

Management Plan for the Columbian Carpet Moss (*Bryoerythrophyllum columbianum*) in Canada

Columbian Carpet Moss



2012

Recommended citation:

Environment Canada. 2012. Management Plan for the Columbian Carpet Moss (*Bryoerythrophyllum columbianum*) in Canada. *Species at Risk Act Management Plan Series*. Environment Canada, Ottawa. v + Appendix.

For copies of the management plan, or for additional information on species at risk, including COSEWIC Status Reports, residence descriptions, recovery strategies, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry (www.sararegistry.gc.ca).

Cover illustration: Terry McIntosh

Également disponible en français sous le titre
« Plan de gestion de l'érythrophyllé du Columbia (*Bryoerythrophyllum columbianum*) au Canada »

© Her Majesty the Queen in Right of Canada, represented by the Minister of the Environment, 2012. All rights reserved.

ISBN 978-1-100-18969-7

Catalogue no. En3-5/20-2012E-PDF

Content (excluding the illustrations) may be used without permission, with appropriate credit to the source.

MANAGEMENT PLAN FOR THE COLUMBIAN CARPET MOSS (*Bryoerythrophyllum columbianum*) IN CANADA

2012

Under the Accord for the Protection of Species at Risk (1996), the federal, provincial, and territorial governments agreed to work together on legislation, programs, and policies to protect wildlife species at risk throughout Canada.

In the spirit of cooperation of the Accord, the Government of British Columbia has given permission to the Government of Canada to adopt the Management Plan for Columbian carpet moss (*Bryoerythrophyllum columbianum*) in British Columbia (Part 2 of this document) under Section 69 of the *Species at Risk Act*. Environment Canada has included an addition which completes the SARA requirements for this management plan.

This management plan is the management plan of the Minister of the Environment of Canada for this species.

2012

This management plan for the Columbian Carpet Moss in Canada consists of:

PART 1: Federal Addition to the “Management Plan for Columbian carpet moss (*Bryoerythrophyllum columbianum*) in British Columbia”, prepared by Environment Canada.

PART 2: “Management Plan for Columbian carpet moss (*Bryoerythrophyllum columbianum*) in British Columbia”, prepared by the British Columbia Bryophyte Recovery Team for the British Columbia Ministry of Environment.

TABLE OF CONTENTS

PART 1: Federal Addition to the “Management Plan for Columbian carpet moss (<i>Bryoerythrophyllum columbianum</i>) in British Columbia”, prepared by Environment Canada	I
PREFACE	II
SPECIES STATUS INFORMATION	II
<i>SPECIES AT RISK ACT</i> REQUIREMENTS	III
1. Management Goal and Objectives	III
2. Measuring Progress	III
EFFECTS ON THE ENVIRONMENT AND OTHER SPECIES	IV
REFERENCES	IV
PART 2: “Management Plan for Columbian carpet moss (<i>Bryoerythrophyllum columbianum</i>) in British Columbia”, prepared by the British Columbia Bryophyte Recovery Team for the British Columbia Ministry of Environment	V

PART 1: Federal Addition to the “Management Plan for Columbian carpet moss (*Bryoerythrophyllum columbianum*) in British Columbia”, prepared by Environment Canada

PREFACE

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA) the federal competent ministers are responsible for the preparation of management plans for listed Special Concern species and are required to report on progress within five years.

SARA section 65 requires the competent Minister, which is the federal Minister of the Environment in this case, to prepare a management plan for all listed special concern species. SARA section 69 allows the Minister to adopt all or part of an existing plan for the species if the Minister is of the opinion that an existing plan relating to a wildlife species includes adequate measures for the conservation of the species.

The attached provincial management plan (Part 2 of this document) for the species was provided as science advice to the jurisdictions responsible for managing the species in British Columbia. Environment Canada has prepared this federal addition to meet the requirements of SARA.

Success in the conservation of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this management plan and will not be achieved by Environment Canada or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this plan for the benefit of the Columbian Carpet Moss and Canadian society as a whole.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

SPECIES STATUS INFORMATION

Legal designation: SARA Schedule 1 (Special Concern) (2005)

Table 1. List and description of various conservation status ranks for the Columbian carpet moss (from NatureServe, 2009).

Global (G) Rank	National (N) Rank	Sub-national (S) Rank	COSEWIC Status	SARA Status
G3G4 (vulnerable/ apparently secure)	Canada: N2N3 (imperiled/ vulnerable) United States: Not ranked	British Columbia (S2S3; B.C. CDC: Blue-list) California (SNR) Idaho (SNR) Oregon (S2) Washington (S2)	Special Concern (2004)	Schedule 1

B.C. CDC: British Columbia Conservation Data Centre; S2: Imperiled; S3: Vulnerable; SNR: Unranked

The Canadian populations of the Columbian Carpet Moss probably represent 11-30% of its global distribution and abundance.

SPECIES AT RISK ACT REQUIREMENTS

The following sections address specific requirements of SARA that are either not addressed in the “Management Plan for Columbian carpet moss (*Bryoerythrophyllum columbianum*) in British Columbia” (Part 2 of this document, referred to hereafter as the “provincial document”), or need to be highlighted.

1. Management Goal and Objectives

The following Management Goal and Objectives are identical to those provided in Section 2 of the provincial document, repeated here for ease of reference.

Goal: to maintain known populations of Columbian carpet moss in British Columbia.

Objectives:

1. To initiate habitat protection for existing populations by 2016.
2. To mitigate threats associated with housing and commercial development, road construction, livestock presence, and recreational activities, and potential threats from invasive species and erosion by 2016.
3. To confirm all known populations of Columbian carpet moss in British Columbia by 2014.
4. To increase public awareness of the existence and conservation value of Columbian carpet moss by 2016.
5. To address knowledge gaps (e.g., population trends and impacts of potential and emerging threats, detailed habitat requirements and biological attributes, species distribution) by 2016.

2. Measuring Progress

As per SARA section 72, the Minister of Environment for Canada must place a report regarding the status of implementation of the management plan on the Species at Risk Public Registry every five years, until the objectives of the management plan have been met. The Minister will use the Performance Measures outlined in section 2.5 of the provincial document, and provided here for reference, as a basis for this report.

