

***Conservation Assessment  
For  
Spreading Wood Fern (*Dryopteris expansa*)  
C. Presl Fraser-Jenkins & Jermy***



*Photo: Wisconsin State Herbarium & Sue R. Crispin*

***USDA Forest Service, Eastern Region***  
February 2003



*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*This Conservation Assessment was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation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.*

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## EXECUTIVE SUMMARY

This Conservation Assessment provides information on the distribution, habitat, ecology and population biology of *Dryopteris expansa* (C. Presl) Fraser-Jenk. & Jermy (spreading wood fern). This species occurs in western and eastern Northern America, Europe (Montgomery & Wagner 1993), and eastern Asia (Carlson & Wagner 1982). In North America, it occurs in “cool moist woods and rocky slopes” (Montgomery & Wagner 1993).

*Dryopteris expansa* has a G5 ranking (demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery). *D. expansa* is a Regional Forester Sensitive Species (RFSS) on the Chequamegon-Nicolet National Forest in Wisconsin, and the Hiawatha and Ottawa National Forests in Michigan (RFSS 2000a).

Any activity that causes habitat loss, decline in habitat quality, or fragmentation is a threat to the survival of *Dryopteris expansa* in the Upper Peninsula of Michigan. For example, in areas where this species occurs, certain timber harvest activities, in addition to blowdowns, fires and insect defoliation, could cause a significant decrease or loss of canopy, adversely affecting the habitat of this species (USDA Forest Service (FS) 1999). Other threats include, but are not limited to, disruption of hydrological regimes, herbivory, displacement by exotic species, and conversion of northern hardwoods to other canopy types (USDA FS 2000b).

Further research on the life history, habitat requirements, ecology, and threats to viability of *Dryopteris expansa* is needed in addition to long-term monitoring in order to obtain baseline information for management of this species in Michigan’s Upper Peninsula. Research and/or monitoring of the known populations on the Ottawa National Forest and the four known populations on the Hiawatha National Forest in Delta County, Michigan is needed in order to analyze potential impacts from proposed Forest management actions.

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**Editorial Committee.** We thank Jan Schultz, of the Hiawatha National Forest, for her

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**Initial Draft.** We are grateful to Deb LeBlanc; west-side Ecologist on the Hiawatha, for her efforts in providing us with an original draft for this Conservation Assessment.

## **OBJECTIVES**

This Conservation Assessment was prepared to compile the published and unpublished information about *Dryopteris expansa* (C. Presl) Fraser-Jenk. & Jermy (spreading wood fern). This is an administrative study only and does not represent a management decision or direction by the U.S. Forest Service. Though the best scientific information available was gathered and reported in preparation of this document, then subsequently reviewed by subject experts, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if the reader has 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, Milwaukee, Wisconsin 53203.

One of the conservation practices of the USDA Forest Service is designation of Regional Forester Sensitive Species (RFSS). The Eastern Region (R9) of the Forest Service updated its Sensitive Species list on February 29, 2000 (USDA 2000a). Part of that process included identification of priority species for conservation assessments and strategies. *Dryopteris expansa* (spreading wood fern) was one of those priorities.

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.

The National Forest Management Act and U.S. Forest Service policy require that Forest Service lands be managed to maintain viable populations of all native plant and animal

species. A viable population has a distribution of reproductive individuals that can ensure the continued existence of the species throughout its range within a given planning area (FSM 2670.5.22). In addition to species listed as endangered or threatened under the Endangered Species Act (ESA), the Forest Service lists species that are sensitive within each region.

*Dryopteris expansa* is listed as a Regional Forester Sensitive Species (RFSS) in Region 9, the Eastern Region of the U.S. Forest Service (USDA 2000a). The objectives of management for such species are to ensure their continued viability throughout their range on National Forest lands and to ensure that they do not become threatened or endangered because of Forest Service actions (FSM 2670.22).

## NOMENCLATURE AND TAXONOMY

(W-3, Wisconsin State Herbarium)

### Taxonomy/hybridization note:

The taxonomic history of *Dryopteris expansa* is somewhat confusing. In past botanical literature, *D. expansa* was known as *D. dilatata* (Hoffm.) Gray or *D. assimilis* S.Walker (Carlson & Wagner 1982). It has been “lumped with other species in the *D. carthusiana* complex, which have collectively been called *D. austriaca* (Jacq.) Woynar (often referred to as *D. dilatata*).” Pre-1960s, some writers unfamiliar with *Dryopteris* species lumped whole clusters of well distinguished taxa under the name of *Dryopteris spinulosa* (Wagner 1963).

