

***Conservation Assessment  
for  
Walking fern (*Asplenium rhizophyllum*) L.***



*Photo: Arien Tal*

***USDA Forest Service, Region 9***  
March 2002



*This document is undergoing peer review, comments welcome*

*This Conservation Assessment was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation Assessment for the Eastern Region of the Forest Service. It does not represent a management decision by the U.S. Forest Service. Though the best scientific information available was used and subject experts were consulted in preparation of this document, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if you have information that will assist in conserving the subject taxon, please contact the Eastern Region of the Forest Service - Threatened and Endangered Species Program at 310 Wisconsin Avenue, Suite 580 Milwaukee, Wisconsin 53203.*

## Table of Contents

<b>ACKNOWLEDGEMENTS .....</b>	<b>4</b>
<b>EXECUTIVE SUMMARY .....</b>	<b>4</b>
<b>NOMENCLATURE AND TAXONOMY (W-1).....</b>	<b>5</b>
<b>DESCRIPTION OF SPECIES .....</b>	<b>5</b>
<b>HABITAT AND ECOLOGY.....</b>	<b>6</b>
<b>DISTRIBUTION AND ABUNDANCE .....</b>	<b>7</b>
<b>PROTECTION STATUS.....</b>	<b>9</b>
<b>LIFE HISTORY.....</b>	<b>10</b>
<b>POPULATION BIOLOGY AND VIABILITY .....</b>	<b>11</b>
<b>POTENTIAL THREATS.....</b>	<b>12</b>
<b>RESEARCH AND MONITORING .....</b>	<b>13</b>
<b>RESTORATION.....</b>	<b>13</b>
<b>SUMMARY .....</b>	<b>14</b>
<b>REFERENCES.....</b>	<b>14</b>
<b>CONTACTS .....</b>	<b>17</b>

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### **Initial Draft**

We are grateful to Julie Williams, contract horticulturist with the Hiawatha National Forest, for her efforts in providing us with an original draft for this Conservation Assessment.

## **EXECUTIVE SUMMARY**

This Conservation Assessment is a review of the distribution, habitat, ecology and population biology of walking fern (*Asplenium rhizophyllum* L.) in the Upper Peninsula of Michigan and throughout the United States and Canada. In Michigan, this species is listed as S2S3 (S2: very rare; S3: Rare to uncommon). Globally, its ranking is G5 (demonstrably secure globally, though it may be quite rare in parts of its range, especially

at its periphery). *A. rhizophyllum* is found in the eastern half of the United States and Canada from Quebec to Minnesota, Georgia, Alabama, Kansas, Arkansas, and Oklahoma. It is found without risk (not listed as a Sensitive species) on the Shawnee National Forest, Hoosier National Forest, Chequamegon-Nicolet National Forest and the Green Mountain National Forest. Situated near the northern edge of this species range on limestone outcrops, the Hiawatha National Forest lists *A. rhizophyllum* as a Region 9 Forest Sensitive Species.

In addition to species listed as endangered or threatened under the Endangered Species Act (ESA), or species of Concern by U.S. Fish and Wildlife Service, the Forest Service lists species that are Sensitive within each region (RFSS). The National Forest Management Act and U.S. Forest Service policy require that National Forest System land be managed to maintain viable populations of all native plant and animal species. A viable population is one that has the estimated numbers and distribution of reproductive individuals to ensure the continued existence of the species throughout its range within a given planning area.

The objectives of this document are to:

- Provide an overview of the current scientific knowledge.
- Provide a summary of the distribution and status range wide and within the Eastern Region of the Forest Service.
- Provide the available background information needed to prepare a subsequent Conservation Approach.

## **NOMENCLATURE AND TAXONOMY (W-1)**

Scientific Name:	<i>Asplenium rhizophyllum</i> L.
Common Names:	walking fern
Synonymy:	<i>Camptosorus rhizophyllum</i> (L.) Link
Class:	Pteridopsida (Filicopsida)
Order:	Aspleniales
Family:	Aspleniaceae
Plants Code:	ASRH2 (USDA NRCS plant database)

*Asplenium rhizophyllum* is closely related to an east Asian vicariant or sibling species known as *A. sibiricum* (= *Camptosorus sibiricus* Rupr.) (Tryon & Tryon 1982).

