

**COSEWIC**  
**Assessment and Status Report**

on the

**Half-moon Hairstreak**  
*Satyrium semiluna*

Okanagan-Similkameen population  
Waterton Lakes population

**in Canada**



**Okanagan-Similkameen population - THREATENED**  
**Waterton Lakes population - ENDANGERED**  
**2022**

**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:

COSEWIC. 2022. COSEWIC assessment and status report on the Half-moon Hairstreak *Satyrium semiluna* Okanagan-Similkameen and population Waterton Lakes population in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xvi + 66 pp. (<https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html>).

Previous report(s):

COSEWIC 2006. COSEWIC assessment and status report on the Half-moon Hairstreak *Satyrium semiluna* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 26 pp.

Production note:

COSEWIC would like to acknowledge Brenda Costanzo and Jennifer M. Heron for writing the status report on Half-moon Hairstreak, *Satyrium semiluna*, Okanagan-Similkameen population and Waterton Lakes population in Canada, prepared under contract with Environment and Climate Change Canada. This report was overseen and edited by David McCorquodale, Co-chair of the COSEWIC Arthropods Specialist Subcommittee.

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEWIC sur le Porte-queue cendré (*Satyrium semiluna*) population de l'Okanagan et de la Similkameen et population des Lacs Waterton au Canada.

Cover illustration/photo:

Half-moon Hairstreak — Photograph by Jennifer M. Heron.

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Catalogue No. CW69-14/482-2023E-PDF

ISBN 978-0-660-48469-3



## COSEWIC Assessment Summary

### Assessment Summary – December 2022

**Common name**

Half-moon Hairstreak – Okanagan-Similkameen population

**Scientific name**

*Satyrium semiluna*

**Status**

Threatened

**Reason for designation**

The butterfly occurs at fewer than 10 disjunct sites in southern British Columbia at the northern extreme of the species' range. Changes in fire regime and invasion by non-native plants are reducing habitat quality, and some sites are under pressure from development. Combining these threats could reduce population size in the near future.

**Occurrence**

British Columbia

**Status history**

The species was considered a single unit and designated Endangered in April 2006. Split into two populations in December 2022. The Okanagan-Similkameen population was designated Threatened in December 2022.

### Assessment Summary – December 2022

**Common name**

Half-moon Hairstreak - Waterton Lakes population

**Scientific name**

*Satyrium semiluna*

**Status**

Endangered

**Reason for designation**

The butterfly is restricted to one small site in Waterton Lakes National Park in southern Alberta at the northern extreme of the species' range and distant from any other sites. Population size is unknown, but very small, and has likely declined in the past as a result of habitat loss. An invasive plant, Spotted Knapweed, is an ongoing threat that reduces habitat quality and availability of nectar plants.

**Occurrence**

Alberta

**Status history**

The species was considered a single unit and designated Endangered in April 2006. Split into two populations in December 2022. The Waterton Lakes population was designated Endangered in December 2022.



**COSEWIC**  
**Executive Summary**

**Half-moon Hairstreak**  
*Satyrium semiluna*

Okanagan-Similkameen population  
Waterton Lakes population

**Wildlife Species Description and Significance**

The Half-moon Hairstreak is in the large family Lycaenidae (gossamer-winged butterflies). Adults are small (2.5–3.4 cm wingspan) with the dorsal wing surfaces a uniform sooty brownish-black. In contrast with other hairstreaks, adults lack small extensions ('tails') on their hindwings. Sexes differ slightly, with females tending to be larger and paler than males. Half-moon Hairstreak is one of a group of butterflies that reach their northern distribution limit in southern Canada. There are no described subspecies; however, there is evidence for two designatable units: the Okanagan-Similkameen population and the Waterton Lakes population.

**Distribution**

Globally, the Half-moon Hairstreak ranges in western North America from south-central British Columbia (BC), south through eastern Washington, to northeastern California and northern Nevada. The eastern boundary extends from Colorado to Waterton Lakes National Park (WLNP) in Alberta (AB). Less than 1% of the species' global range is in Canada.

In Canada, the Half-moon Hairstreak occurs as two designatable units (DU; also referred to as populations): the Okanagan-Similkameen population and the Waterton Lakes population. The Okanagan-Similkameen population occurs as six extant subpopulations in south central BC. The northernmost subpopulation is located southwest of Penticton in the White Lake basin, and the southernmost, about 6 km west of Osoyoos, adjacent to the United States border. The Waterton Lakes population is in WLNP, in extreme southwestern Alberta. There is one subpopulation and it is extant.

## Habitat

In British Columbia, the Half-moon Hairstreak inhabits the dry Big Sagebrush / Bluebunch Wheatgrass ecological community, at an elevation of 600 to 1,000 m above sea level (asl), most with reduced relief in comparison to surrounding steeper areas. In Alberta, the species occurs only in the Blakiston Creek alluvial fan, which is dry grassland and aspen parkland, at an elevation of ~1290 m asl. The soils were formed on rapidly to moderately well-drained, coarse-textured fluvial landforms.

## Biology

The Half-moon Hairstreak has an annual life cycle and undergoes complete metamorphosis with four stages (egg, larva [four instars], pupa, and adult). Adults in the Okanagan-Similkameen population have been recorded from late May through early July, and those in the Waterton Lakes population, from early July to early August.

The caterpillars feed on lupines. For the Okanagan-Similkameen population, the host plants are likely Silky Lupine and Sulphur Lupine. For the Waterton Lakes population, the host plants are Silvery Silky Lupine. The presumed larval food plants are abundant and widespread in British Columbia and Alberta. The presence of these lupines does not limit the Half-moon Hairstreak's range, as they have broader geographic ranges than that of the butterfly. With regard to nectar plants, Half-moon Hairstreak adults are likely opportunistic, with a perceived preference for buckwheat (*Eriogonum* spp.).

Numerous lycaenid butterflies in North America are myrmecophilous: there is a mutualism between ants (Formicidae) and caterpillars. The butterfly larvae secrete honeydew while feeding, which attracts ants; the ants then groom the larvae to obtain more honeydew. Larval secretions serve as food for ants, and the larvae secure ant defense against parasitoids. The mutualism between ants and Half-moon Hairstreak is being studied in WLNP and appears to involve both *Lasius* and wood ants.

## Population Sizes and Trends

Half-moon Hairstreak adults have been recorded in Canada from 1895 to 2021. Surveys in both BC and AB have focused on recording new subpopulations, confirming threats and gathering information on natural history and habitats. The primary survey method consists of wandering transects through potential habitat and changing course where host and nectar plants are abundant. No information on Canadian population size or trends is available for either the Okanagan-Similkameen population or the Waterton Lakes populations

## Threats and Limiting Factors

The primary threats to the Okanagan-Similkameen population are changes in larval plant abundance and nectar plant abundance due to ecosystem modifications associated with fire suppression, as well as the spread and continued introduction of invasive non-native plants, and changes in the ecological community caused by domestic livestock grazing. Wildfires pose a direct threat to these same habitats.

The primary threat to the Waterton Lakes population is the spread of non-native plants, such as Spotted Knapweed. An increase in the abundance of knapweed reduces habitat quality by reducing the availability of the larval host plants (lupines) and nectar sources for adults.

Limiting factors include the presence and abundance of healthy larval host plants. The species' larvae may depend on a mutualistic relationship with ants and, if that is the case, the presence of the appropriate ant species will also be a limiting factor.

## Protection, Status and Ranks

The Half-moon Hairstreak was assessed as Endangered by COSEWIC in 2006, and listed as such on Schedule 1 of the federal *Species at Risk Act* (SARA) in 2007. Critical habitat for the species was identified under this Act in 2016. The Waterton Lakes population of Half-moon Hairstreak is only found in WLNP, and both the host plant species and its habitat are afforded protection under the *Canada National Parks Act*. In British Columbia, the species is identified as a species at risk under the provincial *Forest and Range Practices Act* and is listed as Identified Wildlife under the Identified Wildlife Management Strategy.

The Half-moon Hairstreak is ranked apparently secure (G4) globally, critically imperilled (N1) nationally, and S1 provincially in both British Columbia and Alberta. The larval host plants are not at risk. The Okanagan-Similkameen population has been recorded from private properties, private conservation land, provincial protected areas, federal property leased to a private ranch operator, and parcels of unprotected provincial land.

## TECHNICAL SUMMARY – OKANAGAN-SIMILKAMEEN POPULATION

Half-moon Hairstreak – Okanagan-Similkameen population

Porte-queue cendré - Population de l'Okanagan et de la Similkameen

*Satyrium semiluna*

Range of occurrence in Canada: British Columbia

### Demographic Information

Generation time	1 year
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Inferred and projected continuing decline in mature individuals based on decline in habitat quality and quantity (see threat 7.3 Other ecosystem modifications)
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; b. understood; c. ceased?	a. No b. Partially understood c. No
Are there extreme fluctuations in number of mature individuals?	No

### Extent and Occupancy Information

Estimated extent of occurrence (EOO)	578 km <sup>2</sup>
Index of area of occupancy (IAO)	104 km <sup>2</sup>
Is the population “severely fragmented” i.e., is >50% of its total area of occupancy 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. No b. No
Number of “locations” * (use plausible range to reflect uncertainty if appropriate)	± 6 based on differing land management practices at each of the 6 extant subpopulations.

\* See Definitions and Abbreviations on [COSEWIC website](#) for more information on this term.

Is there an [observed, inferred, or projected] decline in extent of occurrence?	Possible for habitat not within protected areas and, in general, for areas of potential sagebrush habitat.
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Possible for habitat not within protected areas and, in general, for areas of potential sagebrush habitat.
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Possible for habitat not within protected areas and, in general, for areas of potential sagebrush habitat.
Is there an [observed, inferred, or projected] decline in number of "locations"*?	Possible for habitat not within protected areas and in general for areas of potential sagebrush habitat.
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes. Inferred and projected for habitat not within protected areas and, in general, for areas of potential sagebrush habitat.
Are there extreme fluctuations in number of subpopulations?	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 (in each subpopulation)

Subpopulations (give plausible ranges)	N Mature Individuals
Low number of specimens collected and observed, insufficient information to calculate mature individuals	Unknown
Total	Unknown

#### Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, or 10% within 100 years]?	Not applicable, insufficient data.
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\* See Definitions and Abbreviations on [COSEWIC website](#) for more information on this term.



### Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? April 7, 2021. Threat impact: Medium.

- 7.1 Fire & fire suppression (wildfire only): High to low impact
  - 1.1 Housing & urban areas: Low impact
  - 2.1 Annual & perennial non-timber crops: Low impact
  - 7.3 Other ecosystem modifications (fire suppression, invasive plants): Low impact
  - 9.3 Agricultural & forestry effluents: Low impact
  - 11.2 Droughts: Low impact
- 8.1 Invasive non-native/alien species/diseases (parasitic fly only): Unknown impact
- 2.3 Livestock farming & ranching: Unknown impact

What additional limiting factors are relevant?

- Small population size and genetic isolation.
- Larval host plant specificity.
- Natural parasites.
- Vulnerability to extremes in precipitation and temperature.
- Limited dispersal ability.
- Mutualistic relationship with ants (unknown species).

### Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Species is apparently secure (N4) in the United States; and apparently secure (S4) in Washington State
Is immigration known or possible?	Not likely. Adult butterflies are small, unable to disperse long distances and remain localized. Nearest sites in USA >150 km
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada? <sup>+</sup>	Yes, see <b>Threats</b> .
Are conditions for the source (i.e., outside) population deteriorating? <sup>+</sup>	Yes, see <b>Rescue Effect</b> .
Is the Canadian population considered to be a sink? <sup>+</sup>	Unknown, but unlikely, dispersal distance too far.
Is rescue from outside populations likely?	Unknown, but not likely.

### Data Sensitive Species

Is this a data sensitive species?	No
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### Current Status

COSEWIC Status History: The species was considered a single unit and designated Endangered in April 2006. Split into two populations in December 2022. The Okanagan-Similkameen population was designated Threatened in December 2022.

<sup>+</sup> See [Table 3](#) (Guidelines for modifying status assessment based on rescue effect).

## Status and Reasons for Designation

<b>Status:</b> Threatened	<b>Alpha-numeric:</b> B1ab(iii)+2ab(iii)
<b>Reasons for designation:</b> The butterfly occurs at fewer than 10 disjunct sites in southern British Columbia at the northern extreme of the species' range. Changes in fire regime and invasion by non-native plants are reducing habitat quality, and some sites are under pressure from development. Combining these threats could reduce population size in the near future.	

## Applicability of Criteria

<b>Criterion A (Decline in Total Number of Mature Individuals):</b> Not applicable. Insufficient data to reliably infer, project, or suspect population trends.
<b>Criterion B (Small Distribution Range and Decline or Fluctuation):</b> Meets Threatened, B1ab(iii)+2ab(iii). EOO (578 km <sup>2</sup> ) and IAO (104 km <sup>2</sup> ) below thresholds for Endangered, inferred and projected decline in habitat quality, but occurs in >5 locations, so Threatened.
<b>Criterion C (Small and Declining Number of Mature Individuals):</b> Not applicable. Insufficient data to determine number of mature individuals and/or continuing decline.
<b>Criterion D (Very Small or Restricted Population):</b> Not applicable. Number of mature individuals unknown and vulnerability to rapid and substantial population decline are unknown.
<b>Criterion E (Quantitative Analysis):</b> Not applicable. Analysis not conducted.

## TECHNICAL SUMMARY - WATERTON LAKES POPULATION

Half-moon Hairstreak - Waterton Lakes population  
 Porte-queue cendré – Population des Lacs Waterton  
*Satyrrium semiluna*  
 Range of occurrence in Canada: Alberta

### Demographic Information

Generation time	1 year
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Inferred and projected continuing decline in number of mature individuals based on decline in habitat quality due to the spread of non-native Spotted Knapweed and based on population surveys
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; b. understood; c. ceased?	a. Partially reversible through the control of invasive plants and habitat restoration. b. partially understood c. no
Are there extreme fluctuations in number of mature individuals?	No

### Extent and Occupancy Information

Estimated extent of occurrence (EOO)	16 km <sup>2</sup> Actual 2.97 km <sup>2</sup> (ECCC 2014)
Index of area of occupancy (IAO)	16 km <sup>2</sup>

Is the population “severely fragmented” i.e., is >50% of its total area of occupancy 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. No b. No
Number of “locations”* (use plausible range to reflect uncertainty if appropriate)	1, threat from invasive Spotted Knapweed
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No, but only 1 site known
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No, but only 1 site known
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No, but only 1 site known
Is there an [observed, inferred, or projected] decline in number of locations*?	No, but only 1 site known
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes. Observed, inferred, and projected decline in quality of habitat based on invasive Spotted Knapweed encroachment
Are there extreme fluctuations in number of subpopulations?	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 (in each subpopulation)

Subpopulations (give plausible ranges)	N Mature Individuals
Low number of specimens collected and observed, insufficient information to calculate mature individuals	Unknown
Total	Unknown

#### Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, or 10% within 100 years]?	Not applicable, insufficient data.
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\* See Definitions and Abbreviations on [COSEWIC website](#) for more information on this term.

### Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? April 7, 2021. Overall threat impact is Medium.

- 7.1 Fire & fire suppression (wildfire only): Medium impact
- 7.3 Other ecosystem modifications (invasive plants): Medium impact
- 11.2 Droughts: Low impact
- 11.4 Storms and flooding: Low impact
- 8.1 Invasive non-native/alien species/diseases: Unknown impact
- 8.2 Problematic native species/diseases: Unknown impact

What additional limiting factors are relevant?

- Small population size and genetic isolation.
- Larval host plant specificity.
- Natural parasites.
- Vulnerability to weather patterns.
- Dispersal ability.
- Mutualistic relationship with ants (unknown species).

### Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Species is apparently secure: (N4) in the United States and (S4) in Montana. Likely a different DU.
Is immigration known or possible?	Not possible, separate DU
Would immigrants be adapted to survive in Canada?	Not applicable
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?+	Yes, see <b>Threats</b> .
Are conditions for the source (i.e., outside) population deteriorating?+	Yes, see <b>Rescue Effect</b> .
Is the Canadian population considered to be a sink?+	No
Is rescue from outside populations likely?	No

### Data Sensitive Species

Is this a data sensitive species?	No
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### Current Status

COSEWIC Status History: The species was considered a single unit and designated Endangered in April 2006. Split into two populations in December 2022. The Waterton Lakes population was designated Endangered in December 2022.

<sup>+</sup> See [Table 3](#) (Guidelines for modifying status assessment based on rescue effect).

## Status and Reasons for Designation

<b>Status:</b> Endangered	<b>Alpha-numeric:</b> B1ab(iii)+2ab(iii)
<b>Reasons for designation:</b> The butterfly is restricted to one small site in Waterton Lakes National Park in southern Alberta at the northern extreme of the species' range and distant from any other sites. Population size is unknown, but very small, and has likely declined in the past as a result of habitat loss. An invasive plant, Spotted Knapweed, is an ongoing threat that reduces habitat quality and availability of nectar plants.	