*D. expansa* has also been confused with the allotetraploid *D. campyloptera* Clarkson (Mountain Woodfern) of eastern North America (Carlson & Wagner 1982). Wagner (1963) commented that *D. campyloptera* (mountain woodfern) so closely resembles the Lake Superior *Dryopteris dilatata* that “one wonders whether they may be in fact the same species”. However, *D. campyloptera* has 82 chromosomes compared to 41 in the *D. dilatata* group and *D. intermedia* (Wagner 1963). Another source of confusion in the early literature was that Wagner (1962) considered the species *D. dilatata* (ie. *D. expansa*) as different from the western species, but later changed his opinion (F. Wagner, pers. comm. 2002). Hulten (1968) illustrated the range of *D. dilatata* as continuous across Canada. Subsequently Britton (1972) suggested that the range of spreading woodfern extends only as far east as western Alberta (Carlson & Wagner 1982). In addition, *Dryopteris expansa* has three hybrids known at this time, all of which are rare (Montgomery & Wagner 1993).

**Scientific name:** *Dryopteris expansa* (C. Presl) Fraser-Jenkins & Jermy

**Family:** Dryopteridaceae

**Common names:** spreading wood fern, northern wood fern

**USDA NRCS plant code:** DREX2

**Synonymy:** *Dryopteris assimilis* S. Walker  
*Dryopteris dilatata* auct. non (Hoffm.) A. Gray  
*Dryopteris dilatata* (Hoffm.) A.Gray ssp. *americana* (Fisch. Ex Kunze) Hultén  
*Dryopteris spinulosa* (O. F. Müll.) Watt var. *americana* (Fisch. ex Kunze) Fernald  
*Dryopteris spinulosa* (O.F. Müll.) Watt. var. *dilatata* (Fisch. ex Kunze) Fernald  
*Thelypteris spinulosa* (O.F. Müll.) Nieuwl. var. *amer.* (Fisch. ex Kunze) Weath.  
*Aspidium spinulosum* (O.F. Müll.) var. *americanum* Fisch. ex Kunze  
*Nephrodium expansum* C. Presl.

## DESCRIPTION OF SPECIES

[Description from: Montgomery & Wagner (1993), and Lellinger (1985)]; info in quotes directly from Montgomery and Wagner (1993)

**Rhizomes:** stout, ascending, with chaffy, brown scales

**Stipe:** 1/3 length of leaf, with pale brown scales often having a darker brown central strip

**Fronds:** monomorphic, winter-deciduous, blades broadly triangular

**Blade:** “Green, deltate-ovate, 3 pinnate-pinnatifid, herbaceous; usually not glandular, occasionally finely and densely glandular”

**Pinnae:** “In plane of blade, lanceolate-oblong; basal pinnae deltate, slightly reduced, basal

**Sori:** pinnules equal to or longer than adjacent pinnules” “pinnule margins serrate” halfway between midvein and margin of segments

**Indusia:** no glands or sparse glands

## Identification notes

*Dryopteris campyloptera* (Kunze) Clarkson and *D. expansa* (one of the parents of *D. campyloptera*) are difficult to tell apart in eastern Canada where their ranges overlap; however, their chromosome numbers differ. Another distinguishing characteristic in the field is that the fronds of *D. expansa* are more erect than those of *D. campyloptera* (Montgomery & Wagner 1993).

*D. expansa* can also be confused with *D. intermedia*, see Wagner (1963) for a table distinguishing the closely related *D. campyloptera* and *D. intermedia*.

*Dryopteris expansa* may also be confused with *D. carthusiana*; however, a morphological feature that helps to distinguish the two ferns is the relative difference in length of basal pinnules. In *D. expansa* the basiscopic pinnule is 2 to 3 times longer than the acroscopic pinnule; in *D. carthusiana* it is usually less than twice as long (F. Wagner pers. comm. 2002). In addition, the two basal pinnules in *D. carthusiana*, acroscopic and basiscopic are nearly opposite each other, but in *D. expansa* the basiscopic pinnule is noticeably farther from the rachis than the acroscopic pinnule (Montgomery & Wagner 1993). Another distinction is that *D. expansa* often remains green longer in the winter than *D. carthusiana* (Montgomery & Wagner 1993). Early literature tried to distinguish species based on glandularity, but this attribute was found to be too variable to be of much help. At the Huron Mountains in Marquette County, Michigan both glandular and non-glandular forms were found (Wagner & Hagenah 1962).

