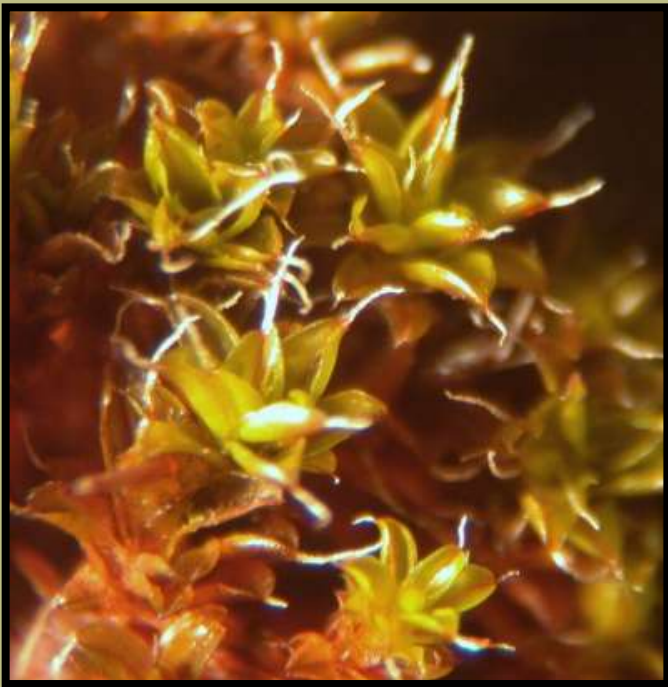


Management Plan for Twisted Oak Moss (*Syntrichia laevipila*) in Canada

Twisted Oak Moss



August 2011



Parks
Canada

Parcs
Canada

Canada

Recommended citation:

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For copies of the management plan, 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 (<http://www.sararegistry.gc.ca>).

Cover illustration: Terry McIntosh (with permission)

Également disponible en français sous le titre
« Plan de gestion de la tortule à poils lisses (*Syntrichia laevipila*) au Canada »

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RECOMMENDATION AND APPROVAL STATEMENT

The Parks Canada Agency led the development of this federal management plan, working together with the other competent minister(s) for this species under the Species at Risk Act. The Chief Executive Officer, upon recommendation of the relevant Park Superintendent(s) and Field Unit Superintendent(s), hereby approves this document indicating that Species at Risk Act requirements related to management plan development (sections 65-72) have been fulfilled in accordance with the Act.

Recommended by:



Dale Redford
A/Field Unit Superintendent, Coastal BC Field Unit, Parks Canada Agency

Approved by:



Alan Latourelle
Chief Executive Officer, Parks Canada Agency

MANAGEMENT PLAN FOR THE TWISTED OAK MOSS (*Syntrichia laevipila*) IN CANADA

August 2011

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.

In the spirit of cooperation of the Accord, the Government of British Columbia has provided the 'Management Plan for twisted oak moss (*Syntrichia laevipila*) in British Columbia' to the Government of Canada. The federal Minister responsible for the Parks Canada Agency and the federal Minister of the Environment as the competent ministers under the Species at Risk Act (SARA) adopt or incorporate, in whole or in part, this management plan pursuant to section 69 of the Act, with any exceptions or modifications as detailed within the body of this document.

The finalized management plan, once included in the Species at Risk Public Registry, will be the SARA management plan for this species. Implementation of this plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

The SARA management plan for the Twisted Oak-Moss in Canada consists of two parts:

1. The Management Plan for twisted oak moss (*Syntrichia laevipila*) in British Columbia being adopted/incorporated, developed by the British Columbia Bryophyte Recovery Team and Garry Oak Ecosystems Recovery Team for the Province of British Columbia (Appendix 2).
2. The federal text which completes the existing management plan in terms of meeting the requirements of SARA section 65. This text included additions, exceptions or modifications to the document being adopted or incorporated, in whole or in part.

EXECUTIVE SUMMARY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated Twisted Oak Moss (*Syntrichia laevipila*) as Special Concern in Canada in 2004. It is listed as ‘Special Concern’ on the federal *Species at Risk Act* (SARA).

Twisted Oak Moss is a small moss species that grows in clumps on tree bark, primarily on Garry oaks (*Quercus garryana*). These trees are found in Garry oak ecosystems, which are nationally threatened. Its current Canadian range consists of 27 occurrences in southwestern British Columbia.

Potential threats to the survival of Twisted Oak Moss populations include loss of host trees, direct removal from host trees, lack of recruitment of host trees, and air pollution. Tree harvesting and pruning could threaten populations found on private property.

The management goal is to maintain known populations of Twisted Oak Moss in British Columbia. The management objectives for Twisted Oak Moss are as follows:

- To initiate stewardship for existing populations by 2016.
- To mitigate the threats of direct destruction to the moss and determine if lack of recruitment of host trees is a direct threat to all known populations by 2015.
- To clarify the distribution of Twisted Oak Moss in British Columbia and to update population and distribution objectives as needed by 2014.
- To increase public awareness of the existence and conservation value of Twisted Oak Moss by 2016.
- To address knowledge gaps relating to demographics, effects of competition with other species, microhabitat attributes, and microclimate and habitat conditions for this species by 2016.

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ADDITIONS, MODIFICATIONS, AND EXCLUSIONS TO THE ADOPTED OR INCORPORATED DOCUMENT

Protection under SARA

This section provides clarity on the use of "protection" in the Management Plan for twisted oak moss (*Syntrichia laevipila*) in British Columbia, (Appendix 2) in relation to the concept of protection definitions under SARA, the Act under which this document is being adopted as the SARA management plan for this species (section 69).