Performance Measures relating to Objectives 1 through 5:

- 1) At least four agreements are established (specific site management plans) with municipal, Crown, Ministry of Transportation and Infrastructure or Protected Area land managers by 2016. Best management practices or specific site management plans are established by 2016.
- 2) Monitoring of the impact of threats to the populations, and monitoring population numbers at a minimum of six sites (municipal, Crown, Ministry of Transportation and Infrastructure or Protected Area) have been investigated by 2014, and threats have been reduced (population numbers remaining stable or increasing in size) by 2016.
- 3) Surveys to confirm occurrence and population estimates have been completed at all 17 extant sites and documented by 2014.

- 4) At least six land owners or land managers have been contacted and provided with education and outreach material for Columbian carpet moss by 2016.
- 5) Population monitoring has been conducted every two years at a minimum of six sites (municipal, Crown, Ministry of Transportation and Infrastructure or Protected Area) and indicates that the numbers of plants at the sites are stable (or increasing) by 2016.

EFFECTS ON THE ENVIRONMENT AND OTHER SPECIES

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that plans may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the plan itself, but are also summarized below.

This management plan will clearly benefit the environment by promoting the conservation of the Columbian Carpet Moss. The potential for the plan to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this plan will clearly benefit the environment and will not entail any significant adverse effects. The reader should refer to the following sections of the document in particular: Habitat and biological needs; Ecological role; Limiting factors; Recommended Management Actions; Performance Measures; and Effects on other species.

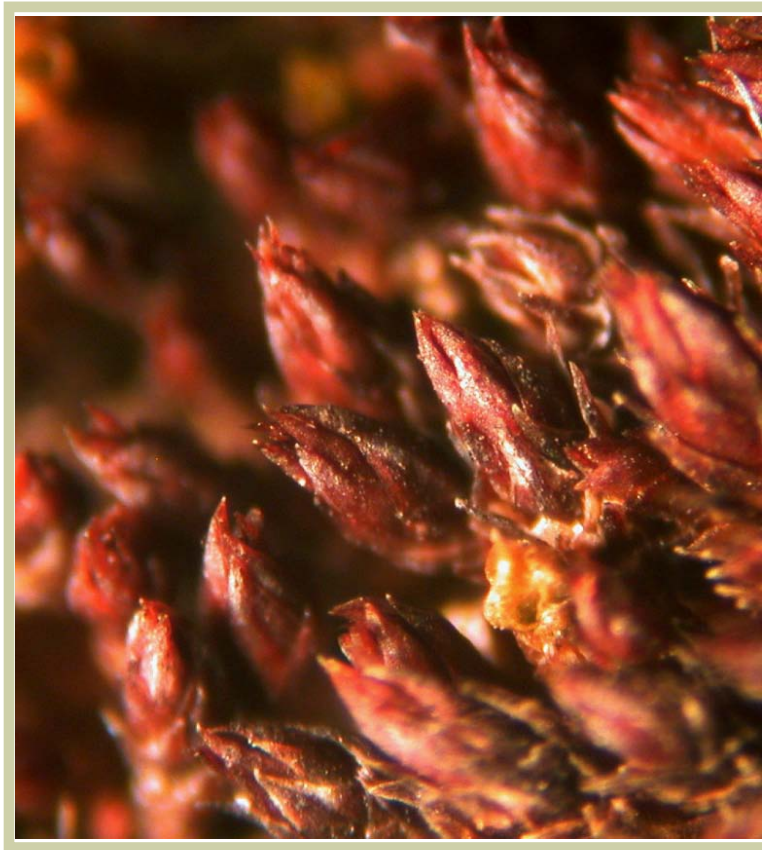
REFERENCES

NatureServe. 2009. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer>. (Accessed: July 28, 2010).

British Columbia Bryophyte Recovery Team. 2010. Management Plan for Columbian carpet moss (*Bryoerythrophyllum columbianum*) in British Columbia. Prepared for the B.C. Ministry of Environment, Victoria, BC. 15 pp.

**PART 2: “Management Plan for Columbian carpet moss
(*Bryoerythrophyllum columbianum*) in British Columbia”,
prepared by the British Columbia Bryophyte Recovery Team
for the British Columbia Ministry of Environment**

Management Plan for Columbian carpet moss (*Bryoerythrophyllum columbianum*) in British Columbia



Prepared by the British Columbia Bryophyte Recovery Team



Ministry of
Environment

July 2010

About the British Columbia Management Plan Series

This series presents the management plans that are prepared as advice to the province of British Columbia. Management Plans are prepared in accordance with the priorities and management actions assigned under the British Columbia Conservation Framework. The Province prepares management plans for species' that may be at risk of becoming endangered or threatened due to sensitivity to human activities or natural events.

What is a management plan?

A management plan identifies a set of coordinated conservation activities and land use measures needed to ensure, at a minimum, that target does not become threatened or endangered. A management plan summarizes the best available science based information on biology and threats to inform the development of a management framework. Management plans set goals and objectives, and recommend approaches appropriate for species or ecosystem conservation.

What's next?

Direction set in the management plan provides valuable information on threats and direction on conservation measures that may be used by individuals, communities, land users, conservationists, academics, and governments interested in species and ecosystem conservation.

For more information

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

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

To learn more about the British Columbia Conservation Framework, please visit the Ministry of Environment Conservation Framework webpage at:

< <http://www.env.gov.bc.ca/conservationframework/>>

Management Plan for Columbian carpet moss (*Bryoerythrophyllum columbianum*) in British Columbia

Prepared by the British Columbia Bryophyte Recovery Team

July 2010

Recommended citation

British Columbia Bryophyte Recovery Team. 2010. Management Plan for Columbian carpet moss (*Bryoerythrophyllum columbianum*) in British Columbia. Prepared for the B.C. Ministry of Environment, Victoria, BC. 15 pp.

Cover illustration/photograph

Terry McIntosh (with permission)

Additional copies

Additional copies can be downloaded from the B.C. Ministry of Environment Recovery Planning webpage at:

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

Publication information

ISBN 978-0-7726-6320-7

Date: July 21, 2010

British Columbia. Ministry of Environment.

Management Plan for Columbian carpet moss (*Bryoerythrophyllum columbianum*) in British Columbia [electronic resource]

[British Columbia management plan series]

Content (excluding illustrations) may be used without permission, with appropriate credit to the source.

Disclaimer

This management plan has been prepared by the British Columbia Bryophyte Recovery Team as advice to the responsible jurisdictions and organizations that may be involved in managing the species.

