

*Conservation Assessment
for
Male Fern (*Dryopteris filix-mas*)*



Photo: Anna-Lena Anderberg

USDA Forest Service, Eastern Region
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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This Conservation Assessment was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation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 and its review, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if the reader has any 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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See Contacts section at the end of this report for a complete list of reviewers.

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See Contacts section at end of report for a complete list.

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EXECUTIVE SUMMARY

This Conservation Assessment is a review of the distribution, habitat, ecology and population biology of *Dryopteris filix-mas* (L.) Schott (male fern). This species is listed as Special Concern in the State of Michigan with a G5 ranking (demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery); it has Regional Forester Sensitive Species (RFSS) ranking on the Hiawatha National Forest in Michigan and Green Mountain National Forest in Vermont (USDA 2000). On the Hiawatha National Forest (Upper Peninsula of Michigan), it occurs in Mackinac County. On the Ottawa National Forest (western end of the Upper Peninsula of Michigan) it is known from 10 locations occurring in Ontonagon and Marquette Counties. Other known occurrences in the Upper Peninsula of Michigan are in Chippewa, Gogebic, and Keweenaw Counties (MNFI 1999a).

Within the New England states fewer than 20 occurrences of *Dryopteris filix-mas* have been documented since 1970 (W-3). On the Green Mountain and Finger Lakes National Forests (combined forest) in Vermont and New York, two populations are known to occur along the Appalachian Trail corridor (D. Burbank, pers. comm., 6/22/01 email). In Vermont, on lands not within the Forest Service, there are approximately 15 localized sites mostly at elevations of 400m to 700m (Art Gilman, pers. comm., 2001). This fern species is listed as Threatened under Vermont statute (Gilman pers. comm. 2001). In Maine, *D. filix-mas*, known from two counties (Oxford and Penobscot), is state Endangered and critically imperiled because of “extreme rarity or vulnerability to extirpation” (W-3).

Primary threats to the survival of *Dryopteris filix-mas* in the Upper Peninsula of Michigan include alteration of habitat and canopy removal via logging (J. Schultz pers. comm. 2001). Although effects of timber harvest on *D. filix-mas* are not known, it is suggested that incomplete canopy removal would have less of an effect on this species than removal of the entire canopy (W-3). On the Green Mountain National Forest in Vermont there is widespread suitable habitat; however, populations of male fern are declining (D. Burbank, pers. comm., 2001). Because of its attractiveness and rarity, collectors dig up *D. filix-mas* for garden use, which has contributed to its decline throughout its American range (W-3).

The opportunities for research and/or monitoring of *Dryopteris filix-mas* include understanding its life history, habitat requirement and threats to viability. Research and/or monitoring known populations on the Hiawatha National Forest in Mackinac County, and the Ottawa National Forest in Michigan’s Upper Peninsula are needed in order to analyze habitat requirements and potential impacts from proposed Forest management actions. Monitoring of known sites will be required to obtain baseline information for management of this species.

INTRODUCTION/OBJECTIVES

One of the conservation practices of the USDA Forest Service is designation of Regional Forest Sensitive Species (RFSS). The Eastern Region (R9) of the Forest Service updated its Sensitive Species list on February 29, 2000 (USDA 2000). Part of that process included identification of priority species for conservation assessments and strategies. *Dryopteris filix-mas* (male 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 strategy.

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 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 (FSM 2670.5.22). In addition to these species listed as endangered or threatened under the Endangered Species Act (ESA), or species of Concern by the U.S. Fish and Wildlife Service, the Forest Service lists species that are sensitive within each region (RFSS).

Dryopteris filix-mas is listed as a Regional Forester Sensitive Species in Region 9 on the Hiawatha National Forest in Michigan and the Green Mountain National Forest in Vermont. 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

- Division:** Polypodiophyta
- Class:** Polypodiopsida
- Family:** Dryopteridaceae
- Scientific name:** *Dryopteris filix-mas* (Linnaeus) Schott
- Common names:** male fern, knotty brake fern, sweet brake, basket (Billington 1952) fern, male shield fern, shield-root, bear's-paw-root and vermifuge.
- USDA plant code:** DRFI2
- Synonyms (W-1):** *Polypodium filix-mas* L.
Polystichum filix-mas (L.) Roth.
Nephrodium filix-mas (L.) L.C.M. Rich.