Pojar & MacKinnon (1994) note that the male fern (*D. filix-mas*) is sometimes confused with *D. expansa*. The male fern has a broadly lance-shaped outline rather than broadly triangular blades. Also the fronds are only 1-2 times pinnate and non-glandular rather than 2-3 times pinnate with chaffy, brown scales as in *D. expansa*.

## DISTRIBUTION AND ABUNDANCE

*Dryopteris expansa* “exhibits an amphioceanic distribution pattern with populations in north temperate and sub-boreal eastern and western North America, northern Europe, and eastern Asia” (Carlson & Wagner 1982). In the British Isles, it occurs most frequently in the Scottish Highlands, mostly in the sheltered niches in mountain scree (Page 1997); it occurs in similar habitat in Norway and Sweden (Carlson & Wagner 1982).

*Dryopteris expansa* occurs on both the western and eastern coasts of North America with a large gap in the plains states and Canadian provinces. In the west it occurs in Alaska, Yukon, Northwest Territories, British Columbia, Alberta, Washington, Oregon, California, Idaho, Montana, Wyoming and Colorado. In the east it occurs in Greenland, Labrador, Quebec, and Ontario.

*Dryopteris expansa* is reportedly widespread and fairly common in the Pacific Northwest and adjacent Canada (USDA FS 1999). The University of Michigan has specimens from Thunder Bay District, Thunder Cape, and Algoma in Ontario (University of Michigan herbarium

2002). In a report of the flora of Caribou Island near Wawa, Ontario, it was “common in better drained locations within the forest” (Morton & Venn 1996). Tony Reznicek (pers. comm. 2002) emphasized that *Dryopteris expansa* is not found in any significant quantities south of Sault St. Marie, Ontario. In the Great Lakes states, *D. expansa* is at its southern edge and occurs in the Upper Peninsula of Michigan, northern Wisconsin, and northern Minnesota (Montgomery & Wagner 1993).

## **Region 9 – Northern Hardwoods**

### **Minnesota**

Only two specimens are filed in the University of Minnesota herbarium (W-2). There is also a specimen from the Superior National Forest, Cook County, filed at the University of Michigan herbarium. Robin Vora of the Superior National Forest (pers. comm. 2001), reported that *Dryopteris expansa* is usually found on rocky sites. On the Superior National Forest this fern occurs in wet depressions or ravines in mixed hardwoods, but not in cedar swamp. An earlier work by Ownbey and Morley (1991) showed more element occurrences (13) mostly in the northeastern quarter of the state; the difference in numbers reported may indicate some confusion as to what ferns in this group of *Dryopteris* should be assigned to this specific species.

### **Wisconsin**

In northern Wisconsin, there are 24 known populations (Douglas, Bayfield, Ashland, Iron, Price, Oneida counties), mostly along the Lake Superior coast (Bayfield County), offshore islands, and the Door Peninsula (Wisconsin State Herbarium, W-3). There are eight documented locations within the Chequamegon-Nicolet National Forest. On the National Forest in Ashland County there are three sites, which ranged from 50 to 200+ plants at each location. One site just off National Forest lands in Ashland County had over 1000 plants. Most Wisconsin sites occur on moist, rocky talus, slopes with moss cover, under full shade within mesic northern hardwood forest. Also listed for Wisconsin is an occurrence in a hemlock stand along the margins of a small wet depression (WI NHP 1999).

### **Michigan**

In the Upper Peninsula of Michigan, *Dryopteris expansa* is documented within six counties: Keweenaw, Baraga, Delta, Dickinson, Marquette (MNFI 1999a) and Gogebic (USDA FS 2001). In Marquette County a large population of hundreds of plants extended for approximately one mile was found near Negaunee in 1984. Don Hansen located several populations in Marquette County in 1993 near creeks (MNFI 1999b). Baraga County harbors one location in shrubby understory. Dickinson County has one known site in talus near Norway (MNFI 1999b). More than one-half of the known locations occur on Isle Royale and outlying islands.

