1
CAN MB: Spirit Dunes, Spruce Woods P.P.	16-Jul-2007	C. Friesen and R. Westwood	UMWM	1
CAN MB: Spirit Dunes, Spruce Woods P.P.	06-Jul-2007	C. Friesen and R. Westwood	UMWM	8

Site	Collection Date	Collector	Museum Collection[1]	Number of specimens
CAN MB: Spirit Dunes, Spruce Woods P.P.	19-Jul-2012	C. Murray	UMWM	2
CAN MB: Spirit Dunes, Spruce Woods P.P.	18-Jul-2012	C. Murray	UMWM	1
CAN MB: Spirit Dunes, Spruce Woods P.P.	08-Aug-2012	C. Murray	UMWM	1
CAN MB: Spirit Dunes, Spruce Woods P.P.	17-Jul-2012	C. Murray	UMWM	3
CAN MB: Spirit Dunes, Spruce Woods P.P.	31-Jul-2013	C. Murray	UMWM	2
CAN MB: Spirit Dunes, Spruce Woods P.P.	18-Jul-2013	C. Murray	UMWM	2
United States Sites				
USA AL: Mobile Co., Delchamps	13-Sep-30	?	AMNH (fide C. Harp)	?
USA KS: Comanche Co., 0.5 mi. S and 1 mi. W of Coldwater	14-Aug-90	C.J. Ochs	FHSM (fide C. Harp)	?
USA KS: Douglas Co., Lawrence	?	?	J. Adams (fide C. Harp)	?
USA KS: Kiowa Co.	16-Aug-93	G.A. Salsbury	G.A. Salsbury (fide C. Harp)	3
USA KS: Phillips Co.	?	C.J. Ochs	Unknown (fide C. Harp)	1
USA LA: Natchitoches Co., Natchitoches Parish, Red Dirt Unit, Kisatchie National Forest	06-Sep-97	J. Slotten	J. Slotten	1
USA LA: St. Tammany Parish, Abita Springs	5-15 Sep-years?	V. Brou	V. Brou	?
USA LA: St. Helena Parish	?	V. Brou	V. Brou	?
USA MS: Okibbeha Co., Mississippi State University (A and M College)	31-Aug-31	R. Hutchins	AMNH (fide C. Harp)	1
USA MS: Oktibbeha Co., Osborn	30-Aug–9-Sep-2003	R.L. Brown	MEM (fide R. L. Brown)	25
USA MS: Stone Co., Little Biloxi Wildlife Area	21-Sep-97	J. Slotten	J. Slotten	1
USA NE: Douglas Co., Omaha	Sep-03	F.H. Marshall	UMN	?
USA SC: Horry Co., Myrtle Beach	20-Sep-37	?	LACM	?
USA SC: Georgetown Co., The Wedge Plantation, nr. McClellanville	?	R.B. Dominick	SCMM (fide C. Harp)	?
USA TX: Bosque Co., Clifton	4-Oct-1874?	?	BMNH (fide Hardwick 1996)	1

Site	Collection Date	Collector	Museum Collection[1]	Number of specimens
USA TX: Bastrop Co.	?	?	Bordelon and Knudson (fide C. Harp)	?
USA TX: Waller Co., Hockley	?	?	AMNH (fide C. Harp)	?
USA TX: Harris Co., Houston	23-Sep-64	A and M.E. Blanchard	BMNH	?
USA TX: Harris Co., Houston	24-Sep-64	A. Blanchard	CNCI	?
USA TX: Harris Co., Houston	26-Sep-64	A. Blanchard	CNCI	?
USA TX: Harris Co.	?	?	Bordelon and Knudson (fide C. Harp)	?
USA TX: Hemphill Co.	?	?	Bordelon and Knudson (fide C. Harp)	?

1 - Museum abbreviations used in Table 1.

AMNH - American Museum of Natural History,

UMWM - University of Manitoba J.B. Wallis Museum,

CNCI - Canadian National Collection of Insects, Arachnids and Nematodes,

BMNH - British Museum of Natural History,

FHSM - Fort Hays State Museum, Hays, KS, LACM - Los Angeles County Museum,

SCMM - University of South Carolina McKissick Museum,

UMN - University of Minnesota, BMS - Buffalo Museum of Science,

NYSM - New York State Museum, MEM - Mississippi Entomological Museum,

RSM – Royal Saskatchewan Museum.

The species has not been documented in Georgia or northern Florida (Adams 2013; Covell pers. comm. 2013) (Figure 4 and Table 1), the northern United States (Minnesota, Montana, North Dakota, and South Dakota) or other potentially suitable habitat in Canada. No occurrences of White Flower Moth have been documented in North Carolina despite the close proximity of the South Carolina records and extensive Lepidoptera surveys in North Carolina over the last 20 years (Hall pers. comm. 2013). A record for Cochise County, Arizona represents a mapping error. The previously considered disjunct record from Rico, Colorado is misidentified (Honey pers. comm. 2013, Pogue pers. comm. 2013).

Canadian Range

In Canada White Flower Moth is recorded at one site in southern Manitoba. The species is within the Bald Head Hills southeast of Brandon (Figure 5), which span both the Spirit Sand Dunes in Spruce Woods Provincial Park and the sand hills in Canadian Forces Base (CFB) Shilo. The occurrence is within the Prairie Ecozone, Aspen Parkland Ecoregion, and Shilo (757) Ecodistrict.

