Recovery Strategy for Behr's Hairstreak (*Satyrium behrii*) in British Columbia

Prepared by the Southern Interior Invertebrates Recovery Team

BRITISH COLUMBIA
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Ministry of Environment

December 2008

About the British Columbia Recovery Strategy Series

This series presents the recovery strategies that are prepared as advice to the province of British Columbia on the general strategic approach required to recover species at risk. The Province prepares recovery strategies to meet its commitments to recover species at risk under the *Accord for the Protection of Species at Risk in Canada*, and the *Canada - British Columbia Agreement on Species at Risk*.

What is recovery?

Species at risk recovery is the process by which the decline of an endangered, threatened or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of a species' persistence in the wild.

What is a recovery strategy?

A recovery strategy represents the best available scientific knowledge on what is required to achieve recovery of a species or ecosystem. A recovery strategy outlines what is and what is not known about a species or ecosystem; it also identifies threats to the species or ecosystem, and what should be done to mitigate those threats. Recovery strategies set recovery goals and objectives, and recommend approaches to recover the species or ecosystem.

Recovery strategies are usually prepared by a recovery team with members from agencies responsible for the management of the species or ecosystem, experts from other agencies, universities, conservation groups, aboriginal groups, and stakeholder groups as appropriate.

What's next?

In most cases, one or more action plan(s) will be developed to define and guide implementation of the recovery strategy. Action plans include more detailed information about what needs to be done to meet the objectives of the recovery strategy. However, the recovery strategy provides valuable information on threats to the species and their recovery needs that may be used by individuals, communities, land users, and conservationists interested in species at risk recovery.

For more Information

To learn more about species at risk recovery in British Columbia, please visit the Ministry of Environment Recovery Planning webpage at:

<http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm>

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Disclaimer

This recovery strategy has been prepared by the Southern Interior Invertebrates Recovery Team, as advice to the responsible jurisdictions and organizations that may be involved in recovering the species. The British Columbia Ministry of Environment has received this advice as part of fulfilling their commitments under the *Accord for the Protection of Species at Risk in Canada*, and the *Canada - British Columbia Agreement on Species at Risk*.

This document identifies the recovery strategies that are deemed necessary, based on the best available scientific and traditional information, to recover Behr's Hairstreak populations in British Columbia. Recovery actions to achieve the goals and objectives identified herein are subject to the priorities and budgetary constraints of participatory agencies and organizations. These goals, objectives, and recovery approaches may be modified in the future to accommodate new objectives and findings.

The responsible jurisdictions and all members of the recovery team have had an opportunity to review this document. However, this document does not necessarily represent the official positions of the agencies or the personal views of all individuals on the recovery team.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that may be involved in implementing the directions set out in this strategy. The Ministry of Environment encourages all British Columbians to participate in the recovery of Behr's Hairstreak.

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The British Columbia Ministry of Environment is responsible for producing a recovery strategy for Behr's Hairstreak under the *Accord for the Protection of Species at Risk in Canada*. Environment Canada's Canadian Wildlife Service and British Columbia Ministry of Forests and Range also participated in the preparation of this recovery strategy.

ACKNOWLEDGMENTS

This recovery strategy has been a collaborative effort by numerous individuals. Norbert Kondla wrote an earlier version of the strategy. Nick Page drafted the latest version of the recovery strategy. This version was revised by Orville Dyer, Jennifer Heron, and Bryn White. Dennis St. John, Sylvie Desjardins, Mike Sarell, and Howie Richardson contributed a substantial amount of data and scientific expertise to this recovery strategy. Dennis St. John and Sylvie Desjardins provided a scientific review. Bryn White, Crystal Klym, and Tricia Klein assisted with editing. Jeff Brown, David Toews, Laura Darling, and Tory Stevens provided additional comments on the final draft. We thank the recovery team and all contributors for their support and efforts to recover this species.

EXECUTIVE SUMMARY

Behr's Hairstreak (*Satyrium behrii*) is a small butterfly (2.5 to 2.9 cm) with a flight period from early June through to early July. The dorsal wing surfaces have large, central, orange patches. The ventral wing surfaces are greyish brown base colour with a series of prominent dark spots bordered by white rings.

The Canadian range for Behr's Hairstreak is restricted to antelope-brush (*Purshia tridentata*) habitats in the south Okanagan valley of British Columbia (B.C.). The butterfly depends on its larval host-plant, antelope-brush, in association with nectar-plants such as yarrow (*Achillea millefolium*), smooth sumac (*Rhus glabra*), gray horsebrush (*Tetradymia canescens*), baby's breath (*Gypsophila paniculata*), sweet-clover (*Melilotus spp*.), oceanspray (*Holodiscus discolor*), and buckwheat (*Eriogonum* spp.). In Canada, Behr's Hairstreak is designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and listed by the Species at Risk Act (*SARA*) as Threatened due to habitat loss and fragmentation related to agricultural and urban development.

The recovery goal is to maintain a viable, well-distributed population of Behr's Hairstreak in protected habitats within the known range in British Columbia.