## Applicability of Criteria

<b>Criterion A (Decline in Total Number of Mature Individuals):</b> Insufficient data to reliably infer, project, or suspect population trends.
<b>Criterion B (Small Distribution Range and Decline or Fluctuation):</b> Meets Endangered, B1ab(iii)+2ab(iii). EOO (16 km <sup>2</sup> ) and IAO (16 km <sup>2</sup> ) well below threshold for Endangered, occurs in <5 locations and there is an inferred and projected continuing decline in habitat quality.
<b>Criterion C (Small and Declining Number of Mature Individuals):</b> Not applicable. Insufficient data to determine number of mature individuals and/or continuing decline.
<b>Criterion D (Very Small or Restricted Population):</b> Meets Threatened, D2. Restricted to one location and prone to substantial decline from effects of human activities or stochastic activities within 1–2 generations.
<b>Criterion E (Quantitative Analysis):</b> Not applicable. Analysis not conducted.

## PREFACE

The Half-moon Hairstreak was assessed as Endangered by COSEWIC in 2006 and listed as such on Schedule 1 of the federal *Species at Risk Act* (SARA) in December 2007. Critical habitat was identified under this Act in 2016. In Alberta (AB), the Half-moon Hairstreak is found in Waterton Lakes National Park (WLNP), and individuals of the host plant species and its habitat are afforded protection under the Canada *National Parks Act*. In British Columbia (BC), the species is identified as a species at risk under the provincial *Forest and Range Practices Act* and is listed as Identified Wildlife under the Identified Wildlife Management Strategy.

Since the first COSEWIC status assessment, knowledge regarding the spatial connectivity of subpopulations has improved. There are seven subpopulations in Canada (one in AB and six in BC). This differs from the first COSEWIC assessment, which lists eight subpopulations. During searches conducted in the 2007-2021 period, additional sites were found between two of the subpopulations, meaning it is now considered one subpopulation. Four of the six known subpopulations in BC are extant and are found primarily on provincial or federal lands. Two of the six subpopulations occur entirely on private lands where surveys have not been conducted for approximately 20 years. Their subpopulation status is unconfirmed, but they are likely extant because the habitat still appears to be suitable. Additional inventory work has been completed in other sagebrush habitats in the province, but no additional subpopulations have been found. Surveys at WLNP confirm that the population is extant, and no additional occurrences have been found in similar habitat nearby.

Half-moon Hairstreak was assessed as one Designatable Unit (DU) in the first COSEWIC status report (2006). Additional information obtained since the first COSEWIC report suggests differences in morphology, behaviour, and habitat use between British Columbia and Alberta. In addition, recent work demonstrates significant genetic differences (see **Designatable Units**). Therefore, the assessment is based on a two DU structure: the Okanagan-Similkameen population in BC, and the Waterton Lakes population in AB.



## 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 (2022)

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  
Service canadien de la faune

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

## **Half-moon Hairstreak**

*Satyrium semiluna*

Okanagan-Similkameen population  
Waterton Lakes population

**in Canada**

2022

## TABLE OF CONTENTS

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE .....	5
Name and Classification .....	5
Morphological Description .....	6
Population Spatial Structure and Variability .....	9
Designatable Units .....	9
Special Significance .....	12
DISTRIBUTION .....	12
Global Range.....	12
Canadian Range.....	13
Extent of Occurrence and Area of Occupancy.....	22
Search Effort.....	22
HABITAT.....	24
Habitat Requirements .....	24
BIOLOGY .....	29
Life Cycle and Reproduction.....	29
Physiology and Adaptability .....	30
Dispersal and Migration .....	30
Interspecific Interactions .....	30
POPULATION SIZES AND TRENDS .....	31
Sampling Effort and Methods .....	31
Abundance .....	31
Fluctuations and Trends .....	32
Rescue Effect .....	32
THREATS AND LIMITING FACTORS .....	33
Threats .....	33
Limiting Factors .....	49
Number of Locations .....	50
PROTECTION, STATUS AND RANKS .....	51
Legal Protection and Status.....	51
Non-Legal Status and Ranks.....	52
Habitat Protection and Ownership .....	52
ACKNOWLEDGEMENTS .....	52
AUTHORITIES CONTACTED .....	53
INFORMATION SOURCES.....	55
BIOGRAPHICAL SUMMARY OF REPORT WRITER.....	64

**List of Figures**

Figure 1. Dorsal wing surfaces of Half-moon Hairstreak collected in British Columbia. Anarchist Mountain, near Osoyoos, BC (collected June 21, 1975, by J. L. Gordon) and housed at the University of British Columbia Spencer Entomological Museum. Photo J. Heron..... 6

Figure 2. Dorsal wing surfaces of male Half-moon Hairstreak, collected from Waterton Lakes National Park, Alberta. Photo N. Kondla..... 7

Figure 3. Ventral wing surfaces of Half-moon Hairstreak. The discal spot on this specimen is not typical, and usually darker in other specimens (see arrow). Specimen from Anarchist Mountain, near Osoyoos, BC (collected June 21, 1975, by J. L. Gordon) and housed at the University of British Columbia Spencer Entomological Museum. Photo J. Heron..... 7

Figure 4. Ventral wing surfaces of male Half-moon Hairstreak, collected from Waterton Lakes National Park, Alberta. Photo N. Kondla..... 8

Figure 5. Global range of Half-moon Hairstreak. Map created by Greg Amos (B.C. Ministry of Environment and Climate Change Strategy 2021). ..... 13

Figure 6. Canadian range of Half-moon Hairstreak, showing both the Okanagan-Similkameen population in British Columbia and the Waterton Lakes population in Alberta. Map created by Greg Amos (B.C. Ministry of Environment and Climate Change Strategy 2021)..... 14

Figure 7. Half-moon Hairstreak (*Satyrium semiluna*) Okanagan-Similkameen population in British Columbia (#2-7). See Table 1 and 2 for associated information. Map created by Greg Amos (B.C. Ministry of Environment and Climate Change Strategy 2021). ..... 20

Figure 7a. Half-moon Hairstreak (*Satyrium semiluna*) Okanagan-Similkameen population in British Columbia (#2-7) Index of Area of Occupancy (IAO; 2 km x 2 km grid squares) over known occurrences. The IAO is calculated at 26 grid squares = 104 km<sup>2</sup>. Map created by Alain Filion (COSEWIC Secretariat). [Editorial note: This figure has been removed to protect precise location information. Please contact the COSEWIC Secretariat if you require this information.] ..... 20

Figure 8. Half-moon Hairstreak (*Satyrium semiluna*) Waterton Lakes population showing all of Blakiston Fan within Waterton Lakes National Park (#1), Alberta. Map created by Greg Amos (B.C. Ministry of Environment and Climate Change Strategy 2021). ..... 21

Figure 8a. Half-moon Hairstreak (*Satyrium semiluna*) Waterton Lakes population Index of Area of Occupancy (IAO; 2 km x 2 km grid square over known records) within Waterton Lakes National Park (#1), Alberta. The IAO is four grid squares and calculated at 16 km<sup>2</sup>. Map created by Alain Filion (COSEWIC Secretariat). [Editorial note: This figure has been removed to protect precise location information. Please contact the COSEWIC Secretariat if you require this information.]..... 21

- Figure 9. Habitat of Half-moon Hairstreak (*Satyrium semiluna*) at White Lake (#7 on Figure 7 of Okanagan-Similkameen population) (west of Okanagan Falls), 17 June 2010. The most recent Half-moon Hairstreak (*Satyrium semiluna*) observation at White Lake was 17 June 2020 (Table 1). Photo by Jennifer Heron..... 24
- Figure 10. Habitat of Half-moon Hairstreak (*Satyrium semiluna*), Blakiston Fan, Waterton Lakes National Park, June 20, 2019. Photo by Jennifer Heron..... 25

### List of Tables

- Table 1. Half-moon Hairstreak subpopulations in Canada: Okanagan-Similkameen population and Waterton Lakes population. .... 15
- Table 2. Recent (since 2003) surveys within the potential range of Half-moon Hairstreak in Canada..... 16
- Table 3. Half-moon Hairstreak Surveys in Waterton Lakes National Park (from Sissons 2018). .... 19
- Table 4. Results for the Half-moon Hairstreak (*Satyrium semiluna*) Okanagan-Similkameen population threats assessment in Canada. The classification below is based on the IUCN-CMP (International Union for the Conservation of Nature–Conservation Measures Partnership) unified threats classification system. For a detailed description of the threat classification system, see the CMP web site (CMP 2010). Threats may be observed, inferred, or projected to occur in the next ten years. Threats are characterized here in terms of scope, severity, and timing. Threat “impact” is calculated from scope and severity. For information on how the values are assigned, see Master *et al.* (2009) and footnotes to this table..... 34
- Table 5. Results for the Half-moon Hairstreak (*Satyrium semiluna*) Waterton Lakes population threats assessment in Canada. The classification below is based on the IUCN-CMP (International Union for the Conservation of Nature – Conservation Measures Partnership) unified threats classification system. For a detailed description of the threat classification system, see the CMP web site (CMP 2010). Threats may be observed, inferred, or projected to occur in the next ten years. Threats are characterized here in terms of scope, severity, and timing. Threat “impact” is calculated from scope and severity. For information on how the values are assigned, see Master *et al.* (2009) and footnotes to this table..... 38
- Table 6. Threats applicable to Half-moon Hairstreak (*Satyrium semiluna*), categorized by the IUCN-CMP (International Union for the Conservation of Nature – Conservation Measures Partnership) unified threats classification system (Y = applicable; N = not applicable; U = unknown; - = not applicable). .... 41

## WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

### Name and Classification

Classification:

Phylum: Arthropoda  
Class: Insecta  
Order: Lepidoptera  
Family: Lycaenidae  
Genus: *Satyrium*  
Species: *Satyrium semiluna* Klots 1930

Synonyms: *Satyrium fuliginosum* (W.H. Edwards 1861); *Satyrium fuliginosa semiluna*

Type locality: Half-Moon Ranch, Jackson Hole, Teton County, Wyoming (Klots 1930).

English Common Names: Half-moon Hairstreak, Sooty Hairstreak, Sagebrush Sooty Hairstreak, Semiluna Hairstreak

French Common Name: Porte-queue demi-lune

Indigenous Names: none

### Taxonomic Background and Similarities

The Half-moon Hairstreak (*Satyrium semiluna* Klots) was formerly a subspecies of Sooty Hairstreak (as *Satyrium fuliginosa semiluna*). However, recent taxonomic work (see Warren 2005) resulted in the separation of *S. fuliginosa* into two species, with *S. semiluna* elevated to species status.

Prior to Warren (2005), Layberry *et al.* (1998) called all Canadian material *Satyrium fuliginosum*. Later, Guppy and Shepard (2001) referred to the Okanagan-Similkameen hairstreaks as *S. fuliginosum semiluna*. Pyle (2002) also quotes A. Warren [BC subpopulations] as “probably undescribed” subspecies. The BC population may be a separate undescribed subspecies of *S. semiluna* from those in Alberta (AB) (as outlined by Kondla 2003b). MacDonald and Dupuis (pers. comm. 2022) suggest that the Waterton Lakes population could warrant description as a subspecies. However, there are no formal taxonomic descriptions. Regardless of formal subspecies descriptions, there is evidence to support two designatable units (DUs) for Half-moon Hairstreak based on morphology, behaviour, ecology, and genetic structure each supports discreteness and significance (see **Designatable Units**).

## Morphological Description

Half-moon Hairstreak develops through complete metamorphosis (see **Biology**). It has an annual life cycle with four distinct developmental life stages (egg, larva [four instars], pupa, and adult).

### Adults

The Half-moon Hairstreak is a small butterfly with a 2.5 to 3.4 cm wingspan. The dorsal wing surfaces have a uniform brownish-black sooty colouration (Figures 1 and 2) and are fringed with scales varying in colour from grey to tan to white. Adults lack the small tail-like extensions on their hindwings that are found in many other hairstreaks. Sexes differ slightly, with females being larger and paler than males. For further descriptions, see Warren (2005), James and Nunnallee (2011), and ECCC (2016).

There are morphological differences between the BC (Figures 1 and 3) and AB (Figures 2 and 4) populations, which provide supporting evidence for two designatable units (see **Designatable Units** for full discussion).



Figure 1. Dorsal wing surfaces of Half-moon Hairstreak collected in British Columbia. Anarchist Mountain, near Osoyoos, BC (collected June 21, 1975, by J.L. Gordon) and housed at the University of British Columbia Spencer Entomological Museum. Photo by J. Heron



Figure 2. Dorsal wing surfaces of male Half-moon Hairstreak, collected from Waterton Lakes National Park, Alberta. Photo by N. Kondla.



Figure 3. Ventral wing surfaces of Half-moon Hairstreak. The discal spot on this specimen is not typical; it is usually darker in other specimens (see arrow). Specimen from Anarchist Mountain, near Osoyoos, BC (collected June 21, 1975, by J.L. Gordon) and housed at the University of British Columbia Spencer Entomological Museum. Photo by J. Heron.



Figure 4. Ventral wing surfaces of a male Half-moon Hairstreak, collected from Waterton Lakes National Park, Alberta. Photo by N. Kondla.

### Eggs

Half-moon Hairstreak eggs are greenish white to golden brown (Scott 1986 a,b; 1992) with intersecting ridges “covered with a thick shiny layer of transparent cement” (James and Nunnallee 2011). There is one observation of an egg, from White Lake (#3<sup>1</sup>; St. John pers. comm. 2020).

### Larvae

Half-moon Hairstreak larvae have a brown head and a light green body with white chevrons on the lateral surface (Scott 1986 a,b; 1992; Ballmer and Pratt 1988; James and Nunnallee 2011). Larvae observed in WLNP (#1) were light brown, small (< 1 cm length) and were at the base of a lupine (Sissons pers. comm. 2021; Glasier pers. comm. 2022). Larvae have not been observed in BC.

### Pupae

Half-moon Hairstreak pupae are brown and shiny, with a row of obscure reddish spots. Pupae are covered in numerous inconspicuous blonde and stubby setae (hairs) (James and Nunnallee 2011). Pupae have been observed in the Waterton Lakes population (Sissons pers. comm. 2021)

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<sup>1</sup> Where a # appears in the text, this refers to the Half-moon Hairstreak subpopulation in AB (#1) or BC (#2–7). More detailed information is provided in Table 1 (list of subpopulations), Figure 7 (BC/Okanagan-Similkameen population map) and Figure 8 (AB/Waterton Lakes population map).



## Population Spatial Structure and Variability

Population spatial structure and variability studies in both the Okanagan-Similkameen and Waterton Lakes populations are limited to abundance observations across a few dates. The Okanagan-Similkameen records indicate that the butterfly is restricted to sagebrush communities and may be composed of subpopulations that are connected through dispersal at a local scale (i.e., patches of habitat that form a metapopulation structure, termed a subpopulation<sup>2</sup>) but are isolated at a regional scale (i.e., the subpopulations do not intermix). The Waterton Lakes population is restricted to the Blakiston Fan, and there are no studies on intrapopulation structure and variability. Gene flow between the Okanagan-Similkameen and Waterton Lakes populations is unlikely because of the extensive geographical separation (> 400 km) and ecological barriers. This has been corroborated by MacDonald and Dupuis (2022). More detail is provided under **Designatable Units**. There are no records of Half-moon Hairstreak in the northern United States between the two Canadian populations. It is unclear whether there is suitable interconnecting habitat in the United States.

### Designatable Units

In the previous assessment (COSEWIC 2006), Half-moon Hairstreak was considered one Designatable Unit (DU). COSEWIC (2020) defines designatable units (DUs) based on discreteness and evolutionary significance. Populations are discrete if there is little transmission of heritable information from other populations, and evolutionarily significant if they have distinct adaptive traits or an evolutionary history not found in other Canadian populations. Based on these criteria and differences in morphology and habitat use along with more recently obtained genetic structure data, the geographically separated BC and AB populations fit a two DU structure: DU 1 - Okanagan-Similkameen population in BC, and DU 2 - Waterton Lakes population in AB.

Discreteness is recognized based on heritable traits (D1) or natural geographic disjunction (D2).