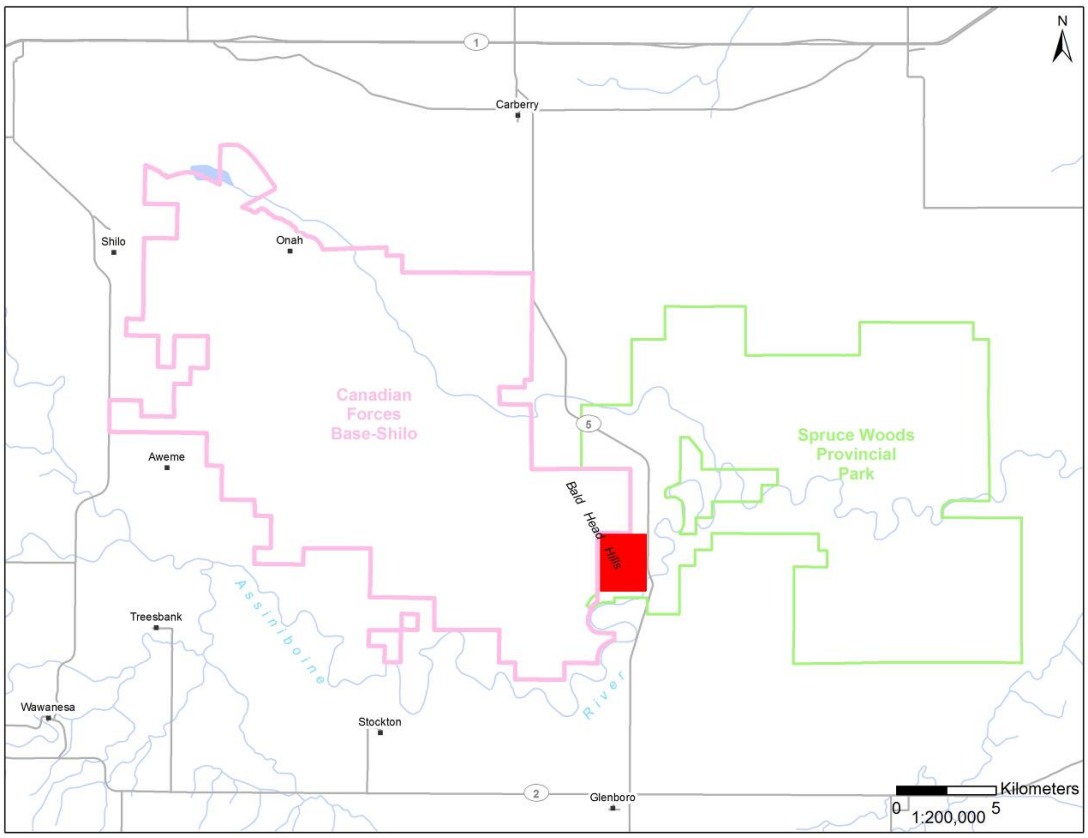

Figure 5. White Flower Moth (*Schinia bimatris)* site within the Bald Head Hills, Spruce Woods Provincial Park near Glenboro, Manitoba (Manitoba Conservation Data Centre 2013).

The southern dune portion of the Bald Head Hills extends north and west from Spruce Woods Provincial Park into CFB Shilo (Wolfe 2010) with a spatial area of approximately 750 hectares (Wolfe *et al.* 2000). The smaller northern portion of the Bald Head Hills is about 500 m distant and covers about 210 ha (Wolfe *et al.* 2000). Of these 960 ha, approximately 78 ha is open sand dunes (Wolfe 2010) and suitable for White Flower Moth. These numbers are less than the first COSEWIC (2005) status report, which stated the Bald Head Hills are approximately 5 km^2 of available habitat for White Flower Moth.

In the early 1900s Norman Criddle, John Braithwaite Wallace, and James Fletcher made the first White Flower Moth collections in Manitoba, and the museum specimen labels indicate these were caught at Aweme, Onah, and Treesbank. These sites are approximately 20 km from the Bald Head Hills and at present do not contain suitable habitat for the White Flower Moth and likely did not at the time these specimens were collected. It has been suggested these specimens were probably collected in the Bald Head Hills but that only very general site collection information was used on the labels.

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EO) in Canada is 10 km^2 and derived from a convex polygon of the known White Flower Moth sites (including habitat within adjacent CFB Shilo) (Murray unpubl. data 2013). Aweme, Onah, and Treesbank have been excluded from the EO calculation (see Canadian Range). The index of area occupancy (IAO) is 8 km^2.

The biological area of occupancy estimated to be 1 – 2 km^2 (134 ha) based on recent collection records. Since the moth is mobile, this calculation also includes a buffer area of similar habitat around the collection sites.

Search Effort

Alberta

Between 2000 and 2011 (although not yearly) most of the sand dune habitat in Alberta was surveyed for sand dune obligate moths (Schmidt pers. comm. 2014). Survey methods involve diurnal wandering transect surveys and nocturnal ultraviolet light traps (Anweiler pers. comm. 2014; Schmidt pers. comm. 2014). Both of these methods are considered suitable to detect this species. Areas searched include the Pakowski Dunes and the dunes at Jasper Lake during the flight period in 2006 – 2011, where there have been extensive surveys (Dombroskie pers. comm. 2014; Schmidt pers. comm. 2014). Other sand ecosystems include Edgerton, Wainwright, Sandy Point/Empress (more riparian type sand type), Dune Point (east of Empress Dunes), Opal and Redwater dunes north of Edmonton (these sandy sites are more in the Boreal ecozone but have some southern species present), sandy area at Kootenay Plains west of Nordag (sandy ecosystem but not dunes). There are other smaller dunes that would have had more sporadic sampling (Anweiler pers. comm. 2014; Dombroskie pers. comm. 2014; Schmidt pers. comm. 2014).

Saskatchewan

In Saskatchewan there were at least five sand dune sites surveyed specifically for White Flower Moth over five days, using pedestrian daytime and nighttime black-light surveys. Sites included: North Burstall Sand Dunes, Suffern Lake Regional Park, C.F.B. Dundurn, Saskatoon, Douglas Provincial Park, southeast Elbow, Seward Sand Dunes, and northeast Webb. Light traps were deployed only at North Burstall Sand Dunes for one night, totalling six traps total.

Manitoba

In 2003 and 2007, extensive black-light trapping occurred in Manitoba in the Spirit Sand Dunes, and White Flower Moth was detected in both years (Westwood and Friesen 2009).

Between 2009 and 2013, extensive day surveys (54 sites) and night surveys using black-light trapping (50 trap nights) were conducted during the flight season at sand dune complexes in Manitoba (Table 2). Surveys targeted larger open sand areas in the Bald Head Hills (Spruce Woods-CFB Shilo-Carberry sand dune complex) and adjacent smaller sand complexes at Lauder, Portage-St. Claude, and Routledge-Oak Lake. White Flower Moth was recorded only in the Bald Head Hills complex when surveyed in 2012 and 2013 (Friesen and Murray 2010; Friesen and Murray 2011; Murray and Friesen 2012; Murray 2013; Murray 2014; Manitoba Conservation Data Centre unpublished data).

Table 2. Summary of recent survey sites for the White Flower Moth in Manitoba sand dune complexes from 2009 to 2013 (Manitoba Conservation Data Centre 2013).

Sand Hill Complex	General Location	Survey Date	Pedestrian Survey	Number Light Traps Deployed	White Flower Moth Detected
Lauder, MB	100°39'W 49°28'N	2009 JUL 7	Yes	1	No
	100°39'W 49°28'N	2009 JUL 23	Yes	1	No
	100°39'W 49°28'N	2009 JUL 23	Yes	0	No
	100°39'W 49°28'N	2010 JUL 14	Yes	0	No
	100°39'W 49°28'N	2010 JUL 14	Yes	0	No
	100°39'W 49°28'N	2010 JUL 28	Yes	2	No
	100°39'W 49°28'N	2010 JUL 29	Yes	1	No
	100°39'W 49°28'N	2011 JUL 13	Yes	2	No
	100°39'W 49°28'N	2011 JUL 21	Yes	1	No
	100°39'W 49°28'N	2012 JUL 24	Yes	0	No
Total			**10**	**8**	
Portage-St. Claude, MB	98°16'W 49°46'N	2009 JUL 29	Yes	2	No
	98°16'W 49°46'N	2010 JUL 6	Yes	2	No
	98°16'W 49°46'N	2010 JUL 21	Yes	0	No
	98°16'W 49°46'N	2010 AUG 5	Yes	0	No
	98°16'W 49°46'N	2010 AUG 5	Yes	0	No
Total			**5**	**4**	
Routledge-Oak Lake, MB	100°51'W 49°47'N	2009 JUL 9	Yes	1	No
	100°51'W 49°47'N	2009 JUL 20	Yes	2	No
	100°51'W 49°47'N	2010 JUL 15	Yes	0	No
	100°51'W 49°47'N	2010 JUL 29	Yes	0	No
	100°51'W 49°47'N	2011 AUG 4	Yes	1	No
Total			**5**	**4**	
Spruce Woods-Shilo-Carberry*	99°33'W 49°40'N	2010 JUL 6	Yes	1	No
	99°18'W 49°40'N	2010 JUL 20	Yes	0	No
	99°33'W 49°40'N	2010 JUL 23	Yes	1	No
	99°33'W 49°40'N	2011 JUL 4	Yes	2	No
	99°33'W 49°40'N	2011 JUL 5	Yes	0	No