According to Montgomery and Wagner (1993), the taxonomy of *Dryopteris filix-mas* is somewhat unclear. They report that “in North America, this fern has been considered both an auto- and an allopolyploid, and may be composed of at least two closely related taxa”. Plants occurring in the northeastern and northwestern parts of the United States are tetraploid. Wagner (1971) reported “irregular pairing in hybrids between *D. filix-mas* and *D. marginalis*, which indicates a cytology similar to that of European *D. filix-mas*, and which increases the probability that the American and European specimens are in fact one species.” “*Dryopteris filix-mas* occurs in Europe, and it is known to be an allopolyploid of *D. caucasica* (A. Braun) Fraser-Jenkins & Corley x *oreades* Fomin” (Montgomery & Wagner 1993). It is speculated that *D. filix-mas* arose by allopolypoidy or a doubling of chromosomes (Britton 1965). *D. filix-mas* has a sporophyte of $4x = 164$ with a meiotic behavior of 82 pairs (Wagner & Hagenah 1962).

Hybrids note:

Dryopteris filix-mas hybridizes reasonably frequently with *D. marginalis* (Britton 1965, F. Wagner pers. comm. 2002). It hybridizes infrequently with *D. goldiana*. Hybrids with *D. filix-mas* and *clintoniana*, *intermedia*, *spinulosa*, or *crinata* are not known (Britton 1965). These hybrids have unpaired chromosomes and therefore the spores will abort (Britton 1965). Florence Wagner states that the only sure way to tell the hybrid x *D. marginalis* from *D. filix-mas* is to look for abortive spores on the hybrid. *D. filix-mas* x *marginalis* has a sporophyte of $3x = 123$ and is unpaired (Wagner & Hagenah 1962). It is not known whether this is related to the limited distribution of *D. filix-mas* or some other factor.

DESCRIPTION OF SPECIES

Description from: Gleason & Cronquist (1991), Montgomery & Wagner (1993), Lellinger (1985).

- FronDS:** Monomorphic, deciduous, to 120 cm high and 30 cm wide.
- Blade:** “Green, ovate-lanceolate, pinnate-pinnatifid to 2-pinnate at base, firm but not leathery, not glandular” (Montgomery & Wagner 1993); usually widest above the middle.
- Pinnae/Leaflets:** 20-30 pairs. “In plane of blade, lanceolate; basal pinnae ovate-lanceolate, much reduced, basal pinnules or segments approximately the same length as adjacent pinnules, basal basioscopic pinnule and basal acroscopic pinnule equal; pinnule margins serrate to lobed” (Montgomery & Wagner 1993).
- Petiole:** Less than ¼ length of blade; scaly especially at base; scales brown, scattered and of two types--one broad, one filamentous.
- Rhizome:** Erect or ascending
- Sori:** Halfway between midvein and edge of segments.

Identification notes:

D. filix-mas, and its close relative *D. marginalis*, may occur together. *D. filix-mas* is larger and greener than the bluish/grayish green of *D. marginalis*. *D. filix-mas* also has a shorter petiole, and its sori are closer to the midvein than those of *D. marginalis*, which are right at the margins of the leaf segment (W-3). *Dryopteris filix-mas* is the only *Dryopteris* species with two distinct types of scales and no intermediates (Montgomery & Wagner 1993). It also hybridizes freely with *D. marginalis* in some localities (Morton & Venn 1984). “The hybrid differs from *D. filix-mas* in having the sori more widely spaced and the sporangia aborted” (Morton & Venn 1984). Florence Wagner (pers. comm. 2002) also notes that the under surface of the hybrid is a lighter bluish green; but the true test is to check for abortive spores.

HABITAT AND ECOLOGY

In the United Kingdom, *D. filix-mas* grows in argillaceous or sandy sub-soils in canopies of mixed, deciduous trees. Most sites are on the sides of small-river valleys at altitudes of between 120 and 165m and in forests over 150 years of age (Willmot 1985).

In North America, *Dryopteris filix-mas* occurs in thick woods and on talus slopes, often of limestone, in the Northeast; in the Rocky Mountains, it occurs in more open woods with boulders and either granite or igneous talus (Montgomery & Wagner 1993). *D. filix-mas* does

not usually occur on limestone or dolomite in Vermont, however, it does require presence of a bedrock with a highly calcareous component (mica schist, or “decaying limestone”) in order to grow (Art Gilman, pers. comm., 2001). In addition, this species appears to grow only within a certain elevation range (mostly 400 - 700 m) Diane Burbank, pers. comm., 2001). In Maine, this fern species has been found on talus slopes and calcareous ledges (W-3). In Cook County, Illinois, *D. filix-mas* was found in a mesic ravine on a mostly undisturbed slope that was northwest-facing (Swink & Wilhelm 1994). Associates at the Illinois site include *Acer saccharum*, *Aralia nudicaulis*, *Hamamelis virginiana*, *Quercus rubra*, and *Trillium grandiflorum* (Swink & Wilhelm 1994).

