

Recovery Strategy for the Nugget Moss (*Microbryum vlassovii*) in Canada

Nugget Moss



2012

Recommended citation:

Environment Canada. 2012. Recovery Strategy for the Nugget Moss (*Microbryum vlassovii*) in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa. XVI pp. + Appendix.

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

Cover illustration: Terry McIntosh

Également disponible en français sous le titre

« Programme de rétablissement du phasque de Vlassov (*Microbryum vlassovii*) au Canada »

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

ISBN 978-1-100-20767-4

Catalogue no. En3-4/138-2012E-PDF

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

RECOVERY STRATEGY FOR THE NUGGET MOSS (*Microbryum vlassovii*) 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 “Recovery strategy for the nugget moss (*Microbryum vlassovii*) in British Columbia” under Section 44 of the *Species at Risk Act*. Environment Canada has included an addition which completes the SARA requirements for this recovery strategy, and excludes the section on Socio-Economic Considerations. Socio-economic factors are not part of the consideration process for federal recovery strategies developed under SARA. These factors are kept isolated from this strategic phase of recovery planning.

2012

The federal Recovery Strategy for the Nugget Moss in Canada consists of:

PART 1: Federal Addition to the “Recovery strategy for the nugget moss (*Microbryum vlassovii*) in British Columbia”, prepared by Environment Canada.

PART 2: “Recovery strategy for the nugget moss (*Microbryum vlassovii*) 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 “Recovery strategy for the nugget moss (<i>Microbryum vlassovii</i>) in British Columbia”, prepared by Environment Canada	I
PREFACE	II
SPECIES STATUS INFORMATION	II
SPECIES AT RISK ACT REQUIREMENTS	III
1. Socio-economic Considerations	III
2. Recovery Feasibility	III
3. Population and Distribution Objectives	IV
4. Critical Habitat	IV
4.1 Identification of the Species’ Critical Habitat	IV
4.2 Schedule of Studies to Identify Additional Critical Habitat	VI
4.3 Examples of Activities Likely to Result in Destruction of Critical Habitat	VIII
5. Statement on Action Plans	VIII
6. Effects on the Environment and Other Species	IX
7. References	IX
Appendix 1. Critical habitat identification and location	X
1. Decision tree for critical habitat identification	X
2. Rationale for decision tree hierarchy	XII
3. References	XIV
4. Map of critical habitat for Nugget Moss in Canada	XV
PART 2: Recovery Strategy for the nugget moss (<i>Microbryum vlassovii</i>) in British Columbia, prepared by the British Columbia Bryophyte Recovery Team for the B.C. Ministry of Environment	XVI

PART 1: Federal Addition to the “Recovery strategy for the nugget moss (*Microbryum vlassovii*) 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 recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years.

SARA section 37 requires the competent Minister, which is the federal Minister of the Environment in this case, to prepare a recovery strategy for all listed extirpated, endangered or threatened species. SARA section 44 allows the Minister to adopt all or part of an existing plan for the species if it meets the requirements under SARA for content (sub-sections 41(1) or (2)).

The attached provincial recovery strategy (Part 2 of this document) 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 recovery 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 strategy and will not be achieved by Environment Canada, or any other jurisdiction, alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Nugget Moss and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Environment Canada and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

SPECIES STATUS INFORMATION

Legal Designation: SARA Schedule 1 (Endangered) (2009)

Table 1. Conservation Status of Nugget Moss (from NatureServe 2011 and B.C. Conservation Framework 2011).

Global (G) Rank	National (N) Rank	Sub-national (S) Rank	COSEWIC Status	B.C. List	B.C. Conservation Framework
G2?*	Canada (NNR)	British Columbia (S1) (critically imperiled),	Endangered (2006)	Red	Highest priority: 1, under Goals 1 and 3**

* Rank 1– critically imperiled; 2– imperiled; 3– vulnerable to extirpation or extinction; 4– apparently secure; 5– secure; H– possibly extirpated; NR – status not ranked

** The three goals of the B.C. Conservation Framework are: 1. Contribute to global efforts for species and ecosystem conservation; 2. Prevent species and ecosystems from becoming at risk; 3. Maintain the diversity of native species and ecosystems

It is estimated that the percent of the global range of this species in Canada is less than 1%.

SPECIES AT RISK ACT REQUIREMENTS

The following sections address specific requirements of SARA that are either not addressed, or which need more detailed comment, in the “Recovery strategy for the nugget moss (*Microbryum vlassovii*) in British Columbia” (Part 2 of this document, referred to henceforth as “the provincial recovery strategy”).

1. Socio-economic Considerations

The “Recovery strategy for the nugget moss (*Microbryum vlassovii*) in British Columbia” contains a short statement on socio-economic considerations. As socio-economic factors are not a consideration in any aspect of the preparation of SARA recovery strategies, (see Section 41(1) of SARA), the Socio-economic Considerations section of the “Recovery strategy for the nugget moss (*Microbryum vlassovii*) in British Columbia” is not considered part of the federal Minister of Environment's recovery strategy for this species. Furthermore, socio-economic factors were excluded from the preparation of all other sections of this federal addition, including Population and Distribution Objectives and Critical Habitat.

2. Recovery Feasibility

This section replaces the “Recovery Feasibility” section in the provincial recovery strategy.

Recovery of the Nugget Moss (*Microbryum vlassovii*) is considered technically and biologically feasible based on the following four criteria (Government of Canada 2009):

1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future, to sustain the population or improve its abundance.

Yes, there is at least one confirmed extant population in Canada. Field data suggest that this population is “apparently stable”. There is “likely” a second extant population of Nugget Moss in Canada, for which abundance trend data is lacking.

2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.

Yes, there is habitat to support the existing populations in British Columbia, and additional suitable habitat might also be made available through habitat management or restoration.

3. The primary threats to the species or its habitat (including threats outside of Canada) can be avoided or mitigated.

Yes, recovery actions in cooperation with land managers can prevent major threats.

4. Recovery techniques exist to achieve the population and distribution objectives, or can be expected to be developed within a reasonable timeframe.

Yes, general recovery methods and techniques are known.

3. Population and Distribution Objectives

This section replaces the “Recovery Goal” section in the provincial recovery strategy.

Environment Canada has determined the Population and Distribution Objective for Nugget Moss to be:

To maintain the one known extant population of this species at its location in Canada. To maintain or improve current population size at this location, as well as any other extant populations that may be identified.

Rationale:

Historical abundance and distribution information for this species show one confirmed extant population near Penticton, B.C. (1980, 2005, 2006, 2011¹ surveys). A second population of Nugget Moss was recorded near Kamloops, B.C. in 1980. Although the exact location and habitat characteristics were not described during that survey, the general location where it was found has not been disturbed, to date. Therefore it is considered “likely” that the second population is still extant, and a schedule of studies has been included in this federal addition, for the purpose of identifying additional population(s) and associated critical habitat. If additional naturally occurring populations are discovered, they should also be maintained. There is no information to indicate that the species was previously more widespread, therefore an objective to actively increase the number of populations, which may allow for downlisting of the species, is not appropriate.

4. Critical Habitat

4.1 Identification of the Species’ Critical Habitat

This section replaces the “Critical Habitat” section in the provincial recovery strategy.

Section 41 (1)(c) of SARA requires that recovery strategies include an identification of the species’ critical habitat, to the extent possible, as well as examples of activities that are likely to result in its destruction. The 2009 provincial recovery strategy for this species noted that critical habitat could not be identified at that time (nor is it required in the provincial process), but that it might be identified in a subsequent federal strategy or addition. This federal document does

¹ Population surveyed and re-confirmed on June 20, 2011: observers Kella Sadler (Environment Canada), Lucy Reiss (Environment Canada), Terry McIntosh (consultant).

identify critical habitat to the extent possible for this species. Current information is inadequate to identify critical habitat for a second historical population near Kamloops, B.C. owing to imprecise location data, and the absence of recent confirmation of the occurrence (i.e., >25 years). Additional critical habitat may be added in the future, if information supports the inclusion of areas beyond what is currently identified. A primary consideration in the identification of critical habitat is the amount, quality, and locations of habitat needed to achieve the population and distribution objectives.

Ecological attributes of Nugget Moss habitat are outlined in the provincial recovery strategy:

1. It is found in Bunchgrass and Ponderosa Pine Biogeoclimatic Zones, in semi-arid steppe environments in south-central British Columbia;
2. Within these environments, it is restricted to habitats on or near silt-rich post glacial lacustrine banks;
3. In association with lacustrine banks, it has been observed in two microhabitats, either:
 - a. On compact mineral soil on steep, nearly perpendicular, exposed bank faces, where few other moss species grow, or, more commonly,
 - b. At the base of lacustrine cliffs on soil in more shaded habitats.