Sand Hill Complex	General Location	Survey Date	Pedestrian Survey	Number Light Traps Deployed	White Flower Moth Detected
	99°18'W 49°40'N	2012 JUL 17	Yes	2	Yes
	99°18'W 49°40'N	2012 JUL 18	Yes	2	Yes
	99°18'W 49°40'N	2012 JUL 19	Yes	2	Yes
	99°18'W 49°40'N	2012 JUL 20	Yes	2	No
	99°18'W 49°40'N	2012 AUG 8	Yes	2	Yes
	99°18'W 49°40'N	2012 AUG 9	Yes	2	No
	99°18'W 49°40'N	2012 AUG 10	Yes	0	No
	99°18'W 49°40'N	2013 JUL 3	Yes	2	No
	99°18'W 49°40'N	2013 JUL 4	Yes	2	No
	99°18'W 49°40'N	2013 JUL 5	Yes	0	No
	99°18'W 49°40'N	2013 JUL 10	Yes	2	No
	99°9'W 49°41'N	2013 JUL 15	Yes	1	No
	99°18'W 49°40'N	2013 JUL 17	Yes	0	No
	99°18'W 49°40'N	2013 JUL 18	Yes	0	Yes
	99°18'W 49°40'N	2013 JUL 19	Yes	0	No
	99°18'W 49°40'N	2013 JUL 29	Yes	0	No
	99°18'W 49°40'N	2013 JUL 30	Yes	2	No
	99°18'W 49°40'N	2013 JUL 31	Yes	2	Yes
	99°18'W 49°40'N	2013 AUG 1	Yes	0	No
	101°19'W 50°24'N	2013 JUL 23	Yes	1	No
	101°19'W 50°24'N	2013 JUL 24	Yes	1	No
	101°19'W 50°24'N	2013 JUL 25	Yes	0	No
	99°29'W 49°35'N	2011 JUN 22	Yes	1	No
	99°29'W 49°35'N	2011 JUL 7	Yes	1	No
	99°12'W 49°58'N	2010 JUL 9	Yes	0	No
	99°12'W 49°58'N	2010 JUL 19	Yes	1	No
	99°12'W 49°58'N	2010 JUL 19	Yes	0	No
	99°12'W 49°58'N	2010 JUL 19	Yes	1	No
	99°12'W 49°58'N	2010 JUL 20	Yes	1	No
Total			**34**	**34**	
Grand Total			**54**	**50**	

Between 2009 and 2011 in Alberta, Saskatchewan, and Manitoba, during surveys for *Schinia avemensis* and *Copablepharon longipenne*, White Flower Moth was indirectly surveyed by daytime wandering transects and nighttime black-light trapping (Belair *et al.* 2011, Curteanu pers. comm. 2013). White Flower Moth was not recorded during these surveys (Belair *et al.* 2011, Curteanu pers. comm. 2013) and does not likely occur west of the Bald Head Hills in Manitoba (Anweiler pers. comm. 2014).

Potential habitat for further surveys includes areas within CFB Shilo as well as two sites north and west of Spruce Woods Provincial Park. At other Manitoba sand hill complexes there are also small areas of suitable habitat at Lauder, Portage, Routledge and St. Lazare which have been searched and no specimens recorded (Table 2).

HABITAT

Habitat Requirements

In Manitoba, White Flower Moth appears to use only active sand dune complexes and sparsely vegetated, semi-stabilized, areas between dunes (Figures 6 and 7) (Westwood and Friesen 2007, Westwood and Friesen 2009), which is approximately 78 ha (Wolfe 2010). The Bald Head Hills sand ecosystem habitat is 960 ha in total. The region is characterized by a cool, sub-humid, boreal climate (Smith *et al.* 1998) and White Flower Moth appears to require these conditions. A detailed plant inventory of White Flower Moth habitat can be found in Westwood and Friesen (2009).

Figure 6. White Flower Moth (*Schinia bimatris*) habitat at Bald Head Hills within Spruce Woods Provincial Park, Manitoba. Photograph taken facing east August 23, 2013. Background plants include White Spruce (*Picea glauca*), Trembling Aspen (*Populus tremuloides*), Creeping Juniper (*Juniperus horizontalis*) and foreground plants show Sand Bluestem (*Andropogon hallii*), Prairie Aunflower (*Helianthus petiolaris*). Photograph Colin Murray.

Figure 7. Typical sparsely vegetated White Flower Moth (*Schinia bimatris*) sand habitat (foreground) and more stabilized sand dunes from vegetation encroachment (background) in Spruce Woods Provincial Park, Manitoba. Plants in background include White Spruce (*Picea glauca*), Trembling Aspen (*Populus tremuloides*), Creeping Juniper (*Juniperus horizontalis*). Plants in the foreground include Sand Bluestem (*Andropogon hallii*) and Silverberry (*Elaeagnus commutata*). Photograph taken facing north July 7, 2013. Photograph Colin Murray.

In Manitoba, White Flower Moth has not been recorded from more densely vegetated and stabilized sand dune complexes, sand prairie, White Spruce (*Picea glauca*) and/or Bur Oak (*Quercus macrocarpa*) dominated forest (Westwood and Friesen 2007, Westwood and Friesen 2009, Murray 2013). Some areas within these stabilized sand dune complexes are characterized by open sand blowouts and sparse vegetation that more closely resemble the Bald Head Hills (Wolfe 2010). These areas may be too small or may not have the necessary host plant(s) to support a population. Alternatively, these sites may be suitable for White Flower Moth but have yet to be recorded.

Potential sand dune habitat for the White Flower Moth exists in Alberta and Saskatchewan (see Search Effort for surveys in some of that habitat), but the climate may be too arid to support a population. This is consistent with the species range in the United States, which does not include the more arid southern states (e.g. Arizona, New Mexico) despite the presence of open sand habitat.

In the United States, White Flower Moth is associated with Longleaf Pine (*Pinus palustris* Mill.) dominated forests in the Gulf and Atlantic Coast states (Brou pers. comm. 2013). Longleaf Pine forest is characterized by open stands of Longleaf Pine with a discontinuous grass and forb understory and few shrubs. These forests are maintained by a high fire frequency and can be found on well-drained sandy soils in sand hills to poorly drained clay or loam soils in lowland areas (NatureServe 2013b; Rosiere 2013). White Flower Moth has also been captured in Shortleaf Pine (*Pinus echinata* Mill.) forest in Louisiana (Brou pers. comm. 2013).

In the United States, specimen capture sites suggest that White Flower Moth prefers the areas of pine forest with sandy soil to those with clay soils. However, until soil analysis has been completed at all sites this association is inconclusive. These sandy sites often have open sand areas and sparse vegetation that appear similar to the Manitoba habitat (Elliott pers. comm. 2013, Hall pers. comm. 2013, Mann pers. comm. 2013, Schafale pers. comm. 2013, Singhurst pers. comm. 2013, Sullivan pers. comm.). In Texas, Post Oak Savannah, just west of Long Leaf Pine forest, is also considered potential White Flower Moth habitat based on its exposed sand blowouts and shifting sand (Singhurst pers. comm. 2013).