## **DESCRIPTION OF SPECIES**

*Asplenium rhizophyllum* is a distinctive fern growing in connected circular tufts, characterized by slender long-tapering lance-shaped leaves with heart-shaped (cordate) to strongly lobed (auriculate) bases. The long-tapering leaf tips elongate and arch forming

new plants where the tips contact the surface, leading to the common name of walking fern (Penskar & Higman 1997).

Material for this section is from Morin 1993, Cobb 1968, Lellinger 1985, and Illinois Plant Information Network.

<b>Roots:</b>	Adventitious, fibrous, not proliferous.
<b>Rhizome:</b>	Erect or ascending, usually unbranched; scales dark brown
<b>Fronds:</b>	Fronds 1-5cm wide having net-like (reticulate) veins and may range from 10-30 cm. in length; rooting at apex.
<b>Type:</b>	Simple, monomorphic, evergreen
<b>Margin:</b>	Entire, undulate
<b>Shape:</b>	Single fronds often are 2-3 cm wide and 12-16 cm long. Long-tapering, narrowly triangular, lanceolate blades with heart shaped (cordate) to strongly lobed (auriculate) bases.
<b>Petiole:</b>	Reddish brown at base, becoming green distally, dull but sometimes lustrous at base, 0.5-12cm, 0.1-1.5 times length of blade; indument of dark brown, narrowly deltate scales at base, club-shaped minute hairs distally.
<b>Rachis:</b>	Green, dull, nearly glabrous
<b>Sori:</b>	Numerous, scattered somewhat irregularly over blade, between midrib and leaf margin, often joined at vein junctures
<b>Indusia:</b>	Thin, whitish, entire
<b>Spores:</b>	64 per sporangium, mature August-October

#### **Identification notes:**

One may confuse *A. rhizophyllum* with the rare American hart's tongue fern (*A. scolopendrium* var. *americana*); however, the hart's tongue fern can "be distinguished by its much larger, broader fronds that are somewhat shiny, wavy-margined (puckered), and have relatively abrupt, blunt-pointed tips" (Penskar & Higman 1997).

## **HABITAT AND ECOLOGY**

*Asplenium rhizophyllum* "occurs primarily on alkaline rock substrates and appears to require moist microhabitat and moderately to densely shaded conditions often growing in dense moss; however, for initial colonization it may require exposed, rock substrate" (Penskar & Higman 1997). *A. rhizophyllum* is an epipetric plant of cliffs, rocks, boulders, edges or cracks and crevices of moist limestone outcroppings, usually with a northerly exposure (TNC 1993). *A. rhizophyllum* grows "on enormous boulders" on Manitoulin Island in Lake Huron (Morton & Venn 1984). Occasionally *A. rhizophyllum* is epiphytic on fallen tree trunks; it is found on moss covered decaying white cedar logs on south Manitou Island within Sleeping Bear National Lakeshore (Penskar & Higman 1997).

A critical element of this species habitat are moss mats composed of several moss species including *Rhodobryum roseum* and several *Mnium* and *Brachythecium* species, as well as the availability of moist crevices and other cavities to serve as initial colonization niches (Penskar & Higman 1997). In Mackinac County, Michigan several moss species were found often growing with the walking fern: *Anomodon attenuatus*, *A. rostratus*, *Mnium cuspidatum*, and *Rhodobryum ontariense* (Evans 1997).