Critical habitat for Nugget Moss is identified for the one known extant population, occurring at Penticton, B.C. A schedule of studies has been included in this federal addition to identify critical habitat for any additional natural population(s) near Kamloops, B.C. Critical habitat is identified as the area occupied by individual plants or patches of plants, including the associated potential location error from GPS units, plus an additional 50 meters to encompass the immediately adjacent areas. This area specified encompasses the contextual lacustrine bank for the one confirmed Nugget Moss population.

Nugget Moss is characteristic of early successional habitats, on the exposed portions of lacustrine banks or among early seral species on soil at cliff bases. Lacustrine banks are common in the Penticton and Kamloops areas, but they are rare elsewhere in the province. Ecosystem processes that occur on lacustrine banks (e.g. erosional patterns) are integral to the production and maintenance of suitable microhabitat conditions for Nugget Moss. For any additional Nugget Moss populations that may be discovered (Section 4.2), where lacustrine banks are apparent as a distinct ecological feature² at the landscape scale, the entire portion of the lacustrine bank associated with the plant or patch of plants should be identified as critical habitat. Connectivity should be maintained between any sub-populations³ where they occur in close proximity. The exact area identified as critical habitat, and the methodology behind the identification is described in Appendix 1.

² "Distinct" ecological, or landscape features are here referred to as those that are distinguishable at a landscape scale (through use of detailed ecosystem mapping or aerial photos), which, at that scale, appear as ecologically contiguous features with relatively distinct boundaries (e.g., cliffs, banks, or slopes, drainage basins, seepage plateaus, or distinct vegetation assemblages), and which comprise the context for a species occurrence.

³ "Populations" are separated by >1 km; "sub-populations" represent records of individuals, or patches of individuals, that are within 1 km of each other.

4.2 Schedule of Studies to Identify Additional Critical Habitat

This section replaces the “Recommended schedule of studies to identify critical habitat” section in the provincial document.

The following schedule of studies (Table 2) will potentially enable the identification of critical habitat for a second population of Nugget Moss in Canada that was previously recorded near Kamloops, B.C. in 1980. Exact location and habitat characteristics were not described during that survey, and the population has not been reconfirmed since the original observation. The general area where this population was found (i.e., a broad network of lacustrine banks shown in Figure 1) has not been disturbed, to date.

Table 2. Schedule of Studies to Identify Additional Critical Habitat

Activity	Rationale	Timeline
Conduct targeted surveys in areas of suitable habitat within the proximity of the historical Nugget Moss population near Kamloops, B.C. (Figure 1), and assess any new or reconfirmed populations against criteria for identifying critical habitat	Ensure critical habitat is identified to support all extant Nugget Moss populations in Canada. Currently, only adequate information exists to identify critical habitat for the population at Penticton, B.C.	2012-2015

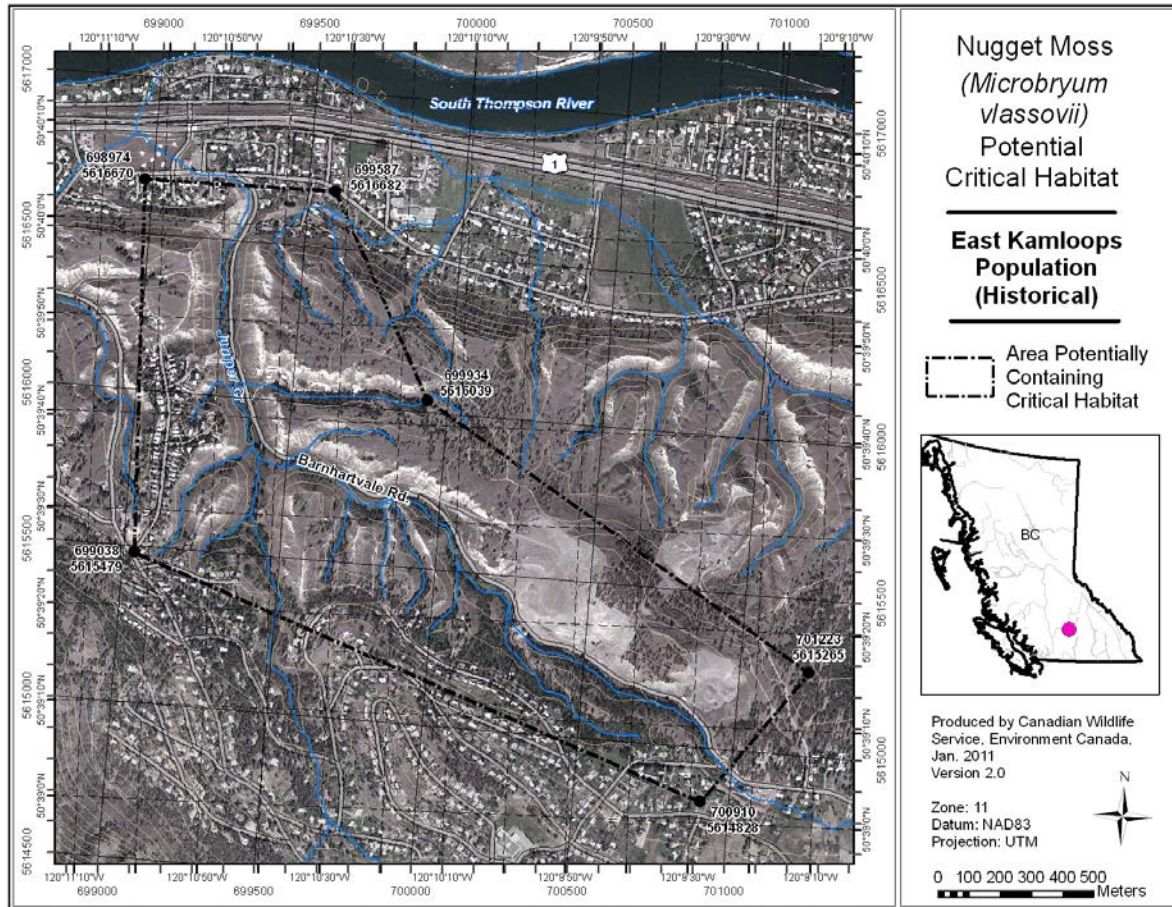


Figure 1. Map showing the broad network of lacustrine banks east of Kamloops B.C., comprising the general area associated with the historical record of Nugget Moss. Suggested survey area is indicated (dashed line).

4.3 Examples of Activities Likely to Result in Destruction of Critical Habitat

Understanding what constitutes destruction of critical habitat is necessary for the protection and management of critical habitat. Destruction is determined on a case by case basis. Destruction would result if part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single or multiple activities at one point in time or from the cumulative effects of one or more activities over time. Activities described in Table 3 include those likely to cause destruction of critical habitat for Nugget Moss; destructive activities are not limited to those listed.

Table 3. Examples of activities likely to result in destruction of critical habitat for Nugget Moss.

Activity	Description of how activity may result in destruction of critical habitat	Threat level
Road expansion or utilities construction and maintenance	Results in destruction of habitat composition and function through debris deposition or impact by machinery.	High
Recreational activities such as hiking or dog-walking outside of existing trails or roads	Results in trampling of associated vegetation, and disturbance or compaction of soil by hikers; also destruction or burial of associated vegetation by digging (dogs).	Low
Deliberate introduction of alien invasive plants	Direct effect is a reduction of space and soil available for Nugget Moss, and indirect effects, e.g., alteration of shade, water, and nutrients available to exclude niche range of Nugget Moss.	Unknown

Road or utilities construction and maintenance has been identified as the major threat likely to result in destruction of critical habitat for Nugget Moss. Both the known and historical populations of Nugget Moss are adjacent to roadways (<1m away), and are sites of potential road expansion and utilities construction. Construction or associated activities such as roadside maintenance (e.g., clearing ditches), subsequent debris deposition, or impact by machinery could destroy Nugget Moss habitat. Road expansion is the most likely event that would destroy habitat on steep banks, as these areas are prohibitive to recreational walking, and invasive plants are mostly absent. Habitat destruction from recreational users may occur at the lower, shaded portions of banks; the threat level was observed to be low in 2009, but this should be monitored, as both the reported Nugget Moss locations are near residential areas, and some existing trails are present in the vicinity.

5. Statement on Action Plans

One or more action plans will be posted on the Species at Risk Public Registry by 2017.

6. 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 strategies 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 strategy itself.