The Recovery Objectives (2009 to 2013) are to:

1. Protect a minimum of 820 hectares of Behr's Hairstreak habitat by 2013.
2. Replant a minimum of 10 hectares of burned antelope-brush habitat on existing conservation lands that were previously occupied by Behr's Hairstreak, by 2013.
3. Address knowledge gaps associated with habitat quality, threats, population size and annual fluctuation, dispersal barriers, larval and pupal ecology, and population viability by 2013.

Habitat protection may involve following best management practices for maintaining Behr's Hairstreak and its habitat, stewardship agreements, conservation covenants, eco-gifts, or sale of private lands by willing landowners, land use designations and management on Crown lands, and in federal, provincial, and local government protected areas. Habitat protection will overlap with the protection for other species at risk within the south Okanagan Valley.

For successful implementation of species at risk protection measures, there is a strong need for engaging stewardship activities on a variety of land tenures, including private and First Nations lands. Stewardship involves voluntary cooperation of all Canadians to protect species at risk and the ecosystems these species rely upon.

No critical habitat, as defined under the federal *Species at Risk Act* [S.2], is proposed for identification at this time. Critical habitat for Behr's Hairstreak may be identified at a later date in a federal addition by Environment Canada or in an action plan. A draft action plan will be ready for submission to the Province of B.C. by March 2013. This action plan will likely be a multi-species document because recovery actions are similar among species that depend on antelope-brush habitat.

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Species Assessment Information from COSEWIC

Date of Assessment: November 2000 (New)
Common Name (population): Behr's (Columbia) Hairstreak*
Scientific Name: *Satyrium behrii columbia*
COSEWIC Status: Threatened
Reason for Designation: This species occurs as scattered populations throughout its historic range and uses antelope-brush (*Purshia tridentata*) as its host plant. Significant portions of the *Purshia* habitat have already been lost and the remaining habitat is fragmented. Further habitat losses are expected.
Canadian Occurrence: British Columbia
COSEWIC Status History: Designated as *Threatened* by COSEWIC in November 2000. Assessment based on a new status report.

* Common names reported in this recovery strategy follow the naming conventions used by the B.C. Conservation Data Centre, which may be different from common names reported by COSEWIC.

Description of the Species

Behr's Hairstreak (*Satyrium behrii*) is classified within Family *Lycaenidae* – gossamer wing butterflies, including coppers, hairstreaks, and blues. In Canada, Behr's Hairstreak is also known as Columbia Hairstreak which refers to the subspecies *columbia* described from Fairview, B.C. (Layberry *et al*. 1998). *Satyrium b. columbia* is the only Behr's Hairstreak subspecies in Canada and when reference is made throughout this document, it is to this subspecies only (see "Populations and Distribution"). Globally, there are two additional subspecies of Behr's Hairstreak, both within the United States, *Satyrium b. behrii* and *Satyrium b. crossii* (The International Lepidoptera Survey [TILS] 2005). In the United States Behr's Hairstreak is also known as Columbia Behr's Hairstreak (The International Lepidoptera Survey [TILS] 2005).

Behr's Hairstreak has four life stages: 1) egg; 2) numerous larval instars (larvae moult numerous times and are larger with each progressive moult); 3) chrysalis (the casing the larvae creates and encloses itself within which to complete metamorphosis); and 4) adult butterfly.

Key identification features for Behr's Hairstreak adults include a wide black margin surrounding large, central, orange patches on the dorsal wing surfaces (Figure 1). The internal edge of the dark margin is indistinct. The ventral surface of the forewing and hindwing have greyish brown base colour, darker near the body, with a row of prominent dark spots with white borders. The marginal line is black, bordered by a submarginal white line, and the wing fringe is grey. The butterfly is tailless. Sexes are similar although when compared side-by-side males are an overall darker tawny-orange and have distinct dark scent patches on the forewings. The wingspan is 2.5 to 2.9 cm.

Figure 1. Behr's Hairstreak adult dorsal wing surface (left) and adult ventral wing surface (right).

Behr's Hairstreak eggs are greenish white and laid singly on the leaves and branches of antelope-brush (*Purshia tridentata*) (Comstock 1928). The eggs turn white just prior to hatching.

Mature Behr's Hairstreak larvae are 1 to 1.5 cm in length, light green overall with a dorsal white line and darker green sides (Comstock 1928; Guppy and Shepard 2001). The dorsal segments of the larvae are ridged. Pale yellow or white shading/streaking on the crest of the abdominal segments of the larvae are present. Behr's Hairstreak chrysalis (cocoon or covering encasing the larvae and within which metamorphosis occurs) is light brown with dark brown speckles or patches and no discernable pattern. The chrysalis is attached to the antelope-brush stem using a silk patch (Guppy and Shepard 2001).

Behr's Hairstreak flight season is once per year from early June to mid-July, with a peak in mid- to late June depending on spring temperatures (COSEWIC 2000; Guppy and Shepard 2001; S. Desjardins, unpubl. data, 2007). Mating and egg-laying coincide with the flight season. Eggs are laid singly on the leaves and branches of the larval host plant antelope-brush and hatch the following spring (Emmel and Emmel 1973). Pupation appears to occur on antelope-brush and the pupa is attached to the stem or twigs using a silk patch (Guppy and Shepard 2001). For further habitat and host plant information, see "Habitat and biological needs".

