EASTERN PRAIRIE FRINGED ORCHID
Platanthera leucophaea (Nuttall) Lindley

RECOVERY PLAN

Prepared by

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for

Region 3
U.S. Fish and Wildlife Service
Fort Snelling, MN

Approved: _____
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EXECUTIVE SUMMARY
EASTERN PRAIRIE FRINGED ORCHID RECOVERY PLAN

Current Status: The federally threatened eastern prairie fringed orchid (*Platanthera leucophaea*) is currently known to persist in 59 populations in 6 states, most populations are in Wisconsin, Illinois, Michigan and Ohio. Only 15 of the extant populations in the United States have full legal protection, and 11 populations lack serious management problems. Six U.S. populations are considered to have high viability with potential for long term persistence, and four of these sites have full legal protection.

Habitat Requirements and Limiting Factors: The eastern prairie fringed orchid requires full sun for optimum growth and reproduction. It occurs in tallgrass silt-loam or sand prairies, sedge meadows, fens, and occasionally sphagnum bogs. It appears to be adapted to natural patch disturbances, or areas with dynamic disturbance regimes; occasionally the orchid colonizes successional habitats or recolonizes previously occupied areas, exhibiting metapopulation dynamics. Long term population maintenance requires reproduction from seed, which is accomplished only with pollination by hawkmoths. Seedling establishment requires development of mycorrhizae with soil-inhabiting fungi, and maintenance of graminoid habitat, usually by fire. Increasing pesticide use may impact both pollinators and fungi.

Recovery Criteria: The eastern prairie fringed orchid may be removed from the list of *Endangered and Threatened Wildlife and Plants* when 22 highly viable populations are distributed across plant communities and physiographic regions within the historic range of the species. A highly viable population typically has more than 50 flowering plants; a population trend that is stable or increasing over a monitoring period of 5 years; available habitat of at least 50 hectares (125 acres) in size; assurances of ongoing management to reduce impacts from drainage, invasive plant species or woody vegetation encroachment; and protection through long term conservation easements, legal dedication as nature preserves, or other means.

Prioritized Recovery Actions:

1. Protect habitat.
2. Manage habitat to support stable or increasing populations of the orchid.
3. Increase the size and number of existing population.
4. Monitor the status of known populations.
5. Conduct research needed to identify recovery actions.
6. Update population ranks and identify populations to be restored to higher levels of viability.
7. Track the progress towards recovery.

Total Estimated Cost of Recovery: $5,315,000.

Date of Recovery: Recovery could occur by 2020, if recovery criteria are met.

Recovery plans delineate reasonable actions needed to recover and/or protect listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, state agencies, and others. The purpose of the plan is to promote the conservation of the threatened eastern prairie fringed orchid (*Platanthera leucophaea*) by implementing identified tasks. Recovery objectives will be attained and funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities.

This plan does not necessarily represent the views or official position of any individuals or agencies involved in plan formulation, other than the U.S. Fish and Wildlife Service. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature citation:

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Cover illustration of the eastern prairie fringed orchid by Mary Phelan.

ACKNOWLEDGMENTS

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PART I. INTRODUCTION

The eastern prairie fringed orchid (*Platanthera leucophaea* [Nuttall] Lindley) is 1 of at least 200 North American orchid species, which is limited in distribution primarily by temperature and drought extremes (Correll 1950). This large and showy orchid species of North American grasslands is adapted to fire and periodic drought. Its populations are characterized by occasional periods of dormancy or mass flowering. Hawkmoths (*Sphingidae*) pollinate the eastern prairie fringed orchid at night (Bowles 1983, Sheviak and Bowles 1986, Bowles *et al*. 1992). The eastern prairie fringed orchid was formerly widespread in prairies and wetlands primarily east of the Mississippi River, while its western species pair, *Platanthera praeclara,* (Sheviak and Bowles 1981) ranged west of the Mississippi.

DESCRIPTION AND TAXONOMY

The eastern prairie fringed orchid is characterized by an upright leafy stem and flower cluster rising 20 to 100 centimeters (cm) (8 to 40 inches) from an underground tuber. Leaves sheath the stem, and are 8 to 20 cm (3 to 8 inches) long, elliptical to lance-shaped, and progressively larger toward the stem base. The single flower spike is usually composed of 5 to 40 creamy white flowers above lance-shaped bracts 1 to 4 cm (less than 2 inches) long. The flowers at the top of the spike open last. The flowers are distinguished by a three-parted fringed lip 1.5 to 3 cm (less than 1 inch) long and a distally thickened nectar spur 2 to 5.5 cm (about 1 to 2 inches) long (Figure 1).

The eastern prairie fringed orchid was first collected in 1819 by Nuttall near the junction of the Kiamichi and Red rivers in the Arkansas Territory, which is now in Choctaw County, Oklahoma (Sheviak and Bowles 1986). Nuttall placed this species in the genus *Orchis* in 1834; it was then transferred to *Platanthera* by Lindley in 1835, a genus that was subsequently treated as *Habenaria* by Gray in 1867, and finally reclassified as *Platanthera.*

Although Gleason and Cronquist (1991) treat the western prairie fringed orchid (*Platanthera praeclara*) as a variety of the eastern prairie fringed orchid, this classification fails to consider quantitative differences in flower structure, which are essential in interpreting evolution and speciation in the Orchidaceae (van der Pijl and Dodson 1966, Dressler 1981, Marlin Bowles, Morton Arboretum, pers. comm. 1991). The eastern prairie fringed orchid and its western species pair are separated by morphologically different flower structures that prevent hybridization (Sheviak and Bowles 1986). When the western prairie fringed orchid is visited by pollinators, pollen is placed on the compound eyes of the moth. Pollinators visiting the eastern prairie fringed orchid collect pollen on the proboscis. This difference prevents cross pollination between the two species. The eastern prairie fringed orchid also has slightly smaller flowers, and often a more elongated and open flower cluster.

Two other orchid species may be confused with the eastern prairie fringed orchid. *Platanthera lacera,* a species of less calcareous habitats, has similar flower color and structure, but has smaller flowers with shorter nectar spurs, ovaries, and flower bracts. *Plathanthera blephariglottis,* a species of acid bogs, has smaller and morphologically different white flowers.

Figure 1. Flower, pollinaria and inflorescence of the eastern prairie fringed orchid (*Platanthera leucophaea*). Reproduced from Mitchell and Sheviak 1981, with permission from the New York State Museum, Albany, New York, and Sheviak and Bowles 1986.

a.

b.

DISTRIBUTION AND STATUS

The eastern prairie fringed orchid formerly occurred from eastern Iowa, Missouri, and Oklahoma eastward across southern Wisconsin, northern and central Illinois, southern Michigan, northern Indiana and Ohio, and northwestern Pennsylvania to western New York and adjacent southern Ontario. Disjunct populations also occurred in New Jersey, Virginia and Maine (Figure 2).

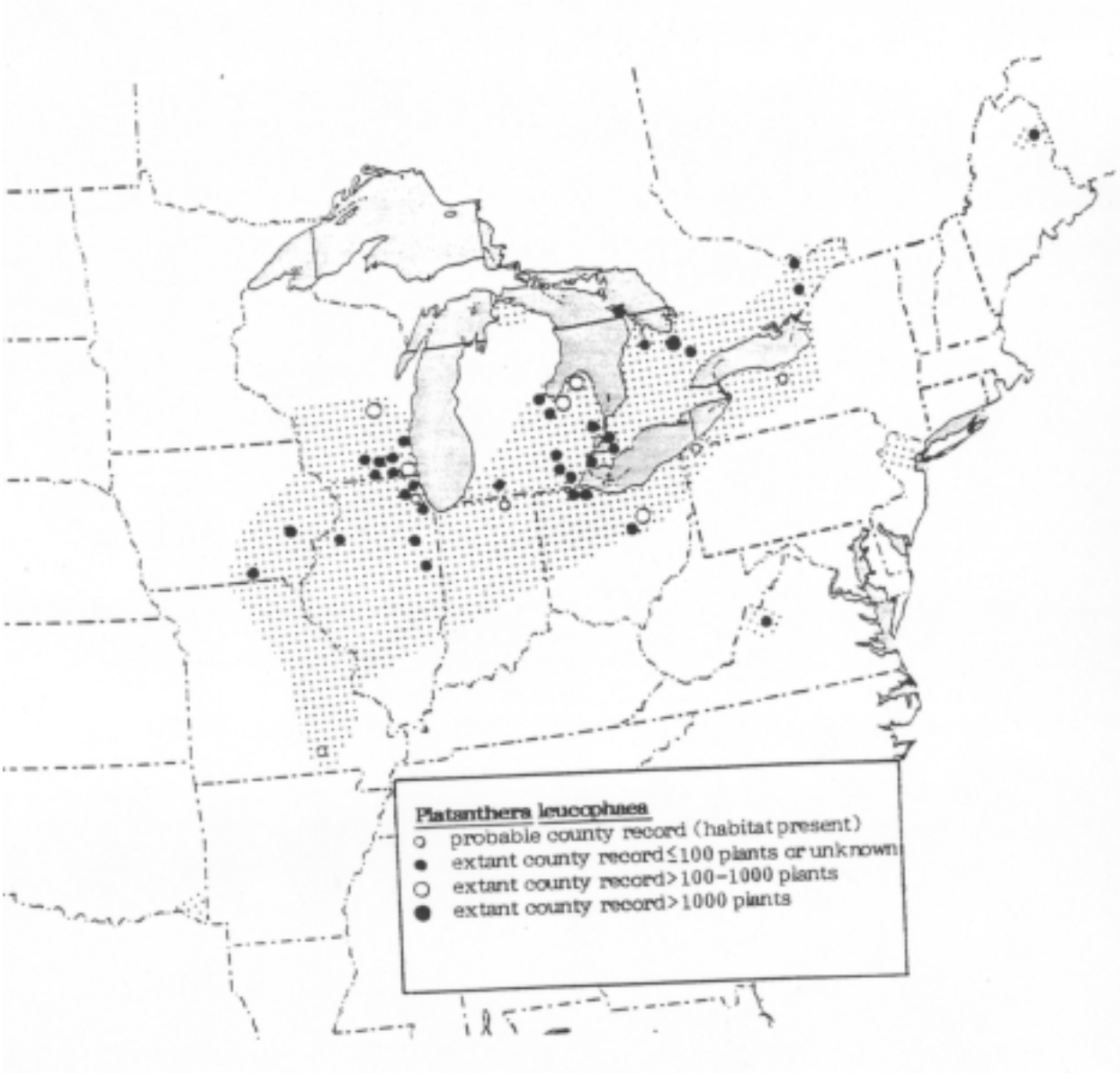
The eastern prairie fringed orchid has declined more than 70 percent from original county records in the United States; 59 populations are extant in 6 states (Table 1). Plants have not been relocated in New York, Pennsylvania, New Jersey, or Oklahoma. This drastic decline has been due mainly to conversion of habitat to cropland and pasture. This orchid may persist in extensive potential habitat in western New York (Reschke 1990) and in fen remnants in New Jersey (Shuey 1996). In Virginia, a population may persist in an unprotected sedge meadow that is maintained in part by grazing, but plants have not been seen at this site since the 1980s.

Remaining populations continue to be threatened by succession to woody vegetation, competition from non-native species, over collecting, and drainage and development of wetland habitats. Most remaining habitats are small, with fewer than 50 plants, and are not representative of the once vast prairie populations of this orchid (Sheviak 1974, Bowles 1983, Case 1987). Only a few population census counts in the United States have exceeded 500 flowering plants, and these numbers are from successional habitats that fluctuate widely over time. Less than 30 percent of the populations in the United States have full legal protection or lack significant management problems; and only about 20 percent are adequately protected and managed. In Canada, 12 populations are known from wetland and prairie habitat in 12 Ontario counties (Brownell 1984). As a result of this decline, on September 28, 1989, the U.S. Fish and Wildlife Service (Service) listed the eastern prairie fringed orchid as threatened under the Endangered Species Act (Act) of 1973, as amended (U.S. Fish and Wildlife Service 1989).

Illinois

Illinois probably contained the largest and most extensive pre-European settlement populations of the eastern prairie fringed orchid, and has sustained the most drastic population decline of any state. Originally the species was known from tallgrass prairie in 33 counties across the northern two thirds of the state, an area now almost totally converted to agriculture (Sheviak 1974, Bowles and Kurz 1981). As many as 20 populations may occur in 6 counties concentrated in the Chicago region, and single populations occur in cemetery prairies in eastern and west-central Illinois counties (Bowles *et al*. 1992). Though 14 Illinois populations are protected and managed, only 2 of these contain more than 100 plants. This orchid was successfully introduced by seed broadcast into three sites in Cook County, Illinois (Packard 1991). Based on the success of these introductions, seeds produced by hand pollination have been introduced into 14 additional northeastern Illinois sites and 1 Wisconsin site (Keibler *et al.* 1993, Keibler 1994, 1995, 1998).

