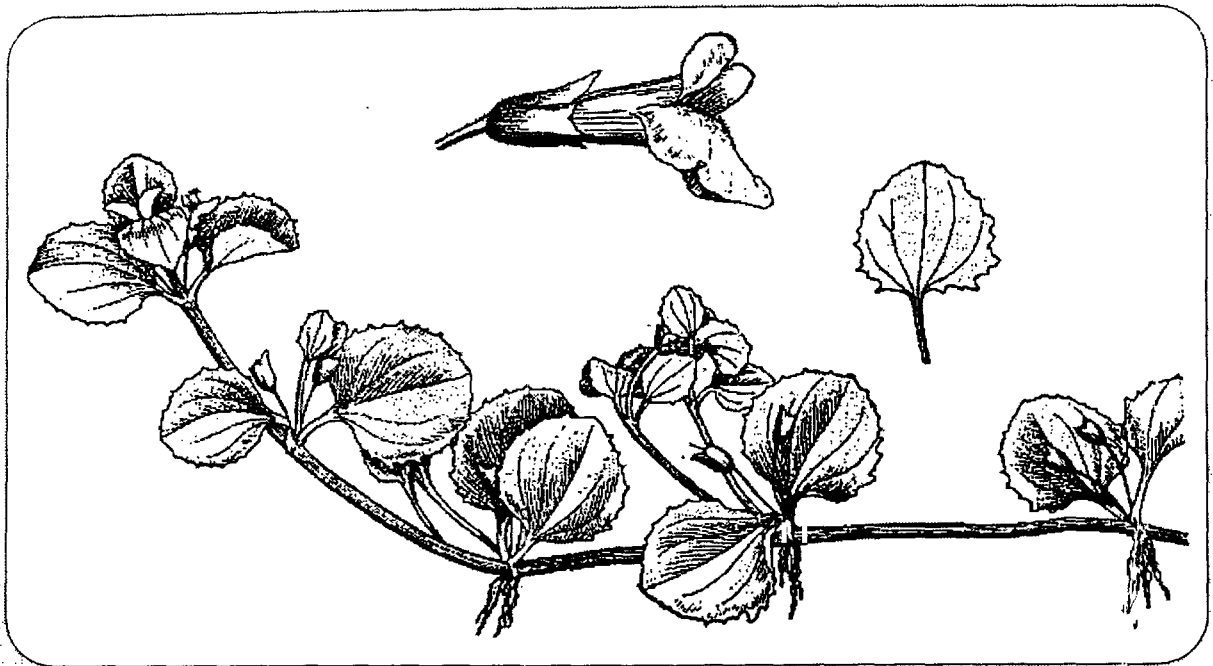


Michigan Monkey-flower

Mimulus glabratus var. *michiganensis*

Recovery Plan



U.S. Department of the Interior
Fish and Wildlife Service



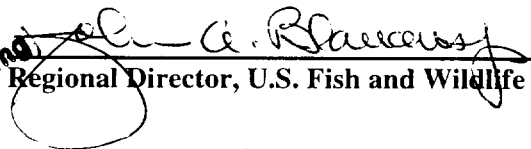
RECOVERY PLAN FOR MICHIGAN MONKEY-FLOWER
(*MIMULUS GLABRATUS* VAR. *MICHIGANENSIS*)

Prepared by

Michael R. Penskar
Michigan Natural Features Inventory
8th Floor Mason Bldg., P.O. Box 30444
Lansing, Mich. 48909-7944

for
Region 3
U.S. Fish and Wildlife Service
Ft. Snelling, Minnesota

Approved:

Acting 
Regional Director, U.S. Fish and Wildlife Service

Date:

9/17/97

EXECUTIVE SUMMARY

Current Status: *Mimulus glabratus* var. *michiganensis* (Michigan monkey-flower), listed as endangered by the Federal government and the State of Michigan, is an Upper Great Lakes endemic known only from 15 extant occurrences in northern Michigan. Twelve occurrences are currently considered viable. Two of the highest quality occurrences are on public land. Few of the remaining occurrences have protection measures in place beyond State and Federal laws. Due to the clonal growth habit and an apparent reliance on dispersal through fragmentation, the number of genetic individuals within colonies and populations is unknown and cannot be reliably estimated.

Habitat Requirements and Limiting Factors: Biological limitations include an extremely low degree of fertility, strict habitat specificity, and a poor capacity for long-range dispersal. With the exception of a single occurrence, sexual reproduction is negligible. Reproduction is almost entirely vegetative in nature, and dispersal is achieved primarily through the fragmentation of clonal colonies. Direct habitat destruction has probably eliminated some colonies at both inland and Great Lakes shoreline sites. Hydrological disruptions within or near the taxon's fragile habitat, particularly those that modify water flow or result in a warming of the substrate, constitute a primary threat to this taxon's long-term survival. A lack of formal contact with private landowners unaware of colonies present on their property also constitutes a major threat to survival.

Recovery Objective: Reclassification to threatened, followed by delisting.

Recovery Criteria: *M. glabratus* var. *michiganensis* will be considered for reclassification from endangered to threatened status when protection is secured for all eight occurrences ranked "A" or "B" (Excellent Occurrence and Good Occurrence, respectively, according to Michigan Natural Features Inventory of The Nature Conservancy ranking criteria). *M. glabratus* var. *michiganensis* will be considered for delisting when protection is secured for all 15 known occurrences. Protection is defined as the collective actions necessary to conserve known occurrences, maintain ecosystem process for the perpetuation of essential habitat, and enable each occurrence to be naturally self-sustaining. New colonies discovered subsequent to the approval of the Recovery Plan, and considered to be viable or restorable, must also be protected in order for delisting to be considered.

Tasks Needed:

1. Establish long-term protection for all known occurrences, with emphasis on the protection of essential habitat and education of land managers and the public through outreach.
2. Determine the specific extent and status of all known and historically documented sites, and conduct inventories in potential areas to identify new occurrences.
3. Conduct biosystematic research to determine the most appropriate taxonomic classification.
4. Conduct demographic, physiological, breeding system, and genetic studies to understand population biology, specific habitat requirements, floral biology, and genetic variability.

Estimated cost of recovery for FY 1998-2008 (in \$1000's): details are found in the Implementation Schedule.

<u>Year</u>	<u>Task 1</u>	<u>Task 2</u>	<u>Task 3</u>	<u>Task 4</u>	<u>Total</u>
1998	45	5	10	25	85
1999	44	5	10	20	79
2000	43	5	5	20	73
2001	10	3	0	10	23
2002	9	2	0	5	16
2003	6	0	0	5	11
2004	6	0	0	2	8
2005	5	0	0	2	7
2006	4	0	0	2	6
2007	2	0	0	2	4
2008	2	0	0	2	4
Total	176	20	25	95	316

Date of Recovery: If recovery criteria are adequately met, reclassification to threatened can be considered in 2001, delisting can be considered in 2004.

DISCLAIMER

Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect listed species. Plans published by the U.S. Fish and Wildlife Service are sometimes prepared with the assistance of recovery teams, contractors, state agencies, and others. Recovery teams serve as independent advisors to the Service. Plans are reviewed by the public and submitted to additional peer review before they are adopted by the Service. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not obligate other parties to undertake specific tasks and may not represent the views or the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service **only** after they have been signed by the Regional Director or Director as **approved**. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks. By approving this document, the Regional Director certifies that the data used in its development represents the best scientific and commercial data available at the time it was written. Copies of all documents reviewed in development of the plan are available in the administrative record, located at the East Lansing Field Office.

Literature Citation should read as follows:

U.S. Fish and Wildlife Service. 1997. Recovery Plan for Michigan monkey-flower (*Mimulus glabratus* var. *michiganensis*). Ft. Snelling, Minnesota. vii+ 37 pp.

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ACKNOWLEDGEMENTS

Preparation of the Recovery Plan (Plan) was completed by Mr. Michael Penskar, Program Botanist, Michigan Natural Features Inventory of The Nature Conservancy. The Plan was enhanced considerably through the careful editing, expertise, and suggestions of the following individuals, whose assistance is gratefully acknowledged: Dr. Leni A. Wilsman, Michigan Natural Features Inventory, Lansing; Dr. Edward G. Voss, University of Michigan Herbarium, Ann Arbor; Ms. Mary Harding, Michigan Department of Natural Resources, Wildlife Division, Lansing; Mr. Robert Jones, naturalist, Glen Arbor, MI and Ms. Elaine Chittenden, Collections Manager, Beal Gardens, Michigan State University. Special thanks must be given to Mr. William Harrison, U.S. Fish and Wildlife Service (Service) Region 3 office, who guided this recovery plan through several phases of preparation and kindly provided help in every way. Additional editing was provided by Ms. Zella Ellshof of the Service's Region 3 office. Final editing and wordprocessing on the plan were completed by Mr. Michael E. DeCapita, Mr. Mark Hodgkins and Ms. Sally Hopp of the Service, East Lansing, Michigan, Field Office. Extensive research by Dr. Robert K. Vickery, Jr., University of Utah, and investigations by Sandra Beadle and Margaret Bliss during their graduate studies at the University of Michigan have greatly enhanced our knowledge of the *Mimulus glabratus* complex. The cover and figure illustration of *Mimulus glabratus* (*sensu lato*) is from *The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada* (Volume 3, page 214, by H. A. Gleason, Copyright 1952), reprinted with permission from the New York Botanical Garden.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	ii
DISCLAIMER	iv
ACKNOWLEDGEMENTS	v
TABLE OF CONTENTS	vi
I. INTRODUCTION	1
A. Background and Description	1
B. Taxonomy and Origin	3
C. Distribution	5
D. Habitat	10
E. Biology	14
F. Threats and Limiting Factors	15
G. Conservation Measures	15
H. Strategy of Recovery	18
II. RECOVERY	18
A. Objective and Criteria	18
B. Step-down Outline	19
C. Narrative Outline for Recovery Actions	20
D. Literature Cited	27
III. IMPLEMENTATION SCHEDULE	30
A. Key to Implementation Schedule Column 1	30
B. Key to Agency Designations in Columns 6 and 7	30
C. Implementation Schedule	31
IV. APPENDICES	33

RES

ensis (Pennell) Fassett (Michigan 2

..... 2

..... 6

us var. michiganensis (Michigan 7

..... 7

ES

lus glabratus var. michiganensis 8

..... 8

ociated with *Mimulus glabratus* var. 12

..... 12

ICES

s of *Mimulus glabratus* var. *jamesii*, *M.* 34

..... 34

occurrence ranking criteria 35

..... 35

he protection of *Mimulus glabratus* var. 36

..... 36

..... 37

..... 37

I. INTRODUCTION

A. Background and Description

Mimulus glabratus var. *michiganensis* (Pennell) Fassett, (Michigan monkey-flower), a member of the Scrophulariaceae (snapdragon family), is an endemic variety of a widespread and diverse complex of yellow monkey-flowers. The taxon is known from only 15 extant occurrences and is distributed principally within Michigan's Mackinac Straits region in Charlevoix, Cheboygan, Emmet, and Mackinac Counties, with outlying localities to the south in Benzie and Leelanau Counties. It is restricted to cool, alkaline springs and streams usually associated with *Thuja occidentalis* (Northern white-cedar) swamps along current and post-glacial Great Lakes shorelines.

