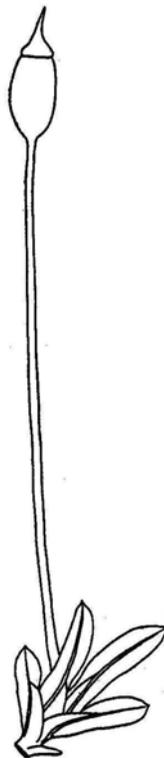


COSEWIC
Assessment and Status Report

on the

Pygmy Pocket Moss
Fissidens exilis

in Canada



SPECIAL CONCERN
2005

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA



COSEPAC
COMITÉ SUR LA SITUATION
DES ESPÈCES EN PÉRIL
AU CANADA

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

COSEWIC 2005. COSEWIC assessment and status report on the pygmy pocket moss *Fissidens exilis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 18 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Production note:

COSEWIC would like to acknowledge Jennifer Doubt for writing the status report on the pygmy pocket moss *Fissidens exilis* prepared under contract with Environment Canada, overseen and edited by René Belland, Co-chair (Mosses and Lichens), COSEWIC Plants and Lichens Species Specialist Subcommittee.

For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, ON
K1A 0H3

Tel.: (819) 997-4991 / (819) 953-3215
Fax: (819) 994-3684
E-mail: COSEWIC/COSEPAC@ec.gc.ca
<http://www.cosewic.gc.ca>

Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur la fissident pygmée (*Fissidens exilis*) au Canada.

Cover illustration:

Pygmy pocket moss — Illustration from Steere 1950.

©Her Majesty the Queen in Right of Canada 2005
Catalogue No. CW69-14/437-2005E-PDF
ISBN 0-662-40604-4
HTML: CW69-14/437-2005E-HTML
0-662-40605-2



Recycled paper



COSEWIC Assessment Summary

Assessment Summary – May 2005

Common name

Pygmy pocket moss

Scientific name

Fissidens exilis

Status

Special Concern

Reason for designation

A moss with a limited distribution in eastern North America, but which is widespread in Europe. Few populations have been documented in Canada, primarily in Ontario where it occurs in heavily populated and developed areas where natural habitats are widely known to be at serious risk. Although cryptic in habit, the species often grows with other small species that have well documented ranges. The species prefers woodlands, where it is usually found on bare clay or disturbed soil. Most locations are in areas benefiting from some level of conservation protection.

Occurrence

Ontario, Quebec

Status history

Designated Special Concern in May 2005. Assessment based on a new status report.



COSEWIC
Executive Summary

Pygmy Pocket Moss
Fissidens exilis

Species information

Fissidens exilis (pygmy pocket moss) is a minute, brown- or dark-green moss of the family Fissidentaceae—a group characterized by a “pocket” in the lower portion of each leaf, enfolding the stem. *F. exilis* is differentiated from other species by leaf characteristics, including a pocket which is not closed at the upper end, and the presence of an “intramarginal border”—unique rows of elongate cells found several cells in from the lower margin of the pocket region of each leaf.

Distribution

Fissidens exilis is known from the British Isles, central and northern Europe, Scandinavia, Japan, and New Zealand. The first discovery of *F. exilis* in North America was made in 1947, in Cleveland, Ohio, and since then it has been collected in ten other eastern states. In Canada, *Fissidens exilis* has been collected in five locales in southern Ontario (two in Essex County and one in each of Kent, Haldimand-Norfolk, and Waterloo Counties) and in two locales in southern Quebec (Gatineau Park and, reportedly, the city of Montréal).

Habitat

Fissidens exilis is found largely on bare, moist, clay soil. It usually occurs in forests, and often on soil disturbed by humans or natural events. It may be associated with ephemeral (extremely short-lived) mosses such as *Ephemerum* and *Micromitrium*. *F. exilis* habitat may be limited climatically to southern latitudes of Ontario and Quebec. Substrate appears not to be limiting, as disturbed clay is frequent in Canada. At least four of the seven Canadian sites where *F. exilis* has been collected are protected to some degree.

Biology

Very little has been published on the biology of *Fissidens exilis*. *F. exilis* disperses as spores and germinates to produce protonemata—filamentous, green precursors to recognizable leafy moss plants (known as ‘gametophytes’)—that permeate and persist

in the soil even after mature gametophytes are established. Moisture is required for photosynthesis and growth of the gametophytes and for fertilization of the egg by the sperm, which in *F. exilis* may occur by self-fertilization or out-crossing. In the absence of repeated disturbance to control moss and herb cover, the exposed soil microhabitats preferred by *F. exilis* may become increasingly less favourable due to competition by other plants, necessitating dispersal to fresh substrates. Spores, which mature in the winter, are probably the main mode of dispersal.

Population sizes and trends

No Canadian collector of *Fissidens exilis* prior to 2002 noted the abundance of the species at the time of collection, and indeed, abundance estimates are very difficult because the species cannot be identified with certainty in the field and tends to intermingle with other small *Fissidens* species. No previously recorded populations were re-discovered during field work carried out in 2002, which may reflect the imprecise location information, the short-term nature of *F. exilis*' preferred substrate, or the practical considerations associated with detecting a rare, cryptic species within a sea of similar common congeners. Field work in 2002, nevertheless, resulted in the discovery of one previously unrecorded population, which occurred in three patches sparsely occupying a total area of about 860 cm².

Limiting factors and threats

Factors limiting the distribution and population sizes of *Fissidens exilis* in Canada may include climate: Canadian populations mark the species' northern range limit in North America, although the species reaches much farther north in Europe. In Canada *F. exilis* is found in a heavily populated and developed region in which natural habitats are widely known to be at serious risk. Particularities of habitat preference, which are not well known, may also come into play. *F. exilis* is minute and inconspicuous, cannot be determined with certainty in the field, and may disperse often to re-establish on exposed substrates as competition excludes it from once-bare soil. These factors make accurate determinations of the species' distribution and abundance very difficult, and may help to explain the relatively recent discovery of *F. exilis* in North America despite widespread exploration throughout its North American range.