Impacts to other species, natural communities, or ecological processes are not anticipated during the recovery of Nugget Moss. In addition, no known COSEWIC-assessed or SARA-listed species are present at the known site for this moss.

7. References

British Columbia Bryophyte Recovery Team. 2009. Recovery strategy for the nugget moss (*Microbryum vlassovii*) in British Columbia. Prepared for the B.C. Ministry of Environment, Victoria, BC. 14 pp.

B.C. Conservation Framework. 2011. Conservation Framework Summary: *Microbryum vlassovii*. B.C. Minist. of Environment. Available: <http://a100.gov.bc.ca/pub/eswp/> (accessed October 24, 2011).

Government of Canada. 2009. *Species at Risk Act* Policies, Overarching Policy Framework [Draft]. *Species at Risk Act* Policy and Guidelines Series. Environment Canada. Ottawa. 38 pp.

NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer>. (Accessed: October 24, 2011).

Appendix 1. Critical habitat identification and location

1. Decision tree for critical habitat identification

In Canada, there is one confirmed population of Nugget Moss at Penticton, B.C (Figure A1). A decision tree was developed to identify critical habitat for this population, based on available knowledge.

The first decision is regarding the quality of available information on all records⁴ of this species in Canada, with the choice of accepting or rejecting any given record for consideration as critical habitat based on three criteria, i.e., time since most recent observation, location uncertainty, and observation of current habitat suitability.

The second decision is based on how readily the habitat is able to be defined. For all accepted records a minimum "critical function zone" distance⁵ is imposed. If critical habitat is readily identifiable based on available ecological information (ecosystem and/or aerial photo mapping, as well as expert advice from individuals who have specialized knowledge of the species and its locations), boundaries are extended on that basis to include areas of importance; i.e., priority landscape features that are plainly critical to the occurrence. "Distinct" ecological, or landscape features are here referred to as those that are distinguishable at a landscape scale (through use of detailed ecosystem mapping or aerial photos), which, at that scale, appear as ecologically contiguous features with relatively distinct boundaries (e.g., cliffs, banks, or slopes, drainage basins, seepage plateaus, or distinct vegetation assemblages), and which comprise the context for a species occurrence.

If the information described above is not available, i.e., (a) absence of high-resolution mapping, (b) lack of detailed ecosystem information, or (c) lack of expert advice, and/or (d) absence of any apparent landscape features of critical importance which would direct identification, then a formula for minimum habitat size (defaulting to minimum "critical function zone" distance) is proposed.

This approach (1) allows for an emphasis on ecological attributes which are of actual importance to the species, (2) permits the opportunity to use all available types of knowledge and information on a priority basis (i.e., within the context of a logical sequence of implementation), and (3) provides a method to identify critical habitat when detailed and/or specialized knowledge is lacking.

⁴ "Records" are here referred to as the finest-scale of data available (i.e., point data representing individual plants, or polygons representing discrete patches of plants). The term "occurrence" is used synonymously in this text, to describe actual portions of a landscape that are occupied by individuals or patches of individuals, and which form the basis for critical habitat mapping.

⁵ Minimum "critical function zone" distance is defined here as 50 m additional to the area of occupancy. Detailed rationale for use of this distance is included in section 2 of this Appendix.

Decision Tree:

- 1a. Occurrences have not been revisited for >25 years, **and** use imprecise and/or inaccurate geographic referencing systems (location uncertainty distance is greater than 100 m), **or** the habitat no longer exists at that location to support the species (no critical habitat will be defined until more is known about the population and location)
- 1b. Occurrences have been relocated and revisited in the past 25 years, **or** habitat has been revisited in the past 5 years to confirm it has the potential to support an occurrence, **or** geographic reference is accurate and precise (location uncertainty distance is less than 100 m) (go to 2)
2. Minimum critical habitat identified for ALL occurrences will include (a) specified area of occupancy, (b) all of the habitat within the GPS error distance (m) of the specified area of occupancy, and (c) an added minimum critical function zone distance of 50 m to ensure the inclusion of all necessary habitat associated with the occurrence (refer to rationale section following the decision tree), i.e., in all cases:

➤ *Minimum critical habitat (distance to boundary) = occurrence area + b + c*

- 2a. Where the species is a generalist associated with widespread habitats, **or** a specialist that occupies dynamic disturbance regimes difficult to delineate as patches in space, **or** occupies habitat that is otherwise poorly defined, **or** the best available information does not support more detailed interpretation and determination of critical habitat at a landscape scale, the minimal critical function zone distance (as defined above) is maintained around all occurrence areas.
- 2b. Where the species occupies readily identifiable habitat patches, such that any or all of the following methods of determination are available, and applicable, and support more detailed interpretation and determination of critical habitat:
 - use of detailed ecosystem mapping
 - use of aerial photos for identification of critical landscape features, and opportunities for connectivity, particularly wherever habitat quality and characteristics are continuous between patches
 - use of any existing studies that can provide more detailed insight into critical habitat location and connectivity between occurrences
 - consideration of any special circumstances or threats

In this case, this additional set of information may be used to extend critical habitat identification beyond the minimal critical habitat distance described above, i.e.:

➤ *Critical habitat (distance to boundary) = occurrence area + b + c + d*

Where d = extent of additional critical habitat identified; i.e., landscape feature, connectivity corridor, adjustment for special circumstances. In order to ensure that the identification of critical habitat is biologically defensible, extended and/or irregular critical habitat boundaries should be developed with, agreed upon, and confirmed by, species experts and/or relevant recovery teams.

2. Rationale for decision tree hierarchy

To identify habitat critical for the survival or recovery of a plant, it is necessary to consider factors that contribute to sustained reproductive success and colonization (i.e., dispersal of propagules, successful germination, and natural population fluctuation), as well as primary resources required for growth (i.e., space, water, sunlight, nutrients).

Population dynamics for plants in early successional environments may show greater fluctuation, both spatially and temporally, as compared to plants that comprise later-successional environments. This can be attributed to contrasting life history strategies typical of colonizing, versus competitive, and/or slow-growing species. Colonizing species can occupy patches opportunistically and perpetually within early-successional habitats (Hanski 1982), and are dependent on (a) local ecosystem dynamics, to perpetuate the creation of suitable habitat patches, and (b) connectivity between patches, for successful dispersal and colonization. Patch dynamics may be important within the context of later-successional environments as well, e.g. some species may persist as "satellite" species in old growth forest, colonizing new forest gaps. Plants with a more competitive live history approach (typically perennial, slower-growing) will have occurrences that are more spatially and temporally consistent, and which may therefore exhibit a more directly observable link between "threshold" breeches in required microhabitat properties, and population decline.

In most cases a detailed understanding of population dynamics will not be available for individual plant species at risk. The task, therefore, is to identify the properties that we know are of critical importance to its success, built on a prioritized model of (1) identifying basic biological requirements, (2) understanding ecological dynamics that relate to the context of the occurrence, (3) promoting connectivity between occurrences to foster reproductive success, and (4) accounting for special circumstances and threats.

The first priority in critical habitat identification should be to identify the primary resources required for the species growth. Each plant species has a different range of biological requirements, however. Where species occur, niche requirements have been met; therefore it follows that identifying an occurrence will involve identifying the unique combination of microhabitat properties at that site. It is understood that activities in areas proximal to an occurrence will affect local microhabitat properties. The distance at which proximal effects will impact rare plant occurrences may vary, depending on circumstance. Since it is unlikely that all factors contributing to local microhabitat can be identified, it is reasonable to include as critical habitat a minimum distance to ensure the maintenance of required microhabitat properties, wherever specialized information is lacking.

Existing research has identified bryophytes (mosses and liverworts) and lichens as uniquely sensitive indicators of microhabitat change. Lacking roots, bryophytes take up the majority of water and nutrients through atmospheric inputs, and as well as passively from the substrata on which they grow (Schofield 1985). As such, this group of plants has been used in monitoring a range of environmental effects, including acid rain, air pollution, and identifying threshold habitat fragment size for maintaining constituent microhabitat properties (light, moisture, humidity).

Studies that have used bryophytes or lichens to identify edge effect thresholds in mixed forest and coniferous forests (Esseen & Renhorn 1998, Baldwin & Bradfield 2005) have identified effects up to a distance of 45-50 m into remnant habitat fragments. Similarly, a study on microenvironmental gradients at habitat edges, i.e., light, temperature, litter moisture, vapor pressure deficit, humidity (Matlack 1993), and a study of edge effects as evidenced by changes in plant community structure and composition (Fraver 1994), each showed that effects could be detected to 50 m into habitat fragments. Forman and Alexander (1998) and Forman et al. (2003) found that most roadside edge effects on plants resulting from construction and repeated traffic have their greatest impact within the first 30 to 50 m. These data provide a logical basis for suggesting a minimum critical function zone distance of 50 m to ensure microhabitat properties for rare plant species occurrences are incorporated in the identification of critical habitat.