Figure 2. Former range and current distribution of the eastern prairie fringed orchid in North America with population size estimates by county (Reproduced from Bowles 1983).



Michigan
Historically, this orchid was known from 21 Michigan counties (Case 1987); now there are 12 populations in 9 counties, and less than half are formally protected. Most occurrences are in southeastern lower Michigan where 1322 flowering stems were counted in 1984 (Chapman and Crispin 1985), and 1150 plants were observed in 1990 (Case and Case 1990). The largest of these populations are in lake plain prairies bordering Saginaw Bay. These habitats are periodically inundated during high lake levels (Case and Case 1990) and are threatened by invasion of non-native plant species. The total number of flowering plants contained in a cluster of populations occurring on degraded prairie and wetland habitat bordering Lake Erie has fluctuated from an estimated 900 plants in 1984 (Chapman and Crispin 1985) to an estimated 314 plants in 1990 (Case and Case 1990).

Ohio
The eastern prairie fringed orchid historically occurred in four northern Ohio counties (Spooner 1981), and is now known from five counties, one in southwestern Ohio (Windus and Cochrane 1997). Two populations remain in disturbed successional habitats affected by Lake Erie water levels (Windus and Stoutamire 1993). Five populations of the eastern prairie fringed orchid have been discovered in Ohio in the last 10 years, bringing the total number to nine populations. Five populations are protected in state wildlife areas and a state park, and receive ongoing management to control woody vegetation and non-native species. One of these sites is managed for wildlife and control of purple loosestrife (*Lythrum salicaria*), and was estimated at over 5600 plants in 1996. Two Ohio populations also occur in protected habitat in north-central Ohio (Windus and Stoutamire 1993). One site, supporting successional sedge meadow, was estimated to contain 400 plants in the early 1980s. The other north-central Ohio population is smaller and occurs in more stable sedge meadow habitat.

Wisconsin
In Wisconsin, this orchid originally was known from 17 counties in the south and southeast portions of the state (Alverson 1981). Thirteen populations now occur in prairies and sedge meadows in eight counties. Eight of these populations occur at sites that are actively managed, and most are protected. One population occurs in an extensive minerotrophic peatland in eastern Wisconsin that is threatened by glossy buckthorn (*Rhamnus frangula*) invasion (Reinartz and Kline 1988), and a population complex of several hundred or more plants occurs in partially protected lake plain prairie habitat bordering Lake Michigan.

Iowa
Two sites known to contain eastern prairie fringed orchid populations remain in Iowa. The first is in mesic prairie along an abandoned railroad right-of-way. The second site was discovered by Keith Oetken in 1994, with over 100 plants. When this 2 acre sedge meadow bordering an impounded marsh was revisited in 1998, there were over 1,000 orchids. An additional population formerly occurred in preserved wet prairie habitat, but plants have not been seen there since the 1980s.

Maine
The Maine population occurs in graminoid portions of an extensive unprotected fen complex undergoing some invasion by woody vegetation (Jacobson *et al*. 1991). Flowering plants appear erratically at this site, and the population size is unknown.

Table 1. Numbers of eastern prairie fringed orchid populations in the United States by state, plant community, and physiographic region.

COMMUNITY / **Physiographic Region**	**State**					
	Illinois	Iowa	Michigan	Maine	Ohio	Wisconsin
PRAIRIE						
Kansan till		1				
Wisconsinan drift	19					7
PRAIRIE						
Lake Erie lake plain			1		5	
Lake Huron lake plain			8			
Lake Michigan lake plain	1					2
SEDGE MEADOW						
Unglaciated	2	1			4	3
MINEROTROPHIC/ SPHAGNUM PEATLAND			3	1		1
TOTAL	22	2	12	1	9	13

HABITAT

The eastern prairie fringed orchid occurs in a wide variety of habitats, from mesic prairie to wetland communities such as sedge meadows, marsh edges and even bogs. It requires full

sunlight for optimum growth and flowering, which restricts it to grass- and sedge-dominated plant communities. The substrate of the sites where it occurs ranges from more or less neutral to mildly calcareous (Case 1987, Sheviak 1974, Bowles 1983).

This Recovery Plan classifies these habitats by plant community (prairie, sedge meadow, fen and sphagnum bog), substrate (glacial soils, lake plain deposits, muck and peat), and physiographic region (Table 1). Prairie occupies glacial soils derived either from loess, glacial drift (till and outwash), or lake plain deposits of sand or coarse silt. Sedge meadows occur in muck soils developed in glaciated or unglaciated substrates. Fens and sphagnum bogs occur in organic substrates usually developed in minerotrophic peat, or occasionally in more acidic peat.

These habitats occur across six physiographic regions. The unglaciated Ozark region supports sedge meadow habitat, from which the eastern prairie fringed orchid is apparently extirpated. Kansan glacial soils support prairie habitat, primarily west of the Mississippi River. East of the Mississippi River, Wisconsinan glacial soils support prairie, sedge meadow, and peatland habitat. The lake plains of the Lake Michigan, Lake Huron, and Lake Erie basins support prairie habitat. Disjunct populations also occur in unglaciated sedge meadow, and formerly occurred in unglaciated prairie in Oklahoma.

The eastern prairie fringed orchid can occupy a broad moisture gradient. In sand prairies, this gradient ranges from mesic prairie along the tops of low dune ridges to wet prairie in shallow interdunal swales (Bowles 1985). Sand prairies are occupied in areas with adequate calcareous groundwater supplies, primarily in the lake plains of the Great Lakes. Most midwestern eastern prairie fringed orchid populations occur in silt-loam soils derived from loess or glacial till. Loess deposits over glacial till or outwash predominate in Illinois, but become thin or absent northward in Wisconsin. In silt-loam soils, most populations are found in level mesic prairie, or in wet prairie along the borders of prairie potholes and watercourses; but the orchid occasionally occurs in upland sites, such as along ridges created by glacial deposits (Bowles *et al*. 1992).

Natural processes that maintain habitats in early or mid-successional phases may be important in providing the sunny, open conditions required by the orchid. In patterned fens, strong groundwater flow often maintains grass and sedge dominated areas within a forested matrix. Sedge meadow and marsh habitats that support the eastern prairie fringed orchid are often early- or mid-successional because of past grazing, drainage, or soil disturbance. Local patch disturbances that expose the soil to this orchid's seeds, and reduce competition from established plants, may be needed for seedling establishment.

Sphagnum bogs supporting this orchid may be successional from sedge meadows (*sensu* Sytsma and Pippen 1982a, 1982b). The plants occurring in sphagnum tamarack bogs have been assumed to root below the sphagnum layer in a more calcareous substrate (Correll 1950, Chapman 1981) or occur in younger advancing mats (Case 1987). Patch disturbances that expose the calcareous substrate in otherwise more acidic sphagnum tamarack bogs may allow seedling establishment and maintain orchid populations.

SPECIES BIOLOGY

Life History

The eastern prairie fringed orchid is a perennial herb with a complex life history (Bowles 1983, Figure 3). The plants grow from an underground tuber. Flowering begins from late June to early July, and lasts for 7 to 10 days. Seed capsules mature over the growing season and disperse seed in late August or September. The requirements for successful seedling establishment are still poorly understood.

The plant has capacity for annual regeneration of the tuber rootstock and associated buds, making individual plants potentially long-lived. The underground tuber develops a bud and the precursors of a flowering stalk during the growing season the year before flowering (see Figure 4). The leaves and a developing flower cluster begin to emerge above ground in May of the following growing season.

Night flying hawkmoths pollinate the nocturnally fragrant flowers of the white-fringed orchids (Bowles 1983, 1985). Reproduction by vegetative spread is apparently rare. Visiting hawkmoths receive pollen on their proboscises as they ingest nectar from the flower's long nectar spurs. A 1998 survey of large sites in Michigan and Ohio identified the following species carrying eastern prairie fringed orchid pollen: *Eumorpha pandorus, Eumorpha achemon,* and *Sphinx eremitis* (D. Cuthrell, Michigan Natural Features Inventory, in litt.1998). Some Illinois records of larval host plants for *Eumorpha pandorus* and *Eumorpha achemon* are *Ampelopsis spp*., and *Vitis spp*.; and for *Sphinx eremitis* are *Monarda spp*., *Mentha spp*., *Lycopsis spp*., and *Salvia spp*. The garden pest tomato and tobacco hornworms have been observed visiting the orchids. A number of additional moth species have been identified as potential pollinators by correlating their proboscis length with the depth to nectar in the eastern prairie fringed orchid's nectar spur. Additional field surveys are needed to confirm their status as pollinators.

White-fringed prairie orchid blossoms often rise just above the height of the surrounding grasses and sedges. The more exposed flower clusters are more likely to be visited by the hawkmoth pollinators (Bowles 1985), though they are also at greater risk of being eaten by deer. Following pollination, white-fringed orchid seed capsules produce thousands of minute, lightweight seeds, that are dispersed by the wind after the capsules dry out and crack open, and release the seeds.

Specific requirements for eastern prairie fringed orchid seedling establishment are not well known. Seed germination may be light-inhibited, with dormancy broken by darkness and moist stratification. Successful seedling establishment requires development of a mycorrhizal association with a favorable soil-inhabiting fungus (Stoutamire 1974). The fungus provides nutrients to the seedling, which may remain underground for several years. Once the seedling emerges from the ground and produces leaves and begins photosynthesis, this relationship may become symbiotic. This relationship, or mycorrhizal association, is likely not species specific for either orchids or fungi, with the fungal genus *Rhyzoctonia* responsible for most orchid mycorrhizae relations (Smith 1966, Sanford 1974, Hadley 1970, Wells 1981). Curtis (1993) found *Rhyzoctonia robusta, R. subtilis, R. sclereotica,* and *R. Stahlii* associated with the eastern

Figure 3. Life Cycle model for the eastern prairie fringed orchid (Modified from Bowles 1983).