Special significance of the species

Fissidens exilis is known from very few Canadian sites and reaches its northern North American range limit in southern Ontario and Quebec.

Existing protection and other status designations

No legislation, regulations, customs, or conditions currently protect this species. Globally, the species is listed as G3G4 and in Ontario the moss has a rank of S1.



COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal agencies (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government members and the co-chairs of the species specialist and the Aboriginal Traditional Knowledge subcommittees. The Committee meets to consider status reports on candidate species.

DEFINITIONS (NOVEMBER 2004)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and it is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A wildlife species for which there is inadequate information to make a direct, or indirect, assessment of its risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994.



Environment
Canada

Environnement
Canada

Canadian Wildlife
Service

Service canadien
de la faune

Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Pygmy Pocket Moss

Fissidens exilis

in Canada

2005

TABLE OF CONTENTS

SPECIES INFORMATION.....	3
Name and classification.....	3
Description.....	3
DISTRIBUTION.....	6
Global range.....	6
Canadian range.....	7
HABITAT.....	7
Habitat requirements.....	7
Trends.....	8
Protection/ownership.....	8
BIOLOGY.....	9
General.....	9
Reproduction.....	10
Survival.....	10
Movements/dispersal.....	10
POPULATION SIZES AND TRENDS.....	10
LIMITING FACTORS AND THREATS.....	11
SPECIAL SIGNIFICANCE OF THE SPECIES.....	12
EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS.....	12
TECHNICAL SUMMARY.....	13
ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED.....	15
INFORMATION SOURCES.....	15
BIOGRAPHICAL SUMMARY OF REPORT WRITER.....	17
COLLECTIONS EXAMINED.....	17

List of figures

Figure 1. Illustrations of <i>Fissidens exilis</i> from Steere.....	4
Figure 2. Approximate North American distribution of <i>Fissidens exilis</i>	6

List of appendices

Appendix 1. Known Canadian collections of <i>Fissidens exilis</i>	18
---	----

SPECIES INFORMATION

Name and classification

The moss *Fissidens exilis* Hedw. belongs to the family Fissidentaceae and order Fissidentales. Within the genus, it belongs to section Aloma Müll. Hal. (Beever 1999). The genus name means “split-tooth,” referring to the teeth surrounding the open end of the spore-bearing capsule, while “exilis” means small, or slender.

Synonyms of *F. exilis* include *F. bloxamii* Wilson (Steere 1950), *Bryum viridulum* Dicks., *Dicranum exile* (Hedw.) Muhl., *Schistophyllum exile* (Hedw.) Lindb., *Skitophyllum exile* (Hedw.) Bach. Pyl., and *Hypnum minutum* Wilson (Missouri Botanical Garden 2002). The species has also been classified as a variety of *F. bryoides*, *F. viridulus*, and *Dicranum palmatum*.