This document identifies the management actions that are deemed necessary, based on the best available scientific and traditional information, to prevent Columbian carpet moss populations in British Columbia from becoming endangered or threatened. Management 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 management 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 conservation 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 management plan. The Ministry of Environment encourages all British Columbians to participate in conservation of Columbian carpet moss.

RECOVERY TEAM MEMBERS

British Columbia Bryophyte Recovery Team

Brenda Costanzo (Chair), Ecosystems Branch, Ministry of Environment, Victoria, BC

Terry McIntosh, Ph.D., Botanist, Vancouver, BC

Karen Golinski, Ph.D., Botanist, Nashville, Tennessee

Michael Ryan, Ecologist, Ministry of Forests and Range, Kamloops, BC

Former Recovery Team member

Ted Lea (retired), Ecologist, Victoria, BC

AUTHOR

Terry McIntosh, Ph.D.

RESPONSIBLE JURISDICTIONS

The British Columbia Ministry of Environment is responsible for producing a management plan for Columbian carpet moss under the *Accord for the Protection of Species at Risk in Canada*. Environment Canada's Canadian Wildlife Service participated in the preparation of this management plan.

ACKNOWLEDGEMENTS

Funding for this management plan was provided by the B.C. Ministry of Environment.

EXECUTIVE SUMMARY

Columbian carpet moss (*Bryoerythrophyllum columbianum*) was designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Special Concern in Canada in May 2004. It was listed on the federal *Species at Risk Act* (SARA) Schedule 1 in 2005. In British Columbia, the Columbian carpet moss is ranked S2S3 (imperiled to vulnerable) by the Conservation Data Centre and ranked G3G4 (vulnerable to apparently secure) globally by NatureServe. The Conservation Framework has assigned Columbian carpet moss a conservation priority 3, under Goal 1: contribute to global efforts for species and ecosystem conservation and priority 2 under Goal 3: maintain the diversity of native species and ecosystems.

Its current Canadian range consists of 17 occurrences in semi-arid areas of south-central British Columbia. Columbian carpet moss is a perennial moss that grows over soil in small clumps or compact turfs, often intermixed with other mosses and lichens. The Canadian populations of the Columbian carpet moss probably represent 11-30% of its global distribution and abundance.

Potential threats to the survival of the populations include vineyard construction, urban or highway development, livestock use, and recreational activities.

The management goal is to maintain known populations of Columbian carpet moss in British Columbia.

The management objectives for Columbian carpet moss are as follows:

1. To initiate habitat protection for existing populations by 2016.
2. To mitigate threats associated with housing and commercial development, road construction, livestock presence, and recreational activities, and potential threats from invasive species and erosion by 2016.
3. To confirm all known populations of Columbian carpet moss in British Columbia by 2014.
4. To increase public awareness of the existence and conservation value of the Columbian carpet moss by 2016.
5. To address knowledge gaps (e.g., population trends and impacts of potential and emerging threats, detailed habitat requirements and biological attributes, species distribution) by 2016.

TABLE OF CONTENTS

RECOVERY TEAM MEMBERS	iii
AUTHOR.....	iii
RESPONSIBLE JURISDICTIONS.....	iii
ACKNOWLEDGEMENTS	iii
EXECUTIVE SUMMARY	iv
1. SPECIES INFORMATION.....	1
1.1 Species Assessment Information from COSEWIC.....	1
1.2 Species Assessment Information: General.....	1
1.3 Description of the Species.....	2
1.4 Populations and Distribution.....	3
1.5 Needs of the Columbian Carpet Moss	7
1.5.1 Habitat and biological needs.....	7
1.5.2 Ecological role	8
1.5.3 Limiting factors	8
1.6 Threats.....	8
1.6.1 Threat classification.....	8
1.6.2 Description of the threats.....	10
1.7 Actions Already Completed or Underway	11
1.8 Knowledge Gaps.....	11
2. MANAGEMENT	11
2.1 Management Goal.....	11
2.2 Rationale for the Management Goal.....	11
2.3 Management Objectives.....	11
2.4 Recommended Management Actions.....	12
2.5 Performance Measures	13
2.6 Effects on Other Species.....	14
2.7 Recommended Approach for Implementation.....	14
3. REFERENCES	15

LIST OF TABLES

Table 1. Population data for Columbian carpet moss in Canada	6
Table 2. Threat Classification for Columbian carpet moss.....	8
Table 3. Recommended management actions for Columbian carpet moss.	12

LIST OF FIGURES

Figure 1. Patch of Columbian carpet moss plants	2
Figure 2. Illustration of plant, leaves, and cell details of Columbian carpet moss.....	3
Figure 3. North American distribution of Columbian carpet moss.	4
Figure 4. Canadian distribution of Columbian carpet moss	5

1. SPECIES INFORMATION

1.1 Species Assessment Information from COSEWIC

Date of Assessment: May 2004
Common Name (population): Columbian carpet moss
Scientific Name: *Bryoerythrophyllum columbianum*
COSEWIC Status: Special Concern
Reason for Designation: This is a western North American endemic species. It is a small perennial species and in Canada has a restricted distribution in the shrub-steppe in semi-arid regions of British Columbia where recent surveys have confirmed its presence from 11 sites. The species is never abundant in sites where it is found and extensive surveys have provided few new locations. At least one population is believed to have been lost to cultivation (vineyard) or to stochastic events. Threats include agriculture (especially vineyards), impact by grazing animals, urban development, road improvements, and human recreational impacts. Based on known occurrences, the species appears to have a very restricted distribution. However the species is patchily distributed at low densities in large habitats not all of which have been censused.
Canadian Occurrence: British Columbia
COSEWIC Status History: Designated Special Concern in May 2004. Assessment based on a new status report.

1.2 Species Assessment Information: General

Columbian carpet moss¹		
Legal Designation		
<u>Identified Wildlife</u> ² : No	<u>B.C. Wildlife Act</u> : No	<u>SARA Schedule</u> : 1 (2005)
Conservation Status³		
B.C. Rank: S2S3 (2007)	B.C. List: Blue	Global Rank: G3G4 (2008)
<u>Subnational Ranks</u> ⁴ : S2 in WA and OR		
B.C. Conservation Framework⁵		
Goal 1: Contribute to global efforts for species and ecosystem conservation.	Priority ⁶ : 3 (2010)	
Goal 2: Prevent species and ecosystems from becoming at risk.	Priority: 6 (2009)	
Goal 3: Maintain the diversity of native species and ecosystems.	Priority: 2 (2009)	
<u>Action Groups</u> : Compile Status Report; Send to COSEWIC; Planning; Habitat Protection; Habitat Restoration; Private Land Stewardship; Monitor Trends		

¹ Data Source: B.C. Conservation Data Centre (2010) unless otherwise noted

² Identified Wildlife under the *Forest and Range Practices Act*

³ S = Subnational; N = National; G = Global; B = Breeding; X = presumed extirpated; H = possibly extirpated; 1 = critically imperiled; 2 = imperiled; 3 = special concern, vulnerable to extirpation or extinction; 4 = apparently secure; 5 = demonstrably widespread, abundant, and secure; NA = not applicable; NR = unranked; U = unrankable

⁴ Data Source: NatureServe (2009)

⁵ Data Source: Ministry of Environment (2010).