Tony Reznicek (pers. comm. 2002) speculates that *D. expansa* is more at home in mountainous regions; therefore the most numerous populations could be expected to occur in

the Huron Mountains, the Porcupine Mountains, the Keweenaw, and Isle Royale. These sites are in the far northern Upper Peninsula at higher elevation.

Sites on the Hiawatha National Forest are quite scattered and often consist of one or two plants. The Delta County site on the Hiawatha National Forest, consists of two plants in a second growth hardwood forest (MNFI 2001). The site occurrence rank is D, poor viability even over a short time frame (10 years or less) (MNFI 2001). The Mackinac County sites (two populations) occur along the Niagara Escarpment and were discovered by D.J. Evans as she did her study on the Hart's tongue fern (*Phyllitis scolopendrium* var. *americanum*). Linda Swartz, a forest botanist on the east unit, found two additional locations on the Hiawatha National Forest. The Chippewa site had one plant mixed with *D. intermedia* which it resembles; the site was fairly close to the road in a stand of young fir trees. The recent Mackinac County site was in a slight depression near a creek; only one individual was located. This site is currently over a mile from any roads, but as the adjacent area is logged it is likely more roads will be built. Presently one-half of the unit scheduled for timber harvest was dropped to protect this fern.

### **McCormick Wilderness and Huron Mountains**

There are 16 locations in the McCormick Wilderness Area near the Huron Mountains managed by the Ottawa National Forest, and one location on the Ottawa National Forest in Gogebic County (S. Trull pers. comm. 2001). *Dryopteris expansa* (*D. dilatata*) was found within two ravines in the Huron Mountains of Marquette County. At both these sites this fern was confined to the bottom of the ravine on humus-covered rocks. A thorough survey at the second ravine located approximately 50 fronds. Its hybrid with *D. marginalis* was found at the first ravine (Wagner & Hagenah 1962).

### **Isle Royale National Park**

On Isle Royale National Park's Passage Island, *D. expansa* is a dominant understory species in mesic white birch forest (Judziewicz 1997). Other sites from Isle Royale include two specimens from the main island, and numerous sites on outlying islands including Amygdaloid, Raspberry, Passage, Portage, and Wright Islands (University of Michigan herbarium 2002; MNFI 1999b). It also occurs on the Keweenaw Peninsula in Grinnell Memorial Nature Sanctuary (MNFI 1999b).

## HABITAT AND ECOLOGY

### Canada and western U.S.

Habitat for *Dryopteris expansa* is cool, moist, rich deciduous forests and rocky slopes (Montgomery & Wagner 1993). In the western United States, *D. expansa* is found in moist forest openings and scree slopes, from low elevation to subalpine (Turner & Davis 1993). In Vancouver, British Columbia, it is found in a second-growth stand of *Pseudotsuga menziesii* along with *Polystichum munitum* (Klinka *et al.* 1995). This site is characterized by a fair amount of decaying wood and the spodic horizon was found to be low in potassium, calcium and magnesium (Klinka *et al.* 1995). In southeast Alaska, *Dryopteris expansa* occurs in old growth forests; it avoids windthrown mounds and instead grows directly on the forest floor (Den Ouden & Alaback 1996).

### Michigan

In the Upper Peninsula of Michigan, *Dryopteris expansa* grows in cool, moist woods of sugar maple and yellow birch amongst boulders or fallen rocks at the base of a rock wall (Chadde 1999). It is found within forests in nearly full shade in the presence of bedrocks, boulders, or outcrops, often associated with *Polystichum braunii* (USDA FS 2000b). It is also found on ravine slopes (particularly in the lower and north facing regions of the ravine) (Chadde 1999). On the Ottawa National Forest it occurs most often in sugar maple, yellow-birch forests, but it also occurs in red maple dominated forest ravines and in a black ash/hemlock dominated wetland (Sue Trull pers. comm. 2001). *D. expansa* prefers “cool, humus rich, mostly sub-acid soils” (Carlson 1979).

*Dryopteris expansa* is found in more mesic locations than *D. goldiana*, according to a panel of field botanists (USDA FS 2000b). Sue Trull (pers. comm.2001) noted that the *D. expansa* sites on the Ottawa National Forest are wetter than those of *D. carthusiana* and *D. goldiana*.