Once a critical function zone distance has been determined (minimum = 50 m), and where additional information exists, these boundaries may be built on or extended to account for factors identified previously (context, connectivity, special circumstances and threats). Ecosystem features that are discrete, identifiable, and which are logically associated with an occurrence should be included in the identification of critical habitat. That is, critical habitat should be identified such that relevant ecosystem dynamics (i.e., that directly contribute to spatial, and temporal perpetuation of the species) are included, wherever they can be determined, using the best available knowledge. Where habitat is consistent between existing occurrences, connectivity should be maintained. Finally, special circumstances should also be considered which may support a critical function zone distance that is greater than the standard minimum (50 m), e.g., proximity to dominant invasive alien species and/or roadside planting that would rapidly reduce or alter existing habitat (Jordan et al. 2008, Van Riper and Larson 2009), or proximity to heavy roadside or industrial emissions that would result in increased deposition of deleterious chemicals and alteration of existing habitat. Some species may be particularly sensitive to atmospheric deposition, which is detectable in plants and soils up to 1 to 2 km away from the source (Meshalkina et al. 1996, Hao et al. 2006, Kochy and Wilson 2001). In some cases, and based on supporting evidence, site- and species-specific factors could logically modify the placement or distance of critical habitat boundaries, based on the area required to maintain necessary resources for plant survival.

Anthropogenic features including roads, houses, and the associated developed urban and residential landscape are not identified as critical habitat, even when they occur within the minimum critical function zone distance. It is not clear at this time whether or to what extent these features provide an essential ecological function (i.e., how they influence resources such as light, heat, moisture, nutrients, etc.) to support Nugget Moss populations.

3. References

- Baldwin, L.K., and G.E. Bradfield. 2005. Bryophyte community differences between edge and interior environments in temperate rain-forest fragments of coastal British Columbia. *Can. J. For. Res.* 35(3): 580–592.
- Esseen, P.A., and K.E. Renhorn. 1998. Edge effects on an epiphytic lichen in fragmented forests. *Conserv. Biol.* 12(6): 1307-1317.
- Forman, R.T.T., and L.E. Alexander. 1998. Roads and their major ecological effects. *Ann. Rev. Ecology and Systematics* 29: 207-231.
- Forman, R.T.T., D. Sperling, J.A. Bissonette, A.P. Clevenger, C.D. Cutshall, V.H. Dale, L. Fahrig, R. France, C.R. Goldman, K. Heanue, J.A. Jones, F.J. Swanson, T. Turrentine, and T.C. Winter. 2003. *Road ecology: Science and solutions*. Island Press. Covelo CA.
- Fraver, S. 1994. Vegetation responses along edge-to-interior gradients in the mixed hardwood forests of the Roanoke River Basin, North Carolina. *Conserv. Biol.* 8(3): 822-832.
- Hanski, I. 1982. Dynamics of regional distribution: the core and satellite species hypothesis. *Oikos* 38: 210-221.
- Hao, X., C. Chang, H.H. Janzen, G. Clayton, and B.R. Hill. 2006. Sorption of atmospheric ammonia by soil and perennial grass downwind from two large cattle feedlots. *Journal of Environmental Quality*. 35: 1960-1965.
- Jordan, N.R., D.L. Larson, and S.C. Huerd. 2008. Soil modification by invasive plants: effects on native and invasive species of mixed-grass prairies. *Biological Invasions*. 10: 177-190.
- Kochy, M., and S.D. Wilson. 2001. Nitrogen deposition and forest expansion in the northern Great Plains. *Journal of Ecology*. 89: 807-817.
- Matlack, G.R. 1993. Microenvironment variation within and among forest edge sites in the eastern United States. *Biol. Conserv.* 66(3): 185-194.
- Meshalkina, J.L., A. Stein, and O.A. Makarov. 1996. Spatial variability of soil contamination around a sulphureous acid producing factory in Russia. *Water, Air and Soil Pollution*. 92: 289-313.
- Schofield, W.B. 1985. *Introduction to Bryology*. The Blackburn Press, N.J.
- Van Riper, L.C. and D.L. Larson. 2009. Role of invasive *Melilotus officinalis* in two native plant communities. *Plant Ecology*. 200: 129-139.

4. Map of critical habitat for Nugget Moss in Canada

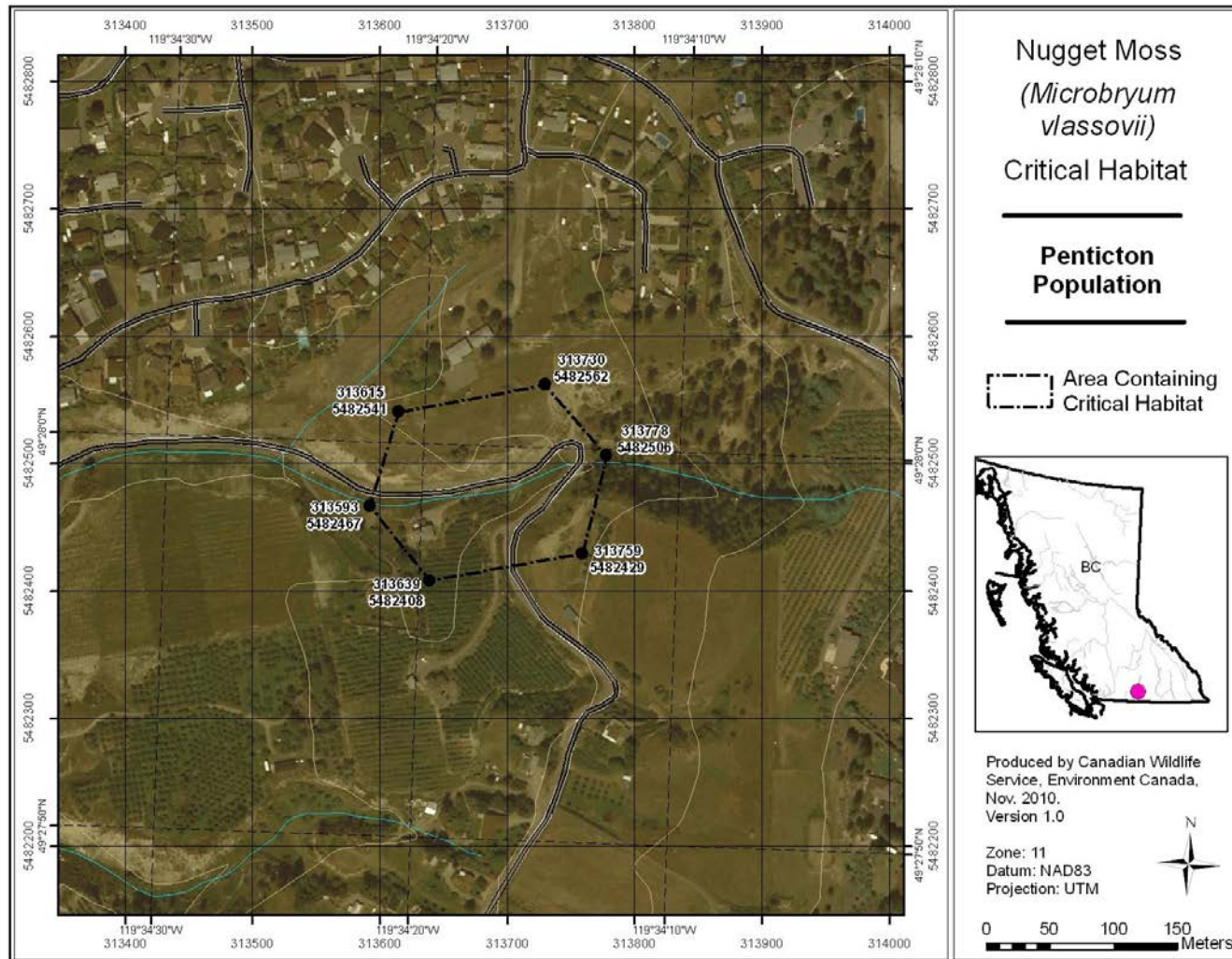


Figure A1. Critical Habitat for Nugget Moss near Penticton, British Columbia. Anthropogenic features within the indicated polygon, including roads, houses, and the associated developed urban and residential landscape, are not identified as critical habitat.

