Dwarf Lake Iris (*Iris lacustris*)

Recovery Plan

U.S. Department of the Interior
Fish and Wildlife Service
Midwest Region
Bloomington, MN

Cover photograph by Joel Trick

Dwarf Lake Iris
(Iris lacustris)

Recovery Plan

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Prepared by

East Lansing Field Office
U.S. Fish and Wildlife Service

for

Midwest Region
U.S. Fish and Wildlife Service
Bloomington, Minnesota

Approved: _____
ACTING **Regional Director, Midwest Region, U.S. Fish and Wildlife Service**

Date: 8/1/13

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By approving this document, the Regional Director certifies that data used in its development represent the best scientific and commercial data available at the time of writing. Copies of all documents reviewed in development of the plan are available in the administrative record, located at the East Lansing Field Office, Michigan.

Literature Citation

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Availability

Recovery plans can be downloaded from FWS website, http://endangered.fws.gov, or you may send a request to:

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EXECUTIVE SUMMARY

Current Species Status

The U.S. Fish and Wildlife Service listed the dwarf lake iris (*Iris lacustris*) as threatened on October 28, 1988, under the provisions of the Endangered Species Act of 1973, as amended. The species grows along the northern shorelines of lakes Michigan and Huron in Wisconsin, Michigan and Ontario, Canada. Of 167 extant occurrences, many lie on private property where awareness of the species' presence and significance is limited. Direct loss of plants and habitat is continuing and expected to accelerate due to the high demand of shoreline properties for development and recreation.

Habitat Requirements and Limiting Factors

Dwarf lake iris typically grows in shallow soil over moist calcareous sands, gravel and beach rubble. Sunlight is one of the most critical factors to the growth and reproduction of the species and partly shaded or sheltered forest edges are optimal for sexual reproduction. Some form of disturbance is also required to maintain the forest openings that provide these partial shade conditions. The species is most often associated with shoreline coniferous forests dominated by northern white cedar and balsam fir. The principal limiting factor for dwarf lake iris is the availability of this suitable shoreline habitat.

Recovery Strategy

The principal recovery strategy is to conserve the habitat containing dwarf lake iris populations by implementing a variety of protection strategies, including landowner notification, education, and the preparation of management and monitoring plans. Additional efforts will focus on improving the baseline understanding of dwarf lake iris ecology. Outreach materials will be developed to improve awareness of the species' presence and its status as a threatened species.

Recovery Goal: To remove the species from the Federal list of Endangered and Threatened Plants (50 CFR 17.12).

Recovery Objectives: (1) To ensure the long-term persistence of a minimum number of viable populations across a majority of the species' geographic range through protection of habitat and conservation under a management plan; (2) to advance the understanding of dwarf lake iris ecology through research and experimental management practices; and (3) to improve public awareness of dwarf lake iris.

Recovery Criteria

Delisting of the species will be considered when the criteria outlined below are met:

Criterion 1. The species has a 95% probability of persistence within the next 20 years, based on data obtained from accepted standardized monitoring methods and on population viability analysis. In order to meet this criterion, the following must be verified:

1.a. There is a sufficient number and geographical distribution of element occurrences required to ensure long-term persistence.

1.b. Each element occurrence needed to ensure a 95% probability of persistence within the next 20 years must meet a minimum viable population size and exhibit an increasing or stable population trend over a 10-year period.

Criterion 2. Management plans have been developed and are being implemented to protect and manage the habitat associated with the element occurrences identified in Criterion 1.b.

Criterion 3. A plan to provide public outreach and education for dwarf lake iris has been developed and is being implemented.

Actions Needed

1) Protect occurrences
2) Manage and restore habitat
3) Inventory and monitor known sites
4) Conduct population viability analysis
5) Develop an education program about dwarf lake iris, other federally listed shoreline species, natural communities, and their protection and management
6) Improve understanding of baseline dwarf lake iris ecology
7) Review and track recovery progress

Estimated Cost of Recovery for FY 2014 – 2029 (in $1,000)

Details are found in the Implementation Schedule.

Year**(s)**	Action 1	Action 2	Action 3	Action 4	Action 5	Action 6	Action 7	**TOTAL**
1	22	37	30	0	11	25	1	**126**
2	22	37	30	0	11	45	1	**146**
3	16	37	30	15	11	65	1	**175**
4-15	75+	10+	20+	15	35	TBD	17	**172+**
TOTAL	**135+**	**121+**	**110+**	**30**	**68**	**135+**	**20**	**619+**

Date of Recovery

Contingent on funding and implementation of recovery actions, full recovery of this species may occur by 2029.

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PART I. INTRODUCTION

Dwarf lake iris is a species of the Upper Great Lakes region, where it grows primarily along the edges of shoreline boreal forests in close association with or proximity to other rare coastal species, such as Houghton's goldenrod (*Solidago houghtonii*), Pitcher's thistle (*Cirsium pitcheri*), piping plover (*Charadrius melodus*), and the Lake Huron locust (*Trimerotropis huroniana*). Thomas Nuttall discovered dwarf lake iris in 1810 on Mackinac Island in Lake Huron (Voss 1972). This attractive shoreline species is among the best known of all the endangered and threatened plants of the Great Lakes region, where it has become a symbol of plant rarity and conservation in both Michigan and Wisconsin. In 1998, Michigan designated the dwarf lake iris as the official State wildflower.

Status of the Species

The U.S. Fish and Wildlife Service (1988) listed the dwarf lake iris (*Iris lacustris*) as threatened on October 28, 1988 (53 FR 37972), under the provisions of the Endangered Species Act of 1973 (ESA), as amended. The recovery priority number for dwarf lake iris is 8C, indicating a moderate threat, a high recovery potential, and conflict with construction or other forms of economic activity. The species is classified as state threatened in Michigan (MDNR 2009) and Wisconsin (WDNR 2011). In Canada, dwarf lake iris is on Schedule 1 of the Species at Risk Act (SARA) as a threatened species (Government of Canada 2006). The species' status in Ontario was recently re-examined and changed from threatened to special concern (COSEWIC 2010).

Description and Taxonomy

Dwarf lake iris is a low-growing perennial with very slender, creeping rhizomes (Figure 1). At their enlarged nodes, the rhizomes produce fans of flattened, sword-like leaves approximately 16 cm or less in height during the blooming period (Foster 1937). The showy blue to purple-colored flowers are borne singly on short flowering stalks up to 4 cm long with one to three reduced leaves at the base and scarious (thin, papery)-margined spathes (bracts) that largely envelop the basal, yellowish floral tube. The flowers, which emerge primarily from mid to late-May, have three, petal-like recurving sepals that are beardless and covered with whitish, multi-ridged crests splotched with yellow. Overarching each sepal and stamen is a petal-like style branch with an upturned tip. On its underside, each style branch bears a thin, delicate, flap-like lip that comprises the stigmatic surface. Alternating with the sepals are three smaller, paler blue, erect petals. In full bloom, dwarf lake iris flowers are approximately 2.5-4 cm wide and 4-6 cm in height. Flowers are most commonly blue but may vary from pale to somewhat darker lilac shades; albino flowers (*I. lacustris* f. *albiflora*) occur sporadically throughout the range of the species (Cruise and Catling 1972). The fruits are rounded capsules about 1.2 cm long, bearing brown, oval seeds with a shiny white, coiling appendage that may function as an elaiosome (food body) to attract potential seed dispersers. Although Planisek (1983) demonstrated that ants are attracted to and will move dwarf lake iris seeds, the extent of their role, if any, in the dispersal of this species is not known.

Dwarf lake iris is distinctive and unlikely to be confused with any other species of *Iris* within its range. In Michigan, the superficially similar, non-native *I. pumila* L. is a cultivated dwarf iris

that has been documented twice as a garden escapee in Newaygo and Gratiot Counties—well south of the known range of *I. lacustris* (Voss 1972). In addition, *Iris pumila* was vouchered at one site in a roadside ditch in Columbia County, Wisconsin in 1999, also far southwest of *I. lacustris* habitat (Lance Potter, Wisconsin Department of Natural Resources, pers. comm. 2012). *I. pumila* is distinguished by its prominently bearded sepals and much thicker rhizomes (more than 5 mm thick versus less than 5 mm thick for most of their length in *I. lacustris*) (Voss 1972). False asphodel (*Tofieldia glutinosa*) is a superficially similar species and a common native plant associate in shoreline fens that could be confused with dwarf lake iris in vegetative condition but can be distinguished by its markedly narrower leaves and non-rhizomatous habit.

Dwarf lake iris is classified within the subgenus *Limniris*, one of the six subgenera of *Iris* and which includes all of the native iris species of North America, a group frequently referred to as the beardless irises (Henderson 2002). Although *I. lacustris* has sometimes been treated as a subspecies of *I. cristata* (Dykes 1913; Mason and Iltis 1965), most authors recognize dwarf lake iris as a distinct species, based on consistent and marked differences in morphology, geographical range, and habitat (Small 1924; Foster 1937). The more southerly ranging *I. cristata* occurs from the Ozark Mountains and Appalachian highlands to the Piedmont and Atlantic Coastal Plain regions (Foster 1937; Henderson 2002). *I. cristata* is about twice the size of *I. lacustris* and inhabits somewhat acidic soils in rich shady woods, banks, wooded bottoms, ravines, and cliffs.

Foster (1937) also considered a reported difference in chromosome numbers of 2n = 32 for *I. cristata* and 2n = 42 for *I. lacustris* as further evidence of specific status for *I. lacustris*. Pringle (1976), however, questioned the chromosome number of 42 for *I. lacustris*, based on other

Figure 1. Dwarf lake iris (*Iris lacustris*) A – Seedling, B – Adult
Figure Credit: USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. An illustrated flora of the northern United States, Canada and the British Possessions. Vol. 1: 540.

documented reports of 2n = 32 for the species, but did not doubt the validity of *I. lacustris* as a separate species. More recently, Henderson (2002) listed *I. cristata* as 2n = 24, 32 and *I. lacustris* as 2n = 32, 42; and Hannan and Orick (2000) have postulated that *I. lacustris* may have originated from a relatively recent, genetically depauperate *I. cristata* gene pool.

Distribution

Dwarf lake iris is endemic to the modern and ancient shorelines of northern lakes Huron and Michigan, where it ranges from the Door Peninsula of northeastern Wisconsin eastward through the Mackinaw Straits region, south to the Bruce Peninsula of Ontario, following the northern calcareous arc of Silurian and Devonian bedrock. Historical records indicate that it once occurred as far south as Milwaukee, Wisconsin and possibly along Detroit River near Sandwich, Ontario (COSEWIC 2004). Guire and Voss (1963) determined reports from Wisconsin's Lake Superior shoreline and northeastern Ohio to be erroneous.

Although conventions for distinguishing individual populations or geographical occurrences vary by jurisdiction, 167 locations of dwarf lake iris have been reported extant throughout its range—85 in Michigan, 41 in Wisconsin (where occurrences are more narrowly defined), and 41 in Ontario**.** The principal concentrations lie in Michigan's Mackinac Straits region and the northeastern Lower Peninsula (principally Mackinac and Presque Isle Counties), the Garden Peninsula in upper Michigan (Delta and Schoolcraft Counties), the Door Peninsula of Wisconsin (Door and Brown Counties), and Ontario's Bruce Peninsula (Bruce County).

Table 1 provides a summary of the globally known occurrences, organized by rank and ownership. Appendices 1, 2, and 3 list all Michigan, Wisconsin, and Canada occurrences respectively, ordered alphabetically by county and then hierarchically by rank, where such information is available. Appendix 5 describes criteria used to assign occurrence rank. Detailed discussions of distribution by jurisdiction are provided below.

Michigan

Most of the world distribution of dwarf lake iris lies in Michigan, where this species ranges from Menominee County in the western Upper Peninsula to the easternmost Upper Peninsula (Drummond Island) and southeast to Alpena County in the northeastern Lower Peninsula to Emmet County in the northwestern Lower Peninsula (Figure 2). The Michigan Natural Features Inventory (MNFI) has confirmed a total of 85 occurrences are extant, with an additional occurrence ranked as historical (H) and another occurrence ranked as extirpated (X). Since the extent of what would be considered meaningful biological populations or meta-populations is extremely difficult to determine, MNFI tracks geographically distinct occurrences, consisting of more or less contiguous colonies or patches usually separated from other such occurrences by a minimum distance of one kilometer.

Of the 85 occurrences known to be extant in Michigan, 33 are ranked A to B (excellent to good quality), with four occurrences ranging more than 500 acres in extent (Table 1). Several of Michigan's most extensive and highest quality occurrences lie on State land. One A-ranked occurrence, Snake Island, lies partly within a dedicated State Natural Area. The Thompson's Harbor occurrence in Presque Isle County is perhaps the largest in existence anywhere, with

scattered colonies extending over several thousand acres. The coastal portion of this area is now largely protected within the established Thompson's Harbor State Park. Significant parts of other large, A-ranked occurrences, including sites in Delta and Mackinac Counties, lie on State land.

Table 1. Summary of dwarf lake iris occurrences by element occurrence rank and ownership

State or Province / Landowner	Element Occurrence Rank[1]											
Michigan[2]	**A**	**AB**	**B**	**BC**	**C**	**CD**	**D**	**E**	**UND**	**H**	**X**	**TOTAL**
Public	4	1	9	5	11	0	0	1	0	0	0	**31**
Private	2	6	7	9	18	0	0	1	0	0	0	**43**
Unknown	3	1	0	0	7	0	0	0	0	1	1	**13**
SUBTOTAL	**9**	**8**	**16**	**14**	**36**	**0**	**0**	**2**	**0**	**1**	**1**	**87**
Wisconsin[3]	**A**	**AB**	**B**	**BC**	**C**	**CD**	**D**	**E**	**UND**	**H**	**X**	**TOTAL**
Public	0	1	3	2	1	0	2	2	0	0	0	**11**
Private	1	0	1	0	7	0	1	4	0	1	0	**15**
Public/Private	1	0	3	2	2	0	6	2	0	0	0	**16**
Unknown	0	0	0	0	0	0	0	0	0	4	2	**6**
SUBTOTAL	**2**	**1**	**7**	**4**	**10**	**0**	**9**	**8**	**0**	**5**	**2**	**48**
Ontario[4]	**A**	**AB**	**B**	**BC**	**C**	**CD**	**D**	**E**	**UND**	**H**	**X**	**TOTAL**
Public	0	0	0	0	0	0	0	8	3	2	0	**13**
Private	0	0	0	0	0	0	0	17	0	4	0	**21**
Public/Private	0	0	0	0	0	0	0	6	0	0	0	**6**
First Nation	0	0	0	0	0	0	0	9	0	1	0	**10**
Unknown	0	0	0	0	0	0	0	1	2	2	0	**5**
SUBTOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**41**	**5**	**9**	**0**	**55**
GRAND TOTAL	**11**	**9**	**23**	**18**	**46**	**0**	**9**	**51**	**5**	**15**	**3**	**190[5]**

[1] **Element Occurrence Rank** – Rank by habitat condition and population size and vigor as follows: excellent to good quality (A to B); good to fair quality (B to C); fair to poor (C to D); verified extant (E); undetermined (UND); historical (H); extirpated (X). See Appendix 5 for more information.

[2] Source: Michigan Natural Features Inventory (2012)

[3] Source: Wisconsin Natural Heritage Inventory (2012)

[4] Source: Committee on the Status of Endangered Wildlife in Canada (2010)

[5] This includes 167 extant occurrences and 23 extirpated, historical, or undetermined occurrences.

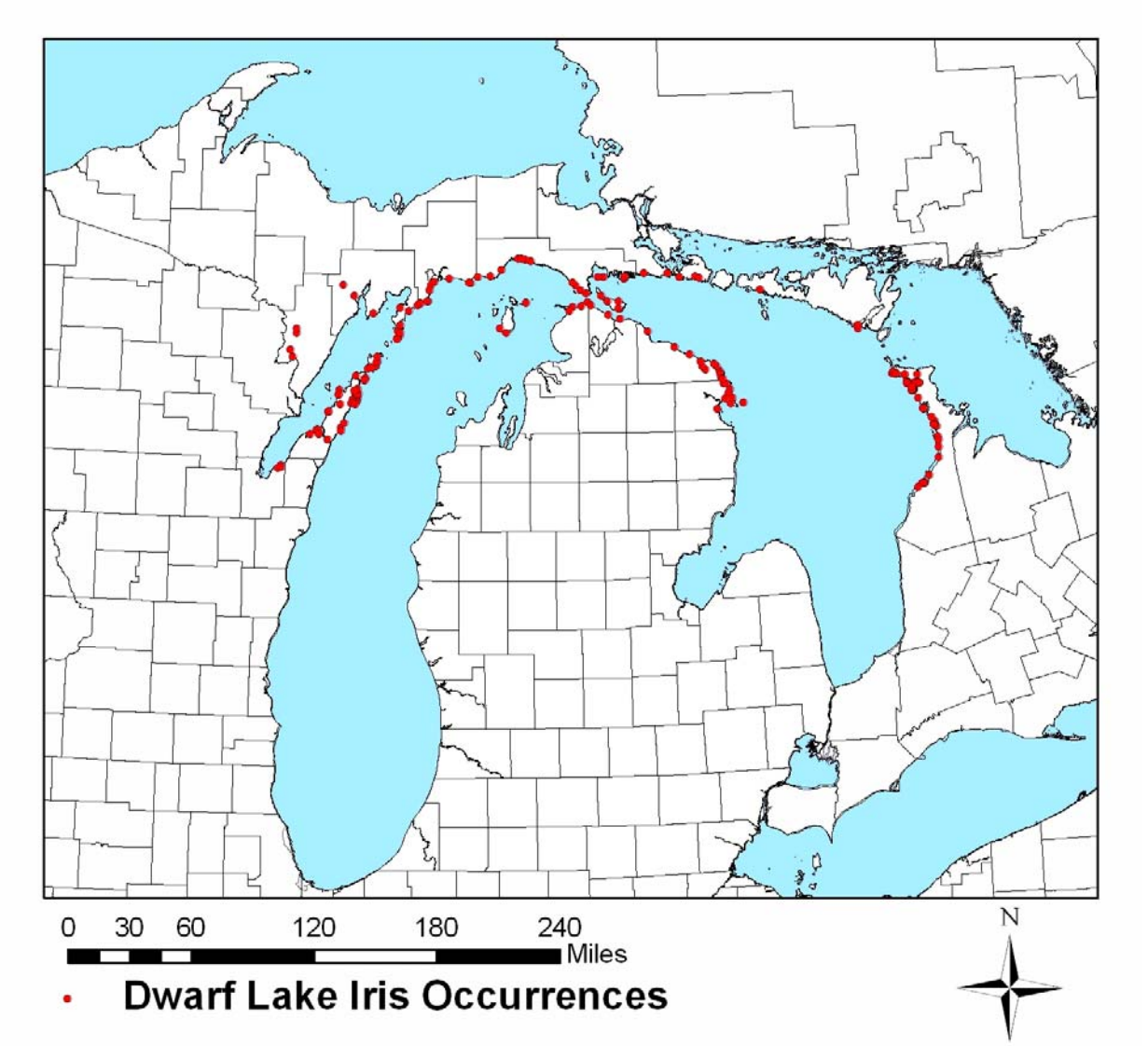

Figure 2. Global distribution of dwarf lake iris occurrences

Except for six anomalous inland occurrences (see discussion below), most dwarf lake iris occurrences lie along or very near the Great Lakes shores. In some areas, such as Thompson's Harbor, extensive dwarf lake iris colonies stretch along the immediate Lake Huron shoreline and also extend inland for up to several miles throughout a parallel series of former shoreline ridges, representing stages of post-glacial Lake Nipissing.