Of the 16 *Dryopteris expansa* sites within the Ottawa National Forest’s McCormick Wilderness Area (Sue Trull, pers. comm.2001), canopy cover ranged from 40-75% (64% average). All of these occurrences were in moist areas on bare rock walls. Associates included *Betula alleghaniensis*, *Ostrya virginiana*, *Betula papyrifera*, *Gymnocarpium dryopteris*, *Dryopteris intermedia*, *Athyrium filix-femina*, *Phegopteris connectilis*, and *Oxalis acetosella*. The occurrence of *D. expansa* on the Ottawa National Forest in Gogebic County, was in a wet depression under 95% tree cover under *Fraxinus nigra*. Herbaceous species were similar to those occurring in the McCormick Wilderness Area.

In the Huron Mountains (granite hills) of Marquette County, *Dryopteris expansa (dilatata)* was found “strictly at the bottom of a ravine, often on humus covered rocks, in the shadiest places on the gulch bottom”. Also found in this ravine were eight plants of *D. expansa x marginalis*. The hybrid plants also grew on rocks low in the ravine (Wagner & Hagenah 1962).

*Dryopteris expansa* also occurs on limestone bedrock sites (USDA FS 1999). Along the Niagara Escarpment (limestone outcropping) in Michigan, *D. expansa* has been found to grow near boulders covered with *Asplenium rhizophyllum* (significant at <0.01). Other common associates were *Sambucus racemosa*, *Circaea alpina*, and *Arisaema triphyllum* (Evans 1997). One *D. expansa* specimen from the Hiawatha National Forest, Mackinac County grew within a minor depression of the forest floor rather than a rocky area (Linda Swartz, pers. comm., 14 Nov. 2001 email).

## Minnesota

In Minnesota, element occurrences occur near Lake Superior between northern hardwood and quaking aspen/birch forests (USDA FS 2000b). University of Minnesota Bell Herbarium lists a specimen from Susie Island in Cook County and another from Winona County (W-2).

## Wisconsin

Wisconsin locations for this fern are in deep creek gorges with moist, mossy cliffs and talus, usually under full shade (WI NHP 1999). In one Wisconsin location, *Dryopteris expansa* occurred under approximately 90% canopy closure of *Acer saccharum*, *Acer rubrum*, *Tilia americana* (Spickerman 1990). It is also known at the Apostle Islands National Lakeshore from a rocky open clearing in a sugar maple woods (Judziewicz & Koch 1993).

In Wisconsin, overstory species commonly observed growing with *Dryopteris expansa* include *Acer saccharum* (sugar maple), *Betula alleghaniensis* (yellow birch), *Tsuga canadensis* (hemlock), *Tilia americana* (basswood) and *Thuja occidentalis* (northern white cedar) (WI NHP 1999). Shrubs often include *Acer spicatum* (mountain maple), *Sambucus racemosa* (red elder berry), *Lonicera canadensis* (northern honeysuckle), *Taxus canadensis* (Canada yew) and *Rubus parviflorus* (thimbleberry) (WI NHP 1999).

Other fern species associated with Wisconsin populations include: *Dryopteris marginalis* (marginal wood fern), *Polystichum braunii* (Braun's holly fern), *D. intermedia* (spinulose wood fern), *Gymnocarpium dryopteris* (oak fern), *D. carthusiana* (toothed wood fern), *Athyrium filix-femina* (lady fern), *Matteuccia struthiopteris* (ostrich fern), *Phegopteris connectilis* (beech fern), and *Polypodium virginianum* (common polypody) (WI NHP 1999).

## STATUS (PROTECTION)

Currently, the official status of *Dryopteris expansa* with respect to Global, Federal and State Conservation Status is:

**U.S. Fish and Wildlife Service:** Not listed (None)

**U.S. Forest Service:** Region 9 Sensitive on Hiawatha, Ottawa, and Chequamegon-Nicolet National Forests

The Regional Forester has identified it as a species for which viability is a concern in Hiawatha, Ottawa and Chequamegon-Nicolet National Forests as evidenced by: **a)** significant

current or predicted downward trends in population numbers or density, and or **b**) significant current or predicted downward trends in habitat capability that would reduce its existing distribution (FSM 2670.5.19).

**Global Conservation Status Rank: G5**

G5: Common, widespread and abundant globally (although it may be rare in parts of its range, particularly on the periphery). Not vulnerable in most of its range. Typically with considerably more than 100 occurrences and more than 10,000 individuals.

**National Conservation Status Rank:** United States: N?  
Canada: N?

N?: Unranked-National rank not yet assessed.