Populations and Distribution

Globally, Behr's Hairstreak occurs from southern B.C. to southern California and New Mexico. Three subspecies of Behr's Hairstreak occur within North America (see "Description of the Species"). Within Canada, this species is found only in south-central B.C. within the southern portion of the Okanagan Valley (Figure 2). Less than 1% of the global distribution of Behr's Hairstreak is in Canada.

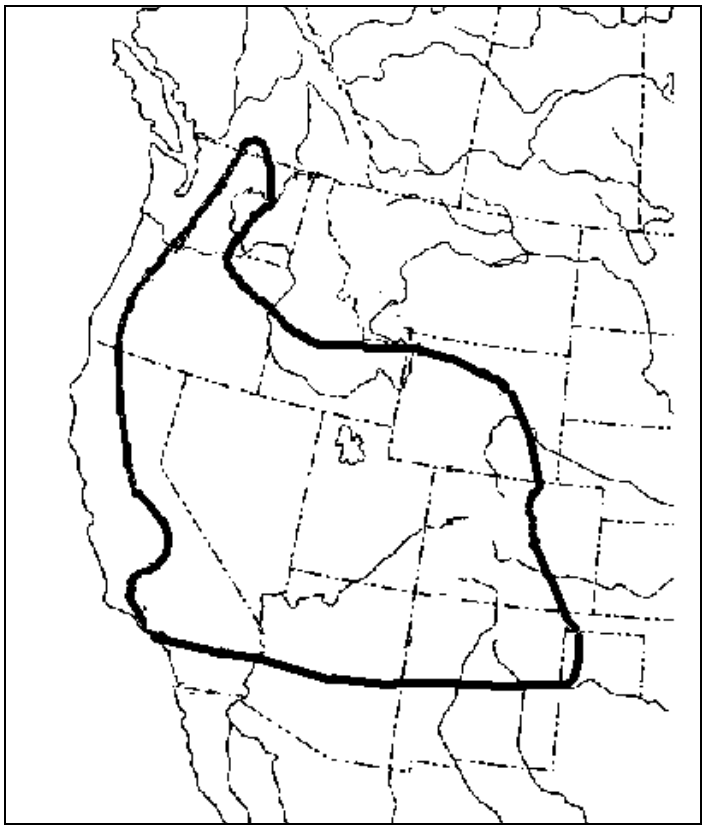

Figure 2. Global range of Behr's Hairstreak, *Satyrium behri.*

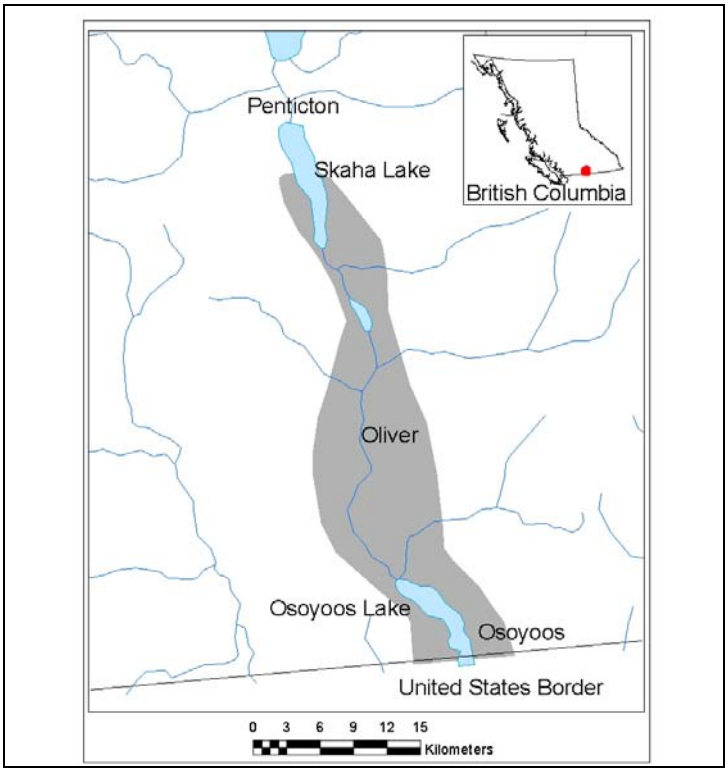

Figure 3. Canadian range of Behr's Hairstreak, *Satyrium berhii* confined to the south Okanagan valley in B.C. Distribution based on recent (past 50 years) records for the butterfly.

In Canada, Behr's Hairstreak occurs in antelope-brush habitats of the southern Okanagan Valley, from Penticton to the U.S. border (Guppy and Shepard 2001) (Figure 3). Little information is available on population numbers or size in B.C., although research is ongoing (S. Desjardins, pers. comm., 2005). Behr's Hairstreak is likely declining due to loss of the antelope-brush plant communities (Schluter *et al.* 1995; Lea 2001) that are necessary for their survival, although trend data are not available for the species. Lea (2008) estimates that 68% of the antelope-brush–needle-and-thread grass plant community in the Okanagan Valley has been lost to development.

