Eastern Prairie Fringed Orchid
(Platanthera leucophaea)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Chicago Illinois Field Office
Barrington, Illinois

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5-YEAR REVIEW
Eastern Prairie Fringed Orchid (*Platanthera leucophaea*)

1.0 GENERAL INFORMATION

1.1 Reviewers

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1.2 Methodology used to complete the review:

The U.S. Fish and Wildlife Service (Service) conducts status reviews of species on the List of Endangered and Threatened Wildlife and Plants (50 CFR 17.12) as required by section 4(c)(2)(A) of the Endangered Species Act (Act) (16 U.S.C. 1531 *et seq.*). The Service provided notice of this status review via the Federal Register (72 FR 41348) on July 27, 2007, requesting new information on the eastern prairie fringed orchid (*Platanthera leucophaea*) that may have a bearing on its classification as threatened. In addition, we applied information from a population viability assessment based on a compilation of data collected from across the species range (Dr. Timothy Bell, Chicago State University, unpub. data 2008), and relied upon this information most heavily. The Service's Chicago, Illinois Field Office conducted the review. We received comments from Cathy Carnes of the Green Bay, Wisconsin Field Office and Serena Selbo of the Ohio Field Office. The preliminary draft was reviewed for scientific accuracy by Jennifer Windus of the Ohio Department of Natural Resources.

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review: 72 FR 41348 (July 27, 2007) Notice of Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Reviews of Three Wildlife Species and Two Plant Species in the Midwest Region.

1.3.2 Listing history

Original Listing
FR notice: 54 FR 39857-39863
Date listed: Thursday, September 28, 1989
Entity listed: Species
Classification: Threatened

1.3.3 Associated rulemakings: Not applicable

1.3.4 Review History: The eastern prairie fringed-orchid was included in a cursory 5-year review conducted for all species listed before 1991 (56 FR 56882). There have been no range-wide biological opinions or other large scale analyses of this species since it was listed as threatened.

1.3.5 Species' Recovery Priority Number at start of 5-year review: 8 – This priority number indicates a species with a moderate degree of threat and high potential for recovery.

1.3.6 Recovery Plan

Name of plan: Eastern Prairie Fringed Orchid (*Platanthera leucophaea* [Nuttall] Lindley) Recovery Plan
Date issued: September 9, 1999
Dates of previous revisions, if applicable: The recovery plan has not been revised.

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

No

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

Yes

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

Yes

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

Yes, see below for explanation and there is new information.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.

The Eastern Prairie Fringed Orchid Recovery Plan (USFWS 1999) contains the following delisting criteria:

1. **Twenty-two populations are distributed across plant communities and physiographic regions within the historic range of the species.** Currently 76 populations exist throughout the range of the species; however, the populations are not distributed as specified in the recovery plan (i.e., by state and physiographic region). The highly viable populations must occur in eight physiographic regions to achieve this criterion. Only eleven highly viable populations exist to date. Therefore, Criterion 1 has not been met.

   Criterion 1 addresses issues associated with Factor A – present or threatened destruction, modification or curtailment of its habitat or range.

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.** Currently only 11 populations are highly viable; Criterion 2 has not been met.

   Criterion 2 addresses issues associated with all listing factors: Factor A - present or threatened destruction, modification or curtailment of its habitat or range; Factor B - overutilization for commercial, recreational, scientific, or educational purposes; Factor C - disease or predation; Factor D - inadequacy of existing regulatory mechanisms; and Factor E - other natural or manmade factors affecting its continued existence.

The recovery criteria listed above were based upon the population viability index in the Eastern Prairie Fringed Orchid Recovery Plan (USFWS 1999) and Bowles *et al.* (1992). The viability index relies upon several types of measurements to fully assess the viability of a population. These variables include population size, potential habitat availability, the need for management, whether the habitat has long-term protection, and whether the population trend is increasing. See Appendix 1 for a brief description of each of these variables that indicate the

viability of an eastern prairie fringed orchid population. The population viability index (Table 1, below) is based on these biological and habitat variables. For each variable, a ranking from 0-3 is assigned and the sum of all variable rankings is divided by the number of variables (e.g. five variables would yield a maximum sum of 15) to produce an index ranging from 0-1. Where no data is available, the variable is not included in the viability assessment. Populations with an index greater than 0.75 have high viability, populations with an index between 0.50 – 0.75 have moderate viability, and populations with an index less than 0.50 have low viability. Under this index, population viability is determined using a number of factors, and gives a more accurate indication of a population's viability or likelihood of persisting.