PART 2: Recovery Strategy for the nugget moss (*Microbryum vlassovii*) in British Columbia, prepared by the British Columbia Bryophyte Recovery Team for the B.C. Ministry of Environment

Recovery Strategy for the nugget moss (*Microbryum vlassovii*) in British Columbia



Prepared by the British Columbia Bryophyte Recovery Team



Ministry of
Environment

February 2009

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>>

Recovery Strategy for the nugget moss (*Microbryum vlassovii*) in British Columbia

Prepared by the British Columbia Bryophyte Recovery Team

February 2009

Recommended citation

British Columbia Bryophyte Recovery Team. 2009. Recovery strategy for the nugget moss (*Microbryum vlassovii*) in British Columbia. Prepared for the B.C. Ministry of Environment, Victoria, BC. 14 pp.

Cover illustration/photograph

Photograph by Terry McIntosh

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: 978-0-7726-6132-6

Catalogue Number: Pending

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

Disclaimer

This recovery strategy has been prepared by the British Columbia Bryophyte 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 its 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 nugget moss 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 the nugget moss.

RECOVERY TEAM MEMBERS

British Columbia Bryophyte Recovery Team

Brenda Costanzo (Chair), Ecosystems Branch, B.C. Ministry of Environment, Victoria.

Terry McIntosh, Consultant, Vancouver, BC.

Karen Golinski, Consultant, Nashville, Tennessee.

Mike Ryan, Ecologist, B.C. Ministry of Forests and Range, Kamloops.

Former recovery team members

Ted Lea (retired), Ecologist, Victoria, BC.

AUTHOR

Terry McIntosh, PhD.

RESPONSIBLE JURISDICTIONS

The British Columbia Ministry of Environment is responsible for producing a recovery strategy for the nugget 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 recovery strategy.

ACKNOWLEDGEMENTS

Initial drafting of this recovery strategy was by Terry McIntosh, with further review and updating by the B.C. Bryophyte Team. Funding for this recovery strategy was provided by the B.C. Ministry of Environment.

EXECUTIVE SUMMARY

The nugget moss (*Microbryum vlassovii*) was designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered in November 2006 and will be considered for listing under the federal *Species at Risk Act* (SARA) Schedule 1 in 2009. Its current known Canadian range consists of two widely separated populations in the semi-arid regions of south-central British Columbia. The nugget moss is a tiny moss that grows as individual plants or in small patches on mineral soil. It is restricted to habitats on or near silt-rich lacustrine banks. As with many arid-land moss species, its growth cycle begins in late autumn after the first fall rains and, when temperature allows, grows through winter and into spring and early summer.

Potential threats to the survival of the populations include road or utilities construction and maintenance, recreational activities, invasive alien vascular plants, and erosion from unusual storm events.

Recovery Goal

The goal of this recovery strategy is to protect and maintain the extant populations of the nugget moss in Canada.

Recovery Objectives

The recovery strategy has the following objectives:

- I. To ensure protection for the extant populations and respective habitats by 2013.
- II. To assess the extent of and mitigate the main threats by 2013.
- III. To determine habitat requirements at known sites by 2013.
- IV. To confirm the distribution of the nugget moss (including new locations) to reliably determine population trends by 2013.

No critical habitat can be identified for the nugget moss in Canada at this time. It is expected that critical habitat will be proposed following the completion of outstanding work required to quantify specific habitat and area requirements for the species. Further research on the biology of the species and monitoring of populations is required to determine population trends.

Consultation with affected land managers will also be necessary.

Approaches to achieve the recovery objectives are: habitat management, habitat protection, stewardship, inventory and monitoring, and scientific research.

An action plan will be completed by 2013.

TABLE OF CONTENTS

BACKGROUND.....	1
Species Assessment Information from COSEWIC	1
Description of the Species	1
Populations and Distribution	3
Needs of the Nugget Moss	5
Habitat and biological needs.....	5
Ecological role	6
Limiting factors	6
Threats	6
Threat classification.....	6
Road or utilities construction and maintenance	7
Recreational activities	7
Invasive alien vascular plants.....	8
Unusual storm events.....	8
Actions Already Completed or Underway	8
Knowledge Gaps	8
RECOVERY	9
Recovery Feasibility	9
Recovery Goal.....	9
Rationale for the Recovery Goal	9
Recovery Objectives	10
Approaches Recommended to Meet Recovery Objectives	10
Performance Measures.....	11
Critical Habitat	11
Existing and Recommended Approaches to Habitat Protection	12
Effects on Other Species	12
Socio-economic Considerations.....	12
Recommended Approach for Recovery Implementation	12
Statement on Action Plans	13
REFERENCES.....	14

LIST OF TABLES

Table 1. Population data for the nugget moss in Canada	4
Table 2. Threat classification for the nugget moss in British Columbia	6
Table 3. Technical and biological feasibility for recovery of the nugget moss	9
Table 4. Recovery planning	10

LIST OF FIGURES

Figure 1. A dried patch of the nugget moss	2
Figure 2. Transverse section of a leaf of nugget moss showing the characteristic bottle-like cells covering the upper side of the midrib and adjacent leaf cells	2
Figure 3. North American distribution of the nugget moss	3
Figure 4. Distribution of the nugget moss in British Columbia and Canada	4

BACKGROUND

Species Assessment Information from COSEWIC

Date of Assessment: November 2006

Common Name (population): nugget moss

Scientific Name: *Microbryum vlassovii*

COSEWIC Status: Endangered

Reason for designation: In North America, this globally rare moss is known from only three localized sites. Two of these sites are in semi-arid areas of south-central British Columbia. Recent surveys have re-located the species at only one of these. This moss grows on fine soils on the steep portions of silt banks in early stages of plant community development. The extremely small populations render this moss vulnerable to disturbance. Threats include potential road development and maintenance of existing roads, and collection of specimens.

Canadian Occurrence: British Columbia

COSEWIC Status History: Designated Endangered in November 2006. Assessment based on a new status report.

Description of the Species

The nugget moss is a tiny, less than 2 mm tall, inconspicuous plant that grows as individuals or in small, scattered patches on mineral soil (Figure 1). It is sometimes hidden under litter or among other mosses. Its leaves are usually light yellow to golden when dry and yellow-green when wet, and they wrap around each other as they grow, protecting the maturing sporophyte (structure that produces spores). Its leaf margins are strongly recurved. The midribs of the leaves extend from the leaf apices as smooth and often orange hair-points. The upper surface of each midrib and parts of the adjacent leaf surface are ornamented with distinctive bottle-shaped cells (Figure 2). Its underground stems bear tiny, hemispherical structures that probably act as vegetative propagules. The nugget moss has both male and female structures on each plant, which may help to ensure successful fertilization and consequent production of spores (although this species has not been observed with mature sporophytes in North America; Zander 2007). Unlike most mosses, the nearly spherical capsules do not open with a lid in order to release their spores. Instead, spores are released when the capsule wall disintegrates after maturity.

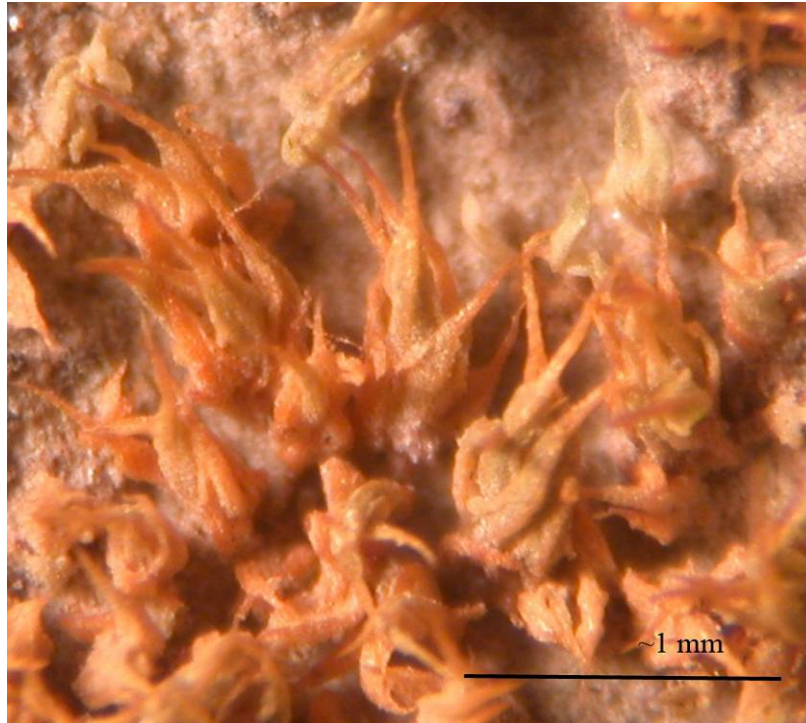


Figure 1. A dried patch of the nugget moss. Photo by T. McIntosh.