⁶ Six-level scale: Priority 1 (highest priority) through to Priority 6 (lowest priority).

1.3 Description of the Species

This description was derived from COSEWIC (2004), McIntosh (1986), and Zander (2007). Columbian carpet moss is a perennial moss that grows over soil in small clumps or compact turfs, sometimes intermixed with other mosses and lichens. Stems are usually 2–6 mm in height. Leaves are 0.8–1.2 mm in length, ovate-lanceolate, and sharply pointed, although the tips are sometimes rounded due to being broken or eroded. The leaves are stiffly erect, overlapping along the stem, and usually dark red-brown when dry, and erect-spreading and lighter red-brown, rarely green, when wet. Leaf margins are entire and narrowly recurved from near the base almost to the apex. The leaf midrib is distinctive: it is up to eight cells wide at midleaf and the upper surface bulges, forming a distinctive, broad pad. The sharp point at the ends of many leaves, formed by elongate cells, separates this species from similar small, red-brown mosses in the genus *Didymodon*. Columbian carpet moss has male and female organs on separate stems. Probably because of this feature, sporophytes, which produce spores, are rarely found across its North American range. Figures 1 and 2 illustrate this species.

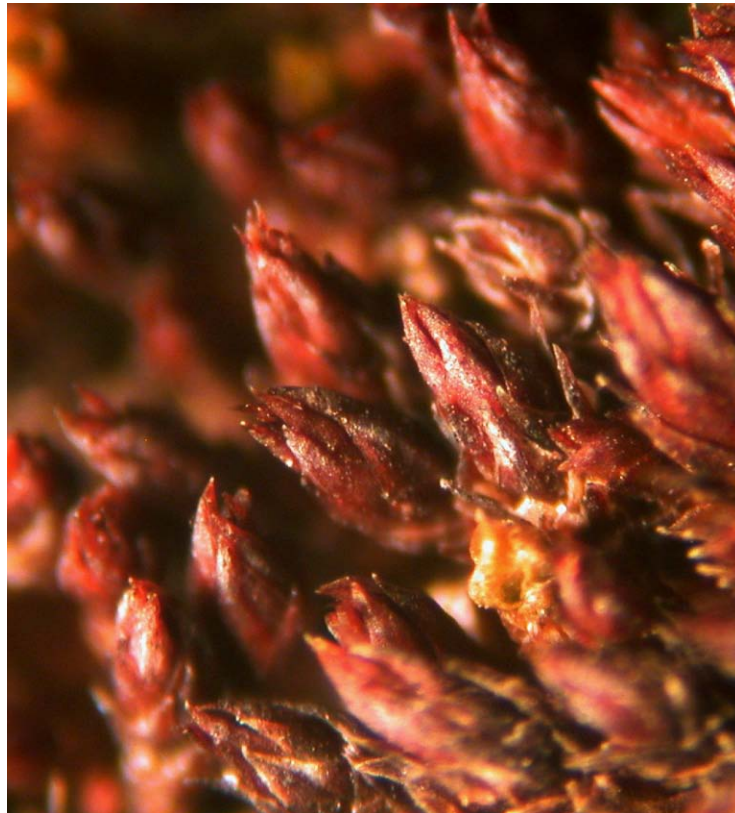


Figure 1. Patch of Columbian carpet moss plants (~2.5 mm across patch). Photograph by T. McIntosh.

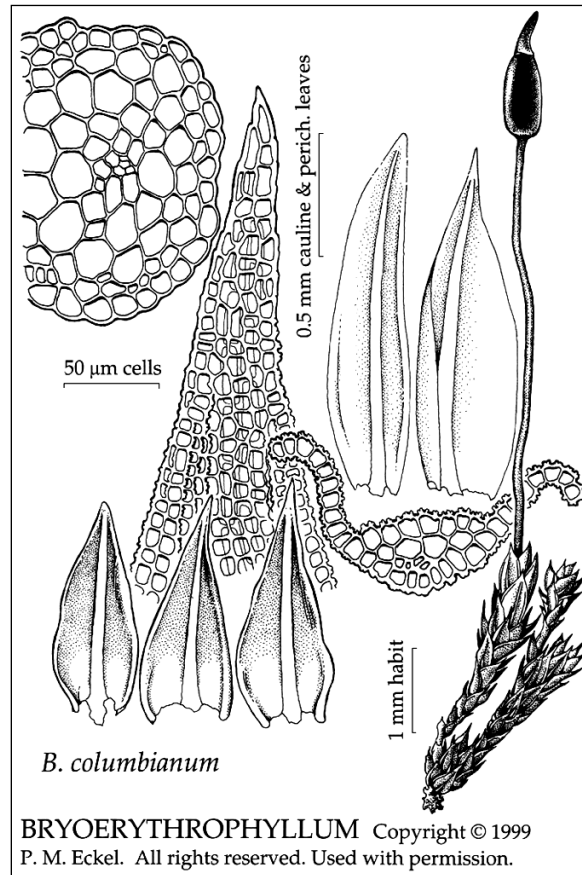


Figure 2. Illustration of plant, leaves, and cell details of Columbian carpet moss (upper left is stem cross-section, center is leaf tip and cross-section near the middle of leaf; Zander 2007).

1.4 Populations and Distribution

Columbian carpet moss is endemic to western North America, reported from British Columbia, Washington, Idaho, Oregon, and California (Zander 2007; Figure 3). Previously, there were only five known occurrences in the United States, two in California, two in Oregon, and one in the extreme south Washington. However, there are now six populations recorded from the southern Columbia Basin in Oregon, and it is thought to be fairly common in parts of northern Oregon (T. McIntosh, pers. comm. 2010). As well, several collections of *Didymodon rigidulus* from Idaho have been re-identified as *B. columbianum* and so it is thought to be fairly widely distributed in the state of Idaho (T. McIntosh, pers. comm. 2010).