Table 1. Determination of Population Viability Index (PVI). 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)
I. Population size[1]	<10 (very small)	10-<25 (small)	25-<50 (medium)	>50 (large)
II. Population trend[2]	absent	decreasing	stable	increasing
III. Population reproduction frequency[3]	<33%	33-≤50%	50-≤67%	>67%
IV. 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)
V. Habitat condition and successional stage[5]	very heavily disturbed/early-successional	heavily disturbed / early-successional	moderately disturbed /mid-successional	lightly disturbed / late-successional
VI. Protection status [6]	none	informal	formal	legal
VII. 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 disturbance and successional stage.
[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.

Achieving Criterion 1:

The recovery plan (USFWS 1999) provides additional detail showing how the 22 highly viable populations should be distributed across plant communities, physiographic regions, and states (see Table 2 below). Table 3 (below) shows current progress towards recovery. Two highly viable populations are required in prairies within

Table 2. Viability of eastern prairie fringed orchid populations across the species' range in the U.S.A. in 1999.

Community, Physiographic Region, State	**Number of High Viability Populations Needed for Recovery**	**Number of High Viability**	**Number of Moderate Viability**	**Number of Low Viability**	**Total**
Prairie, Kansan till, Iowa	2	0	1	0	1
Prairie, Lake Erie lake plain, Michigan		0	1	0	1
Prairie, Lake Erie lake plain, Ohio	2	0	4	1	5
Prairie, Lake Huron lake plain, Michigan	3	2	3	3	8
Prairie, Lake Michigan lake plain, Illinois		0	1	1	2
Prairie, Lake Michigan lake plain, Wisconsin	2	1	0	1	2
Prairie, Wisconsinan drift, Illinois	4	1	10	7	17
Prairie, Wisconsinan drift, Wisconsin	3	2	5	0	7
Sedge Meadow, Unglaciated, Iowa		0	1	0	1
Sedge Meadow, Wisconsinan drift (unglaciated) Illinois		0	2	0	2
Sedge Meadow, Wisconsinan drift (unglaciated), Ohio		0	3	1	4
Sedge Meadow, Wisconsinan drift (unglaciated), Wisconsin	3	0	1	2	3
Minerotrophic/Sphagnum Peatland, n/a, in Maine		0	1	0	1
Minerotrophic/Sphagnum Peatland, n/a, in Michigan		0	3	0	3
Minerotrophic/Sphagnum Peatland, n/a, in Wisconsin	3	0	1	0	1
Total Populations	**22**	**6**	**37**	**16**	**59**

Table 3. Viability of eastern prairie fringed orchid populations across the species' range in the United States in 2007.

Community, Physiographic Region, State	Number of High Viability Populations Needed for Recovery	Number of Current High	Number of Current Moderate	Number of Current Low	Total
Prairie, Kansan till, Iowa	2	0	2	0	2
Prairie, Lake Erie Lake plain, Michigan	2	0	1	0	1
Prairie, Lake Erie Lake plain, Ohio		2	2	3	7
Prairie, Lake Huron Lake plain, Michigan	3	2	0	7	9
Prairie, Lake Michigan Lake plain, Illinois	2	0	1	3	4
Prairie, Lake Michigan Lake plain, Wisconsin		1	0	1	2
Prairie, Wisconsinan drift, Illinois	4	2	8	12	22
Prairie, Wisconsinan drift, Wisconsin	3	1	6	2	9
Sedge Meadow, Unglaciated, Iowa	3	0	0	1	1
Sedge Meadow, Wisconsinan drift (unglaciated), Illinois		0	2	0	2
Sedge Meadow, Wisconsinan drift (unglaciated), Ohio		1	4	0	5
Sedge Meadow, Wisconsinan drift (unglaciated), Wisconsin		1	0	2	3
Minerotrophic/Sphagnum Peatland, Maine	3	0	1	0	1
Minerotrophic/Sphagnum Peatland, Michigan		0	1	2	3
Minerotrophic/Sphagnum Peatland, Wisconsin		1	0	0	1
Prairie, Illinoisan Drift, Illinois	0	0	1	0	1
Sedge Meadow, Wisconsin drift, Illinois	0			3	3
Total Populations	**22**	**11**	**29**	**36**	**76**