Small inland occurrences along Escanaba River in Delta County (Carrol Corners Dam and Escanaba River sites) and Menominee River in Menominee County (near Koss) and a recently discovered occurrence near Wiregrass Lake (Carney Fen) represent remnants of early post-glacial shoreline distributions, comparable to the colonies remaining in Brown County, Wisconsin. These sites may be important to conservation of the species because of their potential genetic diversity (see discussion under "Genetics", pg. 12).

Approximately one-half (43) of Michigan's extant dwarf lake iris occurrences are located primarily on private land, and several occurrences are contained within multiple private ownerships, owing to the finely platted nature of the northern Great Lakes shores, which continue to be subdivided for development. Most of the occurrences lying primarily on private land are ranked B to C (good to fair quality) or better.

Wisconsin

In Wisconsin, dwarf lake iris is restricted to Door and Brown counties. A total of 41 occurrences has been verified extant since 1970 (Table 1). Colonies once located within the modern city limits of Milwaukee have been destroyed in the course of city development. Information on the location and quality of dwarf lake iris occurrences in Wisconsin is summarized in Appendix 2. The comments column provides brief site descriptions where available and/or information on site status.

Wisconsin's surviving dwarf lake iris colonies fall into two categories. Nearly all those in Door County occur near the coasts at elevations below 600 feet, on the lakeplain covered by glacial Lake Nipissing some 3,000 to 4,000 years ago. The second category, located in Brown County, lies at 700 to 800 feet above sea level, along probable shorelines and drainage channels of pre-glacial Lake Oshkosh. These occurrences likely predate the Door County colonies, possibly by many thousands of years, and may represent founder colonies that supplied propagules for later establishment of the Door colonies. Habitat of the Brown and Door County occurrences differs notably. Those occurrences in Door County are in close proximity to Lake Michigan and occupy relatively open sites with cobblestone habitat that dominates these lakeshore areas. However, the Brown County plants, which are not along the lakeshore, often exist in the deep shade of mature cedar or mixed cedar/hardwood forests.

Of ten occurrences ranked A to B, all occur within State Natural Areas although these represent a mixture of public and private ownerships (Kevin Doyle, Wisconsin Department of Natural Resources, pers. comm. 2012). Most of the remaining occurrences lie on private land.

Ontario, Canada

After surveys in 2003, the Ontario Natural Heritage Information Centre identified 43 sites where dwarf lake iris had previously occurred in Ontario (COSEWIC 2004). More recent surveys have resulted in much larger population totals than previously documented (COSEWIC 2010). Current calculations place the dwarf lake iris population total at more than 50,000,000 ramets, almost 50 times the previous estimate, and the overall areal extent of occurrences is about 25 km^2[6] (COSEWIC 2010). Information on the location and quality of dwarf lake iris occurrences in Ontario is summarized in Appendix 3. COSEWIC (2004) classified the status of dwarf lake iris in Canada as Threatened, but the status was re-examined and designated as Special Concern in 2010 (COSEWIC 2010).

The current range in Ontario extends along 160 km of the Lake Huron coast on the mainland of Bruce County and along the southern shore of Manitoulin Island for approximately 30 km

[6] COSEWIC defines extent of occurrence as the area that encompasses the geographic distribution of all known populations and area of occurrence as the area within the extent of occurrence that is occupied by the taxon.

(COSEWIC 2010). A disjunct population occurs near Belanger Bay at the western end of Manitoulin Island.

Two of Ontario's largest populations are found at protected sites within Dorcas Bay Nature Reserve (Bruce Peninsula National Park) and MacGregor Point Provincial Park. Another significant population is protected within the Johnston's Harbour Nature Reserve. Overall, roughly 37% of the total number of Canadian populations occurs on lands under some form of protective ownership, and slightly less than half are on private land (COSEWIC 2010). The remaining sites are either First Nation territories or are municipally owned (COSEWIC 2010). However, in terms of thousands of ramets, 80% of the total population receives some form of protection on the Bruce Peninsula (Parks Canada Agency 2011).

Habitat Characteristics

Dwarf lake iris thrives best near the northern shores of Lakes Huron and Michigan, where it typically occurs in shallow soil over moist calcareous sands, gravel and beach rubble, and limestone crevices (Voss 1972; Crispin 1981). It may occur semi-continuously for several miles along the lakeshore, interrupted only by local discontinuities in habitat, such as rocky points, marshy bays, and areas modified by residential or other development (Crispin 1981).

Dwarf lake iris also occurs sporadically on former beach ridges associated with retreating phases of post-glacial shorelines, with many occurrences persisting at significant distances inland. While some of these areas offer semi-open habitat similar to that of the Great Lakes coasts, many are densely shaded and support aging, largely sterile colonies of dwarf lake iris. Dwarf lake iris can tolerate nearly full shade to open sun but tends to reproduce only vegetatively under such conditions, and usually requires a partly shaded or sheltered forest edge for optimal sexual reproduction (Crispin 1981; Makholm 1986; Van Kley 1989). It is most often associated with coniferous forest dominated by northern white-cedar (*Thuja occidentalis*) and balsam fir (*Abies balsamea*). Other co-dominants may include white pine (*Pinus strobus*), red pine (*P. resinosa*), white spruce (*Picea glauca*), black spruce (*P. mariana*), larch (*Larix laricina*), balsam poplar (*Populus balsamifera*), paper birch (*Betula papyrifera*), and trembling aspen (*P. tremuloides*) (Van Kley 1989).

Understory and other woody plants commonly found with dwarf lake iris typically include bearberry (*Arctostaphylos uva-ursi*), bush-honeysuckle (*Diervilla lonicera*), buffalo-berry (*Shepherdia canadensis*), trailing arbutus (*Epigaea repens*), creeping juniper (*Juniperus horizontalis*), ground juniper (*J. communis*), poison-ivy (*Toxicodendron radicans*), and shrubby St. John's-wort (*Hypericum kalmianum*).

Common herbaceous associates include sedge (*Carex eburnea*), false asphodel (*Tofieldia glutinosa*), fringed polygala (*Polygala paucifolia*), twinflower (*Linnaea borealis*), Canada may-flower (*Maianthemum canadense*), bunchberry (*Cornus canadensis*), bluebead lily (*Clintonia borealis*), yellow lady's-slipper (*Cypripedium parviflorum* var. *pubescens*), bird's-eye primrose (*Primula mistassinica*), silverweed (*Potentilla anserina*), Indian paintbrush (*Castilleja coccinea*), grass-of-parnassus *(Parnassia glauca*), wild sarsaparilla (*Aralia nudicaulis*), starry false solomon-seal (*Smilacina stellata*), starflower (*Trientalis borealis*), lance-leaved tickseed

(*Coreopsis lanceolata*), horsetail (*Equisetum variegatum*), and bastard toadflax (*Comandra umbellata*). The relatively rare ram's-head orchid (*Cypripedium arietinum*) and sedges (*Carex concinna, C. richardsonii*) are also expected associates in several areas of dwarf lake iris concentration although *C. richardsonii* is not an associate at Wisconsin sites. Additional rarities include tuberous Indian plantain (*Arnoglossum plantaginea*) and butterwort (*Pinguicula vulgaris*), which also does not occur at Wisconsin sites. Houghton's goldenrod (*Solidago houghtonii*), which is federally listed as threatened, co-occurs in some areas with dwarf lake iris in Michigan, and the similarly listed Pitcher's thistle (*Cirsium pitcheri*) may lie in close proximity in associated dune habitats.

Soils

Dwarf lake iris occurs predominantly on relatively young, raw, well drained soils with poorly developed horizons (Van Kley 1989). Substrates range from sands and gravels to sandy clay loam and organic-enriched sands (Van Kley 1989). Soil organic matter content varies by location, but most occurrences are found in moderate to high levels of organic matter (Makholm 1986).

The availability of nutrients varies depending upon the soil textures. Sandy, poorly developed soils contain relatively low quantities of potassium and phosphorus while mature forest soils often contain higher levels of nutrients (Makholm 1986). Makholm (1986) noted that dwarf lake iris can tolerate a very broad range of nutrient levels and even does well at relatively low nutrient levels. Observations show that while dwarf lake iris occurs predominantly in well drained soils, some occurrences occupy damp, poorly drained sites, with small colonies persisting along the borders of small forest pools (Makholm 1986).

Van Kley (1989) found that soil pH varied from 5.4 to 7.5, although most measurements were above 6.5. These measurements support those of Makholm (1986), who found that dwarf lake iris tolerated a pH range of 6.9 to 8.0. Both studies confirm the strong fidelity of dwarf lake iris to mostly calcareous substrates. Interestingly, horticulturalists have reported dwarf lake iris relatively easy to cultivate, noting that it thrives equally well in slightly acidic to alkaline soils (Dykes 1913; Atwood 1933). Although these observations indicate that nutrients may not be a particularly limiting factor, distributional and field data demonstrate that dwarf lake iris occurs optimally in calcareous habitats.

Leaf Litter

Leaf litter is an important habitat factor in the life cycle of dwarf lake iris. The presence or absence of leaf litter and its depth and type strongly influence vegetative growth, sexual reproduction, seed germination, and seedling establishment (Makholm 1986; Van Kley 1989). At Michigan study sites, Van Kley (1989) found that increasing litter depth reduced the number of shoots and blooms, consistent with the findings of Makholm (1986) in Wisconsin. Litter also tended to increase as light levels dropped, suggesting that both increasing litter depth and lower light levels serve to inhibit the germination, establishment, and growth of dwarf lake iris in seral and maturing forests. Makholm (1986) found that increasing litter thickness (mostly of white-cedar fragments) affected vegetative and sexual reproduction and prevented seedling roots from reaching mineral soil; however, the roots of dwarf lake iris seedlings more readily penetrated the

relatively small fragments of white-cedar and spruce than the litter of broadleaf trees such as aspen.

Light

Light is one of the most critical factors in the growth and reproduction of dwarf lake iris (Van Kley and Wujek 1993). Optimal vegetative growth and sexual reproduction are clearly light-dependent. Field observations have indicated that the most prolific flowering populations are those that receive a minimum threshold of direct sunlight for at least a portion of the day. Mean light levels in Van Kley's (1989) nine study sites varied from a low of 584 foot-candles at Wilderness State Park to a high of 3,938 foot-candles in Cheboygan State Park. Van Kley (1989) found significant correlations between increased light levels and both the absolute number of blooms and the bloom to shoot ratio in all of his 1988 study plots. When shaded plots were defined as those receiving less than an average of 1,800 foot-candles, light accounted for only about one-third of the observed variation. In addition, higher fruit set was associated with higher light levels. Similarly, Morgan and Wolf (2008) found floral ramet densities of 2.5 and 5.4 per plot in more shaded areas as opposed to 21.9 per plot in more open areas.

Makholm (1986) observed that dwarf lake iris can survive at relatively low light levels as long as some direct sunlight is available. In areas of dense cedar, fir, and spruce overstory, Makholm (1986) found scattered patches of dwarf lake iris correlated with larger sun fleck areas. She also noted that even in sites with moderate light levels, dwarf lake iris was concentrated in areas receiving more direct light through gaps in the tree canopy.

Dwarf lake iris populations may also respond positively to removal of the tree canopy, which increases light levels. For example, *I. lacustris* populations expanded and appeared where they had not previously been documented at Peninsula State Park in Wisconsin after a bike path was built through a wooded area (Darcy Kind, Wisconsin Department of Natural Resources, pers. comm. 2012).

Disturbance

Disturbance is an important component of dwarf lake iris habitats, particularly in immediate shoreline areas. In these sites, cyclical fluctuations of Great Lakes levels and other factors, such as wind, wave, and ice action, are significant natural disturbance features. Specific types of natural shoreline disturbances include erosion, gravel and sand deposition, the creation of new storm berms (i.e., ridges) from beach cobble and sand, tree blowdowns, and the rise of water tables resulting in tree mortality (Van Kley 1989). In Wisconsin, dwarf lake iris populations are usually well protected by surrounding vegetation, and shoreline disturbances likely do not influence these populations (Kind, pers. comm. 2012).

Fire may have been at least locally important in presettlement times, but its role with regard to dwarf lake iris has not been addressed in the published literature. The incidence of fire at inland dwarf lake iris sites may have helped sustain it by reducing canopy closure and maintaining more open, seral forest stages.

Although dwarf lake iris colonies may suffer direct impacts from natural disturbances, they also benefit; the continual modification and formation of habitat provides microsites for subsequent

seed germination and colonization. Disturbance also serves to maintain the forest openings that provide the partial shade conditions optimal for dwarf lake iris growth and reproduction.

Artificial disturbances, especially those caused by burgeoning residential development and the widespread use of off-road vehicles (ORVs), have usually resulted in severe direct and indirect impacts to dwarf lake iris. ORVs can destroy plants and alter natural shoreline processes. Although dwarf lake iris can be an aggressive colonizer and has been known to advance into artificially disturbed habitats (Van Kley 1989), it remains highly vulnerable to the same disturbances and incursions that created the conditions suitable for its colonization.

Life History and Ecology

Reproduction

Dwarf lake iris is a spring flowering perennial with branching, sub-surface rhizomes that are often partially above ground. The branches of each rhizome terminate in swellings characterized as tubers. These annually produce one to five ramets (shoots), one of which may be sexual (flower-bearing) while one to four (usually two) are vegetative (sterile). The latter bear four to eight broadly linear leaves that are usually about 6 cm long at anthesis (when plants are blooming), later elongating up to approximately 20 cm. Vegetative ramets that grow under dense shade usually average fewer and smaller leaves. Flowering ramets are markedly shorter than vegetative ramets at anthesis and produce a single bisexual flower per ramet.

Local conditions may have a significant influence on the growth and reproduction of ramets (Morgan and Wolf 2008). Overall increases in the number of vegetative ramets are typically associated with abundant light conditions, while decreases are often the result of reduced light availability (Morgan and Wolf 2008). Makholm (1986) observed that rhizome elongation under low light conditions is several times greater than under high light conditions. This response may explain the wide spacing of ramets in low-light microsites, which would increase the probability that some may reach areas of higher light penetration.

Flowering usually occurs from late April to early June, typically peaking from about mid-May to early June. Individual flowers remain open for one to three days (Planisek 1983; Van Kley 1989). Although dwarf lake iris is self-compatible, fruit set requires a pollen vector (Planisek 1983; Van Kley 1989). As the fruit ripens, the leaves on the flowering ramet die back such that the mature capsule is usually perched atop a short, bare peduncle. The oval, somewhat triangular-shaped capsules turn yellow and begin to split and dehisce along three suture lines by early July.

Despite years of observations by several researchers, the pollen vector(s) remains to be identified. Larson (1998) reported halictid bees (*Augochlorella striata*) visiting dwarf lake iris flowers at Dorcas Bay, Bruce Peninsula, Ontario in late May 1996. Observations of floral visitation and grooming behaviors suggest halictid bees are potential pollinators. In addition, Van Kley (1989) reported bee flies (Bombyliidae) visiting flowers and probing in such a way that contact with stigma/stamens was likely.

Research on dwarf lake iris in Brown County, Wisconsin found that capsules, on average, contained 22 small seeds (Morgan and Wolf 2008). Each seed possesses a conspicuous elaiosome (food body) that may attract ants. Although a field experiment using wooden platforms demonstrated that ants are attracted to seeds and will remove them (Planisek 1983), field observations of hundreds of capsules have documented only a few instances of ants actually removing seeds from dehiscing capsules (Planisek 1983). During 17 years of observation in Brown County, Wisconsin, ants were never observed ants transporting seeds (Morgan and Wolf 2008).

Field observations and laboratory studies indicate that seeds are dormant at the time of dispersal and require several months of cold temperatures for germination but can remain viable for at least 15 years within a soil bank (Morgan and Wolf 2008). Laboratory studies produced a maximum of 88% germination after five sixteen-week periods of cold stratification (5 C) with an intervening eight-week period of warm temperatures (20 C day and 10 C night thermoperiod) (Morgan and Wolf 2008). While this rate of germination appears to be relatively high, a similar study in which fresh seeds were sown in greenhouse flats and placed outside for a period of nearly five years resulted in only 6% of the seeds germinating (Morgan and Wolf 2008). During field studies, seedlings were found to appear near the end of the flowering season (Morgan 1989). They are rare and are found only in areas with little or no litter (Makholm 1986; Van Kley 1989; Morgan 1989).

During 17 years of observation in Brown County, Wisconsin, only one mass germination event was observed (Morgan and Wolf 2008). Over a two-year period, hundreds of seedlings appeared in two separate patches that had not been occupied by dwarf lake iris for at least four years. This supports the previous suggestion that dwarf lake iris seeds can stay viable for long periods of time, remaining dormant until favorable conditions occur for germination. Within six years of the seedlings' initial appearance, however, one of the patches had vanished completely, and the other patch had experienced a 60% decline in the number of vegetative ramets (Morgan and Wolf 2008). This may have been associated with the relatively closed overstory canopy, resulting in reduced light, a habitat characteristic that may have caused the extirpation of the previous parent colonies (Morgan and Wolf 2008).