In the Great Lakes Region, especially Michigan’s Upper Peninsula and the Canadian Province of Ontario, *Dryopteris filix-mas* is found along the Niagara Escarpment and other rocky areas (Cox & Larson 1993). Typical Michigan habitat is a rocky sheltered site such as a cliff, ravine, crevice or sinkhole in a mixed hardwood forest community (MNFI 1985). On Manitoulin Island in northern Lake Huron it is found both on limestone ledges and on quartzite (Morton & Venn 1984). In Wisconsin, *D. filix-mas* is described as growing along rocky slopes in mixed *Acer/Quercus* woods with *Adiantum pedatum* and *Gymnocarpium dryopteris* (WNHP 2001).

Ten species of ferns are completely or mostly restricted to the Mixedwoods Plains Ecozone of the Niagara Escarpment (W-7). Associates of the male fern (*Dryopteris filix-mas*) include purple cliffbrake (*Pellaea atropurpurea*) green spleenwort (*Asplenium trichomanes-ramosum*), Hart’s-tongue fern (*Asplenium scolopendrium*), Laurentian fern (*Cystopteris laurentiana*), and limestone fern (*Gymnocarpium robertianum*) (W-7).

In a study of vegetation on talus slopes of the Niagara Escarpment, mean abundance [=total abundance (number of sectors in which it occurs) divided by the number of quadrats] of various species were compared (Cox & Larson 1993). *D. filix-mas* had a mean abundance of 0.033 compared to 0.632 for *Cystopteris bulbifera* and 2.080 for *Dryopteris marginalis*.

Although *Dryopteris filix-mas* occurring in Michigan, is most abundant in the western part of the Upper Peninsula, it is uncommon there (Carlson 1979). Western Upper Peninsula sites are on rock outcrops, cliffs, and rocky slopes, with plants often growing within cracks in the rock walls or ledges (Sue Trull, pers. comm., 2001). Of 10 sites on the Ottawa National Forest, all associated with rock, none are limestone. Associates at these sites include *Dryopteris intermedia*, *Polystichum braunii*, *Phegopteris connectilis*, *Athyrium filix-femina*, *Polypodium virginianum*, *Polystichum lonchitis*, *Asplenium trichomanes*, and *Aquilegia canadensis* (Sue Trull, pers. comm., 2001).

Dryopteris filix-mas is also found on neutral basaltic rocks within the Porcupine Mountains State Park in Ontonagon County, Michigan (Carlson 1979). In dry upland areas, it occurs mainly on boulders and is sometimes associated with *Polystichum lonchitis* (northern holly fern), *Asplenium trichomanes-ramosum* (green spleenwort) and *Dryopteris marginalis* (Carlson 1979). On islands in Lake Superior off-shore from the Huron Mountain Club (Marquette County), it was associated with *D. marginalis* and hybrids between the two species (Hagenah 1963). The Huron Islands site (jurisdiction of U.S. Fish and Wildlife

Service) was again confirmed in 2000 during a Natural Features Survey for Marquette County along Lake Superior shoreline (Chadde 2000). In the eastern Upper Peninsula of Michigan, *Dryopteris filix-mas* grows in small cracks and crevices (grikes) of exposed limestone pavement in Mackinac County (Carlson 1979).

DISTRIBUTION AND ABUNDANCE

Dryopteris filix-mas, a circumboreal species, is known from Eurasia, Greenland, across Europe, the Caucasus Mountains, and Turkey. It also is scattered in central Asia, northwestern China, and Africa (Tryon & Moran 1997). *D. filix-mas* occurs in Europe as an allopolyploid of *Dryopteris caucasica* x *oreades* (Montgomery & Wagner 1993) and is fairly common. For example, *D. filix-mas* was listed among the 50 most common plants of Cornwall, England (W-9); it was also chosen as a species for study near Darby, Scotland because it was a common plant (Wilmot 1985).

In North America, *Dryopteris filix-mas* occurs in the Rocky Mountains from New Mexico northwards to British Columbia and sporadically in the Great Lakes Region to Greenland and Iceland (Carlson & Wagner 1982). It occurs in Greenland and the Canadian provinces of SW Alberta, British Columbia, Newfoundland, Nova Scotia, Ontario, Quebec, and Saskatchewan. In the United States it occurs in Arizona, California, Colorado, Idaho, Michigan, Montana, New Mexico, Nevada, Oklahoma, Oregon, Texas, Utah, Washington, Wisconsin, and Wyoming (Montgomery & Wagner 1993). It is disjunct in northern Illinois according to Lellinger (1985) and has a disjunct population in the San Bernadino Mountains in southern California (Carlson & Wagner 1982).