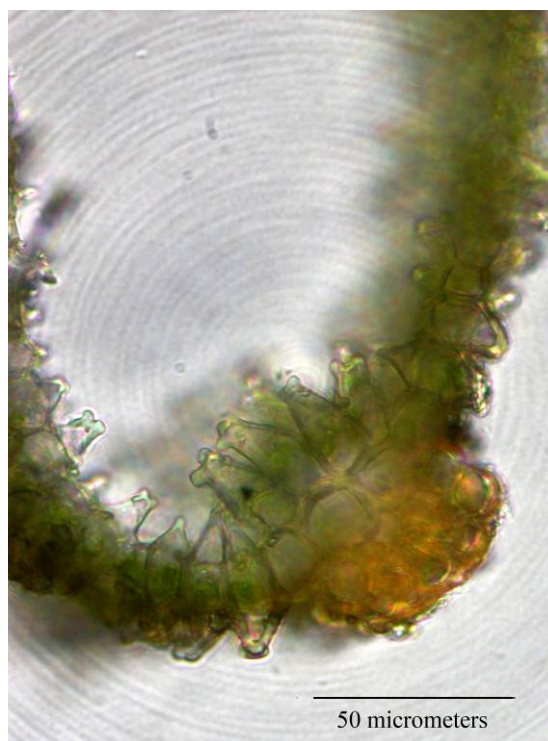


Figure 2. Transverse section of a leaf of nugget moss showing the characteristic bottle-like cells covering the upper side of the midrib and adjacent leaf cells. Photo by T. McIntosh.

Population and Distribution

The nugget moss has a disjunct distribution between western North America and western Eurasia. It is rare across its global range. Eurasian locations include Spain (Jiménez et al. 1990), Ukraine, Armenia, and central Asia (COSEWIC 2006; Zander 2007). In North America it has been reported from southern British Columbia (McIntosh 1986, 1997) and California (Zander 2007; Figure 3). The nugget moss was first collected in Canada in 1980 from two locations in south-central British Columbia (Table 1, Figure 4). During extensive surveys of lacustrine banks east of Kamloops and in the Okanagan Valley between 2004 and 2006 (T. McIntosh, pers. comm. 2007), the more southerly Penticton population was rediscovered. However, the Kamloops population was not rediscovered and no new populations of the nugget moss were found. Because of the broad extent of the lacustrine banks in the Kamloops area and because an exact location for this moss was not recorded in 1980, it may have been missed in recent surveys (especially as this moss is very small in size and therefore difficult to see). The general location where it was found in 1980 has not been disturbed, so it is likely that the population is still extant.

The nugget moss is globally listed as G2? (Possibly Imperiled) and it is Red listed (S1; Critically Imperiled) by the B.C. Conservation Data Centre (CDC; B. C. Species and Ecosystem Explorer 2008). NatureServe Explorer (2008) lists only the CDC rankings for the moss (as *Phascum vlassovii*) and does not rank its Californian location. Nugget moss is a priority 1 species under goal 1 of the B.C. Conservation Framework (see www.env.gov.bc.ca/conservationframework/ for details).



Figure 3. North American distribution of the nugget moss.

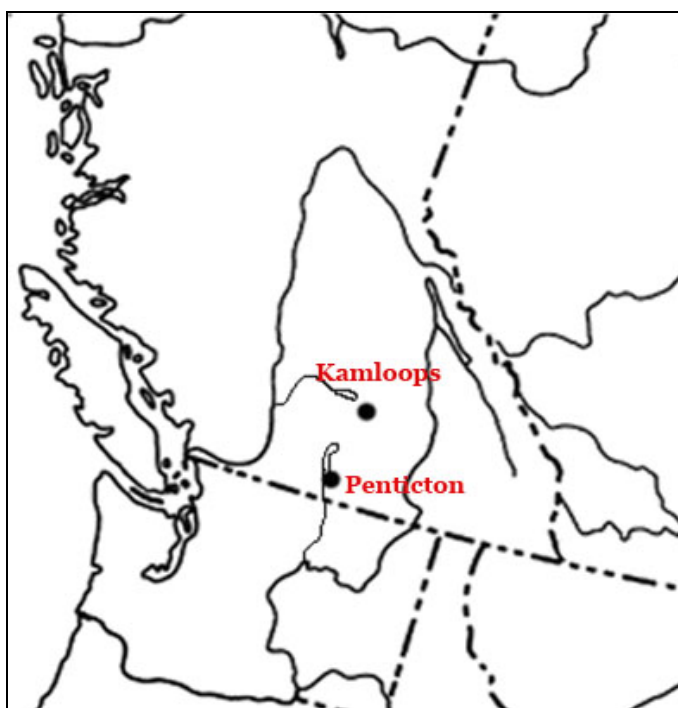


Figure 4. Distribution of the nugget moss in British Columbia and Canada.

Table 1 lists population data for the two known occurrences of the nugget moss in British Columbia and Canada. Both occurrences are represented by a few small ($<1 \text{ cm}^2$) patches¹ or as scattered individual plants that are apparently restricted to relatively small areas at each location. An assessment of population trends is not possible at this time, but field observations suggest that regular recruitment is occurring at some sites. The Canadian populations of the nugget moss represent less than 1% of its global distribution and abundance.

Table 1. Population data for the nugget moss in Canada.

Population	Dates observed	Estimated number of patches/individuals and extent	Habitat characteristics	Population trend	Land tenure
1. Kamloops	1980	One patch observed and collected.	Unknown; extent and habitat not described in 1980.	Unknown	City of Kamloops
2. Penticton	1980, 2005, 2006	Approx. 8 patches (all $<1 \text{ cm}^2$) and a few individuals observed in 3 microhabitats ² of area $>1500 \text{ m}^2$.	Unknown from 1980 collection; 2005: on steep, south-facing lacustrine bank (previous road cut); 2006: at the base of a lacustrine bank along south side of road.	Apparently stable	City of Penticton

¹ 'Patches' refers to a group of plants that cannot be determined to be individual reproducing units.

² 'Microhabitat' refers to the small areas of habitat in which the patches are placed on the landscape.

Needs of the Nugget Moss

Habitat and biological needs

In British Columbia, the nugget moss is restricted to habitats on or near silt-rich post-glacial lacustrine banks in semi-arid steppe environments in south-central British Columbia. Lacustrine banks are often kilometers long, such as those found near Kamloops and Penticton.

In Penticton, the nugget moss has been observed in two microhabitats on lacustrine banks. It has been found on compact mineral soil on steep, nearly perpendicular, exposed bank faces, a mostly bare habitat where few other moss species grow. Associated moss species, all poorly developed in this harsh habitat, include *Aloina bifrons*, *A. rigida*, and *Pseudocrossidium obtusulum* (there are no common names for these mosses). A few early successional lichen species were present as well (including *Collema* spp.). A second microhabitat for nugget moss is at the base of lacustrine cliffs on soil in more shaded habitats. Other mosses, including *Barbula unguiculata*, a species characteristic of more shaded conditions, grow adjacent to nugget moss in this habitat. The nugget moss appears to be more common in this second microhabitat; the largest patches and most developed plants were observed there. It has not been found growing in late successional lichen-dominated crust that dominates on large portions of undisturbed lacustrine banks. These observations imply that the nugget moss may be characteristic of early successional habitats, supported by its association with early seral species of mosses in more shaded habitat and with early seral species of lichens in more exposed habitat. The Californian collection was found on clay soil in an open, hillside pasture, also indicating that it is an early successional species.

The nugget moss is found in Bunchgrass and Ponderosa Pine Biogeoclimatic Zones. Characteristic vascular plants in these zones are bluebunch wheatgrass (*Pseudoroegneria spicata*), needle-and-thread grass (*Hesperostipa comata*), big sage (*Artemisia tridentata*), and, in the southern portions of the Okanagan Valley, antelope brush (*Purshia tridentata*).