Preliminary population viability analysis by Richardson (in prep.) has been completed, but results are not yet available. Results suggest that the current population is viable and will remain viable if a sufficient amount of quality habitat is protected and managed, particularly on the east side of the Okanagan Valley where habitat is less fragmented (H. Richardson, pers. comm., 2007).

Behr's Hairstreak has a global heritage rank of G5 (secure) (Natureserve 2008). The national rank in Canada is N1N2 (critically imperilled/imperilled) and in the United States is N5 (secure). In B.C., the species is ranked S2 (imperilled) (B.C. Conservation Data Centre 2008). It is designated SNR (not ranked) in Arizona, Idaho, Nevada, New Mexico, Oklahoma, Oregon, Texas, Utah, and Wyoming; S5 (secure) in Colorado and Washington; and S4 (apparently secure) in California (NatureServe 2008). Behr's Hairstreak is a priority 1 species under goal 3 of the B.C. Conservation Framework (see http://www.env.gov.bc.ca/conservationframework/ for details).

Needs of Behr's Hairstreak

Habitat and biological needs

Behr's Hairstreak depends on plant communities dominated by its larval host-plant, antelope-brush. Correlations drawn from inventory data and observations suggest that plant communities with antelope-brush plants more than 30 years old may be more important for Behr's Hairstreak than are early-successional plant communities (S. Desjardins, pers. comm., 2005).

Behr's Hairstreak adults require flowering plants for nectar. The species obtains nectar from native and non-native flowering plants including yarrow (*Achillea millefolium*) (native), smooth sumac (*Rhus glabra*) (native), gray horsebrush (*Tetradymia canescens*), baby's breath (*Gypsophila paniculata*) (non-native), sweet-clover (*Melilotus sp*.) (native and non-native species), oceanspray (*Holodiscus discolor*) (native), and buckwheat (*Eriogonum* spp.) (native) (Pyle 2002; St. John and Bunge 2003). Observations suggest that yarrow is the most important nectar source in B.C. due to its widespread prevalence in antelope-brush communities and its prolonged flowering season (St. John and Bunge 2003).

Correlations from observations and inventory data suggest that Behr's Hairstreak adults may require sparse tree cover, particularly ponderosa pine (*Pinus ponderosa*), for shelter during inclement weather, daytime temperature extremes, and night-time resting (S. Desjardins, pers. comm., 2007). Other factors that may increase habitat quality include the presence of puddling sites (mud puddles where adult butterflies obtain moisture and salt, thus preventing dehydration).

The chemical composition of antelope-brush may have an influence on larval ecology of Behr's Hairstreak, because the plant is important for other vertebrate and invertebrate herbivores (Young and Clements 2002).

Possible mutualistic associations between ants and Behr's Hairstreak may be important for supporting populations of the butterfly (Ballmer and Pratt 1992; Pierce *et al.* 2002). St. John and Bunge (2003) hypothesize that habitat quality may relate to the presence of specific ant species. Havester ants (*Pogonomyrmex* spp.) are known to be important for antelope-brush habitats. Ants help to create seed-caching mounds and unique plant communities (Young and Clements 2002) that may be of importance to Behr's Hairstreak presence. Like many members of the *Lycaenid* family, Behr's Hairstreak larvae have specialized organs that secrete amino acids that attract ants (Ballmer and Pratt 1988). Based on studies from Behr's Hairstreak populations in California, Ballmer and Pratt (1992) suggest that the larvae are myrmecophilous—larvae have an association with one or more ant species in which the ants protect the larvae from parasites and parasitoids, and in return the larvae provide the ants with food (amino acids secreted from specialized glands) (Fraser *et al.* 2001). However, it is unknown whether these relationships are mutualistic or facultative (benefit from ants but do not require them) (Balmer and Pratt 1992).

The area of antelope-brush (and other habitat components) necessary to sustain a population of Behr's Hairstreak is unknown. The butterfly likely forms a metapopulation structure among numerous habitat patches, and in some years may only utilize a portion of an apparently suitable antelope-brush patch. These dispersal and recolonization processes are poorly understood.

Ecological role

Behr's Hairstreak is a focal species for the conservation of B.C.'s native antelope-brush grasslands of the southern Okanagan. The species is not considered an essential pollinator of its larval or adult host plants, yet cumulative pollination by many species is essential to overall ecosystem health. Behr's Hairstreak is not known to have significant ecological roles such as food-web dynamics, although it is likely predated upon by small mammals, invertebrate predators, bats, and birds.

Behr's Hairstreak may have a mutualistic association with ants (St. John and Bunge 2003). Ants may be important for Behr's Hairstreak through mutual relationships where the ants protect larvae from predation, and the larvae excrete amino acids that ants consume (Ballmer and Pratt, 1992; Pierce et al., 2002). Harvester ants are known to collect and disperse antelope-brush seeds and they create caches of antelope-brush seeds (Young and Clements 2002). Ants are an important ecological component of arthropod fauna within B.C. grassland environments, contributing to the functioning of an ecosystem not only in their biomass and species richness, but also as soil engineers, seed dispersers, foragers, and scavengers (Hölldobler and Wilson 1990; Folgarait 1998). The effect ants have on other invertebrates in an ecosystem can be drastic and their influences on soil and organic decomposition are significant (Hölldobler and Wilson 1990).