In the Upper Peninsula of Michigan, *Dryopteris filix-mas* is documented within the counties of Chippewa, Ontonagon, Keweenaw, Marquette, and Mackinac along with northern Alpena County (in limestone sinks) in the Lower Peninsula (MNFI 1999a).

The Huron Islands, off the shore of the Huron Mountains in Marquette County, was one of the earliest known sites for *D. filix-mas* (Wagner & Hagenah 1962). A moist saddle between two knobs contained a large clone of the hybrid *D. filix-mas* x *marginalis* with the two parents extended further up the hillside (Wagner & Hagenah 1962). Almost 1/3 of Michigan's 17 occurrences are from Keweenaw County, and most populations are small (MNFI 1985). In Wisconsin, *D. filix-mas* occurs in Ashland, Iron, and Brown counties (W-8); this fern species is not known from Minnesota.

National Forests

There are about 15 sites of *Dryopteris filix-mas* for the state of Vermont (Gilman *et al.* 2000). There are two occurrences of this species in the Green Mountain National Forest, with one plant growing within 20 feet of the Appalachian Trail (Burbank, pers. comm., 2001).

On the Hiawatha National Forest, within Mackinac County, *D. filix-mas* occurs on a hillside with exposed limestone of less than 0.1 acre, where it is associated with *Acer saccharum* (sugar maple) (MNFI 1999b). MNFI has assigned this population a C rank indicating average short term viability and somewhat uncertain long-term viability. *D. filix-mas* also occurs in

Mackinac County just 3.5 miles outside the Hiawatha Forest Boundary (MNFI 1985). *D. filix-mas* was found growing profusely at a limestone pavement location in Michigan's eastern Upper Peninsula (W-4). The Ottawa National Forest has 10 documented occurrences in rocky (non-calcareous) areas with populations ranging from less than 10 to 200 (S. Trull pers. comm. 2001). It has recently come to the attention of the Chequamegon-Nicolet NF that *Dryopteris filix-mas* occurs within the Forests proclamation boundary, possibly on National Forest land. It is probable that this species will be added as an RFSS for the Chequamegon-Nicolet NF in the near future (S. Spickerman, pers. comm., 2001).

STATUS (PROTECTION)

Currently, the official status of *Dryopteris filix-mas* with respect to Global, Federal and State conservation status as well as agency status given by rank, and rank definition is:

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

U.S. Forest Service: Region 9 Sensitive on Green Mountain National Forest in Vermont and Hiawatha National Forest in Michigan

The Regional Forester has identified it as a species for which viability is a concern in Green Mountain National Forest and Hiawatha 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: N4N5

Canada: N4N5

Michigan: Special Concern, S3

Wisconsin: Special Concern

Minnesota: Not tracked

S3: Rare or uncommon in State (21 to 100 occurrences)

Other states: (NatureServe W-5)

Arizona	SR	Oklahoma	S1
California	S1	Oregon	S3
Colorado	SR	Pennsylvania	SU
Hawaii	SR	Rhode Island	SR
Idaho	SR	South Dakota	SR
Illinois	S1	Texas	S1
Maine	S1	Utah	SR
Montana	SR	Vermont	S2
Nevada	SR	Washington	SR
New Hampshire	SR	Wisconsin	S1
New Mexico	SR	Wyoming	S2

Canada: (NatureServe W-5)

Alberta	S1	Nova Scotia	S3
British Columbia	S?	Ontario	S4
New Brunswick	S1	Quebec	S2
Newfoundland (Newfoundland Island)	S3 S4	Saskatchewan	S1

S1: Critically imperiled because of extreme rarity (often < 5 occurrences) making it especially vulnerable to extirpation.

S2: Imperiled because of rarity (often 6-20 occurrences)

S3: Rare or uncommon in State (21 to 100 occurrences)

S4: Apparently secure, although it may be rare at periphery of range.

SR: Reported, not assessed.

SU: Unrankable, currently unrankable due to lack of information or due to substantially conflicting information about status or trends

S?: not enough information available to assess; more field studies and/or specimen identification is needed

LIFE HISTORY

Dryopteris filix-mas is a generally long-lived perennial herbaceous fern; it is not evergreen (leaves die back in winter). In Britain and Ireland, its fronds are semi-persistent and are usually lying flat on the ground by spring and is “still partly green and partly olive-brown and decaying” (Page 1997).