In the eastern forest communities of Michigan's Upper Peninsula, "typical canopy trees include *Acer saccharum* (sugar maple), *Tilia americana* (basswood), *Abies balsamea* (balsam fir), *Fraxinus americana* (white ash), and *Betula alleghaniensis* (yellow birch). Common herbaceous species associated with walking fern in Michigan include: *Polypodium virginianum* (common polypody), *Polystichum lonchitis* (northern holly fern), *Geranium robertianum* (herb-Robert), *Cystopteris fragilis* (fragile fern), *Asplenium trichomanes* (maidenhair spleenwort), and occasionally rare ferns such as the State Threatened *A. trichomanes-ramosum* (green spleenwort) and the State Endangered *A. scolopendrium* (American hart's-tongue fern)" (Penskar & Higman 1997).

In the Upper Peninsula of Michigan, *A. rhizophyllum* exhibits a strong affinity for dolomitic limestone outcrops and boulders of the Niagara Escarpment. The dolostones and low cliff and boulder outcrops associated with the Niagara Escarpment in Upper Michigan are predominately from the high purity Engadine Group (Lindwall 1995). On the Hiawatha National Forest in Mackinac County, this fern species is found in communities such as mesic northern forest, dry-mesic northern forest, as well as upland cedar forest (Evans 1997, Chapman 1986). Chadde (1999) lists the following species as often occurring with *A. rhizophyllum* in the Upper Peninsula of Michigan: fragile fern (*Cystopteris fragilis*), bulblet fern (*Cystopteris bulbifera*), slender rock-brake (*Cryptogramma stelleri*), and Canada columbine (*Aquilegia canadensis*). Evans (pers. comm. 2001) lists *Cystopteris fragilis* (bulblet fern), *Polystichum braunii* (Braun's holly fern), *Sambucus racemosa* (red-berried elder), and *Galium triflorum* (bedstraw).

## **DISTRIBUTION AND ABUNDANCE**

*A. rhizophyllum* is found in eastern North America, ranging from southern Ontario and Quebec, south to Georgia, Alabama, and Mississippi, west to southeastern Minnesota, Iowa, eastern Kansas, northwestern Arkansas (W-7), and Oklahoma (Lellinger 1985). Walking fern is most frequent in the southeastern portion of its range.

Michigan harbors 25 occurrences, most of them in the Eastern Upper Peninsula. The highest concentration of *A. rhizophyllum* in Michigan is in Mackinac County. *A. rhizophyllum* typically occurs on tops and north-facing sides of large, moist, limestone and dolomite boulders and escarpment outcrops in second growth, mesic northern forests within the Niagara Escarpment region. In Michigan, it is found in Delta, Dickinson, Chippewa, Houghton, Keweenaw (historic, non-specific location per M. Penskar pers. comm 2002), Mackinac, Leelanau, and Alpena (MNFI 1999, MNFI 2001b). In the Lower Peninsula, "walking fern occurs on walls and ledges of limestone sinkholes" (TNC 1993).

In Minnesota, walking fern grows in damp, shady situations on calcareous rocks in the southeastern (eleven) counties of the state (Tryon 1980, W-8). Bell Herbarium has 64 specimens from 11 Minnesota counties. Almost one-third (19) of the occurrences are known from a State Forest in the southeast, the Dorer Memorial Hardwood State Forest (University of Minnesota herbarium, W-8). Whitewater State Park in Winona County provides refuge for another six occurrences (University of Minnesota Herbarium, W-8).

In Wisconsin, approximately one-half the occurrences are in the southwest corner of the state along limestone bluffs overlooking the Mississippi River. There are numerous (40+) scattered occurrences in the eastern portion of Wisconsin terminating with the Door Peninsula. Only six occurrences are indicated in northern Wisconsin which is outside the region of limestone bedrock (Wisconsin Herbarium, W-10). All occurrence figures are likely underestimated since walking fern is considered relatively common in Wisconsin and therefore not tracked (S. Spickerman pers. comm. 2001). Presumably the favored distribution in the southwestern corner of Wisconsin would be accurate due to the abundance of limestone cliffs in that region.