Overwintering buds develop in late August to mid-September on tubers that have already developed at the base of vegetative ramets. Flowering ramets die back by the time of seed dispersal; therefore, no tuber or overwintering buds develop at the base of flowering ramets. Vegetative ramets begin to die back by early October.

Reproduction - Resource Allocation

Dwarf lake iris allocates a far lower percentage of resources to sexual than to vegetative reproduction. Studies in Brown County, Wisconsin found that only 16.8% of the total ramets in open areas produced flowers (Morgan and Wolf 2008). Over the course of a 10-year study, the average ratio of floral to vegetative ramets was 0.16:1, with the maximum observed ratio in a single year being 0.34:1 (Morgan and Wolf 2008). Makholm (1986), working in Door County, Wisconsin, found that 17% of shoots produced a single flowering ramet. While 22% produced two or more vegetative ramets, the majority (75%) produced just a single vegetative ramet (i.e., merely maintaining the original rhizome). This suggests that even vegetative expansion of at

least some populations may be quite slow. Van Kley (1989) further speculated that while dwarf lake iris can rapidly increase its overall number of shoots, the rate of increase for colonies as a whole is relatively slow. Makholm (1986) supported this view, suggesting that if a site remained stable, a colony could potentially persist indefinitely through vegetative reproduction. Morgan and Wolf (2008) also found that tubers producing a single vegetative ramet were most common. This indicates that the overall expansion of colonies is relatively slow, with the notable exception being the single mass germination event observed by Morgan and Wolf (2008). Although the mass germination was an occurrence that took place only once in 17 years of observations, it suggests that given ideal conditions dwarf lake iris can rapidly colonize an area devoid of ramets.

Most observations indicate fruit set to be very low. Of the flowering ramets studied by Makholm (1986), 24% set fruit. Only 2.4% of the flowers observed in the 20 1-m^2 plots established by Van Kley (1989) at French Bay, Michigan set fruit. Morgan and Wolf (2008) found 28.5 % fruit set in Brown County, Wisconsin, with an average annual immature fruit to vegetative ramet ratio of 0.057:1; however, once fruit set occurred most fruits matured to the seed dispersal stage (73.1%). Morgan and Wolf (2008) also observed that a major contributor to immature fruit loss was infection by *Botrytis* fungus (26.1%). Overall, the low fruit set indicates limited pollination, corroborating the need for considerably more research addressing the pollination biology of dwarf lake iris.

Habitat Variability and Reproductive Success

Differences in light level can have dramatic effects on both vegetative and sexual reproduction (Makholm 1986; Van Kley 1989; Morgan 1989; Morgan and Wolf 2008). The highest density of vegetative ramets, the greatest absolute number of flowering ramets, and the greatest absolute number of mature fruits were found on microsites that receive sunlight for several hours a day. In contrast, populations that received only low levels of diffuse light, such as those under the dense shade of white-cedar, commonly had the lowest density of vegetative ramets and produced very few flowers that seldom set fruit.

Observations under different light conditions suggest that light is probably the most important limiting factor for both vegetative and sexual reproduction (Makholm 1986; Van Kley 1989; Morgan 1989; Morgan and Wolf 2008). In more open sites, vegetative reproduction produces a high density of flowering and non-flowering ramets from year to year. As light levels decline, flower and fruit production drops until sexual reproduction is essentially absent under dense shade. Vegetative reproduction follows a similar pattern with decreasing light levels. At some point, ramets fail to replace themselves and thus a colony or population will begin to decline and may eventually die out.

Soil moisture can be an important limiting factor during drought years (in sites with particularly droughty soils). Populations on open sites, although optimally reproductive during years of favorable weather, are especially vulnerable to drought. The summer of 1988 in Brown County, Wisconsin was characterized by extreme drought and heat. In response to these stresses, 60% of the vegetative ramets on sites that received three to four hours of direct solar radiation died back in August (Morgan 1989). These ramets did not recover the following spring. Van Kley (1989) also reported a dieback of vegetative ramets in the summer of 1988 on open sites in Michigan.

In contrast, the vegetative ramets on Brown County sites that received approximately one hour of direct sunlight (partially shaded sites) suffered little dieback during the summer of 1988, and the density of vegetative ramets did not decline from 1988 to 1989 (Morgan 1989). The partially shaded sites were thus more favorable for vegetative growth during the drought period.

The drought of 1988 had a severe carry-over effect on sexual reproduction on both types of microsites. During 1989, sunny study sites produced no flowers and partially shaded sites produced only 5% as many flowers as they had in 1988 (Morgan 1989).

Litter depth is also an important limiting factor. Thick litter restricts seedling establishment either by preventing the developing roots from reaching mineral soil or by preventing the developing shoot from reaching light (Makholm 1986). The impact of litter accumulation on reproductive success is exacerbated by the species' low seed germination rates, poor seedling survival, and apparent limited dispersal ability (even nearby microsites that appear favorable often support no plants).

Genetics

Orick (1992) completed a genetic comparison among nine Michigan populations of dwarf lake iris, studying variations both amongst and within populations. In addition, inland populations, assumed to represent founder or relict populations on earlier post-glacial beach ridges, were compared with shoreline populations located on more recent beach ridges on or near the present shorelines.

Orick (1992) found the level of genetic variation in these nine populations of dwarf lake iris lower than that found for widely distributed plant taxa (Hamrick *et al.* 1979). This is consistent with other research (Ledig and Conkle 1983; Prentice 1984) concluding that narrowly distributed species have less diverse genomes than widely distributed taxa.

Hamrick *et al.* (1979) reported a mean heterozygosity of 14.1% in wide-ranging species, compared to 8.6% for rare and endemic plant taxa. Loveless and Hamrick (1988) estimate the total mean heterozygosity for Pitcher's thistle, also a Great Lakes endemic, at only 2.4%, similar to Orick's (1992) data for dwarf lake iris, which had a mean heterozygosity of just 1.7%.

On average, inland dwarf lake iris sites displayed higher polymorphism indices, a greater proportion of polymorphic loci, and slightly more alleles per locus than shoreline sites (Orick 1992). Based on these data, Orick (1992) hypothesized that inland populations represent relicts containing more diverse genomes.

Orick (1992) also concluded that about 70% of the overall genetic diversity occurred within individual dwarf lake iris populations rather than among them and attributed this to the limited gene flow due to low levels of sexual reproduction, limited seed dispersal capabilities, and the clonal habit of dwarf lake iris. The individuals of one island population had the lowest diversity of the sites studied. Orick (1992) found this population to be monomorphic at all loci, possibly due to isolation and founder effects.

In all populations containing polymorphic loci, Orick (1992) found consistently higher than expected levels of heterozygosity. Roose and Gottleib (1976) suggested that in allopolyploid taxa where inbreeding predominates, biochemical diversity may be preserved within individuals as fixed heterozygosity. They suggested fixed heterozygosity may have adaptive value to colonizers that experience repeated population bottlenecks, especially if they are capable of utilizing this stored diversity in marginal habitats.

Based on his analysis, Orick (1992) recommended that priority be given to protecting inland populations of dwarf lake iris. Orick (1992) also recommended that shoreline populations with relatively higher genetic diversity be given priority protection.

Simonich (1992) and Simonich and Morgan (1994) used enzyme electrophoresis to determine the extent of genetic variation within and among nine Wisconsin populations. Ten enzymes coded by 22 genetic loci were examined, and Simonich and Morgan (1994) found that all nine dwarf lake iris populations were monomorphic at the 22 loci. No heterozygosity was detected, and all nine populations were, therefore, genetically identical with respect to isozymes. Simonich and Morgan (1994) indicate that the genetic uniformity in Wisconsin populations suggests a severe population bottleneck during the last glaciation 16,000 years ago. Since then, the species' almost exclusive reliance on vegetative reproduction has probably acted to maintain monomorphism.

Hannan and Orick (2000) compared their results on the genetic structure of dwarf lake iris to the genetic structure of southern dwarf iris. Their data support the hypothesis that dwarf lake iris is a polyploid descendant of southern dwarf iris and suggest a recent evolutionary origin of dwarf lake iris from a limited southern dwarf iris gene pool.

Reasons for Listing and Current Threats

In determining whether to list, delist, or reclassify (change from endangered to threatened status, or vice versa) a taxon under section 4(a)(1) of the ESA, the Service evaluates the role of five factors potentially affecting the species. These factors are: (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors affecting its continued existence.

A. Habitat Destruction or Modification

The rangewide population of dwarf lake iris is vulnerable to both naturally occurring processes and human activities that can modify, fragment, or destroy its habitat. Potentially harmful natural processes include light deprivation, litter accumulation, shoreline fluctuations, and forest succession. The majority of human activities fall into three primary categories: residential development, recreational development and activities, and road construction and maintenance.

Residential Development

Loss of shoreline habitat along lakes Michigan and Huron occurs due, in part, to residential—especially second home—development. Habitat is physically destroyed by home construction, driveways, access roads, earth work, associated landscaping, and long-term maintenance activities. Home development also fragments habitat; however, where home lots are maintained in a natural condition, dwarf lake iris often thrives as an attractive, low maintenance ground cover, and relatively contiguous shoreline habitat can be retained.

Because of closer proximity to southern population centers, dwarf lake iris habitat in Michigan's northern Lower Peninsula is probably under the greatest pressure from home and cottage development. The risks are highest in Cheboygan and Alpena Counties, since remaining habitat in Emmet and Presque Isle Counties lies primarily on State-owned land. Similar pressures existed in Door County, Wisconsin, where subdivisions were developed in shoreline areas, but this threat may not be as prevalent now.

Morton (1990) reports that dwarf lake iris populations on Ontario's Bruce Peninsula occur largely on Crown land where they are not subject to development threats. He also notes that cottage owners typically maintain their property in a natural state, allowing dwarf lake iris to survive.

Recreational Development and Associated Activities

The shores of the Great Lakes provide extensive recreational opportunities. Tourism is a leading industry in both Michigan and Wisconsin, due in great part to the recreational opportunities associated with the Great Lakes. This makes the coastal areas a major focus of economic opportunity, especially for small northern communities with limited economic options.

Major recreational activities along the northern Great Lakes shores include sightseeing, fishing, camping, hiking, boating, skiing, and hunting. With the influx of vacationers from the south, the market for constructed attractions, such as golf courses, amusements and shopping centers, has also increased. The nexus of this development is the Mackinac Straits area of Michigan (Mackinac, Emmet, and Cheboygan Counties) and Door County, Wisconsin.

As more people utilize publicly owned lands, the risks to habitat already considered protected increases. Four of the 11 A-ranked dwarf lake iris occurrences lie on State or Federal lands; however, management plans addressing species protection in both dedicated and multiple-use areas are largely lacking.

Some forms of park development and maintenance may actually improve habitat by creating canopy openings. In Thompson's Harbor State Park, which supports Michigan's largest occurrences of dwarf lake iris, regular maintenance of the park's trails allows light to penetrate to the forest floor, thus stimulating vegetative reproduction. Most likely to benefit from this sort of management are inland localities along ancient shorelines, where dwarf lake iris is declining due to advanced forest succession.

Road and Utility Construction and Maintenance

Many of the extant occurrences of dwarf lake iris lie in close proximity to roads or trails. This is likely due in large part to the suitability of old beach ridges—classic dwarf lake iris habitat—as roadbeds. When roads and trails were developed in these habitats, dwarf lake iris often spread vigorously into the sunny clearings created by opening of the canopy and persists along partly shaded roadsides. But, proximity to roads has also brought risks to dwarf lake iris.

Road maintenance activities, such as mowing, grading, brush and tree removal, herbicide spraying, snow removal, and de-icing with salt may negatively impact dwarf lake iris. Long-term effects of these activities are unknown.

Through consultation under section 7 of the ESA for projects with federal funding and reviews under state laws, such as Michigan's Natural Resources and Environmental Protection Act and Wisconsin's Endangered Species Act, these events have resulted in only minor impacts to dwarf lake iris. For example, several occurrences lie within rights-of-way owned by the Michigan Department of Transportation (MDOT). Major Michigan roads where dwarf lake iris occurs, such as US-2, US-23, and M-134, require periodic upgrading and ongoing maintenance. MDOT has successfully minimized impacts by signing sensitive rights-of-way as Protected Areas and permitting only shoulder mowing in those areas. Since dwarf lake iris usually grows beyond the roadside ditch and generally beyond the back slope, it is not affected.

Road construction projects initiated at the county or municipal levels do not always receive the same level of review although Michigan and Wisconsin review projects with any state funding to ensure those actions are consistent with state and Federal endangered species laws. County road commissions conducting routine maintenance may mow dwarf lake iris where it occurs on the road shoulder or affect these occurrences through snow removal and de-icing with salt.

Roads also generate risks to dwarf lake iris by creating access routes for development, which generates driveways, road spurs, and utility lines that further destroy and fragment habitat. Road and utility corridors may also provide opportunities for spread of invasive species. Utility corridors also require periodic maintenance, including mowing and tree and shrub removal, which may impact dwarf lake iris populations occurring in those corridors.

The Wisconsin Endangered Species Act (S.29.604) and Administrative Code, Chapter NR 27.05 (3) exempts the requirement for obtaining an endangered species permit in the construction, operation, or maintenance of a utility facility. However, utilities are encouraged to conduct a review of the Natural Heritage Inventory and to consult with the Wisconsin Department of Natural Resources (WDNR) if any occurrences are found in relation to a project. Generally, utilities have been cooperative in voluntarily taking efforts to minimize take of rare plants (Potter, pers. comm. 2012).

B. Overutilization for Commercial, Sporting, Scientific or Educational Purposes

Federal regulations (50 CFR 17.61) make it unlawful to sell or to offer for sale in interstate or foreign commerce any endangered plant, and this prohibition is extended to threatened plants with one exception. Seeds of cultivated specimens of threatened species are exempt, provided

that a statement that the seeds are of "cultivated origin" accompanies the seeds or their container (50 CFR 17.71).

At the time of listing, Faith T. Campbell reported that dwarf lake iris was being offered for sale in garden catalogs and that the potential existed for commercial trade of this species (USFWS 1988). The species is still being offered for sale through some online garden catalogs as recently as 2010, but this does not appear to be a significant threat to the species.

C. Disease or Predation

Neither disease nor predation was known to be threatening factors at the time of listing. In Brown County, Wisconsin, more than 15 years of data indicated that pathogens posed little threat to long-term survival of dwarf lake iris. Slug herbivory appeared to contribute to localized extinction in low-sun microsites (Michael Morgan, University of Wisconsin – Green Bay, pers. comm. 2006), and infection of immature dwarf lake iris fruits by *Botrytis* fungus contributed to a loss in seed production (Morgan and Wolf 2008). Given the relatively low rate of fruit set, this fungus does not appear to present a threat to the long-term survival of dwarf lake iris. Disease and predation do not appear to be threats to dwarf lake iris in Michigan (Gary Hannan, Eastern Michigan University, pers. comm. 2005)

D. The Inadequacy of Existing Regulatory Mechanisms

As discussed in the Conservation Measures – Federal Protection section below, the ESA provides protection to federally listed plants on Federal land but provides more limited protection to federally listed plants on State or private property. Protection under State and Canadian laws varies by jurisdiction.

Dwarf lake iris is listed as threatened in both Michigan and Wisconsin through individual State laws. Generally, this State-level protection makes it illegal to cut, root up, pick, injure, destroy, remove or transport any listed plant (See Conservation Measures – State Protection). The Michigan law applies to private and public lands and also prohibits commercial trade. The Wisconsin law applies only to public lands or lands that an individual does not own, lease or have the permission of the landowner, and provides an exemption on public lands for forestry, agriculture, and utility activity; however, listed plants may not be processed or sold in Wisconsin without a valid endangered or threatened species permit.

Dwarf lake iris is listed as threatened in Canada under federal law but is no longer protected under provincial law (see Conservation Measures – Canadian Protection). The Canadian federal law prohibits destruction of plants as well as commercial trade.

Although dwarf lake iris received protection under Michigan and Wisconsin laws at the time of listing, the final listing rule stated that monitoring and enforcement were difficult due to limited personnel. The ESA offers possibilities for protection through section 6 by cooperation between states and the Service and through section 7 by interagency consultation requirements (see Conservation Measures below).

Ideally, landowners should be aware of the presence of a legally protected species on their property well in advance of development plans being made. This not only results in more

effective protection, but reduces the "protection vs. development" polarization that can arise from regulatory and enforcement actions.

E. Other Natural or Manmade Factors Affecting its Continued Existence

Natural succession

One of the primary threats to dwarf lake iris is natural forest succession in its microhabitat. Specifically, the invasion of deciduous species can result in reduced light levels and increased leaf litter, which is detrimental to dwarf lake iris (Gibson and Makholm 1988). The long term survival of dwarf lake iris requires some form of disturbance to alter or deter succession, thereby maintaining occupied habitat as well as creating new areas of suitable habitat. This disturbance has traditionally been the result of storms, wind throw, fluctuating lake levels, and winter ice formations; however, human activity, such as the maintenance of existing roads, trails and paths, has also aided in providing this necessary disturbance (Makholm 1986). On some sites, particularly old, heavily shaded ones with well-developed soils, partial removal of the overstory may provide the site with enough of a flush of both light and nutrients that it becomes rapidly overgrown with fast-growing, nutrient-demanding pioneer species. Thus in certain cases, forest canopy disturbance may be detrimental to the species (James Van Kley, Stephen F. Austin State University, pers. comm. 2012).

Invasive species

Orange hawkweed (*Hieracium aurantacum* L.), an exotic species, has similar ecological requirements and may compete with dwarf lake iris for its open habitat. This species has been observed invading existing dwarf lake iris colonies and occupying areas that could potentially support dwarf lake iris (Gibson and Makholm 1988). Additional invasive species that may negatively affect *I. lacustris* include garlic mustard (*Alliaria petiolata*), spotted knapweed (*Centaurea maculosa*), glossy or common buckthorns (*Rhamnus cathartica* and *R. frangula*), common reed (*Phragmites australis*), and non-native earthworms and slugs.