#### D1. Heritable traits

Evidence of genetic distinctiveness includes differences in morphology and life history traits. All Canadian Half-moon Hairstreak subpopulations are currently described as one subspecies (n nominate<sup>3</sup> subspecies, *Satyrium semiluna semiluna*). However, according to Kondla (2003b; pers. comm. 2019) Okanagan-Similkameen males are measurably and consistently larger than those from Waterton Lakes (Figures 2 and 4), and the overall

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<sup>2</sup> Subpopulations are defined as geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less). Subpopulation size is measured as numbers of mature individuals only (IUCN 2001)

<sup>3</sup> In zoological nomenclature, when a species (e.g., *Satyrium semiluna*) is split into subspecies (e.g., if the Okanagan-Similkameen and Waterton Lakes populations were taxonomically described), the originally described population is retained as the "nominotypical subspecies" or "nominated subspecies," which is referred to by the same name as the species (e.g., *Satyrium semiluna semiluna*).

colouration of Waterton Lakes specimens is consistently lighter grey. Further, Waterton Lake specimens do not have androconial patches on the wings. Because the androconial patches are involved in chemical communication between males and females, this suggests there may be differences in pheromone communication during mating. These morphological and behavioural differences may support erecting two subspecies (Guppy pers. comm. 2019; Kondla pers. comm. 2019).

There is also evidence of behavioural differences between the Okanagan-Similkameen and Waterton Lakes populations. Sagebrush shrubs in provide mating and roosting sites for the Okanagan-Similkameen population. In Waterton Lakes, and more specifically Blakiston Fan, there are no similar shrubs. There, butterflies use Wolf Willow (*Elaeagnus commutata*) for roosting and perching. Wolf Willow occurs in sparse to dense patches in a small portion of the Blakiston Fan (Sissons pers. comm 2021). Kondla (pers. comm. 2019) has noted differences in flight behaviour between the Waterton Lakes and Okanagan-Similkameen populations, which may be due to this structural habitat difference. Whereas in BC, the butterflies often fly at shrub height (e.g., 1 to 2 m above the ground), in Blakiston Fan, they keep low to the ground (< 60 cm). Typically, they land on low vegetation and occasionally on bare soil rather than on shrubs (Kondla pers. comm. 2019).

Recent work on the genetic structure of Half-moon Hairstreak from the Okanagan-Similkameen, Waterton Lakes and Montana populations involving collaboration between the University of Alberta, Parks Canada, the Calgary Zoo, and other experts (Sperling pers. comm. 2022) shows significant differences in genetic make-up between Okanagan-Similkameen and Waterton Lakes populations based on whole genome sequences. This supports genetic distinctiveness associate with behavioural differences. More details on this work are provided below under **Significance**.

## D2. Natural geographic disjunction

The two closest subpopulations of Half-moon Hairstreak in Canada are naturally disjunct. The minimum straight-line distance between the Okanagan-Similkameen (#2 Anarchist Mountain) and AB (#1 Waterton Lakes) subpopulations is approximately 400 km. Most of the land between the two areas is unsuitable habitat, especially the Rocky Mountains.

The closest Half-moon Hairstreak record from south of the Okanagan-Similkameen population is a specimen collected in sagebrush grassland in the Sinlahekin Wildlife Area in Washington State, about 30 to 40 km south of the international border (Kondla pers. comm. 2021). However, there are no records from the past 10 years. The most recent record in nearby Washington is from Sunnyslope (19 June 2019, iNaturalist 2020), which is approximately 177 km south of the closest known record in BC (#3). The habitat occupied in Washington appears to be similar to that in BC (i.e., sagebrush shrub-steppe, see **Habitat**).

The closest known Half-moon Hairstreak records south of Waterton Lakes are in southwestern Montana (at Big Horn, Carbon, Gallatin, Meagher, Sweet Grass, and Wheatland (Kohler 1980; Stanford and Opler 1993). One record on iNaturalist (2020) is from Carbon County, Montana, 560 km from Waterton Lakes (#1). There is a closer record of Half-moon Hairstreak, which was collected 460 km south of Waterton Lakes in Lemhi County, Idaho (iNaturalist 2020). The Lemhi County observation appears to be in habitat similar to that of the Okanagan-Similkameen populations (i.e., sagebrush shrub-steppe, see **Habitat**). There are no historical Half-moon Hairstreak observations that were collected in areas between the Idaho, Montana, British Columbia, and Alberta records. The Waterton Lakes population appears to be disjunct not only from the Okanagan-Similkameen population but also from occurrences in Montana and Idaho. The genetic structure described by MacDonald and Dupuis (pers. comm. 2022) provides evidence for this natural disjunction.

Evolutionary significance is based on evidence or strong inference that DUs have followed independent evolutionary trajectories over a significant period (S1; COSEWIC 2020), or evidence or strong inference that they possess adaptive, heritable traits that cannot be practically reconstituted if lost (S2).

MacDonald and Dupuis (pers comm. 2022) provided a summary of work done on the genetic structure of Half-moon Hairstreak from three geographic areas: Okanagan-Similkameen, Waterton Lakes and southern Montana. They concluded that Okanagan-Similkameen and Waterton Lakes are distinct. This lengthy quote from MacDonald and Dupuis (pers. Comm. 2022) provides some background on methods, results, and conclusions.

“We have assembled a chromosome-level reference genome for *Satyrrium semiluna*, mapping the identity and location of 1.25 billion base pairs and organizing them into 31 chromosomes. We have also sequenced the entire genomes of 15 individuals (mean coverage = 16x) collected from Waterton National Park, Alberta (n = 4), southern British Columbia (BC) (n = 7), and southern Montana (n = 4). Using these sequence data, we were able to identify over a million Single Nucleotide Polymorphisms (SNPs) among the 15 individuals. After stringent filtering, ~100,000 SNPs were used to assess population structure. Population divergence between the three locations is substantial. Fst values between Alberta and BC, Alberta and Montana, and BC and Montana are 0.402, 0.282, and 0.307, respectively.

Our results indicate that the isolated Alberta population is more closely related to other populations east of the Continental Divide than to populations in BC that are geographically closer. Population clustering analyses (using the program structure) indicate that there is no admixture among Alberta, BC, and Montana populations. Based on the substantial genomic divergence between Alberta and BC populations and the lack of admixture, these data support the recognition of Canadian populations as two units (Alberta and BC).

More sampling is required between British Columbia and Montana to determine whether each represents a distinct evolutionary unit or whether they are connected by a cline of genomic divergence. This will help contextualize the uniqueness of the Alberta population, which may warrant recognition as a distinct subspecies.”

Recognition by experts as a potential separate subspecies and the population genetic structure both support Waterton Lakes and Okanagan-Similkameen as units that would not be able to be reconstituted if lost in Canada.

## **Special Significance**

Hairstreak (*Satyrrium* spp.) butterflies are of interest to lepidopterists because of their taxonomic and systematic complexity, their rarity, and their association with at-risk plant communities. The sagebrush ecological communities of the southern Okanagan and lower Similkameen valleys are a hotspot for rare and at-risk invertebrates in Canada (BC CDC 2021). Half-moon Hairstreak can be considered a focal species representing the sensitivity and uniqueness of these habitats in Canada.

Waterton Lakes National Park supports a unique assemblage of species within Canada that are at the northernmost extent of their global range, and Half-moon Hairstreak is a focal species.

## **DISTRIBUTION**

### **Global Range**

Globally, the Half-moon Hairstreak occurs in western North America from south-central BC, south through eastern Washington and Oregon, Idaho, northeastern California and northern Nevada, to Colorado, Montana and the northeasternmost extreme of its range, in WLNP, AB (Figure 5) (James and Nunnallee 2011; BC CDC 2021). Less than 1% of the global range of Half-moon Hairstreak is in Canada.

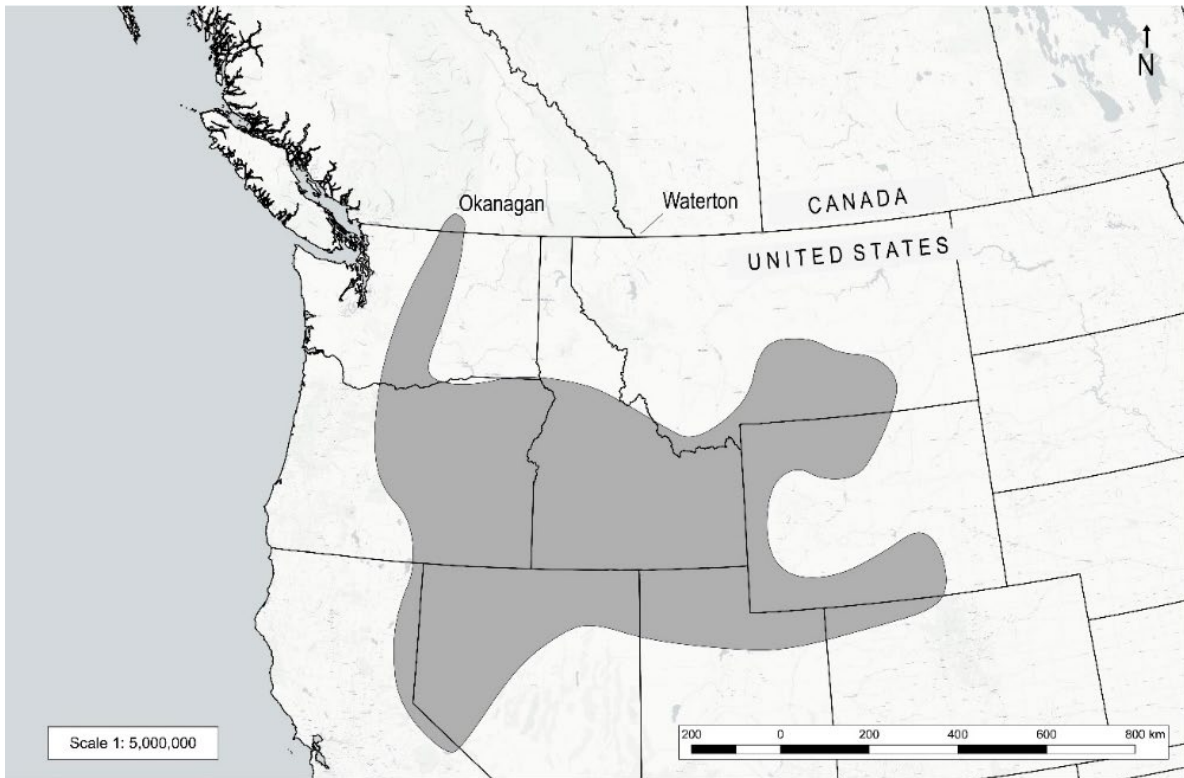


Figure 5. Global range of Half-moon Hairstreak. Map created by Greg Amos (B.C. Ministry of Environment and Climate Change Strategy 2021).

## Canadian Range

In Canada, Half-moon Hairstreak occurs as two designatable units (see **Designatable Units**): the Okanagan-Similkameen population<sup>4</sup> and the Waterton Lakes population (Figure 6).

<sup>4</sup> The term "population" is used in a specific sense in the Red List Criteria that is different from its common biological usage. Population is here defined as the total number of individuals of the taxon. For functional reasons, primarily owing to differences between life forms, population size is measured as numbers of mature individuals only. In the case of taxa obligately dependent on other taxa for all or part of their life cycles, biologically appropriate values for the host taxon should be used (IUCN 2001). The interpretation of this definition depends critically on an understanding of the definition of "mature individuals". For application of Criteria A, C, and D, the word population usually applies to the "Canadian population" (from COSEWIC 2021).

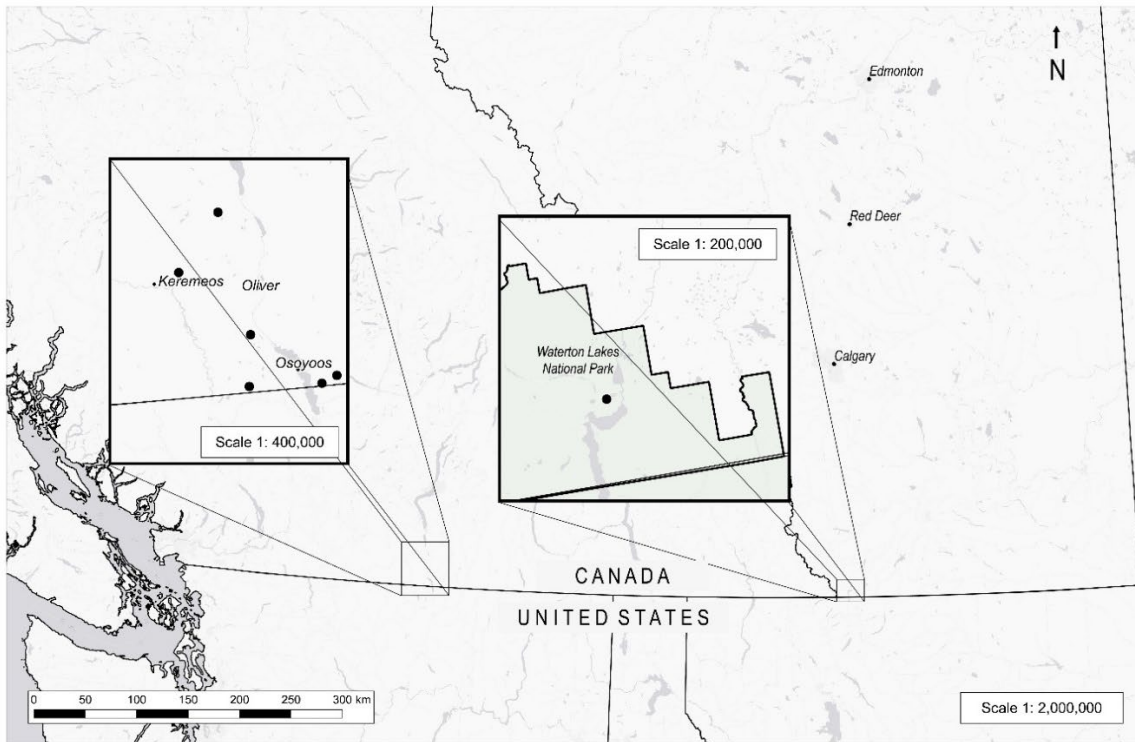


Figure 6. Canadian range of Half-moon Hairstreak, showing both the Okanagan-Similkameen population in British Columbia and the Waterton Lakes population in Alberta. Map created by Greg Amos (B.C. Ministry of Environment and Climate Change Strategy 2021).

The Okanagan-Similkameen population occurs in the southern Okanagan and Similkameen valleys (Figure 7) in British Columbia. There are six subpopulations<sup>5</sup> and all are considered extant (Table 1, Figure 7). The northernmost subpopulation is in the White Lake basin (#7), southwest of Penticton, and the southernmost location is along the United States border about 6 km west of Osoyoos in the South Okanagan Grasslands Protected Area (#4).

The Waterton Lakes population is in extreme southwestern Alberta and located entirely within the Blakiston Fan in WLNP (Table 1, Figure 8).

The absence of Half-moon Hairstreak from other sites where the host plants occur suggests that there are other, unknown factors that restrict the butterfly to these two areas in Canada (see **Limiting Factors**).

<sup>5</sup> Subpopulations are defined as geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less). Subpopulation size is measured as numbers of mature individuals only (IUCN 2001). The distance between subpopulations is 10 km between observations within suitable habitat, and 2 km between observations where there is unsuitable intervening habitat (NatureServe 2020).

**Table 1. Half-moon Hairstreak subpopulations in Canada: Okanagan-Similkameen population and Waterton Lakes population.**

Sub-population (Map) #	Sub-population name <sup>6</sup>	Geographic locality information	Years recorded	Year most recent record	Year most recent targeted search effort	Search effort (see Table 2 for details)	Area (ha)	Elevation (m)	Landowner
1	Waterton Lakes	Southwest corner of Alberta, adjacent to the Montana (United States) and BC borders.	'old record' (Layberry <i>et al.</i> 1998)	2022 (iNaturalist 2021)	2020 (iNaturalist record)	2004, 2008, 2009, 2014, 2017, 2019, 2020, 2021	295.8	1290	National park (federal)
2	Veronica Lake	Along dirt track leading south from HWY #3, at switchback immediately below lookout, near east end of reservoir.	1895 (unknown location in the vicinity of Osoyoos); 1995 (COSEWIC 2006)	1995	1995	1995; no search effort since this date	3	548	Private
3	Anarchist Mountain	Approximately 2.6 km north of site at Veronica Lake.	1975, 1976, 1979, 1985, 1990 and 2003	2003	2019	2003, 2019	18	800	Two landowners: private land and roadside provincial public land (rest area)
4	South Okanagan Grasslands Protected Area (SOGPA)	6–12 km west of Osoyoos, observations occurred 500 m to 3.5 km from the international border.	2003 (COSEWIC 2006)	2020 (iNaturalist 2021)	2021 (iNaturalist record)	2003, 2007, 2008, 2009, 2012, 2013, 2014, 2015, 2018, 2020, 2021	56	765–940	Provincial protected area (BC Parks, South Okanagan Grasslands Protected Area); private conservation land (Sage and Sparrow Grasslands, Nature Conservancy of Canada)
5	Mount Kobau, east	West of Osoyoos, north of Conifryd Lake and Creek (within 1.6 km). West of Deadman Lake (within 2 km).	2002 (COSEWIC 2006),	2020	2020	2002, 2003, 2008, 2009, 2019, 2020	59	710	Provincial (BC Parks protected area); private
6	Keremeos	Northeast of Keremeos (~4.5 km). Blind Creek observations are 4.5 km to the east of the Keremeos Columns.	1923 (Royal BC Museum), 2015	2015	2015	2003, 2010, 2014, 2015	144	984	Provincial public land; private

<sup>6</sup> Subpopulation names in BC coincide with those mapped with the British Columbia Conservation Data Centre (2021) element occurrences. Some of these names differ from those in the provincial recovery strategy (SIRT 2008) and the federal recovery strategy (ECCC 2016).