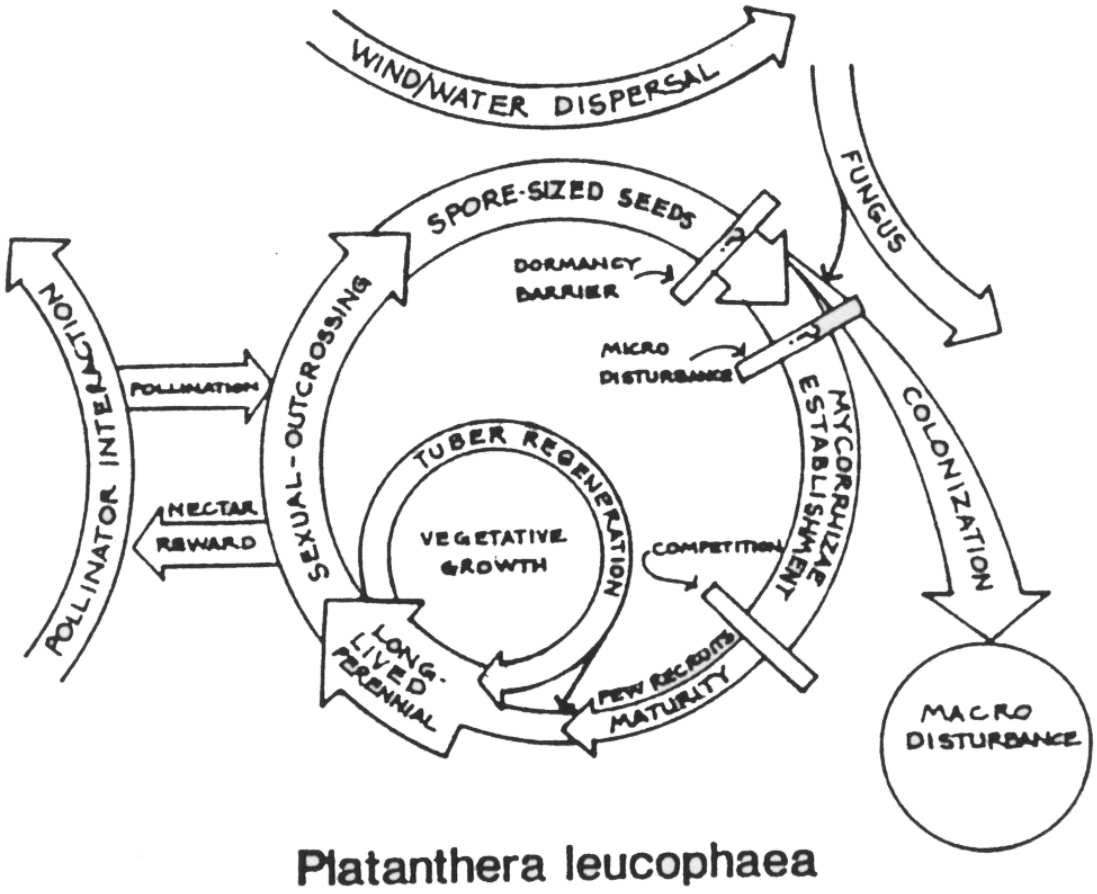
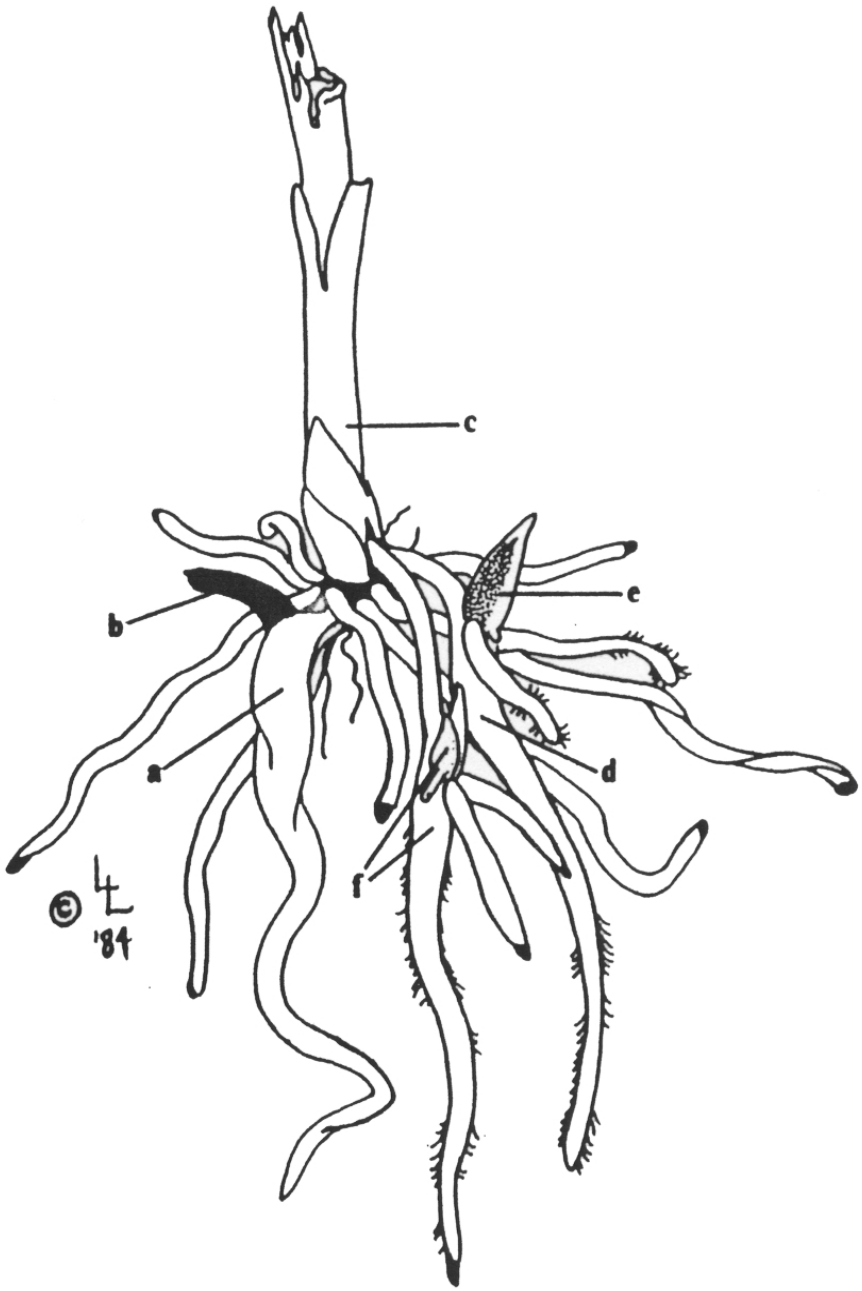


Figure 4. Subterranean organs of the eastern prairie fringed orchid: a, an old primary fusiform tuber or “sinker”; b, old ramet; c, current ramet; d, new primary fusiform tuber; e, perennating bud; f, secondary tuber and bud. Illustrated by Linda Lobik, composite of specimens collected from garden plot, September 1983.



prairie fringed orchid mycorrhizae in different Wisconsin habitats. However, it is not known whether the *Rhyzoctonia* found with orchid mycorrhizae are the species required for successful seed germination (Curtis 1993). The root systems of terrestrial orchids are reduced, and require fungal mycorrhizal associations for proper water uptake and nutrition (Sheviak 1990), especially under stress (Hadley and Pegg 1989). Spring burning of prairie stimulates mycorrhizal productivity (Bentivenga and Hetrick 1991), and could be ecologically important in promoting orchid seedling establishment or performance of established orchids. Thus the stability of orchid populations is closely related to the ecological conditions of their mycorrhizae (Sheviak 1974), which may be in part affected by the increased mycorrhizal productivity that occurs after spring burning of prairie (Bentivenga and Hetrick 1991).

Disturbance also appears important in eastern prairie fringed orchid seedling establishment. Patch disturbance regimes or early-successional vegetation stages are critical for seedling establishment of disturbance-adapted plants, and terrestrial orchids are well known for colonization following disturbance (Sheviak 1974, Case 1987, Pavlovic 1994). The eastern prairie fringed orchid probably colonizes areas where competition from other plants has been reduced, either by patch disturbance from animals or from the death of other plants. Its populations reach highest densities in habitats with areas of disturbance or early- to mid-successional plant communities. Under apparently favorable conditions or in successional habitats, flowering plants have appeared as soon as 5 years after seed dispersal (Case 1987, Packard 1991).

Although the eastern prairie fringed orchid is pre-adapted to dormant season disturbances, such as prairie fires, growing season damage to vegetative material may weaken plants by limiting food storage. Mowing or cropping of plants early in the growing season may also result in failure to form the next season's flower bud, inducing dormancy or even death the following season (Sheviak 1990). High levels of seed production may also weaken individual eastern prairie fringed orchid plants. Although Case (1987) reported that heavy seed set did not appear to affect this orchid in a garden, Snow and Whigham (1989) found reduced levels of flowering and vegetative growth in natural populations of the terrestrial orchid *Tipularia discolor* following seasons of high seed production.

Occasionally plants seem to be entirely dormant, not emerging above ground during the growing season (Bowles *et al*. 1992). Dormant plants rarely reappear. The mechanisms that trigger orchids to go dormant or emerge from dormancy are important to understand. Research to investigate potential relationships with the type and timing of management is needed.

High precipitation levels and fire are two factors that have been suggested to promote flowering of the eastern prairie fringed orchid in tallgrass prairie habitat (Sheviak 1974, Roosa and Eilers 1979, Bowles 1983), but moisture levels seem to be an overriding factor. Over a 12 year period in Illinois, percent flowering in the eastern prairie fringed orchid populations was higher in wetland habitat and was positively correlated with growing season rainfall (Bowles *et al*. 1992). Flowering plants also appeared more quickly in wetland habitat after a severe 1988 drought

(Bowles *et al*. 1992). Thus, burning would most likely promote flowering in tallgrass prairie wetlands or during years of high growing season rainfall. Data from the eastern part of this species' range, however, does not show this correlation (Windus and Cochrane 1997). Fire occurred historically in lake plain prairies with the eastern prairie fringed orchid in Michigan (Hayes 1964) but lake level fluctuations control groundwater levels and the successional stages in which the eastern prairie fringed orchid persists (Case 1987).

Population dynamics

Under some conditions, the eastern prairie fringed orchid can be extremely long-lived. Case (1987) reported plants surviving up to 30 years in gardens, and small populations have persisted in cemetery prairies where annual mowing prevented seed production for decades (Bowles *et al*. 1992). However, dramatic fluctuations in plant numbers may occur in natural populations, with flowering correlated positively with rainfall and negatively with temperature cycles, as evidenced by data from an Illinois wet prairie (Bowles *et al.* 1992). Most of the plants that were marked and tracked died by the third year after initial flowering. However, 31.5 percent of the population survived over a 10 year period with a small percentage of plants showing at least 1 year of dormancy. Plants that do not die may shift between flowering, vegetative, and dormant stages. A small percentage of plants appear to survive at least 1 year of dormancy and plants that do not flower may persist for long time periods.

In habitats with large scale disturbance patterns, eastern prairie fringed orchid populations shift spatially over time, with high population turnover, decline, or total loss (Bowles 1983, Case and Case 1990). Here, populations that persist are characterized by metapopulation dynamics, as some populations become extirpated and new patches colonize. Continual recolonization of successional habitats is dependent on massive seed production and dispersal, which requires high pollinator visitation rates and presence of appropriate soil fungi.

The most remarkable natural population fluctuations of the eastern prairie fringed orchid have occurred in relation to cyclic Lake Huron and Lake Erie shoreline fluctuations and water level fluctuations caused by human management (Case 1987, Case and Case 1990, Watson 1998). Ohio populations around Lake Erie have reached the highest flowering population counts at intermediate lake levels, suggesting that there may be an optimal level that promotes flowering (Windus and Cochrane 1997). It is not clear, however, how the changing lake levels and the timing and period of flooding affect flowering population size. Orchids apparently colonize early-successional habitat 2 to 5 years after lake flooding or diking. After about 5 years, flowering orchids appear, but may gradually decline with invasion by dogwood (*Cornus* sp.) on mesic sites, and by purple loosestrife or reed canarygrass (*Phalaris arundinacea*) on wet sites. Maintenance of a series of advancing successional stages may ensure that suitable sites are available for prairie orchid colonization as water levels fluctuate. Managers of sites with artificially controlled water levels should ensure that orchid populations remain undisturbed for at least 5 years, allowing time for seed production and dispersal to other suitable areas within the site.

Genetics and conservation

Studies of the distribution of genetic diversity in the eastern prairie fringed orchid indicate that greater differences in genetic composition exist between populations in the eastern portion of the species' range than exist between populations in Illinois, the western portion of its range (Linhart and Mendenhall 1977, Cowden 1992). Higher gene flow could have maintained lower genetic differentiation among western populations if they were once contiguous in tallgrass prairie. Since hawkmoths can fly long distances while carrying pollen (Linhart and Mendenhall 1977) the possibility of genetic exchange between orchid populations is great (Cuthrell 1994). Isolated eastern populations may have undergone founder events or genetic drift, resulting in greater genetic variation between populations (Pleasants and Klier 1995). Protecting as many sites as possible may be the best strategy for preserving the species' genetic diversity (Cowden 1992).

Population dynamics may also affect genetic diversity. Large eastern prairie fringed orchid populations occurring in successional habitats in southeastern Michigan contained the highest genetic diversity measured by Cowden (1992). The high rate of population turnover as lake levels fluctuate would require high levels of sexual reproduction, and may maintain high levels of genetic diversity at the metapopulation scale if crossing occurs among populations.

REASONS FOR LISTING AND CONTINUING THREATS

The eastern prairie fringed orchid has declined more than 70 percent from original county records in the United States. At the time of listing, 55 populations were extant in 7 states, and plants had not been relocated in New York, Pennsylvania, New Jersey, Indiana, or Oklahoma. The Virginia population has since apparently been extirpated. Most populations are in need of protection and management; only 15 of the currently extant 59 United States populations have full legal protection, and only 11 populations are relatively free of serious management problems.

Habitat destruction

Most eastern prairie fringed orchid populations have been lost through conversion of habitat to cropland and pasture. Drainage and development now pose the greatest threats to this species' habitat.

Fire suppression and woody vegetation encroachment

Late-successional prairie remnants supporting this species require routine burning to reduce cover of woody vegetation. Woody vegetation that covers the orchid flowers reduces pollination. Lack of appropriate natural areas management threatens populations regardless of their legal protection status. Maintenance of high density orchid populations in natural areas presents a paradox for land managers (Bowles *et al*. 1992) as more stable late-successional conditions are usually preferred in grasslands, but may have lower orchid densities (Bowles 1983).

Impacts to pollinator populations
This orchid's dependence upon hawkmoths for pollination makes it vulnerable to population changes in these insects. The status of most hawkmoth species is poorly known. Information on basic life history requirements such as larval host plants is not known for many species. Pollinator populations may be adversely affected by pesticides and loss of habitat.

Competition from non-native plant species
Invasions of wetlands by non-native plant species such as reed canarygrass, purple loosestrife, and glossy buckthorn are serious threats to the eastern prairie fringed orchid (Bowles *et al*. 1992). Purple loosestrife rapidly invades open sedge meadows and other wetlands to the exclusion of other species (Thompson *et al*. 1987). Although it is not difficult to eliminate small numbers of individual plants, control of large invasions must be at the community level, requiring re-colonization or restoration of native species (Reinartz *et al*. 1987, Heidorn and Anderson 1991). Glossy buckthorn invades both open and closed communities, and is especially difficult to eradicate from fire-sensitive areas such as forested bogs (Reinartz and Kline 1988). Reed canarygrass also aggressively invades and dominates disturbed wetlands and may impact the eastern prairie fringed orchid. Cut-leaved teasel (*Dipsacus laciniatus*) occasionally invades open communities such as cemetery prairies (Solecki 1989).