the Kansan Till region of Iowa where currently none exist; four highly viable populations are required in prairies within the Wisconsinan Drift region of Illinois where currently two exist; three highly viable populations are required in prairies within the Wisconsinan Drift region of Wisconsin where currently one exists; two highly viable populations are required in prairies within the Lake Erie Lake Plain region of either Michigan or Ohio where currently two exist; three highly viable populations are required in prairies within the Lake Huron lake plain region of Michigan where currently two exist; two highly viable populations are required in prairies within the Lake Michigan lake plain region of either Illinois or Wisconsin where currently one exists; three highly viable populations are required in sedge meadows with unglaciated soil within the Wisconsinan Drift region in Illinois, Ohio, and Wisconsin, and in the Unglaciated region in Iowa where currently two exist; and three highly viable populations in minerotrophic/sphagnum peatland are required in either Maine, Michigan, or Wisconsin where currently one exists. Thus, only the Lake Erie Lake Plain region of Michigan and Ohio has the required number of highly viable populations.

Achieving Criterion 2:
Detailed analysis of the biological and habitat variables (Appendix 1) used in the population viability analysis in 1999 and 2007 provides additional insight into the species status and recovery needs. A summary of the variables and an update of how each variable has an influence on the viability of populations across the species range are provided below.

Population size: A population size of more than 50 flowering plants would be more resistant to effects of chance genetic, demographic, or environmental events that could most easily lead to population extirpation. Therefore, populations with 50 or more flowering plants rank the highest in this category. Typically, in an orchid population, some (or most) plants are not flowering, so counting the flowering plants underestimates the total population size. In 1999, 13 eastern prairie fringed orchid populations had 50 plants or more (USFWS 1999). In 2007, 15 of the 59 original populations (known in 1999) had on average 50 or more flowering plants (Bell 2008). The total number of extant populations as of 2007 with an average of 50 plants or more is 18 of 76 populations or an increase of five populations from 1999.

Population trend: Populations that have an increasing trend rank the highest in this category. In 1999, this variable was not used to determine population viability because trend data was not yet available. In 2007, 12 of the 59 original populations (known in 1999) were identified as increasing (Bell 2008). The total number of extant populations as of 2007 that have been identified as increasing is 17 of 76 populations.

Habitat size: Populations in habitats larger than 50 hectares (125 acres) will support large numbers of plants and therefore rank the highest in this category. Based on the management condition of a site, eastern prairie fringed orchids may only occupy a portion of the potential habitat if some of the habitat has been encroached by invasive species. Habitat size is based on the potential habitat at the site. In 1999, nine eastern prairie fringed orchid populations were in 125 acres or greater of habitat (USFWS 1999). Currently there are 11 populations that are 125 acres or greater (Bell 2008). This increase is due to the discovery of previously unknown extant populations.

Habitat condition and successional stage: The successional stage, or "natural quality" (White 1978), is an indicator of past or current disturbance impacts to vegetation. Highly viable eastern prairie fringed orchid populations occur in late-successional habitat in high quality natural areas that are free of invasive species. Fire and other management techniques that mimic natural disturbance may be required to control or eliminate invasive species and to maintain stable late-successional vegetation. Orchid populations may be more stable in late-successional (i.e., high quality natural area free of invasive species) plant communities. In 1999, 23 eastern prairie fringed orchid populations were in a late-successional stage (USFWS 1999). In 2007, only 16 of the original 59 populations and only 17 of the total 76 extant populations are in a late successional stage (Bell 2008). The decrease of six populations that are in a

late-successional stage illustrates the continued threat of invasive species in eastern prairie fringed orchid habitat, and need for continual management.