Habitat Trends

Canadian sand dune complexes were created by sand deposition during the retreat of the Laurentide Ice Sheet about 13,000 years ago. The sand has since been reworked by eolian processes (Wolfe 2002, Hugenholtz *et al.* 2010). Evidence suggests that the sand dunes were predominately active until about 5000 years before present (BP) (Wolfe 2002, Wolf *et al.* 2002).

Over the past 70 years, the ongoing habitat trend is toward dune stabilization. The stabilization rate is estimated at 10 - 20% per decade over the last 40 years and is projected to continue at a similar rate into the coming decades (Hugenholtz and Wolfe 2005, Wolfe 2010, Hugenholtz *et al.* 2010, Wolfe *et al.* 2002, Wolfe 2013). The stabilization process is thought to be rather robust to minor droughts (Hugenholtz and Wolfe 2005, Hugenholtz *et al.* 2010). For example, droughts in the 1930s and 1980s are not considered severe or prolonged enough to initiate large-scale dune reactivation (Wolfe *et al.* 2000, Wolfe *et al.* 2001, Hugenholtz and Wolfe 2005, Hugenholtz *et al.* 2010) (see Canadian Range).

Over the next few decades White Flower Moth population size is expected to decline (see Table 3 and 4) due to projected dune stabilization (Wolfe *et al.* 2000, Wolfe *et al.* 2001, Hugenholtz and Wolfe 2005, Hugenholtz *et al.* 2010). When the coarse population abundance estimates (see Population Sizes and Trends) are projected over the future hundred years the population declines to approximately 35% of its present-day estimate (65% decline) (Tables 3 and 4).

Table 3. Population estimates of White Flower Moth based on data from four survey years. Population Estimate = Trap Area of Attraction / Habitat Available * Moths per Trap/ Proportion of Population Available to be Trapped *2007 traps were 3 Luminok traps checked after 4 nights. All other traps were bucket form factor operating for 1 night.

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Survey Year	Number of Traps*	Number Moths Captured	Moths per Trap	Habitat Available (ha)	Habitat available m^2	Trap Area of Attraction (50m radius) using habitat available in m^2	Trap Area of Attraction (20m radius) using habitat available in m^2	Factor need to calculate for 50m radius (F/G)	Factor need to calculate for 20m radius (F/J)	Population 50m radius (D x I)	Population 20m radius (D x J)	Population X 2 b/c only half are observed for 50m radius (K x 2)	Population X 2 b/c only half are observed for 20m radius (L x 2)
960 ha = Total Area of Bald Head Hills													
2003	24	11	0.46	960	9600000	7853.98	1256.64	1222.31	7639.44	560	3501	1120	7003
2007	3	4	1.33	960	9600000	7853.98	1256.64	1222.31	7639.44	1630	10186	3259	20372
2012	10	6	0.60	960	9600000	7853.98	1256.64	1222.31	7639.44	733	4584	1467	9167
2013	6	2	0.33	960	9600000	7853.98	1256.64	1222.31	7639.44	407	2546	815	5093
Total all years	**43**	**23**	**0.53**	**960**	**9600000**	**7853.98**	**1256.64**	**1222.31**	**7639.44**	**654**	**4086**	**1308**	**8172**
78 ha = Total area of open sand dunes within Bald Head Hills that are suitable for White Flower Moth													
2003	24	11	0.46	78	780000	7853.98	1256.64	99.31	620.70	46	284	91	569
2007	3	4	1.33	78	780000	7853.98	1256.64	99.31	620.70	132	828	265	1655
2012	10	6	0.60	78	780000	7853.98	1256.64	99.31	620.70	60	372	119	745
2013	6	2	0.33	78	780000	7853.98	1256.64	99.31	620.70	33	207	66	414
Total all years	**43**	**23**	**0.53**	**78**	**780000**	**7853.98**	**1256.64**	**99.31**	**620.70**	**53**	**332**	**106**	**664**

Table 4. Bald Head Hills habitat loss projections and White Flower Moth population projections for 100 years into the future. Habitat loss projections based on a 10 – 20% decline per decade (Hugenholtz and Wolfe 2005, Wolfe 2010, Hugenholtz *et al.* 2010, Wolfe *et al.* 2002, Wolfe 2013). Projections assume equal rates of vegetation encroachment throughout the habitat; equal probability of moth capture each year.

	Present Day	10 years	20 years	30 years	40 years	50 years	60 years	70 years	80 years	90 years	100 years
960 ha = Total Area of Bald Head Hills	**Habitat loss projected into the future (ha)**										
10% habitat loss/decade	960	864	777.60	699.84	629.86	566.87	510.18	459.17	413.25	371.92	334.73
20% habitat loss/decade	960	768	614.40	491.52	393.22	314.57	251.66	201.33	161.06	128.85	103.08

	Present Day	10 years	20 years	30 years	40 years	50 years	60 years	70 years	80 years	90 years	100 years
960 ha converted to m^2	**Habitat loss projected into the future (m^2)**										
10% habitat loss/decade	9600000	8640000	7776000	6998400	6298560	5668704	5101833.6	4591650.24	4132485.22	3719236.69	3347313.02
20% habitat loss/decade	9600000	7680000	6144000	4915200	3932160	3145728	2516582.4	2013265.92	1610612.74	1288490.19	1030792.15
Population using a 50 m trap radius = 7853.98m^2 trap area Population = Available (Habitat / trap area) X (moths/trap) X 2 (half the moth population is active at any one time)											
Moth population estimate with 10% habitat loss/decade	1308	1177	1059	953	858	772	695	625	563	507	456
Moth population estimate with 20% habitat loss/decade	1308	1046	837	669	536	428	343	274	219	176	140
Population Using a 20 m trap radius = 1256.64 m^2 trap area. Population = Available (Habitat / trap area) X (moths/trap) X 2 (half the moth population is active at any one time)											
Moth population estimate with 10% habitat loss/decade	8172	7355	6620	5958	5362	4826	4343	3909	3518	3166	2850
Moth population estimate with 20% habitat loss/decade	8172	6538	5230	4184	3347	2678	2142	1714	1371	1097	878
78 ha = Total Area of White Flower Moth habitat	**Habitat loss projected into the future (ha)**										
10% habitat loss/decade	78	70.20	63.18	56.86	51.18	46.06	41.45	37.31	33.58	30.22	27.20
20% habitat loss/decade	78	62.40	49.92	39.94	31.95	25.56	20.45	16.36	13.09	10.47	8.38
m^2	**Habitat loss projected into the future (m^2)**										
10% habitat loss/decade	780000	702000	631800	568620	511758	460582.2	414523.98	373071.58	335764.42	302187.98	271969.18
20% habitat loss/decade	780000	624000	499200	399360	319488	255590.4	204472.32	163577.86	130862.28	104689.83	83751.86
Population using a 50 m trap radius = 7853.98m^2 trap area Population = Available (Habitat / trap area) X (moths/trap) X 2 (half the moth population is active at any one time)											
Moth population estimate with 10% habitat loss/decade	106	96	86	77	70	63	56	51	46	41	37
Moth population estimate with 20% habitat loss/decade	106	85	68	54	44	35	28	22	18	14	11