Published information about the biological needs of the nugget moss is lacking. However, T. McIntosh (pers. comm., 2008) has provided information on this species from British Columbia. As with many arid-land moss species, its growth cycle begins in late autumn after the first fall rains and, when temperature allows, grows through winter and into spring and early summer. However, although sporophytes and spores mature during this period, mature sporophytes of the nugget moss have not yet been observed in British Columbia. Incomplete development of the sporophytes may be a response to the harsh arid climate combined with the compact mineral soil on which this species grows. It is possible that this species needs a relatively prolonged, wet spring period to enable the spores to mature, but this is unknown. Although the primary means of dispersal and reproduction of most mosses is by spores, the nugget moss may depend on vegetative reproduction to maintain or expand populations. The small hemispherical structures on its underground stems probably grow into plants under favorable conditions. There are no data on spore dispersal distances, viability, or germination success for this species, although, if produced, moss spores produced by species in this type of habitat are most frequently water or insect-dispersed.

Ecological role

The nugget moss may have a role in increasing soil stability, but, because of its low abundance, this role would be minor. No other ecological roles are likely for this species.

Limiting factors

A possible limiting factor for the nugget moss is its small size. This may be a competitive disadvantage when growing among other mosses and vascular plants, including invasive species. However, it appears that this species readily takes advantage of open mineral soil. Climate may be another limiting factor: it may prevent this species from producing spores unless there is a wet spring. Lastly, the nugget moss may be limited due the lack of suitable habitat in British Columbia. Although silt banks are common in the Kamloops and Penticton areas, they are rare elsewhere in the province.

Threats

Threat classification

Table 2. Threat classification for the nugget moss in British Columbia.

1. Road or utilities construction and maintenance		Threat attributes	
Threat category	Habitat loss or degradation, accidental mortality	Extent	Unknown
General threat	Road expansion, cleaning ditches, debris deposition, or impact by machinery	Occurrence	Anticipated
		Frequency	Recurrent
Specific threat	Destruction, removal, or burial of species and alteration of habitat.	Causal certainty	High
		Severity	High
Stress	Reduction in population size and local extirpation	Level of concern	High
2. Recreational activities		Threat attributes	
Threat category	Habitat loss or degradation, accidental mortality	Extent	Unknown
General threat	Walking through habitat or near plants in the lower sections of the known habitats	Occurrence	Anticipated
		Frequency	Unknown/recurrent
Specific threat	Trampling or digging (by dogs)	Causal certainty	Low
		Severity	Medium
Stress	Reduction in population size and local extirpation	Level of concern	Low
3. Invasive vascular plants		Threat attributes	
Threat category	Invasive species	Extent	Unknown

General threat	Invasive weedy species (unknown)	Occurrence	Anticipated
		Frequency	Seasonal
Specific threat	Changing habitat characteristics, increased litter and competition for resources.	Causal certainty	Unknown
		Severity	Unknown
Stress	Reduction in population size and local extirpation	Level of concern	Unknown
4. Unusual storm events		Threat attributes	
Threat category	Climate and natural disasters	Extent	Unknown
General threat	Unusual storm events	Occurrence	Anticipated
		Frequency	Unknown
Specific threat	Washing away of populations and part of habitat; burial of plants	Causal certainty	High
		Severity	High
Stress	Reduction in population size and local extirpation	Level of concern	High

Description of the threats

Road or utilities construction and maintenance

Both of the known populations of the nugget moss are adjacent to roadways (<1 m away) and sites for potential road expansion and utilities construction. Construction or associated activities such as roadside maintenance (e.g., cleaning ditches, clearing weeds or debris), subsequent debris deposition, or impact by machinery could impact the nugget moss populations and habitat. Plants could be accidentally destroyed, buried, or removed, and its habitat disturbed or buried. It is likely that road expansion would be the most likely event that would destroy plants on steep banks, as no one can walk there and invasive plants are mostly absent. However, any of these activities would likely affect the lower portions of banks closest to the roadway where, at least in the case of the Penticton site, the nugget moss has been found in greater abundance than on steeper faces of banks. Most or all of the populations and their viability could be reduced or populations could be extirpated. Road construction and maintenance has happened historically, and it is anticipated that it will also occur in the future, especially if these habitats are affected by erosional events that threaten the road. The frequency of these activities is unknown, but probably recurs when needed.

Recreational activities

Although this activity was not observed during visits to B.C. sites, recreational hiking is a threat to the nugget moss since both of the reported locations in B.C. are near residential areas and some trails were observed at the lacustrine banks at the Kamloops site. Also, many hikers take their dogs with them, and the possibility of damage from dogs running along the lower, more shaded portions of the banks is high. Plants could be accidentally destroyed or buried, and their habitat disturbed. Because the plants and the patches are small, damage to habitat and loss of plants could be high.

Invasive alien vascular plants

Invasive alien vascular plants are unlikely to be a threat to this species on steep, exposed silt bankfaces, but may be a threat along bases of banks where the nugget moss is more common, mainly by changing habitat characteristics, such as increasing shade or by producing litter that might bury the nugget moss. Most or all of the lower slope populations and their viability could be reduced, or populations extirpated. The presence or extent of this threat is unknown although numerous alien invasive species were noted (but not listed by name) along this roadway in 2006. The threat of invasive species is anticipated, and probably seasonal. These plants would disturb the habitat as they grow and the litter they produce may cover the nugget moss during the winter to spring growing period. This is a presumed or plausible threat only, thus the causal certainty is low (Table 2). However, this threat may decrease the population size over the long term.

Unusual storm events

Given the location of the main portions of the population along the base of banks in the Penticton area, a severe storm may lead to an unusually high overland waterflow especially in the ditches alongside the road. The subsequent scouring could wash both plants and soil away, or sediments could bury plants. Most or all of the lower populations could be reduced or extirpated. Although the extent of this threat is unknown, the threat of a severe storm event is anticipated, especially in the warmer seasons, but the effects of such a storm are unknown (e.g., erosional pathways may not be where this moss is located). The causal certainty is probably high. However, this threat may have a high severity on population numbers.

Actions Already Completed or Underway

No actions are underway to protect this species in the Kamloops area. The B.C. Ministry of Environment in Penticton (O. Dyer, pers. comm., 2008) as well as the City of Penticton are investigating ways that the known Penticton location for this species could be protected.

Knowledge Gaps

- More information is needed on the threats to this species, including road maintenance and local recreational activities. Potentially threatening invasive vascular species need to be recorded. The impacts of unusual storm events should be monitored.
- Scientific research needs to be completed to determine the habitat requirements of the nugget moss (e.g., soil structure, and composition, and light requirements).
- Detailed inventories need to be completed for this moss at the two reported sites, and accurate location and population data gathered. Little is known about the number of subpopulations of the nugget moss. The Kamloops area population was not rediscovered during COSEWIC-funded searches in 2002, and only four patches were located over the past three years at the Penticton site.
- Distribution and population trends need to be determined for this species.

RECOVERY

Recovery Feasibility

Successful recovery will depend on a combination of scientific investigations, habitat protection and possibly, management activities (e.g., road construction or maintenance contractors are aware of locations of the nugget moss), and long-term population monitoring. The level of effort required for recovery is expected to be low. In most cases, further studies and trials will be needed to determine whether there are insurmountable barriers to the recovery of existing populations.

Overall, recovery is considered to be biologically and technically feasible for the nugget moss. An assessment of the criteria for technical and biological feasibility for recovery of the nugget moss is found in Table 3.

Table 3. Technical and biological feasibility for recovery of the nugget moss.

Criteria	Feasibility
1. Are individuals capable of reproduction currently available to improve the population growth rate or population abundance?	YES – there is at least one extant population in Canada.
2. Is sufficient suitable habitat available to support the species or could it be made available through habitat management or restoration?	YES – the habitat at the currently occupied sites are suitable, and additional suitable habitat may also be available.
3. Can significant threats to the species or its habitat be avoided or mitigated through recovery actions?	YES – recovery actions in cooperation with land managers can prevent major threats.
4. Do the necessary recovery techniques exist and are they demonstrated to be effective?	YES – general recovery methods and techniques are known.

Source: Criteria from Environment Canada et al. (2005).

Recovery Goal

The goal of this recovery strategy is to protect and maintain the extant populations of the nugget moss in Canada.

Rationale for the Recovery Goal

As with many other rare plant species, we lack adequate information about the historical distribution of the nugget moss. There is no evidence to indicate that this species was previously more abundant or widespread in the arid central interior of British Columbia; therefore, recovery with respect to this species should focus on improving the probability that it will persist in the

wild. Although the biology and ecology of nugget moss are not completely understood, field observations suggest that regular recruitment is occurring at some sites.

Recovery Objectives

- I. To ensure protection for extant populations and respective habitats by 2013.
- II. To assess the extent of and mitigate the main threats by 2013.
- III. To determine habitat requirements at known sites by 2013.
- IV. To confirm the distribution of the nugget moss (including new locations) to reliably determine population trends by 2013.