In Canada, there are 17 populations of Columbian carpet moss in south-central British Columbia (Figure 4). B.C. populations are disjunct from the Washington population. It has been observed at eight locations from Osoyoos north to Naramata in the south Okanagan Valley, two sites in the Similkameen Valley east of Keremeos, five sites in the Kamloops area, and at single locations near Spences Bridge and along the west side of the Fraser River west of Williams Lake. Over the past 30 years, shrub-steppe habitat suitable for Columbian carpet moss across British Columbia has been surveyed, primarily by T. McIntosh and also by W. B. Schofield.

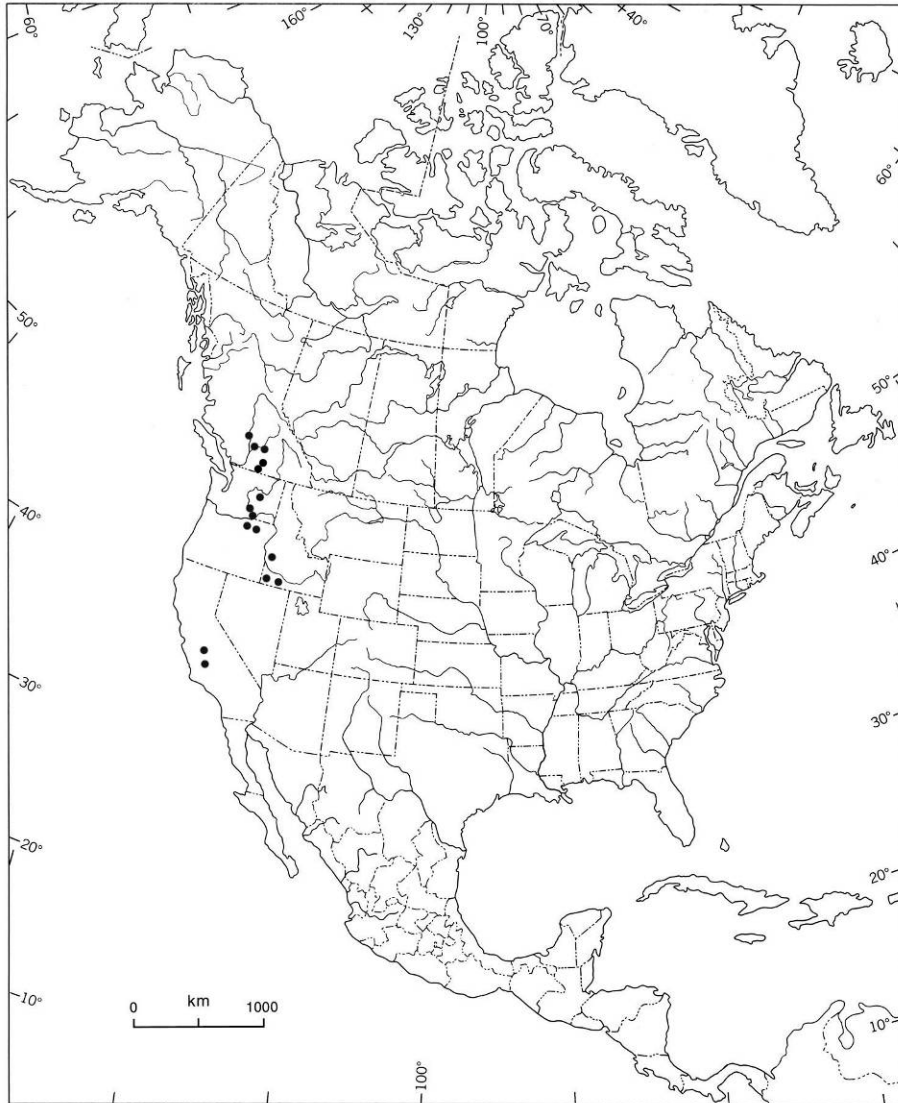


Figure 3. Global distribution of Columbian carpet moss (dots may represent more than one population).

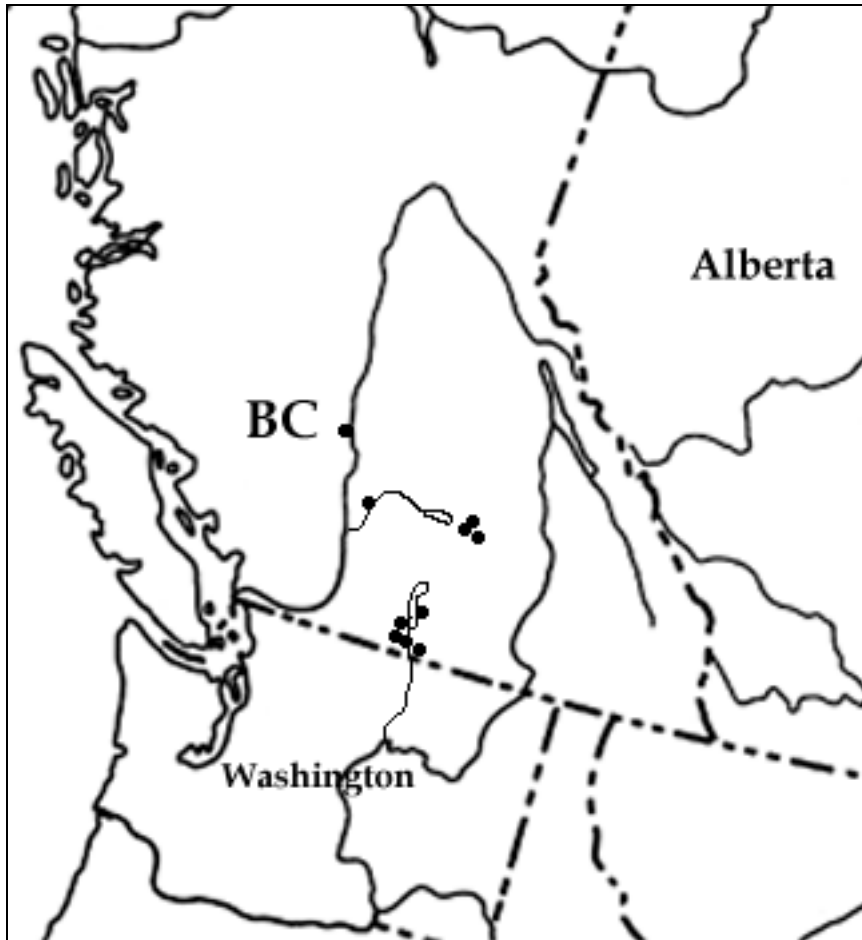


Figure 4. Canadian distribution of Columbian carpet moss (dots may represent more than one population; refer to Table 1 for details).