"Protection" is defined in the Management Plan for twisted oak moss (*Syntrichia laevipila*) in British Columbia in British Columbia in a manner which may not equate to the concept of protection under SARA. Under SARA the adequacy of a given protection measure can only be determined on a case-by-case and/or site-by-site basis. For information on protection under SARA, please see the relevant sections of the Act and the draft SARA Policies, available on the Species at Risk Public Registry.

APPENDIX 1: 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.

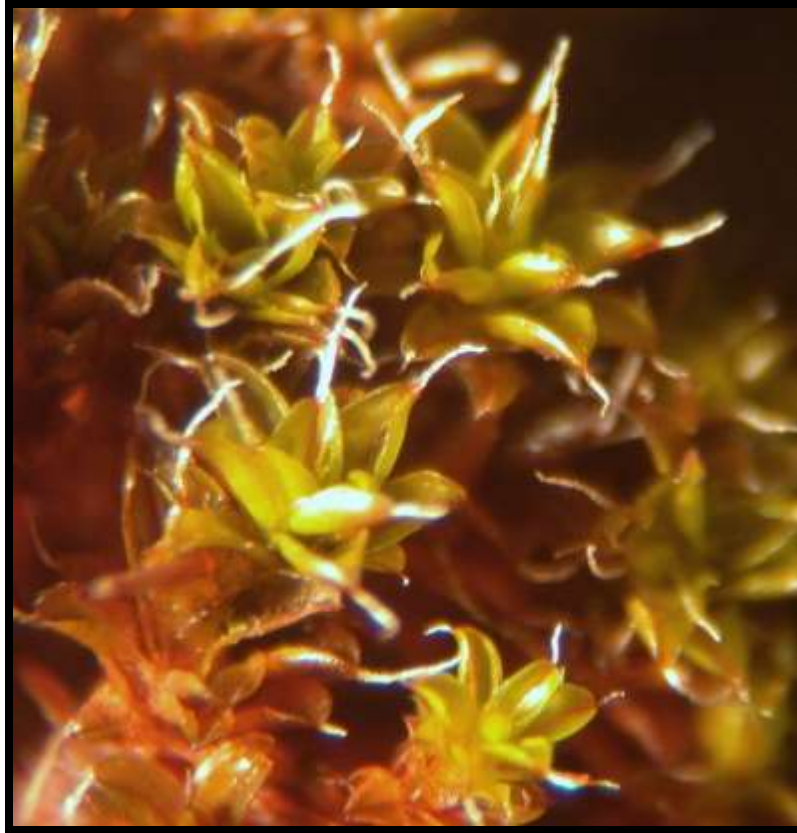
Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into section 2.6 of the management plan.

APPENDIX 2: MANAGEMENT PLAN FOR TWISTED OAK MOSS (*SYNTRICHIA LAEVIPIILA*) IN BRITISH COLUMBIA

As provided by the Government of British Columbia

British Columbia Bryophyte Recovery Team and Garry Oak Ecosystems Recovery Team. 2010. Management plan for twisted oak moss (*Syntrichia laevipila*) in British Columbia. Prepared for the B.C. Ministry of Environment, Victoria, BC. 16 pp.

Management Plan for twisted oak moss (*Syntrichia laevipila*) in British Columbia



Prepared by the British Columbia Bryophyte Recovery Team
and Garry Oak Ecosystems 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 twisted oak moss (*Syntrichia laevipila*)
in British Columbia**

**Prepared by the British Columbia Bryophyte Recovery Team
and Garry Oak Ecosystems Recovery Team**

July 2010

Recommended citation

British Columbia Bryophyte Recovery Team and Garry Oak Ecosystems Recovery Team. 2010. Management plan for twisted oak moss (*Syntrichia laevipila*) in British Columbia. Prepared for the B.C. Ministry of Environment, Victoria, BC. 16 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>>

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Disclaimer

This management plan has been prepared by the British Columbia Bryophyte Recovery Team and the Garry Oak Ecosystems 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 information, to prevent twisted oak 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 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 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 the conservation of twisted oak moss.

RECOVERY TEAM MEMBERS

BC Bryophyte recovery team members

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 twisted oak moss under the *Accord for the Protection of Species at Risk in Canada*. Parks Canada Agency and Environment Canada's Canadian Wildlife Service participated in the preparation of this management plan.

ACKNOWLEDGEMENTS

Funding was provided by the B.C. Ministry of Environment. Members of the Plants at Risk Recovery Implementation Group of the Garry Oak Ecosystems Recovery Team (GOERT) reviewed this plan, and the following contributed comments: Tracy Cornforth (DND); Carrina Maslovat (Consultant); Shyanne Smith (GOERT program manager).

EXECUTIVE SUMMARY

Twisted oak moss (*Syntrichia laevipila*) 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 twisted oak 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 twisted oak moss a conservation priority 2, under Goal 3: maintain the diversity of native species and ecosystems.

Its current Canadian range consists of 27 occurrences in southwestern British Columbia. The twisted oak moss is a small moss that is restricted to the bark of trees, mainly Garry oaks (*Quercus garryana*); these trees are found in Garry oak ecosystems, which are nationally threatened. Potential threats to the survival of twisted oak moss populations include loss of host trees, direct removal from host trees, lack of recruitment of host trees, and air pollution.

The management goal is to maintain known populations of twisted oak moss in British Columbia.