In the United Kingdom, *D. filix-mas* sites in older forests (150+ years) at altitudes between 120 and 165m had an excess of large, fertile plants over small sterile ones. At one site on the floor of a large-river valley, disturbed by a working gravel pit until 1960, there were roughly equal numbers of small, sterile plants and large, fertile plants. The population was visited over a three year period, and the population maintained the same patterns of size-structure. Survival of *D. filix-mas* crowns was 87% from 1981 to 1982 (Willmot 1985). In *D. filix-mas* populations virtually all the smallest plants (1-5 cm) grew among bryophytes, but larger plants grew in various habitats (Willmot 1985). The bryophytes were mostly on small rises.

Sydes and Grime (1981) noted that litter often collects in depressions, and it is the blanketing effect of litter that restricts small ferns to the rises. Another probable factor for limiting the spread of young *D. filix-mas* plants is root competition with woody plants (Nauyalis 1979). The data compiled by Willmot (1985) in histogram form suggest that for *D. filix-mas* that recruitment is a rare event (less than 10%), but once plants are established they live for a long time.

Spores of *D. filix-mas* mature from July through August (Billington 1952). Several factors control dispersal distance of spores including spore properties, the number of spores produced, the number of sporophytes present and habitat properties, especially wind currents (Schneller 1995). 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. This allows some spores to germinate in the first season as well as to form a persistent spore bank (Dyer & Lindsay 1992). It has been documented that 95% of all spores of several tested fern species fall in the immediate vicinity, within 1 to 10 meters of the parent plant (Vogel *et al.* 1999, Dyer & Lindsay 1992). Controlled studies of spore release in *Dryopteris filix-mas* showed that most spores landed within 14 cm from the parent plant (Schneller 1995).

Yatsushashi *et al.* (1996) determined that two phytochrome-mediated responses, which control spore germination, are present in *Dryopteris filix-mas*. “The first phytochrome-mediated response, due to the presence of the far-red absorbing phytochrome form (P_{fr}), stimulates formation of chlorophyll, and formation of rhizoid and protonemal initials. After a time delay, the second phytochrome-mediated response induces rhizoid elongation”.

Two spore samples from natural populations in Finland were collected, and less than a year later, the spores were sown on a nutrient medium; germination was 15% and 44% for the first and second samples (Korpelainen 1994).

Dryopteris filix-mas usually has gametophytes bearing both antheridia and archegonia (hermaphrodites) (Korpelainen 1994). However, many populations, both in nature and in the laboratory, are mixed and contain both male and female individuals as well as hermaphrodites (Hamilton & Lloyd 1991; Tryon & Vitale 1977). Femaleness or hermaphroditism is favored by fast growth and large size, while maleness is favored when the gametophyte exhibits poor vegetative growth (Korpelainen 1994).

In *Dryopteris filix-mas*, hormones called antheridiogens, produced by a large gametophyte, can induce maleness in nearby smaller or more slowly-growing gametophytes by stimulating antheridia production (Korpelainen 1994). This process is actually indirect, i.e., “antheridiogens affect size, and size influences sex expression.” Environmental factors, such as nutrition and source population, may also affect sex determination in gametophytes in this species (Korpelainen 1994). Antheridiogens are a means to avoid intragametophytic selfing (and the resulting loss of genetic variation) (Korpelainen 1994).

Korpelainen (1996) noted in her experiment, that those gametophytes of *Dryopteris filix-mas* that reproduced by intragametophytic selfing only, had greater and more rapid reproduction than those where both intragametophytic selfing and intergametophytic crossing were observed. Therefore, selfing, with the subsequent inbreeding, did not lessen reproductive

success (Korpelainen 1996). “The abundance and the high viability of sporophytes produced by intragametophytic selfing”, observed by Korpelainen (1996), “indicate that *D. filix-mas* does not experience serious inbreeding depression.” Korpelainen (1996) suggested that “the abundance of resources may be more important for the reproductive success of *D. filix-mas* than the actual mating system used.”

Some degree of intragametophytic selfing is useful, such as during colonization and when population sizes are small (Korpelainen 1994).

POPULATION BIOLOGY AND VIABILITY

In Michigan, there are six historical occurrences before the 1930s and another six occurrences from the 1950-1970s. There are approximately eight current records from the Upper Peninsula of Michigan. Also there are seven records on the Ottawa National Forest from 1999 and 2000 that have not yet been entered into the MNFI database. A clearer picture is needed concerning distribution in Michigan before the overall viability of the species can be determined.