Based on a specimen collected in Cheboygan County by J. H. Ehlers in 1925, Francis W. Pennell (1935) described the taxon and named it *Mimulus glabratus* ssp. *michiganensis*. Norman C. Fassett (1939) subsequently gave the taxon varietal status. Some researchers noted morphological overlap with other taxa, particularly the more common, wide-ranging *Mimulus glabratus* var. *jamesii* (James' monkey-flower) (Crispin 1981; Bliss 1983, 1986), but results from studies of floral characters of closely related taxa support maintaining var. *michiganensis* as a distinct taxonomic entity (Bliss 1983, 1986; Minc 1989) (See Appendix A). *Mimulus glabratus* var. *michiganensis* was proposed for listing as an endangered species in 1989 (U.S. Dept. of Interior 1989) and listed in 1990 (U.S. Dept. of Interior 1990) following a status survey (Crispin and Penskar 1989). The taxon is also listed as endangered by the State of Michigan (MDNR 1991). As a taxon with a moderate degree of threat, a high recovery potential, and possible conflicts with recreational activities, construction or other development projects, *M. glabratus* var. *michiganensis* has a Federal recovery priority of 9C¹.

Mimulus glabratus var. *michiganensis* is an aquatic to semi-aquatic perennial plant characterized by its mat-forming, clonal growth habit. The stems, which range to about 40 cm (15.7 in) or more in length, are lax and reclining at their base, rooting freely at lower leaf nodes (Figure 1) to produce numerous additional shoots via stolons. Propagation in this manner often results in the production of clones of up to several hundred stems or more. The broadly ovate to roundish, opposite leaves are inconspicuously to coarsely sharp-toothed and have leafstalks that are usually shorter than the blades. Upward the leaves become somewhat reduced and shorter-stalked. Bright yellow, snapdragon-like, tubular flowers are produced from the upper leaf axils, borne on slender pedicels that may be longer than the leaves. Flowering occurs primarily from approximately mid-June to August, extending occasionally into October. The two-lipped flowers range from 16-27 mm (0.6-1.1 in) in length and have an irregularly red-spotted lower lip and tube. The three-lobed, heavily-bearded lower lip forms a wide landing platform for insect

¹ Federal Priority Numbers from 1 to 18 are assigned to each species at the time of its listing. They are based upon "Endangered and Threatened Species Listing and Recovery Priority Guidelines" that were published by the U.S. Fish and Wildlife Service in 1983 (48 Federal Register 43098, September 21, 1983). These criteria deal with degree and immediacy of threat, recovery potential, taxonomic uniqueness, and conflict with development activities. The Federal Priority Number 9 denotes a moderate degree of threat, a high recovery potential, and that the species will not face extinction if recovery is temporarily held off, although there is continual population decline or threat to its habitat. The "C" designation denotes that the species is, or may be, in conflict with construction or other development projects or other forms of economic activity.

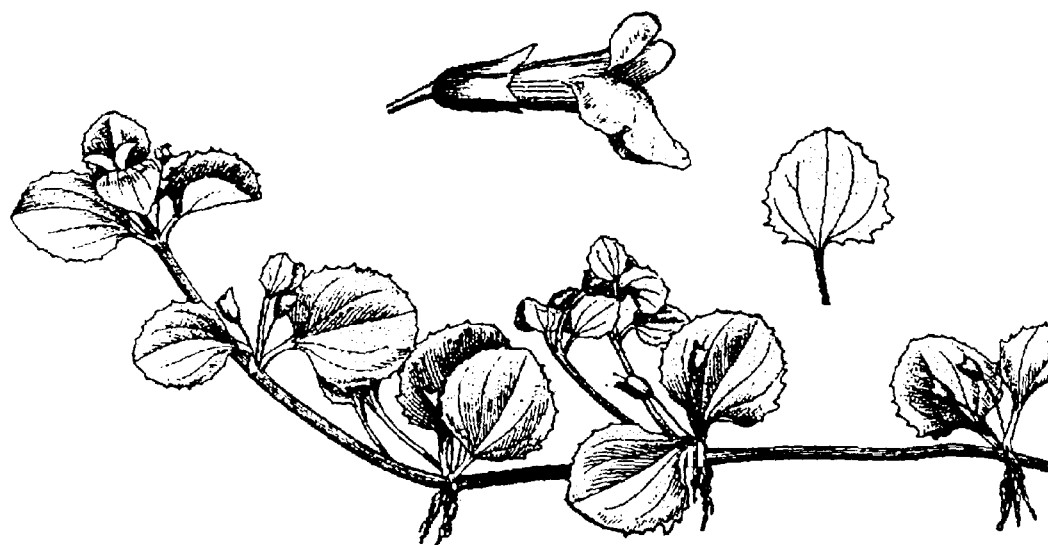


Figure 1. Illustration of *Mimulus glabratus* (sensu lato). Copyright 1952, The New York Botanical Garden.

pollinators; the upper lip bears two upright lobes. The fruit, which is seldom produced, consists of an oblong, pointed capsule ca. 8-10 mm (0.3-0.4 in) long, containing numerous oval seeds with longitudinal striations (Grant 1924).

Mimulus glabratus var. *michiganensis* is most likely to be confused with the more common, wide-ranging *Mimulus glabratus* var. *jamesii* (James' monkey-flower, previously known [Voss 1996] as *M. glabratus* var. *fremontii*), which can often be distinguished by its usually smaller flowers that range from 8-18 mm (0.3-0.7 in) in length. Despite some overlap in flower size between these varieties (see Appendix A), the consistently different style and pistil lengths (ca. 2.8-4.6 mm (0.1-0.2 in) and 6.3-9.3 mm (0.25-0.37 in), respectively, in *M. glabratus* var. *jamesii* versus 8.1-9.1 mm (0.32-0.35 in) and 15.4-17.8 mm (0.6-0.7 in), respectively, in *M. glabratus* var. *michiganensis*) can be used to most reliably separate them, as noted by Bliss (1983, 1986). Spots on the corolla of *M. glabratus* var. *jamesii* are usually only on the tube. Vegetative characters of the two varieties have considerable overlap and cannot be used dependably to distinguish them. The leaves of *M. glabratus* var. *jamesii* are usually smaller, have shorter stalks, and are less conspicuously toothed. *Mimulus guttatus* DC (common monkey-flower), a predominantly western species which is found at a single Michigan locality in the western Upper Peninsula, also has some size overlap with *M. glabratus* var. *michiganensis*. *Mimulus guttatus*, however, is a more erect, stouter plant with much larger flowers that may range from 16-45 mm (0.6-1.8 in) long (Minc 1989). Additional distinguishing floral characters include larger, better developed calyx lobes, a wider corolla, and a more strongly spotted throat and floral tube.

B. Taxonomy and Origin

Mimulus, a large, highly variable (*i.e.*, polymorphic) genus of as many as 150 species (Pennell 1951), was placed in the section *Simiolus* (within the tribe Gratiolieae) by Grant (1924), who considered *Mimulus glabratus* and its varieties to be the most widely distributed group in the genus. *Mimulus glabratus* is found from Quebec to Saskatchewan, ranging south through Mexico and southern Chile, and seven varieties of the species have been named (Grant 1924; Pennell 1935; Fassett 1939; Skottsberg 1953). The varieties represent diploid as well as several polyploid races, which are strongly correlated with well documented geographical, morphological, and other differences, such as allozyme patterns and cytogenetic characteristics (Vickery 1990).

Pennell (1935) recognized *M. glabratus* var. *michiganensis* as a subspecies of *M. glabratus* based on its larger, "unspotted corollas", the more conspicuously toothed, sinuate-dentate leaves, and a more erect growth habit. The type specimen was collected from the banks of Niger Creek "near Topinabee," Cheboygan County, in July 1925 (*J. H. Ehlers 3240*, MICH). Specimens correctly identified as *M. glabratus* var. *michiganensis* were also previously collected near Harbor Springs, Emmet County (*C. F. Wheeler July 12, 1890*, MSC; *M. Irwin*, July 1892, MSC).

Fassett (1939), who gave *M. glabratus* var. *michiganensis* varietal status, essentially agreed with Pennell's description, though he correctly noted in the field that the corolla tube and

throat were usually spotted². Some researchers have subsequently questioned the validity of recognizing *M. glabratus* var. *michiganensis* as a distinct taxon, based on observations of what appeared to be a continuum of morphological diversity with the more common *M. glabratus* var. *jamesii* (Crispin 1981; Crispin and Penskar 1989; Bliss 1983, 1986). In one study, Bliss (1986) examined the morphology, fertility, and chromosomes of *M. glabratus* var. *jamesii* and *M. glabratus* var. *michiganensis* to determine their genetic and morphological distinctiveness. Because of significant morphological differences in their flowers and differences in the percentage of viable pollen produced, Bliss determined that the varieties are genetically different and thus are valid taxonomic entities. Although the origin of *M. glabratus* var. *michiganensis* could not be deduced from the study, Bliss formulated three plausible hypotheses:

1) *Mimulus glabratus* var. *michiganensis* (n = 14, 15) may have originated from *M. glabratus* var. *jamesii* (n = 15) through chromosomal rearrangements, possibly through chromosome breakage and rearrangements of the genome as postulated by Lewis (1958). The numerous cytological abnormalities cited by Tai and Vickery (1970, 1972) and Vickery (1978) for the *M. glabratus* complex corroborate the possibility of this origin.

2) *Mimulus glabratus* var. *michiganensis* may have originated as the result of hybridization between *M. glabratus* var. *jamesii* and *M. guttatus* (n = 14), the latter a western species discovered in Upper Michigan since Bliss' study. The morphological intermediacy of *M. glabratus* var. *michiganensis* strongly suggests this possible relationship.