Climate change

Climate change may constitute a new threat for dwarf lake iris. In the Great Lakes region, the climate will likely grow warmer and probably drier overall during the 21st century (Kling *et al.* 2003). Average temperatures in the Great Lakes region could increase by 3 to 7°C in winter and 3 to 11°C in summer by the year 2100. While average annual precipitation could increase by 10-20 percent, significant changes in the seasonal precipitation cycle are likely, with winter and spring rain increasing and summer rain decreasing by up to 50 percent (Kling *et al.* 2003). A warmer, drier summer will affect surface and groundwater levels, as well as soil moisture, which is projected to decrease by 30 percent in summer (Kling *et al.* 2003).

Climate change projections for the region of Wisconsin with dwarf lake iris populations are available from the Wisconsin Initiative on Climate Change Impacts (WICCI) at www.wicci.wisc.edu. Projected average temperature and precipitation changes from 1980-2055 follow a similar pattern, with a 5 to 6°C increase in average annual temperature and an increase of one inch in winter precipitation.

Earlier models had indicated that increased precipitation, higher air temperatures, and reduced ice cover would increase evaporation in the Great Lakes, resulting in lake level drops of 1.5 feet to as much as 8 feet (Sousounis and Glick 2000). However, more recent models show a more variable response in lake levels. A majority of the model simulations run by Angel and Kunkel (2010) resulted in reductions in lake levels, yet also showed a high degree of uncertainty in possible future lake levels, depending on future emissions. Furthermore, Hayhoe *et al.* (2010) suggest that the competing effects of shifting precipitation and warmer temperatures will result in little change in Great Lake levels until the end of the century, when net decreases in lake levels are expected under higher emission scenarios.

Regional warming may result in shifts in forest distribution (Kling *et al.* 2003). As the extent of canopy cover and leaf litter influence dwarf lake iris populations, changes to forest species composition and/or distribution of forest cover across the landscape could affect the long-term survival of the species. Drier conditions could also have a significant adverse effect on the suitability of microhabitats, particularly in open sites with constant solar exposure (Morgan 1989). How Great Lakes water levels may change and what effect this may have on habitat availability and suitability for dwarf lake iris is unclear. Because of the relatively low genetic diversity and narrow distribution of dwarf lake iris, warming of the Great Lakes region may alter the unique conditions required for its persistence.

Conservation Measures

Federal Regulatory Protection

Conservation measures provided to dwarf lake iris include recognition, recovery, Federal protection, and prohibitions against certain practices. Recognition through listing encourages and results in conservation actions by Federal, state and private agencies, groups, and individuals. The ESA allows for land acquisition in cooperation with the States if funds are available. The ESA requires the development of recovery plans for most listed species. The ESA section 7 obligations of Federal agencies and the section 9 prohibitions against certain activities involving listed plants are discussed below.

Section 7 – Interagency Cooperation with Federal Agencies

Section 7(a)(2) of the ESA requires Federal agencies to consult with the Service when federally permitted, authorized, or funded actions may affect listed species, including dwarf lake iris. This consultation process promotes interagency cooperation in finding ways to avoid or minimize adverse effects to listed species. If a Federal action is likely to adversely affect any listed species, the Federal agency must enter into formal consultation with the Service. The consultation process is intended to ensure that the Federal action is not likely to jeopardize the continued existence of listed species, nor destroy or adversely modify critical habitat. Additionally, Section 7(a) (1) requires all Federal agencies to use their authorities to further the conservation of federally listed species. Regulations implementing section 7 interagency cooperation provisions of the ESA are codified at 50 CFR Part 402.

Since its listing in 1988, numerous consultations regarding dwarf lake iris have taken place. In the majority of these consultations, the U.S. Army Corps of Engineers was the action agency,

processing permit applications under section 404 of the Clean Water Act. On several occasions, dwarf lake iris was successfully transplanted to avoid conflicts with development projects.

Sections 9 and 10

Section 9 of the ESA and its implementing regulations, found at 50 CFR 17.71, sets forth a series of prohibitions that apply to threatened plant species not covered by a special rule. No special rule has been published for dwarf lake iris. These prohibitions, in part, make it unlawful for any person subject to the jurisdiction of the United States to: 1) import or export listed plants; 2) remove and reduce to possession listed plants from areas under Federal jurisdiction; 3) transport listed plants in interstate or foreign commerce in the course of a commercial activity; or 4) sell or offer for sale listed plants in interstate or foreign commerce. "Plant" means any member of the plant kingdom, including seeds, roots, and other parts. Because dwarf lake iris is a threatened plant species, seeds from cultivated specimens are exempt from these prohibitions, provided that a statement of "cultivated origin" appears on their containers. Certain exceptions apply to agents of the Service and State conservation agencies. The ESA does not directly prohibit the taking of threatened plants on non-Federal land. Where Federal agency actions involve non-Federal land, section 7, as discussed above, provides the Service a means to make recommendations for protection, management, and conservation.

Section 10 of the ESA and 50 CFR 17.72 provide for the issuance of permits to carry out otherwise prohibited activities involving threatened species under certain circumstances. Such permits are available for scientific purposes or to enhance the propagation or survival of the species. In some instances, permits may be issued for a specified time to relieve undue economic hardship that would be suffered if such relief were not available. It is anticipated that few trade permits would ever be sought or issued as dwarf lake iris is not commonly cultivated. Requests for permit applications, copies of the regulations on plants, and inquiries regarding them may be addressed to Permits Coordinator, Division of Endangered Species, U.S. Fish and Wildlife Service, 5600 American Blvd. West, Suite 990, Bloomington, MN 55437-1458 (phone 612-713-5350, fax 612-713-5292, TTY 800-877-8339). Information on permits and other endangered species issues also is available via the internet at http://midwest.fws.gov/Endangered/.

Section 6 – Cooperation with States

Section 6 of the ESA allows the Service to provide money to States for the conservation of species. The Service has funded the MNFI, through the Michigan Department of Natural Resources (MDNR), to conduct a Landowner Contact Program to notify landowners of the presence of dwarf lake iris and other threatened or endangered plants, and to suggest methods for protecting the species on their lands. From July 1992 through August 1997, a total of 2,170 landowners in ten counties were contacted by letter and provided information on threatened and endangered species, including dwarf lake iris (Paskus 1997). A similar landowner contact program was implemented by the WDNR. Initiated in 1991, landowners were contacted through letters and site visits, ultimately resulting in numerous voluntary protection agreements. Many have since become permanent protection agreements through conservation easements and fee title acquisitions. Due to funding cuts, this program ended in 2005 (Kind, pers. comm. 2007);

however, landowners associated with this program still contact the WDNR when concerns or questions arise (Kind, pers. comm. 2012).

State Protection

Dwarf lake iris is listed as a threatened species in Michigan under Part 365, Endangered Species Protection, of the Natural Resources and Environmental Protection Act, which makes it illegal to take (collect, pick, cut, dig up, or destroy in any manner), possess, transport, import, export, process, sell or offer for sale, or buy or offer to buy any plant listed as endangered or threatened by the Federal government (M.C.L.A. 324.36501 – 07). "Plant" means any member of the plant kingdom and includes seeds, roots, or other parts.

Dwarf lake iris is also listed as threatened under Wisconsin law, which makes it illegal to cut, root up, sever, injure, destroy, remove, transport, or carry away a listed plant on public lands or lands you do not own [Wis. Stats., s. 29.604(4)(c) and Administrative Rule NR 27]. The law provides an exception on public lands for forestry, agriculture, and utility activity.

Canadian Protection

In Canada, dwarf lake iris is on Schedule 1 of the Species at Risk Act (SARA) as a threatened species (Government of Canada 2006). SARA makes it an offense to kill, harm, harass, capture or take an individual of a species that is listed as extirpated, endangered or threatened; possess, collect, buy, sell or trade an individual of a species that is listed as extirpated, endangered or threatened, or its part or derivative; or damage or destroy the residence of one or more individuals of a species listed as endangered or threatened or that is listed as extirpated if a recovery strategy has recommended its reintroduction (S.C. 2002, c. 29). Further, SARA prohibits the destruction of the critical habitat of endangered and threatened species found on federal lands. The Recovery Strategy for the Dwarf Lake Iris (*Iris lacustris*) in Canada (Parks Canada 2011) identified 30 critical habitat parcels on the northern Bruce Peninsula.

Dwarf lake iris had been listed as threatened under Ontario's Endangered Species Act of 2007 (S.O. 2007, c. 6.). In 2011, the Committee on the Status of Species at Risk in Ontario (COSSARO) reassessed dwarf lake iris and changed its status from threatened to special concern (COSSARO 2011). As a species of special concern, dwarf lake iris no longer receives protection under Ontario's endangered species law (Eric Snyder, Ontario Ministry of Natural Resources, pers. comm. 2012).

Surveys and Monitoring

Survey records for Michigan vary broadly, with some sites remaining unvisited since the early 1980s, while others were surveyed as recently as 2005. Due to funding restrictions, no all-inclusive surveys have been conducted since the species' listing in 1988. In Wisconsin, the most recent monitoring efforts took place in 2005; however, not all of the known populations were re-visited. Currently, there is no set schedule for monitoring dwarf lake iris in Wisconsin, but the WDNR is attempting to establish a three-year monitoring cycle of the existing populations, including population and habitat health (Craig Anderson, Wisconsin Department of Natural Resources, pers. comm. 2005).

Habitat Management

Vegetation management is critical to maintaining dwarf lake iris colonies. Habitat management to set back forest succession and remove other competing vegetation is essential to prevent sites from becoming too densely shaded for reproduction to occur. In addition, invasive species control is required at some sites and may become more important into the future.

Transplanting Efforts

There have been several instances in both Michigan and Wisconsin where small populations were relocated for the construction of new homes and the maintenance of existing roads. Monitoring reports submitted to the MDNR indicate consistently successful translocations (Chris Hoving, Michigan Department of Natural Resources, pers. comm. 2011). Additionally, dwarf lake iris was successfully established in the University of Wisconsin – Green Bay's Arboretum (Anderson, pers. comm. 2005).

Research

Since listing, surveys and research have been conducted in an effort to learn more about the species. Universities in both Wisconsin and Michigan have completed various studies, ranging topically from the general habitat and ecology of dwarf lake iris to its genetic diversity. While a great deal of observation and study has been completed in the past, there is still a need to understand pollination biology, management techniques, the impact of invasive species, and the potential effects of climate change. In addition, questions regarding the larger ecosystem, such as the rate of forest succession and return interval of natural disturbances, remain. Understanding these processes better and how they influence dwarf lake iris colonies would enhance the further development of management techniques, including the creation of artificial disturbances to benefit dwarf lake iris.

Biological Constraints and Needs

Biological constraints of dwarf lake iris include reproductive limitations and dependence on disturbance to maintain semi-open habitat, reduce leaf litter accumulation, and ensure correct type of litter. Propagation of dwarf lake iris occurs predominately through the spread of vegetative rhizomes. While sexual reproduction does occur, poor seed dispersal and seedling establishment as well as lack of pollination all contribute to dwarf lake iris' rarity.

Light is one of the most critical factors in the growth and reproduction of dwarf lake iris. Field observations have indicated that the most prolific flowering populations are those that receive a minimum threshold of direct sunlight for at least a portion of the day (Van Kley 1989). Leaf litter is also an important habitat factor in the life cycle of dwarf lake iris, with increasing litter depth reducing the number of shoots and blooms (Makholm 1986; Van Kley 1989). Litter tended to increase as light levels dropped, suggesting that both increasing litter depth and lower light levels serve to inhibit the germination, establishment, and growth of dwarf lake iris.

Perhaps the most critical biological need of dwarf lake iris and constraint to its recovery is its dependence on disturbance to alter or suppress natural forest succession in which the invasion of deciduous species results in reduced light levels and increased leaf litter. This disturbance has

traditionally been the result of storms, wind throw, fluctuating lake levels, and winter ice formations; however, any recovery strategy for dwarf lake iris must include a component of habitat management to maintain semi-open habitat to ensure the long-term viability of the species.

PART II. RECOVERY

Recovery Strategy

Dwarf lake iris has a very limited range. While its greatest concentrations lie in the Mackinac Straits region of Michigan, it is also found in Brown and Door Counties of Wisconsin and on the Bruce Peninsula of Ontario. Historically, dwarf lake iris was known to occur as far south as Milwaukee County, Wisconsin and along the Detroit River in Ontario; however, the species was never widespread and is endemic to the northern shores of lakes Michigan and Huron.

Although there are high-quality dwarf lake iris occurrences on public land and private nature preserves, many populations lie on private property and the threats to this species remain high. Direct loss of plants and habitat as well as fragmentation of habitat are continuing and expected to accelerate because of the desirability of coastal properties for development and recreation. This risk is exacerbated by the lack of awareness on the part of shoreline landowners, public land managers, and local governments.

The recovery of dwarf lake iris will be achieved by implementing a variety of protection strategies, including landowner notification, education, comprehensive shoreline protection planning, adequate enforcement, the preparation of management and monitoring plans, and in a few selected cases, acquisition. Work to identify landowners in Wisconsin and Michigan was begun in the 1990s, and many of these owners are still following their protection agreements. This effort will need to be re-started and records updated to reflect any changes in land ownership.

Consistent application of the Federal and State Endangered Species Acts and the development of protection policies and guidelines will also bolster protection efforts. Research and management must be carried out to address questions of pollination, invasive species impacts, and vegetation management practices. Monitoring is necessary to assess population changes over time and to measure the success of various protection and management techniques.

Recovery Goal and Objectives

The goal of this recovery plan is the removal of dwarf lake iris from the Federal List of Endangered and Threatened Plants (50 CFR 17.12). To achieve this goal, the recovery plan's objectives are: (1) to ensure the long-term persistence of a minimum number of viable populations across a majority of the species' geographic range through protection of habitat and conservation under a management plan; (2) to advance the understanding of dwarf lake iris ecology through research and experimental management practices; and (3) to improve public awareness of dwarf lake iris.

Recovery Criteria

An endangered species is defined in the ESA as a species that is in danger of extinction throughout all or a significant portion of its range. A threatened species is one that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. When we evaluate whether or not a species warrants downlisting or delisting, we consider

whether the species meets either of these definitions. A recovered species is one that no longer meets the ESA's definitions of threatened and endangered. Determining whether a species should be downlisted or delisted requires consideration of the of the same five categories of threats (i.e., the five threat factors, A-E) that were considered when the species was listed and are specified in section 4(a)(1) of the ESA.

The Service may consider delisting the dwarf lake iris when the recovery criteria outlined below are met. Recovery criteria are conditions that, when met, are likely to indicate that a species may warrant downlisting or delisting. Thus, recovery criteria are mileposts that measure progress toward recovery. These recovery criteria are our best assessment at this time of what needs to be completed so that the dwarf lake iris may be delisted. These criteria define the demographic characteristics of a recovered population and ensure that the threats to the species have been alleviated, both of which are necessary to ensure that dwarf lake iris is no longer threatened with extinction.

Because we cannot envision the exact course that recovery may take and because our understanding of the vulnerability of a species to threats is very likely to change as more is learned about the species (e.g., habitat, demography, genetics) and its threats, it is possible that a status review may indicate that delisting is warranted although not all of these recovery criteria are met. Conversely, it is possible that the recovery criteria could be met, but a status review may indicate that delisting is not warranted (e.g., a new threat may emerge that is not addressed by the recovery criteria below and that causes the species to remain threatened or endangered).

Delisting of the species will be considered when the criteria outlined below are met:

Criterion 1. The species has a 95% probability of persistence within the next 20 years, based on data obtained from accepted standardized monitoring methods and on population viability analysis. In order to meet this criterion, the following must be verified:

> 1.a. There is a sufficient number and geographical distribution of element occurrences required to ensure long-term persistence.
>
> 1.b. Each element occurrence needed to ensure a 95% probability of persistence within the next 20 years must meet a minimum viable population size and exhibit an increasing or stable population trend over a 10-year period.

Criterion 2. Management plans have been developed and are being implemented to protect and manage the habitat associated with the element occurrences identified in Criterion 1.b.

Criterion 3. A plan to provide public outreach and education for dwarf lake iris has been developed and is being implemented.

Stepdown Recovery Outline

The stepdown outline lists actions required to meet the recovery objectives of this Recovery Plan. The stepdown outline and narrative are presented in order of action category. Priority level of each sub-action is indicated at the end of the action description in parentheses. Implementation of all actions with Priority **(1)** is essential to prevent dwarf lake iris from becoming extinct in the foreseeable future. Implementation of all actions with Priority level **(2)** is necessary to prevent a significant decline in population numbers or habitat quality and quantity. Actions assigned Priority **(3)** are all other actions necessary to provide for full recovery of the species.

1. Protect occurrences

    1.1. Identify landowners (1)
    1.2. Notify landowners (1)
    1.3. Develop agreements for protection of occurrences on private lands (1)
    1.4. Implement administrative designations for the protection of occurrences on public lands (2)
    1.5. Promote comprehensive shoreline protection and include provisions for protection and conservation of dwarf lake iris occurrences and other federally listed species in all phases of land-use planning and leverage through agency and private conservation initiatives (2)
    1.6. Acquire sites (3)

2. Manage and restore habitat

    2.1. Develop and implement site management plans (1)
    2.2. Establish and monitor experimental restoration sites (2)
    2.3. Integrate management plans with specific land managers at the Federal, State, local, county, and municipal levels (2)

3. Inventory and monitor known sites

    3.1. Inventory current sites and habitat conditions (1)
    3.2. Inventory historic sites and habitat conditions (2)
    3.3. Establish and implement a monitoring program to determine population and species viability and population trends (1)

4. Conduct population viability analysis

    4.1. Develop a population viability analysis (PVA) suitable for the dwarf lake iris (1)
    4.2. Determine the number and geographical distribution of occurrences required to ensure long-term persistence (1)
    4.3. Define minimum viable population size (1)

5. Develop an education program about dwarf lake iris, other federally listed shoreline species, natural communities, and their protection and management

    5.1. Develop educational brochures, photos, posters, and digital media (3)
    5.2. Utilize educational material in the landowner contact programs, park interpretive programs, schools, coastal and environmental programs, and social networking sites (3)
    5.3. Provide educational material to government planning agencies, zoning boards, engineering and consulting firms, developers, utilities, and county road associations (3)

6. Improve understanding of baseline dwarf lake iris ecology

    6.1. Determine specific habitat requirements (limiting factors) for vegetative and sexual reproduction (2)
    6.2. Examine pollination biology and determine potential pollinators (2)
    6.3. Determine bottlenecks in sexual reproduction (2)

7. Review and track recovery progress

    7.1. Review the status of the species periodically and assess the effectiveness of the management plans and other recovery tasks (2)
    7.2. Revise recovery plan as appropriate (3)

Recovery Narrative

1. Protect occurrences

1.1. Identify landowners (1)

Before protection efforts can be implemented, all landowners must be identified. Heritage program databases are largely inadequate with regard to delineating specific ownerships, which are numerous as a result of the linear nature of dwarf lake iris occurrences. It will be necessary to maintain and update ownership data on all sites due the high ownership turnover on Great Lakes' shoreline property.