Dryopteris filix-mas is better known from Canada. Ontario has 11 specimens at the University of Michigan herbarium (2002), while British Columbia has 10. More specimens would likely be located if Canadian herbaria were examined. This fern also grows in the Rocky Mountains extending from British Columbia to Colorado. Presumably these higher latitude and higher altitude sites are more conducive to the fern’s establishment and growth. Population viability would likely be reasonably secure in Canada due to fairly large well-established populations.

The only documented site on the Hiawatha National Forest, Michigan, is one colony on a hillside with exposed limestone (HNF EO). The major overstory component at this site was *Acer saccharum* (sugar maple). This site cannot be assumed to be viable long-term given the amount of deer herbivory within the southern part of the Upper Peninsula, climate factors, and environmental stochasticity. It is likely there are other as yet undiscovered sites on the Hiawatha National Forest and adjacent lands, which would contribute to the long-term viability of this species.

Several populations of *D. filix-mas* occurring in the western Upper Peninsula have been known since the 1950s (Billington 1952); recent field work on the Ottawa National Forest documented 10 additional occurrences. Both on and off Forest populations in the western Upper Peninsula would appear to be more viable since more widespread colonies have been undisturbed for decades in designated Wilderness areas allowing the fern to spread naturally. Four of the Ottawa National Forest colonies are in Wilderness areas, but steps need to be taken to protect those six that are not (Sue Trull, pers. comm., 2001).

POTENTIAL THREATS

Several threats exist to the survival of *Dryopteris filix-mas* in the Upper Peninsula of Michigan. These include species competition, climatic factors including drought, loss of protective snow pack during cold winters, short growing season, deer herbivory, and change in canopy closure or habitat alteration (due to timber harvesting activities or natural blowdowns.) (LeBlanc pers. comm. 2001).

Deer herbivory is high at known locations of *Dryopteris filix-mas* (Deb LeBlanc pers. comm. 2001). Deer herbivory can impact existing plants and their ability to reproduce. 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 is removed, vegetative growth is greatly decreased the next summer. Plants that had greater than 25% of their rhizomes removed produced virtually no growth during the following growing season (Gillingham *et al.* 2000).

Changes in canopy closure can also occur from catastrophic windfall which has occurred in recent years in the southern portion of the Hiawatha National Forest (LeBlanc pers. comm. 2001). The known Hiawatha National Forest location could potentially be under threat of canopy removal related to timber harvesting operations (J. Schultz pers. comm. 2001). Threat from competition by invasive non-native plants, such as *Arctium minus* (common burdock), could occur indirectly due to activities such as the creation of roads for timber harvesting, or use of snowmobile and ATV trails in the area (J. Schultz pers. comm. 2001).

The populations in the United Kingdom reported by Willmot (1985) were mostly in old growth forest (over 150 years). MNFI considers only eight occurrences of northern mesic forest, constituting just over 56,000 acres, as high quality representations of this community type (Cohen 1999). MNFI recommends that where tracks of mesic northern forest are managed for timber harvest, care should be taken to minimize fragmentation, and maintain a canopy closure comparable to pre-harvest closure (Cohen 1999). The best management is to leave large tracts unharvested and allow natural processes to operate unhindered. Johnson and Van Wagner (1985) suggest that a landscape should be at least twice the size of the largest disturbance event.

Although there is no indication of virus problems in North America, fern potyvirus was first reported in *Dryopteris filix-mas* and *Polypodium vulgare* from Germany by Nienhaus *et al.* (1974). This virus is transmitted in a non-persistent manner by an insect of the Aphididae, *Myzus persicae* (W-6).

Long-term viability for *Dryopteris filix-mas* may be dependent on maintaining potential habitat and known occupied habitat on public lands. Private landowners are under no obligation to protect these species. Therefore, the need exists to create and maintain refugia for rare species within public lands; the conservation approach for this species will address this issue.

SUMMARY

In the Great Lakes area of Michigan's Upper Peninsula and adjacent Canada, *Dryopteris filix-mas* occurs as a terrestrial element on basalt cliffs, limestone outcrops or limestone pavement associated with the Niagara Escarpment. In both Michigan and Wisconsin, this fern species is listed as special concern. While not as restricted to habitat as Hart's tongue fern (*Asplenium scolopendrium* var. *americanum*), or green spleenwort (*Asplenium trichomanes-ramosum*), this species is relatively uncommon. It is likely, however, that this species is often overlooked or assumed to be another, more common *Dryopteris* species. In addition, *D. filix-mas* often hybridizes with *Dryopteris marginalis* making field identification difficult.