**Michigan:** (S2S3, previously Special Concern until 1999)

S2: Imperiled in State of Michigan because of rarity (6 to 20 occurrences or few remaining individuals or acres).

S3: Rare or uncommon in State (on the order of 21 to 100 occurrences).

**Wisconsin** (S1, Special Concern) **Minnesota** (SR, not tracked)

**Other States** (W-1, NatureServe):

<b>Alaska</b>	SR	<b>Montana</b>	SR
<b>California</b>	SR	<b>Oregon</b>	SR
<b>Colorado</b>	S1	<b>Washington</b>	SR
<b>Idaho</b>	SR	<b>Wisconsin</b>	S1
<b>Michigan</b>	S2S3	<b>Wyoming</b>	S1
<b>Minnesota</b>	SR		

**Canada** (W-1, NatureServe):

<b>Alberta</b>	SR	<b>Northwest Territories</b>	SR
<b>British Columbia</b>	S5	<b>Ontario</b>	S4S5
<b>Labrador</b>	S3S5	<b>Quebec</b>	SR
<b>Newfoundland</b>	SH	<b>Yukon Territory</b>	SR
<b>Newfoundland Island</b>	SR		

**Definitions of State/Provincial Ranks:** (The Nature Conservancy)

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

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

S5 = Very common; demonstrably secure under present conditions.

S? = Not enough information available to assess; more field studies and/or specimen identification is needed.

SH = Possibly extirpated (historical)

SR = Reported, but not assessed.

**LIFE HISTORY**

Strictly sexual reproduction is characteristic of less than one-fourth of North American fern species. Often a colony of a pteridophyte is derived from an originally sexually produced plant and a colony of ten to a hundred or more vegetative plants. Reproduction by rhizome branching and subsequent death and decay of the older stem sectors accounts for the bulk of propagation of North American terrestrial ferns. Development of new plants by auxillary buds is less common overall, but it is important in the genus *Dryopteris* (Wagner 1963).

The majority of homosporous ferns produce high numbers of spores, many of which do not germinate. The number of these spores depends primarily on the size of the fern (Schneller 1995). *Athyrium filix-femina*, with leaves up to 1 m long, can produce more than 75 million spores annually as does *Dryopteris filix-mas* (Schneller 1995). With leaves up to 90 cm long, *Dryopteris expansa* might be expected to produce similar numbers.

Reproduction of *Dryopteris expansa* occurs mainly on logs or rocks (USDA FS 2001). According to Gureeva (1996), in his study of *D. expansa* in Russia, gametophyte establishment required the “presence of rotten wood free of mosses and other plants.” Although there appears to be other suitable habitat available in the Great Lakes northern hardwoods, this species has not colonizing much of it (USDA FS 2001).

In Scotland, Willmot (1985) found that all populations of *D. expansa* (*D. dilatata*) displayed the pattern of a large number of small, sterile plants and a smaller number of larger, fertile plants. Similar to the Russian study, small plants of *D. expansa* often grew among bryophytes on wood. There have been few size-structure studies done for this fern species, but Page (1982) comments that in the British Isles juvenile plants of *D. expansa* may be common in some habitats whilst adults predominate in others. Between 1981 and 1982 survival of crowns of *D. expansa* was 78% compared to 87% for *D. filix-mas*. Willmot concluded, based

on histograms and field observations, that there was a high level of recruitment each year for *D. expansa*, but a low chance of survival to maturity. Willmot also suggested that the few plants that survived to maturity only lived for a short time.

*Dryopteris expansa* is a diploid fern species which has a mixed mating system comprised of outbreeding and intragametophytic selfing (Soltis & Soltis 1987). In outbreeding, after spores from different fern plants germinate and produce two gametophytes, cross-fertilization of the gametophytes takes place. In intragametophytic selfing, selfing occurs within a single gametophyte and results in extreme inbreeding. The degree of inbreeding of a given population is apparently related to sporophyte density (Soltis & Soltis 1987). Populations with higher numbers of plants in close proximity have exhibited a greater degree of outcrossing and hence greater genetic variation than populations in which sporophytes are more widely scattered. (Soltis & Soltis 1987). Soltis & Soltis (1992) reported a mean intragametophytic selfing rate of 0.34 (interpopulation variation ranged from 0 to nearly 0.60.)