Walking fern was found historically in both New Hampshire and Maine in small pockets of limestone outcrops in granite landscapes. It is infrequent in Rhode Island occurring in a calcareous bedrock community in shaded, moist woodlands (TNC 1993). In Vermont, it occurs on clearly calcareous rock outcrops and boulders in enriched northern hardwood stands at about 1500 foot elevation (Deller pers. comm. 2001). Two sites are known from the Green Mountain National Forest (Burbank & Deller pers. comm. 2001), but the Forest does not list this species as Sensitive (RFSS 2000). Walking fern is found in most counties within New York, with the exceptions of Long Island and the southwestern unglaciated tier of the state. In New York this species is also limited to calcareous bedrock or boulder substrates in forest settings (Evans pers. comm. 2001).

“ The habitat in Illinois, where walking fern is scattered throughout the state, is described as rocky woodlands, either on sandstone or limestone” (TNC 1993). Walking fern is most common in the southern quarter of the state and along the Mississippi River; it is absent from the central portion of the state (Mohlenbrock 1967). Walking fern is common and not tracked in Indiana, but there are at least 25 sites for *A. rhizophyllum* on the Hoosier National Forest (S. Olson, pers. comm.). The majority of Hoosier National Forest sites are in the Crawford Upland, an area of sandstone with numerous interbedded limestones and calcareous shales. Most of the ferns occur near a contact zone with a limestone formation. Many sites are protected by sandstone overhangs where they are well protected from drying by wind and sun. Populations on the Hoosier are generally small, consisting of a “parent” and a few generations, spreading over a rock face (S. Olson, pers. comm. 2001).

In the eastern two-thirds of Tennessee (W-2) and the other Southeastern states, walking fern is found in the Appalachian Mountains and the Piedmont on limestone rocks and ledges in moist woods, and in rock crevices of limestone boulders (Radford *et al.* 1968).

In North Carolina, the habitat “consists of mafic or calcareous rock outcrops in forested areas; outcrops may also be subcalcareous or submafic such as calcite-cemented sandstone, siltstone, or mudstone, or intermediate composition of gneiss, schist, or igneous rock” (TNC 1993). “Walking fern is generally found in moss mats over thin soil (less than 1 cm) on outcrops or on boulder fields, shaded talus, or periglacial boulder fields. In Appalachian outcrop areas, the soil pH usually ranges from 5.0 to 5.5” (TNC 1993).

In Canada, Soper (1962) notes that the Niagara Escarpment geological formation, with its extensive areas of exposed limestone and dolomites formed along the contact line between the Silurian and Ordovician eras of the Paleozoic period, is one of the prime areas for *A. rhizophyllum* in North America.

## PROTECTION STATUS

Currently, the official status of *Asplenium rhizophyllum* with respect to Global, Federal, and State Conservation Status is (NatureServe, W-5):

<b>U.S. Fish and Wildlife Service:</b>	Not listed (None)
<b>U.S. Forest Service, Region 9 Sensitive:</b>	Hiawatha National Forest (MI State Threatened) Species not tracked in either Wisconsin or Minnesota.
<b>Global Heritage Status Rank:</b>	G5
<b>U.S. National Heritage Status Rank:</b>	N? (July 1993)
<b>Canada National Heritage Status Rank:</b>	N? (August 1993)

### Individual State Status: (NatureServe)

Alabama	SR	Missouri	SR
Arkansas	SR	New Hampshire	S1
Connecticut	SR	New Jersey	S4
Delaware	SX	New York	SR
Georgia	SR	North Carolina	S3
Illinois	S4S5	Ohio	SR
Indiana	SR	Oklahoma	SR
Iowa	S4	Pennsylvania	S?
Kansas	SR	Rhode Island	S1
Kentucky	S?	South Carolina	S2
Maine	SX	Tennessee	SR
Maryland	SR	Vermont	S4
Massachusetts	SR	Virginia	SR
Michigan	S2S3	West Virginia	S?
Minnesota	SR	Wisconsin	SR

Mississippi S1S2

**Canadian Provinces Status:** (NatureServe)

Ontario S4

Quebec S2

**Definitions (W-5)**

S1: Extremely rare; typically 5 or fewer known occurrences in the state; or only a few remaining individuals; may be especially vulnerable to extirpation.