1.2. Notify landowners (1)

Landowner notification was started in the 1990s and has been shown to be a successful tool for species protection. The first stage begins by notifying all landowners, public and private, of the presence or potential presence of dwarf lake iris on or near their property. For federally listed shoreline species, including dwarf lake iris, this information is provided as written notification and/or through group meetings (as opposed to one-on-one contact due to the high number of landowners requiring contact). The notification explains the protection provided by both the Federal and State Endangered Species Acts and includes basic information, such as how to recognize dwarf lake iris and the importance of conserving this rare species. Follow-up through personal contact or phone conversations is necessary in some cases to answer questions and provide any additional information requested.

1.3. Develop agreements for protection of occurrences on private lands (1)

Both non-binding and binding voluntary agreements are desirable to help conserve occurrences on private land. These consist of such strategies as acquiring development or management rights to land parcels and obtaining conservation easements. For sites with landowner agreements already in place, records may require updating to reflect any changes in ownership and to renew agreements, as necessary.

1.4. Implement administrative designations for the protection of occurrences on public lands (2)

Public lands support some of the most significant and viable occurrences. These can be protected in a variety of ways, such as through Wilderness and Natural Area dedication, written management agreements, memoranda of understanding between public agencies, and provisions for protection in Master Plans for parks, National and State Forests, and any other publicly owned area for which such plans are prepared and periodically revised and updated. Many such agreements are already in place and can be used as a foundation to expand protection on other public lands. Contact with pertinent land managers is essential, as is ensuring that their database contains location information and other data necessary for the management and conservation of iris colonies.

1.5. Promote comprehensive shoreline protection and include provisions for protection and conservation of dwarf lake iris occurrences and other federally listed species in all phases of land-use planning and leverage through agency and private conservation initiatives (2)

Provide specific information on dwarf lake iris occurrences to all land managers and land-use planners such that conservation of occurrences is prescribed. Encourage coordination among planners and staff at the Wisconsin Bureau of Endangered Resources, the Michigan Department of Natural Resources, the U. S. Fish and Wildlife Service, and private conservation organizations throughout the land-use planning process. Several federal agency and private Great Lakes programs and initiatives currently underway will comprehensively approach the issues of shoreline protection and ultimately have bearing on the survival of dwarf lake iris.

1.6. Acquire sites (3)

Combined acquisition, administrative designation, and management afford the highest level of protection for dwarf lake iris. A small number of sites is recommended for acquisition because of imminent threats, site priority, or because the site has a large proportion of rare species in addition to dwarf lake iris.

2. Manage and restore habitat

2.1. Develop and implement site management plans (1)

Because dwarf lake iris usually shows the best growth and reproduction on sites that daily receive several hours of direct sunlight, some type of disturbance that occasionally removes the overstory may be required for the long-term perpetuation of the species at sites where the natural disturbance regimes are limited. Active management will probably be required on sites where disturbance is minimal, such as state parks, where human-related disturbances may be minimized and fires suppressed, and private lands, where landowners do not practice some form of selective cutting. Invasive species control should also be considered in these plans. Management plans should be developed and implemented for each site so that the special characteristics of the site and the conditions of the dwarf lake iris populations are considered.

2.2. Establish and monitor experimental restoration sites (2)

In areas of large healthy populations, small-scale, experimental management should be conducted to determine potential impacts prior to large-scale implementation. Procedures should be devised so that other components of the microsites experience minimal impact. Experimental restorations should address artificial disturbances, which may be key to successful management of dwarf lake iris. Furthermore, experiments with transplanting small groups of ramets from inland populations into other populations to enhance local genetic diversity could be attempted if viability analyses indicate population enhancement is warranted. Experimental introductions north of the species' current range into suitable

habitat along Lake Superior should be considered and evaluated as a means to address potential threats from climate change.

2.3. Integrate management plans with specific land managers at the Federal, State, local, county, and municipal levels (2)

Because more than a quarter of the remaining populations exist on sites that are managed by government agencies, it is essential to integrate dwarf lake iris management into the standard operating procedures of these agencies. Discussions with the appropriate agencies regarding the status of dwarf lake iris and evaluation of the management plan should be held on a regular basis.

3. Inventory and monitor known sites

3.1. Inventory current sites and habitat conditions (1)

Determining or estimating the size of known dwarf lake iris populations range-wide is necessary to ascertain its status and to acquire data to build the PVA. In addition, assessing the habitat conditions and presence of exotic species will provide information to update the element occurrence ranking for each site (according to appropriate ranking standards, see Appendix 5) and gauge each population's potential for improvement with management.

3.2. Inventory historic sites and habitat conditions (2)

Inventories at historic sites will allow for verification that dwarf lake iris is no longer present and an assessment of factors or conditions that may be responsible for the demise of the colony. If dwarf lake iris is found at the site, procedures for determining population size, as described in 3.1, should be followed.

3.3. Establish and implement a monitoring program to determine population and species viability and population trends (1)

Regular monitoring data will be used to update the PVA to provide a robust tool for species status assessment to inform management actions. Monitoring plans for each site will be designed such that they can continue to be used post-delisting.

4. Conduct population viability analysis

4.1. Develop a population viability analysis (PVA) suitable for the dwarf lake iris (1)

Population viability analysis (PVA) is a general term that describes a suite of quantitative methods used to predict the future condition of one or more populations of conservation concern (Morris *et al.* 1999). Species, such as dwarf lake iris, that exhibit clonal growth present challenges to assessing viability; however, PVAs can be developed for such

species (Schwartz 2003). Development of a PVA will entail an assessment of the type of data available and what is necessary to build a PVA appropriate for dwarf lake iris.

4.2. Determine the number and geographical distribution of occurrences required to ensure long-term persistence (1)

The overall risk of extinction for a species drops when multiple and independent populations exist. The probability that all populations of a species become extinct can be extrapolated from the population viability estimates for multiple occurrences of independent populations (Morris *et al.* 1999). In addition, representation of populations from across the full range of the species, including occurrences at the range margins, are desirable because of their potential contribution to overall genetic diversity.

4.3. Define minimum viable population size (1)

The minimum viable population size refers to a threshold below which the population has a high probability of extinction. Determining a minimum viable population size through population viability analysis will enable evaluation of each occurrence of dwarf lake iris and the likelihood that the occurrence will persist into the future.

5. Develop an education program about dwarf lake iris, other federally listed shoreline species, natural communities, and their protection and management

5.1. Develop educational brochures, photos, posters, and digital media (3)

The key to the survival of dwarf lake iris lies in raising public awareness and appreciation for the unique and fragile nature of Great Lakes' shoreline communities and the plants and animals that occur in them, as well as the landowner's role in conserving these environments. The Wisconsin Bureau of Endangered Resources and the former Michigan Natural Heritage Program have produced publications that include dwarf lake iris and other federally listed shoreline species. Future educational materials will focus on natural shoreline communities, ecosystem processes, and habitat management guidelines. A short video may focus on the uniqueness of the shoreline, the impacts of trespass, ORV damage, trampling, habitat fragmentation and illegal take, and opportunities for voluntary conservation and management, while emphasizing the importance of a healthy Great Lakes ecosystem to the long-term economy of the region.

5.2. Utilize educational material in the land owner contact programs, park interpretive programs, schools, coastal and environmental programs, and social networking sites (3)

Long-term protection of shoreline resources will become increasingly difficult without public appreciation of and support for the resource. Educational materials must be made available to a large audience and provided in a form that is easy to access in order to insure a wide distribution.

5.3. Provide educational material to government planning agencies, zoning boards, engineering and consulting firms, developers, utilities, and county road associations (3)

These groups can have profound impacts on current and long-term land use decisions. Outreach to these entities, through educational materials and direct communication, will allow for integration of dwarf lake iris conservation into land-use planning.

6. Improve understanding of baseline dwarf lake iris ecology

6.1. Determine specific habitat requirements (limiting factors) for vegetative and sexual reproduction (2)

Several factors, including low light levels, inadequate soil moisture and competition from other herbaceous species, are known to limit growth and reproduction of dwarf lake iris. The rate of successional changes in these habitats and the return interval of disturbances influence these factors, with implications for dwarf lake iris colonies. In addition, invasive species, such as orange hawkweed (*Hieracium aurantacum* L.) and garlic mustard (*Alliaria petiolata*), likely compete with dwarf lake iris. Other invasive species that may be affecting dwarf lake iris should be investigated. The role of these limiting factors and their interactions needs further clarification before appropriate management strategies can be devised.

6.2. Examine pollination biology and determine potential pollinators (2)

Observations of pollination are extremely limited and a large portion of potential pollinators have yet to be identified. A better understanding of dwarf lake iris' pollination biology would be beneficial to promoting sexual reproduction, a factor that would ultimately increase genetic diversity.

6.3. Determine bottlenecks in sexual reproduction (2)

The relative success of sexual reproduction appears to be limited at several points in the life cycle. These apparent bottlenecks include pollination (which may limit fruit set as well as seeds per fruit), seed dispersal, and seedling establishment. Although its breeding system has been determined, little is known about the potential limitations posed by pollen supply and pollinators. Assuming that successful sexual reproduction is essential for long-term adaptation to a changing environment, the significance of these apparent bottlenecks should be investigated.

7. Review and track recovery progress

7.1. Review the status of the species periodically and assess the effectiveness of the management plans and other recovery tasks (2)

Assessing progress toward recovery is critical for successful implementation of this plan.

7.2. Revise recovery plan as appropriate (3)

This plan may need to be revised to address changing conditions, incorporate new findings, and update recovery actions.

PART III. IMPLEMENTATION

The following Implementation Schedule outlines actions and estimated costs for the recovery program in the United States portion of dwarf lake iris range. It is a guide for meeting the objectives discussed in the Recovery section. The Implementation Schedule lists and ranks recovery actions, provides action descriptions and duration, identifies partner agencies, and provides estimated costs. The listing of a partner in the Implementation Schedule does not require, nor imply requirement, that the identified partner has agreed to implement the action(s) or to secure funding for implementing the action(s); however, partners willing to participate may benefit by being able to show that their funding request is for a recovery action identified in an approved recovery plan and is therefore considered a necessary action for the overall coordinated effort to recover dwarf lake iris. Also, Section 7(a)(1) of the ESA directs all Federal agencies to utilize their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation of threatened and endangered species. This schedule will be reviewed periodically until the recovery objective is met, and priorities and actions will be subject to revision. Actions are presented in order of priority.

Key to Implementation Schedule

Column 1: Action Priority

Priority 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2: An action that must be taken to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction.

Priority 3: All other actions necessary to meet the recovery objectives.

Column 2: Action Number

The number from the Stepdown Recovery Outline (Part II).

Column 3: Action Description

A short description of the recovery action which coincides with the Stepdown Recovery Outline (Part II).

Column 4: Action Duration

The number of years that it is expected to take before the action is completed. The letter "O" indicates that the action is currently ongoing. The letter "C" indicates that the action will be continuous throughout the recovery period. Actions may be both ongoing and continuous.

Column 5 and 6: Recovery Partner

This designates the Service programs and other organizations that may be involved in carrying out the task. A key to the acronyms is provided here.

ES	USFWS Division of Ecological Services
LCO	Local Conservation Organizations (e.g., The Nature Conservancy, Tip of the Mitt Watershed Council, Conservation Resource Alliance, and others)
LG	Local Government (e.g., County Road Commissions, Conservation Districts, towns, cities, and villages)
WDNR	Wisconsin Department of Natural Resources
USFS	U.S. Forest Service
NPS	National Park Service
USGS	U.S. Geological Survey
MDNR	Michigan Department of Natural Resources
MNFI	Michigan Natural Features Inventory
NRCS	Natural Resources Conservation Service
OTHERS	Other individuals or groups willing to participate (e.g., private landowners)
RSCH	Universities and Research Institutions
USFWS	U.S. Fish and Wildlife Service

Columns 7-10: Cost estimates for Years 1, 2, 3, and 4-15

This column gives the estimated cost for carrying out the action during the next three years and for years four through twenty. Costs are listed in thousands of dollars. TBD means costs are yet to be determined.

Column 11: Comments

Explanatory comments. For more detailed information, refer to the Recovery (Part II) section.

Table 2. Implementation schedule for dwarf lake iris

Priority	Action Number	Description	Action Duration (Years)	Recovery Partner		Est. Cost ($1,000)				Comments
				R3 USFWS	Other	Year 1	Year 2	Year 3	Year 4-15	
1	1.1	Identify landowners.	C	ES	MDNR, WDNR, MNFI	4	4	2	10	
1	1.2	Notify landowners.	C	ES	MDNR, WDNR, MNFI	4	4	2	10	
1	1.3	Develop agreements for protection of occurrences on private lands.	C	ES	MDNR, WDNR, OTHERS, MNFI	4	4	2	10	
1	2.1	Develop and implement site management plans.	C	ES	MDNR, WDNR, USGS, NPS, USFS, LCO, MNFI	25	25	25	TBD	Cost will depend on the number of additional management plans developed after year 3.
1	3.1	Inventory current sites and habitat conditions.	C	ES	MDNR, WDNR, USGS, NPS, USFS, LCO, MNFI	10	10	10	20	

Priority	Action Number	Description	Action Duration (Years)	Recovery Partner		Est. Cost ($1,000)				Comments
				R3 USFWS	Other	Year 1	Year 2	Year 3	Year 4-15	
1	3.3	Establish and implement a monitoring program to determine population and species viability and population trends.	C	ES	MDNR, WDNR, USGS, NPS, USFS, MNFI, LCO, OTHERS	10	10	10	TBD	Cost will depend on the regularity of surveys for years 4-15.
1	4.1	Develop a population viability analysis (PVA) suitable for the dwarf lake iris.	2	ES	USGS, RSCH, MNFI, WDNR	0	0	5	5	
1	4.2	Determine the number and geographical distribution of occurrences required to ensure long-term persistence.	2	ES	USGS, MNFI, WDNR, RSCH	0	0	5	5	
1	4.3	Define minimum viable population size.	2	ES	USGS, MNFI, WDNR, RSCH	0	0	5	5	
2	1.4	Implement administrative designations for the protection of occurrences on public lands.	5	ES	MDNR, WDNR, USGS, NPS, USFS	5	5	5	10	

Priority	Action Number	Description	Action Duration (Years)	Recovery Partner		Est. Cost ($1,000)				Comments
				R3 USFWS	Other	Year 1	Year 2	Year 3	Year 4-15	
2	1.5	Promote comprehensive shoreline protection and include provisions for protection and conservation of occurrences of dwarf lake iris and other federally listed species in all phases of land-use planning and leverage through agency and private conservation initiatives.	O, C	ES	MDNR, WDNR, USGS, NPS, USFS	5	5	5	15	
2	2.2	Establish and monitor experimental restoration sites.	C	ES	MDNR, WDNR, USGS, NPS, USFS	10	10	10	TBD	
2	2.3	Integrate management plans with specific land managers at the Federal, State, local, county, and municipal levels.	C	ES	MDNR, WDNR, USGS, NPS, USFS, LG,LCO	2	2	2	10	
2	3.2	Inventory historic sites and habitat conditions.	3	ES	MDNR, WDNR, USGS, NPS, USFS	10	10	10	0	No cost expected after year 3.