The management objectives for twisted oak moss are as follows:

1. To initiate habitat protection for existing populations by 2016.
2. To mitigate the threats of direct destruction to the moss and determine if lack of recruitment of host trees is a direct threat to all known populations by 2015.
3. To clarify the distribution of twisted oak moss in British Columbia and to update population and distribution objectives as needed by 2014.
4. To increase public awareness of the existence and conservation value of twisted oak moss by 2016.
5. To address knowledge gaps relating to demographics, effects of competition with other species, microhabitat attributes, and microclimate and habitat conditions for this species by 2016.

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1. SPECIES INFORMATION

1.1 Species Assessment Information from COSEWIC

Date of Assessment: May 2004
Common Name (population): Twisted Oak Moss
Scientific Name: *Syntrichia laevipila* Brid.
COSEWIC Status: Special Concern (met criterion for Threatened, D2, but designated Special Concern because of the high potential numbers of Garry Oak hosts).
Reason for Designation: This moss is a small species that occurs from British Columbia and Washington southward to California. The Canadian populations are at the northern limits of their range in western North America, and in Canada the species has a restricted distribution where it occurs in the area of south-eastern Vancouver Island and the Gulf Islands. The species is known from 25 sites where it is restricted to the bark of trees, in particular Garry oaks. This species is never dominant where it grows, nor is it frequent in large oak stands. Many of the known populations are in protected areas. The major threat to the species is the disappearance of mature Garry oaks, which would result in the extirpation of most populations of this species.
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

twisted oak moss¹	
Legal Designation	
Identified Wildlife² : No	B.C. Wildlife Act : No SARA Schedule :1 (2005)
Conservation Status³	
B.C. Rank: S2S3 (2007)	B.C. List: Blue Global Rank: G3G4 (2009)
Subnational Ranks⁴ : Not assessed in CA or WA	
B.C. Conservation Framework⁵	
Goal 1: Contribute to global efforts for species and ecosystem conservation.	Priority ⁶ : Not assessed
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)
Action Groups	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 is based on COSEWIC (2004), Mischler (2007), and Lawton (1971). Twisted oak moss is a small moss that grows as tufts or patches of $<1 \text{ cm}^2$ on the bark of trees, usually Garry oak (*Quercus garryana*). Its stems are usually $<5 \text{ mm}$ tall and its leaves rarely longer than 1.5 mm . The leaves are oblong and are twisted around the stem when dry, and spreading and slightly bent backwards when wet. Leaf margins are plain to sometimes weakly recurved in the middle of the leaf. In larger plants, leaf mid-ribs often extend beyond the leaf tip as smooth to toothed, clear hairpoints (Figure 1). Smaller plants are often characterized by a lack of hairpoints and the presence of small ($\sim 0.4 \text{ mm}$ long), leaf-like gemmae (asexual reproductive structures) in the upper axils of the leaves (Figure 2). The middle and upper leaf cells of twisted oak moss are isodiametric (each side of the cell has the same dimensions) to short-rectangular and covered by papillae (small bumps). The basal leaf cells are elongate, smooth, and clear. Twisted oak moss has both male and female sex organs on the same plant, which aids in successful fertilization and subsequent production of sporophytes (structures that produce spores). The sporophytes are composed of long, cylindrical capsules (which produce the spores) on the ends of long setae (stalks).

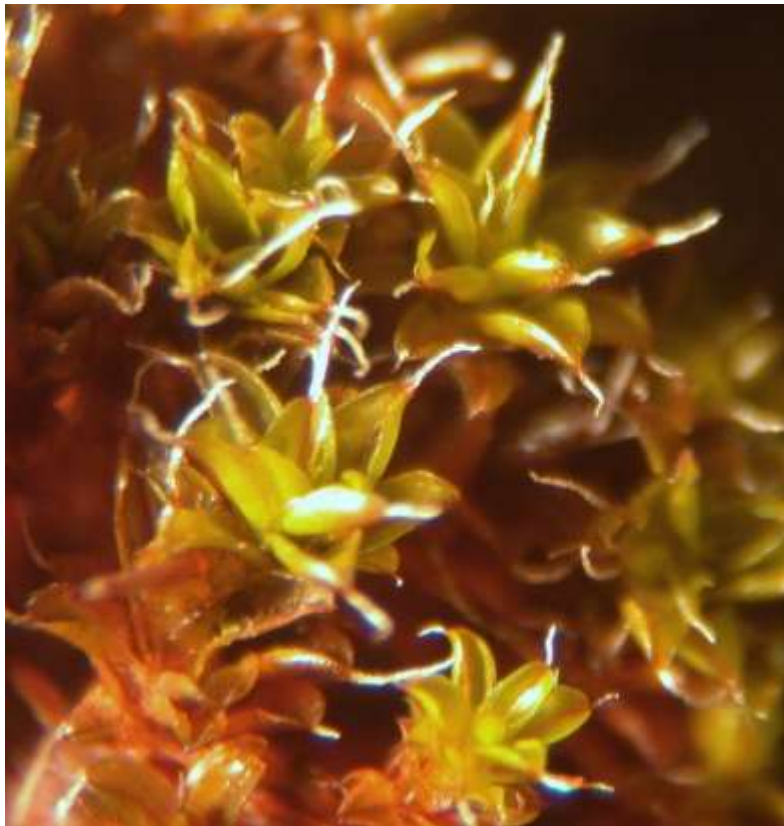


Figure 1. Twisted oak moss plants showing hairpoints on leaves ($\sim \times 15$). Photograph by T. McIntosh.



Figure 2. A patch of twisted oak moss showing plants with gemmae at tops of the stems and leaves without hairpoints (~ x 15). Photograph by W. Miles.