3) *Mimulus glabratus* var. *michiganensis* may have originated as an aneuploid³ of *M. guttatus*, a species considered by Grant (1924) to be the most variable in the genus. Vickery et al. (1968) found aneuploid pollen in *M. guttatus*, and Vickery (1959) notes that populations with reduced seed set, a characteristic of *M. glabratus* var. *michiganensis*, commonly produce aneuploid pollen.

Bliss (1986) stated that it would not be possible to determine the origin of *M. glabratus* var. *michiganensis* without a comparative analysis with *M. guttatus*. The discovery of a presumed native occurrence of *M. guttatus* in the western Upper Peninsula, a region where other western disjuncts are well known, provided an opportunity to initiate such an investigation. Michigan Natural Features Inventory (MNFI) conducted a morphological study that compared *M. guttatus* with *M. glabratus* var. *jamesii* and *M. glabratus* var. *michiganensis* by using the only available Michigan specimens of *M. guttatus* augmented with additional live specimens of *M. guttatus* from Utah. Minc (1989) analyzed floral⁴ morphological data of four sample populations of *M. glabratus* var. *jamesii*, four populations of *M. glabratus* var. *michiganensis*, and two populations of *M. guttatus* (see Appendix A for a summary of these data). When used in a

² As Bliss (1983) observed during her research, corolla spots tend to fade on herbarium specimens, which likely led to Pennell's incorrect observation.

³ Aneuploid refers to a chromosome count that is higher or lower by one or more chromosomes, as compared to the normal haploid number; the extra or lost chromosomes occur as a result of cytological irregularities.

⁴ Because Bliss (1983, 1986) found floral characteristics to be more diagnostic and less variable than vegetative ones, only floral characters were analyzed in this study.

canonical discriminant analysis, the data revealed a strong separation of the three taxa (Figure 2), indicating the substantial differences in floral morphology between these taxa. Although most of the mean values for floral characters in *M. guttatus* differed significantly from those of *M. glabratus* var. *michiganensis*, the range of variation for most floral characters overlapped with *M. glabratus* var. *michiganensis*, likely indicating the polymorphism of *M. guttatus*.

Vickery (1991) provided evidence which documents the genetic isolation and morphological distinctiveness of *M. glabratus* var. *michiganensis*. In reciprocal crossing experiments, plants from Michigan's Maple River site, the only population known to regularly produce seed, were hybridized with plants representative of other diploid *M. glabratus* flower varieties known to be at least partially interfertile. Because of the failure to produce F₁ hybrids among 10 interpopulation crosses, Vickery concluded that *M. glabratus* var. *michiganensis* is genetically as well as morphologically distinct, and should be promoted to full species status, pending corroboration of these results with other *M. glabratus* var. *michiganensis* populations.

These studies confirm that *M. glabratus* var. *michiganensis* is a legitimate taxonomic entity, possibly worthy of recognition as a distinct species. This research also demonstrates that further investigation is required to elucidate the taxon's origin and systematic relationships. Biosystematic research involving isozyme analyses and possibly chloroplast or ribosomal DNA studies, in conjunction with natural history studies, may provide the information needed.

C. Distribution

Mimulus glabratus var. *michiganensis* is known only from 15 extant occurrences in northern Michigan, ranging from Benzie and Leelanau Counties in northwestern Lower Michigan to Mackinac County in the eastern Upper Peninsula (Figure 3). Two additional occurrences are known from historical records. The majority of occurrences are clustered within the Mackinac Straits region. Because of the particular difficulty in ascertaining, in meaningful biological terms, precisely what constitutes a "population", MNFI's definition of "occurrences" for *M. glabratus* var. *michiganensis* will be used. An occurrence consist of colonies of plants in contiguous to semi-contiguous habitat within arbitrarily defined areas; several occurrences could thus appropriately be considered what are termed "metapopulations"⁵.

Of the three best occurrences of *M. glabratus* var. *michiganensis* (Table 1), McFarlane Woods is largely contained within Sleeping Bear National Lakeshore, and Carp Creek (essentially the western region of Reeses Swamp) is contained within University of Michigan Biological Station (UMBS) property, with the latter occurrence located within designated Biosphere Reserve lands. Colonies within the locality named Reeses Swamp (essentially the eastern region of this extensive cedar swamp) lie primarily on private lands, with some colonies occurring on adjoining UMBS property (See Appendix B for an explanation of MNFI occurrence ranking criteria). A portion of a significant *M. glabratus* var. *michiganensis* occurrence at Epoufette Bay is protected within a Michigan Nature Association (MNA) preserve. The remainder, and perhaps the majority of the population, occurs on township and private land.

⁵ A metapopulation can be defined as a patchwork of interacting populations (*i.e.* sub-populations) over a wide and heterogeneous area of landscape (Sandland et al. 1992).

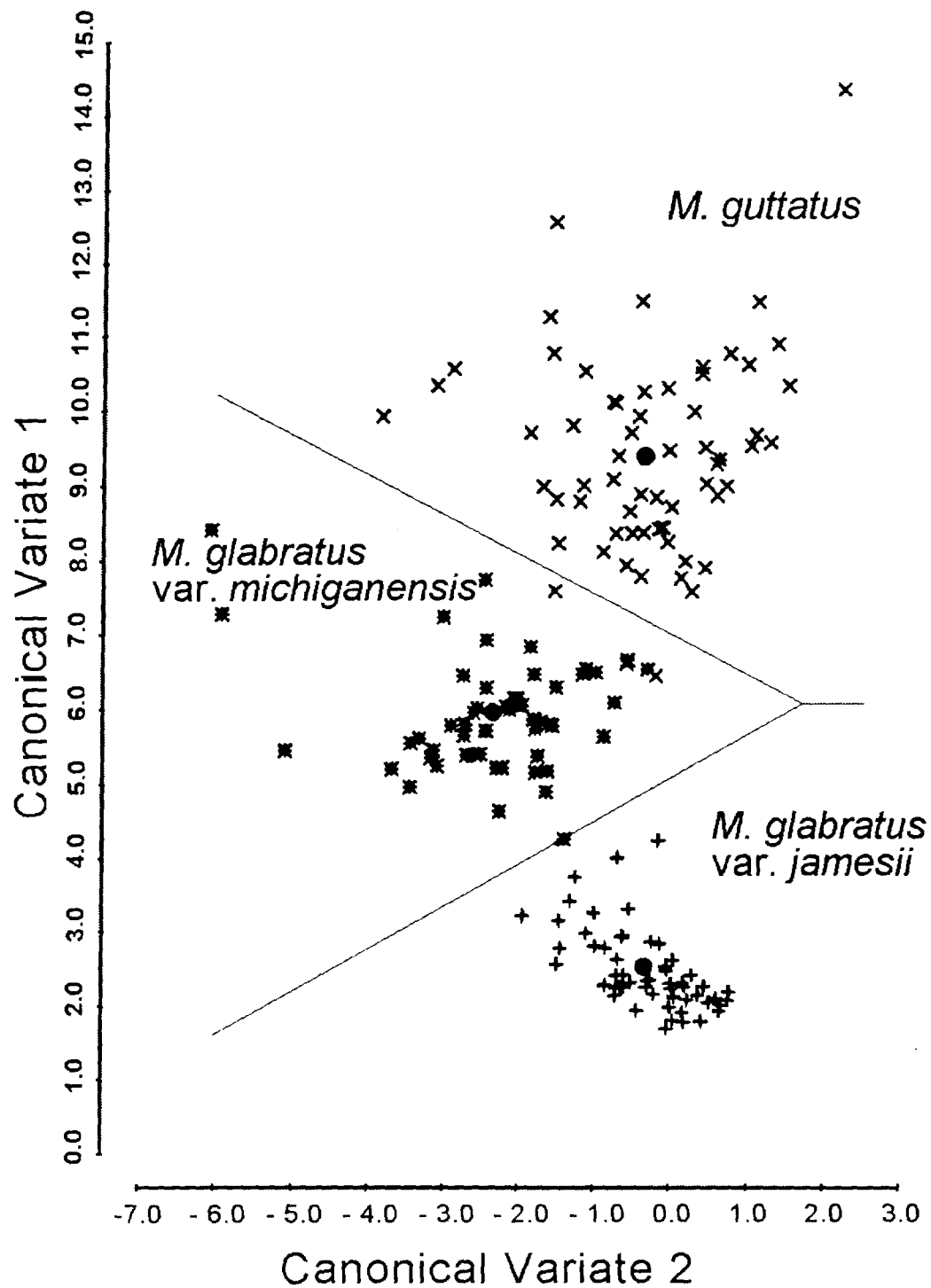


Figure 2.

Plot of canonical variates based on discriminant analysis of floral measurements of three of Michigan's *Mimulus* taxa (Minc 1989).



Figure 3. The rangewide distribution of *Mimulus glaberratus* var. *michiganensis* (Michigan monkey-flower). Closed circles indicate extant occurrences and open circles indicate documented historical occurrences.

Table 1. The range-wide¹ distribution and status of *Mimulus glabratus* var. *michiganensis* (Michigan monkey-flower), arranged by county and element occurrence (EO)² rank.

OCCURRENCE NUMBER	COUNTY	SITE NAME	OWNER(S)	EO RANK	LAST OBSERVED	ABUNDANCE AND STATUS
010	Benzie	Platte River	multiple/private	BC	1990	Widely scattered in small clumps.
008	Charlevoix	Beaver Island Harbor	private	B	1989	Very local. Several clumps in a beach pool and a swamp.
013	Charlevoix	Little Sand Bay	private	B	1989	Plants in scattered, moderate-sized clumps along a stream.
001	Cheboygan	Carp Creek	University of Michigan	A	1990	Numerous clumps widely scattered along the creek in high quality habitat.
003	Cheboygan	Reese's Swamp	multiple private; Univ of Michigan	A	1990	Locally abundant. Numerous large clumps scattered in northern white cedar swamp.
006	Cheboygan	Parrott Point (Mullett Lake SE)	private	D	1989	Scanty colony in a small spring-fed stream in a lawn area.
002	Cheboygan	Burt Lake - West Shore		H ³	1933	Known only from a dried specimen. Good, habitat but no plants found in area searches.
004	Cheboygan	Mullett Lake - West Shore (type locality)		H	1925	Potential habitat found in recent searches.
017	Cheboygan	Burt Lake Southeast	Nature Preserve, multiple private	C	1995	Scattered, localized clumps along lakeshore.
005	Emmet	Maple River	private	B	1989	Locally abundant at this TNC Registry site. Vigorous plants, some are fertile. Habitat slightly disturbed.

Table 1 (continued). The range-wide distribution and status of *Mimulus glabratus* var. *michiganensis* (Michigan monkey-flower), arranged by county and element occurrence (EO) rank.