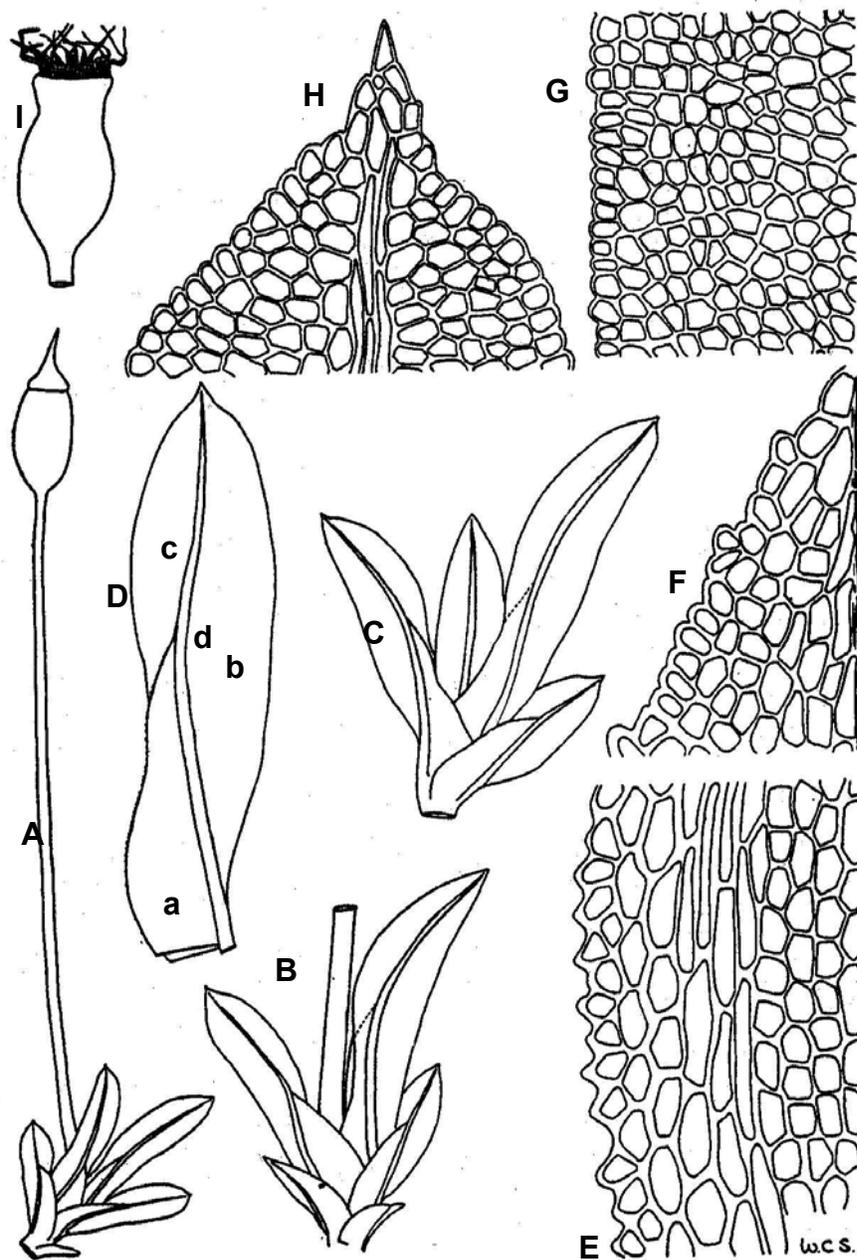
Description

Steere (1950) provides the most thorough description of *Fissidens exilis*, but it is also described and illustrated well by Crum and Anderson (1981). These descriptions are summarized below. Illustrations from Steere (1950) are reproduced in Figure 1. Definitions for technical terms used in the description below may be found in Crum and Anderson (1981) or in Magill (1990).

General: Leafy plants of *F. exilis* are dark green to dark brown in colour. They are minute, growing 1.0 – 2.0 mm high, and are scattered or gregarious (growing together, but not closely enough to form a turf). They may be mixed with other species of *Fissidens* (Molnar 1975, Steere 1950). Plants are unbranched and erect or prostrate at their bases. Persistent, abundant protonemata (filamentous, chlorophyllose precursors to recognizable leafy moss plants) are found with the plants and independently. The colour and size of *F. exilis* makes it very difficult to spot in the field, and impossible to determine with certainty without the aid of a microscope. It should be noted, however, that other small species of *Fissidens* (e.g. *F. bryoides* and *F. taxifolius* are 8 mm tall or less) have been collected abundantly in southern Ontario (Ireland & Ley 1992).

Leaves: Leaves are crowded in a single plane at the apex of the stems, arranged in 2-4 pairs of variable size with the largest pair (1 – 2.0 mm long) occurring at the tip. Leaves are oblong-lanceolate and curved with acute or obtuse and apiculate apices.

The distichous (in two rows) leaves of the genus *Fissidens* display characteristic morphology: the lower portion of the adaxial (inner) side of each leaf is doubled, forming two ‘vaginant laminae’ that generally envelop (hence the name ‘pocket moss’) the stem and the bases of the leaves above (Figure 1). The abaxial (outer) side of each leaf is known as the ‘dorsal



*Figure 1. Illustrations of *Fissidens exilis* from Steere (1950). A. Habit of leafy plant bearing sporophyte, x21. B-C. Detail of gametophyte plants, x33. D. Single leaf, x63, showing characteristic *Fissidens* morphology: a. vaginant lamina, b. dorsal lamina, c. apical lamina, d. costa. E. Areolation (cell pattern) of margin of vaginant lamina to show intramarginal border, x408. F. Cell detail of apex of vaginant lamina, at junction with costa, x408. G. Cell detail of apical lamina, from margin towards costa, x408. H. Cell detail of leaf apex, x408. I. Detail of capsule, showing peristome, x63.

*Disclaimer: the original size of the drawing may not be reproduced accurately in the figure. The scales provided should be used only as indicators of relative size. Actual length measurements are given in the text.

Lamina,' while the top (undoubled) part of the adaxial side of the leaf is called the 'apical lamina.' In *Fissidens exilis*, the vaginant laminae, one of which is tapered to the stout costa (leaf midrib) at its tip, measure about one

half of the leaf length, and are not joined distally, except at the costa. The dorsal lamina does not reach the leaf base.

The costa reaches to within a few cells of the leaf apex. Leaf margins are subentire or appear shallowly toothed because of projecting cells above and appear particularly dentate in the vaginant laminae.

Perigonal leaves (leaves of the male inflorescence) consist largely of vaginant laminae with the apical lamina represented by a short or long spine. Leaf margins are conspicuously toothed in appearance as a result of projecting cell tips. Perichaetial leaves (leaves of the female inflorescence) are much larger than the vegetative leaves, but are otherwise similar to them in appearance.

Leaf cells: Cells of *F. exilis* are smooth with thick, colourless walls. Upper leaf cells (apical and dorsal laminae) are isodiametrically polygonal, measuring 8 – 15 µm in diameter. Cells of the vaginant laminae are larger and longer, and less regular in shape. A few marginal rows of cells have thickened cell walls, and the basal cells, which are much elongated, extend upward in most leaves to form an intramarginal (two-three rows of cells in from the leaf margin) border.

Seta: The seta (stalk supporting the capsule) is pale, becoming reddish with age. It varies in length from 2 – 5 mm.

Capsule: The capsule, which contains the spores, is erect and oval or short-cylindric, measuring 0.5 – 0.8 mm in length. Once the operculum (lid of the capsule) has fallen off, the capsule constricts below its mouth. The operculum is conic-rostrate with a straight or curved beak covered early in development by a small calyptra. True to the name *Fissidens*, meaning 'split-tooth,' the (red) peristome teeth (surrounding the capsule mouth) are divided at their tips.

Sexuality: *F. exilis* is rhizautoicous, meaning that the male perigonia (containing the sperm-producing antheridia) occur on protonemata buried in mud at the base of leafy plants that bear the female perichaetia (containing the egg-producing archegonia). The perigonia are often buried in the soil at the bases of the leafy stems and may appear to be dissociated from the plants, a condition that led Steere (1950) to describe *F. exilis* as dioicous (perigonia and perichaetia occur on separate plants).