Limiting factors

The main limiting factor for the Behr's Hairstreak is its larval host plant, antelope-brush. Antelope-brush is the species' only known larval host plant, and without this plant the butterfly is unable to complete its life cycle. The age structure of antelope-brush plants and the presence of trees or shrubs may also limit population size at a given location (S. Desjardins, pers. comm., 2006). There is a high correlation between the number of Behr's Hairstreak adults observed and the age of the antelope-brush community: more are found in communities older than 30 years (S. Desjardins, pers. data, 2007).

Behr's Hairstreak adults have a limited number of nectar host plants due to their morphology: the species has a short proboscis (tongue) (D. St. John, pers. data, 2004). The short proboscis means that the adults cannot obtain nectar from flowering plants that have a deep corolla (nectar is at the base of the corolla, inside the flower).

The distribution, abundance, and flowering period of nectar plants may affect Behr's Hairstreak occupancy at antelope-brush locations. Low spring temperatures and/or spring rains may adversely affect early instar larvae (S. Desjardins, pers. comm., 2006), and the impact may be more severe in Canada because the species is at the northern extent of its range.

Behr's Hairstreak adults have limited dispersal capabilities. In the Okanagan Valley, Desjardins (in prep.) documented average dispersal distances of 120 m in 2005 (during warm and dry spring weather) and 80 m in 2006 (cool and rainy spring weather), with a maximum dispersal of 1.2 km (one individual). These observations suggest that recolonization of habitat patches is negatively correlated with an increasingly fragmented landscape (S. Desjardins, in prep.; H. Richardson, in prep.). The probability of recolonization and population numbers at a location likely declines with the frequency and amplitude of stochastic events.

Threats

(in order of importance)

1) Habitat loss or degradation

The primary threat to Behr's Hairstreak is habitat loss, degradation, and fragmentation of antelope-brush plant communities. The larvae depend exclusively on antelope-brush and without this plant the species cannot complete its life cycle. This threat is severe, widespread, and continuous. Approximately 68% of the antelope-brush – needle-and-thread grass plant community within the known range of Behr's Hairstreak in B.C. has been destroyed by agricultural and urban development (Lea 2008). Between 1995 and 2001, the rate of antelope-brush habitat loss was 2% of the remaining habitat per year. This rate increased to 4% per year between 2001 and 2003, and the increase is ongoing, primarily due to agricultural development associated with new vineyards (O. Dyer, pers. comm., 2004). Preliminary results from population viability modelling demonstrate that as fragmentation of antelope-brush plant communities increases, re-occupancy rates after stochastic events decrease, because of the species' poor dispersal capabilities (H. Richardson, in prep.).

2) Ecological dynamics and natural processes
Alteration of the natural fire regime by wildfire protection and suppression programs appears to have increased fire intensity. Wildfires were likely once more common throughout antelope-brush habitats (Young and Clements 2002). Fire suppression results in large stand-replacing fires rather than small less intense surface and patchy fires that otherwise leave patches of the antelope-brush plant community intact. Tree encroachment, in the absence of frequent fire, has likely reduced the size and extent of antelope-brush plants at some sites due to shading and competition. These threats are localized, ongoing, and of moderate severity.

3) Exotic species
Many introduced, invasive plants occur throughout antelope-brush ecosystems, including cheatgrass (*Bromus tectorum*), sulphur cinquefoil (*Potentilla recta*), diffuse knapweed (*Centaurea diffusa*), and Dalmatian toadflax (*Linaria genistifolia* ssp. *dalmatica* L.). Some species, such as sulphur cinquefoil which can form monocultures, may out-compete Behr's Hairstreak nectar host plants and prevent re-establishment of antelope-brush after wildfires. This threat is widespread and ongoing because there are exotic plant species in all sites where Behr's Hairstreak is known to occur. The severity and causal certainty are unclear and require research; the presence of these plants in low numbers does not appear to affect Behr's Hairstreak populations, although should exotic plant densities increase, cumulative impacts could be detrimental.

Parasitic Tachinid flies (Family Tachinidae) have been introduced as a biological control agent for the European Gypsy Moth. These flies are known to have a detrimental effect on all Lepidoptera. Currently, these flies are only introduced in eastern United States and Canada, but they are considered a potential threat to Behr's Hairstreak populations if they establish in interior B.C. There is a possibility these species could be introduced to western North America through natural dispersal mechanisms or intentionally for biological control, so they have been identified as potential threats.

4) Climate and natural disasters
Climate change is a potential but poorly understood threat to Behr's Hairstreak. The climate envelope suitable for antelope-brush growth could potentially increase as a result of climate change (R. Hebda, pers. comm., 2004), which could dramatically increase the range where antelope-brush could theoretically grow. However, current rates of habitat loss and fragmentation within the known range and barriers to antelope-brush seed dispersal and Behr's Hairstreak dispersal are likely to prevent natural expansion of both the antelope-brush plant community and Behr's Hairstreak. Climate change may increase summer drought in southern B.C., potentially resulting in premature senescence of larval and nectar host plants, or may change rain patterns during the larval period, potentially reducing juvenile survival. Additional research is required.