Protection status: Populations protected under binding legal conservation easements, including dedication under some state nature preserve acts, have the highest level of protection and therefore are ranked the highest in this category. Public land that is preserved in perpetuity and/or provides for regulatory protection would be examples of land that would also be ranked highest in this category. In 1999, 18 of 59 eastern prairie fringed orchid populations had binding legal protection (USFWS 1999). The total number of extant populations as of 2007 with binding legal protection is 23 of 76 populations indicating an increase of five legally protected populations since 1999 (Bell 2008). This increase is due to the discovery of a previously unknown extant population, legal dedication of sites since 1999, and successful reintroduction in legally designated sites.

Management need: Eastern prairie fringed orchid populations are susceptible to woody vegetation encroachment and invasion by aggressive non-native plant species. In addition, management may be needed to mimic a lost function such as hydrology. This variable is assigned a value based on the degree of management needed to maintain the plant community (USFWS 1999; Bowles *et al.* 1992). In assessing this variable, the Service evaluates whether needed management is likely to continue in the future, and not just whether the site currently is free of management needs. Populations without a management need, rank the highest. In 1999, 12 eastern prairie fringed orchid populations had no management need (USFWS 1999). In 2007, 12 of the 59 original populations (known in 1999) had no management need (Bell 2008). The total number of extant populations as of 2007 with no management need is 13 of 76 populations or an increase of one from 1999 (USFWS 1999, Bell 2008).

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on species' biology and life history:

Zettler and others (2001, 2005) determined that the mycorrhizal fungus *Ceratorhiza goodyerae-repentis* promotes germination of eastern prairie fringed orchid seed (Zettler *et al.* 2005) and can sustain mature plants (Zettler *et al*. 2001). In addition, the fungus *C. pernacatena* has also been recovered from mature eastern prairie fringed orchids (Zettler *et al*. 2001). Zettler *et al.* (2005) also determined that photosynthesis is supplemented by mycrotrophy throughout adulthood by *C. goodyerae-repentis* and *C. pernacatena,* and *Epulorhiza* to a lesser degree. As part of their research on the mycorrhizal fungus and invitro germination, Zettler *et al.* (2005) and Piskin *et al*. (2003) determined that eastern prairie fringed orchid seeds require two cold treatments for seedling development which suggests that at least 2 years is required to initiate leaf emergence. The timeframe of 2 to 3 years for germination concurs with field observations that eastern prairie fringed orchids flower within 5 years after seed dispersal (Keibler 1997, Bowles and Bell 1999).

2.3.1.2 Abundance, population trends, demographic features, or demographic trends:

In 2008, a rangewide population viability assessment for the eastern prairie fringed orchid was completed based on data collected across the range from 1999 to 2007 (Bell 2008). The results from this research (Table 3) indicate that there are now a total of 76 known extant populations or 17 more populations than in 1999. In addition, there are now 11 highly viable populations or an increase of five highly viable populations since 1999. Other differences from the 1999 population viability assessment include a decrease from 37 to 29 populations with moderate viability and an increase from 16 to 36 populations with low viability.

In Illinois, demographic monitoring and hand pollination have been used as recovery strategies and tools to guide efforts to augment extant populations and during reintroduction of seed for establishing new populations. Data collected in the Illinois orchid program is used to track the status of individual populations. This data indicates fluctuations in population size from year to year, but the most drastic shifts in population size occur after a drought (Keibler et al 1993; Keibler 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2003; TNC 2007). These findings agree with earlier research (Bowles 1983) that moisture levels are an important factor in the promotion of eastern prairie fringed orchid growth.