Steere (1950) notes some similarity between *Fissidens exilis* and *F. pauperculus*, *F. closteri*, and *F. pellucidus*, but suggests that “the peculiarly differentiated margin of incrassate and elongated cells” readily distinguishes *F. exilis*. Steere also suggests that the examination of herbarium material of *F. minutulus*, *F. viridulus*, and *F. bryoides* may result in the discovery of new populations of *F. exilis*.

DISTRIBUTION

Global range

Fissidens exilis is known from the British Isles, central and northern Europe, Scandinavia (Steere 1950), and Japan (Iwatsuki & Noguchi 1973). It also occurs in New Zealand, where it is thought to have been introduced (Beever 1999). NatureServe (2005) reports that it is also found in Algeria and South America. In North America, the distribution of *F. exilis* appears to reflect that of a large number of eastern deciduous forest species (e.g. Argus & Pryer 1990). In Europe, *F. exilis* occupies much higher latitudes than are attained by the species in North America.

The first discovery of *Fissidens exilis* in North America was made in 1947, in Cleveland, Ohio (Steere 1950), and since then it has been collected in ten other eastern United States (Crum & Anderson 1981, Missouri Botanical Garden 2002, New York Botanical Garden 2002) and in two Canadian provinces (Ontario, Quebec) (Figure 2). That all North American populations have been discovered only within the last 55 years or so in a relatively well-botanized region is unexplained.



Figure 2. Approximate North American distribution of *Fissidens exilis*. Black diamonds indicate sites for which the co-ordinates of the population are known. Open diamonds show states for which *F. exilis* is known but for which no exact co-ordinates are given in on-line records (Missouri Botanical Garden 2002, New York Botanical Garden 2002).

Canadian range

In Canada, *Fissidens exilis* has been collected from Essex (two localities), Kent, Waterloo, and Haldimand-Norfolk Counties in southern Ontario, and from two locales in Quebec: one in Gatineau Park, near the south end of the Ontario-Quebec border, and one in the city of Montréal (Appendix 1). The Montréal occurrence represented the first Canadian report (Molnar 1975), but no specimen supporting the claim has been found either at the McGill University McDonald Campus Herbarium (MTMG), where it was reportedly deposited (Molnar 1975) or at any of several major eastern North American herbaria. This may indicate that the specimen has been annotated, casting doubt on the occurrence record. The first Ontario record was reported by Oldham (1983).

Field work associated with this report in 2002 involved searching for minute *Fissidens* at over thirty sites in southern Ontario and Quebec that were visited for COSEWIC status reports on *Bryoandersonia illecebra*, *Helodium paludosum*, and *Fissidens exilis*. Samples were gathered from eleven sites, three of which were previously documented for *Fissidens exilis*. *Fissidens* was sought incidentally along site access routes and at sampling destinations at each site for a minimum of 1 hour and a maximum of five hours per site. Forty-six voucher collections were made. Of these, just one represented *F. exilis*. Most of the remaining samples represented *F. taxifolius*. This result after concerted search effort shows despite the small, inconspicuous aspect of *F. exilis*, undercollection does not fully account for the small number of Canadian records.

HABITAT

Habitat requirements

As Beever (1999) points out, species of *Fissidens* reflect the preference of many bryophytes for specific micro-environmental conditions. *F. exilis* is found largely on bare, moist, often clay soil. It usually occurs in woodlands but has also been collected on roadsides and floodplains where soil has been disturbed (Crum & Anderson 1981, herbarium records). It may be associated with ephemeral (extremely short-lived) mosses such as *Ephemerum* and *Micromitrium* (Crum & Anderson 1981), which are known to prefer temporary habitat patches.

In Montréal, *F. exilis* was reportedly collected from clay soil below a planted spruce-tamarack (*Picea-Larix*) canopy in the Morgan Arboretum of McGill University. In Essex County, *F. exilis* was found on the floodplain or banks of rivers, on clay in mature deciduous Carolinian forest (Appendix 1). In Kent County, the species was found on bare trailside mud in upland maple-beech forest. No habitat notes accompany the specimens from Gatineau Park, Waterloo County, or Haldimand-Norfolk County.

Trends

Mature, deciduous, Carolinian forest such as that characterizing the Essex and Kent County sites where *F. exilis* was found is increasingly rare in Canada, and many Canadian Carolinian species are endangered. However, the fact that *F. exilis* was also discovered in Gatineau Park and (reportedly) in a coniferous site in Montréal, and that the species has been found on roadsides and other anthropogenic habitats in the United States, indicates that *F. exilis* may not rely heavily on mature temperate forest, and that its habitat may therefore be more abundant. The species' known distribution (Figure 2) suggests climatic limitation and may be susceptible to change concomitant with long-term climate change.

Protection/ownership

Bare clay soil may be found in many forested privately owned and public protected areas in southern Ontario and Quebec. The details of habitat preference in *F. exilis* are not well known; only an unknown subset of these sites would be likely to support populations of the species.

At one Essex County (Canard River) site where *F. exilis* has been recorded, the land is privately owned, but is adjacent to the Canard Valley Conservation Area (CVCA), where bare clay substrate is abundant. The CVCA has been listed as one of the top botanical sites in Essex County (Varga & Allen 1990). Although fifteen bryophyte collections made by J. Doubt in the CVCA in 2002 proved, upon laboratory inspection, not to represent *F. exilis*, more research should be conducted there. The other Essex County (Cedar Creek) site for *F. exilis* falls within the Cedar Creek Area of Natural and Scientific Interest (ANSI) and was recently purchased by the Nature Conservancy (Ron Gould, personal communication 2005), providing it some protection through stewardship and municipal zoning. The Cedar Creek ANSI is described by Eagles and Beechey (1985) as the most significant natural site in Essex County not under public ownership, due to its large size, its potential for beneficial research and education, and its high aesthetic and historical value. The national and provincial importance of the Cedar Creek ANSI is widely acknowledged among local and provincial authorities, who take close interest in activities at the site.