1.4 Populations and Distribution

Twisted oak moss has a widespread but scattered global distribution. It has been reported from North America, Chile, southern Europe, eastern Asia, Japan, South Africa, and, possibly, New Zealand and Australia (COSEWIC 2004). Its North American distribution closely follows the distribution of Garry oak ecosystems. It is found along portions of the south coast of British Columbia and inland through Washington and Oregon and into California (Figure 3); this distribution does not follow that proposed by Mischler (2007), as he includes another, more widespread species of uncertain taxonomy, *S. pagorum*, within his description.

In Canada, twisted oak moss has a narrow distribution in southern coastal B.C. (Figure 4; Table 1). It is most common in the Victoria area, with populations in the municipalities of Oak Bay, Saanich, and Victoria (Miles 2001, COSEWIC 2004). Outside of the Victoria area, twisted oak moss has been found in scattered populations: Pedder Bay, west of Victoria; Duncan, north of Victoria; Galiano Island; Salt Spring Island; and Nanoose Hill (Notch Hill), north of Nanaimo. Total populations for twisted oak moss in B.C. is 27, with two new populations documents since the COSEWIC status report (Table 1). Most occurrences are represented by numerous small (<1 cm²) patches that are restricted to relatively small areas at each site.

Before 2001, this species had been observed only occasionally in B.C. A 2001 study focusing on the distribution of the form of this species that produces gemmae (Miles 2001) showed that

twisted oak moss is relatively widespread in the Victoria area, although rather uncommon within this range. It was found on only about 5% of the hundreds of trees examined. During field work for the COSEWIC status report (COSEWIC 2004), more than 400 Garry oaks in sites near Duncan and Nanaimo and on Salt Spring Island were examined and twisted oak moss was found on only three trees. COSEWIC (2004) lists 31 populations, but some populations have been combined based on the B.C. Conservation Data Centre and NatureServe separation criteria for populations to be at least 1 km from one another (NatureServe 2009). Because of financial constraints put on her study, Miles (2001) mainly looked for and collected the smaller plants without hairpoints on the leaves. Therefore, this species may be more common in the Victoria area than her survey showed. Monitoring of populations has not been initiated.

The B.C. populations of twisted oak moss probably represent less than 1% of its global distribution and abundance (there are no reported estimates of global distribution and abundance for this moss). The population trend for the species is not known.

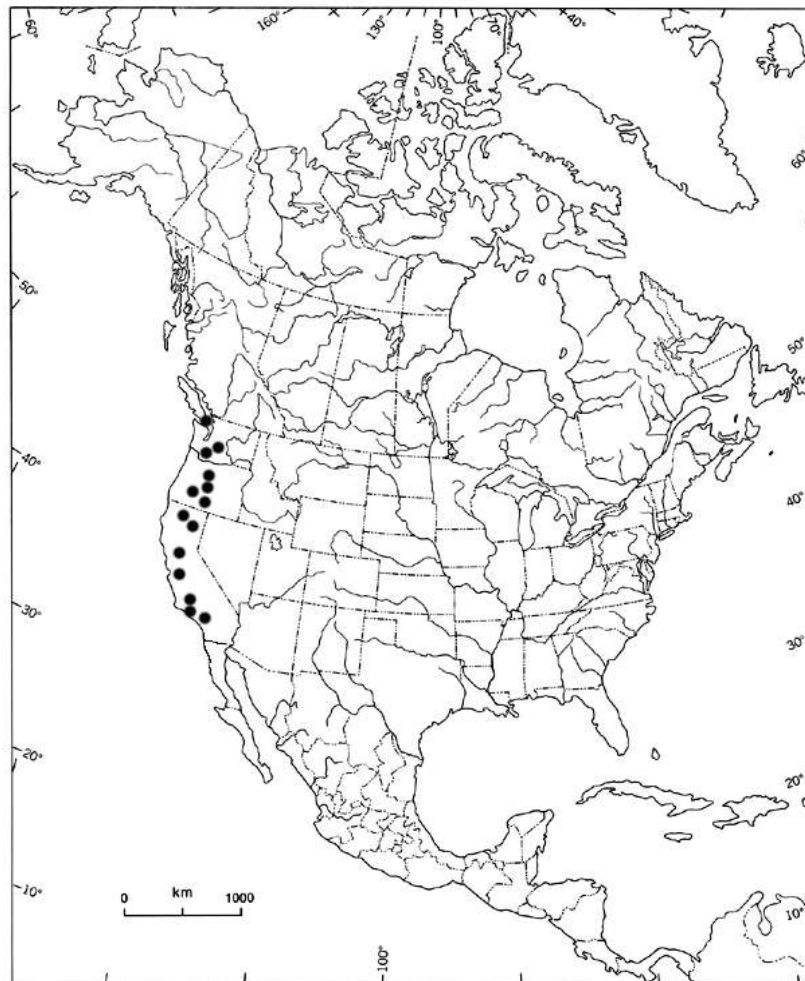


Figure 3. North American distribution of twisted oak moss (the dot in B.C. represents all extant locations).