S2: Very rare; typically between 6 and 20 known occurrences; may be susceptible to becoming extirpated.

S3: Rare to uncommon ; typically 21 to 50 known occurrences; S3 ranked species are not yet susceptible to becoming extirpated in the state but may be if additional populations are destroyed.

S4: Common; apparently secure under present conditions; typically 51 or more known occurrences, but may be fewer with many large populations; usually not susceptible to immediate threats.

S5: Very common; demonstrably secure under present conditions.

SX: Species has been determined or presumed to be extirpated. All historical occurrences have been searched, or all known sites have been destroyed, and a thorough search of potential habitat has been completed.

SR: Reported from the state, but without persuasive documentation that would provide a basis for either accepting or rejecting the species.

**LIFE HISTORY**

*Asplenium rhizophyllum* is an evergreen perennial herb. “The sporangia are borne on leaf undersides in elongated, linear sori scattered along the veins in irregular rows” (TNC 1993). The spores disperse to available microhabitat from August to October (Billington 1952).

The fronds are long and tapering towards the tip, becoming a threadlike ribbon of a leaf that buds and roots at the tip to form a new plant, thus “walking” over boulders or rocks. Walking fern gets its name from its ability to proliferate through tip rooting. Two or three generations originate from one parent plant (Billington 1952).

Until recently, walking fern was placed in its own genus *Camptosorus*, because the sori of walking fern grow at all different angles on the backs of the fronds. It is now assigned to the genus *Asplenium* because it hybridizes so commonly with other *Asplenium* species and is clearly congeneric with them (TNC 1993). For example, *Asplenium pinnatifidum* (lobed spleenwort) arose as a hybrid between *A. rhizophyllum* and *A. montanum* (mountain spleenwort) (W-1). *A. rhizophyllum* is part of a complex of Appalachian spleenworts researched by Wagner (1954) in a study of hybridization and backcrossing (Penskar & Higman 1997). The reticulate evolution described by Wagner based on morphology has been confirmed by electrophoresis of enzyme systems (Werth *et al.* 1985). The genetic integrity of the three diploid species (*A. rhizophyllum*, *A. platyneuron* (ebony spleenwort), *A. montanum* (mountain spleenwort)) is borne out by large genetic distances among them. However, *A. rhizophyllum* has a lower distance value from *A. montanum* than it does from *A. platyneuron* (Werth *et al.* 1985).

## POPULATION BIOLOGY AND VIABILITY

In a study of plasticity of gametophytes (Greer & McCarthy 1999), gametophyte emergence rates were compared for four species of ferns in southeastern Ohio; rates of emergence were lowest 20-30% for *Asplenium rhizophyllum* compared to 60% for *Athyrium pycnocarpon* (glade-fern). To compensate for a likelihood of increased mortality, three of the four species including *A. rhizophyllum* exhibited greater reproductive effort in environments that were unfavorable to growth (Greer & McCarthy 1999).

*Asplenium rhizophyllum* has bisexual gametophytes. A propensity for self-fertilization may facilitate the distribution of these species to isolated habitats such as rock outcrops. *A. rhizophyllum* maintained a constant gametophyte across all four soil treatments and exhibited a great amount of plasticity of reproductive effort. The ability to drastically increase reproductive effort in nutrient-poor environments facilitates rapid establishment of sporophytic offspring which may explain the ability of *A. rhizophyllum* to colonize rock outcrops (Greer & McCarthy 1999).

“*Asplenium rhizophyllum* is primarily epipetric (occurring on a rock substrate) and typically requires moist, calcareous rock outcrops in moderately to densely shaded conditions. It is usually associated with bryophyte beds, but may require exposed rock substrate for initial colonization” (TNC 1993). Once established, walking fern proliferates through tip rooting, often forming dense colonies over large boulders and other rock surfaces (TNC 1993).