	Present Day	10 years	20 years	30 years	40 years	50 years	60 years	70 years	80 years	90 years	100 years
Population Using a 20 m trap radius = 1256.64 m^2 trap area. Population = Available (Habitat / trap area) X (moths/trap) X 2 (half the moth population is active at any one time)											
Moth population estimate with 10% habitat loss/decade	664	598	538	484	436	392	174	318	286	257	232
Moth population estimate with 20% habitat loss/decade	664	531	425	340	272	218	174	139	111	89	71

In southwestern Manitoba at least six intervals of dune stabilization and dune activation have occurred over the past 5000 years, with a reactivation cycle peak as recently as 200 years before present (Wolfe *et al.* 2000; Hugenholtz and Wolfe 2005; Hugenholtz *et al.* 2010). Dune activation-stabilization cycles appear strongly driven by fluctuations in available moisture rather than temperature (Wolfe *et al.* 2002b, Wolfe *et al.* 2009). However, dune stabilization and cooler weather temperatures may delay this process and lead to a shorter growing season and slower vegetation encroachment (Hugenholtz and Wolfe. 2005, Wolfe *et al.* 2009).

Fire suppression and lack of natural disturbance from Plains Bison (*Bison bison bison*), from herbivory and trampling, indirectly contribute to dune stabilization. These processes would likely affect the surrounding sand prairie, yet would indirectly impact White Flower Moth habitat—e.g., if these habitats are experiencing vegetation encroachment, eventually this would impact White Flower Moth habitat.

The warmer and drier climate expected across the prairies from global climate change (Sauchyn and Kulshreshtha 2008) may eventually be substantive enough to initiate large-scale dune reactivation (Wolfe *et al.* 2001; Hugenholtz *et al.* 2010). Despite a potential increase in suitable habitat, the more arid climate may also be unsuitable for White Flower Moth.

Although sand dunes are widespread in southern prairie habitats of Alberta (AB), Saskatchewan (SK) and Manitoba (MB), dune blowouts are limited and occur primarily in the Middle Sand Hills (AB), Great Sand Hills (SK) and to a lesser extent in the Brandon Sand Hills (MB) (Wolfe 1997). The Brandon Sand Hills occur in a humid to sub-humid region whereas prairie dunes elsewhere in Canada are characterized by a much more arid climate (Wolfe 1997) which may be unsuitable habitat for White Flower Moth. Absence of historical and current records in Alberta and Saskatchewan supports a habitat preference (see Search Effort).

BIOLOGY

Little is known about the biology of White Flower Moth. In Manitoba the species has been observed as both a nocturnal and diurnal flier (Westwood and Friesen 2007, Westwood and Friesen 2009; Murray 2013, Murray 2014 unpublished data) as well as further south in Mississippi, USA. Emergence dates are closely correlated with degree-days and in warmer summers adults are likely to emerge earlier.

Life Cycle and Reproduction

The adult flight period of White Flower Moth is from mid- to late July with some records from early July and early August (Environment Canada 2011; Manitoba Conservation Data Centre 2013). The flight period coincides with the flowering of the larval host plant. The adult life span in the wild is unknown although in captivity the species lives less than one week (Hardwick 1996). The species most likely has one brood per year.

Little life cycle and reproduction information specific to White Flower Moth is available and general information is based on similar owlet moths (*Schinia spp.*) (Hardwick 1996). The species likely overwinters as pupae within the soil. Pupation occurs sometime in mid- to late June and females climb to the top of larval host plants, dry their wings and wait for a mate. After mating, the female extends its ovipositor into a floret of the larval host plant to deposit its eggs. When compared with other owlet moth species overall, White Flower Moth eggs are relatively large and females lay fewer eggs. Eggs hatch after several days and the larvae feed on the host plant flower heads. The larval stage lasts two to four weeks, after which the larva forms a pupa at or below the soil surface. Adults emerge in about five days in laboratory conditions but in the wild they likely overwinter as pupae and then emerge as adults in early summer.

Physiology and Adaptability

There is little information on the physiology and adaptability of White Flower Moth. Some owlet moth species will remain in the pupal stage for a number of years if there is low rainfall (and inferred low host plant growth) and White Flower Moth may have this ability. This is thought to be an adaptation to adverse weather, which would presumably limit host plant quality (Hardwick 1996). The larvae of some owlet moth species spend daylight hours in a cell on the ground or create a silk and ray floret shelter in the flower head, both activities in an effort to avoid predation (Hardwick 1996). Larvae may also have colour and tactile camouflage to aid concealment (Hardwick 1996).

Dispersal and Migration

White Flower Moth dispersal is probably only through flight. Adults fly in an undulating pattern for approximately 50m (Westwood and Friesen 2009, Murray 2013, Murray unpub. data 2014). Other owlet moth species are noted to be strong fliers; so egg-laying females could potentially disperse and visit other host plants separated by unsuitable habitat. However, this is not highly likely with White Flower Moth because females have large eggs and thus large body mass, and would have difficulty flying for more than short distances. However, some owlet species show high host plant patch fidelity (Hardwick 1996, Swengel and Swengel 1999). Sand dune complexes with suitable habitat or a known White Flower Moth population are widely separated. White Flower Moths have about a seven-day lifespan, thus it is unlikely flight dispersal could create links to other sand dune sites in Manitoba or the United States. White Flower Moths do not migrate.

Interspecific Interactions

White Flower Moth larval host plant(s) are not known. White Evening Primrose (*Oenothera nuttallii* Sweet) may be a host plant because the flowering period corresponds to the flight period of White Flower Moth and the flower and moth colour match (Lafontaine pers. comm. 2013). White Evening Primrose density may be insufficient to support large estimated population sizes (i.e. 5000 individuals) (Westwood and Friesen 2009). For example, of the *Schinia* species where the larval host plants are known, approximately 61 of 74 owlet moth species (82%) rely on members of the Aster family (Asteraceae) with moth and host flower being highly concolourous in many, though not all, species (Hardwick 1996).

Some owlet moth larvae are known to predate larvae of other moth species, a life strategy thought to reduce competition for food resources on the same flower head (Hardwick 1996). There is no known information on specific parasitism to or predation of White Flower Moth.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

To date, surveys have focused on assessing White Flower Moth distribution and searching potential habitats for new occurrences, rather than population size. These surveys have not been designed to yield data amenable to population size estimates. In addition, the biology and ecology of White Flower Moth is poorly known, making coarse population estimates difficult.

Population abundance at suitable White Flower Moth habitat was calculated using the same methods as the first COSEWIC status report. Survey results from 2003 were combined with recent survey years (2007, 2012 and 2013). Population estimates are based on the amount of potential habitat, average moth catch per trap, number of trap nights, and the light trap capture radius (i.e., distance moths would be attracted to the trap by the ultraviolet light). Population size is challenging to estimate when using moth data from light-trap catches.

Average catch per trap was calculated as total moths caught / (total number of traps * number of trap nights). Traps were in operation one night except in 2007 when traps were operational for four nights.