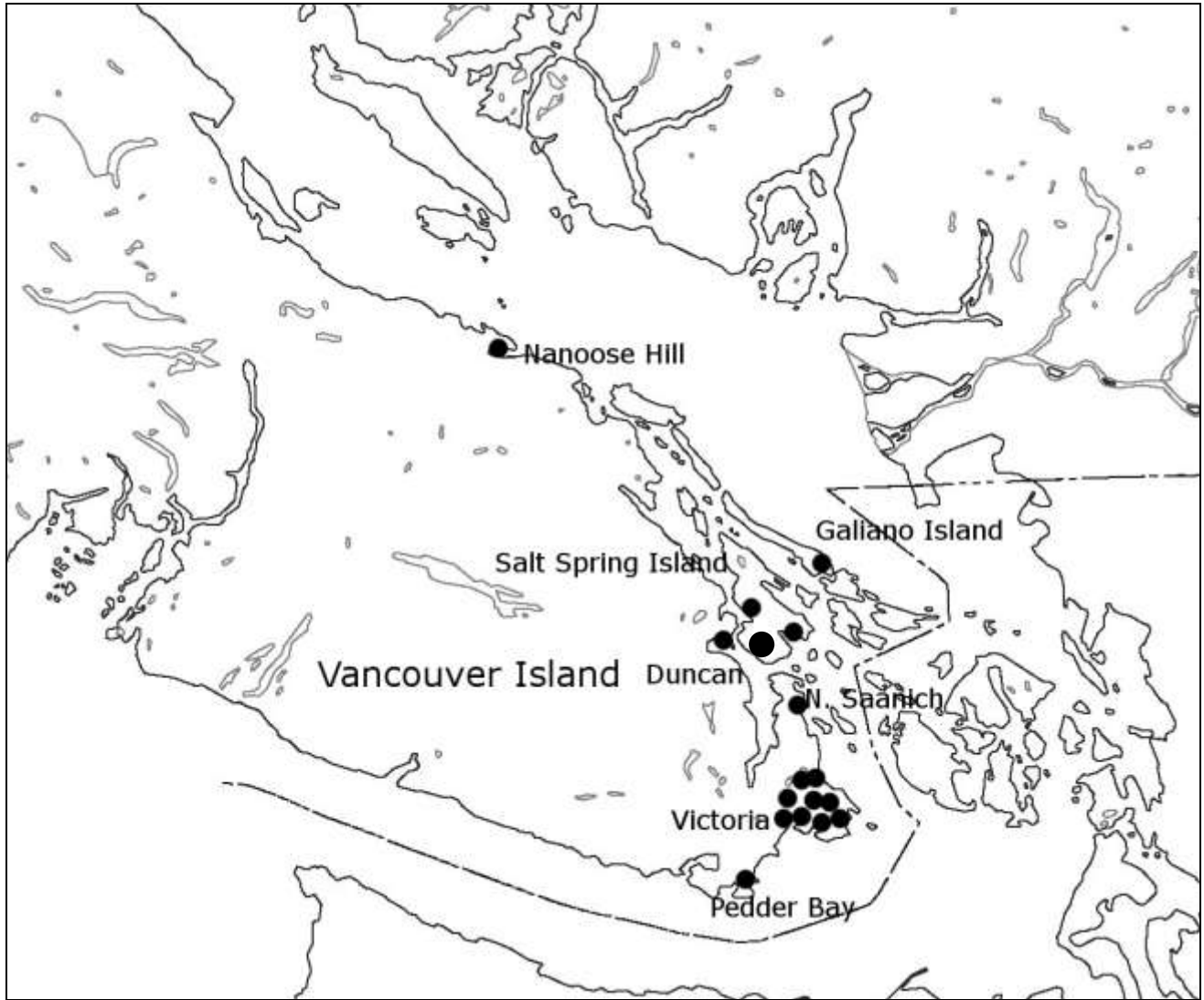


Figure 4. British Columbia distribution of twisted oak moss (the Victoria area set of dots represents multiple populations in Victoria, Langford, Esquimalt, Colwood, Oak Bay, and Saanich).

Table 1. Population¹ data for twisted oak moss in British Columbia (Miles 2001, COSEWIC 2004; populations 22 and 24 are occurrences documented since completion of the COSEWIC status report).

Population number and locality	Dates observed	Estimated number of patches and extent²	Land tenure
1. Pedder Bay	1976	? (no data collected)	unknown
2. Langford	2002	>20 patches (1.8)	municipal
3. Esquimalt	2002	>20 patches (0.7)	municipal
4. Colwood	2002	>20 patches (0.1)	municipal
5. Victoria	2001, 2002	>20 patches (0.3)	municipal park
6. Victoria	2001, 2002	5–20 patches (0.2)	municipal park
7. Victoria	2002	>20 patches (0.6)	municipal park
8. Victoria	2002, 2003	>20 patches (1.8)	private property
9. Victoria	2003	>20 patches (1.8)	municipal park
10. Victoria/Oak Bay	2007, 2008	>20 patches (>2.5) on multiple trees	Camosun College
	2001, 2002	>20 patches (1.0)	municipal
11. Oak Bay, Victoria	2001, 2002	>20 patches (1.0)	municipal
12. Oak Bay, Victoria	2002, 2003	<5 patches (<0.01)	private property
	2001, 2002	>20 patches (0.5)	municipal
13. Oak Bay, Victoria	2001, 2002, 2003	5–20 patches (0.2)	municipal park
14. Saanich	2001, 2002	5–20 patches (0.03)	municipal park
15. Saanich	2002, 2003	5–20 patches (0.03)	municipal park
	2002	>20 patches (0.6)	municipal park
	2002	5–20 patches (0.3)	likely municipal
	2001	>20 patches (0.1)	municipal park
	2001	5–20 patches (0.06)	municipal park
16. Saanich	2002	>20 patches (2.6)	municipal
17. Saanich	2002, 2003	5–20 patches (0.8)	University of Victoria
18. Saanich	2002	5–20 patches (0.4)	municipal
19. Saanich	2002	5–20 patches (0.05)	municipal park
20. North Saanich	2002	<5 patches (< 0.01)	municipal
21. Galiano Island	2002	<5 patches (0.06)	CRD regional park
22. Salt Spring Island	2006	>20 patches (<1.0)	B.C. ecological reserve (provincial government)
	2002	5–20 patches (<0.01)	
23. Salt Spring Island	2001, 2002, 2007	<5 patches (<0.02)	B.C. ecological reserve (provincial government)
24. Salt Spring Island	2005	a few patches	private property
25. Duncan	2001	unknown	Nature Conservancy of Canada
26. Duncan	1978	unknown	B.C. ecological reserve (provincial government)