Overutilization for commercial and scientific purposes
Because native terrestrial orchids are rarely grown from seed, adult plants are often sought for scientific and commercial purposes, or for gardens. Smaller populations of the prairie fringed orchids can be negatively impacted by collecting. Because of high human population densities in some parts of the range of the eastern prairie fringed orchid, it is subject to scientific and commercial pressures. At least one Michigan population and two Illinois populations have been impacted by removal of plants.

Existing regulatory mechanisms
Protection of threatened plants on privately owned lands is extremely limited in most states, leaving those populations vulnerable to habitat destruction and extirpation. Michigan and Iowa require state permits for actions that would affect plants on private lands.

CONSERVATION MEASURES

Eastern prairie fringed orchid populations can receive various forms of protection through public ownership, formal agreements from private landowners, or legal dedication through permanent conservation easements under state nature preserve acts. Legal dedications that declare the land set aside to its highest and best use and protect it from other forms of government use, development, or use for public utility projects, represent the highest form of protection because of their permanence (Pearsall 1984). Such dedications can usually be made by private or public landowners, and thus do not require transfer of property ownership. Conservation easements or dedication as Nature Preserves protects 14 populations.

Once habitats are protected, land management is the most important and most useful tool for conservation of the eastern prairie fringed orchid. Landowners can receive management assistance or management advice from professional land managers (e.g., Apfelbaum and Tams 1987, Apfelbaum *et al*. 1990, Hutchison 1992) and the Service.

Volunteer networks in Illinois and Wisconsin monitor orchid populations and manage orchid sites, through brush clearing, herbiciding of non-native vegetation, and prescribed burning. After application of a grass-specific herbicide to control reed canarygrass adjacent to an orchid population at one site in Illinois, orchids bloomed the following year for the first time in the treated area (J. Keibler, pers. comm.). Volunteers in the Chicago, Illinois area also hand-pollinate the orchids, and collect and disperse the orchid seeds.

Hand-pollination of prairie fringed orchids can induce seed production in small populations (Bowles 1983) and provide seeds for introduction into new habitats. For example, seed dispersal into three northeastern Illinois sites resulted in the appearance of flowering plants after 5 years (Packard 1991). Based on the success of these introductions, the Service contracted with The Nature Conservancy in 1993, 1994, and 1995 to conduct hand-pollination of eastern prairie fringed orchids in northeastern Illinois populations, and to disperse seeds into 14 additional northeastern Illinois sites and 1 Wisconsin site (Keibler *et al.* 1993, Keibler 1994, 1995). Eastern prairie fringed orchids have since bloomed in two of these dispersal areas (Keibler 1998, J. Keibler, pers. comm.).

Ohio Department of Natural Resources staff and volunteers for The Nature Conservancy in the Chicago area have been collecting detailed demographic data on individual tagged orchids to develop a data set that may help identify critical life stages to focus recovery efforts. The Chicago Botanic Garden and the University of Akron are conducting genetic diversity studies to identify distribution patterns of genetic diversity in the eastern prairie fringed orchid. This information will be used to guide cross pollination and reintroduction decisions. The Service has funded staff from Michigan Natural Features Inventory and the University of Wisconsin in Madison, to conduct surveys at prairie orchid sites to identify the insect species that are pollinating the prairie orchid, as a first step to assessing the status of those pollinator populations. The Morton Arboretum, in Lisle, Illinois, is conducting experimental seed germination studies using native *Rhizoctonia* isolated from orchid roots.

In Wisconsin, the Department of Agriculture, Trade and Consumer Protection has developed pesticide protection plans with more than 15 neighbors of orchid sites.

Conservation measures provided to the eastern prairie fringed orchid as a threatened species include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. The eastern prairie fringed orchid was listed as a threatened species under the Act in 1989 (U.S. Fish and Wildlife Service 1989). Recognition through listing encourages and results in conservation actions by Federal, State, private agencies, groups, and

individuals. The Act provides for possible land acquisition and cooperation with the States and requires that recovery actions be carried out for all listed species.

Section 7 of the Endangered Species Act requires Federal agencies to consult with the Service if any action they may fund, authorize, or carry out may affect listed species. Section 7 also requires that these agencies use their authorities to further the conservation of federally listed species. This consultation process promotes interagency cooperation in finding ways to avoid or minimize adverse effects to listed species. Wetland orchid populations receive some protection through section 404 of the Clean Water Act, which requires permits from the U.S. Army Corps of Engineers (COE) for the discharge of fill material into wetlands. The COE must consult with the Service under section 7 of the Act on any proposed permit that may affect the orchid.

Sections 9 and 10 of the Act and its implementing regulations found at 50 CFR 17.71 and 17.72 set forth a series of prohibitions and exceptions that apply to all threatened plant species not covered by a special rule. No special rule has been published for *P. leucophaea*. These prohibitions, in part, make it illegal for any person subject to the jurisdiction of the United States to import or export; transport in interstate or foreign commerce in the course of a commercial activity; sell or offer for sale this species in interstate or foreign commerce; or to remove and reduce to possession this species from areas under Federal jurisdiction; maliciously 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. The term "plant" means any member of the plant kingdom, including seeds, roots and other parts. Because *P. leucophaea* 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 Act provides for the issuance of permits to implement 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. Requests for 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, 1 Federal Drive, Fort Snelling, Minnesota 55111-4056 (phone: 612-713-5350, fax: 612-713-5292). TTY users may contact the Permits Coordinator through the Federal Relay Service at 1-800-877-8339.

Excluding Virginia, where it is not State listed, the eastern prairie fringed orchid is formally or officially listed as state endangered throughout its range in the United States. However, protection varies at the state level (Table 2). In most states, only populations occurring on public lands or dedicated nature preserves are provided full protection. Only Michigan and Iowa require state permits for actions that would affect plants on private lands. In Illinois, consultation with the Department of Natural Resources is required when state and local government actions or funds will impact state listed species. All state laws require permits for sale of listed plants.

Table 2. State listing status, and level of protection for the eastern prairie fringed orchid in the United States.

STATE/STATUS	PROTECTION ACT	LEVEL OF PROTECTION
Illinois/endangered	Endangered species protection act (1988)	Prohibits removal without permission of landowner, and sale without permit; Requires consultation between Department of Conservation and state and local agencies authorizing or funding impacts on state listed species.
Iowa/endangered	Management and protection of endangered plants and wildlife (109A)	Prohibits taking, possessing, importing, exporting, transporting, processing, selling, or buying of any state or federal listed plant.
Maine/endangered	Maine's official list of endangered and threatened plants	None
Michigan/endangered	Michigan Endangered Species Act. MCL	Transport, buying, selling, possessing or destroying in any manner prohibited.
Ohio/endangered	Revised code Chapter 1518 to protect endangered species of native Ohio wild plants	Commercial taking prevented, collecting without landowner permission or state permit prohibited.
Virginia/not listed	Not applicable	Not applicable
Wisconsin/endangered	Statute (Section 29.45)	Removal prohibited from native habitat on public property or from unowned or unleased private property except in forestry, agriculture, or utility construction operation or maintenance. Commerce prohibited, and permits required for collection.

RECOVERY STRATEGY

The first priority in recovering the eastern prairie fringed orchid is to protect the land on which it occurs. This can be done through legal dedication, conservation easements, and landowner agreements. The next and equally urgent priority is to manage those lands to allow continued support to viable populations of the orchid. Little is known about the orchid's life history or the requirements for seedling establishment. Research is needed to understand these aspects of orchid biology. In addition, studies should be conducted to determine the effects of management techniques.

The primary criteria for delisting the orchid are the protection and maintenance of viable populations. A minimum viable population (MVP) is usually the smallest population size capable of persisting over a specified time period (100 years) with a low extinction probability (less than 5 percent), and with sufficient genetic variation to adapt to changing environmental conditions (Soule 1980). To do so, populations must survive extinction risks from natural disasters and from environmental, genetic, and demographic variation while demonstrating stable or positive population growth rates (Gilpin and Soule 1986) measured by demographic changes in mortality, survivorship, and fecundity (Menges 1986, 1991). An important aspect of such demographic analysis is the identification of critical life history stages that have the greatest effect on population growth and factor resolution of the biological and ecological causes of variation in these stages (Pavlik 1994, Schemske *et al.* 1994). Estimating minimum viable population sizes is difficult for species, such as orchids, with cryptic life history stages. An artificial population viability index (PVI) may be used to assess factors promoting or impeding progress toward recovery of the eastern prairie fringed orchid.

Nine characteristics appear to strongly affect population viability of the eastern prairie fringed orchid (Table 3). This orchid requires natural prairie or wetland habitat and is vulnerable to habitat modifications, especially severe habitat degradation. Viable populations cannot occur without land protection, and even protected populations will decline without land management. Because this species is non-rhizomatous and is often short-lived, long-term population maintenance apparently requires high levels of seed production. Large populations would have greater potential viability because of their greater capacity for outcrossing and seed production. However, large populations that develop in disturbed habitat are also vulnerable to vegetation succession and may decline as succession advances. Because flowering and seed production are dependent upon adequate rainfall, reproduction and subsequent population structure are affected by climatic variation. This orchid's dependence upon hawkmoths for pollination makes it vulnerable to population changes in these insects, which are in turn sensitive to environmental effects. When adequate precipitation and high rates of pollination allow production of large amounts of seed, this species is capable of population growth and expansion. However, seed germination and establishment is dependent upon presence of appropriate soil fungi and formation of mycorrhizae. As a result, soil fungi populations and vigor of orchid mycorrhizae are also critical for population maintenance.

Table 3. Factors affecting eastern prairie fringed orchid population viability.

Factor	Implications for recovery
1) Requires natural prairie or wetland habitat	Vulnerable to severe habitat modification, requires protected and managed habitat
2) Short-lived (usually) non-rhizomatous perennial	Long-term population maintenance requires seed production and natural disturbance
3) Colonizes successional vegetation	Vulnerable to successional change unless maintained as metapopulations
4) Flowering enhanced by adequate rainfall and fire	Climate and management affect population structure and dynamics
5) Outcrossing breeding system	Small populations composed of closely related individuals may not be capable of producing viable seed
6) Obligate insect pollen vector	Pollinator fluctuations can affect population dynamics
7) Potentially high reproductive output	High potential for population growth and expansion
8) Mycorrhizae required	Appropriate soil fungi required for establishment
9) Seed germination and protocorm development are critical life stages	Changes have large impacts on population maintenance and growth

Indexing population viability

In order to evaluate the viability of eastern prairie fringed orchid populations, the following artificial population viability index has been developed based on seven biological and habitat variables (Bowles *et al*. 1992). Factors include biological variables that indicate population growth trends, and habitat availability and protection status variables that address external threats

to the viability of the orchid populations. These variables are combined into a population viability index that can be used to target recovery actions that will reduce the chances of population extirpation to acceptable levels (Table 4). The index may be refined as further research provides insight into factors affecting viability. Index ratings will need to be re-evaluated on an annual basis to track recovery efforts and identify positive and negative trends.

Population size: Eastern prairie fringed orchid flowering population trend statistics are drawn from annual flowering plant census data. Flowering plant numbers are important measures of viability because populations appear to rely on seed production for their maintenance. Population size estimates can be based on mean annual flowering plant census data, with the recognition that numbers of plants and proportion of flowering plants will vary annually. Population extirpation simulations indicate that fewer than 10 plants are highly vulnerable to effects of chance genetic, demographic, or environmental events that could most easily lead to population extirpation, and population size of more than 50 plants would be more resistant to these factors (Bowles and Bell 1999). Because populations include flowering and non-flowering plants, flowering plant census data will underestimate actual population sizes.

Population trend: Estimates of the population trend should indicate whether the population size is stable, increasing, or decreasing over time, after accounting for variations in population size that follow annual rainfall and temperature fluctuations.

Population reproduction frequency: Reproduction population trend statistics should be drawn from annual flowering plant census data. The frequency of years in which flowering plants reproduce directly affects population persistence by regulating the potential for seedling establishment.

Habitat size: Larger habitats will support higher numbers of orchids, and may provide greater opportunity for surviving changing environmental conditions since orchids may colonize suitable areas if current habitat becomes unsuitable. Larger habitats are also more likely to support greater levels of natural disturbances, such as from habitat-size restricted animals, and thus more patch disturbance for orchid seedling establishment and potential for orchid colonization. Chances of extirpation might be highest in habitats smaller than 1 hectare (2.5 acres). Pioneer cemeteries, which often support the smallest prairie remnants found in the range of the eastern prairie fringed orchid, are usually no more than 2 hectares (5 acres) in size. Habitats larger than 50 hectares (125 acres) will support large numbers of plants.