The effective sampling area of the light trap is the radius over which a light attracts moths. The attracting radius of a light trap is from 3 – 5m (Baker and Sadovy 1978). Since White Flower Moths are mobile (i.e. flying) the light trap sampling radius is likely larger. In this calculation the effective sampling area is set at a minimum of 20 m and maximum of 50 m. Suitable habitat in 2013 is 960 ha (total area of Bald Head Hills), which is calculated as the maximum possible habitat White Flower Moth could occupy. The more accurate estimate of White Flower Moth habitat within the Bald Head Hills is 78 ha. These area calculations are much different than the $5km^2$ stated in the first COSEWIC (2005) report and based on more recent and accurate calculations reported in Wolfe (2001). Trapping occurred during peak flight period, which assumes that approximately half the total moth population is potentially available to sampling during the peak (with the remainder having either already completed their flight or not yet emerged).

Abundance

The first COSEWIC (2005) status report estimated the population size in the Bald Head Hills to vary between 100 and 5000 individuals, depending on weather conditions and host plant abundance. The abundance calculated in 2007, 2012 and 2013 using 20m and 50 m trap area of attraction radius (Table 3 and 4) is different than the 2003 estimate of 100 to 5000.

Coarse abundance estimates were calculated using average trap catch over 2003, 2007, 2012 and 2013. The abundance is calculated at 1308 (50 m trap radius) – 8172 (20 metre trap radius) moths within the 960 ha Bald Head Hills. The moth abundance calculation across the entire 960 ha of the Bald Head Hills is the maximum possible moth population. If only the 78 ha of suitable open sand blowout habitat considered highly suitable for White Flower Moth, the population is estimated at 106 (50 m trap radius) – 664 moths (20 metre trap radius). See Table 3.

Westood and Friesen (2009) reported a 'robust' population during 2007, but suggested that 5000 individuals may be an overestimate given the limited extent of suitable habitat.

Fluctuations and Trends

It is unknown if White Flower Moth experiences extreme population fluctuations. There are no data to describe temporal changes in distribution or metapopulation structure. Similar to other owlet moth species (e.g., Swengel and Swengel 1999), White Flower Moth population size likely experiences inter-annual variation due to environmental factors such as weather and host plant availability.

Rescue Effect

Rescue from other populations is very unlikely. The closest known White Flower Moth site was collected in 1903 near Omaha, Nebraska, which is approximately 1000km south (Thomson pers. comm. 2013). The closest known habitat is the Denbigh Dune field in North Dakota, approximately 160 km to the southwest of the Manitoba site. However, White Flower Moth has not been recorded at this site (Fauske 2013), and this dune field is considered stabilized with a well-developed layer of vegetation (Anderson 2011) and unlikely to have suitable habitat for White Flower Moth.

THREATS AND LIMITING FACTORS

The International Union for Conservation of Nature-Conservation Measures Partnership (IUCN-CMP) threats calculator was used to classify and list threats to White Flower Moth (Table 5) (COSEWIC 2012, Salafsky *et al.* 2008, Masters *et al.* 2009, 2012). Threats were compiled from previous reports and expert opinion (Environment Canada 2011, 2013).

Threats are listed below from highest to lowest according to IUCN threat number. The overall IUCN Threat Impact is Very High (Table 5). The primary threat to the White Flower Moth is problematic native species leading to natural succession of the open sand dune complexes and to degraded and unsuitable habitat. Additional threats include: natural habitat shifting and alteration, temperature extremes, recreational vehicles, and hunting and collecting.

Table 5. Threats assessment for White Flower Moth. The threat classification below is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system. For a detailed description of the threat classification system (see the CMP website (CMP 2010) and Master *et al.* (2009) on methodology).

Species Scientific Name	White Flower Moth (*Schinia bimatris*)			
Date:	October 31, 2013.			
Assessor(s):	Colin Murray (Manitoba Conservation), Chris Friesen (Manitoba Conservation), Angele Cyr (Environment Canada) and Jennifer Heron (Arthropods SSC Co-chair)			
Overall Threat Impact Calculation:			**Level 1 Threat Impact Counts**	
	Threat Impact		**High range**	**Low range**
	A	Very High	0	0
	B	High	3	1
	C	Medium	1	0
	D	Low	4	2
	Calculated Overall Threat Impact:		Very High	High

Threat		**Impact (calculated)**	**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development	Negligible	Negligible (<1%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
1.1	Housing & urban areas					Not applicable. The Bald Head Hills spans Spruce Woods Provincial Park and CFB Shilo (federal military base), both not likely to be developed. There is no cottage development nearby; the closest development is at least 5km from the park or the military base.
1.2	Commercial & industrial areas					Not applicable.
1.3	Tourism & recreation areas	Negligible	Negligible (<1%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Not applicable. Spruce Woods Provincial Park trail expansion and maintenance may increase the footprint of the trail, although this is not currently planned and would likely be negligible. CFB Shilo does not permit recreational development or activities.
2	Agriculture & aquaculture	Not Calculated (outside assessment timeframe)				Not applicable.
2.1	Annual & perennial non-timber crops					Not applicable. Conversion to crop or forage is cited as a threat to critical habitat in 2011 Recovery Strategy. It seems unlikely the land would be converted to crop forage: dune habitat is not considered to be of high crop productivity. Surrounding habitat is also not of high forage production quality. Upon review of the threat, this is unlikely and not applicable.

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.2	Wood & pulp plantations	Not Calculated (outside assessment timeframe)				Not applicable. Historically wood plantations were located to provide windbreaks for areas prone to severe wind erosion particularly during dry periods. They were not planted directly within occupied moth habitat. However, they may unintentionally provide wind shelter that would promote encroachment and stabilization and thereby indirectly affect open sand dune habitat further downwind.
2.3	Livestock farming & ranching					Not applicable. No livestock farming or ranching occurs within the area. There is no livestock ranching in adjacent properties; further north there are cattle adjacent to CFB Shilo but the distance is greater than 5km from the site.
2.4	Marine & freshwater aquaculture					Not applicable.
3	Energy production & mining					Not applicable.
3.1	Oil & gas drilling					Not applicable. Not likely to occur within Spruce Woods Provincial Park or CFB Shilo. Current legislation/regulation does not allow for oil and gas development within the park. No oil and gas development within the general surrounding area either.
3.2	Mining & quarrying					Not applicable. Sand deposits within Bald Head Hills are of suitable quality/ quantity. However, existing legislation prohibits extraction within Spruce Woods Provincial Park. In areas outside the park (but not proximal to the park), this threat potentially applies: sand is used for fracking and road development.
3.3	Renewable energy					Not applicable. The probability of solar energy or wind turbine construction within the area is unlikely.
4	Transportation & service corridors					
4.1	Roads & railroads					Not applicable. There are no planned roads within the White Flower Moth habitat in Spruce Woods Provincial Park or CFB Shilo.
4.2	Utility & service lines					Not applicable. There are no planned utility or service lines through Spruce Woods Provincial Park or CFB Shilo.
4.3	Shipping lanes					Not applicable.