OCCURRENCE NUMBER	COUNTY	SITE NAME	OWNER(S)	EO RANK	LAST OBSERVED	ABUNDANCE AND STATUS
016	Emmet	Harbor Springs	Idylwilde Association - multiple private	BC	1997	Rediscovered 1 large, 2 small colonies in seeps below bluff near houses. Previously not seen since 1892.
015	Leelanau	McFarlane Woods	National Park Service	A	1989	Abundant along a lakeshore at edge of northern white cedar swamp.
007	Leelanau	Burdickville	multiple private	BC	1990	Scattered colonies persist in springs and seeps. Locally abundant in at least one stream within a residential area.
012	Mackinac	Brevort	multiple private	B	1990	Scattered colonies. Some clumps have several hundred or more stems.
009	Mackinac	Epoufette Bay	Michigan Nature Association	BC	1990	Several moderately sized or larger clumps in a swamp, a road ditch, and down to the beach.
014	Mackinac	Cut River West	State of Michigan	B?	1990	Site was confirmed by Beadle, but little information is known about population.
011	Mackinac	Manitou Payment Highbanks	Sand Products Company	BC	1991	Site needs field survey. Additional shoreline habitat requires inventory.

¹ All known and historical occurrences of *M. glabratus* var. *michiganensis* are in Michigan.

² Element occurrence (EO) ranks are assigned by the Michigan Natural Features Program. For an explanation of ranking criteria, see Appendix B.

³ H = historical record.

One private landowner has reportedly destroyed plants on his property despite notification of their Federal and State protected status.

The Harbor Springs site had only been known from an 1892 historical record until it was rediscovered in 1997. This site occurs within the private ownership of the Idylwilde Association, a lakeshore homeowners association. The Association is protecting wetlands on the site with a Michigan Landowner Forest Stewardship Plan (Fuller 1994).

Two historical occurrences, Burt Lake-West Shore and Mullett Lake-West Shore, if rediscovered, would almost certainly exist on private land. A new occurrence along the southeastern shore of Burt Lake was discovered in 1995. It is comprised of several local colonies inhabiting springs on the margin of the lake. A portion of this occurrence is reported to be present within the Seven Springs Nature Preserve, which is owned and managed by the Little Traverse Conservancy (LTC). At least two distinct colonies persist within the Manitou Payment Highbanks site on property of the Sand Products Corporation. Survey of previously unexplored shoreline to the east, with its extensive potential habitat, is very likely to result in the identification of additional colonies. A significant new locality, confirmed in 1990 near the Cut River mouth in Mackinac County, appears to occur on state forest land; scanty population information on this occurrence will necessitate further inventory.

The remaining *M. glabratus* var. *michiganensis* occurrences lie on private land, several involving multiple ownerships. The Maple River site and portions of the Platte River occurrence are registered with the Michigan Chapter of The Nature Conservancy (TNC), conveying at least informal protection. An occurrence in Little Sand Bay on Beaver Island occurs at least partially within LTC's Little Sand Bay Nature Preserve. The existence of the Beaver Island Harbor occurrence may be in doubt based on a recent field check (J. Paskus, MNFI, pers. comm.). A second Beaver Island occurrence was persisting at the last report. Although the colony remains highly vulnerable to lakeshore development and potential hydrological disruptions, no protection arrangements have been made. Newly discovered colonies within a condominium development in the City of Brevort were protected during construction. Detailed plans, prepared in consultation with the U.S. Fish and Wildlife Service and the MDNR Endangered Species Program, were implemented to perpetuate this colony and its vulnerable habitat. Protection plans for the Brevort colony have included fencing around the colony, placement of a viewing boardwalk, and an information kiosk describing this species and its status. Additional protective measures were also implemented to prevent hydrological disturbances and erosion during and following condominium construction.

The status of colonies in other sites is more tenuous. In the Burdickville locality, some colonies are being informally protected through the notification of landowners by a local environmentalist. The occurrence consists of a string of *M. glabratus* var. *michiganensis* patches persisting in seepy springs along the largely developed eastern shore of Glen Lake. At Parrott Point on Mullett Lake, an extremely small, very localized colony persists in a small spring on a homeowner's lawn, despite repeated mowing.

D. Habitat

Mimulus glabratus var. *michiganensis* is restricted to cold, alkaline spring seepages and streams, usually in association with northern white cedar (*Thuja occidentalis*) swamps occurring

along current or post-glacial Great Lakes shorelines. It frequently occurs in northern white cedar swamps formed in drainages found at the base of relatively steep, morainic slopes and bluffs. In these sites, *M. glabratus* var. *michiganensis* generally flourishes best in tree canopy openings, along forest edges, or along streams adjacent to open, meadow-like areas. It flowers most abundantly when growing in full sunlight, although it appears to persist as mostly sterile colonies when growing under heavy tree canopy cover.

Northern white cedar is an important and usually dominant overstory tree, commonly occurring with *Abies balsamea* (balsam fir), *Betula papyrifera* (paper birch), and occasionally *Larix laricina* (larch or tamarack). In some sites, such as along the Mackinac County shoreline, *M. glabratus* var. *michiganensis* occurs in seeps and ravines bordered by upland hardwood forest, dominated by species such as paper birch, *Acer rubrum* (red maple), *Acer saccharum* (sugar maple), and *Fagus grandifolia* (beech). *Caltha palustris* (marsh-marigold), *Impatiens capensis* (jewelweed), and *Nasturtium officinale* (watercress) are nearly constant herbaceous associates. *Myosotis scorpioides* (forget-me-not), although non-native, is often present. A list of vascular plants and bryophytes commonly associated with *M. glabratus* var. *michiganensis* is presented in Table 2.

Beadle (1990), in an extensive rangewide survey, and Bliss (1982), quantified several of the parameters characterizing *M. glabratus* var. *michiganensis* habitat, elucidating several of the specific abiotic requirements for establishment and growth. Beadle found that colonies nearly always occurred in muck-covered sand (Tawas soil series) in cold, flowing water that ranged in temperature from 8.7° to 16.6° C (47.6° - 61.9° F). Beadle also found that *M. glabratus* var. *michiganensis* occurs in an exceptionally narrow pH range, which over numerous study sites ranged only from 7.66 to 8.21. This range is very comparable to that indicated for *M. glabratus* var. *michiganensis* habitat on Glen Lake, where pH has been reported as ranging from 7.8 to 8.4 (Jones 1991). Conductivity readings, indicative of nutrient content, were predictably high, ranging from 190 µmhos at Brevort to well over 300 µmhos at most other sites. Selected water sample tests indicated high concentrations of ammonium (NH_3^+), nitrate (NO_3^-), and phosphorus (P^+).

At one site, Beadle also conducted field observations with a portable infrared gas analyzer to determine photosynthesis and transpiration rates, an experiment that resulted in apparently significant findings. Beadle compared the photosynthesis and transpiration rates of *M. glabratus* var. *michiganensis* plants growing in shallow water versus more terrestrial plants located on an adjacent stream bank. She found that the partly immersed plants had approximately twice the photosynthesis and transpiration rates of non-immersed plants. Beadle noted that the higher recorded photosynthesis rate was similar to the middle of the range of values recorded for crop plants exhibiting C_3 photosynthesis. Oxygenation, though not measured by Beadle, was also suggested as an abiotic parameter that may be significant. These data collectively suggest that optimal habitat conditions for *M. glabratus* var. *michiganensis* are comprised of a combination of moderate to high light availability, cool substrate, and high nutrient availability within a narrow pH range, demonstrating the relatively specialized habitat requirements.

Table 2. Vascular plants and bryophytes commonly associated with *Mimulus glabratus* var. *michiganensis* (Michigan monkey-flower).

SPECIES	COMMON NAME
<i>Abies balsamea</i>	balsam fir
<i>Alnus incana</i> ssp. <i>rugosa</i>	speckled alder
<i>Caltha palustris</i>	marsh-marigold
<i>Carex disperma</i>	sedge
<i>Carex trisperma</i>	sedge
<i>Circaea alpina</i>	enchanter's-nightshade
<i>Conocephalum conicum</i>	liverwort
<i>Coptis trifolia</i>	goldthread
<i>Cypripedium reginae</i>	showy lady-slipper
<i>Cystopteris bulbifera</i>	bulblet fern
<i>Cystopteris fragilis</i>	fragile fern
<i>Equisetum arvense</i>	horsetail
<i>Equisetum scirpoides</i>	dwarf horsetail
<i>Eupatorium maculatum</i>	spotted Joe-Pye weed
<i>Gaultheria hispidula</i>	creeping snowberry
<i>Impatiens capensis</i>	spotted touch-me-not
<i>Listera convallarioides</i>	broad-leaved twayblade
<i>Listera cordata</i>	heartleaf twayblade
<i>Lycopus uniflorus</i>	water horehound
<i>Mitella nuda</i>	naked miterwort
<i>Myosotis scorpioides</i> *	forget-me-not
<i>Nasturtium officinale</i>	watercress

Table 2 (continued). Vascular plants and bryophytes commonly associated with *Mimulus glabratus* var. *michiganensis* (Michigan monkey-flower).

SPECIES	COMMON NAME
<i>Platanthera obtusata</i>	blunt-leaf orchid
<i>Ribes lacustre</i>	swamp black currant
<i>Rubus pubescens</i>	dwarf raspberry
<i>Sphagnum centrale</i>	sphagnum moss
<i>Sphagnum squarrosum</i>	sphagnum moss
<i>Sphagnum girghensonii</i>	sphagnum moss
<i>Thuidium delicatulum</i>	feather moss
<i>Thuja occidentalis</i>	arbor vitae
<i>Trientalis borealis</i>	starflower
<i>Veronica americana</i>	ironweed

*Although forget-me-not is a frequent and often characteristic associate of *M. glabratus* var. *michiganensis*, it is non-native.

E. Biology

Habitat requirements, though not definitively known, clearly indicate the relatively restrictive conditions for *M. glabratus* var. *michiganensis* establishment and growth, as outlined above. The localized nature of available habitat is thus a strong limiting factor within the currently known range of this monkey-flower. Other significant biological characteristics also serve to severely limit the growth, dispersal, and establishment of *M. glabratus* var. *michiganensis*.