Habitat successional stage and condition: The successional stage, or "natural quality" (*sensu* White 1978), is an indicator of past or current disturbance impacts to vegetation. Orchid populations may be more stable in late-successional plant communities. Early- to mid-successional communities can contain large orchid populations. However, these habitats are successionally unstable and orchid populations are at risk unless management can sustain optimum conditions under which the high population levels originated (Sheviak 1990), which may conflict with management for more stable late-successional prairie vegetation (Bowles *et al*. 1992). In large multiple-use landscapes, metapopulation management may provide potential for maintaining orchid populations in successional habitats.

Table 4. Determination of Population Viability Index (PVI). PVI = [A + B + C + D + E + F + G]/21. Values for each variable range from 0-3, and PVI ranges from 0-1. Low population viability #.50 PVI, moderate viability >.50-.75 PVI, and high population viability >0.75 PVI.

	<&&&&&&&&&&&&&&&&&&&& Range of Values &&&&&&&&&&&&&&&&&&&&>			
Variable	(0)	(1)	(2)	(3)
A. Population size[1]	<10 (very small)	10-<25 (small)	25-<50 (medium)	>50 (large)
B. Population trend[2]	absent	decreasing	stable	increasing
C. Population reproduction frequency[3]	<33%	33-#50%	50-#67%	>67%
D. Habitat size[4]	<1ha (very small) (<2.5 acres)	1<25 ha (small) (2.5<62.5 acres)	25<50 ha (medium) (62.5<125 acres)	>50 ha (large) (>125 acres)
E. Habitat condition and successional stage[5]	very heavily disturbed/early-successional	heavily disturbed / early-successional	moderately disturbed /mid-successional	lightly disturbed / late-successional
F. Protection status[6]	none	informal	formal	legal
G. Management condition[7]	severe	moderate	low	none

[1] Size derived from mean annual census data of flowering plants.

[2] Trend based on partial correlation (excluding rainfall and temperature) of annual population size with time. Decreasing = significant negative correlations, increasing = significant positive correlation.

[3] Percent frequency of years in which 10 percent or more of the flowering plants within a population produce seed.

[4] Area of potential habitat within an area occupied by orchids.

[5] Based on natural quality grades. Lightly or undisturbed = grade A, moderately disturbed = grade B, heavily disturbed = grade C, very heavily disturbed = grade D.

[6] Function of ownership and deed restrictions. None = private ownership with no protection, informal = private ownership with informal protection agreements but without legally binding protection, formal = private or public ownership with formal but not legal protection, legal = private or public ownership with legally binding protection.

[7] Degree of management needed due to habitat degradation from fire suppression and woody plant succession, non-native plant species invasion, hydrology alteration, and other land use impacts.

Protection status: Protection status is a function of ownership and legal deed restrictions. Public or private tracts protected under legal conservation easements, including dedication under some state nature preserve acts, have the highest level of protection. Habitats in public ownership that are not legally protected may have formal protection status but can be subject to management or use that could conflict with orchid habitat maintenance. Private land not protected by legal conservation easements might have informal protection such as volunteer registry programs and landowner agreements, but long-term land use remains at the discretion of the landowner.

Management condition: The eastern prairie fringed orchid occurs in grass- and sedge-dominated communities that are susceptible to woody vegetation encroachment in the absence of fire, creating an almost continual management need. In addition, if past actions have destroyed some ecosystem functions, then management may be needed to mimic the lost function. For example, drainage and water table loss can directly impact orchid populations and can also accelerate invasion by woody plant species. Invasion by aggressive non-native plant species such as glossy buckthorn, reed canarygrass and purple loosestrife can also require corrective action. Moderate management needs are for threats that are not directly impacting orchid populations, such as invasion of early stages of woody or non-native plant species, or surrounding land use.

PART II. RECOVERY

RECOVERY OBJECTIVE

The recovery objective is to delist, preserve, manage, and recover or restore a minimum number of viable eastern prairie fringed orchid populations in plant communities representing the modern range of the species' habitats and geographic distribution. The specific preservation goal is to provide the highest available legal protection for these populations. Specific management goals are: 1) maintain natural areas or successional habitats large enough to support eastern prairie fringed orchid population dynamics in relation to natural disturbance processes and vegetation successional change, 2) prevent invasions of non-native plant species, and 3) prevent other biological impacts, such as loss of genetic diversity, that might threaten long-term population maintenance. Specific recovery and restoration goals are: 1) recover small populations to higher numbers of plants capable of withstanding random genetic or demographic events or environmental catastrophes that might otherwise cause population extirpation, and 2) restore new populations to similarly high levels.

RECOVERY CRITERIA

The eastern prairie fringed orchid may be removed from the list of *Endangered and Threatened Wildlife and Plants* when:

1. Twenty-two populations are distributed across plant communities and physiographic regions within the historic range of the species (See Table 5 for distribution of these populations).

2. Each of these 22 populations is highly viable. A highly viable population typically has more than 50 flowering plants; a population trend that is stable or increasing over a monitoring period of 5 years; available habitat of at least 50 hectares (125 acres) in size; assurances of ongoing management to reduce impacts from drainage, invasive non-native plant species or woody vegetation encroachment; and protection through long-term conservation easements, legal dedication as nature preserves, or other means.

Table 5 presents a framework for identifying the critical communities and regions in which eastern prairie fringed orchid populations must be preserved or restored in order to recover the species. The number and viability of extant populations are given for each region, along with the minimum number of highly viable populations that must be preserved in each region to achieve recovery. This number varies from two to four, based on the extent of the physiographic region, former distribution of the species, and number of extant populations. Appendix 1 describes the status of extant populations by recovery criteria categories.

Populations may be restored in: 1) natural plant communities, 2) restorations of native plant communities, or 3) successional communities managed to maintain orchid populations. Habitats

for restored populations should have the maximum protection available, such as nature preserve dedication or other forms of legal deed restriction. Restored populations would need to be monitored over time to determine their ability to persist through successional changes and drought cycles. Although not a recovery criterion, many other populations should be protected, and they may be prioritized within physiographic regions or local political jurisdictions. Protection of peripheral populations, even small ones, may be important in preserving the genetic variability of the species.

Table 5. Number of extant eastern prairie fringed orchid populations and number of populations needed to meet recovery criteria in the United States by plant community, physiographic region, and state.

COMMUNITY Physiographic Region State	Number of high viability populations needed for recovery	<!!!! Population Viability !!!!> of Extant Populations		
		HIGH	MODERATE	LOW
PRAIRIE				
Kansan till				
Iowa	(2)		1	
Wisconsinan drift				
Illinois	(4)	1	10	7
Wisconsin	(3)	2	5	
Lake Erie lake plain	(2)			
Michigan			1	
Ohio			4	1
Lake Huron lake plain	(3)			
Michigan		2	3	3
Lake Michigan lake plain	(2)			
Illinois			1	1
Wisconsin		1		1

Table 5. Number of extant eastern prairie fringed orchid populations and number of populations needed to meet recovery criteria in the United States by plant community, physiographic region, and state.

COMMUNITY Physiographic Region State	Number of high viability populations needed for recovery	<!!!! Population Viability !!!!> of Extant Populations		
		HIGH	MODERATE	LOW
SEDGE MEADOW	(3)			
Wisconsinan drift-unglaciated				
Illinois			2	
Ohio			3	1
Wisconsin			1	2
Unglaciated				
Iowa			1	
MINEROTROPHIC/SPHAGNUM PEATLAND	(3)			
Maine			1	
Michigan			3	
Wisconsin			1	
TOTALS	(22)	6	37	16

STEPDOWN OUTLINE

1 Protect habitat
- 1.1 Seek Nature Preserve dedication
- 1.2 Contact landowners
- 1.3 Increase number of sites managed or owned by conservation organizations

2 Manage habitat
- 2.1 Conduct management assessments
- 2.2 Prepare and implement management plans

3 Increase size and number of populations
- 3.1 Augment existing populations
- 3.2 Reintroduce or restore new populations

4 Conduct field surveys to monitor the status of known populations
- 4.1 Monitor populations
- 4.2 Conduct demographic monitoring
- 4.3 Coordinate state monitoring
- 4.4 Encourage volunteer monitoring

5 Conduct research needed to identify recovery actions
- 5.1 Conduct management research
- 5.2 Determine status and management needs of pollinators
- 5.3 Develop propagation and restoration techniques
- 5.4 Determine environmental impacts on orchid populations

6 Update population ranks
- 6.1 Update initial PVI rankings and assess recovery status
- 6.2 Select sites for recovery to higher viabilities
- 6.3 Select sites for population restoration

7 Review progress on recovery plan

NARRATIVE OUTLINE FOR RECOVERY ACTIONS

1 Protect habitat

In order to achieve recovery for the orchid, additional habitat should receive protection.

1.1 Seek Nature Preserve dedication

In most states the highest available form of legal protection consists of conservation easements under state nature preserve acts (Pearsall 1984). Such dedications can usually be made by private or public landowners, and thus do not require transfer of property rights. Because greater than 60 percent of the extant eastern prairie fringed orchid populations do not have such legal protection, landowner contact and subsequent protection under state nature preserve acts provides a highly effective method for increasing population viability. For states that do not have active nature preserve acts (such as Michigan), other forms of conservation easements that can be held by private organizations such as the Michigan Nature Association should be sought. If established, such easements should provide management for the habitats and plant communities associated with the eastern prairie fringed orchid, and should allow access for monitoring.

1.2 Contact landowners

Though the majority of public landowners are aware of the eastern prairie fringed orchid on their properties, all landowners should be informed of the presence of populations on their properties, the species' Federal and state listing status, the levels of protection afforded by Federal and state law, population management needs, and management assistance available from management agencies. Information provided to landowners should include non-technical educational materials that explain why the eastern prairie fringed orchid is federally listed and what its management needs are. Inform private landowners of the options and incentives for private protection.

1.3 Increase number of sites managed and owned by conservation organizations

A second protection option to willing owners is conveyance of property rights to public or private conservation agencies that will provide legal protection and management.

2 Manage habitat

Sites supporting orchid populations may require varying degrees of active management to maintain or enhance orchid populations. Management techniques needed may include prescribed burns, or brush and weed removal. Specific management plans would help direct these activities. As discussed below, the orchid populations themselves may benefit from management actions.

2.1 Conduct management assessments

Survey all eastern prairie fringed orchid habitats identified for recovery actions to determine the ecological conditions maintaining orchids and associated plant communities. Additional sites also may be assessed to determine their recovery potential. Specific management problems should be identified and resolved, and determinations should be made as to the recovery potential of each site.

2.2 Prepare and implement management plans

Use site-specific management assessments to develop guidelines for recovery and maintenance of orchid populations and associated plant communities. These documents should provide treatments for management problems, identify and resolve potential conflicts between population and community management, and differentiate between routine (e.g., burning) and specific (e.g., brush removal) management treatments. Incorporate this management information into any site-specific master plans or management plans that might have been developed. Estimate costs and completion dates for all management.

3 Increase size and number of populations

In order to recover the eastern prairie fringed orchid, the number of plants within extant populations may be increased, or the number of populations may be increased by creating new populations. First, the eastern prairie fringed orchid's habitat may be increased by removing woody vegetation that has encroached these areas as a result of fire suppression. Increasing the size of potential habitats may also help augment populations by allowing the persistence of habitat-size restricted animal species that contribute to habitat disturbance and creation of regeneration niches. Second, smaller populations might be limited in pollinator visits and volume of seed production; as a result, hand-pollination can maximize seed production. Seedling establishment appears to occur most readily in successional habitat or in disturbance patches. Thus, artificial seed dispersal sites should include natural openings, disturbance patches, or successional areas within habitat occurrences. If seedling establishment is successful, appearance of flowering plants might occur in as little as 5 years. Although procedures should be developed for controlled propagation and establishment of plants, hand-pollination and seed dispersal appear to provide cost effective methods for establishing plants. In addition, these practices allow environmental conditions to determine if the species can be established in a given area and allow for the selection of individuals that have adapted to such conditions.

3.1 Augment existing populations

When small eastern prairie fringed orchid populations (usually <50 plants) do not appear to occupy all potential habitat within a population occurrence, pollination and artificial seed dispersal should be considered.

3.2 Reintroduce or restore new populations

When eastern prairie fringed orchid is absent from specific communities and geographic regions, new populations might be created and managed in appropriate habitats in order to reach recovery. The intent of restoration is to provide supplemental population occurrences within a geographic range and community. Seedling establishment and colonization by the eastern prairie fringed orchid occurs most readily in successional communities or large disturbance patches, which are likely analogous to smaller disturbances colonized in natural communities. This suggests that population restoration should be most successful in either prairie restorations or disturbed prairies in early- to

mid-successional stages. Artificial localized disturbance might be appropriate when there is no impact on natural vegetation. Maximizing habitat size may also maintain habitat-size restricted animals that contribute to disturbance. If orchids are established, management options are to achieve stable late-successional vegetation (such as in prairie restorations), or maintain early- to mid-successional stages specifically for orchids (such as in wildlife management areas).