Occurrences on the Hiawatha range from six plants to a large unspecified population extending over 0.5 miles. Nine element occurrences are listed for the East unit of the Hiawatha National Forest (HNF) in *Acer saccharum* dominated forests (MNFI 1999). One site is rated at A (population is reasonably large, habitat good, unlikely to drop below a threshold from which it cannot recover) in terms of long-term viability. Two

other HNF sites have been given ratings of B (medium-size population, landscape is somewhat connected, surrounding landscape in fair condition) (MNFI 2001a). The Hiawatha National Forest sites represent about one-third of the state's occurrences (MNFI 1999).

Summary from (W-4)

Habit:	Forb
Life Cycle:	Perennial
Reproduction:	Sexual (spores); vegetative by leaf tips
Major Spore Dispersal Agent:	Wind, long distance dispersal

## POTENTIAL THREATS

The primary threat to *Asplenium rhizophyllum* is a lack of moist, shaded microhabitats. It is important that the present forest canopy be maintained. All known populations of *A. rhizophyllum* occur in at least partially shaded areas, so “even selective cutting or shelterwood cuts near a population of *A. rhizophyllum* may cause enough desiccation to damage populations” (TNC 1993).

Logging activities that eliminate the required shade and humidity are a major threat; canopy removal also makes the area more susceptible to colonization by invasive non-native plants (Schultz pers. comm. 2001). Other potential threats include nearby trail placement, overcollection by botanists and rock gardeners, and the effects of recreationists such as rock climbers when the fern is found on ledges (TNC 1993). In small colonies, slugs and snails can disrupt establishment by repeatedly eating the growing tip thus preventing propagation of the parent plant (W-3).

Habitat fragmentation can also have profound effects on the success and persistence of local populations. Any activities that result in barriers to dispersal, such as developments, clearcuts, road/utility line corridors, and mined areas limit the possibility of population expansion and genetic exchange. Deleterious effects of fragmentation could possibly go unnoticed for a period of time, making the short term effects on species viability less apparent. Over time, as populations become increasingly more isolated, the effects of fragmentation can potentially be observed at the molecular level by reduced genetic frequencies caused by random drift (Evans 1993).

In Michigan the major threat to populations is overstory removal through logging activities, including the felling of logs onto boulders during timbering or road maintenance activities, periodic defoliation of canopy vegetation by insect pests such as the gypsy moth, and limestone mining (Evans pers. comm. 2001, TNC 1993). The best management practice is “to leave large tracts unharvested and to allow natural processes (growth, senescence, windthrow, fire, and disease to operate unhindered” (Cohen 2000). When tracts are managed for timber, care should be taken to minimize fragmentation and maintain a canopy closure comparable to pre-harvest conditions (Cohen 2000). Johnson and Van Wagner (1985 *cf* Cohen 2000) suggest that a landscape should be at least twice

the size of the largest disturbance event; individual downbursts in the Great Lakes can be as large as 3785 ha. (Frelich & Lorimer 1991). Another threat is the colonization of large boulders by invasive non-native weeds if the overstory is removed (Schultz pers. comm. 2001).

## RESEARCH AND MONITORING

Currently, there are no known monitoring programs for *A. rhizophyllum*. In the Hiawatha National Forest, Michigan there are ongoing surveys of *A. rhizophyllum*, as well as catalogued sitings of the species and future planned studies, all of which should provide adequate baseline data and help to ascertain population trends in relation to artificial and natural disturbance regimes and habitat characteristics.