Priority	Action Number	Description	Action Duration (Years)	Recovery Partner		Est. Cost ($1,000)				Comments
				R3 USFWS	Other	Year 1	Year 2	Year 3	Year 4-15	
2	6.1	Determine specific habitat requirements (limiting factors) for vegetative and sexual reproduction.	5	ES	MDNR, WDNR, USGS, NPS, USFS	10	20	30	TBD	Additional research may be necessary in years 4-15.
2	6.2	Examine pollination biology and determine potential pollinators.	5	ES	MDNR, WDNR, USGS, NPS, USFS	5	5	5	TBD	Additional research may be necessary in years 4-20.
2	6.3	Determine bottlenecks in sexual reproduction.	5	ES	MDNR, WDNR, USGS, NPS, USFS	10	20	30	TBD	Additional research may be necessary in years 4-20.
2	7.1	Review the status of the species periodically and assess the effectiveness of the management plans and other recovery tasks.	C	ES	MDNR, WDNR, MNFI	1	1	1	12	
3	1.6	Acquire sites.	C	ES	MDNR, LCO, WDNR	0	0	0	20+	

Priority	Action Number	Description	Action Duration (Years)	Recovery Partner		Est. Cost ($1,000)				Comments
				R3 USFWS	Other	Year 1	Year 2	Year 3	Year 4-15	
3	5.1	Develop educational brochures, photos, posters, and digital media.	5	ES	MDNR, WDNR, USGS, NPS, USFS, LCO, MNFI	1	1	1	5	
3	5.2	Utilize educational material in the landowner contact programs, park interpretive programs, schools, coastal and environmental programs, and social networking sites.	C	ES	MDNR, WDNR, USGS, NPS, USFS, LCO, MNFI, RSCH, OTHERS	5	5	5	15	
3	5.3	Provide educational material to government planning agencies, zoning boards, engineering and consulting firms, developers, utilities, and county road associations.	C	ES	MDNR, WDNR, USGS, NPS, USFS, LCO, MNFI, RSCH, OTHERS	5	5	5	15	
3	7.2	Revise recovery plan as appropriate.	2	ES	MDNR, WDNR, MNFI, RSCH	0	0	0	5	

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APPENDICES

Appendix 1. Distribution of Dwarf Lake Iris in Michigan

Site name	County	EO #	EO Rank	Last obs.	Owner	Comments
El Cajon Bay/ Misery Bay	Alpena	23	A	1992	Private	Very large, flowering population in prime habitat with much potential for protection
North Point	Alpena	32	A	1996	Unknown	Extensive population
Middle Lake Fen	Alpena	91	A	2002	Unknown	Abundant in quality habitat
Monaghan Point Road	Alpena	58	AB	1997	Private	Widespread population occurring discontinuously along several miles of shoreline
Whitefish Bay	Alpena	22	B	1991	Private	Uncertain, as entire area was not surveyed
Thunder Bay/ Squaw Bay	Alpena	57	B	1987	Private	
Grass Lake	Alpena	25	BC	1981	Private	
Rockport South	Alpena	34	C	2002	Private	Sparse & patchy
Thunder Bay Island	Alpena	62	C	1981	Unknown	No human disturbance, but colony very small
French Bay Beaver Island	Charlevoix	37	B	1999	Public	Thriving population, quality habitat
Appleby Point Beaver Island	Charlevoix	74	BC	1999	Public	Partial disturbance by house and road
Hog Island - East Shoreline	Charlevoix	84	C	1999	Public	Very small population
Indian Harbor – Garden Island	Charlevoix	101	E	2012	Public	Two small patches, collectively only a few square meters in size
Cheboygan State Park	Cheboygan	33	B	1999	Public	Locally dense colonies N of road & campground, moderate colonies within Grass Bay preserve
Mackinaw City Cadottes Point	Cheboygan	52	B	1991	Private	Population increasingly fragmented
Cheboygan West	Cheboygan	11	BC	1996	Private	
Drummond Island - Seamans Point	Chippewa	16	BC	1998	Private	

Site name	County	EO #	EO Rank	Last obs.	Owner	Comments
Drummond Island - Big Shoal Cove	Chippewa	9	C	1989	Private	
Drummond Island - Pike Bay	Chippewa	13	C	1989	Private	
Seymour Creek	Chippewa	81	C	1990	Unknown	Needs survey to solidify rank
Portage Bay	Delta	21	A	1980	Public	
Point Detour	Delta	42	A	2004	Public	
Escanaba River - Cornell	Delta	40	BC	1991	Private	Not large in extent but vigorous; highly significant as an inland locality, one of two riparian ones
South River Bay	Delta	50	BC	1981	Private	Dense and thriving, undisturbed, however area rather local
Poverty Island	Delta	6	C	1982	Public	Eastern population ranked C prior to merging of 2 occurrences.
Carrol Corners Dam	Delta	15	C	1990	Private	Small population, but significant inland locality
Poverty Island	Delta	24	C	1996	Public	Small, isolated colony at edge of forest. May be somewhat more widespread, but found only very locally
Summer Island North	Delta	26	C	1968	Unknown	
Summer Island South	Delta	28	C	1968	Public	
Summer Island	Delta	43	C	1995	Public	Very localized, but possibly more widespread
Wedens Bay	Delta	72	C	1993	Public	Dense and thriving, undisturbed, but area not large
Fayette	Delta	41	X	1939	N/A	Only plant noted was apparently collected
Point O'Keefe West	Delta / Schoolcraft	66	BC	1991	Private	
Big Stone Bay	Emmet	1	B	2005	Public	Poor data on largest portion of occurrence
Trail's End Bay, Cecil Bay	Emmet	2	B	2001	Public	Abundant, but in localized patches, residential development
Sturgeon Bay	Emmet	8	C	1991	Public	Detailed survey and mapping may raise rank
Mackinaw City	Emmet	38	E	1981	Private	Status in Mackinaw City area needs to be confirmed

Site name	County	EO #	EO Rank	Last obs.	Owner	Comments
Waugo-shance Point	Emmet	5	H	1966	Historical	
Bois Blanc (Snake) Island	Mackinac	44	A	1997	Public	Abundant along the coastal areas
Beaver Tail Point	Mackinac	54	A	1998	Private	Large population extending over many acres in high quality habitat protected via TNC Lake Huron Bioreserve
Birch Point East West	Mackinac	10	AB	2002	Public	
Cadogan Point	Mackinac	55	AB	1996	Private	High quality habitat with colonies extending over a broad area of shoreline
Lime Kiln Point / W. Bois Blanc Island	Mackinac	63	AB	1997	Private	Extensive collectively, covering many acres along the western portion of Bois Blanc Island
Point Detachee	Mackinac	64	AB	1983	Private/ State	
Marquette Southeast Peninsula	Mackinac	80	AB	1999	Private	Extensive population, quality habitat
Peck Bay	Mackinac	82	AB	1999	Private	Extensive population, quality habitat
Gros Cap	Mackinac	20	B	2001	Private	Several colonies scattered along shoreline area
Big Knob Campground	Mackinac	69	B	2001	Public	Population includes additional areas into Sect 19 (1991)
Round Island	Mackinac	29	BC	1993	Public	
Pointe Labarbe	Mackinac	36	BC	2001	Public	Colonies occur throughout the area, but population threatened in part by human activity.
Little Lasalle Island	Mackinac	68	BC	1994	Private	
Naubinway East	Mackinac	4	C	2001	Private	
West Moran Bay	Mackinac	19	C	1993	Private	Large colonies, localized
Hog Island Point	Mackinac	30	C	2001	Public	Small colony; viability uncertain

Site name	County	EO #	EO Rank	Last obs.	Owner	Comments
Pointe Aux Chenes Bay	Mackinac	51	C	1991	Private	More abundant than originally thought. 2001: status uncertain
McRae Bay	Mackinac	65	C	1991	Public	
Hughes Point	Mackinac	88	C	2001	Private	Fragmented local colonies
Black River Rd.	Mackinac	89	C	2001	Private	Small isolated patch, possibly more widespread
Naubinway East	Mackinac	90	C	2001	Private	Local colony
St. Martin Island	Mackinac	97	C	1993	Unknown	Local along edges of northern fens
Big St. Martin Island	Mackinac	98	C	1993	Unknown	Somewhat local and sparse where observed, better evaluation is needed
Kells West	Menominee	100	AB	2005	Unknown	Excellent viability of population with some threat from transmission line construction
Koss	Menominee	45	BC	2005	Private	Dense but localized; important as one of two colonies far inland
Carney Fen	Menominee	95	BC	2005	Public	Significant threats to population from logging machinery and ATV's
Pokavich Rd	Menominee	96	C	2005	Public	Only vegetative reproduction observed. Rank can improve if larger population identified, with observations of flowering and sexual reproduction
Thompson's Harbor	Presque Isle	3	A	2001	Public	Largest occurrence documented globally
Stevenson's Fen	Presque Isle	92	A	2002	Unknown	Abundant in high quality habitat
Grand Lake / Schaut Creek	Presque Isle	14	B	1996	Private	Extensive clones in large clearing
Besser Natural Area South	Presque Isle	17	B	1996	Private	Looks like a good quality occurrence. Needs more survey. 1996: extensive population
Presque Isle Harbor	Presque Isle	35	B	1998	Public	Likely more extensive than limited area surveyed
Wreck Point	Presque Isle	59	B	2001	Private	Locally abundant, mostly occurs on private land
Miller Road East	Presque Isle	99	B	1996	Public	Somewhat localized population in high quality limestone glade habitat

Site name	County	EO #	EO Rank	Last obs.	Owner	Comments
Grace North	Presque Isle	18	C	1981	Unknown	
Hoeft State Park	Presque Isle	31	C	1996	Private	Small isolated population
Rockport North	Presque Isle	39	C	2004	Unknown	Isolated population
False Presque Isle	Presque Isle	75	C	1989	Private	
Adam's Point	Presque Isle	93	C	2002	Private	Small pop in young second growth
Parent Bay	Schoolcraft	7	B	2000	Private	Thriving colony
Seul Choix Point	Schoolcraft	46	B	2000	Public	
Thompson Dunes	Schoolcraft	27	BC	1991	Public	Large colonies but area disturbed by US-2 and ORV use
Point Aux Barques	Schoolcraft	49	BC	1981	Private	
Dry Creek (Michibay Rd. Township Park)	Schoolcraft	12	C	2000	Private	Small localized colonies
Stony Point	Schoolcraft	47	C	2001	Private	Unknown pop size and extent, impacted by development
Snyder Creek North	Schoolcraft	67	C	2000	Private	Local patches
Hiram Point South	Schoolcraft	85	C	2000	Public	Small, localized clusters
Lake Superior State Forest Dunes	Schoolcraft	86	C	2000	Private	Localized colony
Point Aux Barques South	Schoolcraft	87	C	2000	Private	Small, local patches

EO Rank: A = Excellent, B = Good, C = Marginal, D = Poor, H = Historical, X = Destroyed, E = Extant, UNK = Unknown

Appendix 2. Distribution of Dwarf Lake Iris in Wisconsin

Site name	County	EO #	EO Rank	Last obs.	Owner	Comments
Gilson Creek Woods Easement	Brown	023	A	2001	Private	2001(Judziewicz): 10,000s of ramets. 1999 (Morgan): over 100,000 ramets. Density rather constant over last 13 years on first ridge. Varied on 2nd and 3rd ridges. 1997(Trick *et al.*): observed. 1994: ca 500 stems observed. Dense flowering patches in openings and sparse non-flowering patches in shade.
Gravel Pit Roadside Woods	Brown	028	C	2005	Private	2005: population threatened by loss of habitat due to potential development. 1999 (Morgan): 8,000 - 10,000 ramets. 1997 (Trick *et al.*): observed. 1993 (Fewless): species observed. 1992: collected 35 leaves. 1979: species observed.
Highway T Cedar Grove	Brown	029	C	2005	Private	2005: species observed during a roadside survey. 1997 (Trick *et al.*): species observed. 1993 (Fewless): species observed. 1979: small colonies (2-10' diameters).
The Ridges Sanctuary	Door	011	A	1994	Public/ Private	1994: species observed. 1992: 30 leaves collected. 1989-87?: extensive colonies. Population size estimated at over 10,000 ramets, 80% mature. Quality varies from very feeble to very vigorous. Plants in full sun were dying.
Newport State Park	Door	018	AB	2000	Public	2000 (Judziewicz): 15 sterile clones each 1-4 m in diameter. 2000 (Fewless): hundreds of thousands of ramets, very few with fruit. 1987: extensive colonies with over 10,000 ramets, of widely varying quality. Discrete colonies occur on tops of mounds where light levels are higher than surrounding areas. Continuous colonies in young forest. Much iris in blowdowns.
Cana Island Roadside Cedars	Door	005	B	2005	Private/ Public	2005: species present. 1980: extensive colonies
County Highway Q Roadside Cedars	Door	008	B	1981	Private/ Public	Extensive population with thousands of ramets.

Site name	County	EO #	EO Rank	Last obs.	Owner	Comments
Peninsula State Park - Sunset Trail	Door	012	B	1992	Public	1992: collected 30 leaves. 1987: 10,000+ ramets. Most colonies of medium or higher quality.
Peninsula State Park - Tennison Bay	Door	014	B	2003	Public	2003: species present. 1992: collected 21 leaves. 1987?: moderately shaded colonies with 1,000s of ramets. Plants vary from feeble to vigorous, some in flower. 1957: species collected.
Newport State Park	Door	017	B	1989	Public	1989 (Clark): very large population (5% in flower, 45% asexual reproduction, 50% senescent). 1979 (Alverson): over 1,000 upright stems.
Michigan Road Woods and Dunes	Door	020	B	2005	Private/ Public	2005: plentiful, but not flowering due to shade.
Washington Island - Southeast Coast Alkaline Rockshore	Door	045	B	2003	Private	2003: Healthy populations viewed during visit with landowners. Private landowners also actively managing for irises by opening up the canopy by cutting branches.
Whitefish Dunes	Door	001	BC	2005	Public	2005: patch 4 ft by 25 ft. 1979: small patch 6 ft. in diameter.
Jackson Harbor Ridges and Fowler Boreal Forest	Door	041	BC	2002	Private/ Public	2005: Many colonies throughout Jackson Harbor Natural Area site; plants in the shade are sterile. Most plants found along edges of open foot/deer paths. Numerous flowering plants found on both sides of Indian Point Rd. Dense colonies found along both sides of “McDonald’s Cabins” driveway off of Indian Point Rd.

Site name	County	EO #	EO Rank	Last obs.	Owner	Comments
Detroit Island - Dwarf Lake Iris Sites	Door	044	BC	2003	Private/ Public	2003: Small portion of population observed, including *Iris lacustris alba*. Landowners regularly contacted. 1998: About 10 genets and 30,000 ramets in swale just inland from west coast. Small (1 genet, 1,000 ramets) northern subpopulation and much larger southern subpopulation (9 genets, 29,000 ramets). Plants in filtered shade in level, moist, calcareous gravelly sand.
Washington Island - Percy Johnson County Park Wooded Dunes and Beach	Door	046	BC	2005	Public	2005: 1,000s of flowering stems. 2004: ca 1,000 flowering stems. Population remains stable but being shaded by creeping juniper. Town parks department aware of iris population at the park.
Not "Newport State Park"	Door	015	C	1981	Private/ Public	Extensive colonies and in very dense patches, extending 0.5 mi. along road.
Idlewild Alvar	Door	024	C	2000	Private	2000: new subpopulation with 2 m diameter clone. 2000: 3 clones with 100s or 1,000s of stems, 20% flowering. 1998: ca 200 stems, 100% mature non-flowering. Patches 6 ft. or more in diameter on forest edge or openings within forest. 3 patches seen, maybe more.
Potawatomi State Park	Door	025	C	2006	Private/ Public	2000: 2 clones totaling 2-3 m^2.
Unamed Location	Door	036	C	2005	Private	1994: abundant plants along roads in subdivision. 1882: species collected.
High Cliff Road – High Cliff Park Estates	Door	039	C	2004	Private	2004: healthy populations observed roadside. 1989?: 80-90% of the population is vegetative, with 10% in fruit and widely scattered, forming large mats in places.
Carlsville Bluff - North	Door	047	C	1999	Private	100,000-1,000,000 ramets noted in shaded, level, moist sandy ground.
Carlsville Bluff - North	Door	049	C	1999	Private	In swamp and extending into drier woods. Over a fairly broad area.

Site name	County	EO #	EO Rank	Last obs.	Owner	Comments
Kinsey Bay Lane	Door	050	C	2000	Public	2000: 10-15 clones, each 1-3 m in diameter. 1999: ca 1,000 stems, possibly more. All sterile.
Whitefish Bay Roadside Cedars	Door	002	D	1979	Private/ Public	1979: found along roadside, 80 m x 1 m strip of varying plant density. Plants thin and spotty in woods in thin to dense small patches, 1 m x 1 m in size.
Goldenrod Lane	Door	003	D	2004	Private/ Public	2005 (P. Robinson): plants not located. 2004 (Kind): healthy populations observed. 1979: plants scattered for ca. 180 ft. on north side of road On south side of road, sometimes dense (50+ stems per sq. ft.) and otherwise discontinuous. Four flowering plants seen.
Moonlight Bay Boat Ramp and Shoreline	Door	007	D	2005	Private/ Public	2005: species present and extensive.
Toft Point	Door	009	D	1979	Private/ Public	Small, scattered colonies
Toft Point	Door	010	D	1979	Private/ Public	Dense colony, 8 ft. diameter.
Peninsula State Park - Shore Road Parking Lot	Door	013	D	2000	Public	2000: ca 5 clones with 1,000s of stems. 500 stems in full flower. 1981: dense colony.
South Point Shoreline Woods	Door	021	D	1981	Private	Three small clones (2-3 meters in diameter).
Plum Island	Door	040	D	1999	Public	1999 (Judziewicz): very common along old road bed, a total of perhaps 50-100 sq meters of "sod". 1998: about 10 ramets and 775 genets. 1982: extensive population.
Pine Drive Beach	Door	043	D	2002	Private/ Public	2002: healthy population through woods and close to shoreline. High priority for permanent protection (TNC and DNR) because so much of the property is still intact and is a large tract of land.

Site name	County	EO #	EO Rank	Last obs.	Owner	Comments
Bailey's Harbor Boreal Woods	Door	004	E	1980	Public	*Iris* is apparently being shaded out.
Moonlight Bay Bedrock Beach	Door	006	E	1980	Private/ Public	Colonies in woods.
Marshall's Point	Door	016	E	1973	Private	Widely scattered, forming large mats in places.
Newport State Park	Door	019	E	1977	Public	Extensive carpets.
Sand Bay Road Bend	Door	026	E	2000	Private/ Public	2000: 1-5 patches covering ~5m^2, ca. 150 flowering stems.
Unamed Location	Door	042	E	1988	Private	No data. EO needs to be checked on ground.
North Bay Wetlands	Door	048	E	2000	Private	2000: 2 or 3 non-flowering clones totaling 1,000s of stems. 1998: ca 200 clumps of mature, non-flowering plants in a small dense patch.
Sawyer Harbor	Door	051	E	2004	Private	2004: healthy clones observed along roadside. Also likely that there are populations farther east. Many private roads/drives.
Unamed Location	Door	031	H	1952	Historical	
Unamed Location	Door	032	H	2005	Historical	1916: fairly common.
Unamed Location	Door	033	H	1961	Private	1961: species collected. Very common.
Unamed Location	Door	034	H	1961	Historical	1961: species collected.
Unamed Location	Door	035	H	1921	Historical	1921: species collected. Abundant.
Milwaukee County Historic Records	Milwaukee	037	X	1898	Historical	Area has been developed.
Milwaukee County Historic Records	Milwaukee	038	X	1943	Historical	Area has been developed.