4 Conduct field surveys to monitor the status of known populations

Field surveys are needed to assess the status of known populations and alert managers of any potential problems at the sites.

4.1 Monitor populations

Monitor populations to gauge the results of population recovery and restoration attempts, the status of naturally occurring populations over time, and the need for management or recovery actions. Long-term population census of flowering plants can be used to determine responses of flowering to changing environmental variables.

4.2 Conduct demographic monitoring

Demographic monitoring is needed to follow changes in population structure (Bowles *et al*. 1992). Monitoring of restored populations should be conducted initially at the demographic level, allowing tracking of individual plants. It should determine if populations survive changes in successional plant communities, especially through random events (such as drought) that might cause the loss of those populations. Lengths of time for first appearance of flowering from seeds or plantings are critical monitoring data for artificially restored plants. Important information about all populations includes frequency of flowering, vegetative, and dormancy stages, inflorescence size, and percent fruit set. These data should be related to changing environmental conditions (e.g., Bowles *et al.* 1992) such as precipitation or drought, and to management treatments, to ascertain what conditions or treatments help maintain populations over time.

4.3 Coordinate state monitoring

Not all state monitoring programs use the same protocols or visit populations with the same frequency. Coordination of monitoring efforts may increase the comparability of state gathered data across the range of the orchid.

4.4 Encourage volunteer monitoring

Volunteers have provided detailed monitoring on populations in some areas. Volunteer monitoring in other areas should be organized and promoted.

5 Conduct research needed to identify recovery actions

To improve the chances of recovering the eastern prairie fringed orchid, research is needed to better understand: 1) how to manage for orchid population persistence; 2) the status and management needs of orchid hawkmoth pollinators; 3) how to conduct orchid restoration;

and 4) how to protect against and alleviate anthropogenic factors (e.g., drainage, pesticides) that might affect orchid populations and orchid mycorrhizae, or populations of hawkmoth pollinators.

5.1 Conduct management research

The requirements for persistence of eastern prairie fringed orchid populations appear to be complex, and management needs beyond maintenance of natural vegetation are poorly understood. Conduct research to identify soil fungi responsible for seed germination and establishment, and maintenance of mycorrhizae, and to determine how management and succession affect these fungi and orchid persistence, dormancy, and mortality. Demographic monitoring of orchid populations is needed to assess the effects and interactions of fire management, precipitation, and hydrological fluctuations on survivorship, flowering, and reproduction. Research is also needed to determine if orchids require metapopulations for persistence as successional vegetation changes over time.

5.2 Determine status and management needs of pollinators

The status and management needs of hawkmoth pollinator populations is essentially unknown, yet they appear critical for orchid population maintenance. Conduct research to identify pollinators in different regions, and to assess their population levels and fluctuations, food sources, and vulnerability to human impacts. A specific need is to determine if introduced *Manduca* hawkmoths, which are garden pests, are important pollinators. The potential for hawkmoth propagation and population maintenance to enhance orchid pollination should be investigated.

5.3 Develop propagation and restoration techniques

Methods for restoring eastern prairie fringed orchid populations are virtually unknown. Determine the potential roles of *ex situ* propagation, seed broadcasting, site management (burning, artificial disturbance, etc.), and vegetation successional stage in population recovery. In relation, it should be determined if soil fungi (*Rhyzoctonia*) that establish mycorrhizae can be used to inoculate seedlings or introduced into potential restoration sites, and how the relative abundance of mycorrhizae-forming fungi affects orchid establishment.

5.4 Determine environmental impacts on orchid populations

Environmental impacts on orchids, soil fungi and mycorrhizae, and pollinators in urban environments may be severe. Determine the effects of urban development, especially water table manipulation, watershed alteration, runoff, and pollution on local orchid populations. Pesticide use may have severe effects on hawkmoth pollination and soil fungi; these impacts should be determined and addressed.

6 Update population ranks

Using the results of the monitoring studies, the Service would determine the viability of each known population, and assess the progress towards recovery.

6.1 Update initial PVI rankings and assess recovery status

The PVI assessments provided in this plan are based on field surveys conducted between 1990 and 1998. Assess progress toward recovery annually through updates to the PVI rankings.

6.2 Select sites for recovery to higher viabilities

The Service coordinates the selection of priority sites for recovery actions among various agencies. There are multiple populations from which a minimum number might be chosen to meet recovery criteria in some categories. In these instances, final site selection is not provided by this Plan, but should be made by the appropriate agency in agreement with the Service.

6.3 Select sites for population restoration

When population restoration is needed to meet recovery criteria for a given category, the Service coordinates the selection of sites for restoration actions among appropriate agencies. As with extant populations, these sites should meet the recovery criteria of having legal protection and minimum size and management needs so as to be able to achieve at least moderate viability. Because the potential for restoration is not well known, restoration attempts should be on an experimental basis so as to provide information that will guide other restorations.

7 Review progress on recovery plan

Review progress towards meeting recovery plan goals periodically by holding meetings of Federal and State agency personnel, interested scientists, and others contributing towards the recovery of this species.

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PART III. IMPLEMENTATION

The eastern prairie fringed orchid Implementation Schedule summarizes actions and estimated costs for the recovery program. It is a guide for meeting the objectives discussed in Part II of this Plan. This schedule indicates task priorities, task numbers, task descriptions, duration of tasks, the responsible agency, and cost estimates. These actions, when accomplished, should bring about the recovery of the species and protect its habitat. It should be noted that the estimated monetary needs for all parties involved in recovery are identified and, therefore, Part III reflects the total estimated financial requirements for the recovery of this species for the time period noted. The U.S. Fish and Wildlife Service's Endangered Species Program in Region 3 is responsible for implementing the tasks marked "R3" in the Responsible Party column of the Implementation Schedule.

Priorities in column 1 of the following Implementation Schedule are assigned as follows:

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 objective.

Key to abbreviations in the Implementation Schedule:

IADNR - Iowa Department of Natural Resources
ILDNR - Illinois Department of Natural Resources, and the Nature Preserves Commission
MDNR - Michigan Department of Natural Resources, and the Michigan Natural Features Inventory
ODNR - Ohio Department of Natural Resources
WDNR - Wisconsin Department of Natural Resources
UNIV - botanic gardens, arboretums, universities
R3 - U.S. Fish and Wildlife Service (Region 3)

EASTERN PRAIRIE FRINGED ORCHID IMPLEMENTATION SCHEDULE

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party		Total Cost	Cost Estimates ($000)			Comments
				FWS	Other		Year 1	Year 2	Year 3	
1	1.1	Seek Nature Preserve dedication	1	R3	IADNR ILDNR MDNR ODNR WDNR	5	5			
1	1.3	Increase number of sites managed or owned by conservation organizations	5	R3	IADNR ILDNR MDNR ODNR WDNR	2500	500	500	500	
1	2.1	Conduct management assessments	3	R3	IADNR ILDNR MDNR ODNR WDNR	45	15	15	15	
1	2.2	Prepare and implement management plans	ongoing	R3	IADNR ILDNR MDNR ODNR WDNR	1000	50	50	50	

EASTERN PRAIRIE FRINGED ORCHID IMPLEMENTATION SCHEDULE (continued)

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party		Total Cost	Cost Estimates ($000)			Comments
				FWS	Other		Year 1	Year 2	Year 3	
1	3.1	Augment existing populations	3	R3	IADNR ILDNR MDNR ODNR WDNR	60	20	20	20	
2	1.2	Initiate landowner contact	1	R3	IADNR ILDNR MDNR ODNR WDNR	5	5			
2	3.2	Reintroduce or restore new populations	3	R3	IADNR ILDNR MDNR ODNR WDNR	30	10	10	10	
3	4.0	Develop population monitoring programs	ongoing	R3	IADNR ILDNR MDNR ODNR WDNR	500	25	25	25	
3	5.1	Conduct management research	ongoing	R3	UNIV	500	25	25	25	
3	5.2	Determine status and management needs of pollinators	ongoing	R3	UNIV	200	10	10	10	

EASTERN PRAIRIE FRINGED ORCHID IMPLEMENTATION SCHEDULE (continued)

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party		Total Cost	Cost Estimates ($000)			Comments
				FWS	Other		Year 1	Year 2	Year 3	
3	5.3	Develop propagation techniques for recovery and restoration	ongoing	R3	UNIV	200	10	10	10	
3	5.4	Determine environmental impacts on orchid populations	ongoing	R3	UNIV	200	10	10	10	
3	6.1	Update PVI assessments	2	R3	IADNR ILDNR MDNR ODNR WDNR	40	20	20		
3	6.2 6.3	Select sites for recovery to higher viabilities and for population restoration	2	R3	IADNR ILDNR MDNR ODNR WDNR	30	20	10		

APPENDIX 1

STATUS OF EXTANT POPULATIONS

Based on the recovery criteria established by this plan, the eastern prairie fringed orchid could be considered recovered when 22 highly viable sites are preserved, representing each of the different plant communities and physiographic regions currently occupied by this species. However, among the 60 known extant natural United States populations of the eastern prairie fringed orchid, 8 are ranked high viability, among which 4 are legally protected. Among all United States populations, 17 have full legal protection and 13 have minor management needs. As a result, to meet recovery criteria, populations must be preserved or restored. This assumes that many populations can be recovered to higher levels of viability by improving management, providing legal protection, or other means.

For each recovery category provided in Table 6, the sites that could be preserved or managed to reach delisting criteria are identified. However, because various combinations of these actions can be used to attain delisting criteria, specific recommendations are not always provided. Additional low viability populations not required to meet delisting criteria might be evaluated to determine feasibility of increasing their viability.

Extirpated populations
Potential habitat remains in Missouri, New York, and in Indiana, and could be considered for population reintroduction. If populations are found in these areas, they should be addressed in revisions to this Recovery Plan.

Prairie - loess over drift (Kansan Glaciation)

Eastern prairie fringed orchids are known from the Williams Prairie in Johnson County, Iowa, and the Garden Grove Prairie in Decatur County, Iowa. Because of the peripheral distribution and limited number of populations, the recovery requirement for this category is legal protection of two high viability populations.

The Williams Prairie is protected as an Iowa Nature Preserve; however, the habitat size is small and orchids have not been observed since the 1980s. The Garden Grove Prairie is a small prairie remnant along an abandoned railroad right-of-way that also supports the federally threatened Mead's milkweed (*Asclepias meadii*). This population has moderate viability because of its high quality, but it is not preserved. High viability could be achieved through legal protection, management, and increasing the size of the habitat and population. If these sites cannot be increased to high viability, restoration of new populations using seeds from the two extant sites could be used to increase the number of populations in this region.

Prairie - loess over glacial drift (Prairie Peninsula Wisconsinan Glaciation)

This physiographic region is restricted to Illinois; it represents the former center of distribution for the eastern prairie fringed orchid, and still contains 18 populations, the largest number in any region. One high viability population, the Wadsworth Prairie, 10 moderate viability populations, and 7 low viability populations exist in this region.

Although the Wadsworth Prairie population has high viability, it is only partially preserved, and the moderate viability Lyons Prairie, West Chicago Prairie, and Middlefork Savanna are not legally protected. Many of the moderately viable sites could be improved by management, or increasing habitat and orchid population sizes. Management needs include control of teasel and day lily at the Loda Cemetery Prairie, and control of shrubs, buckthorn, or purple loosestrife at Lyons Woods, Wolf Road Prairie, Hybernia, Middlefork Savanna, Abbott Park, and the Wrigley tract. Restoration of drainage is apparently needed at the Churchill Prairie and possibly at Wolf Road Prairie; however, orchid populations may be extirpated from both sites. Many Illinois sites are in early- or mid-successional stages, which presents a management paradox as orchid populations may decline with advancing succession toward more stable conditions. Monitoring will be needed to track changes in these populations over time. Most of the sites also have small population sizes that might be increased by enhancing seed production and dispersal. These populations might be increased either within existing natural habitats, such as at the West Chicago Prairie, and Middlefork Savanna, or within restored prairie habitat that could be added to existing sites, such as at the Loda and Munson cemetery prairies.

Prairie - glacial drift (Prairie Peninsula Wisconsinan Glaciation)

Seven populations, all in Wisconsin, occur in this habitat. The recovery criteria are legal protection of three high viability populations. Two sites are ranked as high viability and five sites are ranked as moderate viability. Thus, improvement of moderately viable populations to high viability would be required to meet recovery criteria for this category.

Most of the moderate viability populations are legally protected. Their recovery needs are primarily increased population or habitat sizes, restored drainage, or control of woody vegetation. The Faville-Snapper Prairie population ranks highest because of its protection status, high quality community, and large population size. The Newark Road prairie has been actively managed, and the population has increased, and is now ranked as a high viability population. The Scuppernong Prairie population occurs in a large prairie remnant in which brush encroachment may be a threat. The Greene Prairie population is within a University Arboretum prairie and adjacent prairie restoration. The protected Oshkosh-Larsen Trail includes two orchid colonies in high quality railroad prairie habitat. It should be determined if this site can be managed to increase habitat and population size.