Kent and Haldimand-Norfolk County populations of *F. exilis* occur on land managed by local Conservation Authorities, and as such are protected from certain kinds of disturbance. Sinclair's Bush, the Kent County site, houses seven rare plant species, and has special designation as a Carolinian Canada site. However, only four acres of the site is actually owned by the Conservation Authority (Valerie Towsley, personal communication 2002). Although voluntary conservation is encouraged by the municipality through incentive programs, the absence of a tree-cutting by-law and heavy development pressure has resulted in recent clearing and road building in privately owned sectors of the site. It should be noted that *F. exilis* was found on a trail, and its persistence may rely on disturbance by foot traffic. The Gatineau Park and Morgan Arboretum (Montréal) populations are presumably protected, but without knowing the

location or conditions under which the species was found, protection cannot be assessed. The effect of infrastructure, management activities, or visitor activities on the populations cannot be determined.

Sudden Tract, where the Waterloo County population of *F. exilis* occurs, consists mainly of municipally owned regional forest (Chris Gosselin, personal communication 2003). The forest, and some adjacent privately owned land were designated in 1976 as an Environmentally Sensitive Policy Area (ESPA #52), giving it protection from development. The exceptional conservation value of Sudden Tract in terms of rare species (including plants, birds, and salamanders) is well-recognized and promoted. Human activities such as active management intervention to preserve natural species and processes and recreational hiking may influence local plant populations.

BIOLOGY

Very little has been published on the biology of *Fissidens exilis*. As an acrocarpous, autoicous, soil-dwelling moss, *F. exilis* possesses the characteristics summarized below.

General

The moss life cycle has four main stages, each of which is characterized by different ecological requirements:

1. *Dispersal* — Mosses such as *F. exilis* disperse as spores, which sift into the air through specialized teeth surrounding a hole, or “peristome,” at the end of the capsule. Upon contact with a favourable substrate in a suitable microhabitat, spores germinate to produce protonemata.
2. *Establishment* — At the protonemal stage, mosses may be very sensitive to desiccation. Leafy plants grow from the protonemata.
3. *Growth* — Gametophytes of *Fissidens exilis* proliferate vegetatively by outward expansion of filamentous protonemata from existing plants. Protonemata, in turn, initiate the growth of new leafy plants. The expansion of acrocarpous moss colonies relies on the addition of new plants to the colony. Moisture is required for photosynthetic activity and growth.
4. *Reproduction* — Gametophytes produce sessile eggs and flagellate sperm, and free water is required for the two to unite. A fertilized egg, still enclosed within the gametophyte, grows into a sporophyte consisting of a spore-filled capsule at the end of a stalk, or ‘seta.’

Reproduction

As discussed in the species description, *F. exilis* is autoicous, meaning that male perigonia, containing the antheridia and female perichaetia, containing the archegonia, both occur on each gametophyte. This makes self-fertilization possible, eliminating the need for male and female plants to occur close together to ensure spore production. At least five of the seven Canadian collections of *F. exilis* bear sporophytes (one of the two remaining collections could not be located) (Appendix 1). Spores mature in the winter (Steere 1950).

Survival

The persistent protonemata of *F. exilis* may influence the species' survival. Embedded in the substrate, thereby avoiding water loss and minor surface disturbance, the protonemata may form an important 'diaspore bank' to maintain populations through periods during which environmental conditions prohibit growth and reproduction of mature gametophytes. They may also facilitate the expansion of colonies by invading nearby substrates.

Fissidens exilis relies on bare, clayey mineral soil, making it vulnerable to successional changes in its habitat. In places where disturbance returns periodically (e.g. stream and river banks, floodplains), soil may be kept bare, or new patches may open as old ones are covered with vegetation. In other cases where the disturbance is not repeated, however, *F. exilis* may be eliminated over time. Populations of species of patchy, temporary substrates may be more difficult to track than more perennial species, as they may move frequently.

Movements/dispersal

As noted above, *F. exilis* is autoicous, making self-fertilization possible and spore production likely. Spore production is very important to 'shuttle' type species reliant upon patchy, temporary, but locally recurring substrates (e.g. During 1979). Fragmentation of the embedded protonemata is also possible with repeated soil disturbance, which is characteristic of the riparian habitats preferred by *F. exilis*. If this form of dispersal is important, riparian corridors would also provide an important dispersal route. However, demographic evidence demonstrating dispersal rates/modes and establishment ability are not available.

POPULATION SIZES AND TRENDS

Trends in individual populations of *F. exilis* could not be determined because previously known populations were neither described in detail at the time of their discovery, nor re-discovered in association with this report. Difficulty in finding previously recorded populations does not necessarily indicate decline or extirpation, because very little detail concerning the population locations was available to direct field

searches. Furthermore, the species' persistent protonemata, which are presumably more common than the shorter-lived mature gametophytes, cannot be reliably identified, even at the family level, and populations lacking distinguishable leafy gametophytes at the time of the field work would not have been recorded. It is also possible that collecting by J. Doubt in 2002 failed to detect mature *F. exilis* at the sites, because small *Fissidens* abunds on muddy substrates in southern Ontario and species tend to intermingle. In the absence of characters for field recognition, collectors must gather a representative sample for lab identification. Rare species are less likely to be detected with this somewhat random (but necessary) approach. Finally, a species reliant on bare (disturbed) soil would be expected to disperse and re-establish often in response to increasing competition from plants and plant litter as post-disturbance succession progresses. Long-term persistence at narrowly defined sites is probably not in the nature of *F. exilis*, although it may be expected to persist in a general area in which patches of suitable substrate predictably recur. Despite these factors, one previously unrecorded population of *F. exilis* was discovered. This population occurred in three patches sparsely occupying a total area of about 860 cm².