5) Pollution
Pesticide drift from adjacent agricultural areas may detrimentally affect Behr's Hairstreak through direct mortality at localized sites, but impacts are not documented. Herbicide treatments for invasive plants may affect non-target species including antelope-brush and nectar host plants.

Impacts to Behr's Hairstreak are not understood, but are likely localized and may be reduced through improved Integrated Pest Management techniques.

6) Accidental mortality
The eggs and larvae of Behr's Hairstreak may be subject to direct mortality or damage by browsing animals. Mule Deer (*Odocoileus hemionus*), California Bighorn Sheep (,*Ovis canadensis*) and domestic cattle browse antelope-brush in the south Okanagan (Krannitz 2000). The effect of browsing on Behr's Hairstreak is unknown.

Actions Already Completed or Underway

- Inventory, mapping, and monitoring
    - Inventory and monitoring programs on Crown land (provincial and federal), since 2003.
    - Antelope-brush ecosystems mapped by B.C. Ministry of Environment (2007).
- Public outreach and stewardship
    - Interpretive public education programs through the Osoyoos Desert Centre (Osoyoos), Nk'Mip Desert Cultural Centre (Osoyoos), Okanagan Similkameen Conservation Alliance (Penticton), and annual Meadowlark Festival (Penticton) since 2003. These programs aim to increase awareness and support for antelope-brush and Behr's Hairstreak conservation.
    - South Okanagan Similkameen Conservation Program, established in 2000; a partnership of 41 government and non-government organizations dedicated to conservation of biodiversity in the region. Promotes antelope-brush and Behr's Hairstreak conservation through their partners.
    - A stewardship program involving landowner contact to private lands with antelope-brush; program ongoing since the early 1990s through The Land Conservancy and South Okanagan Similkameen Conservation Program, Stewardship Program.
- Habitat protection
    - Approximately 290 ha of antelope-brush–needle-and-thread grass plant community protected in provincial and federal protected areas.
    - Approximately 250 ha of antelope-brush habitat protected by The Nature Trust of B.C. through partnerships with the Habitat Conservation Trust Foundation, Fortis, and other groups.
- Research
    - Behr's Hairstreak habitat use, demographics, dispersal, and population genetics (since 2005). Research by Sylvie Desjardins, University of British Columbia, Okanagan.
    - Behr's Hairstreak population viability analysis, to model long-term persistence within the south Okanagan antelope-brush habitats (since 2007). Research by Howie Richardson, Okanagan College.

Knowledge Gaps

1. Qualitative habitat measures to support Behr's Hairstreak populations at a given location; age structure of antelope-brush; shelter tree and host plant density (age, health of plants, threats to plants); habitat patch area and connectivity between antelope-brush habitats; threshold of degradation from invasive plants in which a population is able to survive.
2. Quantitative fieldwork on population numbers at each Behr's Hairstreak location.
3. Research impacts from habitat loss and fragmentation on Behr's Hairstreak dispersal and population viability.
4. Research and clarify potential threats, including fire (due to suppression); natural weather processes; pollution (e.g., pesticide run-off, cumulative impacts of pesticide use); accidental mortality (e.g., from grazing); and stochastic events (e.g., washouts through antelope-brush habitats, windstorms and deep freezing that cause antelope-brush loss).
5. Research biological and life history information for Behr's Hairstreak, including population size and annual fluctuation, dispersal barriers, larval and pupal ecology, ant associations, and parasites/parasitoids.
6. Gather further inventory and qualitative habitat information in order to complete further population viability analysis modelling, and improve confidence in model outputs.

RECOVERY

Recovery Feasibility

Recovery of Behr's Hairstreak in Canada is considered biologically and technically feasible based on the following four criteria:

1. Are individuals capable of reproduction currently available to improve the population growth rate or population abundance?
Yes. Stable and persistent populations remain viable within protected areas within the south Okanagan and are available to support recovery.

2. Is sufficient habitat available to support the species or could it be made available through habitat management or restoration?
Yes. Behr's Hairstreak population viability analysis suggests that populations are likely to persist in the south Okanagan valley within currently available habitat (H. Richardson, in prep.).

3. Can significant threats to the species or its habitat be avoided or mitigated through recovery actions?
Yes. The main threat to the species is habitat loss, which can be mitigated through habitat protection measures (see "Existing and Recommended Approaches to Habitat Protection").

4. Do the necessary recovery techniques exist and are they known to be effective?
Yes. Recovery techniques focus on habitat protection.

Recovery Goal

Maintain a viable, well-distributed population of Behr's Hairstreak in protected** habitats within the known range in British Columbia.

***Protected habitat* is habitat (see "Habitat and biological needs") managed to maintain Behr's Hairstreak over a long time period (i.e., 100 years). Management may involve protection in various forms, such as following best management practices for maintaining Behr's Hairstreak and its habitat, stewardship agreements, conservation covenants, eco-gifts or sale of private lands by willing landowners, land-use designations and management on Crown lands, and protection in federal, provincial, and local government protected areas.