Relatively little is known of the population biology of *M. glabratus* var. *michiganensis* owing, in part, to a lack of long-term monitoring of this taxon. However, Bliss' study (1983, 1986) of reproductive biology provides information on significant life history characteristics. Bliss found that for 11 populations of *M. glabratus* var. *michiganensis* the proportion of viable pollen was only 2.8 percent (± 2.6 percent), and that there was considerable variation among sample sites. Only a single population, the Maple River site, produced an appreciable amount of viable pollen, averaging 29 percent (± 5 percent), whereas all other sites averaged just 0.18 percent (± 0.09 percent). Bliss' data for seed set paralleled the pollen data: all shoots at the Maple River site had some seed set, in contrast to an average seed set of only 3.4 percent for all other populations. Bliss concluded that *M. glabratus* var. *michiganensis* is nearly totally dependent on vegetative propagation. Because of its dependence on this form of reproduction, dispersal is greatly limited and likely occurs only locally through the fragmentation of clonal colonies.

Even when Bliss attempted to cross different populations (occurrences) of *M. glabratus* var. *michiganensis*, no seed set was achieved. The reason for *M. glabratus* var. *michiganensis*'s low production of viable pollen and consequent sterility is thus unknown, but it may be due to cytological abnormalities that typically result in interpopulational crossing barriers within the *Mimulus glabratus* complex (Vickery 1969; Tai and Vickery 1970). The fertility of the Maple River occurrence is therefore particularly notable. Beadle (1990) has collected and successfully germinated seed collected from this site, as has Vickery (1991). The Maple River site thus may be the only occurrence with significant long-range seed dispersal potential, possibly via water or animal vectors.

Neither Bliss (1983) nor Beadle (1990) observed pollinators, whose role is thus far unknown. Pennell (1935) described nectar-producing *Mimulus* flowers as being highly adapted to bee pollination, owing to their broad, bearded palates (*i.e.* the lower petals) that serve as suitable landing platforms. Vickery (1991) noted that *M. glabratus* plants are characteristically self-compatible and readily self-pollinate, producing seed frequently in this fashion.

Little population monitoring of *M. glabratus* var. *michiganensis* colonies has been conducted, and thus the demography of populations cannot be characterized. S. Beadle (1990, pers. comm.), however, has observed colonies of the taxon through summer and winter seasons, reporting that in the fall colonies die back and become more or less dormant in streams and springs where water flow and temperature stay relatively constant, with colonies re-initiating growth in the spring.

F. Threats and Limiting Factors

The greatest threat to *M. glabratus* var. *michiganensis* is direct destruction and modification of the species' essential habitat. Development, both inland and along Great Lakes shores, has probably resulted in local extinctions such as at Mullet Lake and portions of Burt Lake. Apparently, potential habitat remains near these historical locations, but they lack the northern white cedar swamps that were cleared and drained for residential areas and seasonal homes. However, collection information is vague for several of these historical occurrences. The 1997 Harbor Springs rediscovery indicates that extant colonies may still remain at or near their original collection sites. Because much of the remaining potential habitat is relatively inaccessible, persistent exploration is necessary before extinction can be presumed for colonies from these localities.

Other than direct habitat destruction, hydrological disruptions of any type, particularly those that result in eliminating or warming a water source, unquestionably constitute the next most serious threat to the *M. glabratus* var. *michiganensis*. Although the occurrences of *M. glabratus* var. *michiganensis* colonies in sites such as Parrott Point and Burdickville demonstrate that plants can persist where groundwater flow has been somewhat altered, this may represent far less than optimal habitat conditions. On Burt Lake, Mullett Lake, and at Burdickville prior to development, *M. glabratus* var. *michiganensis* probably occurred much more abundantly.

Perhaps one of the strongest current threats to known occurrences of *M. glabratus* var. *michiganensis* is the lack of knowledge of their existence and significance. Because the majority of occurrences lie within private landholdings, colonies are likely to be threatened by those who do not know that *M. glabratus* var. *michiganensis* occurs on their property or what this species requires to survive. Several local occurrences are threatened because the landowners have not been formally contacted about the presence of a protected plant on their property. Despite the need for increased enforcement, which in one case was necessary to achieve future protection, notification and education are ultimately the best tools and perhaps the only hope for preventing the steady attrition of significant local colonies.

Lastly, an increased interest in this taxon by the scientific community has the potential to result in overcollection and possible contamination of colonies during experimental manipulations. At present, this kind of activity is not a significant threat, but it may become so in the future and should be carefully monitored and regulated. Over the past few years, collectors and institutions, such as arboreta, have become highly interested in propagating and displaying live specimens of endangered species. This may also place additional collection pressure on *M. glabratus* var. *michiganensis* colonies and should likewise be closely monitored and regulated to determine impacts.

Principal Federal and State laws directly relevant to the protection of *M. glabratus* var. *michiganensis* and its habitat are listed in Appendix C.

G. Conservation Measures

Conservation measures include scientific studies, legal protection, and activities that affect the conservation of the species.

1. Studies

The most recent study on *M. glabratus* var. *michiganensis* was conducted by Beadle (1990) on ecological and physiological requirements affecting its distribution.

2. Federal Protections

Conservation measures provided to *M. glabratus* var. *michiganensis* as a listed endangered species under the Federal Endangered Species Act of 1973, as amended (Act), include recognition, recovery actions, requirements for 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 Act provides for possible voluntary land acquisition and cooperation with the States and requires that recovery actions be carried out for all listed species. The protection required of Federal agencies and the prohibition against certain activities involving listed plants are discussed, in part, below.

Section 9(a)(2) of the Act and its implementing regulations found at 50 CFR 17.61 set forth prohibitions and exceptions that apply to endangered plants. Prohibited activities applicable to any person subject to the jurisdiction of the United States are as follows: 1) import or export; 2) transport in interstate or foreign commerce in the course of a commercial activity; 3) sell or offer for sale in interstate or foreign commerce; or 4) to remove and reduce to possession from areas under Federal jurisdiction; 5) maliciously damage or destroy this species on any area under Federal jurisdiction; or 6) remove, cut, dig up, damage, or destroy this species on any other area in knowing violation of any State law or regulation or in the course of any violation of a State criminal trespass law. "Plant" means any member of the plant kingdom, including seeds, roots, and other parts. Certain exceptions apply to agents of the U.S. Fish and Wildlife Service (Service), other Federal land management agencies, and State conservation agencies [50 CFR 17.61(c)(2)]. In addition, State conservation agencies which are party to a Cooperative Agreement with the Service may conduct certain prohibited activities with endangered plants for conservation purposes [50 CFR 17.61(c)(4)].

Section 10 of the Act and its implementing regulations provide for the issuance of permits to carry out otherwise prohibited activities under certain circumstances. Permits are available for scientific purposes or to enhance the propagation or survival of the species in the wild. In some instances, permits may be issued 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, because this species is not common in cultivation or in the wild. A section 10 permit was granted in 1995 to the Hiawatha National Forest of the U.S. Forest Service for the collection of voucher specimens necessary for a forest-wide survey. In addition, activities carried out by a state conservation agency may include many recovery research projects that are identified in this plan, in accordance with authorities described above [(50 CFR 17.61(c)(4)]. Requests for copies of the regulations on endangered plants and inquiries regarding them may be addressed to the U.S. Fish and Wildlife Service, Ecological Services Operations, 1 Federal Drive, Fort Snelling, Minnesota 55111-4056. Copies of Federal laws and regulations are also available electronically at <http://www.thomas.loc> and related sites.

Section 7 of the Act requires Federal agencies to consult with the Service prior to authorizing, funding, or carrying out activities that may affect listed species. Section 7 also

requires that these agencies use their authorities to further the conservation of listed species. There has not been any formal Section 7 consultation for *M. glabratus* var. *michiganensis*. The National Park Service, Army Corps of Engineers, and the U.S. Forest Service have conducted informal consultations for this species.

Section 6 of the Act provides for Cooperative Agreements between the Service and state agencies for conservation of listed species. Currently, the Service has partially funded a landowner contact program since 1992 as well as status surveys in 1994 and 1996 through a Federal grant program administered under Section 6(d) of the Act. These activities have been carried out by the Wildlife Division of the Michigan Department of Natural Resources.

Rules for protection of listed plants in the National Forests are in the U.S. Forest Service Manual Title 2600--Wildlife, Fish, and Sensitive Plant Habitat Management, Chapter 2670--Threatened, Endangered and Sensitive Plants and Animals. The U.S. Forest Service must abide by the Endangered Species Act and the National Environmental Protection Act in managing national forests. Horseshoe Bay Wilderness Area within Hiawatha National Forest was established by the Wilderness Act and yields an untouched, protected area. The National Forest Management Act of 1976 mandates that a Management Plan be written for each National Forest. The Hiawatha National Forest Land and Resource Management Plan (U.S. Dept. of Agriculture 1986) includes management actions to be performed for endangered, threatened, and special concern plants, including *M. glabratus* var. *michiganensis*.

3. State Protections

Mimulus glabratus var. *michiganensis* was listed as a threatened species by the Michigan Department of Natural Resources in 1976. It was listed pursuant to Michigan's Endangered Species Act (Public Act 203 of 1974), now Part 365, Endangered Species Protection, of the Natural Resources and Environmental Protection Act (NREPA), PA 451 of 1994. The plant was elevated to endangered species status in 1991 pursuant to Federal listing as endangered. Part 365 of NREPA prohibits the taking of endangered species on both public and private lands without a permit. Part 303 of NREPA also provides for the preservation, management, protection, and use of certain wetland habitats. The law lists habitat for threatened and endangered wildlife species as a criteria to be considered in the administration of the Public Act.

4. Interagency Measures

In May, 1994, seven Federal agencies, including the U.S. Fish and Wildlife Service, U.S. Forest Service and National Park Service signed the Federal Native Plant Conservation Memorandum of Understanding to establish the Federal Native Plant Conservation Committee. The committee is to identify conservation needs for native plants and coordinate implementation of programs to address those needs. Since the original signing by seven agencies, additional agencies have joined the agreement.

In September 1994, 18 Federal agencies signed a Memorandum of Understanding (MOU) on the Implementation of the Endangered Species Act. In this MOU, the cooperators agreed to work together to (1) conserve Federally listed species; (2) use existing Federal authorities and programs to further the purposes of the Act; and (3) to improve the efficiency

and effectiveness of consultation under Section 7 of the Act. Conservation Agreements are specifically mentioned as a tool to implement this MOU.

H. Strategy of Recovery

Recovery of *M. glabratus* var. *michiganensis* is based on three fundamental components: (1) the protection of the relatively few known extant occurrences, (2) field surveys to better determine the status of this taxon, and (3) biosystematic research, including long-term monitoring, to ascertain the most appropriate taxonomic placement of *M. glabratus* var. *michiganensis*, and to understand its basic natural history so that it may be properly managed.