Field work in 2002 was conducted at over thirty southern Ontario and Quebec sites. Field sites represented previously documented sites for *F. exilis* or for other species (*Helodium paludosum*, *Bryoandersonia illecebra*) for which COSEWIC field work was under way, or sites thought likely to support these species. At eleven sites, minute *Fissidens* species were located and collected for laboratory identification, only one of which proved to represent *F. exilis*. Additional field work involving extensive sampling throughout the suspected Canadian range of *F. exilis* is likely to result in the (re)discovery of more populations (Wilf Schofield, personal communication 2004).

LIMITING FACTORS AND THREATS

Factors limiting the distribution and population sizes of *F. exilis* in Canada include climate, as Canadian populations mark the species' northern range limit in North America. Canadian populations of *F. exilis* fall within a highly populated region of the country, where air and water pollution, habitat destruction, and habitat fragmentation have affected the survival of many plant species (e.g. Argus & Pryer 1990, Klinkenberg *et al.* 1990, Lamb & Rhynard 1994, Maycock 1963, Oldham 1990). However, over the geographic range of *F. exilis*, apparently suitable bare soil remains abundant, even in protected areas with unimpeded native vegetation coverage. Human activities, including recreation and conservation management, have the potential to affect the species' survival even at protected sites (as outlined in Habitat Protection / Ownership), particularly if managers are unaware of the species' presence. Particularities of habitat preference (such as forest age, shade characteristics), which are not well known, may help to account for the species' apparent rarity.

SPECIAL SIGNIFICANCE OF THE SPECIES

Fissidens exilis has been collected from seven Canadian sites since 1973, only three of which were confirmed in the current decade. The species reaches its northern limit of its North American range in southern Ontario and Quebec.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Fissidens exilis is currently ranked G3G4 (NatureServe 2005), indicating some uncertainty about the global population: a rank of G3 is reserved for species that are rare to uncommon, usually with between 20 and 100 occurrences worldwide, that may be susceptible to large-scale disturbances; G4-ranked species are common, usually with more than 100 occurrences, and are not susceptible to immediate threats (Ontario Natural Heritage Information Centre 2002). In Ontario, *F. exilis* is ranked S1 (March 2000), meaning that there are five or fewer known Ontario occurrences (ONHIC 2002). Across the international border, in New York, *F. exilis* is ranked SU, showing that its status is “uncertain because of the cryptic nature of the plant” (Clemants & Ketchledge 1993). No centralized database of rare moss occurrences exists in Quebec.

TECHNICAL SUMMARY

Fissidens exilis

Pygmy pocket moss

Range of Occurrence in Canada: ON, QC

fissident pygmée

Extent and Area information	
<ul style="list-style-type: none"> • extent of occurrence (EO)(km²) 	30,000 km ² (estimated from Figure 2)
<ul style="list-style-type: none"> • specify trend (decline, stable, increasing, unknown) 	Stable
<ul style="list-style-type: none"> • are there extreme fluctuations in EO (> 1 order of magnitude)? 	No
<ul style="list-style-type: none"> • area of occupancy (AO) (km²) 	<1 km ²
<ul style="list-style-type: none"> • specify trend (decline, stable, increasing, unknown) 	Unknown
<ul style="list-style-type: none"> • are there extreme fluctuations in AO (> 1 order magnitude)? 	No
<ul style="list-style-type: none"> • number of extant locations 	7
<ul style="list-style-type: none"> • specify trend in # locations (decline, stable, increasing, unknown) 	Unknown
<ul style="list-style-type: none"> • are there extreme fluctuations in # locations (>1 order of magnitude)? 	No
<ul style="list-style-type: none"> • habitat trend: specify declining, stable, increasing or unknown trend in area, extent or quality of habitat 	Not known
Population information	
<ul style="list-style-type: none"> • generation time (average age of parents in the population) (indicate years, months, days, etc.) 	Perennial – generation time unknown
<ul style="list-style-type: none"> • number of mature individuals (capable of reproduction) in the Canadian population (or, specify a range of plausible values) 	One location recorded in 2002 contained three patches totalling 860 cm ² .
<ul style="list-style-type: none"> • total population trend: specify declining, stable, increasing or unknown trend in number of mature individuals 	Unknown
<ul style="list-style-type: none"> • if decline, % decline over the last/next 10 years or 3 generations, whichever is greater (or specify if for shorter time period) 	Not applicable
<ul style="list-style-type: none"> • are there extreme fluctuations in number of mature individuals (> 1 order of magnitude)? 	Not applicable
<ul style="list-style-type: none"> • is the total population severely fragmented (most individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange, i.e., ≤ 1 successful migrant / year)? 	Yes
<ul style="list-style-type: none"> • list each population and the number of mature individuals in each 	One population has three patches totaling 860 cm ² .
<ul style="list-style-type: none"> • specify trend in number of populations (decline, stable, increasing, unknown) 	Unknown
<ul style="list-style-type: none"> • are there extreme fluctuations in number of populations (>1 order of magnitude)? 	Unknown
Threats (actual or imminent threats to populations or habitats)	
Human activities, including recreation and conservation management, have the potential to affect the species' survival even at protected sites (as outlined in Habitat Protection / Ownership), particularly if managers are unaware of the species' presence.	