Sub-population (Map) #	Sub-population name <sup>6</sup>	Geographic locality information	Years recorded	Year most recent record	Year most recent targeted search effort	Search effort (see Table 2 for details)	Area (ha)	Elevation (m)	Landowner
7	White Lake	Two sites, within 1.5 km of each other. "White Lake, north of" is along White Lake Road, starting west of the Observatory road and continuing west of the Willowbrook-White Lake Road junction.	2003 (COSEWIC 2006), 2020, 2021	2021	2021 (iNaturalist record)	2003, 2007, 2008, 2009, 2010, 2012, 2019; 2020, 2021	200	595-615	Federal/ provincial/ private conservation land (The Nature Trust of BC) (White Lake Basin Biodiversity Ranch)

**Table 2. Recent (since 2003) surveys within the potential range of Half-moon Hairstreak in Canada.**

Survey Year	General Geographic Area	# sites (total)	Person-hours of search effort	Date Range	Half-moon Hairstreak observations	Reference
2007	BC: Okanagan and lower Similkameen valleys	3	48 hours 20 minutes	May 25–28	Half-moon Hairstreak recorded from White Lake (#7) and North Kilpoola (#5)	Blanchette <i>et al.</i> 2007
2007	BC: Okanagan and lower Similkameen valleys	16	96 hours 14 minutes	June 8–26	None.	Blanchette <i>et al.</i> 2007
2007	BC: Kootenays	3	23 hours 40 minutes	June 8–9	None.	Blanchette <i>et al.</i> 2007
2007	BC: Kootenays	3	12 hours 43 minutes	July 19–22	None; the surveys were scheduled in the Kootenays in July to coincide with later emergence (i.e., the Waterton Lakes observations are in July)	Blanchette <i>et al.</i> 2007
2008	BC: Okanagan Valley	15	at least 52 hours 19 minutes	June 12–30	79 recorded at North Kilpoola (#5), Mt. Kobau (#5) and East Chopaka (#4)	Knopp <i>et al.</i> 2008
2008	BC: Okanagan Valley; White Lake Basin	8	at least 21 hours 10 minutes	June 12–30	Recorded from White Lake (#7).	St. John and Scott 2008.
2009	BC: Okanagan Valley	7	at least 75 hours 55 minutes	May 20–June 2	None.	Dyer <i>et al.</i> 2009
2009	BC: Grand Forks	3	14 hours 40 minutes	June 3–4	None.	Dyer <i>et al.</i> 2009
2009	BC: Okanagan Valley	10	at least 50 hours 50 minutes	June 9–29	Recorded Half-moon Hairstreak (3 of 4 targeted sites had observations) (#4, #5, #7). Survey included multiple butterfly species.	Dyer <i>et al.</i> 2009



Survey Year	General Geographic Area	# sites (total)	Person-hours of search effort	Date Range	Half-moon Hairstreak observations	Reference
2010	BC: Okanagan and lower Similkameen valleys; White Lake and Keremeos/Armstrong Creek	8	68 hours and 31 minutes	June 18–July 20	Half-moon Hairstreak recorded (unrecorded number of observations) at White Lake (#7) and at Keremeos/Armstrong Creek (#6)	Shervill 2010
2010	BC: Okanagan and lower Similkameen valleys; farms, vineyards, parks, and provincial lands.	40	158 hours	May 5–August 19	None. Sites included 9 farms, 17 vineyards, 9 parks and 5 provincial properties in the south Okanagan - Similkameen.	Heron pers. comm. 2021
2012	BC: Okanagan Valley; White Lake (#7)	2	at least 1 hour	June 12	Half-moon Hairstreak recorded at White Lake (#7).	Sadler pers. comm. 2012
2012	BC: Okanagan Valley, SOGPA - East Chopaka (#5)	1	at least 1 hour	June 21	Half-moon Hairstreak recorded at SOGPA - East Chopaka (#4).	Weston pers. comm. 2012
2012	BC: Okanagan Valley; SOGPA (#4 and #5)	2	10 hours	June 25–27	Half-moon Hairstreak recorded at SOGPA (#4 and #5).	Dyer pers. comm. 2012
2012	BC: Okanagan Valley; SOGPA (#5)	2	45 hours and 15 minutes	July 10–13	Half-moon Hairstreak recorded at SOGPA (#4).	Ramsay 2012
2013	BC: Okanagan Valley; South Okanagan Grasslands Protected Area	2	at least two hours	July 3–4	Half-moon Hairstreak recorded at SOGPA (#4).	Sarell 2013
2014	BC: Okanagan and lower Similkameen valleys	18	60 hours 25 minutes	June 26–July 25	Half-moon Hairstreaks recorded at Keremeos – Armstrong/Blind Creek (#6), East Chopaka - SOGPA (#4)	Alcock and Sarell 2014
2014	BC: Okanagan Valley; antelope and sagebrush habitats	14	15 hours	June 19–August 8	None.	Haney and Heron 2014
2015	BC: Okanagan and lower Similkameen valleys	12	Approx. 110 hours	June 11–26	527 Half-moon Hairstreak recorded from June 24–26, 2015, at Keremeos Columns/Armstrong Creek (#6) and 158 individuals recorded from June 11–23, 2015, in the South Okanagan Grasslands Protected Area (#4)	Heron pers. comm. 2021
2016	BC: Okanagan Valley	12	110 hours 22 minutes	June 13–July 13	None. Surveys targeted Behr's Hairstreak and pollinators more generally on government and private lands.	Heron and Sheffield 2016,
2017	BC: Okanagan Valley	32	229 hours 32 minutes	May 10–July 17	None. Surveys targeted Behr's Hairstreak and pollinators more generally on government and private lands.	Heron <i>et al.</i> 2017

Survey Year	General Geographic Area	# sites (total)	Person-hours of search effort	Date Range	Half-moon Hairstreak observations	Reference
2018	BC: Okanagan Valley	33	202 hours 36 minutes	May 28– July 17	Half-moon Hairstreak observed at one site within South Okanagan Grasslands Protected Area (#4). Most properties were farms and private ranchlands.	Heron <i>et al.</i> 2018
2019	BC: Okanagan Valley	6	21 hours 5 minutes	June 10– 14	Recorded at White Lake (#7).	Heron pers. comm. 2021
2020	BC: Okanagan Valley; North Kilpoola and Sagebrush Sparrow (NCC property)	2	at least 2 hours	early June	Half-moon Hairstreak observed at two sites: North Kilpoola (#5) and NCC near SOGPA (#4).	Bunge pers. comm. 2020
2020	BC: Okanagan Valley	2	Not applicable	June 18	Half-moon Hairstreak recorded east of Mount Kobau (#5) and in Sage and Sparrow Conservation Area (#4)	iNaturalist 2020
2021	BC: Okanagan Valley	2	Not applicable	June	Half-moon Hairstreak recorded at White Lake (#7) and in Sage and Sparrow Conservation Area (#4).	iNaturalist 2022
2008	AB: Waterton Lakes, Blakiston Fan	1	Not recorded	July	93 adults on only 1,100 metres of Transect (#1).	Poll and Poll 2008
2009	AB: Waterton Lakes; Blakiston Fan, Coppermine Creek Fan, Yarrow Creek Fan, Dungarvan Creek Fan, Galway Creek Fan	5	Blakiston Fan – not recorded Coppermine Creek – 4 hours Yarrow Creek Fan – not recorded Dungarvan Creek Fan – not recorded Galway Creek Fan – not recorded	July 21-27	Blakiston Fan - 198 adults over fifty-five 150 m transects: an additional 40 incidental observations (#1).  None recorded from the other four fans (#1).	Kondla 2009
2009	AB: Waterton Lakes	1	Not recorded.	July	40 incidental observations.	Sissons 2018
2012	AB: Waterton Lakes, Stoney Flat and Blakiston Fan	2	3 hours at Stoney Flat 3 hours at Blakiston Fan	Aug 4	None.	Kondla 2012
2012	AB: Waterton Lakes, Blakiston Fan	1	Not recorded.	Not recorded	5 adults (#1)	Sissons pers. comm. 2021
2014	AB: Waterton Lakes	1	Part of a comparative wandering transect and set route transect survey (see Table 3)	July	Approximately 260 Half-moon Hairstreaks recorded (#1).	Sissons 2018
2017	AB: Waterton Lakes	1	Part of a comparative wandering transect and set route transect survey (see Table 3)	July	Approximately 18 Half-moon Hairstreaks recorded (#1).	Sissons 2018; Oetterich 2018
2017	AB: Waterton Lakes	1	Not recorded.	July	8 incidental observations of Half-moon Hairstreak recorded (#1).	Sissons 2018

Survey Year	General Geographic Area	# sites (total)	Person-hours of search effort	Date Range	Half-moon Hairstreak observations	Reference
2018	AB: Waterton Lakes	1	Part of a comparative wandering transect and set route transect survey (see Table 3)	July	6 (#1).	Sissons pers. comm. 2022
2019	AB: Waterton Lakes	1	Part of a comparative wandering transect and set route transect survey (see Table 3)	July	68 (#1).	Sissons pers. comm. 2022
2020	AB: Waterton Lakes	1	Not applicable	July 14, July 16 and July 21	Photographs of 3 separate Half-moon Hairstreak adults at Waterton Lakes (#1).	iNaturalist 2020

**Table 3. Half-moon Hairstreak Surveys in Waterton Lakes National Park (from Sissons 2018).**

Year	Number of transects		Total length (m) of transects		Area surveyed (ha)		# Hairstreaks recorded		# Hairstreaks/ha		Mean Hairstreaks / Ha	Reference
	Set Route transect	Wandering transect	Set route transect	Wandering transect	Set route transect	Wandering transect	Set route transect	Wandering transect	Set route transect	Wandering transect		
2004	10	5	5,154	6,219	5.23	6.21	67	163	12.8	26.2	20.1	Kondla 2004
2008	4	--	1,773	--	1.73	--	109	--	62.9	--	62.9	Poll and Poll 2008
2009	55	--	8,510	--	8.94	--	198	--	22.1	--	22.1	Kondla 2009
2014	15	2	4,987	926	4.99	0.91	191	69	38.3	76.2	44.1	Sissons pers. comm. 2021
2017	54	11	7,517	2,950	7.94	2.95	6	11	0.6	3.7	1.5	Sissons pers. comm. 2021
2018	66	--	10,762	--	11.43	--	6	0	0.52	0	0.52	Sissons pers. comm. 2022
2019	66	--	10,762	--	11.43	--	68	--	6.0	--	5.95	Sissons pers. comm. 2022

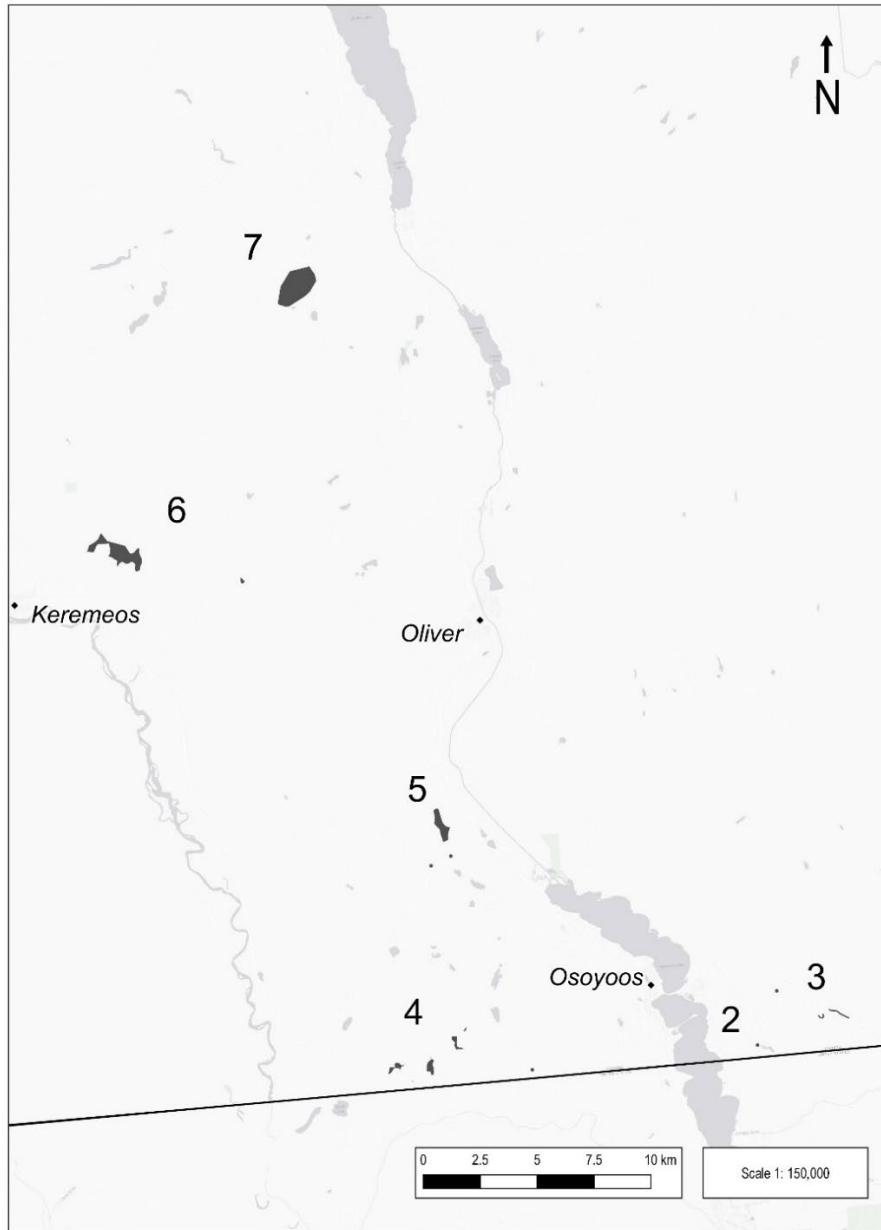


Figure 7. Half-moon Hairstreak (*Satyrium semiluna*) Okanagan-Similkameen population in British Columbia (#2–7). See Tables 1 and 2 for associated information. Map created by Greg Amos (B.C. Ministry of Environment and Climate Change Strategy 2021).

Figure 7a. Half-moon Hairstreak (*Satyrium semiluna*) Okanagan-Similkameen population in British Columbia (#2–7) Index of Area of Occupancy (IAO; 2 km x 2 km grid squares) over known occurrences. The IAO is calculated from 26 grid squares as 104 km<sup>2</sup>. Map created by Alain Filion (COSEWIC Secretariat). [Editorial note: This figure has been removed to protect precise location information. Please contact the COSEWIC Secretariat if you require this information.]



Figure 8. Half-moon Hairstreak (*Satyrium semiluna*) Waterton Lakes population showing all of Blakiston Fan within Waterton Lakes National Park (#1), Alberta. Map created by Greg Amos (B.C. Ministry of Environment and Climate Change Strategy 2021).

Figure 8a. Half-moon Hairstreak (*Satyrium semiluna*) Waterton Lakes population Index of Area of Occupancy (IAO; 2 km x 2 km grid square over known records) within Waterton Lakes National Park (#1), Alberta. The IAO is calculated from four grid squares and is 16 km<sup>2</sup>. Map created by Alain Filion (COSEWIC Secretariat). [Editorial note: This figure has been removed to protect precise location information. Please contact the COSEWIC Secretariat if you require this information.]

## Extent of Occurrence and Area of Occupancy

The EOO for the Okanagan-Similkameen population is 578 km<sup>2</sup> and the IAO, 104 km<sup>2</sup> (Table 1; Figure 7a).

The EOO for the Waterton Lakes population is 2.97 km<sup>2</sup> and the IAO, 16 km<sup>2</sup> (Table 1; Figure 8a). According to a COSEWIC convention, when the EOO is less than the IAO, the EOO must be increased so that it is equal to the IAO. Therefore, the EOO for the Waterton Lakes population is 16 km<sup>2</sup>. The EOO and the IAO reported here have been updated based on new and more accurate mapping (from BC CDC 2021). Any changes from the previous status report (COSEWIC 2006) are not based on habitat loss or declines.