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.4	Flight paths					Not applicable.
5	Biological resource use	Medium - Low	Restricted - Small (1-30%)	Extreme (71-100%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
5.1	Hunting & collecting terrestrial animals	Medium - Low	Restricted - Small (1-30%)	Extreme (71-100%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	There is the possibility of mortality from over the overcollection of White Flower Moth and/or incidental mortality from by-catch related to the trapping and collecting of other moth species related to scientific research. Spruce Woods Provincial Park and CFB Shilo require permits, which stipulate capture techniques and limit moths collected.
5.2	Gathering terrestrial plants					Not applicable. Park visitors may pick random wildflowers but this is likely insignificant.
5.3	Logging & wood harvesting					Not applicable.
5.4	Fishing & harvesting aquatic resources					Not applicable.
6	Human intrusions & disturbance	Low	Small (1-10%)	Serious - Moderate (11-70%)	High (Continuing)	
6.1	Recreational activities	Low	Small (1-10%)	Serious (31-70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Foot traffic within the dunes is mainly limited to designated trails with some observed small amount of off-trail traffic. All-terrain vehicle (ATV) use is prohibited within the park although there is evidence of use within the sand dunes and blowout of both the base and the park.
6.2	War, civil unrest & military exercises	Negligible	Negligible (<1%)	Moderate (11-30%)	High (Continuing)	Military exercises occur within CFB Shilo, which is adjacent to the known site at Spruce Woods Provincial Park. However, the majority of habitat is protected by the provincial park or in an area of CFB Shilo where military training is restricted and vehicle use is restricted to assigned trails. Military exercises are not ongoing within the moth habitat.
6.3	Work & other activities	Negligible	Negligible (<1%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Research activities other than moth trapping (accounted for under Hunting and Collecting), from vegetation monitoring to climate change monitoring are ongoing. Any permitting for these research activities includes provisions to protect the moth.
7	Natural system modifications	Negligible	Negligible (<1%)	Unknown	High (Continuing)	

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.1	Fire & fire suppression	Negligible	Negligible (<1%)	Unknown	High (Continuing)	Wildfires are not part of the natural dune processes but would likely reduce vegetation at the periphery of dune habitat and therefore impede encroachment. Fires caused by artillery practice in the military base are not extinguished unless they are a threat to base assets or personnel. There is a fireguard around CFB Shilo to ensure artillery fires do not spread outside the base and into the park.
7.2	Dams & water management/ use					Not applicable.
7.3	Other ecosystem modifications	Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	There is a proposed pilot study to determine if dune reactivation restoration is a viable option and should proceed. This project would include provisions for the protection of the moth during restoration activities. The methods used for dune reactivation restoration may include herbicide use.
8	Invasive & other problematic species & genes	High	Pervasive - Large (31-100%)	Serious (31-70%)	High (Continuing)	
8.1	Invasive non-native/alien species	Not Calculated (outside assessment timeframe)	Small (1-10%)	Serious - Moderate (11-70%)	Low (Possibly in the long term, >10 yrs/3 gen)	Invasive plant species are present in the moth habitat. These plants are currently established but are sporadic and occur in clusters. Based on these observations it is thought that they will persist and expand but at a much slower rate than when compared to sand mixed-grass prairie adjacent to the dune habitat. Invasive plant spread is not considered a high threat because the plants just don't grow or establish quickly unless there is preceding encroachment of the other species. They are in low-lying areas.
8.2	Problematic native species	High	Pervasive - Large (31-100%)	Serious (31-70%)	High (Continuing)	The spread of native plants is leading to further dune stabilization through natural succession, which leads to suitable habitat degradation/elimination. This is projected to continue within the coming decades, mainly due to the continuation of a wetter climatic regime.
8.3	Introduced genetic material					Not applicable.
9	Pollution					
9.1	Household sewage & urban waste water					Not applicable.
9.2	Industrial & military effluents					Not applicable.

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.3	Agricultural & forestry effluents					Not applicable. Agricultural areas are adjacent to the park, but the distance is at least 3 – 5 km from the moth sites.
9.4	Garbage & solid waste					Not applicable. CFB Shilo operates a garbage dump on this property; however, the facility is not within close proximity to the moth habitat and not considered a threat. There is minor refuse discarded from recreational users within the park (e.g., old beer cans); however, this is not considered a threat to the moth or its habitat.
9.5	Air-borne pollutants					Not applicable. Nitrogen deposition is not considered a threat within this region. There are no large chemical plants or large air pollution inputs from vehicle traffic that would otherwise change soil productivity.
9.6	Excess energy					Not applicable.
10	Geological events					
10.1	Volcanoes					Not applicable.
10.2	Earthquakes / tsunamis					Not applicable.
10.3	Avalanches/ landslides					Not applicable.
11	Climate change & severe weather	Unknown	Pervasive (71-100%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
11.1	Habitat shifting & alteration	Not Calculated (outside assessment timeframe)	Unknown	Unknown	Low (Possibly in the long term, >10 yrs/3 gen)	The projected climate change (human influenced) to warmer and drier on the prairies may eventually be enough to initiate dune activity; however, the arid climate may not be suitable for the White Flower Moth or its host plants.
11.2	Droughts		Pervasive (71-100%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	It is possible drought could cause direct mortality or stress the moth or its host plants.
11.3	Temperature extremes		Pervasive - Restricted (11-100%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Late frost is possible throughout the entire moth habitat. Although frost would be patchy throughout the habitat.

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.4	Storms & flooding	Not Calculated (outside assessment timeframe)	Unknown	Unknown	Low (Possibly in the long term, >10 yrs/3 gen)	Not applicable. Extreme flooding is not a factor; the Assiniboine River is adjacent to the dunes, but the flood zone of this river does not encompass the dunes. The possibility of a large storm within ten years could impact the site.

Invasive and Other Problematic Species and Genes (Overall Impact: High) (IUCN Threat 8)

Invasive non-native/alien species (Impact: Not calculated [outside of specified time frame]) (8.1)

Invasive plants such as Leafy Spurge (*Euphorbia esula* L.), Smooth Brome (*Bromus inermis* Leyss.), and Kentucky Blue Grass (*Poa pratensis* L.) are recorded within Spruce Woods Provincial Park and CFB Shilo and are considered serious threats to native mixed-grass sand prairie (Schykulski and Moore 1996; Tetres 2007). These plants are known to contribute to dune stabilization (Environment Canada 2013). At present these species are not considered high threats in the active dune area in the Spirit Sands (Environment Canada 2011) and have relatively low abundance and low growth within White Flower Moth habitat (Murray pers. obs. 2013), likely because the dry dune habitat is unsuitable for their widespread growth (Elliot pers. comm. 2013, Moore pers. comm. 2013).

Problematic Native Species (Impact: High) (8.2)

The primary threat to the White Flower Moth is native plant encroachment into the sparsely vegetated and open sand ecosystems, which initiates natural succession and, subsequently, dune stabilization to mixed-grass sand prairie and mixed-wood forest. These processes degrade White Flower Moth habitat. Native plants include White Spruce (*Picea glauca*), Trembling Aspen (*Populus tremuloides*), Creeping Juniper (*Juniperus horizontalis*), Sand Bluestem (*Andropogon hallii*), Prairie Sunflower (*Helianthus petiolaris*) and Silverberry (*Elaeagnus commutata*).

Native plant encroachment is not ongoing at equal rates throughout the Bald Head Hills. It occurs along the outer edge of the habitat and at irregularly distributed patches within. Succession is likely driven by the current natural wetter climatic regime, which is projected to continue within the coming decades (Wolfe *et al.* 2000, Wolfe *et al.* 2001, Hugenholtz and Wolfe 2005, Hugenholtz *et al.* 2010, Environment Canada 2011 and 2013). Other drivers of native plant encroachment include wildfire suppression, 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 and 2013).