REFERENCES

- Billington, C. 1952. Ferns of Michigan. Cranbrook Institute of Science. Bloomfield Hills, Michigan. pp. 175-177.
- Britton, D.M. 1965. Hybrid Wood Ferns in Ontario. The Michigan Botanist. Vol. 4: 3-9.
- Carlson, T.J. 1979. The comparative ecology and frequencies of interspecific hybridization of Michigan woodferns. Michigan Botanist 18:47-56.
- Carlson, T.M., and W.H. Wagner, Jr. 1982. The North American Distribution of the Genus *Dryopteris*. Contributions of the University of Michigan Herbarium 15:141-162.
- Chadde, S.W. 2000. Natural Features Survey, Lake Superior Shoreline, Marquette County, Michigan. PocketFlora Press. Calumet, Michigan. P. 18.
- Cohen, J.G. 1999. Natural community abstract for mesic northern forest. Michigan Natural Features Inventory. Lansing, MI. pp. 1-7
- Cox, J.E., and D.W. Larson. 1993. Spatial heterogeneity of vegetation and environmental factors on talus slopes of the Niagara Escarpment. Canadian Journal of Botany 71:323-332.
- Gillingham, M.P., K.L. Parker, and T.A. Hanley. 2000. [Abstract] Partial consumption of shield fern (*Dryopteris dilatata*) rhizomes by Black-tailed deer (*Odocoileus hemionus sitkensis*) and its potential implications. Canadian Field-Naturalist 114(1):21-25.
- Gleason, H.A., and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada, 2nd edition. The New York Botanical Garden, Bronx, NY. 910 pp.
- Hagenah, D.J. 1963. Pteridophytes of the Huron Mountains, Marquette County, MI. Michigan Botanist 2:78- 93.

- Korpelainen, H. 1994. Growth, sex determination and reproduction of *Dryopteris filix-mas* (L.) Schott gametophytes under varying nutritional conditions. *Botanical Journal of the Linnean Society* 114: 357-366.
- Korpelainen, H. 1996. Intragametophytic selfing does not reduce reproduction in *Dryopteris filix-mas*. *Sexual Plant Reproduction* 9(2) p. 117-122.
- Lellinger, D.B. 1985. *A Field Manual of the Ferns and Fern-Allies of the United States and Canada*. Smithsonian Institution Press. Washington D. C. p. 38, 293, 322 and 383.
- Michigan Natural Features Inventory (MNFI). 1985. An overview of endangered and threatened species in Hiawatha National Forest, Michigan. P. 101.
- Michigan Natural Features Inventory (MNFI). 1999a. Michigan County Element Lists. September 1999.
- Michigan Natural Features Inventory (MNFI). 1999b. Element Occurrence Records database. November 19, 1999.
- Michigan Natural Features Inventory (MNFI). 2002. Electronic Database at: <http://web4.msue.msu.edu/mnfi/search/>
- Montgomery, J.D., and W.H. Wagner, Jr. 1993. *Dryopteris* In: *Flora of North America* Editorial Committee, Editors. *Flora of North America Vol 2. Pteridophytes and Gymnosperms*. Oxford University Press, New York. pp. 280-288.
- Morton, J.K. and J. M. Venn. 1984. *The Flora of Manitoulin Island*. University of Waterloo. Waterloo, Ontario. P. 40.
- Page, C.N. 1997. *The Ferns of Britain and Ireland*. Cambridge University Press. Cambridge, United Kingdom pp. 202-207.
- Schneller, J.J. 1995. Aspects of spore release of *Asplenium ruta-muraria* with reference to some other woodland ferns: *Athyrium filix-femina*, *Dryopteris filix-mas*, and *Polystichum aculeatum*. *Botanica Helvetica* 105(2):87-197.
- Swink, F., and G. Wilhelm. 1994. *Plants of the Chicago Region*. Morton Arboretum at Lisle, Illinois. P. 309.
- Tryon, A.F., & R.C. Moran. 1997. *The Ferns and Allied Plants of New England*. Center for Biological Conservation, pp. 110-111.
- USDA. 2000. Regional Forester Sensitive Species (RFSS) plant list. Eastern Region (R9). 29 February 2000.