Rescue Effect (immigration from an outside source)	
• <i>does species exist elsewhere (in Canada or outside)?</i>	Yes
• <i>status of the outside population(s)?</i>	Unknown
• <i>is immigration known or possible?</i>	Unknown
• <i>would immigrants be adapted to survive here?</i>	Yes
• <i>is there sufficient habitat for immigrants here?</i>	Yes
Quantitative Analysis	Not applicable

Status and Reasons for Designation

Status: Special Concern	Alpha-numeric code: Not Applicable
<p>Reasons for Designation: A moss with a limited distribution in eastern North America, but which is widespread in Europe. Few populations have been documented in Canada, primarily in Ontario where it occurs in heavily populated and developed areas where natural habitats are widely known to be at serious risk. Although cryptic in habit, the species often grows with other small species that have well documented ranges. The species prefers woodlands, where it is usually found on bare clay or disturbed soil. Most locations are in areas benefiting from some level of conservation protection.</p>	
<p>Applicability of Criteria</p>	
<p>Criterion A (Declining Total Population): Data not available.</p>	
<p>Criterion B (Small Distribution, and Decline or Fluctuation): Meets criteria for Threatened B2a (area of occupancy less than 500 km², 7 locations, and the Canadian populations are severely fragmented). However, a decline in habitat or area of occupancy cannot be demonstrated (b).</p>	
<p>Criterion C (Small Total Population Size and Decline): Data not available for population size.</p>	
<p>Criterion D (Very Small Population or Restricted Distribution): Area of occupancy is less than 20 km², and there are 7 locations in Canada. However, criterion for Threatened D2 is not met because there is no evidence that the species could become Endangered or Extirpated in a short period of time since the locations are spread over a large geographic area, and most of the locations are in areas benefiting from some level of conservation protection.</p>	
<p>Criterion E (Quantitative Analysis): Not applicable.</p>	

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

The author gratefully acknowledges the helpful correspondence of Mike Oldham regarding his collections of *F. exilis*. Anne Godbout and other staff of the Morgan Arboretum were invaluable in facilitating the preparation and execution of field work in Montréal. Mike Shchepanek and Pak Yau Wong of the Canadian Museum of Nature provided access to specimens and the means to examine and record them.

Funding for the preparation of this status report was provided by the Canadian Wildlife Service, Environment Canada.

Authorities contacted

Ron Gould, Species at Risk Biologist, Aylmer District Office of the Ontario Ministry of Natural Resources.

Chris Gosselin, Manager of Environmental Planning for the Region of Waterloo, which manages the Sudden Tract where *F. exilis* was recorded in 1995.

Deb Jacobs, Species at Risk Biologist with the Chatham office of the Ontario Ministry of Natural Resources, which is responsible for the Cedar Creek ANSI in Essex County where *F. exilis* was found.

Linda Ley of Ottawa, Ontario, an experienced bryologist with extensive experience in CANM collections, collectors, and collecting history, and who identified the MNR samples of *F. exilis* cited in this report.

Mike Oldham of the Ontario Natural Heritage Information Centre, who collected *F. exilis* in Essex County, and who manages rare species occurrence data for Ontario.

Marcia Waterway of the McGill University (MacDonald campus) herbarium.

René Belland of the Devonian Botanic Garden in Edmonton Alberta, an experienced bryologist who has collected extensively in Canada.

Robert Ireland of Annandale, Virginia, an experienced bryologist who identified several Canadian specimens of *F. exilis*.

Valerie Towsley of the Lower Thames Conservation Authority, which manages Sinclair's Bush Conservation Area where *F. exilis* occurred in 2002.

Wilf Schofield of the Department of Biology, University of British Columbia, an experienced bryologist who has collected extensively in Canada.

INFORMATION SOURCES

Argus, G.W. & Pryer, K.M. 1990. Rare Vascular Plants in Canada – Our Natural Heritage. Canadian Museum of Nature, Ottawa, Canada. 191 pp.

Beever, J.E. 1999. Studies of Fissidens (Bryophyta: Musci) in New Zealand: a synopsis and key to taxa. New Zealand Journal of Botany 37: 659-670.

Clemants, S.E. & E.H. Ketchledge. 1993. New York Natural Heritage Program Rare Moss Status List. Available on-line at www.nynhp.org.

Crum, H.A. & L.E. Anderson. 1981. Mosses of Eastern North America. Columbia University Press, New York. 1328 pp.