## Search Effort

Half-moon Hairstreak surveys have been conducted by wandering transects through potential habitat, stopping periodically to gently shake or knock herbaceous and shrubby vegetation and flush out resting butterflies. Half-moon Hairstreaks tend to sit on nectar plants and shrubbery, and this is why gently tapping shrubbery is an effective method. Wandering transects allow the surveyor to change course depending on the host plant and nectar resources encountered (e.g., places where adult butterflies congregate). This is an effective method of determining butterfly presence when little information is available on the species' preferred microhabitats and its roosting, mating, or resting sites (Longcore *et al.* 2010). Surveys typically do not target eggs, larvae, or pupae because these life stages are cryptic and difficult to locate among host plants (see **Life Cycle**).

Half-moon Hairstreaks may be overlooked due to their non-descript grey colouration, small size, and low abundance. However, butterfly enthusiasts are keen to seek them out and with the rise in popularity of online citizen science forums such as BugGuide® and iNaturalist®, more observers are contributing observations. There are no Half-moon Hairstreak records for either DU posted on BugGuide® (as of January 28, 2022). There are 30 records posted on iNaturalist® in Canada (as of October 3, 2022): 1 from Anarchist Mountain (#3), 7 from South Okanagan Grasslands Protected Area (#4), 5 from east of Mount Kobau (#5), 6 from White Lake (#7) and 10 from Waterton Lakes (#1) (as of January 27, 2022), all of them corroborated and reviewed by Canadian experts.

Surveys for Half-moon Hairstreak in the past 10 years (Table 2) have focused on surveying potential habitat, recording the species' abundance, and documenting habitat and natural history information. Data were assembled from numerous sources (see **Collections Examined** and Table 2).

Okanagan-Similkameen *population history and surveys*: Half-moon Hairstreak museum specimens, inventory information, and photographic records in Canada date from 1895 to 2021 (Table 1). The earliest Canadian records consist of ones labelled 'Osoyoos' in 1895 and three specimens collected between 1898 and 1901 at an unknown site in BC. Subsequently, there were a few collections from the vicinity of Keremeos in 1923 and from

Anarchist Mountain in 1975, 1976, 1979, 1985, and 1990; and there is one sight record from Richter Pass in 2002 (COSEWIC 2006). The most recent records consist of photographs posted to iNaturalist® Mount Kobau, east of (#5) (2020), White Lake (#7) (2021), and South Okanagan Grasslands Protected Area (#4) (2021) (Table 1).

In preparation for the first COSEWIC status report (2006), field surveys were carried out in 2003 to confirm some past records and locate additional sites. This work resulted in the documentation of new sites in the vicinity of Kilpoola Lake (#4), White Lake (#7), and Mt. Kobau (#5), as well as the confirmation of the species' presence at Richter Pass (#5) and Anarchist Mountain (#3). An additional site near Keremeos Columns Provincial Park (#6) was reported in 2003 (Fenneman pers. comm. 2003 as cited in COSEWIC 2006).

A minimum of 1,504 hours of search effort has been completed since 2010 (Table 2). No additional subpopulations have been recorded since the first COSEWIC assessment (2006), although the area of occupancy of the butterfly has expanded (e.g., there are more sites; the species forms a metapopulation where some sites are occupied in some years but not others). The range and spatial area of occupancy of the Half-moon Hairstreak in BC is well-defined (e.g., #4, 5, 6, 7).

There may be additional sites that support Half-moon Hairstreaks in grasslands in the east Kootenay region between the Okanagan-Similkameen and Waterton Lakes populations. Priority areas in British Columbia include the dry grasslands from Rock Creek to Grand Forks and portions of the southern Rocky Mountain Trench. Some search effort has taken place within Grand Forks and the Kootenay region (see Table 2) but no observations were made.

*Waterton Lakes population history and surveys in Alberta*: "... there is an old record from Waterton Lakes in Alberta" is the extent of the reporting on the Waterton Lakes population in *The Butterflies of Canada* (Layberry *et al.* 1998) (as Sooty Hairstreak). iNaturalist includes 4 observations from 2020 to 2022.

In preparation for the first COSEWIC status report (2006), Kondla (2003a, 2004) searched for Half-moon Hairstreak in habitats with lupines at low to high elevations outside of the Blakiston Fan; only three individuals were observed on hummocky moraine fan habitat (Kondla 2003a, 2004). These three individuals were observed under very windy conditions and only in 2003. Surveys in this same habitat in 2004 under calm conditions (i.e., no wind) failed to record additional hairstreaks. Therefore it is possible that the three individuals seen in 2003 had blown in from their normal habitat.

There has been some search effort in and near WLNP since the first COSEWIC status report (2006). Additional surveys conducted in 2009 in other habitats within WLNP did not reveal new occurrences (Kondla 2009; Table 3). Surveys undertaken by Sissons (pers. comm 2020–2021) between 2017 and 2021 confirmed the presence of Half-moon Hairstreak at Blakiston Fan. Future surveys could be conducted on the sage slopes in the South Castle River valley in AB, which may contain suitable habitat for the species.

Larval searches have continued within the Blakiston Fan. Parks Canada staff reported that they were most successful at finding larvae when they focused on identifying ant activity below a lupine and then checked for small larvae in the duff layer below the plant. Larvae were observed starting in mid-May and were confirmed to be Half-moon Hairstreak larvae in 2021 (see **Morphological Description** for more details) (Sissons pers. comm. 2021).

There is no specific Aboriginal Traditional Knowledge available on the distribution or abundance of Half-moon Hairstreak for either DU. However, Half-moon Hairstreak is part of ecosystems that are important to Indigenous people who recognize the interconnectedness of all species.

## HABITAT

### Habitat Requirements

#### Okanagan-Similkameen population

Half-moon Hairstreak habitat includes the Big Sagebrush / Bluebunch Wheatgrass ecological community (Figure 9), at an elevation of 600 to 1,000 m above sea level (asl) and with reduced relief in comparison to surrounding steeper areas.



Figure 9. Habitat of Half-moon Hairstreak (*Satyrium semiluna*) at White Lake (#7 on Figure 7 concerning the Okanagan-Similkameen population) (west of Okanagan Falls), June 17, 2010. The most recent Half-moon Hairstreak (*Satyrium semiluna*) observation at White Lake was made on June 17, 2020 (Table 1). Photo by J. Heron.



The larval host plants for Half-moon Hairstreak are lupines (*Lupinus* spp.) although the specific host plants in BC are speculative: Silky Lupine, (*Lupinus sericeus*) and Sulphur Lupine (*Lupinus sulphureus*) are at known sites (St. John pers. comm. 2019). Elsewhere within the global range of Half-moon Hairstreak, Spurred Lupine (*Lupinus arbustus*) is a known larval host plant. However, this lupine species is likely not a host plant for either Canadian DU because it does not occur in BC or AB (BC CDC 2021).

Additional flowering nectar plants at Half-moon Hairstreak sites include Common Yarrow (*Achillea millefolium*), Umbrella-plant (*Eriogonum heracleoides*), Missouri Goldenrod (*Solidago missouriensis*) (COSEWIC 2006; Knopp *et al.* 2008), and Grey Horsebrush (*Tetradymia canescens*). Nectar plants are likely chosen opportunistically (St. John pers. comm. 2019).

Additional common plants in this ecological community include Big Sagebrush, Prairie Junegrass, Bluebunch Wheatgrass, Idaho Fescue (*Festuca idahoensis*), and Pinegrass (*Calamagrostis rubescens*).

#### Waterton Lakes population

Half-moon Hairstreak habitat is found within the Blakiston Creek alluvial fan (Figure 10) in the Foothills Parkland Natural Subregion as described in the document *Natural Regions and Subregions of Alberta* (2006) and Blakiston Ecoregion of WLNP (Parks Canada Agency 2003).



Figure 10. Habitat of Half-moon Hairstreak (*Satyrium semiluna*), Blakiston Fan, Waterton Lakes National Park, June 20, 2019. Photo by Jennifer Heron.

The Blakiston Ecosection (BL) is composed of dry grassland (BL1 and BL2 dry grassland ecosites) and aspen parkland (BL3 and BL4 ecosites) (Achuff *et al.* 2002). The soils were formed on rapidly to moderately well-drained, coarse-textured fluvial landforms (Achuff *et al.* 2002). The vegetation communities found in all four ecosites are the H25 type, Oatgrass-Rough Fescue-June Grass. This is the most common and widespread vegetation type in the grasslands (Achuff *et al.* 2002) and it includes a dominant component of bunchgrasses. This vegetation type is found on mesic gentle slopes with a variety of aspects at elevations ranging from 1,280 to 1,560 m asl. The second vegetation type found in these ecosites is the H27 type, Bluebunch Wheatgrass-Rough Fescue. Whereas oatgrasses are dominant in the H25 vegetation type, this type of plant is not found in the H27 vegetation community. This vegetation type is found on subxeric to mesic, gentle to steep south-facing slopes, at elevations between 1,300 and 1,700 m asl (Achuff *et al.* 2002).

The larval host plants found in both vegetation types consist of Silvery lupine (*Lupinus argenteus*) and Silky Lupine, with Silvery Lupine appearing to be preferred (James Glasier pers. comm. 2022). The percent cover of Silvery Lupine ranged from 0% to 10% in localized areas of the fan (Tannas 2014), while the cover of Silky Lupine ranged from < 0.5% to 15% across the Blakiston fan (Achuff *et al.* 2002).

Silvery Lupine cover was much lower in the 2000s than in the 1990s (2008 = 0.2% and 2013 = 0.5%) and restricted to core hairstreak habitat (Tannas 2014). Surveys in the mid-1990s estimated Silky Lupine cover to be up to 15% in general vegetation plots (Achuff *et al.* 2002) and up to 65% (range 0–65%) in plots where hairstreak butterflies were present (Kondla 2004). Tannas (2014) recorded Silky Lupine across all areas of hairstreak habitat, with cover averaging 9.1% in 2008 and 8.6% in 2013.

Yellow Buckwheat (*Eriogonum flavum*) and Missouri Goldenrod are prominent flowering nectar plants (Kondla 2004).

#### Habitat attributes applicable to both DUs

##### *Mating*

Larval and nectar host plants may provide mating sites for Half-moon Hairstreak. Mating pairs have been observed on flowers of Yellow Buckwheat, Missouri Goldenrod (#2–7; St. John pers. obs. 2008), Prairie Sagewort (*Artemisia frigida*) and various species of lupines (#2–7). Half-moon Hairstreak has been observed mating on Big Sagebrush (#2–7; Knopp pers. comm. 2020), a shrub that may be important for male perching (COSEWIC 2006). In WLNP (#1), mating pairs have been observed on goldenrod (*Solidago* spp.), buckwheat (*Eriogonum* spp.), Prairie Sagewort, and lupines (Kondla 2009). Adults perch on non-native Spotted Knapweed (*Centaurea stoebe*, formerly *C. maculosa* and tetraploid form known as *C. biebersteinii*) (#1); however, no mating or feeding was observed (Sissons pers. comm., 2021).

## *Ants (Family Formicidae)*

Ants play a role in the presence of Half-moon Hairstreak, as ants were observed in close association with lupine plants in locations where the Half-moon Hairstreak occurs at the White Lake (#7) (St. John pers. comm. 2008 as cited in ECCC 2016). In WLNP, Glasier (2022) has observed *Lasius americanus* and three species of wood ants (*Formica argentata*, *F. neogagates* and *F. obscuripes*) protecting and grooming Half-moon Hairstreak caterpillars (see **Interspecific Interactions**).

### Habitat Trends

#### Okanagan-Similkameen population

Historical trends in habitat loss continue as a result of strong pressure to develop undesignated provincial land and private rangeland for more intensive use (e.g., housing, commercial development, and more intensive agricultural use). These trends will continue, particularly on undesignated provincial land that can be sold to the private sector for further development.

The conversion of rangelands to orchards and the conversion of orchards and other fruit crops to vineyards is prevalent throughout the region. Vineyard agriculture typically involves more intensive use of land than orchards, with fewer natural plants and natural patches of habitat and more intensive pesticide applications. The rich, sandy, and well-drained soils that support the grassland ecological communities of the Okanagan and Similkameen valleys are considered an indicator for high grape crop production and continue to be specifically targeted for development by the wine industry (COSEWIC 2012; ECCC 2016). Sometimes, pockets of natural intact habitat remain within these developed agricultural areas and small populations of butterflies can persist. However, surveys conducted over a four-year period on private farms and in vineyards, and other agricultural areas within the Okanagan and Similkameen valleys did not record any Half-moon Hairstreak (Table 2).

In southern BC, the distribution and abundance of invasive plant species have increased since European settlement (Environment Canada 1999; CCIS 2021). Invasive plants alter natural habitats, compete with native plant species for nutrients, space, and water, degrade resources for wildlife, and alter fire regimes (CCIS 2021). Invasive plant species are a concern in the Okanagan-Similkameen region, with at least 40 plant species being tracked by the Okanagan and Similkameen Invasive Species Society (2021). Non-native plant invasions are second to habitat loss in terms of the threat they pose to Okanagan Valley grasslands (Cannings *et al.* 1998). Habitat degradation trends in this region are ongoing from the long-term cumulative ecosystem modification from invasive plants at all subpopulations (#2–7).

Historically, livestock grazing has affected all subpopulations (#2–7) (COSEWIC 2006). In the past 10 years, grazing pressure has decreased in some portions of the South Okanagan Grasslands area (#4) as a result of the establishment of the Sage and Sparrow

grasslands protected area by the Nature Conservancy of Canada. In other portions of the protected area, grazing has ceased entirely because these locations cannot be accessed through private land. It is not known whether grazing occurs at Anarchist Mountain (#3); however, some grazing likely occurs at Veronica Lake (#2). It appears that Half-moon Hairstreak can persist in areas with low grazing regimes, likely because the larval host plants (i.e., lupines) are not consumed by livestock. No formal studies have been completed.

Lupines are early successional plants (USDA-USFS 2021) that are negatively impacted by fire suppression. Fire suppression leads to tree encroachment into open habitats such as those used by Half-moon Hairstreak. The alteration to fire regimes that is associated with the elimination of low- and medium-severity fires can make ecosystems vulnerable to high-severity fires, even beyond the levels of severity historically experienced in an area (Brookes *et al.* 2021).

Historical wildfires have affected various areas including Anarchist Mountain (#3), which burned in 2003 (COSEWIC 2006). In 2014, wildfire burned a 20-ha area at White Lake (#7) including most of the habitat where Half-moon Hairstreak was known to occur (Dyer pers. comm. 2019; Bunge pers. comm. 2020). Surveys in 2019 confirmed that the subpopulation is still present at this site (Heron pers. comm. 2021), and incidental observations of Half-moon Hairstreak were made here in 2021 (iNaturalist 2022). In 2015, the 5,202-ha Testalinden Creek wildfire included habitat occupied by Half-moon Hairstreak east of Mount Kobau (#5) (Province of British Columbia 2022). Surveys conducted in 2020 confirmed that the subpopulation is still present at this site (Bunge pers. comm. 2020).

Taking into account the slow and gradual decline in habitat quality associated with ecosystem modifications (e.g., fire suppression, invasive native/non-native species ingrowth, adverse effect of wildfire smoke pollution on host plant and nectar plant growth), there is an inferred and projected decline in extent of occurrence and index of area of occupancy.

### Waterton Lakes population

Waterton Lakes National Park was established in 1895. The wide open grasslands of the Blakiston Fan enabled temporary human encampments, staging areas, and infrastructure development. Grazing of cattle and horses was permitted in the national park starting in 1914, and for most of the following 40 years, the area was subject to various levels of grazing. In 1947, livestock grazing in the park was stopped due to the public outcry over habitat degradation caused by the presence of too many cattle (Parks Canada Agency 2016).

Although Spotted Knapweed was first recorded in the park in the late 1960s, it was likely introduced when this area was used for domestic livestock grazing and ranching (i.e., sometime between 1895 and 1947). Biological control agents were released into the park in 1994 and in the Blakiston Fan area in 2012. This invasive plant species continues to spread and increase in abundance throughout the Blakiston Fan (observations as of 2020; Sissons

pers. comm. 2021). The long-term impacts of Spotted Knapweed are of concern because of the threat to the ecological integrity of the Blakiston Fan (Oetterich 2017; Sissons pers. comm. 2021).

Several wildfires have occurred in Waterton Lakes over the past 10 years. In 2017, the Kenow wildfire affected a portion of the Half-moon Hairstreak habitat (Sissons 2018); however, the butterfly is still present within the Blakiston Fan (Sissons pers. comm. 2019). The Boundary Wildfire (2018) and the Sofa Mountain Wildfire (1998) are also significant wildfires that occurred within the park (Parks Canada Agency 2019). These fires did not occur within habitat known to be occupied by Half-moon Hairstreak habitat, but smoke (e.g., air pollution) is thought to have impacted butterfly host plant, nectar plant and habitat quality.

## BIOLOGY

### Life Cycle and Reproduction

Half-moon Hairstreak has a one-year life cycle with complete metamorphosis including four life stages (egg, four larval instars, pupa, and adult) (Layberry *et al.* 1998; Guppy and Shepard 2001; James and Nunnallee 2011).