- Wagner, W.H. and D.J. Hagenah. 1962. *Dryopteris* in the Huron Mountain Club Area of Michigan. *Brittonia* 14: 90-100.
- Willmot, A. 1985. Population dynamics of woodland *Dryopteris* in Britain. *Proceedings of the Royal Society of Edinburgh* 86: 307-313.
- Wisconsin Natural Heritage Program (WNHP) element occurrences. 2001. Botany Department, University of Wisconsin, Madison, WI.
- Yatsushashi, H., S. Turnwald, and R. Scheuerlein. 1996. Germination in spores of *Dryopteris filix-mas*: Regulation of rhizoid elongation as a second phytochrome-mediated response. *Physiologia Plantarum* 98:399-406.

CITED IN OTHER REFERENCE

- Dyer, A.E., and S. Lindsay. 1992. Soil spore banks of temperate ferns. *Amer. Fern. J.* 82:89-122 cited in Schneller (1995)
- Gilman, A.V., D.S. Barrington, C.A. Paris, P.T. Hope, and D.S. Conant. 2000. Annotated checklist of Vermont Pteridophytes: Lycopsidea, Equisetopsida, Filicopsida. Published by A.V. Gilman, PO Box ?, Marshfield, Vermont 05658, cited in Diane Burbank, 10/25/00 & 6/22/01 emails.
- Hamilton, R.G., & R.M. Lloyd. 1991. Antheridiogen in the wild: The development of fern gametophyte communities. *Functional Ecology* 5:804-809 cited in Korpelainen (1994)
- Johnson, E.A. and C.E. Van Wagner. 1985. The theory and use of two fire history models. *Canadian Journal of Forest Research* 15: 214-220 cited in Cohen (1999).
- Nauyalis, I.I. 1979. Some features of the ecology of sprouts and juvenile plants of *Athyrium filix-femina* (L.) Roth and *Dryopteris filix-mas* (L.) Schott in the mixed coniferous broad-leaved forests of Moskovskaya Oblast. *Byull. Mosk. Obshch. Ispyt. Prir. Biol.* 84: 54-63 cited in Willmot (1985).
- Nienhaus, F., C. Mack, and U. Schinzer. 1974. *Z. PflKrankh. PflPath. PflSchutz* 81:533 cited in W-6
- Sydes, C. and Grime, J.P. 1981. Effects of tree litter on herbaceous vegetation in deciduous woodland. *Field investigations. Journal of Ecology* 69: 237-248 cited in Willmot (1985).
- Tryon, R.M., & G. Vitale. 1997. Evidence for antheridiogen production and its mediation of a mating system in natural populations of fern gametophytes. *Botanical Journal of the Linnean Society* 74:243-249 cited in Korpelainen (1994)

Vogel, J.C., F.J. Rumsey, J.J. Schneller, J.A. Barrett, and M. Gibby. 1999. Where are the glacial refugia in Europe? Evidence from Pteridophytes. *Biol. J. of the Linn. Soc.* 66:23-37 cited in USDA (1999).

Wagner, W.H. 1971. Evolution of *Dryopteris* in relation to the Appalachians. In P. C. Holt, ed. *The Distributional History of the Biota of the Southern Appalachians, Part II, Flora.* Virginia Polytech. Inst. State Univ. Res. Div. Monogr. 2 pp. 147-192, cited in Lellinger (1985)

WEBSITES

W-1. Dryopteridaceae (synonyms)

<http://jagor.srce.hr/botanic/cisb/Edoc/flora/check/pterido/filico/dryopter.html>

W-2. Ecology & Evolutionary Biology Conservatory

http://florawww.eeb.uconn.edu/acc_num/199800033.html

W-3. Maine Department of Conservation. Natural Areas Division. *Dryopteris filix-mas*

<http://www.state.me.us/doc/nrimc/mnap/factsheets/snameindex.htm>

W-4. Michigan Fern Foray

<http://www-mtl.mit.edu/~penfield/pubs/foray-90.html>

W-5 NatureServe: An online encyclopedia. 2000. Version 1.2. Arlington, Virginia

<http://www.natureserve.org>

W-6. Plant Viruses Online—Fern potyvirus

<http://image.fs.uidaho.edu/vide/descr334.htm>

W-7. Pteridophytes from Assessment of species diversity in the mixedwood plains ecozone

<http://www.cciw.ca/eman-temp/reports/publications/Mixedwood/ferns/ferns3.htm>

W-8. Wisconsin species detail for *Dryopteris filix-mas*

<http://wiscinfo.doit.wisc.edu/herbarium/scripts/detail.asp?SpCode=DRYFIL>

W-9. 100 Most Recorded Plants in Cornwall

<http://info.ex.ac.uk/~cnfrench/ics/cbru/checklist/complant.htm>

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