EO Rank: A = Excellent, B = Good, C = Marginal, D = Poor, H = Historical, X = Destroyed, E = Extant, UNK = Unknown

Appendix 3. Distribution of Dwarf Lake Iris in Canada

Site Name	Location	EO #	EO Rank	Last obs.	Owner	Comments
Pike Bay Alvar	Bruce Peninsula	013	E	2003	Private	>3,000 ramets
NEW	Bruce Peninsula	New	E	2006	Private	>5,000 ramets
	Bruce Peninsula		E	2004	Private	1 m^2 patch
Dyer Bay Rd. and Hwy 6	Bruce Peninsula	016	E	2007	Public/ Private	~45,280,000 ramets estimated in 14.5 km^2 area
Corisande Bay	Bruce Peninsula	038	E	2005	Public/ Private	50,000 – 100,000 ramets in Corisande Bay ANSI; 95,361 ramets in 6 patches on trail to Rover property; ~100 ramets at Rover property
MacGregor Point	Bruce Peninsula	003	E	1998	Private	3 patches, 11 m^2, ~9500 shoots.
Miramichi Bay	Bruce County	005	E	2003	Private	1 m^2 patch; not found in 2008
Frenchman Bay Indian Reserve	Bruce Peninsula	006	E	2003	First Nation	0.5 m^2 patch
Sucker Creek Howdenvale	Bruce Peninsula	010	E	2006	Private	~25,000 ramets in several patches
Oliphant Fen	Bruce Peninsula	011	E	2003	Private	~400 shoots.
Pine Tree Harbour	Bruce Peninsula	015	E	2007	Public/ Private	836 ramets found in 2 separate patches during partial survey
Bruce Peninsula National Park	Bruce Peninsula	017	E	2007	Public	265,000 to 280,000 ramets in 4 large patches south of road; + approx. 3,600 ramets in 3 patches
Bruce Peninsula National Park	Bruce Peninsula		E	1991	Public	Not found in 2007.
Bruce Peninsula National Park	Bruce Peninsula		E	2006	Public	~21,200 ramets

Site Name	Location	EO #	EO Rank	Last obs.	Owner	Comments
	Bruce Peninsula		E	1991	First Nation	
Hopkins Bay	Bruce Peninsula	022	E	2007	Private	~11,000 ramets
West of Port Elgin	Bruce County	027	E	2005	UNK	Addition property: 2,200-4,200 ramets
Scugog Lake Alvar (Johnston Harbour Nature Reserve)	Bruce Peninsula	053	E	2006	Public	~6,500 ramets over 50 m^2, + >500 ramets
Oliphant	Bruce Peninsula	059	E	2003	Private	~4000 shoots/27 m^2
MacGregor Point Park	Bruce County	063	E	2008	Public	Areal extent estimated semi-continuous presence over ~10 km
MacGregor Point Park	Bruce County	065	E	2003	Public	NE end of park: 118 m^2, ~46,000 ramets
Cape Hurd area	Bruce Peninsula		E	2003	Private	Patch 6 m^2, ~1000 shoots, 200 flowers. Growing with cedar, tamarack, yellow birch, ninebark and bearberry. Also a patch beside the road 1 m^2, no flowers.
Unamed Location	Bruce County	New	E	2008	Private	~2,250 shoots
West of Port Elgin	Bruce County	004	H	1952	Private	Species not found. Most of the area is now housing.
Stokes Bay	Bruce County	014	H	1954	Private	Species not found. Area is now mostly residential.
Swamp south of Tobermory	Bruce County	024	H	1931	UNK	Species not found. Vegetation appears too dense to support species.
Sandwich (Windsor)	Bruce County		H	1901	Public	Now in City of Windsor; habitat gone.
South Bay	Manitoulin Island	033	E	2007	Private	>10,000 ramets

Site Name	Location	EO #	EO Rank	Last obs.	Owner	Comments
Petrol Point Nature Reserve	Bruce Peninsula	037	E	2004	Private	NGO nature reserve; <100 ramets
Sauble Falls North	Bruce County	008	H	1974	UNK	Not found. New road is in the approximate area.
Cape Hurd - Baptist Harbour	Bruce Peninsula	023	E	2004	Private	40,000 to 80,000 ramets
Fishing Islands	Bruce County	026	H	1874	Private	Species not found.
Bear's Rump Island	Bruce County	029	UNK	1982	Public	Not found in 2007 or 1996.
Hungerford Point – Wikwemikong	Manitoulin Island	030	E	2007	First Nation	>10,000 ramets
Girouard Pt.	Manitoulin Island	034		1969	UNK	Record is erroneous.
Cove Island	Bruce County	035	UNK	1983	Public	Not found in any recent surveys.
Chiefs Point Indian Reserve	Bruce Peninsula	040	E	UNK	First Nation	No info
	Bruce Peninsula		E	1991	First Nation	No info
	Bruce Peninsula		E	2004	First Nation	6,000 – 7,500 shoots
Lyal Island	Bruce Peninsula	041	E	2006	Private	>1,500 ramets
Wikwemikong #5	Bruce Peninsula		H	1997	First Nation	Not found; habitat altered.
Inverhuron Provincial Park	Bruce County	001	H	1989	Public	Species not found.
Scott Point	Bruce County	002	E	2008	Private	220 shoots in private yard

Site Name	Location	EO #	EO Rank	Last obs.	Owner	Comments
Sauble Beach	Bruce Peninsula	007	E	2008	Private	~5,300 shoots in 10 patches in Walker Woods Nature Preserve and 10,000 to 20,000 shoots in adjacent yard
Oliphant Fen	Bruce County	009	UNK	1973	UNK	Species not found.
Carter Bay	Manitoulin Island	031	E	2006	Private/ Municipal	~10,000 ramets
Black Creek Provinical Park	Bruce County	039	UNK	1982	Public	Not found.
Unamed Location	Bruce County	060	UNK	UNK	UNK	Species not found - large fen in the area, too wet for species.
Belanger Bay	Manitoulin Island	042	E	2004	Public	Patches cover 10 ha.
South Baymouth	Manitoulin Island	032	E	2006	Private/ Municipal	Discontinuously present over ~5 km of shoreline; 1,000,000s of ramets
South Baymouth	Manitoulin Island	047	H	1959	Private	Species not found. Habitat gone.
NEW	Manitoulin Island	New	E	2008	Public	2 patches; <1,000 ramets
NEW	Manitoulin Island	New	E	2006	Public/ Private	Discontinuous over ~5.5 km of shoreline; >1,000,000 ramets
NEW	Manitoulin Island	New	E	2007	First Nation	~75,000 ramets
NEW	Manitoulin Island	New	E	2007	First Nation	>7.5 km^2; 1,000,000s of ramets
NEW	Manitoulin Island	New	E	2007	First Nation	>30,000 ramets

EO Rank: A = Excellent, B = Good, C = Marginal, D = Poor, H = Historical, X = Destroyed, E = Extant, UNK = Unknown

Appendix 4. Glossary of Terms and List of Acronyms

Glossary of Terms

Allopolyploid:	Having two or more complete sets of chromosomes derived from different species.
Anthesis:	Period during which a flower is fully open and functional.
Elaiosome:	A fleshy structure attached to the seeds of a plant.
Element Occurrence:	An area of land and/or water in which a species or natural community is or was present.
Endemic:	Native or confined to a certain area.
Extant:	Still in existence.
Genet:	A group of genetically identical individuals, originating vegetatively, not sexually, from a single ancestor
Heterozygosity:	Having different alleles at one or more corresponding chromosomal loci.
Locus:	The position that a given gene occupies on a chromosome.
Monomorphic:	Having one or the same genotype, form, or structure through a series of developmental changes.
Perennial:	Plants that grow and bloom each year from an existing root-stock.
Polymorphic:	The occurrence of different forms, stages, or types in individual organisms or in organisms of the same species, independent of sexual variations.
Ramets:	An individual member of a clone or genet.
Rhizomes:	A horizontal stem capable of producing new growth in the form of shoots and roots.
Sepal:	Modified leaves, usually enclosing or surrounding the flowering parts of a plant.
Seral:	An intermediate stage of ecological succession.
Stamen:	Male reproductive portion of a flower.
Stigma:	The portion of the pistol that receives pollen.
Tubers:	Enlarged plant structure used to store nutrients.

List of Acronyms

COSEWIC:	Committee on the Status of Endangered Wildlife in Canada
EO:	Element Occurrence
ESA:	Endangered Species Act of 1973, as amended
MDNR:	Michigan Department of Natural Resources
MDOT:	Michigan Department of Transportation
MNFI:	Michigan Natural Features Inventory
USFWS:	United States Fish and Wildlife Service
WDNR:	Wisconsin Department of Natural Resources

Appendix 5. Element Occurrence Ranking Criteria

Rank	Explanation
A	**Excellent Occurrence.** Protection of A-ranked occurrences is essential to conservation of the maximum diversity and viability of an element in the state. A-ranked communities are essentially undisturbed by humans or have nearly recovered from early human disturbance. Species composition shows little departure from original structure and composition (except in seral or disturbance-dependent communities). A-ranked populations of a sensitive species are large in number of individuals, stable or growing, show good reproduction, and exist in a natural, sustainable habitat.
B	**Good Occurrence.** Protection of these occurrences is important to the survival of an element in the state, especially if very few or no A-ranked occurrences exist or in natural regions of the state where there are few or no A-ranked occurrences. A B-ranked community is still recovering from early disturbance or recent light disturbance but eventually will reach a B-rank. Presence of exotic species (if only localized and/or a minor component of the flora), a recoverable departure from original structure and composition for the site (except in seral and disturbance-dependent communities), result in a B-rank. B-ranked populations of a sensitive species are at least stable, occur in minimally disturbed habitat, and are of moderate population size.
C	**Fair Occurrence.** Protection of these occurrences helps conserve the biotic diversity on a regional or local level and is important to statewide conservation only if no higher-ranked occurrences exist. A C-ranked community is in an early stage of recovery from disturbance or its structure and composition have been altered such that the original vegetation of the site will never rejuvenate, yet with management and time, partial restoration of the community is possible. C-ranked populations of sensitive species are in clearly disturbed habitats, small in size and/or number, and possibly declining.
D	**Poor Occurrence.** Protection of these occurrences is seldom worthwhile except for historical reasons or only if no better occurrences exist. D-ranked communities are severely disturbed, their structure and composition have been greatly altered, and recovery to original conditions, despite management and time, essentially will not take place. D-ranked populations of sensitive species are very small with a high likelihood of dying out or being destroyed and exist in highly disturbed and vulnerable habitats.
E	**Verified extant.** Occurrence recently has been verified as still existing, but sufficient information on the factors used to estimate viability of the occurrence has not yet been obtained. Use of the E rank should be reserved for those situations in which the occurrence is thought to be extant, but an A, B, C, D, or combination rank cannot be assigned.
H	**Historical.** Recent field information verifying the continued existence of the occurrence is lacking.
X	**Extirpated.** Adequate surveys by one or more experienced observers at times and under conditions appropriate for the species at the occurrence location, or other persuasive evidence, indicate that the species no longer exists there or that the habitat or environment of the occurrence has been destroyed to such an extent that it can no longer support the species.

Appendix 6. Summary of Threats and Recommended Recovery Actions

Listing Factor	Threat	Delisting Criteria	Recovery Actions
A	Residential development	1, 2	1.3, 1.5, 1.6, 2.1, 2.2, 2.3, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 6.1, 7.1, 7.2
A	Recreational development and associated activities	1, 2	1.4, 1.5, 2.1, 2.2, 2.3, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.3, 6.1, 7.1, 7.2
A	Road and utility construction and maintenance	1, 2	1.4, 1.5, 2.1, 2.3, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.1, 5.3, 6.1, 7.1, 7.2
D	Lack of monitoring and enforcement	1, 2, 3	1.1. 1.2, 1.5, 2.1, 2.3, 3.1, 3.2, 3.3, 5.3
D	Lack of awareness of plants' presence and importance	1, 3	1.1, 1.2, 5.1, 5.2, 5.3, 7.1, 7.2
E	Natural succession	1, 2	2.1, 2.2, 2.3, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 6.1, 6.2, 6.3, 7.1, 7.2
E	Invasive species	1, 2	2.1, 2.2, 2.3, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 6.1, 6.2, 6.3, 7.1, 7.2
E	Climate change	1, 2	2.2, 3.3, 4.1, 4.2, 4.3, 6.1, 6.2, 6.3, 7.1, 7.2

Listing Factors:

A. Habitat Destruction and Modification
B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes (Not applicable)
C. Disease or Predation (Not applicable)
D. The Inadequacy of Existing Regulatory Mechanisms
E. Other Natural or Manmade Factors Affecting its Continued Existence

Delisting Criteria:

Criterion 1. The species has a 95% probability of persistence within the next 20 years based on data obtained from accepted standardized monitoring methods and on population viability analysis. In order to meet this criterion, the following must be verified:

1.a. There is a sufficient number and geographical distribution of element occurrences required to ensure long-term persistence.

1.b. Each element occurrence needed to ensure a 95% probability of persistence within the next 20 years must meet a minimum viable population size and exhibit an increasing or stable population trend over a 10-year period.

Criterion 2. Management plans have been developed and are being implemented to protect and manage the habitat associated with the element occurrences identified in Criterion 1.b.

Criterion 3. A plan to provide public outreach and education for dwarf lake iris has been developed and is being implemented.

Appendix 7. Summary of Comments on Draft Recovery Plan and U.S. Fish and Wildlife Service Responses

On May 30, 2012, the U.S. Fish and Wildlife Service (Service) released the Dwarf Lake Iris (*Iris lacustris)* Draft Recovery Plan (Draft Plan) for a 30-day review and comment period ending on June 29, 2012. Availability of the Draft Plan was announced in the Federal Register (77 FR 31869) and via a news release to media contacts throughout the species' U.S. range.

In accordance with Service policy, requests for peer review of the Draft Plan were sent to experts outside the Service. Requests for peer review were sent to the following individuals:

Dr. Gary Hannan, Eastern Michigan University, Ypsilanti, Michigan
Dr. James Van Kley, Stephen F. Austin State University, Nacogdoches, Texas

Three comment letters were received during the official comment period. Affiliations from which the comments came include two peer reviewers and one state agency.

Each correspondence contained one or more comments or questions, and some letters raised similar issues. Most letters requested explanation or clarification of points made in the plan and included suggestions for changes. Some commenters provided updated data on populations and their status. Adjustments within the text and to the appendices reflect those additional data. All comments received were considered and noted. The majority of comments received are summarized below, including significant comments that were not incorporated or that required further clarification.

All of the comments that the Service received on the Draft Plan are on file at the U.S. Fish and Wildlife Service, 2651 Coolidge Road, Suite 101, East Lansing, Michigan, 48823.

Comments with Service Responses

Part I. Introduction

- **Comment:** The plan does a rather good job of describing what is known about the reproduction, ecology and genetics of *Iris lacustris* and the potential threats to the species. It is reasonable and defensible based on what is currently known about this species from the scientific literature.

  Response: Comment acknowledged.

- **Comment:** The section about elaiosomes on page 1 is inconsistent with page 10. One says they *may* assist with ant dispersal, another says they *do*.

  Response: Page 1 states, "The fruits are rounded capsules about 1.2 cm long, bearing brown, oval seeds with a shiny white, coiling appendage that **may** function as an elaiosome (food body) to attract potential seed dispersers"; and Page 10 states, "Each seed possesses a conspicuous elaiosome (food body) that **may** attract ants" [emphases added]. We believe these statements are consistent and reflect the uncertainty whether the elaiosome attracts ants as seed dispersers.

- **Comment:** On some sites, particularly old, heavily shaded ones with well-developed soils (observe if there is a thick organic-rich mineral soil layer or A-horizon in addition to the organic surface layer), partial removal of overstory may provide the site with enough of a flush of both light and nutrients that it becomes rapidly overgrown with fast-growing nutrient-demanding pioneer species. Thus in certain cases, forest canopy disturbance may be detrimental to Iris rather than the more common helpful case. The Garden Island site appeared to potentially have this problem; soils were relatively rich and adjacent open areas were dense stands of Poa, Solidago, and other field species as along with young Populus.

  Response: We have added this information to page 18.

- **Comment:** One commenter indicated that demand for dwarf lake iris as a garden plant could increase if the public outreach portions of the plan meet with success. The commenter suggested that taking iris from wild populations could become a significant threat or the demand for commercial cultivation or trade could also increase in which case, a contingency plan should be in place.

  Response: Horticultural demand for dwarf lake iris has not become a threat since the plant was listed in 1988. Although we do not anticipate demand increasing, information to prevent this could be included in outreach materials.

- **Comment:** Some analogy for foot-candle numbers may make the information on light more easily understandable. Perhaps % canopy would work better.

  Response: This section does not discuss absolute number of foot-candles necessary for

dwarf lake iris. Rather, the discussion references Van Kley's work in which he found a correlation between light levels (which he measured in foot-candles) and the number of blooms. We believe this gives the reader an understanding of the point that dwarf lake iris produces fewer blooms in densely shaded areas. A conversion from foot-candles to percent canopy was not provided in Van Kley's publications.

- **Comment:** Is there any information on return interval of natural disturbances? Can we assume this is one of the reasons natural disturbances function differently than artificial disturbances? This is the key to successful management of Iris once sites are protected, and it has not been adequately addressed in the existing literature. For example: What types and magnitude of disturbances adjacent to existing Iris patches will create appropriate open habitat and facilitate colonization and what disturbances will merely damage existing ramets or create openings that rapidly become overgrown with weeds? These issues need to be the focus of a new wave of ecological literature-- the goal being development of very specific management/ habitat quality-improvement regimes that are appropriate for a specific type of site (for example on a shaded deep-litter site). Perhaps the recovery plan should emphasize these questions a bit more?

  Response: We agree with the commenter that disturbance is an important facet to understand in order to recover this species. We have added a discussion of natural processes, including disturbance, to the research section on page 22 and to recovery actions 2.2 and 6.1 to include this topic as part of experimental restoration as well as to identify it as a research need.

- **Comment:** Under "Reasons for Listing and Current Threats", we recommend separate sections for 1) Lack of awareness, and 2) Forest succession and invasive species rather than incorporating them in D and E.

  Response: In determining whether to list a species, the Service evaluates the role of five factors potentially affecting the species. These factors are: (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors affecting its continued existence. The reasons for listing must be addressed under these five categories.

  The final listing rule did not discuss lack of awareness as a threat to the species. Although this could be considered a manmade factor, the recovery plan discusses a lack of awareness of the dwarf lake iris' legal status as a protected species under factor D (see page 17). In addition, the final listing rule included natural successional processes as a threat under E, and we have continued that convention in the recovery plan. Although not identified as a threat at the time of listing, invasive species are now recognized to compete with dwarf lake iris, and we believe this threat most appropriately falls under factor E.

- **Comment:** The listing of threats in Appendix 6 does not follow with the treats as outlined on pages 14-18. We agree that lack of awareness and forest succession are the major threats,

but they were buried under D. and E. on pages 16 and 17. We suggest they be highlighted in the plan text as they are here, but with "Invasive Species" added to the "Forest Succession" threat. Lack of enforcement was not found among the threats.