In order to most effectively manage this species, long term monitoring is needed to determine population trends and specific habitat needs. One of the best ways to monitor walking fern is to track coverage with permanent quadrants, because the main mode of reproduction is asexual via tip rooting (TNC 1993). The most reasonable survey time is when new fronds are maturing in mid-May through mid-October (Penskar & Higman 1997). Overall conservation of *Asplenium rhizophyllum* is dependent upon protection of its habitat from major disturbances. Evans (1997) suggests that rock size and density may be important factors to consider in selecting sites for restoration or in selecting areas of suitable habitat to provide linkages between populations in Eastern Upper Michigan. Although never completely analyzed, Evans work included data collection at many rock outcrop areas that lacked rare ferns. Further analysis of this data may serve to strengthen the claim that *A. rhizophyllum* and associated rare epipetric fern species may individually or collectively, be found in areas with a particular range of rock cover, distribution, and size (Evans pers. comm. 2001).

Recommended monitoring practices for *Asplenium rhizophyllum* include: “1) mapping, quantifying, and classifying habitat characteristics of known populations to establish baseline conditions with a Geographic Information System database, 2) monitoring plant numbers within populations as well as tracking plant distribution over time with respect to canopy openings and competition with other associated groundcover and outcrop flora, including bryophytes, 3) tracking response to the invasion of non-native weeds in given areas, and 4) studying populations with regard to varying light levels and types of disturbances to understand responses to these factors” (TNC 1993).

## RESTORATION

There are currently no restoration programs in place for *Asplenium rhizophyllum*. However, the fact that walking fern can be grown in rock gardens by adding crushed limestone (Tryon & Tryon 1982, W-3) indicates that there is an excellent potential for restoration and reintroduction of the species in the wild if suitable microhabitat exists. Protection from drought needs to be provided during the establishment period by

restoration of forest overstory (shaded conditions) in areas that were logged, substrate is also critical and suitable alkaline boulders must exist in the area (Evans pers. comm. 2001).

In Michigan, “several exemplary populations of *A. rhizophyllum* are protected, including colonies found within the Hiawatha National Forest, Sleeping Bear National Lakeshore and a Michigan Nature Association preserve” (TNC 1993). *A. rhizophyllum* is absent from many sites in Michigan that appear to contain suitable habitat. The Hiawatha National Forest is evaluating several walking fern sites for incorporation into the Hiawatha’s old-growth system.

## SUMMARY

Globally *A. rhizophyllum* is a reasonably secure species as evident by its G5 status. In particular, *A. rhizophyllum* is fairly frequent in southern Ontario along the Niagara Escarpment. It is also sufficiently common within the southeastern portion of its range in the Smoky Mountains Region where there is abundant limestone outcrop habitat in North Carolina and Tennessee. In Michigan, *A. rhizophyllum* has a Threatened status (MNFI 1998), since the few known sites occur in the eastern Upper Peninsula along the Niagara Escarpment, a unique community type. In the Midwest and the southeastern states, logging has resulted in the loss of needed forest canopy which provides the shady, moist microhabitats that this species requires.

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## CONTACTS

Chequamegon-Nicolet National Forest, Wisconsin:

Quita Sheehan, Plant Ecologist (715) 479-2827

Steven Spickerman, West Zone Plant Ecologist (715) 264-2511

Steve Janke, East Zone Plant Ecologist (715) 276-6333

Hiawatha National Forest, Michigan: Jan Schultz, Forest Plant Ecologist  
(906) 228-8491

Shawnee National Forest, Illinois: Beth Shimp, Forest Botanist (618) 253-1053

Hoosier National Forest, Indiana: Steve Olson, Forest Botanist (812) 547-7051

Green Mountain National Forest, Vermont: Diane Burbank, Forest Ecologist  
(802) 388-4362

Green Mountain National Forest: MaryBeth Deller (802) 767-4261 ext. 524

Chippewa National Forest, Minnesota: Ian Shackelford

(currently at Ottawa, but was the contact for this document)

New York Natural Heritage Program: Dorothy Evans, Associate Ecologist  
(518) 402-9263

University of Wisconsin – Madison, Botany Dept. – Herbarium: Merel Black  
mblack@facstaff.wi

Library Services, North Central Research Station: Laura Hutchinson

[lhutchinson@fs.fed.us](mailto:lhutchinson@fs.fed.us)

Michigan Natural Features Inventory: Mike Penskar (517) 373-1552