The flight period for Half-moon Hairstreak is correlated with the onset of the flowering and senescence of lupines, the larval host plants (see **Habitat**). Oviposition has not been observed for either the Okanagan-Similkameen or Waterton Lakes populations. In other parts of the species' range, females lay eggs on the larval host plants or in the leaf litter at the base of these plants (Scott 1986b; 1992; Pratt pers. comm. 2008 as cited in ECCC 2016). Eggs overwinter until the following spring, when the larvae hatch. Larvae (in California) likely begin feeding on spring plant growth, prior to snowmelt and under the protection of snow cover (Pratt pers. comm. 2008 as cited in ECCC 2016). In California, larvae are quite large and well developed prior to the onset of host plant flowering (Pratt pers. comm. 2008 as cited in ECCC 2016). Larval feeding has not been observed in the Okanagan-Similkameen population. In the Waterton Lake population, larvae have been observed in the litter at the base of lupine plants, with a few found on the lower part of the stems during the daytime. It is unclear whether movements of larvae have increased at night (Glasier pers. comm. 2022).

Larvae feed from April to early May, then pupate briefly before emerging as adult butterflies. The timing of the adult flight period differs between the Okanagan-Similkameen and Waterton Lakes populations, and is correlated with the flowering of lupines. In the Okanagan-Similkameen population, adult Half-moon Hairstreaks fly from late May through early July (BC CDC 2021), with a peak during the last two weeks of June (BC CDC 2021). In the Waterton Lakes population, they fly in July (COSEWIC 2006), with a peak in the last two weeks of July (COSEWIC 2006; Sissons 2018).

## Physiology and Adaptability

The physiology and adaptability of Half-moon Hairstreak has not been studied. However, common plants with short corollas, such as yarrow, goldenrods, and *Eriogonum* buckwheats provide nectar (COSEWIC 2006; Dyer *et al.* 2009). As is the case for some other hairstreaks (e.g., Behr's Hairstreak [*Satyrrium behrii*], St. John pers. comm. 2020), the length of the proboscis (i.e., tongue) may limit the flowers the species can access. If the depth of the corolla is greater than the length of the proboscis, the butterfly cannot reach the nectar.

## Dispersal and Migration

The dispersal ability of Half-moon Hairstreak has not been measured. Behr's Hairstreak, a related species known from habitats similar to those used by the Half-moon Hairstreak, can disperse up to 5 km; however, it is unlikely to disperse across unsuitable habitat (e.g., across lakes or through urban areas) (Desjardins pers. comm. 2014). Gravid females may be too heavy to fly long distances. The Half-moon Hairstreak is non-migratory.

## Interspecific Interactions

Evidence of bite marks on the wings of live-caught specimens suggest that the Half-moon Hairstreak may be preyed upon by small mammals, birds, and invertebrates (St. John pers. comm. 2020). Half-moon Hairstreak larvae are dependent upon lupines. Adults are not an essential pollinator of the species' larval host plants or nectar plants.

Some *Satyrrium* species have mutualistic relationships with ants (Formicidae): the larvae secrete a liquid containing amino acids and carbohydrates which the ants consume, and the ants protect the larvae from predators and parasitoids (Pierce 1987). Alternatively, Hairstreak larvae may 'give' sugar packets to prevent ants from eating the larvae, and thus minimize predation by ants. Pratt (pers. comm. 2008 as cited in ECCC 2016), who gained extensive knowledge from captive rearing butterflies, observed that these butterflies rely heavily on ants, to the extent that the ants' presence may determine whether the butterfly species is present in some habitats. Wood ants (*Formica* spp.) and carpenter ants (*Camponotus* spp.) have been associated with Half-moon Hairstreak larvae (Pratt pers. comm. 2008 as cited in ECCC 2016).

Sissons (pers. comm. 2020) also noted ants with larvae in Waterton Lakes, and Glasier (2022) recently observed *Lasius americanus* and three species of wood ants (*Formica argentata*, *F. neogagates* and *F. obscuripes*) protecting and grooming Half-moon Hairstreak caterpillars. St. John (pers. comm. 2020) observed ants in close association with lupines in locations where Half-moon Hairstreak occurs at White Lake (#7).

## POPULATION SIZES AND TRENDS

### Sampling Effort and Methods

Half-moon Hairstreak surveys in Canada have focused on recording new subpopulations, confirming presence at a site, and gathering information on natural history, threats, and habitat. Surveys have primarily been conducted by wandering transects through suitable habitat (Table 2) (see **Search Effort**) and tallying abundance. Abundance is an index. These surveys have not included methods that would provide estimates of population sizes or trends.

#### Waterton Lakes population

In addition to surveys involving wandering transects through suitable habitat (see **Search Effort**), some controlled surveys and transects of various lengths (e.g., modified Pollard Walks; Pollard 1977) have been completed (Kondla 2004, 2009; Sissons 2018) (Table 3). Starting in 2021, transects were established throughout Blakiston Fan to conduct distance sampling to acquire better population trend and habitat data (Sissons 2021). There have been no surveys using these methods in Okanagan-Similkameen habitats.

### Abundance

#### Okanagan-Similkameen population

Half-moon Hairstreak abundance estimates are not available, and methods used to count butterflies across the years have not been consistent. The few data available cannot be compared across time (Table 1). The largest counts consist of 527 individuals identified from June 24 to 26, 2015, at Keremeos Columns/Armstrong Creek (#7), and 158 individuals identified from June 11 to 23, 2015, at South Okanagan Grasslands Protected Area (#4) (Heron pers. comm. 2021) (Table 1).

#### Waterton Lakes population

Methods used to derive abundance estimates for Half-moon Hairstreak have been inconsistent since the fieldwork was conducted for the first COSEWIC status report (Table 3). Surveys in 2008, 2009, 2014, and 2017 included systematic wandering transects/routes through the Half-moon Hairstreak habitat (Table 3) (Sissons 2018). Across years, there have been differences in data collection and the survey route and/or length was not always accurately recorded, plus the distance covered on either side of the transect varied (Sissons 2018) (see Table 3). The sum of all observations collected over several years was more than 190. Estimates of the number of Half-moon Hairstreaks per hectare are as high as 63, but mostly less than 30 (Table 3).

## Fluctuations and Trends

There is insufficient information on the abundance and distribution of Half-moon Hairstreak within the habitats in either DU to assess fluctuations or trends. Natural fluctuations in butterfly population are the result of factors such as parasites and predators, the distribution and abundance of larval and nectar host plants, and weather patterns in previous years. It is unlikely that the Half-moon Hairstreak experiences extreme population fluctuations<sup>7</sup>, as the species has never been observed in great abundance. Many sites have been visited over multiple years (Tables 2 and 3); however, these sites were visited on only one or two dates during the flight season to confirm presence, record abundance and/or assess threats to the subpopulation. There are insufficient data to conclude that extreme fluctuations have occurred. The abundance of the Waterton Lakes population appears to be declining (Sissons pers. comm. 2019).

## Rescue Effect

The genetic structure evidence discussed under **Designatable Units** suggests that rescue is not possible. For completeness, the nearest occurrences are considered below.

There are few records for Half-moon Hairstreak from northern Washington State (adjacent to the Okanagan-Similkameen population) or northern Montana (adjacent to the Waterton Lakes population).

### Okanagan-Similkameen population

The closest Half-moon Hairstreak record obtained south of BC (Okanagan-Similkameen population) dates to 2003 and is from the Sinlahekin Wildlife Area about 30 to 40 km south of the international border in Washington State; the specimen was collected in sagebrush grassland (Kondla pers. comm. 2021). There is a recent record from north of Sunnyslope (June 19, 2019, iNaturalist 2020) in Washington State, approximately 177 km south of the closest known records (#2 and sites at #4). Natural re-establishment from the Washington subpopulations may be possible because there is intervening sagebrush habitat. However, given the low number of newly documented sites in Canada (i.e., no new subpopulations recorded since 2003) and the fragmentation of the intervening habitat, immigration is unlikely.

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<sup>7</sup> The COSEWIC definition of Extreme Fluctuation is "changes in distribution or in the total number of mature individuals of a wildlife species that occur rapidly and frequently, and are typically of more than one order of magnitude" (adapted from IUCN 2010).



## Waterton Lakes population

The closest known records of Half-moon Hairstreak are referenced in older publications that list records in southwestern Montana (Kohler 1980; Stanford and Opler 1993). The most recent confirmed and closest record is posted on iNaturalist (2020) and is from Carbon County in southwest Montana, about 560 km from Waterton Lakes, where the species is reported as uncommon to common (Glassberg 2001). There are no known records in intervening areas<sup>8</sup>.

The Okanagan-Similkameen and Waterton Lakes populations are naturally disjunct [see **Designatable Units**]. The minimum (straight-line) distance between the Okanagan-Similkameen (#3) and Waterton Lakes populations (#1) is approximately 400 km. There is a large amount of unsuitable habitat in between, including the Rocky Mountains.

## THREATS AND LIMITING FACTORS

### Threats

Threats to the Half-moon Hairstreak were assessed based on the IUCN-CMP (International Union for the Conservation of Nature–Conservation Measures Partnership) unified threats classification system (see Salafsky *et al.* 2008; Master *et al.* 2012). Two threat assessments were prepared: one each for the Okanagan-Similkameen population (Table 4) and the Waterton Lakes population (Table 5). Threats are summarized from the COSEWIC status report(2006) and the species recovery strategy (SIRT 2008; ECCC 2016) and updated with new information.

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<sup>8</sup> Many regional museums (in both Canada and the United States) hold historical specimens that have not been databased. There may be undatabased Half-moon Hairstreak specimens from these intervening areas.



Threat			Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs)	Timing	Comments
2	Agriculture & aquaculture	D	Low	Small (1–10%)	Serious (31–70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
2.1	Annual & perennial non-timber crops	D	Low	Small (1–10%)	Serious (31–70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Potentially at #2 and #3 (private land)
2.2	Wood & pulp plantations						Not applicable.
2.3	Livestock farming & ranching		Unknown	Pervasive (71–100%)	Unknown	High (Continuing)	#2, 3, 4, 5, 6 and #7
2.4	Marine & freshwater aquaculture						Not applicable.
3	Energy production & mining						
3.1	Oil & gas drilling						Not applicable.
3.2	Mining & quarrying						Not applicable.
3.3	Renewable energy						Not applicable.
4	Transportation & service corridors						
4.1	Roads & railroads						Not applicable.
4.2	Utility & service lines						Not applicable.
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		Negligible	Large (31–70%)	Negligible (<1%)	High (Continuing)	

Threat			Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs)	Timing	Comments
6.1	Recreational activities		Negligible	Large (31–70%)	Negligible (<1%)	High (Continuing)	#4, 5, 6, 7; Sage and Sparrow and International Grasslands do have the odd person use it for recreation.
6.2	War, civil unrest & military exercises						Not applicable.
6.3	Work & other activities						Not applicable.
7	Natural system modifications	BD	High - Low	Pervasive (71–100%)	Serious – Slight (1–70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
7.1	Fire & fire suppression		High - Low	Pervasive (71–100%)	Serious - Slight (1–70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Wildfire is scored only in this category. Fire suppression is scored under 7.3
7.2	Dams & water management/ use						Not applicable.
7.3	Other ecosystem modifications	D	Low	Pervasive (71–100%)	Slight (1-10%)	High (Continuing)	#2, 3, 4, 5, 6 and # 7; includes fire suppression, natural succession of shrubs and impacts to ecosystem from livestock overgrazing.
8	Invasive & other problematic species & genes		Unknown	Unknown	Unknown	Unknown	Unknown
8.1	Invasive non-native/ alien species/diseases		Unknown	Unknown	Unknown	Unknown	All sites (#2 - #7)
8.2	Problematic native species/diseases						Not applicable.
8.3	Introduced genetic material						Not applicable.
8.4	Problematic species/ diseases of unknown origin						Not applicable.
8.5	Viral/prion-induced diseases						Not applicable.
8.6	Diseases of unknown cause						Not applicable.
9	Pollution	D	Low	Large - Restricted (11–70%)	Slight (1–10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Low
9.1	Domestic & urban wastewater						Not applicable.
9.2	Industrial & military effluents						Not applicable.

Threat			Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs)	Timing	Comments
9.3	Agricultural & forestry effluents	D	Low	Restricted - Small (1-30%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	#2, 3, #7; unknown at #4
9.4	Garbage & solid waste						Not applicable.
9.5	Airborne pollutants						Not applicable.
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	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
11.1	Habitat shifting & alteration						Not applicable.
11.2	Droughts	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	#2-7; drought will impact host plant senescence.
11.3	Temperature extremes						Not applicable.
11.4	Storms & flooding						Not applicable.
11.5	Other impacts						Not applicable.

<sup>1</sup>**Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each stress is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: very high (75% declines), high (40%), medium (15%), and low (3%). Unknown: used when impact cannot be determined (e.g., if the value for either scope or severity is unknown).

<sup>2</sup>**Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population, in the area, of interest. (Pervasive = 71-100%; Large = 31-70%; Restricted = 11-30%; Small = 1-10%)

<sup>3</sup>**Severity** – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population (Extreme = 71-100%; Serious = 31-70%; Moderate = 11-30%; Slight = 1-10%).

<sup>4</sup>**Timing** – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.

**Table 5. Threat assessment results for the Half-moon Hairstreak (*Satyrrium semiluna*) Waterton Lakes population in Canada. The classification below is based on the IUCN-CMP (International Union for the Conservation of Nature–Conservation Measures Partnership) unified threats classification system. For a detailed description of the threat classification system, see the CMP web site (CMP 2010). Threats may be observed, inferred, or projected to occur in the next 10 years. Threats are characterized here in terms of scope, severity, and timing. Threat “impact” is calculated from scope and severity. For information on how the values are assigned, see Master *et al.* (2009) and footnotes to this table.**

<b>Scientific Name</b>	Half-moon Hairstreak ( <i>Satyrrium semiluna</i> ) Waterton Lakes population			
<b>Date:</b>	April 7, 2021			
<b>Assessor(s):</b>	Brenda Costanzo (report writer), Dawn Marks (Arthropods SSC), Dave Fraser (threats assessment facilitator), David McCorquodale (Arthropods SSC Co-chair), Jamie Lewthwaite (Arthropods SSC), Jennifer Heron (report writer), Crispin Guppy (Lepidopterist), Greg Wilson (BC Rep), John Richardson (Arthropods SSC), Leah Ramsay (Arthropods SSC), Rosana Nobre-Soares (COSEWIC Secretariat), Natasha Lloyd (Parks Canada Agency), Robert Buchkowski (Arthropods SSC), Robert Sissons (Parks Canada Agency)			
<b>References:</b>	Recovery Strategy for the Half-moon Hairstreak ( <i>Satyrrium semiluna</i> ) in Canada (ECCC 2016)			
		<b>Overall Threat Impact:</b>	<b>Level 1 Threat Impact Counts</b>	
	<b>Threat Impact</b>		<b>high range</b>	<b>low range</b>
	A	Very High	0	0
	B	High	0	0
	C	Medium	1	1
	D	Low	1	1
		<b>Calculated Overall Threat Impact:</b>	<b>Medium</b>	<b>Medium</b>
<b>Assigned Overall Threat Impact:</b>	<b>C = Medium</b>			
<b>Impact Adjustment Reasons:</b>	No adjustment.			
<b>Overall Threat Comments</b>	Waterton Lakes population. The primary threat appears to be the spread of non-native plants, such as Spotted Knapweed, which are causing ecosystem modifications to the habitat and contributing to the decline in abundance and quality of larval host and adult nectar plants.			

Threat	Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs)	Timing	Comments
1 Residential & commercial development					
1.1 Housing & urban areas					Not applicable.
1.2 Commercial & industrial areas					Not applicable.
1.3 Tourism & recreation areas					Not applicable to habitat where Half-moon Hairstreak occurs.
2 Agriculture & aquaculture					
2.1 Annual & perennial non-timber crops					Not applicable.
2.2 Wood & pulp plantations					Not applicable.
2.3 Livestock farming & ranching					Not applicable.
2.4 Marine & freshwater aquaculture					Not applicable.