Table 1 lists population data for the documented occurrences of Columbian carpet moss in British Columbia. The number of individuals or patches at seven of the 17 sites has not been confirmed by recent surveys. Only one new population has been observed since completion of the COSEWIC report #5), and one population from the COSEWIC report (#12 below) now includes two subpopulations. Most populations are represented by a few small (<math><4\text{ cm}^2</math>) patches or as scattered individual plants that are restricted to relatively small areas. The Canadian populations of the Columbian carpet moss probably represent 11-30% of its global distribution and abundance (there are no reported estimates of global distribution and abundance for this moss).

A detailed assessment of population trends for the Columbian carpet moss in British Columbia is not possible at this time. However, five populations (#4, 7, 8, 12, 13) are currently considered stable because disturbance from livestock in these areas has been more or less constant for many decades. However, if livestock use and hiking in the area increase, these populations may become unstable. Two populations (# 3 and # 5) are considered potentially declining because they are in areas where urban development or roads are nearby, and five populations (#'s 1, 5, 6, 11, 16) are probably extirpated (Table 1).

Table 1. Population data for Columbian carpet moss in Canada¹. These populations have been reorganized under different geographical groupings and different numbers since COSEWIC (2004); population 11 includes Kamloops 2 and 3 from COSEWIC (2004) because of their close proximity and the presence of suitable habitat between them.

Population number and locality	Dates observed	Estimated number of patches/individuals and extent	Habitat characteristics	Land tenure
1. NW side of Osoyoos Lake	1981	Unknown (probably extirpated)	Unknown	unknown
2. NW of Osoyoos	2002, 2006	rare (1 patch observed in 2006)	adjacent to a rest stop and site heavily disturbed from walking in area; possible damage to site from road construction	Crown land (Ministry of Transportation and Infrastructure)
3. W of Osoyoos	1981, 2003, 2007	numerous patches scattered over a wide area on West Osoyoos Bench	livestock trampling has destroyed large areas of biological crust; some hiking and off-road vehicle use; urban development in area including road building	Town of Osoyoos and Crown land
4. Osoyoos	2005, 2006, 2007, 2008	rare (2 patches observed)	good condition; no livestock	First Nations
5. S of Oliver	1980	Unknown (probably extirpated)	probably converted to a vineyard; possible road construction	private
6. N of Oliver	1986	Unknown (probably extirpated)	unknown	Town of Oliver
7. E of Penticton	2003	rare (1 patch observed)	good condition; no livestock; hiking evident near site	City of Penticton
8. N of Naramata	2001, 2002	uncommon (3 patches observed)	good condition; no livestock	private
9. SE of Keremeos	2003	widespread across rangeland; numerous patches both sides of the fenceline	livestock trampling has destroyed most of the biological crust inside fence, but larger patches outside fence	Private and Crown land (Ministry of Transportation and Infrastructure right of way)
10. SSE of Keremeos	2003	uncommon (2 patches observed)	livestock trampling has destroyed large areas of biological crust	South Okanagan Grasslands Protected Area

¹ Prior to SARA legislation, bryological surveys were conducted for collection locations and distribution records only and did not include data required for conservation efforts.

Population number and locality	Dates observed	Estimated number of patches/individuals and extent	Habitat characteristics	Land tenure
11. N of Kamloops	1983, 2002	Unknown (probably extirpated)	unknown	Private
13. Valleyview area E of Kamloops	2002	probably widespread but only a few patches observed	good condition; no livestock; some hiking in area and possible road building	City of Kamloops
13. Dallas area E of Kamloops	2002	probably widespread but only a few patches observed	good condition; no livestock; some hiking in area and possible road building	Private
14. E of Kamloops	2002	uncommon (a few patches observed)	livestock trampling has destroyed large areas of biological crust	Private
15. E of Kamloops	2002	uncommon (a few patches observed)	some hiking in area	Private and Crown land
16. Spences Bridge	1980	unknown (probably extirpated)	livestock trampling evident and erosion in area near waterfalls	Town of Spences Bridge
17. McGhee Flats, W of Williams Lake	2001	unknown	livestock trampling has destroyed large areas of biological crust	Churn Creek Protected Area (Crown land)

1.5 Needs of the Columbian Carpet Moss

1.5.1 Habitat and biological needs

In British Columbia, Columbian carpet moss has been found on a variety of soil types, including compact silts, silt-loams, and sandy loams; it is rarely found on very sandy soils. It is restricted to semi-arid shrub-steppe and grassland habitats characterized by dry, hot summers and cool to cold, moderately wet winters in the Bunchgrass Biogeoclimatic Zone. This zone is restricted to a number of narrow valleys in the south-central part of the province. Common plant associates include bluebunch wheatgrass (*Pseudoroegneria spicata*), needle-and-thread grass (*Hesperostipa comata*), big sagebrush (*Artemisia tridentata*), and, in the southern portions of the Okanagan Valley, antelope-brush (*Purshia tridentata*). It commonly has numerous moss and lichen associates as part of the biological soil crust that covers the ground between the vascular plants in these arid habitats. Detailed habitat requirements and specific biological attributes are unknown for this species. The potential impacts of climate change on the biology and reproduction of this species are also unknown.

Little is known about the dispersal and reproductive capacity of this species. For example, sporophytes, which produce spores in early spring, are rarely found across the North American range for Columbian carpet moss, and only once in Canada. As arid habitats may restrict gamete

and sporophyte production, reproduction through spores is likely not the main means of dispersal. Instead, dispersal may be through fragmentation of the leaf tips (COSEWIC 2004).

1.5.2 Ecological role

In British Columbia, Columbian carpet moss is one of the many soil-binding components of biological soil crusts, important contributors to the health of arid land ecosystems (Belnap *et al.* 2001). Also, it is one of the late seral species in biological crusts (McIntosh 2003) and is common only where disturbances have been restricted for long periods of time.