¹ Populations are separated by a distance of at least 1 km based on the NatureServe criteria, and land tenure park names represent different parks. Municipal parks are managed by municipal governments (Colwood, Esquimalt, Langford, North Saanich, Oak Bay, Saanich, and Victoria), whereas regional parks are part of the Capital Regional District (CRD) parks system.

² The number in parentheses is the approximate area of the population in m²; this usually includes other bryophytes and exposed bark.

Population number and locality	Dates observed	Estimated number of patches and extent²	Land tenure
27. Nanoose Hill (Notch Hill)	1975, 1980, 2009	unknown unknown 3–5 patches (<0.03)	Department of National Defence (federal government)

1.5 Needs of Twisted Oak Moss

1.5.1 Habitat and biological needs

In B.C., twisted oak moss is restricted to the bark of trees, principally living on older Garry oaks, although it has been found once on bigleaf maple (*Acer macrophyllum*; Miles, pers. comm. 2006). It grows most commonly on lower tree trunks, but is occasionally found on the upper branches. Twisted oak moss usually forms isolated patches and is rarely found growing with other mosses or lichens, which may indicate that it does not compete well with other epiphytic species. As well, it may grow on drier and more protected microhabitats that other mosses do not utilize as habitat on the trees, but more research on microhabitats is needed to determine whether this is true (McIntosh, pers. comm. 2009). Most populations of twisted oak moss are found on trees in open habitats where the climate is characterized by hot to mild, dry summers and cool to cold, wet winters. Due to the limited number of scientific studies on this species, very little is known about its biological needs (e.g., microhabitat requirements, microclimate conditions, reproduction or dispersal mechanisms) and habitat conditions (e.g., exposure, level of shading, elevation, role of disturbance).

1.5.2 Limiting factors

Fragmentation of Garry oak ecosystems, which support the host tree for this species, along with the loss of approximately 95% of these ecosystems (Fuchs 2001) is a key limiting factor.

An additional potential limiting factor for twisted oak moss is its small size, which may be a competitive disadvantage. However, it appears that this species readily takes advantage of open microhabitats on tree bark. Due to its small size and small patch size, this species is susceptible to stochastic events.

1.6 Threats

1.6.1 Threat classification

Table 2. Threat classification for twisted oak moss.

1 Loss of host trees		Threat attributes		
Threat category	Habitat loss or degradation	Extent	Widespread	
			Local	Range-wide
General threat	Host tree removal	Occurrence	Anticipated in urban areas	Probable
		Frequency	Recurrent	Probable
Specific threat	Destruction or removal of species and alteration of habitat	Causal certainty	Medium	Probable
		Severity	High	Probable
Stress	Killing of species, reduced reproduction	Level of concern	High	
2 Direct removal from host tree		Threat attributes		
Threat category	Disturbance or harm	Extent	Localized	
			Local	Range-wide
General threat	Removal from host tree or damage	Occurrence	Anticipated in urban areas	Probable
		Frequency	Recurrent	Probable
Specific threat	Destruction or removal of species	Causal certainty	Low	Probable
		Severity	Low	Probable
Stress	Killing of species, reduced reproduction	Level of concern	Low	
3 Lack of recruitment of host trees		Threat attributes		
Threat category	Habitat degradation	Extent	Widespread	
			Local	Range-wide
General threat	Lack of Garry oak recruitment due to invasive grasses, browsing, and conifer encroachment	Occurrence	Anticipated in urban areas	Unknown
		Frequency	Recurrent	Unknown
Specific threat	Lack of future suitable habitat	Causal certainty	Low	Unknown
		Severity	Low	Unknown
Stress	Decreased recruitment, lower population viability, local extirpation	Level of concern	Medium	

1.6.2 Description of the threats

Loss of host trees

Urbanization, road construction, and agricultural development have all been the cause of the removal of mature Garry oak trees. Most or all of the populations and their viability could be reduced or populations extirpated if the host tree is removed. Garry oak tree removal (for safety or residential housing development) has occurred in the past and is ongoing due to urban development and home yard maintenance activities. Three of the known populations of twisted oak moss are within ecological reserves, which do not allow the removal of Garry oaks, but the three identified private properties are potentially under this threat. There is no information on the remaining populations regarding this threat.

Direct removal from host tree

Some landowners remove mosses and lichens from oaks on their property and may unknowingly remove patches of twisted oak moss. Damage can occur to the moss found at the bases of oaks in parks during routine grass or weed maintenance, and dog urination has killed mosses at the bases of some trees where the twisted oak moss has been seen (McIntosh, pers. comm. 2009). Branch pruning has happened historically and is ongoing due to urban development and home yard and municipal maintenance activities. These activities are anticipated to occur in the future, especially in urban areas.