Threat			Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs)	Timing	Comments
3	Energy production & mining						
3.1	Oil & gas drilling						Not applicable.
3.2	Mining & quarrying						Not applicable.
3.3	Renewable energy						Not applicable.
4	Transportation & service corridors						
4.1	Roads & railroads						Not applicable.
4.2	Utility & service lines						Not applicable.
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		Negligible	Large (31–70%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities		Negligible	Large (31–70%)	Negligible (<1%)	High (Continuing)	#1 People use the site, but use is managed and monitored.
6.2	War, civil unrest & military exercises						Not applicable.
6.3	Work & other activities						Not applicable.
7	Natural system modifications	C	Medium	Pervasive (71–100%)	Moderate (11–30%)	High (Continuing)	
7.1	Fire & fire suppression	C	Medium	Pervasive (71–100%)	Moderate (11–30%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Wildfire is scored only in this category. Fire suppression is scored under 7.3.
7.2	Dams & water management/use						Not applicable.
7.3	Other ecosystem modifications	C	Medium	Pervasive (71–100%)	Moderate (11–30%)	High (Continuing)	#1; includes fire suppression (7.1 but the area where Half-moon Hairstreak occurs does not have much tree growth); and the spread of non-native Spotted Knapweed (8.1).
8	Invasive & other problematic species & genes		Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
8.1	Invasive non-native/alien species/diseases		Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	#1

Threat			Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs)	Timing	Comments
8.2	Problematic native species/diseases		Unknown	Unknown	Unknown	Unknown	#1
8.3	Introduced genetic material						Not applicable.
8.4	Problematic species/diseases of unknown origin						Not applicable.
8.5	Viral/prion-induced diseases						Not applicable.
8.6	Diseases of unknown cause						Not applicable.
9	Pollution						
9.1	Domestic & urban wastewater						Not applicable.
9.2	Industrial & military effluents						Not applicable.
9.3	Agricultural & forestry effluents						Not applicable.
9.4	Garbage & solid waste						Not applicable.
9.5	Airborne pollutants						Not applicable.
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	D	Low	Pervasive (71–100%)	Slight (1–10%)	High (Continuing)	
11.1	Habitat shifting & alteration						Not applicable.
11.2	Droughts	D	Low	Pervasive (71–100%)	Slight (1–10%)	High (Continuing)	#1; drought will impact host plant senescence.
11.3	Temperature extremes						Not applicable.
11.4	Storms & flooding	D	Low	Pervasive (71–100%)	Slight (1–10%)	High (Continuing)	#1
11.5	Other impacts						Not applicable.

<sup>1</sup>**Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened, in the area, of interest. The impact of each stress is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: very high (75% declines), high (40%), medium (15%), and low (3%). Unknown: used when impact cannot be determined (e.g., if the value for either scope or severity is unknown).

<sup>2</sup>**Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population, in the area, of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%)

<sup>3</sup>**Severity** – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%).

<sup>4</sup>**Timing** – High = continuing; Moderate = only in the future (could happen in the short term [ $< 10$  years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.



**Table 6. Threats applicable to Half-moon Hairstreak (*Satyrrium semiluna*), categorized by the IUCN-CMP (International Union for the Conservation of Nature–Conservation Measures Partnership) unified threats classification system (Y = applicable; N = not applicable; U = unknown; - = not applicable).**

Subpopulation (Map) Number and Name	BC CDC Element Occurrence # and Name <sup>9</sup>	Site	1.1 Housing & urban areas	2.1 Annual & perennial non-timber crops	2.3 Livestock farming & ranching	6.1 Recreational activities	7.1 Fire & fire suppression	7.3 Other ecosystem modifications	8.1 Invasive non-native/alien species/diseases	9.3 Agricultural & forestry effluents	11.2 Droughts
1 Waterton Lakes	Not applicable	-	-	-	-	Horseback riding, walking, both on designated trails.	Y - wildfire	Y - Cumulative effects of non-native plants; fire suppression	Non-native Spotted Knapweed scored under 7.3	N	Y
2 Veronica Lake	EO #1 Osoyoos, “Veronica Lake”	-	Private land, not likely to be urban development	Private land, at present natural & potential conversion.	Y - Cattle and horse grazing.	-	Y - wildfire	Unknown but likely Y - Cumulative effects of native/non-native plants; fire suppression; livestock overgrazing.	U – non-native parasitic flies	Y	Y
3 Anarchist Mountain	EO #2 Anarchist Mountain	a. Anarchist Mountain	Yes, COSEWIC (2006) and threat continues at present.		Y - Cattle grazing	-	Y - wildfire	Y - Cumulative effects of native/non-native plants; fire suppression; livestock overgrazing.	U – non-native parasitic flies	N	Y
		b. Anarchist Pass				-	Y - wildfire	Y - Cumulative effects of native/non-native plants; fire suppression.	U – non-native parasitic flies	Y – potential spray for roadside vegetation control	
4 South Okanagan Grasslands Protected Area (SOGPA) - international grasslands	EO #8 South Okanagan Grasslands Protected Area	a - x.			Y - Cattle grazing	Negligible; areas where butterflies occur are remote	Y - wildfire	Y - Cumulative effects of native/non-native plants; fire suppression; livestock overgrazing (some sites).	U – non-native parasitic flies	Y – potential spray for roadside vegetation control	Y

<sup>9</sup> The B.C. Conservation Data Centre (CDC) maps known element occurrences (an area of land and/or water where a species or ecosystem is known to have been) of red- and blue-listed species and ecosystems. The CDC database includes the best available information and is updated on a regular basis. In some instances, two element occurrences (EO) are merged and a third EO is created; thus EO numbers are not always sequential. An element occurrence (EO) record can consist of one or more source features (i.e., observations), is generally equivalent to a subpopulation (COSEWIC definition of subpopulation), has conservation significance and is relevant in land management decisions; it is not an observation. It is a value-added product that includes assessment of observations for conservation significance and includes verification of the information source. All element occurrences are polygons: the size of the polygon usually reflects the locational uncertainty associated with the source data, which is represented by different sized circles. Some polygons may be larger to reflect the actual area covered by the element occurrence (BC CDC 2022).

Subpopulation (Map) Number and Name	BC CDC Element Occurrence # and Name <sup>9</sup>	Site	1.1 Housing & urban areas	2.1 Annual & perennial non-timber crops	2.3 Livestock farming & ranching	6.1 Recreational activities	7.1 Fire & fire suppression	7.3 Other ecosystem modifications	8.1 Invasive non-native/alien species/diseases	9.3 Agricultural & forestry effluents	11.2 Droughts
5 Mount Kobau, East	EO #4 Conifryd Lake, North	a. North Kilpoola				Negligible; areas where butterflies occur are remote	Y - wildfire	Y - Cumulative effects of native/non-native plants; fire suppression; livestock overgrazing.	U – non-native parasitic flies	N	Y
		b. Mount Kobau Road - 2008			Y - Cattle grazing.	Negligible; areas where butterflies occur are remote	Y - wildfire	Y - Cumulative effects of native/non-native plants; fire suppression; livestock overgrazing.	U – non-native parasitic flies	Y – potential spray for roadside vegetation control	Y
		c. Mt Kobau Rd				Negligible; areas where butterflies occur are remote	Y - wildfire	Y - Cumulative effects of native/non-native plants; fire suppression; livestock overgrazing.	U – non-native parasitic flies		Y
		d. Gravel pit				-	Y - wildfire	Y - Cumulative effects of native/non-native plants; fire suppression	U – non-native parasitic flies		
6 Keremeos	EO #7 Manuel Creek	a – d			Y - Cattle grazing.	Negligible; areas where butterflies occur are remote	Y - wildfire	Y - Cumulative effects of native/non-native plants; fire suppression; livestock overgrazing.	U – non-native parasitic flies		Y
7 White Lake	EO #6 White Lake, north	a, b			Cattle grazing.	Negligible; areas where butterflies occur are remote	Y - wildfire	Y - Cumulative effects of native/non-native plants; fire suppression; livestock overgrazing.	U – non-native parasitic flies	Y – potential spray for roadside vegetation control	Y

### Okanagan-Similkameen population

The primary threat to the Okanagan-Similkameen population consists of changes to the distribution and abundance of larval and nectar plants due to ecosystem modifications associated with fire suppression, the spread and continued introduction of invasive non-native plants, and domestic livestock overgrazing. Wildfires are direct threats to these same habitats. The overall threat impact to this population is Medium (Table 4).

Indirect effects of habitat conversion include fragmentation of the species' population. The Richter Pass (# 5) gravel reserve licence has been owned by the Ministry of Transportation and Highways since 1985, and this area is not protected.

### Waterton Lakes population

The primary threat appears to be the spread of non-native plants, such as Spotted Knapweed, which is causing ecosystem modifications to the habitat and contributing to the decline in abundance and quality of larval host and adult nectar plants. The overall threat impact to this population is Medium (Table 5).

Details are discussed below under the IUCN-CMP unified threats classification system headings and numbering scheme.

### **Threat 7. Natural system modifications (High to low impact, Okanagan-Similkameen; Medium impact, Waterton Lakes)**

7.1 Fire and Fire suppression. Wildfire is scored under this subheading (7.1). Fire suppression is scored under threat 7.3.

### *Okanagan-Similkameen population*

Impact: high–low.

Frequent, low-intensity wildfires were historically more common throughout the Okanagan and Similkameen valleys. Fires were attributable to burns started by First Nations peoples to improve root crops and to lightning (Cannings and Durance 1998; Iverson 2012). The Okanagan Valley grasslands area historically experienced frequent, low-intensity fires that limited the growth of woody plants (Gayton 2003). Fires are now less frequent, due to active fire suppression since the 1940s; however, they are more intense, because of the higher fuel loads associated with encroaching fire-intolerant shrubs such as Antelope-brush (*Purshia tridentata*) and non-native Cheatgrass. Wildfire severity and intensity are increasing as a result of fire suppression activities and climate change (Spittlehouse 2008). An extensive wildfire at White Lake (#3) in 2014 eliminated one of the two main Half-moon Hairstreak areas (Dyer pers. comm. 2020). Lupines will increase in abundance within 5 to 10 years after a fire if there is enough moisture (Guppy pers. comm., 2021). This would increase food supplies for Half-moon Hairstreak larvae. These post-fire disturbed sites are also subject to invasions of exotic species that affect ecosystem processes (Gayton 2003; scored under 7.3).

### *Waterton Lakes population*

Impact: medium

Extensive wildfires burned throughout the open lowland and forested regions of WLNP in 1998, 2017, and 2018 (Parks Canada Agency 2019). A portion of the Blakiston Fan burned in the 2017 fire but did not burn in the 1998 or 2018 fires. Extensive smoke may affect air quality for active larvae and/or adult butterflies and food plant quality. Fires are anticipated to be more frequent and severe in the future (de Groot *et al.* 2002; Flannigan *et al.* 2005).

Silky Lupine is generally enhanced by or not affected by fire (Johnson *et al.* 1987). This lupine species has a deep root system allowing it to survive after fire, and it is able to resprout from the caudex (Lyon *et al.* 1976). After a disturbance, Silky Lupine can germinate from buried seed (Matthews 1993). Within the Blakiston Fan, both Silvery and Silky Lupines rebounded after the 2017 Kenow fire; however, so did invasive Spotted Knapweed. As a result of the increase in Spotted Knapweed, Half-moon Hairstreak eggs near the soil surface were suspected to have been lost (Sissons pers. comm. 2021).

### 7.3 Other ecosystem modifications

Other ecosystem modifications include the cumulative effects of threats that alter ecosystem functions, services, quality, and quantity. While these threats do not directly kill the butterflies, they adversely affect the ecosystem and available habitat, rendering it less suitable for Half-moon Hairstreak.

### *Okanagan-Similkameen population*

Impact: low

The cumulative effects of livestock overgrazing (2.3), fire suppression (7.1), and the spread of non-native/alien (8.1) and native plants (8.2) have contributed to a decline in the quality and quantity of habitat available for Half-moon Hairstreak. Non-native Cheatgrass (*Bromus tectorum*), Dalmatian Toadflax (*Linaria genistifolia* ssp. *dalmatica*), Diffuse Knapweed (*Centaurea diffusa*) and Sulphur Cinquefoil (*Potentilla recta*) are invasive plants with horizontally spreading surface roots that have been recorded throughout the habitats where Half-moon Hairstreak occurs. Sulphur Cinquefoil can form monospecific stands (SIRT 2008). These plants grow into and occupy open soil areas and slow or prevent the establishment of native vegetation, thereby modifying the habitat and making it less suitable for host and nectar plants.

Over the past 100 years, fire suppression programs have altered the natural fire regime within the Okanagan and Similkameen valleys. Fire suppression has resulted in a build-up of fuels on the ground. As a result, more intense, stand-replacing fires may occur instead of the less intense patchy fires that leave sagebrush ecological community patches intact. Reduced wildfire frequency leads to tree encroachment, which in turn reduces the size and extent of bare soil and open sandy areas available for healthy larval host and nectar plant populations.

Lupines (larval host plant) are early successional plants; they are able to sprout from the base of the plant stem or germinate from seeds in the soil after fires (USDA-USFS 2021). Lupines nonetheless need some moisture in the summer or conditions will be too dry for their future growth. Certain types of fires (e.g., patchy fires) can be beneficial to lupine reproduction and spread, as these fires leave more open areas, competition from other plants is reduced, and more sunlight is available, thus allowing the lupines to regenerate. Conversely, if there is a lack of fire disturbance, succession is altered and the lupines will die out due to the increased shade under trees, plus increased competition from shrubs and grasses/forbs all of which are not conducive to lupine growth and reproduction.

Livestock overgrazing can result in trampling of larval host plants and adult nectar plants, changes in soil nutrient content caused by the animals' urination and defecation, as well as soil compaction. Livestock also consume flowering/nectar plants, reducing the abundance of these plants during the adult flight period. The first COSEWIC status report (2006) states that livestock grazing is likely a factor in population dynamics for Half-moon Hairstreak on lands that are subject to "extremely intense and persistent grazing". At Richter Pass (#5), the butterfly is exposed to a fairly high level of livestock grazing. In contrast, at White Lake (#7) individuals have been found in an area subject to light grazing. None were seen at a nearby heavily grazed site (COSEWIC 2006). Livestock grazing also increases the introduction and spread of invasive plants (see above).

#### *Waterton Lakes population*

Impact: medium

Spotted Knapweed is a non-native plant that is well-established throughout the Blakiston Fan (Oetterich 2018; Sissons pers. comm. 2019). The plant has spread throughout this area and appears to have contributed to the decline in the quality and quantity of Half-moon Hairstreak habitat (Sissons pers. comm. 2019). Seeds germinate in the fall of the year and can remain viable for more than 8 years (Davis *et al.* 1993). Spotted Knapweed seeds can be transported by native species (e.g., in the fur of ungulates) and anthropogenic means (e.g., attaching to shoes, vehicle tires). The plant produces dense monotypic stands. The long-term ecological changes associated with Spotted Knapweed include reduced soil water filtration and increased surface water runoff and stream sedimentation (Lacey *et al.* 1989). Spotted Knapweed secretes catechin, a phytotoxin, from its roots. Catechin decreases the growth of many plants, including prairie grasses (Ridenour and Callaway 2001), and promotes monotypic stands of knapweed. Lupines, which are a food source for the Half-moon Hairstreak, are less susceptible to these

phytotoxic properties than many plants (Weir *et al.* 2005; Alford *et al.* 2009). There is some evidence that symbiotic rhizobia provide protection from the toxicity of catechin for Silky Lupine, and therefore it is a useful species for carrying out habitat restoration after invasion by Spotted Knapweed (Alford *et al.* 2009). In Waterton Lakes, knapweed likely outcompetes lupines and nectar plants and causes changes in the soil chemistry and invertebrate ground fauna (e.g., ants). There are also some agronomic grasses that are reducing habitat for Half-moon Hairstreak (e.g., Cheatgrass or Smooth Brome [*Bromus inermis*] and are difficult to control (Sissons pers. comm. 2021).

### **Threat 11 Climate Change and severe weather (Low impact, Okanagan-Similkameen; Low impact, Waterton Lakes)**

Climate change is a potential but poorly understood threat to the ecosystems in both the Okanagan-Similkameen and Waterton Lakes populations.

#### 11.2 Droughts

Changes in the intensity, frequency, and longevity of droughts could affect the long-term survival and abundance of host and nectar plants bloom time as well as the start of senescence.

Okanagan-Similkameen population. *Impact: low.* Available models predict the climate will become drier in the summer and the frequency and duration of summer droughts will increase in the Okanagan Valley (Spittlehouse 2008; Haughian *et al.* 2012). The larval host plants are drought tolerant thanks to their deep tap root and can also re-establish after fire either by sprouting from their caudex (base of the stem) or germinating from seed banks in the soil (USDA-USFS 2021). Silky Lupine is a cool-season plant that begins its growth in May and typically flowers from June to July, or in August and September within its range. The seeds are disseminated in August and the plants dry up by the end of August (USDA-USFS 2021). Larvae feed starting in May and are not likely to encounter premature seasonal plant senescence. However, drought may impact adult nectar plants, such as Parsnip-flowered Buckwheat (*Eriogonum heracleoides*). In 2015, a particularly dry summer, these buckwheat plants withered (Marks 2022).