*Dryopteris marginalis* was used to assess the effects of acidic conditions on development of gametophytes from germinating spores. High levels of acidity had little effect on spore germination, but acid conditions severely impacted the maturation of the gametophytes which remained in an unorganized mass of cells. Growth of the gametophyte was best between pH 5.2 and 6.8 (Otto *et al.* 1983). It is possible that gametophyte development in *D. expansa* could be affected similarly by acidic conditions.

According to Schneller (1995), spores of *Dryopteris filix-mas* are released from the sori after a “few phases of wetting and drying” during a few weeks in late summer. It has been documented that 95% of all spores of *D. filix-mas* fall in the immediate vicinity, within 1 to 10 meters of the parent plant (Vogel *et al.* 1999, Dyer 1994). Controlled studies of spore release in *Dryopteris filix-mas* showed that most spores landed within 14 centimeters from the parent plant (Schneller 1995). Although this research did not include *D. expansa*, similar patterns may apply to this species.

In winter, the leaves of *Dryopteris expansa*, according to Montgomery & Wagner (1993), tardily die back, they remain green at beginning of winter. Wagner and Hagenah (1962) found some of the previous year’s leaves green and persistent into late June. Spickerman (pers. comm. 2001) noted that where he has seen this species in northwestern Wisconsin, it typically disappears soon after the leaves have fallen and the first heavy freezes reach the forest floor.

## **POPULATION BIOLOGY AND VIABILITY**

The Population Viability Assessment prepared by the USDA-Forest Service (2000b) for Upland Forest-Ferns including *Dryopteris expansa* considered 100 individuals in a given population necessary for short-term viability, and 100 patches over 1.6 million acres as desirable for high long-term viability (Outcome 1--habitat is distributed broadly across historic range and is of sufficient quality to support the type and degree of metapopulation interactions). The appropriate distribution of patches over this acreage is unknown. Threats

that could significantly impact population viability are discussed in the Potential Threats section of this report.

On the Hiawatha National Forest, there is one known site in Delta County, Michigan (MNFI 1999b) and three other specimens from Mackinac County (Linda Swartz, pers. comm., 14 Nov. 2001 email). The potential for viable populations on the Hiawatha National Forest is poor; none of the sites harbor many individuals and are too scattered for effective spore dissemination. However, Sue Trull (pers. comm. 2001) suggests that Michigan may have viable populations of this species. Michigan's Ottawa National Forest has sites with 50, 60, 80, 100+, and 200 individuals of this recently delisted Michigan species, and forest botanists continue to find more. Sites in Wisconsin with 100 individuals may also be viable populations. There are 24 specimens at the University of Wisconsin herbarium (1999) with almost 2/3 of the sites occurring in Bayfield County. The Great Lakes states are at the southern boundary for this fern species (Montgomery & Wagner 1993); therefore, population numbers in the Great Lakes Region will likely remain somewhat lower.

In the British Isles, *Dryopteris expansa* appears to be at a competitive disadvantage, probably due to its flushing appreciably later in the growing season, than its competitors (Page 1997). Increased wetness favors *D. carthusiana* (Vill.) H.P. and increased drainage and denser tree canopy appears to favor *D. dilatata* (Hoffm.) A. Gray. However, *D. expansa* does well within mountains of the British Isles since it has a "greater tolerance of lower mean temperatures, and its later flushing is doubtless an advantage at such altitudes" (Page 1997).

## POTENTIAL THREATS

Habitat loss, fragmentation and a decrease in habitat quality for *Dryopteris expansa* may be caused, in part, by timber harvest (USDA FS 1999). Threats include timber harvest and road-building activities, which result in a substantial decrease or loss of canopy. Disruption of the hydrological function, and conversion of northern hardwoods to other cover types, along with displacement by invasive species are other potential threats (USDA FS 2000b). The Chequamegon-Nicolet Forest lists habitat alteration due to logging, herbicide application, and alteration of ground water levels as potential threats (USDA FS 1993). Gametophyte development appears to require rotting wood for establishment (Gureeva 1996); therefore, either harvesting too frequently or strict clean up of debris after timber harvest could eliminate suitable habitat for the gametophyte generation.