There are very few known occurrences of the *M. glabratus* var. *michiganensis* and its biology is poorly understood. Although additional significant occurrences can be expected, intensive site inventories have thus far resulted in the identification of few new occurrences. Therefore, to insure its survival, the immediate recovery priority is to protect all extant "populations" and their immediate habitat. One large, exemplary occurrence is predominantly contained and protected within a National Lakeshore. Another occurrence lies within a University of Michigan biosphere reserve. Portions of three additional occurrences lie within small nature preserves. The remainder, which are the majority of the extant occurrences, occur primarily on private land where they remain highly vulnerable to both direct and indirect impacts. The conservation of most known occurrences of *M. glabratus* var. *michiganensis* must occur through landowner notification to implement voluntary protection programs. Voluntary programs may include landowner contact and education, non-binding registry agreements with private or governmental agencies, and formal, recorded conservation easements. Fee title purchase from willing sellers and ownership by a private conservation organization, or a state or federal agency, is an option for the protection of some sites.

Artificial propagation and reintroductions of the *M. Glabratus* var. *michiganensis* are not currently being considered. Prior to consideration of these actions, more productive tasks such as protection of extant occurrences and searches for new occurrences should be exhausted. If new information indicates a pressing need for reintroduction, it should only be considered when there is a complete understanding of the original extirpation, original threats have been eliminated, adequate protection of the sites is guaranteed, and a monitoring program is in place.

II. RECOVERY

A. Objective and Criteria

The fundamental recovery objective for *M. glabratus* var. *michiganensis* is to secure long-term protection for all of its 15 known occurrences as well as viable or restorable occurrences discovered subsequent to the preparation of this recovery plan, or newly identified extant colonies in historical sites. Viable sites contain the number of individuals and area of essential habitat necessary for a self-sustaining population. Protection is defined as the collective actions necessary to conserve known occurrences, maintain ecosystem processes for the perpetuation of essential habitat, and enable each occurrence to be naturally self-sustaining. *M. glabratus* var. *michiganensis* will be considered for reclassification from endangered to threatened status when protection is secured for all eight occurrences ranked "A" or "B"

(“Excellent Occurrence” and “Good Occurrence”, respectively, see Appendix B). When all known Michigan occurrences are sufficiently protected, delisting can be considered.

The goals of the recovery plan can be accomplished by (1) long-term protection for all known existing occurrences, with primary emphasis on the preservation of essential habitat, (2) field surveys for new occurrences and to determine the specific status of recently discovered and historical sites, (3) biosystematic research to determine the most appropriate taxonomic classification, and (4) demographic, physiological, breeding system, and genetic studies to understand population biology, specific habitat requirements, floral biology, and genetic variability, and long-term post delisting viability monitoring.

B. Step-down Outline

1. Enact long-term protection for all known existing occurrences, with primary emphasis on the preservation of essential habitat.
 11. Landowner notification.
 12. Education of land managers and the public.
 121. Preparation and distribution of educational materials to appropriate agencies and citizenry.
 122. Interpretation of scientific research and communication of relevant findings to land managers and the public.
 123. Preparation and dissemination of specific guidelines for the management of *M. glabratus* var. *michiganensis* occurrences.
 13. Development of management plans for occurrences on Federal, State, and local public lands.
 14. Registry agreements, conservation easements, and other contractual arrangements for site and colony protection.
 15. Land purchase.
 16. Implementation of protection strategies for all identified sites.
 - 16-1. Beaver Island Harbor.
 - 16-2. Brevort.
 - 16-3. Burdickville.
 - 16-4. Burt Lake-West Shore (historical occurrence).
 - 16-5. Burt Lake Southeast
 - 16-6. Carp Creek.
 - 16-7. Cut River West.
 - 16-8. Epoufette Bay.
 - 16-9. Harbor Springs.
 - 16-10. Little Sand Bay.
 - 16-11. Manitou Payment Highbanks.

- 16-12. Maple River.
- 16-13. McFarlane Woods.
- 16-14. Mullett Lake-West (historical occurrence).
- 16-15. Parrot Point (Mullett Lake-Southeast).
- 16-16. Platte River.
- 16-17. Reeses Swamp.

- 2. Conduct field surveys for new occurrences and to determine the specific status of recently discovered and historical sites.
 - 21. Historical sites.
 - 22. Known extant sites.
 - 23. New occurrences.
- 3. Conduct comparative biosystematic research of *M. glabratus* and *M. guttatus* to determine the most appropriate taxonomic classification.
- 4. Conduct demographic, physiological, breeding system, and genetic studies to monitor and understand population biology, specific habitat requirements, floral biology, and genetic variability.
 - 41. Population demography.
 - 42. Physiology studies.
 - 421. Field research.
 - 422. Greenhouse research.
 - 43. Breeding system biology.
 - 44. Genetic research.
 - 45. Long-term monitoring.

C. Narrative Outline for Recovery Actions

- 1. Enact long-term protection for all known existing occurrences, with primary emphasis on the preservation of essential habitat.

The perpetuation of *M. glabratus* var. *michiganensis* depends on achieving long-term protection for its specialized habitat so that the few known occurrences can be self-sustaining. This can be best attained through the following recovery actions.

- 11. Landowner notification - Landowner notification is an immediate, short-term recovery action fundamental and precursory to long-term recovery efforts. Landowner notification or contact consists, at a minimum, of communicating

with all landowners, both public and private, on whose property *M. glabratus* var. *michiganensis* occurs. Landowner notification is currently carried out by MNFI with the eventual goal of turning over the program to local land trusts. Initial contact is made by mail and/or telephone with follow up contact made in person. Notification consists of the confirmation that a Federal and State endangered species occurs within an ownership. This notification must include prepared educational materials that clearly describe and illustrate the *M. glabratus* var. *michiganensis* in non-technical terms, providing information on the rarity of the species, why it is rare, what it requires to be self-sustaining, and why it should be protected. Integral to the notification process is the necessity of apprising landowners of the legal protection afforded *M. glabratus* var. *michiganensis* under provisions of both the Federal and State Endangered Species Acts. Notification should entail contacting adjacent landowners whose property provides contiguous and potential habitat. Notification may be a continuing process, requiring the transmittal of new information relevant to protection as provided by scientific research.

12. Education of land managers and the public - Both short and long-term protection and management of *M. glabratus* var. *michiganensis* are dependent upon the dissemination of understandable information to land managers and the public, especially those who require non-technical information on important elements of Great Lakes biological diversity. Education can be accomplished in the following ways.
 121. Preparation and distribution of educational materials to appropriate agencies and citizenry - The same materials (fact sheets, etc.) prepared and distributed for landowner notification can be disseminated for use by public agencies and citizens for a variety of needs, such as providing general management information, assistance in the identification of populations, or general information on the distribution, ecology, and status of *M. glabratus* var. *michiganensis*.
 122. Interpretation of scientific research and communication of relevant findings to land managers and the public - As research provides important information, these findings require interpretation and transfer to all distributed materials, and particularly to public land managers and private owners directly responsible for maintaining *M. glabratus* var. *michiganensis* colonies and their habitat.
 123. Preparation and dissemination of specific guidelines for the management of *M. glabratus* var. *michiganensis* occurrences - In addition to notification and general educational materials concerning *M. glabratus* var. *michiganensis*, most public agencies and private land owners will require specific instructions and guidelines for preparing management plans.
13. Development of management plans for occurrences on Federal, State, and local public lands - The protection of occurrences on public lands, including Federal,

State, and local (county, township, or city) holdings, should be guided by specific management plans. Clear management plans are particularly important for public agencies and governmental units, owing to the expected changes in personnel and the need for familiarity and consistency in management policies and actions. For local government units, management plans may consist of the enactment of zoning provisions or other plans that allow for the perpetuation of *M. glabratus* var. *michiganensis* habitat and occurrences. Sites that are at least partially within public ownership, and for which management plans are appropriate, include McFarlane Woods (National Park Service), Carp Creek (UM Biological Station), Cut River West (State Forest) and Epoufette Bay (city and/or township).

14. Registry agreements, conservation easements, and other contractual arrangements for site and colony protection - Public and private registry agreements, consisting of legal, non-binding contracts, are proactive alternatives that can provide short-term protection for occurrences. Because *M. glabratus* var. *michiganensis* occurrences often lie within several private ownerships, registry is a desirable approach that provides short-term protection. It may ultimately lead to long-term protection through eventual donation, purchase, natural area designation, or other means. The registry program of TNC, complementing the landowner contact/registry program of the Michigan Natural Heritage Program (Wildlife Division, Michigan DNR), should place a high priority on protecting *M. glabratus* var. *michiganensis*. Conservation easements, pursuant to provisions of Part 21, Conservation and Historic Preservation Easement, NREPA, or other formal, legally-binding contracts, also provide a viable approach to protection.
15. Land purchase - The above recovery actions are all based primarily on the perpetuation of essential habitat of the *M. glabratus* var. *michiganensis*. Land purchases from voluntary sellers are another definitive method of protecting the plant's essential habitat. Two programs in Michigan have good potential for incorporating critical sites under state ownership. Purchases under the Michigan Natural Resources Trust Fund are nominated by citizens or government officials and administered by the state or local government organizations. Part 21, Land Exchange Facilitation Fund, of NREPA allows the MDNR to sell state land and use the proceeds to purchase other land. Land purchase by TNC, the LTC, or other statewide and local land conservation organizations, are also recommended approaches.
16. Implementation of protection strategies for all identified sites - Recovery actions are recommended for the following sites with extant and historical occurrences.
 - 16-1. Beaver Island Harbor- A localized but good quality occurrence, under private ownership (possibly multiple ownership), is vulnerable due to its location next to a residential shoreline and beach area. Registry, conservation easement, or possible acquisition by a conservation organization are recommended. A survey is necessary to determine the status of this population which is in doubt after a recent field check.