Recovery Objectives (2009 to 2013)

Recovery objectives for Behr's Hairstreak are:

1. Protect a minimum of 820 hectares of Behr's Hairstreak habitat by 2013.
2. Replant a minimum of 10 hectares of burned antelope-brush habitat on existing conservation lands that were previously occupied by Behr's Hairstreak, by 2013.
3. Address knowledge gaps associated with habitat quality, threats, population size and annual fluctuation, dispersal barriers, larval and pupal ecology, and population viability by 2013.

Rationale for Recovery Goal and Objectives

Preliminary population viability modelling suggests that the current population is viable and will remain viable if a sufficient amount of quality habitat is protected and managed, particularly on the east side of the Okanagan Valley where habitat is less fragmented (H. Richardson, pers. comm., 2007). Analysis is ongoing and preliminary results from the population viability analysis are not available at this time. At present it is not possible to quantify long-term population and habitat goals because current information is not sufficient to develop these goals.

The recovery goal, *to maintain a viable and well-distributed population,* is to ensure the species will not be extirpated in Canada and is based on recovery team consensus. A short-term (2009 to 2013) habitat protection target (820 ha) is quantified in the objectives section to ensure that reasonable protection is achieved while knowledge gaps are addressed and a quantitative goal is developed.

The habitat protection target includes 540 ha of existing protected areas on provincial and federal Crown land and on private conservation lands owned by The Nature Trust, The Okanagan Region Wildlife Heritage Fund Society, The Land Conservancy, and the Osoyoos Desert Centre (leased land from provincial government). Although these lands are protected from development, management activities may need adapting to ensure that the specific components of Behr's Hairstreak habitat are protected. The habitat protection target also includes 80 ha of proposed protected area on Crown land (federal and provincial), recommended by the Okanagan Shuswap

Land and Resource Management Plan and the Okanagan Land Act Review process. An additional 200 ha of protected habitat, to be achieved through cooperative stewardship, is targeted in order to maintain corridors and reduce fragmentation between protected sites.

The recovery objective to *replant a minimum of 10 hectares of burned antelope-brush habitat on existing conservation lands that were previously occupied by Behr's Hairstreak*, is to ensure that previously occupied Behr's Hairstreak habitats that were burned in recent wildfires are restored to maintain connectivity to other locations. Replanting and restoring these burned habitats will theoretically decrease habitat fragmentation in these protected areas and contribute to achieving the recovery goal.

Approaches Recommended to Meet Recovery Objectives

Approaches recommended to address recovery objectives and threats include *habitat protection, habitat management, inventory and monitoring, research,* and *public outreach*. These approaches will ideally be accomplished through voluntary stewardship by willing landowners and multi-group partnerships such as the South Okanagan-Similkameen Conservation Program (SOSCP). Habitat protection may include stewardship agreements and conservation covenants on private lands, land use designations on Crown lands (e.g., regulatory mechanisms), and protection in federal, provincial, and local government areas. A multi-species, ecosystem-based approach for habitat protection is recommended due to the high number of COSEWIC designated species in antelope-brush habitats. A single-species approach is required for research.

Table 1. Recovery planning table.

Objective	Threat(s) or concerns addressed	Recommended approach	Priority	Specific steps
1, 2	Habitat loss or degradation	Habitat protection	Urgent	Map antelope-brush habitats into definable polygons using GIS applications, and determine land ownership for these polygons.
			Urgent	Prioritize antelope-brush polygons for protection based on risk of habitat loss and results from preliminary population viability analysis modelling.
			Urgent	Identify habitat protection options for priority polygons.
			Urgent	Protect priority polygons through SOSCP partnerships.
			Necessary	Implement measures to address potential threats from natural disasters (such as fire) that could potentially impact that habitat surveyed.
			Beneficial	Develop communication materials regarding habitat protection actions and achievements.
2	Habitat loss or degradation	Habitat management	Urgent	Identify burned antelope-brush polygons within protected areas that 1) have previous Behr's Hairstreak records; and/or 2) are adjacent to polygons currently populated by Behr's Hairstreak.
			Urgent	Develop antelope-brush restoration plans in cooperation with land managers.
			Urgent	Implement restoration plans.
3	Habitat loss or degradation,	Inventory and monitoring	Necessary	Inventory antelope-brush polygons to determine resident populations, distribution, and occupied polygons.

	knowledge gaps		Necessary	Monitor occupied polygons for annual population variation, habitat loss, and changes to habitat from threats.
3	All	Research	Urgent	Develop and implement research partnerships.
			Urgent	Research Behr's Hairstreak habitat needs, including the age structure of antelope-brush, optimal tree and host plant density, antelope-brush polygon area (with occupied Behr's Hairstreak), and connectivity between habitat polygons.
			Urgent	Research importance of ant species for Behr's Hairstreak.
			Necessary	Research impacts from exotic plants on host plants and determine if there is a negative correlation with densities, species (of exotic plants), etc.
			Necessary	Research potential threats from fire regimes, pollution, accidental mortality, and stochastic events.
			Necessary	Improve confidence in population viability analysis using modelling programs or similar techniques.
			Necessary	Implement measures to address potential threats from climate change, accidental mortality, and pollution. Implement measures concurrently with new research on these threats.
			Necessary	Research life history, dispersal barriers, and larval and pupal ecology.