Approaches Recommended to Meet Recovery Objectives

- Habitat management
- Habitat protection
- Stewardship
- Inventory and monitoring
- Scientific research

Table 4. Recovery planning for the nugget moss.

Priority	Obj. No.	Broad approach / Strategy	Threat addressed	Specific steps	Outcomes or deliverables
High	I	Habitat management	Road or utilities construction and maintenance, recreational activities	<ul style="list-style-type: none"> • Communicate with the cities of Kamloops and Penticton (ongoing) about the presence of the species and the importance of protecting habitat. • Work with the municipalities to ensure their activities are compatible with conservation of the species. 	<ul style="list-style-type: none"> • Populations maintained. • Mortality reduced. • Increased awareness and assistance by the land managers in the protection and recovery of this species.
High	I	Habitat protection	Road or utilities construction and maintenance, recreational activities	<ul style="list-style-type: none"> • Establish appropriate protection mechanisms (e.g., stewardship agreements), depending on land tenure. 	<ul style="list-style-type: none"> • Securement and protection of populations and habitats.
High	I, II	Stewardship	Recreational activities	<ul style="list-style-type: none"> • Communicate with land managers and encourage them to steward and manage lands for persistence of the species. 	<ul style="list-style-type: none"> • Populations maintained. • Mortality reduced. • Increased understanding and stewardship of species at risk and their habitats among land managers.

High	II	Scientific research: real and potential threats of invasive plants, road/utility construction/maintenance; recreational activities; storm events	All	<ul style="list-style-type: none"> • Research and document potential impact of threats to habitat at both known sites. • Mitigate threats (e.g., prevent and treat invasive species; identify location of species to highway crews; trail signs or redirect trails; erect storm drain controls). 	<ul style="list-style-type: none"> • Precise information on degree and extent of threat. • Maintenance of current suitable habitat for the species.
Medium	III	Scientific research: investigate habitat requirements	All	<ul style="list-style-type: none"> • Analyze soil structure and composition. • Analyze light requirements. 	<ul style="list-style-type: none"> • Precise information on habitat requirements to manage the life history stages to ensure recovery.
High	IV	Inventory and population monitoring	All	<ul style="list-style-type: none"> • Inventory suitable habitat throughout the species' range. • Design and implement a monitoring program. • Research and document population sizes and health. 	<ul style="list-style-type: none"> • Data on population sizes, reproduction status, and health, and determination of population trends. • Ability to assess status of populations and effectiveness of recovery actions.

Performance Measures

- I. Protection of known populations and habitats of the nugget moss is secured by 2013 (Objective I).
- II. Impact of the main threats to the populations has been investigated, and threats reduced by 2013 (Objectives II and III).
- III. Agreements with appropriate resource managers are developed to mitigate the impacts of road construction, utility construction and maintenance activities by 2013 (Objective II).
- IV. Assessments of habitat requirements are completed by 2013 (Objective III).
- V. Surveys of suitable habitat at extant sites for new populations (and resurvey of the Kamloops site) has been conducted and documented and a monitoring program initiated by 2013 (Objective IV).

Critical Habitat

No critical habitat can be identified for the nugget moss in Canada at this time. It is expected that critical habitat will be proposed following the completion of outstanding work required to quantify specific habitat and area requirements for the species, further research on the biology of the species and monitoring of populations to determine population trends. Consultation with affected land managers will also be necessary.

The schedule of studies included in the section below outlines the additional research and analysis required to address the biological and technical limitations that prevent identification of critical habitat in this recovery strategy.

Recommended schedule of studies to identify critical habitat

The following studies will allow for identification of critical habitat for extant populations:

1. Identify habitat attributes, including microhabitats, at extant sites (e.g., soil composition, structure and texture; light and moisture requirements) by 2013.
2. Using established survey and mapping techniques, delineate the boundaries of all occupied habitat by 2013.
3. Identify, map, and describe all suitable sites that are currently occupied by the nugget moss by 2013.

Existing and Recommended Approaches to Habitat Protection

To date, the extant nugget moss population is not protected, although protective measures are presently being considered for the Penticton site. Recommended approaches to protection of the nugget moss include stewardship with the two municipalities. This species is a potential candidate for addition to the list of Species at Risk under the *Wildlife Amendment Act (2004)*.

Effects on Other Species

Impacts to other species, natural communities, or ecological processes are not anticipated during the recovery of the nugget moss. In addition, no other known COSEWIC-assessed or SARA-listed species are present at the known sites for this moss.

Socio-economic Considerations

The socio-economic impact is considered low for the nugget moss. Modification of recreational activities and city works programs may incur some cost (meetings, pamphlets, etc.), but this is probably minor.

Recommended Approach for Recovery Implementation

A number of opportunities are available to implement this recovery strategy. The City of Penticton is aware that rare species are important to their natural heritage and that protection measures should be considered within their mandate. Protection measures are presently being discussed with O. Dyer, Regional Rare and Endangered Species Specialist Wildlife Biologist for the B.C. Ministry of Environment in Penticton.

The South Okanagan Similkameen Conservation Program (SOSCP) should be contacted and be made aware of this species and its potential habitat. Integrating the protection of the nugget moss

within their conservation program would be beneficial to this species recovery. The Grasslands Recovery Implementation Group is currently developing an action plan (first draft is due for completion by March 31, 2009) for grassland species at risk, which will include this species. The Grasslands Recovery Implementation Group draft action plan is an ecosystem-based, landscape-level recovery action plan which identifies priority recovery actions for implementation (2009-2013). Nugget moss is one of the species occurring in the regions covered by this action plan which will address the most significant threats to B.C.'s interior grassland ecosystems and species.

Statement on Action Plans

An action plan for the nugget moss will be completed by 2013. Nugget moss is also included in the grasslands draft action plan (see Recommended Approach for Recovery Implementation). This initiative will improve communication and coordination between stakeholder groups, and will facilitate the development and implementation of SAR recovery action plans at the local level. In addition, this initiative will work towards building a broad level of awareness and understanding about species at risk and land use pressures leading to fragmentation and development of grasslands and species at risk habitat (development includes, but is not limited to, urban growth, urbanization of rural landscapes, intensive agriculture, mining, etc.).

REFERENCES

- B.C. Species and Ecosystems Explorer. 2008. Victoria, BC. Available at <http://srmapapps.gov.bc.ca/apps/eswp/>.
- Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2006. COSEWIC assessment and status report for the nugget moss *Microbryum vlassovii* in Canada. COSEWIC, Ottawa, ON. <www.sararegistry.gc.ca/>
- Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2008. Canadian Species at Risk. <www.cosepac.gc.ca/eng/sct0/index_e.cfm>.
- Environment Canada. 2004. *Species at Risk Act* (SARA). Ottawa, ON. Available at: <www.speciesatrisk.gc.ca/default_e.cfm>.
- Environment Canada, Parks Canada Agency, and Fisheries and Oceans Canada. 2005. *Species at Risk Act* policy: Draft policy on the feasibility of recovery. Ottawa, ON.
- Crum, H., and L.E. Anderson. 1981. Mosses of eastern North America. Vol. 1. Columbia Univ. Press, New York.
- Jiménez, M.N., R.M. Ros, and J. Guerra. 1990. *Phascum vlassovii* Laz. (Pottiaceae, Musci) en Europa. *Anales Jard. Bot. Madrid* 47:234–235.
- McIntosh, T.T. 1986. The bryophytes of the semi-arid steppe of south-central British Columbia. PhD thesis, Botany Dep., Univ. of British Columbia, Vancouver.
- McIntosh, T.T. 1989. New and interesting bryophytes of the semi-arid steppe of British Columbia; including four species new to North America. *The Bryologist* 92:292–295.
- McIntosh, T.T. 1997. The biogeography of the bryophytes of the semi-arid steppe of south-central British Columbia. *J. Hatt. Bot. Lab.* 82:157–169.
- NatureServe Explorer: An online encyclopedia of life. 2008. V. 1.6. Arlington, VA. Available at: <www.natureserve.org/explorer>.
- National Recovery Working Group. 2004. Recovery handbook (ROMAN). Working draft, Oct. 2004. Recovery of Nationally Endangered Wildlife, Ottawa, ON.
- Zander, R.H. 2007. *Microbryum*. Pages 627–631 in *Flora of North America* Editorial Committee, eds. *Flora of North America*. Vol. 27: Bryophytes, mosses, part 1. Oxford Univ. Press, New York.

Personal communications

- Orville Dyer. Regional Rare and Endangered Species Wildlife Biologist, B.C. Ministry of Environment, Penticton.
- Terry McIntosh. Botanist, Vancouver, BC. Phone: 604-874-1175.