According to John Rintoul (pers. comm., 31 October 2001 email), "logging may be a threat outside protected areas in Alberta" to *Dryopteris expansa*. On most sites in the Ottawa National Forest, *Dryopteris expansa* occurs in wetlands where timber harvest activities do not occur (Sue Trull, pers. comm. 2001) In one *D. expansa* Hiawatha National Forest site, which is currently managed for timber it is being buffered by a no cutting zone of two chains (Jan Schultz, pers. comm. 2001). In contrast, Johnson and Van Wagner (1985) suggest that a preferred landscape should be at least twice the size of the largest disturbance event. Timber harvest pressure tends to be somewhat greater on northern hardwood stands on the Hiawatha National Forest than other Eastern Region National Forests since only half of the Hiawatha National Forest acreage is suitable for timber harvest (Tyrrell 1996). When mesic northern

forest is managed for timber harvest, care should be taken to minimize fragmentation by preserving a forest matrix and maintain a canopy closure comparable to pre-harvest closure (Cohen 1999).

In addition to certain timber harvest activities, other factors may alter the habitat of *Dryopteris expansa*, such as blowdowns, fire, and defoliation by insects which will cause reductions in or loss of canopy. Whatever the cause of canopy disruption, there may be decreased moisture and elevated temperatures (Chen 1991; Chen *et al.* 1992) in addition to increased light levels, which could adversely affect populations of *Dryopteris expansa*. When the overstory is entirely removed, recolonization by this species could take more than a century (Duffy & Meier 1992).

Other possible threats to *Dryopteris expansa* include climatic factors such as loss of protective snow pack during winters. In addition, small, scattered populations of *Dryopteris expansa* show increased selfing over time so retention of more lethal recessive genes might occur (Vogel *et al.* 1999).

In coastal Alaska, according to Gillingham *et al.* (2000), the rhizomes of *D. dilatata* (Hoffm.) A. Gray is an important food during the winter for black-tailed deer (*Odocoileus hemionus sitkensis*). If any part of the rhizome of *D. dilatata* was removed, vegetative growth was greatly decreased the next summer. Plants that had greater than 25% of their rhizomes removed produced virtually no growth during the following growing season. In mild winters, the subsequent increase in deer browsing may potentially decrease the abundance of *D. dilatata* (Gillingham *et al.* 2000). Florence Wagner (pers. comm. 2002) pointed out that *D. dilatata* was an earlier synonym for *D. expansa*.

*D. expansa* has been documented as a food source for native peoples in northwestern North America (Turner *et al.* 1992). The rhizomes of *D. expansa* could possibly be eaten as a deer survival food. In the Great Lakes area, population numbers of *D. expansa* are scarce so that it is unlikely that deer have learned to use this fern as a food source. However Deb LeBlanc, west side ecologist on the Hiawatha, (pers. comm. 2001) reports that she has seen deer browse on other *Dryopteris* species.

## RESEARCH AND MONITORING

Little is known about many aspects of the biology and ecology of *Dryopteris expansa* including its microclimatic requirements (USDA FS 1999) such as optimal light, moisture, and nutrient levels. It should not be assumed that a known characteristic of another *Dryopteris* species will be applicable to *D. expansa* yet it does provide a basis for possible research. More information is needed on various aspects of the life cycle of *D. expansa* such as spore germination, establishment, and growth requirements. Further inventory work is needed to locate new populations of this species and obtain information on its distribution and population sizes. According to USDA FS (1999), *D. expansa* is “commonly misidentified in the eastern parts of its range in North America.” Wagner (1963) discusses how difficult it is to tell *D. campyloptera* from *D. dilatata*.

Long-term monitoring of *Dryopteris expansa* populations and preferred habitats is necessary. Results of monitoring and research may provide managers with data to develop a Conservation Approach, which could include developing goals for maintaining species viability. Management prescriptions could then be developed for known sites. Public education and outreach efforts are also an important component to protect this fern's populations and habitat.

Monitoring at known Forest sites and off Forest locations is needed to analyze effects associated with management actions and answer management questions. Mitigation efforts for this species on the Hiawatha National Forest need to be monitored for effectiveness (Schultz, pers. comm. 2001).

## SUMMARY

*Dryopteris expansa* occurs in western and eastern North America, Europe, and eastern Asia. In eastern North America, it reaches its southern limit in the Great Lakes region, where the populations are more scattered and more vulnerable than in the western United States. Habitat for *D. expansa* in the Great Lakes states is wet and/or rocky areas within mature second-growth and old-growth forests. Habitat loss, fragmentation, and a decline in habitat quality are all threats to *D. expansa* and may be caused by various factors (for example, certain timber harvesting activities, blowdowns, fires, etc.). More research on the basic life history, biology, and ecology as well as long-term monitoring studies of this species are needed.

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