Lack of recruitment of host trees

On many urban private properties young oaks are often removed, particularly from cultivated lawn areas. However, there is no information on the specific occurrence of these threats to the known populations. Since there may be mature oaks at some locations that can support twisted oak moss, it may take some time before the lack of recruitment of Garry oak affects twisted oak moss in these locations. Whether lack of recruitment will affect twisted oak moss needs to be determined for each of the known populations.

In certain areas of urban Victoria, there are resident deer populations that browse on all types of vegetation, including oak saplings and seedlings. In some areas, such as in the Mount Maxwell Ecological Reserve on Salt Spring Island, there are abundant older oaks; most are 90–140 years old, while some veterans date back to the 1700s (Smith, pers. comm. 2009). However, regeneration of oaks in this ecological reserve is minimal, apparently due to browsing by deer and feral sheep, although the situation is improving following efforts to remove the sheep.

Potential threats

Other potential contributors to the lack of recruitment of host trees in some areas are invasive grasses, which produce a thick thatch and may not allow acorns to reach safe germination sites, and the encroachment of conifer trees, mainly Douglas-fir (*Pseudotsuga menziesii*), due to fire suppression.

Air pollution may be a potential threat to twisted oak moss populations in the Victoria area. Adams and Preston (1992) note that compared to other moss species in the United Kingdom,

twisted oak moss appears to be one of the most sensitive and adversely affected by air pollution. Many of the known sites for twisted oak moss in B.C. are near roadways; automobile exhaust pollution may affect some populations, although this is unknown. Most or all of the urban populations could have their viability reduced and some could be extirpated.

1.7 Actions Already Completed or Underway

The Garry Oak Ecosystems Recovery Team (GOERT) has a land owner contact program for informing land owners of the potential for Garry oak species to be found on their lands. The team has also produced a field manual (GOERT 2009) to educate land owners and land managers about species at risk found in Garry oak ecosystems, including twisted oak moss, and to suggest management activities.

1.8 Knowledge Gaps

- Population statistics, including size and number of patches per population, are not known for many populations.
- Age of host trees is not known at the extant sites.
- Research on reproduction and dispersal success is needed.
- The distribution and land tenure of twisted oak moss needs to be clarified.
- The effects on twisted oak moss of competition with other species are not known.
- Habitat conditions (e.g., exposure, level of shading, elevation, role of disturbance) for twisted oak moss are not known.
- The microhabitat attributes (e.g., of the bark) and microclimate conditions (moisture, temperature, light exposure) for twisted oak moss are not known.
- Whether lack of recruitment is a threat to twisted oak moss at the known sites needs to be determined.
- Whether air pollution has negative effects on twisted oak moss needs to be determined.

2. MANAGEMENT

2.1 Management Goal

The management goal is to maintain known populations of twisted oak moss in British Columbia.

2.2 Rationale for the Management Goal

No quantitative management goal is possible for this species as basic population demographics and population trends are unknown for all known populations. As this species is restricted to small and specialized habitats, it is highly susceptible to being disturbed or destroyed. Therefore, to prevent twisted oak moss from becoming threatened or endangered, all known populations should be maintained. Once the knowledge gaps have been filled, particularly clarification of the species' distribution, the goal can be refined.

2.3 Management Objectives

1. To initiate habitat protection³ for existing populations by 2016.
2. To mitigate the threats of direct destruction to the moss and determine if lack of recruitment of host trees is a direct threat to all known populations by 2015.
3. To clarify the distribution of twisted oak moss in British Columbia and to update population and distribution objectives as needed by 2014.
4. To increase public awareness of the existence and conservation value of twisted oak moss by 2016.
5. To address knowledge gaps relating to demographics, effects of competition with other species, microhabitat attributes, and microclimate and habitat conditions for this species by 2016.

2.4 Recommended Management Actions

Table 3. Recommended management actions for twisted oak moss.

Priority	Obj. No.	Threat or concern addressed	Conservation Framework action group	Management action	Timeline (start date)
High	1,4	Habitat loss and degradation, Direct harm	Habitat Protection	• Determine land ownership of populations	2011
			Habitat Protection; Private Land Stewardship	• Utilize the Garry Oak Ecosystems Recovery Team's land owner contact program and outreach program to contact landowners (3) and land managers (BC Parks and Protected Areas, University of Victoria, Camosun College,	2012

³ 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.

Priority	Obj. No.	Threat or concern addressed	Conservation Framework action group	Management action	Timeline (start date)
				Department of National Defence, Capital Regional Parks, Nature Conservancy of Canada) to gain their cooperation to steward and manage lands for persistence of the species, as well as to deliver public educations and outreach concerning twisted oak moss and its management to naturalist and outdoor recreation clubs, and local governments (7).	
			Habitat Protection; Private Land Stewardship	<ul style="list-style-type: none"> Develop site-specific management plans to reduce threats and maintain or increase populations where required 	2013
			Habitat Protection	<ul style="list-style-type: none"> Review tree cutting bylaws and determine if minimal diameter of Garry oak trees is small enough to prevent removal, and recommend changes to various municipalities if not 	2012
			Habitat Protection	<ul style="list-style-type: none"> Establish monitoring protocols to assess populations and their responses to management techniques 	2012
High	2	ALL	Monitor Trends	<ul style="list-style-type: none"> Establish monitoring protocols to assess threats 	2012
			Monitor Trends	<ul style="list-style-type: none"> Monitor sites to assess the effects of mitigation actions and protection measures 	2012
			Monitor Trends	<ul style="list-style-type: none"> Collect ongoing data on site parameters that will allow interpretation of population trends 	2013
			Monitor Trends	<ul style="list-style-type: none"> Adapt management of sites based on the above and on type of land tenure 	2014
High	3	Knowledge gap: population statistics; clarification of distribution	Compile Status Report	<ul style="list-style-type: none"> Survey all known sites to determine population size 	2012
			Compile Status Report	<ul style="list-style-type: none"> Conduct inventory surveys in areas of potential habitat that have not been previously searched and document any new populations 	2013
Medium	5	Knowledge gaps	Compile Status Report	<ul style="list-style-type: none"> Conduct demographic studies 	2014
			Compile Status Report	<ul style="list-style-type: none"> Determine the effects of 	2014