1.5.3 Limiting factors

A possible limiting factor for this species is its small size, which may be a competitive disadvantage when growing amongst invasive vascular plants. As well, the small number of individuals within populations makes the species vulnerable to local extirpation and to stochastic events. The lack of sexual reproduction in Canada may potentially limit dispersal over long distances.

1.6 Threats

1.6.1 Threat classification

Table 2. Threat classification for Columbian carpet moss.

1 Commercial development - vineyard construction		Threat attributes		
Threat category		Extent	Unknown	
			Local	B.C. Range-wide
General threat	Removal of all native habitat when constructing vineyards	Occurrence	Historic/Anticipated	Unknown
		Frequency	Recurrent	Unknown
Specific threat	Destruction, removal, and burial of species and alteration of habitat	Causal certainty	High	Unknown
		Severity	High	Unknown
Stress	Increased mortality, reduced population size, or local extirpation	Level of concern	High	
2 Urban expansion		Threat attributes		
Threat category		Extent	Localized	
			Local	B.C. Range-wide
General threat	Construction of buildings	Occurrence	Historic/Anticipated	Unknown
		Frequency	Recurrent	Unknown
Specific threat	Destruction, removal, or burial of species and alteration of habitat (fragmentation or	Causal certainty	High	Unknown
		Severity	High	Unknown

	destruction of habitat)			
Stress	Increased mortality, reduced population size, or local extirpation	Level of concern		High
3 Road development		Threat Attributes		
Threat category	Habitat loss or degradation	Extent		Localized
			Local	B.C. Range-wide
General threat	Construction of roads, road widening or maintenance	Occurrence	Historic/Anticipated	Unknown
		Frequency	Recurrent	Unknown
Specific threat	Destruction, removal, or burial of species and alteration of habitat (fragmentation or destruction of habitat)	Causal certainty	High	Unknown
		Severity	High	Unknown
Stress	Increased mortality, reduced population size, or local extirpation	Level of concern		High
4 Livestock presence		Threat attributes		
Threat category	Habitat loss or degradation	Extent		Localized
			Local	B.C. Range-wide
General threat	Trampling of habitat and plants, compaction of soil	Occurrence	Anticipated	Unknown
		Frequency	Recurrent	Unknown
Specific threat	Destruction, removal, or burial of species and alteration of habitat (fragmentation or destruction of habitat)	Causal certainty	High	Unknown
		Severity	High	Unknown
Stress	Increased mortality, reduced population size, or local extirpation	Level of concern		High
5 Recreational activities		Threat attributes		
Threat category	Habitat loss or degradation	Extent		Unknown
			Local	B.C. Range-wide
General threat	Walking through habitat and on plants; hiking and ATV use	Occurrence	Anticipated	Unknown
		Frequency	Unknown/recurrent	Unknown
Specific threat	Destruction, removal, or burial of species and alteration of habitat (fragmentation or destruction of habitat)	Causal certainty	Low	Unknown
		Severity	Medium	Unknown
Stress	Increased mortality, reduced population size, or local extirpation	Level of concern		Low

1.6.2 Description of the threats

Commercial development (vineyard construction)

The construction of vineyards completely eliminates native vegetation, including the moss and biological soil crust components. Vineyards are especially common in the south Okanagan Valley and they continue to increase in number in the area. One population probably has been extirpated because of this (COSEWIC 2004). Vineyard construction has happened historically and it is anticipated that it will also occur in the future.

Housing development

As human populations in the south Okanagan and around Kamloops increase, there is a greater degree of threat to shrub-steppe habitats through urban expansion and road development. If this occurs, it may destroy all or portions of the resident populations of Columbian carpet moss. At least one population on the west side of Osoyoos has been reduced in size by urban expansion, and others in this area are under threat as the Town of Osoyoos is planning to expand housing developments there.

Road construction

Four sites are threatened by road construction or maintenance. Road development has happened historically and is anticipated to occur in the future.

Livestock presence

Impacts from livestock, particularly cattle, include trampling, soil compaction, and general habitat alteration, and are common at some sites where Columbian carpet moss is found. Trampling by grazing herds reduces the cover of biological crusts in rangelands with the result, in some areas, of a near complete elimination of viable crust cover. Six (33%) of the Columbian carpet moss populations in B.C. are subject to livestock damage (see Table 1). A minor threat is the covering of patches of this moss by manure, as observed near Osoyoos. Livestock use of Columbian carpet moss habitat has happened historically and it is anticipated that it will also occur in the future.

Recreational activities

Recreational activities, in particular hiking but also off-road vehicle use, are a threat to this species. Hiking has negatively impacted the population at one site and may have affected three other populations through damage to the biological soil crust. Off-road vehicle use has potentially negatively impacted this species and its habitat at one site. Recreational activities have happened historically, although mostly infrequently. It is anticipated that they will also occur in the future at some sites.

Other potential threats

Although competition from invasive plant species is a potential threat, this has not been documented. The harsh, dry soil habitats favoured by this species appear to restrict invasion by many alien plants unless the soil is disturbed, such as by livestock trampling (McIntosh, pers. comm. 2008).

The destruction of biological crust and/or erosion may contribute to the loss of populations and has been noted at six sites, with potentially one population already lost (Site #16).

1.7 Actions Already Completed or Underway

One population of Columbian carpet moss is in a B.C. protected area at Churn Creek. However, this protected area has an active cattle ranch. Additional inventory of six populations has been conducted since completion of the COSEWIC status report (COSEWIC 2004).

1.8 Knowledge Gaps

- Detailed biological attributes are not known for Columbian carpet moss.
- Population trends for the species are unknown.
- Dispersal rate of the species is unknown.
- Many of the attributes (e.g., tenure, population numbers) of the populations are unknown.
- Detailed habitat requirements (e.g., geology, soil characteristics, aspect) are not known.
- The effects of competition from invasive alien plants and livestock presence are not known.
- Full distribution of this species is unknown.

2. MANAGEMENT

2.1 Management Goal

The management goal is to maintain known populations of Columbian carpet moss in British Columbia.

2.2 Rationale for the Management Goal

No quantitative management goal is possible for Columbian carpet moss as basic population demographics are unknown for most occurrences and population trends are unknown for all populations. As well, there is no evidence that this species was once more widespread than current records show. The initial management will be to maintain the known populations of this species to ensure that its status does not become worse. Once the knowledge gaps have been filled, the goal can be refined.

2.3 Management Objectives

1. To initiate habitat protection² for existing populations by 2016.
2. To mitigate threats associated with housing and commercial development, road construction, livestock presence, and recreational activities, and potential threats from invasive species and erosion by 2016.