- During, H.J. 1979. Life strategies of bryophytes: A preliminary review. *Lindbergia* 5:2-18.
- Eagles, P.F.J. and T.J. Beechey (eds.) 1985. Critical Unprotected Natural Areas in the Carolinian Life Zone of Canada. Final Report, Identification Subcommittee, Carolinian Canada. The Nature Conservancy of Canada, The Ontario Heritage Foundation and World Wildlife Fund (Canada). 400 pp.
- Ireland, R.R. and L.M. Ley. 1992. Atlas of Ontario Mosses. Syllogeus No. 70, Canadian Museum of Nature, Ottawa, Canada. 138 pp.
- Iwatsuki, Z. & A. Noguchi. 1973. Index muscorum Japonicarum. *Journal of the Hattori Botanical Laboratory* 37:299-418.
- Klinkenberg, R., J.M. Bowles, & M. Kanter. 1990. Summary report on the Kent-Elgin Natural Areas Survey. In G.M. Allen, P.F.J. Eagles, & S.D. Price (Eds.), *Conserving Carolinian Canada: Conservation Biology in the Deciduous Forest Region*. University of Waterloo Press, Waterloo, Canada. 346 pp.
- Lamb, L. & G. Rhynard. 1994. *Plants of Carolinian Canada*. Federation of Ontario Naturalists, Don Mills, Canada. 51 pp.
- Magill, R.E. (Ed.) 1990. *Glossarium polyglottum Bryologiae: A multilingual glossary for bryology*. Missouri Botanical Garden, St. Louis, U.S.A. 297 pp.
- Maycock, P.F. 1963. The phytosociology of the deciduous forests of extreme southern Ontario. *Canadian Journal of Botany* 41:79-438.
- Missouri Botanical Garden. 2002. On-line herbarium records
<http://mobot.mobot.org/W3T/Search/most.html>.
- Molnar, L. 1975. New distribution data on two mosses, *Fissidens exilis* and *Thuidium pygmaeum*, in Quebec. *The Canadian Field Naturalist* 89: 324-325.
- NatureServe. 2005. On-line Encyclopedia of Life.
http://www.natureserve.org/explorer/servlet/NatureServe?menuselect=none&sourceTemplate=tabular_report.wmt&loadTemplate=species_RptComprehensive.wmt&selectedReport=RptComprehensive.wmt&summaryView=tabular_report.wmt&elKey=126738&paging=home&save=true&startIndex=1&nextStartIndex=1&reset=false&offPageSelectedElKey=126738&offPageSelectedElType=species&offPageYesNo=true&post_processes=&radiobutton=radiobutton&selectedIndexes=126738&menuelectfooter=none
- New York Botanical Garden. 2002. Online herbarium index:
http://scisun.nybg.org:8890/searchdb/owa/wwwspecimen.search_list?taxon=Fissidens+exilis&projcode=BRYO.
- Oldham, M.J. 1990. Provincially rare plants of the Carolinian zone. In G.M. Allen, P.F.J. Eagles, & S.D. Price (Eds.), *Conserving Carolinian Canada: Conservation Biology in the Deciduous Forest Region*. University of Waterloo Press, Waterloo, Canada. 346 pp.
- Oldham, M.J. 1983. *Fissidens exilis*, a moss new to Ontario. *Ontario Field Biologist* 37: 38.
- ONHIC (Ontario Natural Heritage Information Centre) 2002. On-line species lists.
http://www.mnr.gov.on.ca/mnr/nhic/queries/listout.cfm?el=n&sort=sci_name&alpha=f
- Steere, W.C. 1950. Notes on *Fissidens*. II. The discovery of *Fissidens exilis* in North America. *The Bryologist* 53: 131-136.

Varga, S. & G.M. Allen. 1990. County/regional municipality vascular plant floras for the Carolinian zone of Canada. In G.M. Allen, P.F.J. Eagles, & S.D. Price (Eds.), *Conserving Carolinian Canada: Conservation Biology in the Deciduous Forest Region*. University of Waterloo Press, Waterloo, Canada. 346 pp.

BIOGRAPHICAL SUMMARY OF REPORT WRITER

Jennifer C. Doubt completed a B.Sc. in Botany at the University of Guelph in 1995. In 2001, she received an M.Sc. in Bryophyte Ecology at the University of Alberta for work on bryophyte diversity in Waterton Lakes National Park, Alberta. As a botanical consultant based in Edmonton, Alberta, she specializes in bryophyte inventories, identifications, and rare species surveys and assessments. She is well known in western Canada as an instructor of bryophyte identification skills and contributor to provincial rare species tracking efforts. Having collected and identified over 10, 000 bryophyte specimens, she has accumulated considerable field experience across Canada.

COLLECTIONS EXAMINED

A list of the known Canadian specimens of *Fissidens exilis* is provided in Appendix 1.

Appendix 1. Known Canadian collections of *Fissidens exilis*.

“Spec. Loc.” refers to the institution(s) that house each specimen (Canadian Museum of Nature (CANM), McGill University (MTMG), Devonian Botanic Garden (DBG)). Where accession numbers are available, they are also provided in this column. Under ‘Sporos,’ the presence or absence of fruiting bodies is noted.

Spec. Loc.	Sporos	Locality Habitat	Collector Collecting # Date	Determined / Examined by
CANM 290756	Present	Canada, Ontario, Essex County, Anderdon Township, “Canard River Kentucky Coffee Tree Woods”	M.J. Oldham B-255	R.R. Ireland 1985
CANM 275055	Present	Floodplain woods, on lumps of clay Canada, Ontario, Essex County, Colchester South Township	March 24, 1984 M.J. Oldham B-35	R.R. Ireland 1982
DBG	Absent	Mature deciduous woods, oak-dominated Canada, Ontario, Kent County, Municipality of Chatham-Kent. Sinclair’s Bush Conservation Area (Lower Thames Conservation Authority)	March 26, 1981 J.C. Doubt 9348 August 16, 2002	J.C. Doubt 2003
Ontario Ministry of Natural Resources	Present	Maple / Beech forest, on bare mud (no debris or herb cover). Canada, Ontario, Haldimand-Norfolk County, Walsingham Township, Deer Creek Conservation Area (Long Point Region Conservation Authority) south of Langton, Ontario	OMNR 10-17-5350-47250 June 22, 1995	L.M. Ley
Ontario Ministry of Natural Resources	Present	Veg type FOM3-1 Canada, Ontario, Waterloo County, North Dumfries Township, Sudden Tract (Region of Waterloo), southwest of Cambridge, Ontario	OMNR 10-17-5500-47900 September 23, 1995	L.M. Ley
CANM 291533	Present	Veg type ‘FOD6-5’ (Deciduous Forest) Canada, Quebec, Gatineau County, Gatineau Park	J.Ranger June 1982	R.R. Ireland 1985
MTMG? (as cited by Molnar 1975)	No record of sample at MTMG	Canada, Quebec, west end of the Island of Montréal, Macdonald campus of McGill University, Morgan Arboretum In a planted spruce-tamarack association on clay soil	L. Molnar Fall 1973	R.R. Ireland