Lake plain prairie - Lake Erie Basin

At least six populations are known to be extant in the Lake Erie basin of Michigan and Ohio, and potential habitat is limited in extent. As a result, recovery criteria are legal protection of two high viability populations.

Five of the existing populations, one in Michigan and four in Ohio, have moderate viability; one of the additional Ohio populations has low viability. Two of the moderate viability populations, (Monroe County, Michigan #1, and Pickerel Creek, Sandusky County, Ohio) contain the largest known concentrations of the eastern prairie fringed orchid. These populations function as metapopulations in managed successional habitats where their numbers fluctuate spatially and temporally in relation to fluctuating lake levels, vegetation management for wildlife, and purple loosestrife control. Management research is needed to determine if these populations can be maintained at a high viability level. Also in Ohio, the moderate viability Yondata Road population consists of four colonies that occur in roadside, ditch, or under power line habitats. These plants have appeared erratically, possibly in relation to fluctuating levels of Lake Erie, but collectively contain a large number of plants. Brush was cleared at this site in 1996, and the number of flowering orchids has increased. Orchids numbers have also increased at the Metzger site, as have management activities. The size of the Wrightman's Grove population has declined steadily over the past 6 years. This population is located along a roadside ditch that is regularly mowed.

Lake plain prairie - Lake Huron Basin

Nine eastern prairie fringed orchid populations, all in Michigan, occur in lake-plain prairie in the Lake Huron Basin. The recovery requirements for this category are legal protection of three high viability populations. Two of these populations are high viability and three populations are moderate viability.

The Tuscola County #1 population supports the largest known concentration of this orchid on high quality lake plain prairie. The Huron County #1 population, on protected private land, also supports a large population on high quality lake plain prairie. These populations should be given the highest form of legal protection available, and appropriate management. Purple loosestrife is a potential threat to both sites; it should be monitored for and controlled. Three populations are moderate viability. The Tuscola County site #2 is a population complex with a range of habitat quality and ownership. The site owners should be given various protection options and management guidance. The Bay County #1 site has recently declined in population size and is threatened by brush and loosestrife invasion. Preservation and management assessment of this population is important because it is an upland lake plain refugium from high lake levels. The St. Clair County #1 site is an informally protected prairie within a golf course, and has not been surveyed in recent years.

Lake plain prairie - Lake Michigan Basin

Four eastern prairie fringed orchid populations, in Illinois and Wisconsin, occur in lake plain prairie in the Lake Michigan Basin. A fifth, at Illinois Beach State Park has not been relocated and may be extirpated. Because of the limited number of populations and limited potential recovery habitat, recovery requirements for this category are legal protection of two high viability populations. One high viability population occurs in this region.

The preserved and managed Chiwaukee Prairie complex supports the largest and only high viability population on lake plain prairie in the Lake Michigan basin. If plants reappear at Illinois Beach, the population would rank moderately viable because it occurs within an extensive nature preserve and state park complex. Reintroduction of seeds may have potential for increasing the size and viability of this population. Seed have been introduced at this site for the past 3 years. Also in Illinois, the Gensburg-Markham prairie population is threatened with development; but it occurs on high quality prairie and is contiguous with an adjacent nature preserve and National Natural Landmark. A small population occurs in a prairie restoration at Bain Station Road.

Sedge Meadow - Wisconsinan drift and unglaciated

As many as nine eastern prairie fringed orchid populations may occur in sedge meadow habitat within the Wisconsinan glaciated region of Illinois, Wisconsin, and Ohio, and a tenth population exists in Iowa. An eleventh population may be extant in unglaciated habitat in Virginia. Many of these sites, especially in Illinois and Wisconsin, may have been wet prairie that was disturbed by grazing; none are high viability populations, and seven are moderate viability. Recovery requirements for this category are legal protection of three high viability populations. Only two sites have full legal protection. One occurs on Federal property and the other is dedicated as an Illinois Nature Preserve. Thus, legal protection should help achieve higher viability.

Even though sedge meadow populations of the eastern prairie fringed orchid occupy wetland habitat, many have undergone large fluctuations in census numbers over time. This may be due in part to successional changes caused by past disturbance. Thus, the management or restoration potential of these sites is not well understood. Two sedge meadow populations occur in adjacent counties within the Killbuck Wildlife Area in Ohio. The Holmes County site contains a small population in undisturbed vegetation. The Wayne County population originally was large with over 100 individuals, but it occurs in successional vegetation and census numbers have declined. In Illinois, the Hildy Prairie contains a high density population in successional vegetation on informally protected private property. These sites are managed by prescribed burning and control of woody and non-native plant species. The Uihlein (Waukau Marsh) population occurs in successional habitat and may have been adversely affected by past drainage; the current status of this population is not clear. The Baldwin Marsh population, in a sedge meadow at the margins of a managed waterfowl impoundment, increased from 100 flowering plants in 1994 to more than 1,000 in 1998. Only one extant population of eastern prairie fringed orchids is known to occur in unglaciated sedge meadow habitat along the South River in Virginia. This small population has

appeared erratically in a large unprotected wetland, and orchids have not been seen at the site since the 1980s. The Pell Lake population has high potential for increased viability by seed introduction into the adjacent "Des Plaines Restoration Project," owned by The Nature Conservancy.

Minerotrophic peatland and bogs

Three eastern prairie fringed orchid populations are now known to occur in minerotrophic peatlands in the glaciated United States, while three extant populations, all in southern Michigan, are known from sphagnum bog habitat. Although floristically different, these communities are treated in a single category because they have similar substrates, often occur in mosaics within the same peatland, and because bog habitats appear to represent a later successional stage. All five populations are moderate viability. Recovery requirements for this category are legal protection of three high viability populations.

The Cedarburg Bog population is small, and has not been surveyed since 1993. Protection against potential invasion by buckthorn and purple loosestrife is needed. The Crystal Bog site is an extensive unprotected minerotrophic peatland complex supporting a moderate viability population. The size of the orchid population has fluctuated over time, possibly in relation to a post-settlement expansion and subsequent contraction of graminoid vegetation (Jacobson *et al*. 1991). Although the population could be increased to high viability through legal preservation, some management may be needed to control succession by woody vegetation or non-native plant species. The St. Joseph County Site #1 in Michigan is a small unprotected fen with moderate viability population. Only a few plants have been observed, and occur in a small area that could succeed to bog forest. The site should be preserved and monitored for change in population or community status. Additional populations formerly occurred in extant northern Indiana fens (Homoya 1991); these should be inventoried to determine if populations persist or if restoration is possible.

The three Michigan Bog population habitats are similar. They support moderate viability small populations that might not be reproducing, and their maintenance may not be an achievable recovery objective. The Washtenaw County #1 site is legally protected, while the Livingston County #1 site is formally protected. St. Joseph County #2 is informally protected and small. These sites should be given highest available legal protection, and monitored to determine if reproduction is limited by succession (*sensu* Sytsma and Pippen 1982a, 1982b) toward sphagnum and bog forest conditions. Additional populations might have occurred in southern Michigan and adjacent Indiana (Homoya 1991); these areas should be inventoried to determine if populations persist or could be restored.

Table 6. Summary of Population Viability Index (PVI) and recovery options for the eastern prairie fringed orchid in the United States. For each category, the number of legally protected high viability (PVI >0.80) populations required for recovery is indicated. Specific actions that contribute to recovery are those that will increase the level of each factor contributing to the Population Viability Index (PVI); see text and Appendix 1 for more information. Asterisks (*) indicate introduced populations. EXT = extirpated? PVI values for extirpated populations estimate habitat potential. Numbers in parentheses refer to the value assigned for that factor in the calculation of the PVI for that population.

Site name and location by county and state	Population Viability	Population size	Habitat size	Protection status	Successional status	Management needs
PRAIRIE (Kansan till) -- 2 High Viability Populations Required for Recovery						
Garden Grove Prairie/Decatur/IA	MODERATE	(1) small	(2) medium	(0) none	(3) late	(2) moderate
Williams Prairie/Johnson/IA	EXTIRPATED?	(0) extirpated?	(2) medium	(3) legal	(2) mid	(2) moderate
PRAIRIE (Wisconsinan drift) -- 4 High Viability Populations Required for Recovery						
Wadsworth Prairie/Lake/IL	HIGH	(3) large	(3) large	(3) legal/formal	(2) mid	(2) moderate
Lyons Woods/Lake/IL	MODERATE	(3) large	(1) small	(2) formal	(2) mid	(2) moderate
Munson Cemetery/Henry/IL	MODERATE	(1) small	(1) small	(3) legal	(3) late	(3) low
Loda Cemetery/Iroquois/IL	MODERATE	(1) small	(1) small	(3) legal	(3) late	(2) moderate
Hybernia/Lake/IL	MODERATE	(1) small	(1) small	(3) legal	(2) mid	(2) moderate
W. Chicago Prairie/DuPage/IL	MODERATE	(1) small	(2) medium	(2) formal	(2) mid	(2) moderate
Middlefork Savanna/Lake/Il	MODERATE	(1) small	(1) small	(2) formal	(2) mid	(2) moderate
Nippersink/McHenry/IL	MODERATE	(1) small	(2) medium	(2) formal	(1) early	(2) moderate
Grant Creek/Will/IL	MODERATE	(1) small	(2) medium	(3) legal	(3) late	(3) low
Ascension Sedge Meadow/Lake/IL	MODERATE	(2) medium	(2) medium	(2) formal	(2) mid	(2) moderate
Wrigley tract/Lake/IL	MODERATE	(2) medium	(2) medium	(1) informal	(1) early	(2) moderate

Table 6. Summary of Population Viability Index (PVI) and recovery options for the eastern prairie fringed orchid in the United States (continued). For each category, the number of legally protected high viability (PVI >0.80) populations required for recovery is indicated. Specific actions that contribute to recovery are those that will increase the level of each factor contributing to the Population Viability Index (PVI); see text and Appendix 1 for more information. Asterisks (*) indicate introduced populations. EXT = extirpated? PVI values for extirpated populations estimate habitat potential. Numbers in parentheses refer to the value assigned for that factor in the calculation of the PVI for that population.

Site name and location by county and state	Population Viability	Population size	Habitat size	Protection status	Successional status	Management needs
PRAIRIE (Wisconsinan drift) -- 4 High Viability Populations Required for Recovery (continued).						
Abbott Park/Lake/IL	LOW	(1) small	(1) small	(1) informal	(2) mid	(1) severe
Baxter/Lake/IL	LOW	(1) small	(1) small	(0) none	(1) early	(2) moderate
Schiller FP/Cook/IL	LOW	(1) small	(1) small	(2) formal	(1) early	(2) moderate
Carpentersville/Kane/IL	LOW	(1) small	(1) small	(0) none	(1) early	(1) severe
Lincolnshire' Lake/IL	LOW	(1) small	(1) small	(2) formal	(2) mid	(2) moderate
*Somme Woods FP/Cook/IL	LOW	(1) small	(1) small	(2) formal	(1) early	(2) moderate
Churchill Prairie/DuPage/IL	LOW/EXT	(0) extirpated?	(2) medium	(2) formal	(1) early	(1) severe
Wolf Road Prairie/Cook/IL	LOW/EXT	(0) extirpated?	(1) small	(3) legal	(2) mid	(2) moderate
Lone Grove/Cook/IL	LOW	(1) small	(1) small	(2) formal	(2) mid	(2) moderate
PRAIRIE (Wisconsinan drift) -- 3 High Viability Populations Required for Recovery						
Faville-Snapper/Jefferson/WI	HIGH	(2) medium	(2) medium	(3) legal	(3) late	(3) low
Newark Rd/Rock/WI	HIGH	(2) medium	(2) medium	(3) legal	(2) mid	(3) low
Scuppernong/Waukesha/WI	MODERATE	(1) small	(2) medium	(3) legal	(3) late	(2) moderate

Table 6. Summary of Population Viability Index (PVI) and recovery options for the eastern prairie fringed orchid in the United States (continued). For each category, the number of legally protected high viability (PVI >0.80) populations required for recovery is indicated. Specific actions that contribute to recovery are those that will increase the level of each factor contributing to the Population Viability Index (PVI); see text and Appendix 1 for more information. Asterisks (*) indicate introduced populations. EXT = extirpated? PVI values for extirpated populations estimate habitat potential. Numbers in parentheses refer to the value assigned for that factor in the calculation of the PVI for that population.