² Protection can be achieved through various mechanisms including: voluntary stewardship agreements, conservation covenants, sale by willing vendors on private lands, land use designations, and protected areas

3. To confirm all known populations of Columbian carpet moss in British Columbia by 2014.
4. To increase public awareness of the existence and conservation value of Columbian carpet moss by 2016.
5. To address knowledge gaps (e.g., population trends and impacts of potential and emerging threats, detailed habitat requirements and biological attributes, species distribution) by 2016.

2.4 Recommended Management Actions

Table 3. Recommended management actions for Columbian carpet moss.

Priority	Obj. No.	Threat or concern addressed	Conservation Framework action group	Management action	Timeline (start date)
High	1,2,4	Habitat loss or degradation: commercial development (vineyard construction), housing and road development, livestock presence, recreational activities, potentially invasive species and erosion	Habitat Protection	<ul style="list-style-type: none"> • Determine land tenure for 10 locations with unknown tenure • Contact landowners and land managers on 5 municipal and Crown lands, 1 Ministry of Transportation and Infrastructure land, and 1 provincial protected area and engage their cooperation to establish habitat protection on these sites using tenure-appropriate tools for the species • Provide best management practices or site-specific management plans for at least 6 of the 17 locations (5 city/municipal lands and 1 protected area) • Engage land owners in stewardship agreements and activities at a minimum of 6 sites to mitigate threats of recreational activities, livestock presence, invasive species and erosion 	2011
			Habitat Protection; Private Land Stewardship		2012
			Habitat Protection; Private Land Stewardship		2013
			Habitat Protection; Private Land Stewardship		2014
Medium	5	Knowledge gaps	Monitor Trends	<ul style="list-style-type: none"> • Develop and implement standardized habitat survey and monitoring protocol • Initiate the monitoring of the known populations every 2 years 	2012
			Monitor Trends		2012
			Monitor Trends		2012

Priority	Obj. No.	Threat or concern addressed	Conservation Framework action group	Management action	Timeline (start date)
				<ul style="list-style-type: none"> Report monitoring results every 2 years, and assess trends in populations, area of occupancy, and habitat condition 	2013
Medium	3,5	Knowledge gaps	Habitat Protection	<ul style="list-style-type: none"> Inventory to confirm distribution 	2012
Medium-Low	2	Knowledge gaps, Invasive plant species	Monitor Trends	<ul style="list-style-type: none"> Monitor populations to assess the effects of invasive species 	2012
			Habitat Restoration	<ul style="list-style-type: none"> Manage invading vegetation to protect the species occurrences as appropriate 	2013
Medium – Low	2	Knowledge gaps, research	Compile Status Report	<ul style="list-style-type: none"> Analyze dispersal rates of this species 	2013
			Compile Status Report	<ul style="list-style-type: none"> Determine biological attributes for the species 	2013
			Compile Status Report	<ul style="list-style-type: none"> Determine habitat requirements 	2013

2.5 Performance Measures

Objective 1: At least four agreements are established (specific site management plans) with municipal, Crown, Ministry of Transportation and Infrastructure or Protected Area land managers by 2016. Best management practices or specific site management plans are established by 2016.

Objective 2: Monitoring of the impact of threats to the populations, and monitoring population numbers at a minimum of six sites (municipal, Crown, Ministry of Transportation and Infrastructure or Protected Area) have been investigated by 2014, and threats have been reduced (population numbers remaining stable or increasing in size) by 2016.

Objective 3: Surveys to confirm occurrence and population estimates have been completed at all 17 extant sites and documented by 2014.

Objective 4: At least six land owners or land managers have been contacted and provided with education and outreach material for Columbian carpet moss by 2016.

Objective 5: Population monitoring has been conducted every two years at a minimum of six sites (municipal, Crown, Ministry of Transportation and Infrastructure or Protected Area) and indicates that the numbers of plants at the sites are stable (or increasing) by 2016.

2.6 Effects on Other Species

Habitat protection for this species will also protect other flora and fauna, including the numerous moss and lichen biological soil crust species that reside in arid habitats with Columbian carpet moss.

2.7 Recommended Approach for Implementation

Land managers and the public should be made aware of the species and engaged in its conservation, which can partially be accomplished by directed land owner contact programs with suggestions for protection and management (Table 3). The South Okanagan Similkameen Conservation Program could potentially work with private land owners. The Parks and Protected Areas Branch of the Ministry of Environment is responsible for the Churn Creek Protected Area and therefore for its management through parks management plans. The Ministry of Transportation and Infrastructure is responsible for managing their lands, which includes Site #2, NW of Osoyoos.

3. REFERENCES

- B.C. Conservation Data Centre. 2010. BC Species and Ecosystems Explorer. B.C. Min. Environ., Victoria, BC. <<http://a100.gov.bc.ca/pub/eswp/>> [Accessed Feb. 12, 2010]
- Belnap, J. Kaltenecker, R. Rosentreter, J. Williams, S. Leonard, and D. Eldridge. 2001. Biological soil crusts: ecology and management. US Department of the Interior, Bureau of Land Management. Tech. Ref. 1730-2.
- Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2004. COSEWIC assessment and status report on the Columbian carpet moss *Bryoerythrophyllum columbianum* in Canada. Ottawa, ON.
- McIntosh, T.T. 1986. The bryophytes of the semi-arid steppe of south-central British Columbia. Ph.D. Dissertation, University of British Columbia, Vancouver, BC.
- McIntosh, T.T. 2003. Biological soil crusts of the Hanford Reach National Monument. Pages 23–42 in Biodiversity studies of the Hanford Site. Final report: 2002–2003. The Nature Conservancy of Washington. <<http://www.pnl.gov/ecomon/Docs/Doc.html>>
- Ministry of Environment. 2010. Conservation framework. B.C. Min. Environ., Victoria, BC. <<http://www.env.gov.bc.ca/conservationframework/index.html>> [Accessed Feb. 12, 2010]
- NatureServe. 2009. NatureServe explorer: an online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, VA. <<http://www.natureserve.org/explorer>> [Accessed Feb. 12, 2010]
- Zander, R.H. 2007. *Bryoerythrophyllum*. Pages 565–569 in Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. Vol. 27, Bryophytes: Mosses, part 1. Oxford Univ. Press, New York, NY.

Personal Communications

Terry McIntosh, Ph.D. Botanist. Vancouver, BC.