Climate Change and Severe Weather (Overall Impact: Unknown) (IUCN Threat 11)

Habitat shifting and alteration (Impact: Not calculated [outside of specified time frame]) (11.1)

The current natural wetter climatic regime appears to be driving dune stabilization by native plant species (see IUCN Threat 8.2) and may eliminate suitable habitat for the White Flower Moth (Wolfe et al 2000, Wolfe et al 2001, Hugenholtz and Wolfe 2005, Hugenholtz *et al.* 2010, Environment Canada 2011 and 2013).

Conversely, 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). This change may eventually initiate dune reactivation (Hugenholtz *et al.* 2010, Wolfe *et al.* 2001) and may create additional habitat. However, the more arid climate may not be suitable for the White Flower Moth.

The White Flower Moth appears to be limited to the active sand dunes and semi-stabilized sparsely vegetated areas between dunes. The overall, suitable habitat is not much greater than the calculated 78 ha of open sand (Wolfe 2010). White Flower Moth may also be limited to occupying suitable habitat in more humid or sub-humid regions as evidenced by the lack of records from the more arid sand dune complexes in AB and SK and western parts of the United States.

Temperature Extremes (Impact: Not calculated [outside of specified time frame]) (11.3)

The small area of occupancy of the Canadian population makes the species vulnerable to severe weather such as numerous late frosts, which could adversely impact the entire population (Environment Canada 2011).

Human intrusions and disturbance (Overall Impact: Low) (IUCN Threat 6)

Recreational activities (Impact: Low) (6.1)

Recreational activities, primarily hiking, may disrupt adult White Flower Moth behaviour and result in trampling of host and nectar plant(s) and potentially larvae and pupae. However, foot traffic within the dunes is usually limited to designated trails with only a small amount of off-trail traffic. Currently, evidence of all-terrain vehicle (ATV) use within the sand dunes is not widespread or common (Murray pers. obs. 2013); however, an increase could cause a significant impact in a short time period. ATVs are not permitted in the park portion of the Bald Head Hills (Kelly pers. comm. 2013, Manitoba 1996b).

Civil unrest and military exercises (Impact: Negligible) (6.2)

Military training exercises occur within CFB Shilo. However, the majority of moth habitat adjacent to Spruce Woods Provincial Park has restricted military training and vehicle use is restricted to assigned trails. There is potential habitat within the base and further west into areas authorized for military use; however, the moth has not been recorded from these areas. There is a potential for military exercises and artillery fire within these unsurveyed areas.

Work and other activities (Impact: Negligible) (6.3)

Research activities other than moth trapping (accounted for under Hunting and Collecting), from vegetation monitoring to climate change monitoring, are ongoing. Any permitting for these research activities includes stipulations within the permit to protect the moth.

Natural System Modifications (Overall Impact: Low) (Threat 7)

Fire and fire suppression (Impact: Negligible) (7.1)

The present open sand and sparse vegetation does not have the high fuel loads able to sustain an intensive wildfire. However, fire suppression is thought to accelerate the natural vegetation encroachment that leads to dune stabilization (Hugenholtz *et al.* 2010, COSEWIC 2011). There is ongoing fire suppression in mixed-grass sand prairie habitats adjacent to the sand dunes. Over time, this fire suppression will adversely affect White Flower Moth habitat by indirectly allowing vegetation cover to sufficiently develop and eventually encroach on the dune habitat (COSEWIC 2011).

Fire suppression is identified as a threat to mixed-grass sand prairie in both CFB Shilo and Spruce Woods Provincial Park, and fire frequency management of approximately 5 and 10 years respectively is recommended. At present, there is no recommendation for fire frequency in the Bald Head Hills (Punak-Murphy pers. comm. 2013b; Tetres 2007; Schykulski and Moore 1996).

Other ecosystem modifications (Impact: Negligible) (7.3)

Dune reactivation studies have been carried out in some stabilized dunes in Alberta (Hugenholtz 2010). There is some discussion that human-mediated dune reactivation should be initiated within the Spirit Sand Dunes. Although artificial reactivation of the dunes may benefit White Flower, reactivation activities must consider the potential risks to the moth.

Biological Resource Use (Overall Impact: Low) (IUCN Threat 5)

5.1. Hunting and collecting terrestrial animals (Impact: Medium-Low).

Mortality from overcollection and/or incidental mortality from by-catch related to the trapping and collecting for scientific research is a plausible threat to White Flower Moth. Light trapping using non-poisonous methods (Belair *et al.* 2011) and catch-release by butterfly net can still cause some injury or mortality though difficult to estimate. Wasps and ants have been observed predating moths attracted to light traps in the Spirit Sand Dunes, and clipped moth wings from predation at light trap sites have been observed (Murray pers. obs. 2012, 2013). CFB Shilo requires SARA permits in order to moth trap and there are limits to the number of moths trapped in a night.

Limiting Factors

Kin selection in the form of cannibalism has been observed among some owlet moth larvae (Hardwick 1996). It is unknown if White Flower Moth exhibits kin selection.

Number of Locations

The White Flower Moth is considered to have one location. The most serious plausible threat is succession by native vegetation to the Bald Head Hills, leading to further dune stabilization, habitat fragmentation and a decline in host plant abundance and habitat quality.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

In 2005, the White Flower Moth was assessed by COSEWIC as Endangered, and in 2006 was designated as such under Schedule 1 the federal *Species at Risk Act* (SARA). In 2012 the moth was designated Endangered under the Manitoba *Endangered Species and Ecosystems Act*; this act prohibits destroying, disturbing or interfering with the species or its habitat.

Non-Legal Status and Ranks

The conservation status rank for White Flower Moth in Manitoba is S1 (Critically Imperiled) (Manitoba Conservation Data Centre 2013b). The Canadian national rank is N1 (Critically Imperiled) and global rank is G2G4 (Imperiled to Apparently Secure) (NatureServe 2013).

Habitat Protection and Ownership

The known White Flower Moth occurrence is within Spruce Woods Provincial Park and has some protection under Manitoba's *Parks Act*, which prohibits activities that damage or interfere with the environmental features within the park (Manitoba 1993, Manitoba 1996).

Following a ministerial order, critical habitat identified in the federal Recovery Strategy (Environment Canada 2011) would be protected on CFB Shilo. As mentioned above, the Manitoba *Endangered Species and Ecosystems Act* prohibits destroying, disturbing or interfering with the species' habitat outside CFB Shilo. Training and vehicle use within the sand ecosystem habitat of CFB Shilo that is likely to have a population of White Flower Moth is tightly restricted, as per the CFB Shilo leasehold agreement between the Province of Manitoba and the federal government (Punak-Murphy pers. comm. 2013).

Much of the potential habitat is within a military base, and the security provided from being within this perimeter further protects the moth's habitat. There is also the danger of encountering unexploded ordinances if recreational vehicles or hikers venture off-trail from Spruce Woods Provincial Park and into habitat within CFB Shilo. There is signage posted explaining this danger, which also provides indirect protection for the moth and its habitat.

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