#### *Waterton Lakes population*

Impact: low

In AB, there is expected to be a mean annual temperature increase (2 to 6°C) and a small increase in mean annual precipitation in winter and spring by the 2080s (Barrow and Yue 2005; Parks Canada Agency 2017). Soil moisture will subsequently decrease and is predicted to decline by 20% to 30% in western AB (Schindler and Donahue 2012). Southeastern BC (e.g., adjacent to WLNP) will also experience an increase in mean annual precipitation in the winter and spring and a decrease in summer precipitation (Spittlehouse 2008; Walker and Sydneysmith 2008). The frequency, intensity, and duration of drought are projected to increase (Gillett *et al.* 2004).

## 11.4 Storms and flooding

### *Waterton Lakes population.*

Impact: low

The current frequency of flooding is normal in the Blakiston Fan; however, climate models predict that high levels of flooding may occur (Parks Canada Agency 2017; Sissons pers. comm. 2021).

## **Threat 1. Residential or Commercial Development (Low Impact, Okanagan-Similkameen)**

### 1.1 Housing and urban areas

#### *Okanagan-Similkameen population*

Impact: low

Direct and irreversible physical destruction of grassland habitat (e.g., construction of housing developments) is ongoing throughout the Okanagan Valley, although little of the habitat used by Half-moon Hairstreak subpopulations appears to be affected. Portions of five subpopulations (#2, #3, #4, #5, #6) are on private land (Land Title and Survey Authority of British Columbia 2022); however, all of these areas are rural and not within areas zoned for redevelopment. Since the 2006 status assessment (COSEWIC 2006), private land parcels occupied by subpopulation #4 have been purchased by the Nature Conservancy of Canada and are being managed for conservation purposes. Together, they are now known as the Sage and Sparrow Conservation Area (Nature Conservancy of Canada 2020). Private land within subpopulations #2, #3, and #5 is highlighted as Environmentally Sensitive in the Regional District of Okanagan-Similkameen's Environmentally Sensitive Development Permit (ESDP) mapping (Regional District of Okanagan-Similkameen 2022). ESDP areas highlight parcels that have been designated for the protection of natural biodiversity. Subdivision or building within these areas requires an environmental impact assessment by a qualified environmental professional (Regional District of Okanagan-Similkameen 2020). In the 1970s, a lot of rural development took place near #3 (Anarchist Mtn.), and between 2004 and 2008 subdivision of the "Regal Ridge" development was initiated (now Osoyoos Mountain Estates). This trend has slowed recently, but any fragmentation of sagebrush communities is expected to reduce re-occupancy rates after natural stochastic events (based on observations of Behr's Hairstreak in the south Okanagan; SIRT 2008).

## **Threat 2. Agriculture and aquaculture (Low Impact, Okanagan-Similkameen)**

### 2.1 Annual and perennial non-timber crops

#### *Okanagan-Similkameen population*

Impact: low

Natural habitat conversion and/or agricultural crop conversion/intensification can affect Half-moon Hairstreak habitats on private lands (#2 and 3, portions of #5 and #6). These properties are large natural areas with apparently intact native plant communities; however, the adjacent properties are agricultural land. The potential for development of these intact natural areas is therefore high. Vineyards can be established at elevations up to 490 m (British Columbia Ministry of Agriculture and Lands 2010), which would likely not affect these four Half-moon Hairstreak subpopulations (#2 > 548 m; #3 > 800 m; #5 > 700 m; #6 > 900m; Table 1).

### 2.3 Livestock farming and ranching

#### *Okanagan-Similkameen population*

Impact: unknown

Impacts from livestock are scored based on direct consumption of larvae, trampling of larvae, overwintering pupae, or puddling adults (possible). Livestock graze in some Half-moon Hairstreak habitats (#2, 6, and 7) but the intensity varies from site to site, and is unknown. Cattle rarely eat lupines (i.e., larval host plants); however, nectar plants are consumed. Ecosystem modifications that result from livestock overgrazing and resultant habitat changes are scored under 7.3.

## **Threat 9. Pollution (Low impact, Okanagan-Similkameen)**

### 9.3 Agricultural and forestry effluents

#### *Okanagan-Similkameen population*

Impact: low

There is potential for herbicide overspray that affects non-native plants (e.g., spray application is across a broad area and not targeted at specific plants; as a result all plants in an area are adversely impacted). On private lands (#2 and #3) and the roadside portion of #3 (a provincial rest stop), herbicide overspray may impact non-target larval and nectar host plants by killing both the plant and/or larvae that are present on the plant. Pesticide overspray may also occur along roadsides adjacent to White Lake (#7) and the portion of Anarchist Mountain (#3) managed by the Ministry of Transportation, Infrastructure, and Highways (MOTH). Herbicide treatments that target non-native plants are not likely to occur



near subpopulations within protected areas (#4, portion of #5, #6, and #7). Pesticide drift from adjacent agricultural areas may impact Half-moon Hairstreak subpopulations through direct mortality at localized sites, but the impacts have not been documented.

Waterton Lakes population. *Impact: unknown.* Spotted Knapweed appears to be increasing in abundance throughout the Blakiston Fan (Oetterich 2018; Sissons pers. comm. 2019). Herbicides have been tested with the aim of controlling the plant (Oetterich 2018). Should herbicides be used in the future, there would be careful consideration for species at risk, including Half-moon Hairstreak. (Oetterich 2018; Sissons pers. comm. 2019).

## **Threat 8. Invasive and other problematic species and genes (Unknown impact, Okanagan-Similkameen and Waterton Lakes)**

### 8.1 Invasive non-native/alien species

#### *Okanagan-Similkameen and Waterton Lakes populations*

Impact: unknown

*Compsilura concinnata* (Diptera: Tachinidae) is a non-native parasitic fly introduced into eastern North America as a biological control agent for European Spongy Moth (*Lymantria dispar*). This fly may affect Half-moon Hairstreak (Boettner *et al.* 2000) and may be present in BC and AB (GBIF Secretariat 2019). Non-native invasive plants, which alter the available habitat, but do not cause direct mortality to butterflies, are discussed under 7.3, Other ecosystem modifications.

## **Limiting Factors**

Limiting factors are innate characteristics that make Half-moon Hairstreak vulnerable to ongoing threats. The main limiting factors for Half-moon Hairstreak are summarized from the recovery strategy (SIRT 2008; ECCC 2016):

### Larval host plant specificity

Half-moon Hairstreak is dependent on lupines as larval host plants and without these plants the butterfly cannot complete its life cycle (see **Habitat**). Adults forage for nectar opportunistically.

### Small population size

Half-moon Hairstreak subpopulations occur within small, isolated, and limited habitat patches. Some subpopulations (#4) have more than 400 individuals. However, the species appears to occur as small or localized subpopulations. For the Waterton Lakes population, fewer than 1,000 individuals have been observed in 15 years of surveys, suggesting a population of a few hundred individuals at most (i.e., 2004–2019) (Table 3).

### Natural parasites

Parasitic wasps impact butterflies during all life stages; however, no species-specific information is available for Half-moon Hairstreak.

### Vulnerability to weather patterns

The previous year's weather affects the abundance of the next year's generation of butterflies. Extreme differences in frost, temperature, degree-days, humidity, and precipitation affect survival at all life stages. These factors contribute to the numbers that emerge in the next generation.

### Limited dispersal capability

Half-moon Hairstreak is small and does not likely disperse long distances (< 5 km), especially through unsuitable habitats. Insularity in subpopulations may lead to decreased genetic diversity, greater genetic differences, inbreeding depression, and no rescue effect.

### Myrmecophily

Myrmecophily is the mutualistic relationship between larval hairstreaks and adult ants (see **Habitat**). It is likely that ants are critical for oviposition and the survival of subpopulations (St. John pers. comm. 2020) (see **Interspecific Interactions**).

### Short adult life cycle

Adult butterflies have a short flight season and individuals live approximately two weeks. Inclement weather and the premature senescence of host plants, combined with the short flight period, small size, limited dispersal ability, and declining habitat quality and quantity, may limit growth of the subpopulation.

## **Number of Locations**

### Okanagan-Similkameen population

A minimum of six locations<sup>10</sup> based on differing land management and variable threats to the habitat where each of the six subpopulations occurs (see Table 1; Figure 7).

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<sup>10</sup> 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. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations. Where a taxon is affected by more than one threatening event, location should be defined by considering the most serious plausible threat. Where the most serious plausible threat does not affect all of the taxon's distribution, other threats can be used to define and count locations in those areas not affected by the most serious plausible threat (IUCN 2010, 2011). In the absence of any plausible threat for the taxon, the term "location" cannot be used and the subcriteria that refer to the number of locations will not be met. (IUCN 2010, 2011)

## Waterton Lakes population

One location based on the threat of ecosystem changes due to the presence of non-native/invasive Spotted Knapweed within Half-moon Hairstreak habitat in WLNP.

## **PROTECTION, STATUS AND RANKS**

### **Legal Protection and Status**

#### Federal protection

Half-moon Hairstreak was assessed as one designatable unit and listed as Endangered under the federal *Species at Risk Act* on December 13, 2007. Critical habitat has been described (ECCC 2016). The Alberta subpopulation, assessed as one DU, is located entirely within WLNP and is also protected under the *Canada National Parks Act*. A portion of the subpopulation at White Lake (#7) is on federal land.

#### Provincial protection

Two Half-moon Hairstreak subpopulations (#4 and #5) span three parcels of a large provincially protected area (South Okanagan Grasslands Protected Area [Table 1]). The BC *Park Act* protects invertebrate species at risk (provincially assessed as Red or Blue-listed by the BC Conservation Data Centre) in provincial parks and protected areas. When species at risk and the habitats they require are known to occur within a protected area, provisions for management are incorporated into the park master plan. Provincial park staff within the range of Half-moon Hairstreak are aware of the species' presence at sites within the sagebrush ecological communities. When scientific research permits and other activities within parks and protected areas are proposed, parks staff consider the adverse impacts of the proposed activities on the butterfly and its habitat (Bunge pers. comm. 2019; Safford pers. comm. 2019; Weston pers. comm. 2019).

The BC *Forest and Range Practices Act* and the *Oil and Gas Activities Act* are applicable to species defined as Identified Wildlife and occupying habitat on provincial land managed for forest resources, grazing leases, and oil and gas extraction. Species can be listed as Identified Wildlife, which enables habitat for the species to be spatially protected within wildlife habitat areas. Half-moon Hairstreak is listed under these Acts, and 15 wildlife habitat areas totalling 383.6 ha have been created to protect the species (BCMOE 2019); most of these are within the South Okanagan Grasslands Protected Area and others are located northeast of Keremeos and one near White Lake.

## Non-Legal Status and Ranks

The conservation status ranks for Half-moon Hairstreak:

Global Status	G4 (Apparently Secure) (NatureServe 2020)
Canada National Status	N1 (Critically Imperilled) (NatureServe 2020)
British Columbia	S1 (Critically Imperilled) (BC CDC 2021)
Alberta	S1 (Critically Imperilled) (ANHIC 2020)
United States	N4 (Apparently Secure) (Natureserve 2020)
Subnational state ranks	California (SNR), Colorado (S3), Idaho (S3), Montana (S4), Nevada (SNR), Oregon (SNR), Utah (SNR), Washington (S4), Wyoming (SNR) (NatureServe 2020).

## Habitat Protection and Ownership

Half-moon Hairstreak surveys in the past 10 years have contributed to the creation of 15 wildlife habitat areas that protect the species under the BC *Forest and Range Practices Act*. Okanagan-Similkameen subpopulations of Half-moon Hairstreak have been recorded from private properties (#2, #3 [in part], #5 [in part], and #6 [in part]), one is private conservation lands (#4 [in part]) and one managed by private conservation organization (#7 [in part]), three parcels of a provincial protected area (#4 [in part], and #5 [in part]), one federal property leased to a private ranch operator (#7 [in part]) and two unprotected provincial sites (#3 [in part], #6 and #7). Land management within these properties is variable (see **Threats**).

The entire Waterton Lakes population is in the Blakiston Fan at Waterton Lakes National Park (population #1) which is identified as critical habitat under SARA. There is clear signage at the periphery of this habitat asking visitors to stay on designated trails.

In British Columbia, non-government conservation organizations, such as The Land Conservancy, The Nature Trust, and the South Okanagan Similkameen Conservation Program (and affiliated organizations) work with private landowners to protect arthropod species at risk on private lands. Should additional information become available on Half-moon Hairstreak, these organizations may initiate stewardship actions within their current management and outreach networks.

## ACKNOWLEDGEMENTS

The status report writers would like to thank the British Columbia Ministry of Environment and Climate Change Strategy (ENV) for providing time and resources to complete this report. The following people provided field support: Denis Knopp, Dennis St. John, Dawn Marks, Kyle Grant, Cara Dawson, Kirk Safford, Orville Dyer, Sara Bunge, Mark Weston, Josie Symonds, Katie Calon, Jamie Leatham, Claudia Copley, Lea Gelling, Leah

Ramsay, Crispin Guppy, Norbert Kondla, Cory Sheffield, Wendy Pope, Eric Gross, Purnima Govindarajulu, and Manjit Kerr-Upal. Ann Potter (Washington Department of Fish and Wildlife) provided information about the species in Washington State. Claudia Copley (Royal BC Museum, Victoria) and Karen Needham (Spencer Entomological Collection, Beaty Biodiversity Museum at the University of British Columbia) provided access to museum specimens. Robert Sissons (Parks Canada Agency) and Kim Pearson (Parks Canada Agency) provided information on the Waterton Lakes population, habitat, and potential threats in WLNP. Zachary MacDonald, Julian Dupuis, Felix Sperling, and other collaborators generously provided a summary of their work on the population genetic structure of these hairstreaks.

COSEWIC reviews added value, including from members of the Arthropods Specialist Subcommittee (Robert Buchkowski, Syd Cannings, Jeremy de Waard, Allan Harris, Colin Jones, John Klymko, Jayme Lewthwaite, Jessica Linton, Dawn Marks, Jeff Ogden, Leah Ramsay, John Richardson, Michel Saint-Germain, Sarah Semmler, Brian Starzomski, Myrle Ballard and Dan Benoit), and individuals from the jurisdictions and government departments (Purnima Govindarajulu, Robert Sissons, Pippa Shepard, Leah deForest, and Gina Schalk). Jenny Wu, Alain Filion, and Sydney Allen (COSEWIC Secretariat), and Greg Amos (ENV) provided mapping support. David McCorquodale (Arthropods SSC Co-chair), Rosana Nobre Soares and Joanna James (COSEWIC Secretariat) provided oversight throughout the process.

Norbert Kondla and Crispin Guppy wrote the first COSEWIC status report (2006).

Cover photograph of Half-moon Hairstreak, taken on June 19, 2019, at White Lake (#7) BC, by Jennifer Heron. Specimen was not collected.

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Brenda Costanzo is the Senior Vegetation Specialist with the Conservation Science Section, British Columbia Ministry of Environment and Climate Change Strategy. For the past 18 years, Brenda has been involved in leading recovery teams and/or writing numerous recovery plans for plants at risk in British Columbia. Her background includes a M.Sc. from the University of Victoria in biology on the seed germination of two native shrubs from BC. She has written several status reports on rare vascular plants in BC.

Jennifer M. Heron is the provincial Invertebrate Conservation Specialist with the Conservation Science Section, British Columbia Ministry of Environment and Climate Change Strategy. She directs and manages the provincial approach to invertebrate conservation, including the development and implementation of provincial legislation, policy, procedures, and standards for the conservation and recovery of invertebrate species at risk, their habitats, and ecosystems, and measures to keep these species from becoming at risk. Her background includes a M.Sc. from the University of British Columbia on ant diversity in the south Okanagan region of BC. Her current interests include the native bees of western Canada and thermal spring invertebrates.

## **ONLINE DATA SOURCES AND COLLECTIONS EXAMINED**

- University of Calgary, Insects and Invertebrate Zoology Museum, Department of Biological Sciences, Calgary, AB (John Swann 2019)
- Northern Forestry Centre, Natural Resources Canada, Edmonton, AB (Greg Pohl 2019)
- Strickland Entomological Museum, Department of Biology, University of Alberta, Edmonton, AB (Danny Shepley 2019)



- Invertebrate Zoology, Royal Alberta Museum, Edmonton, AB (Matthias Buck 2019)
- Royal British Columbia Museum, Victoria, BC (Claudia Copley 2019)
- Spencer Entomological Collection, Beaty Biodiversity Museum, University of British Columbia, Vancouver, BC (Karen Needham 2019)
- Canadian National Collection of Insects, Arachnids and Nematodes, Agriculture and Agri-Food Canada, Ottawa, ON (online database 2019)
- iNaturalist® (December 2021)
- BugGuide® (December 2021)
- eButterfly® (December 2021)

These additional collections were examined in the first COSEWIC (2006) status report and hold specimens of Half-moon Hairstreak:

- Crispin Guppy, Private Entomologist, Whitehorse, YT
- Gerald Hilchie, University of Alberta, Edmonton, AB
- Norbert Kondla, Private Entomologist, Calgary, AB
- Oregon State University, Corvallis, OR