- 16-2. Brevort - Under multiple private ownership, one large colony has been formally registered with TNC. A newly discovered colony is being protected within a condominium complex under construction, where formal registry is desirable. An additional shoreline survey is necessary in areas to the west.
- 16-3. Burdickville - Scattered colonies, some forming many-stemmed, dense clones, persist in a highly developed residential area along a lakeshore. Landowner notification followed by registry are perhaps the only viable alternatives. Conservation easements may also be a possibility to ensure more rigorous protection of the more viable remaining patches.
- 16-4. Burt Lake-West Shore (historical occurrence) - Known only as a historical site, this occurrence was identified as the "west shore" of Burt Lake where a specimen was collected in 1933. Recent surveys have not found extant populations, but surveyors have identified potential habitat and advised that inventory should be implemented. Systematic inventory of the west shore area, with permission from private landowners to examine this habitat, needs to continue, especially in potential areas where development is imminent. Consideration for reintroductions at this site may be premature without further inventory. In addition, there is the possibility for natural recolonization from neighboring colonies at Burt Lake Southeast.
- 16-5. Burt Lake Southeast - This population was unknown until its discovery in 1995, corroborating the need for more thorough inventory of the Burt Lake shoreline. The occurrence consists of approximately 17 local colonies extending along the immediate shoreline. A portion of this occurrence is reportedly contained within the Seven Springs Nature Preserve owned and managed by the LTC; the preserve includes approximately 600 m (2000 ft) of lake frontage. The remainder of this occurrence lies within multiple private ownership where some owners are voluntarily protecting colonies. Because of recent legal intervention concerning driveway construction, this occurrence would benefit from careful landowner contact and registry. Further inventory in adjacent shoreline areas is needed, in addition to exploration of swamp areas landward that may support additional colonies.
- 16-6. Carp Creek - This site is managed by the UM Biological Station within a designated Biosphere Reserve. Recovery actions are currently unnecessary. However, an occurrence within a Biosphere Reserve may not automatically convey complete protection. A long-term protection and management plan is desirable.
- 16-7. Cut River West - This site was reported and confirmed in 1990, although little information on population status is available. Detailed inventory is necessary for an adequate evaluation of status.

- 16-8. Epoufette Bay - A portion of this occurrence is protected within a Michigan Nature Association preserve. However, the population extends to other private and township properties. Registry should be sought for colonies outside the nature preserve, and a management or protection plan should be prepared by the township. The occurrence has recently become highly vulnerable due to the upgrading of the shoreline road by Hendricks Township. The MDNR is currently monitoring this project because a substantial part of the occurrence lies immediately adjacent to the roadway.
- 16-9. Harbor Springs - Prior to 1997 this occurrence was known only as a historical site from an 1892 specimen which was cited as being collected "near Harbor Springs." The occurrence was rediscovered within a private homeowner association near Forest Beach during a systematic survey of remaining potential habitat by MNFI. One large and 2 small colonies were found in springs at the base of a small bluff. The habitat was and is being protected by the owners through the implementation of a Forest Stewardship Plan. Landowner contact should be maintained to assure continued protection of the site. Additional potential habitat which should be systematically surveyed exists in the Harbor Springs area.
- 16-10. Little Sand Bay - This occurrence is in proximity to a shoreline of natural area quality. Several colonies occur along a stream drainage in a cedar swamp. At least a portion of this occurrence now lies within the Little Sand Bay Nature Preserve, a 24 ha (60 ac) sanctuary owned and managed by the LTC. Additional survey work may be necessary to determine the precise extent of the entire occurrence. A long-term management plan for the site is recommended.
- 16-11. Manitou Payment Highbanks - Thought to be extirpated following high lake levels in 1985 and 1986, this occurrence was confirmed as being extant during a brief 1991 field survey. Extensive potential habitat remains west of two colonies found in 1991, and thus continued inventory is likely to result in the identification of additional colonies. Registry with the owner, Sand Products Company, is strongly recommended.
- 16-12. Maple River - Despite some human disturbance, this colony remains vigorous. It is also particularly notable for its ability to set viable seed, and is thus perhaps the most significant known occurrence. The site is currently registered with the Michigan Chapter of TNC. Registry and occasional monitoring should be maintained. Additional inventory work downstream from this occurrence should be conducted.
- 16-13. McFarlane Woods - This is a large, exemplary occurrence, protected within the boundaries of Sleeping Bear Dunes National Lakeshore.

Preparation of a long-term management plan by the National Park Service for this occurrence should be a priority.

- 16-14. Mullett Lake-West (historical occurrence) - A specimen was collected here in 1925 and has been tracked as a historical site. A recent search (Beadle 1990) identified potential habitat but no extant populations. The area has been poorly explored due to access difficulty. Continued systematic inventory is needed. This is a site for potential reintroductions if it is first carefully surveyed and evaluated.
 - 16-15. Parrot Point (Mullett Lake-Southeast) - Reduced to an extremely localized colony on the lawn of a lakeshore resident, this clump persists, apparently in spite of mowing. This occurrence should be given high priority for immediate landowner contact and possible registry. Any potential habitat in the general area strongly merits inventory.
 - 16-16. Platte River - Surveys in 1990 found small colonies more widely ranging than known previously and many occurring on private property. A brief downstream survey conducted at the same time did not result in the identification of additional colonies, although this inventory was conducted over less than a 400 m (0.25 mi) stretch. Detailed surveys of the general area are necessary, including potential areas within the Platte River drainage near and beyond this branch. Two owners are currently registered with the Michigan Chapter of TNC. Additional registry, as appropriate, should be sought.
 - 16-17. Reeses Swamp - While only a relatively small portion of this occurrence exists on University of Michigan Biosphere Reserve land, the majority of the population occurs in multiple private ownerships. TNC registry is strongly recommended, and possibly the pursuit of conservation easements, to ensure long term habitat protection.
2. Conduct field surveys for new occurrences, status determinations for recently discovered sites, and historical sites.

Relatively few *M. glabratus* var. *michiganensis* sites are known, and of these, several are disturbed. However, significant potential habitat, which merits surveys, exists both within and beyond its current delineated range. Although recent field investigations have resulted in few new sites, they are highly important discoveries (e.g. McFarlane Woods) and have given direction to future surveys. Continued inventory is strongly recommended, as are detailed assessments of known sites and historical occurrences.

21. Historical sites - Surveys of the Mullett Lake West and Burt Lake-West Shore areas by Beadle (1990) did not locate extant colonies, but available habitat persists in the general locality. Inventory in these sites should be continued.
22. Known extant sites - Detailed mapping of colonies in several known extant occurrences is still needed to determine the complete local distribution and

status. Mapping could result in the potential revision of element occurrence ranks.

23. New occurrences - Conducting inventories in northern Lower Michigan and the eastern Upper Peninsula, focusing on current and post-glacial Great Lakes shorelines, may result in the identification of significant new colonies.
3. Conduct biosystematic research to determine the most appropriate taxonomic classification.

Bliss (1983, 1986) and Minc (1989) confirmed the validity of recognizing *M. glabratus* var. *michiganensis* as a distinct variety of *M. glabratus*, as established by Fassett (1939). However, significant questions remain concerning possible recognition at the species level, which, if identified as valid, would place greater urgency upon protection. Research should be conducted to address the fundamental question of relationship and taxonomic placement, particularly because of recent findings by Vickery (1990, 1991) that emphasize significant evidence for recognition above the rank of variety. Biosystematic research, involving thorough comparative studies of *M. glabratus* var. *jamesii*, *M. glabratus* var. *michiganensis* and *M. guttatus*, are recommended. This research should be in conjunction with isozyme and/or chloroplast DNA analyses to determine the taxonomic standing and origin of var. *michiganensis*. It is suggested that reciprocal crossing experiments, such as those conducted by Vickery (1991), be continued to corroborate a potential assignment of specific standing.

4. Conduct demographic, physiological, breeding system, and genetic studies to understand population biology, specific habitat requirements, floral biology, and genetic variability.

There are currently no long-term monitoring studies of *M. glabratus* var. *michiganensis* and there exists little knowledge of population dynamics. Beadle (1990) gathered data on ecological and physiological requirements from wide-ranging field studies of most occurrences, supplementing these data with observations of greenhouse-cultured specimens. Long-term demographic monitoring is an immediate priority, in addition to continued ecological physiology studies, to clarify specific biological and abiotic requirements. These studies must be linked with research of the breeding system, which, at present, is poorly understood. Lastly, studies (e.g. isozyme analyses) to determine genetic variability would assist in understanding population structure (e.g. the number of genetic individuals within colonies) and dynamics.

41. Population demography - Long-term monitoring using standard demographic techniques should be conducted in at least three sites.
42. Physiology studies - Because of the narrow restriction of *M. glabratus* var. *michiganensis* to very specific and vulnerable habitat, an understanding of physiological requirements is critical for protection and management. Both field and greenhouse research are necessary for quantifying significant physiological parameters.

421. Field research - Field studies should continue, following Beadle's (1990) investigation of physiological parameters, possibly within the same plots or sites selected for long-term demographic monitoring. Statistical analyses would detect whether significant differences among and within sites exist.
422. Greenhouse research - Physiological studies are incomplete without complementary investigations of inherent parameters (temperature, nutrients, oxygen and light) determined through experiments and observations of greenhouse-cultured specimens.
43. Breeding system biology - *Mimulus glabratus* var. *michiganensis* reproduces primarily by vegetative propagation (Bliss 1986), yet is markedly different in fertility in at least one site where viable seed is produced (Beadle 1990). The breeding system is poorly known and requires comprehensive study, comprising detailed research on vegetative and floral biology to determine pollinators, ability to self pollinate, the role of sexual versus asexual reproduction, and other factors relevant to natural propagation.
44. Genetic research - Because this taxon persists largely through vegetative propagation, the number of genetically distinct individuals within sites, and thus population structure and dynamics, is unknown. Genetic research would focus on the degree of variability within and among occurrences. This information would provide critically important data relevant to protection and long-term management such as the number of genetic individuals within populations and the degree of heterozygosity and homozygosity.
45. Long-term monitoring - Long-term monitoring needs to continue beyond the potential delisting date to confirm the vitality and viability of populations. Monitoring should continue on selected sites for a minimum of five years to ensure that recovery activities have been successful and no further actions will be required.

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III. IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows outlines actions and estimated costs for the recovery program. It is a guide for meeting the objectives discussed in Part II of this Plan. Actions are subdivided into tasks. This schedule indicates task priorities, task numbers, task descriptions, duration of tasks, the responsible agencies, and lastly, estimated costs. These actions, when accomplished, should bring about the recovery of the species and protect its essential habitat. The estimated funding needs for all parties anticipated to be involved in recovery are identified. Part III reflects the total estimated costs for the recovery of this species. The estimated recovery costs for the 11-year program are \$316,000; \$10,000 of this estimated cost is allocated to a minimum of five years of monitoring following a potential delisting date of 2004, to assess the adequacy of recovery actions and determine if there will be cause to consider re-listing. Funding is indicated beyond the potential delisting year of 2004 for some subtasks such as landowner contact and public education because these activities will be necessary even after delisting.

The costs presented are the estimates of the author and the Service, based on experience with costs of similar work. They are not based on budgets prepared for individual tasks or sub-tasks. Actual costs may be higher or lower than costs indicated in the Implementation Schedule.

A. Key to Implementation Schedule Column 1

Task priorities are set according to the following standards:

- 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.