Site name and location by county and state	Population Viability	Population size	Habitat size	Protection status	Successional status	Management needs
Greene/Dane/WI	MODERATE	(1) small	(2) medium	(2) formal	(2) mid	(3) low
PRAIRIE (Wisconsinan drift) -- 3 High Viability Populations Required for Recovery (continued).						
Oshkosh-Larsen/Winnebago/WI	MODERATE	(1) small	(1) small	(3) legal	(3) late	(2) moderate
Rock1/Rock/WI	MODERATE	(3) large	(3) large	(1) informal	(2) mid	(2) moderate
Young/Walorth/WI	MODERATE	(1) small	(2) medium	(3) legal	(3) late	(1) severe
PRAIRIE (Lake Erie lake plain) -- 2 High Viability Populations Required for Recovery						
Monroe Co. #1/MI	MODERATE	(3) large	(3) large	(2) formal	(1) early	(1) severe
Pickerel Creek/Sandusky/OH	MODERATE	(3) large	(2) medium	(2) formal	(1) early	(1) severe
Maumee Bay, Lucus/OH	MODERATE	(1) small	(1) small	(2) formal	(2) mid	(2) moderate
Yodonta Rd/Lucas/OH	MODERATE	(3) large	(1) small	(2) formal	(1) early	(2) moderate
Metzger/Sandusky/OH	MODERATE	(3) large	(1) small	(0) none	(2) mid	(2) moderate
Wightman's Grove/Sandusky/OH	LOW	(1) small	(1) small	(0) none	(1) early	(2) moderate
PRAIRIE (Lake Huron lake plain) -- 3 High Viability Populations Required for Recovery						
Tuscola County #1/MI	HIGH	(3) large	(3) large	(2) formal	(3) late	(3) low

Table 6. Summary of Population Viability Index (PVI) and recovery options for the eastern prairie fringed orchid in the United States (continued). For each category, the number of legally protected high viability (PVI >0.80) populations required for recovery is indicated. Specific actions that contribute to recovery are those that will increase the level of each factor contributing to the Population Viability Index (PVI); see text and Appendix 1 for more information. Asterisks (*) indicate introduced populations. EXT = extirpated? PVI values for extirpated populations estimate habitat potential. Numbers in parentheses refer to the value assigned for that factor in the calculation of the PVI for that population.

Site name and location by county and state	Population Viability	Population size	Habitat size	Protection status	Successional status	Management needs
Huron County #1/MI	HIGH	(3) large	(3) large	(2) formal	(3) late	(3) low
Tuscola County #2/MI	MODERATE	(1) small	(2) medium	(0) none	(2) mid	(3) low
PRAIRIE (Lake Huron lake plain) -- 3 High Viability Populations Required for Recovery (continued).						
Bay County #1/MI	MODERATE	(1) small	(2) medium	(1) informal	(2) mid	(2) moderate
St. Clair County #1/MI	MODERATE	(1) small	(1) small	(1) informal	(3) late	(2) moderate
Bay County #2/MI	LOW	(1) small	(1) small	(2) formal	(2) mid	(1) severe
St. Clair County #2/MI	EXT/LOW	(0) extirpated?	(1) small	(0) none	(3) late	(2) moderate
Saginaw County #1/MI	LOW	(1) small	(2) medium	(0) none	(2) mid	(1) severe
Bay County #3/MI	LOW	(1) small	(1) small	(0) none	(2) mid	(1) severe
PRAIRIE (Lake Michigan lake plain) -- 2 High Viability Populations Required for Recovery						
Chiwaukee Complex/Kenosha/WI	HIGH	(3) large	(3) large	(3) legal	(3) late	(2) moderate
*Miami Woods FP/Cook/IL	MODERATE	(1) small	(1) small	(2) formal	(2) mid	(2) moderate
Illinois Beach/Lake/IL	EXT/ MODERATE	(0) extirpated?	(2) medium?	(3) legal	(3) late	(3) low
Gensburg-Markham/Cook/IL	LOW	(1) small	(1) small	(0) none	(3) late	(1) severe

Table 6. Summary of Population Viability Index (PVI) and recovery options for the eastern prairie fringed orchid in the United States (continued). For each category, the number of legally protected high viability (PVI >0.80) populations required for recovery is indicated. Specific actions that contribute to recovery are those that will increase the level of each factor contributing to the Population Viability Index (PVI); see text and Appendix 1 for more information. Asterisks (*) indicate introduced populations. EXT = extirpated? PVI values for extirpated populations estimate habitat potential. Numbers in parentheses refer to the value assigned for that factor in the calculation of the PVI for that population.

Site name and location by county and state	**Population Viability**	**Population size**	**Habitat size**	**Protection status**	**Successional status**	**Management needs**
Bain Station/Kenosha/WI	LOW	(1) small	(2) medium	(1) informal	(1) early	(1) severe

Table 6. Summary of Population Viability Index (PVI) and recovery options for the eastern prairie fringed orchid in the United States (continued). For each category, the number of legally protected high viability (PVI >0.80) populations required for recovery is indicated. Specific actions that contribute to recovery are those that will increase the level of each factor contributing to the Population Viability Index (PVI); see text and Appendix 1 for more information. Asterisks (*) indicate introduced populations. EXT = extirpated? PVI values for extirpated populations estimate habitat potential. Numbers in parentheses refer to the value assigned for that factor in the calculation of the PVI for that population.

Site name and location by county and state	Population Viability	Population size	Habitat size	Protection status	Successional status	Management needs
SEDGE MEADOW (Wisconsinan drift/unglaciated) -- 3 High Viability Populations Required for Recovery						
Dayton/Clark/OH	MODERATE	(3) large	(2) medium	(2) formal	(2) mid	(2) moderate
Killbuck SM/Holmes/OH	MODERATE	(1) small	(2) medium	(2) formal	(3) late	(3) low
Killbuck SM/Wayne/OH	MODERATE	(2) medium	(2) medium	(2) formal	(1) early	(2) moderate
Hildy Prairie/Grundy/IL	MODERATE	(3) large	(1) small	(1) informal	(2) mid	(2) moderate
Long Grove/Lake/IL	MODERATE	(1) small	(1) small	(3) legal	(2) mid	(2) moderate
Baldwin Marsh/Jackson/IA	MODERATE	(3) large	(1) small	(1) informal	(1) early	(2) moderate
Desplaines/Kenosha/WI	MODERATE	(1) small	(3) large	(1) informal	(2) mid	(2) moderate
Ledingham/Clark/OH	LOW	(1) small	(1) small	(0) none	(2) mid	(2) moderate
Uihlein (Waukau) /Winnebago/WI	LOW	(1) small	(1) small	(3) legal	(1) early	(1) severe
Pell Lake/Walworth/WI	LOW	(0) extremely small	(1) small	(0) none	(3) late	(2) moderate
South River SM/Augusta/VA	EXT/LOW	(0) extirpated?	(3) large	(0) none	(2) mid	(1) severe
Harrison Benwell/McHenry/IL	EXT/LOW	(0) extirpated?	(1) small	(2) formal	(2) mid	(1) severe

Table 6. Summary of Population Viability Index (PVI) and recovery options for the eastern prairie fringed orchid in the United States (continued). For each category, the number of legally protected high viability (PVI >0.80) populations required for recovery is indicated. Specific actions that contribute to recovery are those that will increase the level of each factor contributing to the Population Viability Index (PVI); see text and Appendix 1 for more information. Asterisks (*) indicate introduced populations. EXT = extirpated? PVI values for extirpated populations estimate habitat potential. Numbers in parentheses refer to the value assigned for that factor in the calculation of the PVI for that population.

Site name and location by county and state	Population Viability	Population size	Habitat size	Protection status	Successional status	Management needs
MINEROTROPHIC/SPHAGNUM PEATLAND -- 3 High Viability Populations Required for Recovery						
Cedarburg/Ozaukee/WI	MODERATE	(1) small	(1) small	(3) legal	(3) late	(3) moderate
Crystal Bog/Aroostook/ME	MODERATE	(1) small	(3) large	(1) informal	(3) late	(3) low
Washtenaw County #1/MI	MODERATE	(1) small	(1) small	(3) legal	(3) late	(2) moderate
St. Joseph County #1/MI	MODERATE	(1) small	(2) medium	(0) none	(3) late	(3) low
St. Joseph County #2/MI	MODERATE	(1) small	(1) small	(1) informal	(3) late	(2) moderate
Livingston County #1/MI	EXT/ MODERATE	(0) extirpated?	(1) small	(2) formal	(3) late	(2) moderate

APPENDIX 2

AGENCY AND PUBLIC COMMENT ON THE DRAFT PLAN

Summary of Agency and Public Comment on the *Technical/Agency Draft Recovery Plan for the Eastern Prairie Fringed Orchid*

In August 1991, the U.S. Fish and Wildlife Service (Service) released the *Technical/Agency Draft Recovery Plan for the Eastern Prairie Fringed Orchid* (T/A Draft Plan) for review and comment by Federal agencies, state and local governments, and members of the public. The comment period ended on September 27, 1991. Nine letters commenting on the draft were received. In the time since the comment period closed, additional comments and information or updates to the plan have been received by the Service. These comments have also been considered and reflected in the approved Plan.

This section provides a summary of general information about the comments the Service received, including the number of letters from various sources. Five of the letters were from state conservation agencies, one letter each was received from the National Park Service and the U.S. Environmental Protection Agency. Two letters were received from professionals in the field commenting as private citizens. Each letter contained one or more comments. Some letters raised similar issues. Most of the letters requested explanation of various points made in the draft plan and included suggestions for clarity. Some letters provided updated information on population occurrences. Most comments were incorporated into the final version of the recovery plan. Information and comments not incorporated into this Recovery Plan were considered and noted. Significant comments that were not incorporated or that require clarification in addition to their incorporation are addressed below.

Summary of Comments and Service Responses

Comment: One commenter suggested that the term "viability index" was misleading because factors affecting viability of the eastern prairie fringed orchid populations are still not fully understood. This commenter suggested that the index be called a "protection priority" or "recovery priority" index.

Response: The population viability index is intended to be used as a tool to assess the viability of populations and to identify actions that can be taken to increase the viability of those populations. Unlike traditional population viability analysis, the viability index presented in this plan incorporates factors external to the life history of the species such as site protection status and management condition. The index will be updated as research provides additional insight into factors affecting viability of eastern prairie fringed orchid populations. Annually updating the index ratings will provide a useful framework for tracking progress toward recovery. The term suggested by the commenter, "recovery priority," does not capture these functions and also has the potential to be misleading by suggesting that the Service is determining recovery

priorities for the listed sites. Prioritization of recovery actions at sites supporting eastern prairie fringed orchid populations will vary among state conservation agencies and individual land managers.

Comment: One commenter noted that a consensus on when ecological restoration or reintroduction of plants is appropriate does not currently exist among conservation biology professionals but that the Plan identified restoration of eastern prairie fringed orchid populations as a recovery task. Several commenters suggested the Plan recommend criteria or guidelines for selecting areas in which to establish new populations.

Response: The Service recognizes that States have their own and sometimes differing approaches to ecological restoration. The Plan provides a general framework for a distribution of populations across physiographic regions that would lead to recovery of the species. Specific decisions about reintroduction sites or restorations are left to the State conservation agencies, though the Service is willing to work with the state agencies to identify criteria for selecting sites and to coordinate efforts between states.

Comment: Two commenters suggested that the Plan consider the potential importance of the genotypic diversity that may be maintained in small outlying populations, or small populations in very disturbed habitats, and that the recovery criteria include a reference to genetic variability.

Response: The importance of protecting peripheral populations, regardless of size, is noted in the Recovery section, but is not explicitly stated in the recovery criteria. The distribution of populations across physiographic regions required by the recovery criteria, however, is intended to capture the genetic variability that populations distributed across a diverse ecological landscape will represent.

Comment: One commenter asked how any newly discovered populations would fit into the recovery criteria, especially if they occur outside of the physiographic regions listed in the recovery criteria.

Response: The population viability index could be used to evaluate any newly discovered populations. Newly discovered high viability populations could help meet the recovery criteria for this species. If a significant number of populations were discovered in areas outside the physiographic regions listed in the recovery criteria section, such new information would warrant a review of the required distribution of populations in the recovery criteria and may warrant revision of the Recovery Plan.

Comment: One commenter asked how recovery efforts will be coordinated among states and who will perform this function.

Response: The Plan is intended to establish a framework for recovery efforts for this species. The Service is committed to ongoing coordination of these efforts in partnership with state conservation agencies, and other conservation organizations and members of the public.

Comment: More than one commenter expressed concerns that the T/A Draft Plan appeared to advocate herbicide use for the control of non-native invasive vegetation.

Response: Management practices to control non-native invasive vegetation, including the use of herbicide, differ among regions and probably vary in response to the degree of threat and the availability of effective alternatives. Herbicide has been used effectively, at least in the short term, to control invasive non-native plant species near and among eastern prairie fringed orchid populations. The Plan presents the array of tools known to be effective in managing orchid habitat by controlling invasive vegetation, with the understanding that the choice to use or to not use herbicide is left to the individual land manager. The Plan responds to this comment, however, to more generally state that invasive non-native vegetation should be controlled near orchid populations, without offering specific recommendations on control measures.