Performance Measures

- 820 ha of high-quality antelope-brush plant community occupied by Behr's Hairstreak protected by 2013.
- 10 ha of burned antelope-brush habitat on existing conservation lands restored by 2013.
- Knowledge gaps addressed by 2013.

Critical Habitat

Identification of the species' critical habitat

No critical habitat, as defined under the federal *Species at Risk Act* [S.2], is proposed for identification at this time. It is expected that critical habitat for Behr's Hairstreak will be identified at a later date in a federal addition by Environment Canada or in the action plan for the species. The proposed action plan may be specifically for Behr's Hairstreak, but other action planning items (such as habitat protection and antelope-brush conservation actions) may be completed through recovery actions completed for other SARA-listed species in the area. A schedule of studies outlining the work necessary to identify critical habitat is in Table 2.

The attributes of critical habitat for Behr's Hairstreak will include antelope-brush habitats with abundant host plants and low densities of ponderosa pine within the south Okanagan valley.

Recommended schedule of studies to identify critical habitat

Table 2. Schedule of studies.

Description of activity	Outcome/rationale	Timeline

o Map antelope-brush polygons and prioritize polygons for habitat quality.	o Potential antelope-brush habitats are identified.	o 2010
o Map Behr's Hairstreak distribution and relative density by habitat polygons.	o Mapped occupied habitat polygons and larger, densely populated polygons are identified.	o 2010
o Map land ownership polygons, including conservation lands.	o Land ownership and options for habitat protection are clarified.	o 2010
o Research knowledge gaps, including population fluctuations, specific habitat needs (e.g., age of antelope-brush, requirement for tree perches, heat requirements and tolerances), impacts of fire and fire recovery, habitat connectivity.	o knowledge gaps that increase confidence in population viability analysis are addressed.	o 2013
o Identify priority antelope-brush polygons using population viability analysis modelling.	o Priority polygons required for population persistence are identified.	o 2013

Existing and Recommended Approaches to Habitat Protection

Habitat protection for existing locations can be established through stewardship and other mechanisms by following best management practices, voluntary stewardship agreements, conservation covenants, ecogifting or sale by willing vendors on private lands, land-use designations on Crown lands, and protection in federal, provincial, and local government protected areas.

Portions of the antelope-brush plant community have been protected by The Nature Trust, the provincial government (in parks and the South Okanagan Wildlife Management Area), and the federal government (in the Vaseux Bighorn National Wildlife Area). Note that the antelope-brush plant communities at these sites do not all currently function as habitat for Behr's Hairstreak due to fires removing antelope-brush and other issues relating to habitat quality.

Recovery actions in the South Okanagan valley should be implemented through the South Okanagan Similkameen Conservation Program and coordinated with other recovery teams focusing on the Pallid Bat (*Antrozous pallidus*), Great Basin Spadefoot (*Spea intermontana*), Tiger Salamander (*Ambystoma tigrinum*), Western Rattlesnake (*Crotalus oreganus*), and Gopher Snake (*Pituophis catenifer*), which also depend on antelope-brush habitats.

Effects on Other Species

In addition to Behr's Hairstreak, 88 provincially listed and 17 COSEWIC listed species at risk (note some COSEWIC species are also provincially listed) depend on antelope-brush ecosystems in B.C. (Dyer and Lea, 2003). Protection for Behr's Hairstreak habitat will directly benefit most of these species. Negative impacts on other species at risk are not expected. Conservation strategies are concurrent with South Okanagan-Similkameen Conservation Program.

Socioeconomic Considerations

Recovery of Behr's Hairstreak may impact the following economic sectors: agriculture, urban development, and transportation. The location of impact is low elevation lands in the South

Okanagan Valley, south of Penticton. The magnitude of the impact is unknown but expected to be low due to a strong focus on existing and proposed conservation lands.

Recommended Approach for Recovery Implementation

For successful implementation of species at risk protection measures, there is a strong need for engaging stewardship activities on a variety of land tenures, including private and First Nations lands. Stewardship involves voluntary cooperation of landowners to protect species at risk and the ecosystems they rely upon.

The preamble to the federal *Species at Risk Act* states that "stewardship activities contributing to the conservation of wildlife species and their habitat should be supported" and that "all Canadians have a role to play in the conservation of wildlife in this country, including the prevention of wildlife species from becoming extirpated or extinct." Furthermore, the Bilateral Agreement between British Columbia and Canada on Species at Risk states that "stewardship by land and water owners and users is fundamental to preventing species from becoming at risk and in protecting and recovering species that are at risk" and that "cooperative, voluntary measures are the first approach to securing the protection and recovery of species at risk."

Habitat protection for Behr's Hairstreak will use an ecosystem approach for protecting and restoring antelope-brush habitats through SOSCP partnerships. Outreach activities will consider an ecosystem and multi-species approach, including other species at risk that use antelope-brush habitat such as Western Rattlesnake, Tiger Salamander, Badger (*Taxidea taxus*) and Pallid Bat. A singles-species approach will be used to conduct research and clarify threats that are specific to Behr's Hairstreak.

Statement on Action Plan

A draft action plan will be ready for submission to the Province of B.C. by March 2013. This action plan will likely be a multi-species document because recovery actions are similar among species that depend on antelope-brush habitat.

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