Priority	Obj. No.	Threat or concern addressed	Conservation Framework action group	Management action	Timeline (start date)
			Compile Status Report	competition from other species • Determine microhabitat attributes	2014
			Compile Status Report	• Determine microclimate and habitat conditions	2014
			Compile Status Report	• Determine if lack of recruitment of Garry oak trees is a threat to this species	2012
			Compile Status Report	• Determine air pollution effects	2014
			Compile Status Report	• Determine age class of host trees	2014

Recommended actions have been categorized by the action groups of the Conservation Framework.

Habitat protection

Once the knowledge gaps have been investigated for the compilation of an updated COSEWIC status report, habitat protection measures should be implemented on the unprotected populations. Currently, of the 27 known populations, there are three private locations and one unknown tenure (population #1 at Pedder Bay). To protect these unprotected populations, municipal tree protection bylaws could be amended to include the protection of young, smaller diameter Garry oaks as well as the retention of mature Garry oak trees. The remainder of the 27 populations are on municipal property, two are on institutional lands (University of Victoria and Camosun College) one on federal lands (Department of National Defence), three are in ecological reserves, one is on Nature Conservancy lands, and one is in a regional park. Protection at these 27 sites could be improved by adopting some existing best management practices for urban and rural development within British Columbia developed by the Ministry of Environment (Ministry of Environment 2006); the BMPs include a general section on Garry oak ecosystems. However, more specific best management practices could be developed for this ecosystem and the associated species.

Private land stewardship

Through the Garry Oak Ecosystems Recovery Team's land owner contact program, land owners and land managers can be made aware of the species and possibly engaged in future survey and stewardship activities for this species. The GOERT outreach program also works with other partners, such as the Habitat Acquisition Trust Foundation and the Garry Oak Meadow Preservation Society, to increase awareness of the values of Garry oak ecosystems.

Monitor trends

The extant populations should be revisited to confirm population sizes. Once population statistics have been gathered, an effective monitoring strategy must be implemented so that success of all aspects of the management plan can be measured. This must be completed concurrent with or closely following the documentation of population attributes.

Threats, although described in a general nature in COSEWIC (2004) need to be more fully described and understood for each known population, and possible mitigation measures need to be defined. Further, threats that can be measured must be monitored and assessed, and, if mitigative measures are introduced, these must also be monitored.

Compile status report

As baseline information is needed to complete an updated COSEWIC status report for this species, areas of potential habitat should be thoroughly investigated for twisted oak moss. In order to undertake effective management of twisted oak moss, this information should include: population statistics, including the size and numbers of patches per population, and the extent of occurrence at each known population.

Research is needed to determine the demographics, effects of competition with other species, reproduction, and dispersal methods, as well as the habitat and microhabitat attributes for this species.

2.5 Performance Measures

Objective 1: Land owners at the three private locations and land managers for all of the seven municipalities and the remaining institutional, provincial, and federal properties have been contacted and have applied the appropriate tools (e.g., stewardship, best management practices) for habitat protection by 2016.

Objective 2: Specific details about the known threats of loss of host trees, direct removal of the species from host trees, and recruitment of host trees have been investigated, and potential new threats at all known locations have been documented by 2014. Mitigation measures, best management practices, or specific site management plans are developed and monitored to decrease the impact of these threats by 2016.

Objective 3: Re-surveys of the 27 known locations on Vancouver Island have been conducted and documented by 2014. 60% of suitable habitat not previously searched in Garry oak ecosystems on lower Vancouver Island has been surveyed to document occurrence of twisted oak moss by 2016.

Objective 4: At least six land owners or land managers (in addition to those at currently known sites) within the species' potential range have been contacted and provided with education and outreach material for twisted oak moss by 2016.

Objective 5: Research on knowledge gaps (e.g., reproduction and dispersal, effects of competition from other species, microhabitat attributes, microclimate and habitat conditions) have been initiated by 2014.

2.6 Effects on Other Species

Habitat protection for this species will also protect other flora and fauna of Garry oak ecosystems. In particular, understanding the relationship between twisted oak moss and mature Garry oaks will lead to greater awareness of the importance of maintaining the remaining oaks and associated oak ecosystems. Understanding ways to increase recruitment of host trees and retention of these to maturity will also protect other species that rely on Garry oak ecosystems and will contribute to habitat protection over the long-term.

2.7 Recommended Approach for Implementation

Land managers and the public should be made aware of the species and engaged in its conservation. This can partially be accomplished by directed land owner contact programs such as through the Garry Oak Ecosystems Recovery Team. GOERT could also work with the Ministry of Environment, BC Parks and Protected Areas Branch, as well as with the municipalities, to clarify distribution and land tenure and to assess and mitigate threats (Table 3).

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Personal communications

Wynne Miles. Consultant. Victoria, BC.

Terry McIntosh. Consultant. Vancouver, BC.

Shyanne Smith. Botanist. Victoria, BC.