Response: Invasive species and climate change were inadvertently left out of the appendix, and we have corrected that oversight. With those two exceptions, the threats listed in Appendix 6 are the same threats as discussed on pages 14-19. Lack of enforcement was included in the final listing rule and is discussed on page 17.

- **Comment:** Table 1 distribution of EO ranks for WI does not match their database. Correct numbers were attached in their spreadsheet.

  Response: We have corrected Table 1 and Appendix 2 with the information provided by the Wisconsin Department of Natural Resources.

- **Comment:** When the term, "open," is used to describe sites, open could describe canopy, shrub, amount of acreage available, etc. The term "open" needs more description.

  Response: Oftentimes, the term, "open," as used in the recovery plan, refers to the overhead canopy and relates to light levels. While the recovery plan does not provide a specific definition of "open", we believe the meaning is evident from the context in which the term is used in the plan.

- **Comment:** Information about polymorphism in inland populations on page 13 suggests that a component of management strategy could be that small groups of ramets from inland populations are transplanted into other populations in order to enhance local genetic diversity.

  Response: We have added this suggestion as experimental management under recovery action 2.2.

- **Comment:** We received several comments that habitat management is not adequately included in the recovery plan.

  Response: We have added a discussion of habitat management under "Conservation Measures" on page 21 to clarify its necessity for recovery of dwarf lake iris. However, we believe that habitat management is sufficiently recognized in the recovery strategy (recovery action #2, "Manage and Restore Habitat") and implementation schedule.

- **Comment:** We received two comments that the plan should consider invasive species, such as garlic mustard, in addition to orange hawkweed. One commenter also suggested that if invasive species were a problem, habitat or vegetation management would be a more efficient use of resources than further research.

  Response: We have added other invasive species that potentially compete with dwarf lake iris (see page 18) and have included invasive species control in recovery action 2.1.

However, we believe research into the effects of invasive species would inform management decisions and direct resources to the most effective and efficient habitat management.

- **Comment:** Do the prohibitions under Canadian law apply to both private and public land?

  Response: We have added clarifying language regarding the Canadian federal law and updated the discussion of protection under provincial law to reflect dwarf lake iris' current status in Ontario.

Part II. Recovery

- **Comment:** The discussion of threats on private lands should include mention of the many conservation easements and protection agreements that have been put into place over the last twenty years as well as the extensive past landowner and land manager awareness efforts. Many of these managers are still following their protection agreements.

  Response: We fully intended that future work would build upon any past efforts. We have added clarifying language on page 23 to acknowledge the protection measures already in place.

- **Comment:** It is important to consider that in Wisconsin many of the iris populations on private land are on properties that are considered second or vacation homes. Many are also rented out. Active management can be challenging when working with this type of property due to time constraints, and landowner ability. Local land trust play an important role in the conservation and permanent protection of sites especially in Door Co., and because they are a local non-governmental agency are often well-received by local landowners.

  Response: Comment acknowledged. This information will be important to consider as recovery actions from this plan are implemented.

- **Comment:** We received a comment that research should be a priority, and specifically that research on the development of appropriate vegetation management techniques to maintain the partially shaded habitat. Also, there needs to be a way to get a handle on the rate of successional changes in these habitats: How many years would one expect it to take for a high quality site to close in the absence of any disturbance? Years? Decades? Centuries?

  Response: We agree that research on habitat management techniques is necessary. Recovery action 2.2 that calls for experimental restoration sites would address this need. We have added successional change to recovery action 6.1 as well as to the research section on page 22.

- **Comment:** We also received several comments that further research was either not necessary or not a good use of resources. Specifically, comments suggested that there have already been several years of observations by several researchers on pollination, and more research is not necessary. Another comment stated that if invasive species are a problem, habitat or vegetation management will be a more efficient use of the resources, than further

research. Recovery does not require a great deal more research, it requires habitat management.

Response: We believe that continued research on the habitat requirements and biology and ecology of dwarf lake iris would inform management decisions and direct resources to the most effective recovery actions. We acknowledge that habitat management is critical and a higher priority than research. The recovery plan reflects this by ranking recovery action 2.1 (Develop and implement site management plans) as a Priority 1 activity and the research actions as Priority 2 activities.

- **Comment:** One commenter suggested adding the need for further research on seed dispersal by ants (as the previous study did not seem to come to applicable conclusions), and another commenter recommended adding seed dispersal as a separate recovery action.

  Response: We agree that further research into seed dispersal is necessary, and the recovery plan includes seed dispersal as a research topic under 6.3. We believe placement under 6.3, to determine whether seed dispersal is limiting sexual reproduction, is appropriate rather than under a separate recovery action.

- **Comment:** The "accepted standardized monitoring methods" should include one or more references.

  Response: The monitoring methods will be developed and standardized as the monitoring program is established and the population viability analysis is undertaken.

- **Comment:** The MVP for a clonal species will be difficult to determine since the number of genets is hard to ascertain. Plus, stochastic events, such as the 1988 drought, can skew single season monitoring data.

  Response: As we noted in the recovery plan, viability analyses are more difficult, but not impossible, for species with clonal growth habits. We agree that the quality of the data used in viability analyses is critical to the reliability of the results.

- **Comment:** The criteria appear to be science-driven and directly related to the known threats to this species.

  Response: Comment acknowledged.

- **Comment:** The goals and their priorities on pages 24-30 appear reasonable based on the science of this plant and its ecology.

  Response: Comment acknowledged.

- **Comment:** Extensive recovery actions are called for. Will this include reconstituting the recovery team?

Response: Any decisions related to the recovery team will be made separately from finalizing this recovery plan.

- **Comment:** Much of the work to identify landowners was done in Wisconsin and Michigan in the 1990s. This plan seems to ignore the extensive landowner contact work already done. It needs to acknowledge this work and call for updating records and reinitiating a landowner contact program. Landowner records would need to be updated.

  Response: We have added language on page 27 to indicate that landowner notification started in the 1990s and records may require updating. We have also identified this action as "continual" in the implementation schedule.

- **Comment:** Many of the plat maps are now online. How will this landowner identification and contact be done? Will section 6 funding again become available for this? Will it be through grants to the states?

  Response: Landowner information is not uniformly maintained within or among states. A landowner contact program should be developed and implemented as appropriate for each state or county. Development of this recovery plan does not include funding to implement the recovery actions.

- **Comment:** In Wisconsin, many of the privately owned sites are held by families for many generations with little turnover. In these cases, the contact will involve reminding them of past agreements, working with the younger generations of the families, and reacquainting them with the iris and its protection needs.

  Response: We encourage each state or municipality to implement landowner contacts in the most effective and efficient manner for its individual situation.

- **Comment:** Many public lands have master plans that may already or could include discussion of conservation of rare species. The recovery plan seems to ignore that much of the work for public lands protection has already been done and that such agreements are already in place for many public lands. The first step is to determine what is currently in place and reconnect with those agencies and reevaluate how the populations are being managed on their properties. Then additional agreements can be developed for those sites where they currently either do not exist or could be strengthened. In Wisconsin, some occurrences are on county, village and town lands, not only federal and state.

  Response: We have added language to page 27 to clarify that many agreements are already in place.

- **Comment:** Recovery action 1.5 (Comprehensive shoreline protection) seems to be calling for increased regulations and mandatory protections. Voluntary compliance and cooperative efforts with county and local planners and landowner groups will be much more effective in long-term conservation. The term "consultation" should not be used here unless it is referring to section 7 consultations.

Response: This action intends to encourage consideration of dwarf lake iris conservation in land-use planning decisions through coordination among local, state, and Federal agencies. This action does not call for any changes to regulations. We have changed "consultation" to "coordination" in order to avoid confusion with section 7 consultation or other regulatory phrases.

- **Comment:** As per Wisconsin laws that define "shorelines", most iris populations on the Wisconsin side are not within legally designated shorelines.

  Response: Comment acknowledged. Although not of use along shorelines in Wisconsin, integrating dwarf lake iris protection into land-use planning decisions in areas where dwarf lake iris occurs (regardless of proximity to shorelines) should be an effective conservation tool for this species.

- **Comment:** Recovery action 1.6 implies that there is an existing listing of sites recommended for acquisition. If such a list exists, it should at least be shared with the states and perhaps should be included as an appendix to this plan.

  Response: No sites have been identified for acquisition, and such a list does not exist to our knowledge. This recovery action states that acquisition will likely involve only a small number of sites.

- **Comment:** Recovery action 2.1 should include "…and implement site management plans". Implementing these plans is a critical component and needs to be added, along with the financial support that this will require. Someone (recovery team?) should develop criteria for providing funds for management. For most populations, vegetation management will not require much time or labor. It may be simplest to provide funding to the state to allow a crew to go around to populations every few years and conduct the necessary management. If this was agreed to in the landowner's protection agreements, it could be done very efficiently.

  Response: We did not intend that management plans would not be implemented once developed. Indeed, implementation of management plans is included in delisting criterion #2. For clarity, we have added "implementation" to 2.1. However, developing a recovery plan does not guarantee that funds will become available to implement any of the recovery actions.

- **Comment:** Section 2.1 should include assessing the role of trails and roads on individual properties to see where further management is needed.

  Response: Management plans should be site-specific and address the limiting factors, whether caused by trails and roads or other influences, particular to each site.

- **Comment:** In recovery action 2.2, why is habitat manipulation being suggested only on large healthy sites? If it is known that too much shade and competition from other native and from invasive species is limiting their growth, why isn't the focus on recovery? Small

populations disappear from overcrowding and shading. Recovery should be focused on restoring habitat conditions that keep the populations healthy. This should be the highest priority for this plan and funds should be set aside for assisting landowners and land managers with implementing habitat management plans.

Response: We agree that restoring and sustaining suitable habitat is critical to recovering this species. This recovery action addresses experimental restoration. Large populations are more appropriate for these experiments because they can likely withstand these manipulations better than small populations. We maintain that small populations should be managed with known or accepted methods, which may include those that are proven to work through the experimental process.

- **Comment:** Other than asking for protection from destruction, invasive species and excessive shade, can site management plans be realistic without 2.2 being completed?

  Response: New management methods may be identified through the experimental process. However, this should not prevent management of sites now with currently known and accepted methods.

- **Comment:** The statement under 2.3 that many populations are on public lands seems to conflict with Table 1 and the statement under "Current species status" in the Executive Summary.

  Response: Under recovery action 2.3, we have clarified the wording for the relative number of occurrences on public lands so that it does not appear to conflict with other statements in the recovery plan.

- **Comment:** Recovery action 3.1 does not include procedures for determining population size.

  Response: These procedures will be developed as part of implementing recovery actions 3.1 (Inventory current sites and habitat conditions) and 4.1 (Develop a population viability analysis (PVA) suitable for the dwarf lake iris).

- **Comment:** This plan should provide some indication as to what type of monitoring should be done, how frequently, methods used, how data will be shared and analyzed, etc.

  Response: Monitoring methodologies, frequencies, etc. are dependent upon the objective of the monitoring. For example, the monitoring plan for an experimental restoration site may differ from the monitoring plan to track status or condition of known sites. These objectives and appropriate methodologies will be developed during the establishment of a monitoring program (recovery action 3.3).

- **Comment:** Under recovery action 3, standard element occurrence ranking criteria should include Wisconsin and Ontario.

Response: We have changed the wording to indicate the use of appropriate ranking criteria.

- **Comment:** Recovery action 5.1 (Develop educational materials) states that "the key to iris survival is the development of educational materials". We believe the key is the proper use of those materials and of direct person-to-person contact explaining the uniqueness of the plant and the habitat and the landowner's role in conservation.

  Response: The narrative under 5.1 states, "The key to the survival of dwarf lake iris lies in developing educational materials for use in raising public awareness and appreciation for the unique and fragile nature of Great Lakes' shoreline communities and the plants and animals that occur in them." We agree that development of education materials itself is not the key but rather a means to achieve public awareness and appreciation. We have reworded this section to clarify that.

- **Comment:** Education was high during the 1990s when there was section 6 funding for landowner contact. Other than the digital media, most of the educational materials and programs are developed, but need funding to contact landowners and public land managers. A video that includes the identification and conservation needs of the iris will be useful.

  Response: In the Recovery Narrative, we recognize that Wisconsin and Michigan have developed some educational tools, and we certainly encourage the use of any current materials. Implementing this recovery action should include evaluating available resources and identifying additional needs.

- **Comment:** Wisconsin does not have a specific brochure on dwarf lake iris. We have a wildcard and several publications that refer to the iris and include photos of it.

  Response: We have corrected this statement.

- **Comment:** Under recovery action 5.3, getting local units of government, developers, utilities and others to become aware of a rare plant and committed enough to do something to conserve it requires more than providing educational materials. It requires communicating with them, sometimes repeatedly. It requires working with them to resolve conflicts and develop creative solutions that can help conserve the plants while allowing their activities to continue. This will require a fair amount of work. Populations and target audiences should be prioritized.

  Response: We agree with the commenter that coordination with these groups will require more than providing education materials. We have adjusted this action to reflect the need for more frequent and direct communication with these entities.

- **Comment:** The plan does not explain what ecological information regarding habitat requirements is still needed. The basic limitations are already known. Recovery action 6.1 should include mention of experimental habitat manipulation.

  Response: The recovery plan identifies pollination biology, management techniques,

invasive species, and climate change as limiting factors that require more research. We have clarified recovery action 6.1 to address the interactions among habitat requirements, invasive species, and successional change to inform management strategies. We agree that experimental habitat manipulation is necessary, but this is covered under recovery action 2.2.

- **Comment:** As shown on pages 11-14, extensive genetic work has already been done and shows that the bottleneck likely occurred post-glaciation, 16,000 years ago. Why is more research on this (recovery action 6.3) needed?

  Response: Recovery action 6.3 calls for research into the factors that may limit or inhibit successful sexual reproduction—pollination, seed dispersal, and seedling establishment. We maintain that a better understanding of these limiting factors and their influence on dwarf lake iris populations is necessary in order to address these potential threats and achieve full recovery.

- **Comment:** Perhaps exploration of potential suitable habitat (and experimental introductions) north of the current range along Lake Superior may be used to address the global warming aspects of the threats to dwarf lake iris.

  Response: We have added this suggestion as experimental management under recovery action 2.2.

Part III. Implementation

- **Comment:** Towns, cities, and villages, First Nations, and Ontario should be added to the implementation schedule.

  Response: Although towns, cities, and villages were not excluded from the implementation schedule, we have added them as examples of entities included under "LG". Because Ontario has removed dwarf lake iris from protection under their Endangered Species Act of 2007 and COSEWIC has revised the species' status to special concern, dwarf lake iris appears secure in Canada. Based on this, we have not added any federal or provincial agencies, First Nations, or other entities in Canada to the implementation schedule.

- **Comment:** We received several comments about the estimated costs in the implementation schedule. Most comments indicated that the costs were underestimated; however, one comment suggested that funding for research was too high and the funding priority should be on landowner and land manager contact and vegetation management.

  Response: Based upon additional feedback from commenters, we have adjusted the cost estimates in the implementation schedule. We maintain that continued research is necessary to inform management decisions. We have estimated the cost of research activities as accurately as possible. The recovery plan identifies management and landowner contact programs as Priority 1 activities while research actions are Priority 2 activities.

- **Comment:** If the goal of the recovery plan is to ensure long-term persistence of a number of populations, the focus of recovery should be to manage those populations in ways to improve the health and reproduction of the populations. A significant amount should be set aside for vegetation control to minimize shading, crowding and competition for water. This could be put into a program such as a Landowner Incentive Program or some other program where landowners and land managers can apply for funds.

  Response: Comment acknowledged. We agree that management is a high priority to recover dwarf lake iris; however, finalizing the recovery plan does not guarantee that funds for any recovery actions will become available. This type of funding structure could be considered when those recovery actions are implemented.

- **Comment:** Why is Wisconsin left out of the development of PVA and MVP size? These are the only tasks Wisconsin was not included on and it is critical that organizations representing the full range of the plant are included in this. Selected university members should also be involved in this.

  Response: We regret this oversight and have added the Wisconsin and Michigan Departments of Natural Resources to 4.1 in the implementation schedule. The implementation schedule already included research institutions under this recovery action.

Appendices

- **Comment:** The Garden Island population (Indian Harbor) in Charlevoix County, Michigan and the Mast Point population in Presque Isle County, Michigan are not included in the list of occurrences.

  Response: The Michigan Natural Features Inventory (MNFI) has updated their database with the Garden Island occurrence, which we have added to the table in Appendix 1. We will continue to coordinate with the commenter and MNFI to get documentation of the Mast Point occurrence.

- **Comment:** A spreadsheet was provided with updated information on Wisconsin's element occurrences. Wisconsin EO#039 is not High Cliff State Park. It is a privately owned development. The comments field for EO#40 mentions "10 ramets and 775 genets." This is likely backwards as one genet contains many ramets.

  Response: We have updated the table in Appendix 2 with this information and corrected EO #39. Upon consultation with WDNR, the statement in the comments field for EO #40 accurately reflects what is currently in the Wisconsin database. We have not made any changes to this occurrence in Appendix 2 at this time.

- **Comment:** Terminology in the comments fields in Appendices 1 – 3 is inconsistent. It seems to use population, colony, patch, clone, cluster, and genet interchangeably. Stems, shoots, plants, and ramets are also used interchangeably.

Response: We used the terminology as provided to us by the respective databases. We did not edit or alter any terms in these databases.

- **Comment:** Add "Genet", "EO Ranks", "Extant", "Historical", and "Unknown" to the glossary (Appendix 4).

  Response: We have added "extant", "element occurrence", and "genet" to the glossary and "EO" to the list of acronyms in Appendix 4. "Historical" has a specific meaning in terms of element occurrence rankings and is defined in Appendix 5. We believe "Unknown" is self-explanatory.

- **Comment:** Wisconsin's EO Ranking Criteria is very similar to the MNFI criteria and should be mentioned in Appendix 5.

  Response: Species-specific ranking criteria, or element global rank (EGR) standards, have not been finalized yet for dwarf lake iris. Our understanding is that Wisconsin and Michigan use more generic ranking criteria at this time until EGRs are developed and implemented. Based upon this understanding, we have changed the title of Appendix 5 to "Element Occurrence Ranking Criteria" to reflect the more generic nature of the criteria currently applied to dwarf lake iris occurrences.