B. Key to Agency Designations in Columns 6 and 7

FWS	U.S. Fish and Wildlife Service
TE	Endangered Species Division, FWS
MDNR	Michigan Department of Natural Resources
NPS	National Park Service (Department of Interior)
MNFI	Michigan Natural Features Inventory
TNC	The Nature Conservancy

C. Implementation schedule for *Mimulus glabratus* var. *michiganensis* (Michigan monkey-flower) Recovery Actions.

PRIORITY NUMBER	TASK NUMBER	TASK DESCRIPTION	TASK DURATION (YEARS)	RESPONSIBLE PARTY			COST ESTIMATES (\$000)				COMMENTS
				FWS		Other	FY98	FY99	FY00	FY01-08	
				Region	Program						
1	11	Landowner notification	ongoing	3	TE	MDNR MNFI	5	5	5	6	Can be coordinated with current Landowner Contact Program.
1	121	Preparation and distribution of educational materials to agencies and citizens	ongoing	3	TE	MDNR MNFI	2	2	2	2	Can be coordinated with Landowner Contact Program for other species.
1	122	Communication of relevant scientific findings to managers and public	2 - 3	3	TE	MDNR MNFI	1	1	0	0	Can be coordinated with Landowner Contact Program for other species.
1	123	Preparation and dissemination of specific management guidelines	4 - 5	3	TE	MDNR MNFI	2	2	2	2	Can be coordinated with Landowner Contact Program for other species.
2	13	Development of management plans for occurrences on public land	2 - 3	3	TE	MDNR NPS local government	3	2	2	0	Can be done in coordination with Landowner Contact Program. Management plans must be site-specific and can be prepared with assistance from MNFI.
2	14	Registry agreements and other contractual arrangements for habitat and colony protection	ongoing	3	TE	MNFI	2	2	2	4	Can be accomplished by Michigan Natural Heritage Program. Coordinate if necessary with TNC registry program.
2	15	Land purchase	ongoing	3	TE	TNC MDNR MNFI	23	23	25	25	Acquisition is partly dependent on the identification of new occurrences.

C. (continued) Implementation schedule for *Mimulus glabratus* var. *michiganensis* (Michigan monkey-flower) Recovery Actions.

PRIORITY NUMBER	TASK NUMBER	TASK DESCRIPTION	TASK DURATION (YEARS)	RESPONSIBLE PARTY			COST ESTIMATES (\$000)				COMMENTS
				FWS		Other	FY98	FY99	FY00	FY01-08	
				Region	Program						
2	16-1 - 16-17	Implement protection strategies for all identified sites	4	3	TE	MDNR MNFI NPS	7	7	5	5	
2	21	Field surveys of historical sites	4 - 5	3	TE	MNFI	2	1	2	2	
2	22	Field surveys of known extant sites	4 - 5	3	TE	MNFI	1	2	2	2	
2	23	Field surveys to locate new sites	4 - 5	3	TE	MNFI	2	2	1	1	
2	31	Biosystematic research to determine most appropriate taxonomic classification	2 - 3	3	TE	MNFI	10	10	5	0	MNFI to coordinate research.
2	41	Demographic study of populations	4 - 5	3	TE	MNFI	5	5	5	5	Research will possibly be conducted in collaboration with MNFI.
2	42	Physiological studies	4 - 5	3	TE	MDNR MNFI	5	5	5	5	
2	43	Breeding system studies	4 - 5	3	TE	MNFI	5	5	5	5	
2	44	Genetic studies	4 - 5	3	TE	MNFI	10	5	5	5	
2	45	Population/occurrence monitoring.	ongoing	3	TE	MNFI				10	Monitoring must continue for 5 years following delisting.

VI. APPENDICES

APPENDIX A. MEAN AND RANGE VALUES FOR FLORAL MEASUREMENTS OF *MIMULUS GLABRATUS* VAR. *FREMONTII* (=VAR. *JAMESII*)*, *M. GLABRATUS* VAR. *MICHIGANENSIS*, AND *M. GUTTATUS* (MINC 1989).

POPULATION (SAMPLE SIZE)	COROLLA LENGTH (MM)	COROLLA WIDTH (MM)	PISTIL LENGTH (MM)	STYLE LENGTH (MM)	OVARY LENGTH (MM)
<i>MIMULUS GLABRATUS</i> VAR. <i>FREMONTII</i>					
Cadillac (N = 22 - 25)	10.70 (8.0 - 12.5)	6.56 (4.5 - 8.5)	6.56 (5.5 - 7.5)	2.82 (2.5 - 3.5)	3.74 (3.0 - 4.5)
Cadillac (Matthaei) (N = 9 - 10)	10.47 (9.7 - 11.0)	5.31 (4.3 - 5.9)	6.30 (6.0 - 6.8)	3.34 (2.9 - 4.0)	2.96 (2.0 - 3.9)
Killpecker Creek (N = 16 - 22)	15.28 (13.5 - 18.0)	8.82 (6.5 - 12.5)	9.27 (8.5 - 10.0)	4.68 (4.0 - 5.5)	4.60 (3.5 - 5.5)
Montcalm County (Matthaei) (N = 10)	10.06 (9.1 - 11.3)	5.59 (4.0 - 8.0)	6.35 (5.2 - 7.5)	3.11 (2.1 - 4.0)	3.24 (2.7 - 3.7)
COMBINED (N = 61 - 66)	11.82 (8.0 - 18.0)	7.00 (4.0 - 12.5)	7.32 (5.2 - 10.0)	3.52 (2.1 - 5.5)	3.81 (2.0 - 5.5)
<i>MIMULUS GLABRATUS</i> VAR. <i>MICHIGANENSIS</i>					
Carp Creek (N = 24)	--	--	15.40 (13.0 - 16.5)	8.12 (6.0 - 9.5)	7.27 (6.0 - 8.0)
Epoufette (N = 17 - 26)	22.82 (19.5 - 26.5)	12.39 (8.5 - 16.0)	15.94 (13.5 - 17.5)	9.08 (7.5 - 10.5)	6.86 (5.5 - 8.0)
Epoufette (Matthaei) (N = 15)	21.19 (17.2 - 24.3)	14.99 (10.0 - 20.5)	15.80 (13.8 - 20.0)	9.30 (7.2 - 14.0)	6.50 (5.1 - 11.5)
Maple River (N = 22 - 26)	22.80 (20.0 - 27.0)	15.62 (12.5 - 17.5)	15.92 (15.0 - 18.5)	8.61 (7.5 - 10.0)	7.32 (6.5 - 9.5)
Maple River (Matthaei) (N = 4)	24.58 (22.1 - 26.7)	19.92 (18.0 - 21.4)	17.80 (15.8 - 21.1)	8.45 (8.1 - 9.0)	9.35 (7.7 - 12.6)
COMBINED (N = 60 - 93)	22.5 (17.2 - 27.0)	14.80 (8.5 - 21.4)	15.85 (13.0 - 21.0)	8.72 (6.0 - 14.0)	7.13 (5.1 - 12.6)
<i>MIMULUS GUTTATUS</i>					
Ottawa National Forest (N = 25)	34.33 (20.0 - 45.0)	23.56 (15.0 - 32.0)	24.84 (15.5 - 31.0)	17.50 (10.0 - 21.0)	7.34 (3.5 - 10.0)
Utah (Matthaei) (N = 38)	22.93 (16.0 - 33.8)	21.99 (13.2 - 32.6)	18.86 (14.1 - 29.3)	11.85 (9.0 - 22.0)	7.00 (1.7 - 11.5)
COMBINED (N = 63)	27.41 (16.0 - 45.0)	22.61 (13.2 - 32.6)	21.32 (14.1 - 31.0)	14.09 (9.0 - 22.0)	7.14 (1.7 - 11.5)

* Minc (1989) and others refer to *M. glabratus* var. *jamesii* as *M. glabratus* var. *fremontii*, but var. *jamesii* currently is the correct name (Voss 1996:248).

APPENDIX B. MNFI ELEMENT OCCURRENCE RANKING CRITERIA

RANK	EXPLANATION
A	<p>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.</p>
B	<p>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.</p>
C	<p>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.</p>
D	<p>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.</p>

APPENDIX C. PRINCIPLE FEDERAL AND STATE LAWS APPLICABLE TO THE PROTECTION OF *MIMULUS GLABRATUS* VAR. *MICHIGANENSIS* AND ITS HABITAT

Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1544). Regulations, in part, at 50 CFR 17 and 50 CFR 402.

Federal Water Pollution Control Act of 1948, as amended (“*Clean Water Act*”) (33 U.S.C. 1251-1376). Regulations at 33 CFR 320-338.

National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321-4347).

Part 17, Michigan Environmental Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. MCL Sections 324.1701 - 324.1706.

Part 19, Natural Resources Trust Fund, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. MCL Sections 324.1901 - 324.1910.

Part 21, Land Exchange Facilitation Fund, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. MCL Sections 324.2130 - 324.2136.

Part 21, Conservation and Historic Preservation Easement, of the Natural Resources and Environmental Protection act, 1994 PA 451, as amended. MCL Sections 324.2140 - 324.2144.

Part 301, Inland Lakes and Streams Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. MCL Sections 324.30101 - 324.30113

Part 303, Wetland Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. MCL Sections 324.30301 - 324.30323.

Part 323, Shorelands Protection and Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. MCL Sections 324.32501 - 324.32515.

Part 353, Sand Dune Protection and Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. MCL Sections 324.35301 - 324.35326.

Part 365, Endangered Species Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. MCL Sections 324.36501 - 324.36507.

APPENDIX D. PEER REVIEW AND PUBLIC COMMENT

Development of this recovery plan began shortly after listing in July, 1990, before the Service issued its July 1, 1994, policy on peer review. A draft recovery plan for *Mimulus glabratus* var. *michiganensis* (Michigan monkey flower) was made available for public review and comment for 30 days on June 10, 1991 (56 FR 26693). The administrative record for public review and comment on this plan is maintained by the Service Regional Office in Twin Cities, MN.

Although 20 or more reviewers, representing a wide spectrum of agencies and private individuals, received copies of the combined technical/agency draft plan, the reviewers listed here consist only of those who submitted written comments to the U.S. Fish and Wildlife Service. Comments and opinions received are not summarized separately in this plan, but have been considered and incorporated when appropriate into the Final Recovery Plan.

Margaret Bliss
1420 Providence Hwy.
Norwood MA 02062

Mr. Robert Jones
Box 242
Glen Arbor, Michigan 49636

Dr. Robert K. Vickery, Jr.
Department of Biology
University of Utah
Salt Lake City, Utah 84112

Dr. Edward G. Voss
Herbarium
North University Building
University of Michigan
Ann Arbor, Michigan 48109-1057