Research conducted by Vitt (2001and 2003) found that pollinating 30% of an eastern prairie fringed orchid flowers is the best ratio for reproduction and survival of that plant. This research supports the methodology used in Illinois. In addition, the data collected in the Illinois orchid program is used to track seed production from natural pollination and hand pollination. This data provides a guide to how populations are being augmented and where seed may be collected and disbursed for reintroduction. As a result of these efforts, seven populations have been reintroduced in Illinois. Two of the reintroduced populations occur in prairies in the Lake Michigan Lake Plain physiographic region and five in prairies in the Wisconsinan drift physiographic region.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation:

Genetic analysis has been conducted on eastern prairie fringed orchid populations in Illinois, Michigan, and Ohio. Havens and Bradford (2001) reported that the average genetic diversity for each eastern prairie fringed orchid population in northern Illinois was very similar across populations and was not affected by population size. Sixteen percent of the genetic variation was distributed among populations. This is a fairly average value relative to other plant species (Hamrick *et al*. 1991). Wallace (2002) found that populations from Ohio and Michigan were slightly less differentiated than populations from Illinois (Havens and Buerkle 1999). Havens and Bradford (2001) found that in Illinois, many bands were found across populations and the majority of low frequency bands ("rare alleles") were not restricted to any single population. The

average genetic diversity within Illinois populations was found to be significantly variable even in the smaller populations, suggesting that inbreeding depression might not be as serious a risk for Illinois populations as speculated. However, Wallace's (2002 and 2003) analysis of allozyme diversity in Michigan and Ohio populations suggest high, variable levels of inbreeding. The genetic research conducted in Illinois, Michigan, and Ohio did not find a consistent relationship between geographic distance and genetic divergence (Havens and Bradford 2001, Wallace 2002 and 2003). Because of the findings from this research and the potential risk of outbreeding depression, existing populations in Illinois are not being augmented with seeds or pollen from another population. In addition, we are matching donor and recipient sites that have similar habitat when collecting seed for reintroductions.

2.3.1.4 Taxonomic classification or changes in nomenclature:

There has been no new information regarding taxonomic classification or nomenclature since the 1991 Review.

2.3.1.5 Spatial distribution, trends in spatial distribution, or historic range:

The eastern prairie fringed orchid's distribution has not changed appreciably since 1991.

2.3.1.6 Habitat or ecosystem conditions:

While habitat loss and degradation continue to threaten the eastern prairie fringed orchid**,** management strategies are being implemented to address threats from invasive species. Private Stewardship grants from the Service have been used to fund habitat management on privately-owned sites in Illinois, Wisconsin, and Maine. Habitat management activities, funded from private stewardship grants, have delayed the threat from invasive species. Conservation organizations and local and state government agencies are also managing their land to various degrees. One success story occurred in Ohio at the Ottawa National Wildlife Refuge in 2007 where habitat management led to the discovery of a previously unknown population of 127 plants (Huffman 2009).

2.3.1.7 Other:

Three species of hawkmoths (*Eumorpha pandorus*, *Eumorpha achemon*, and *Sphinx eremitis)* have been verified as eastern prairie fringed orchid pollinators (Cuthrell 1994, Crosson *et al.* 1999, Cuthrell *et al.* 1999, Pollack 2009). More research is needed on the hawkmoths' distribution, population levels, management needs, and reproduction.

2.3.2 Five-Factor Analysis

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

Most eastern prairie fringed orchid populations have been lost through conversion of habitat to cropland and pasture. Drainage and development pose threats to this species' habitat. In addition, late-successional (i.e., high quality natural areas free of

invasive species) prairie remnants supporting this species require management to reduce cover of woody vegetation. Fire and other management techniques that mimic natural disturbance may be required to control or eliminate invasive species and to maintain stable late-successional vegetation. Most sites within the species range need continual management. In addition, if past actions have destroyed some ecosystem functions (i.e., natural drainage), then management may be needed to mimic the lost function. Lack of appropriate natural areas management threatens populations regardless of their legal protection status (USFWS 1989).

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

Native terrestrial orchids are rarely grown from seed. Adult plants are often sought for scientific and commercial purposes or, for gardens and therefore are susceptible to collection. Smaller populations of eastern prairie fringed orchids can be negatively impacted by collecting. Due to high human population densities in some parts of the range of the eastern prairie fringed orchid, it is subject to collection pressures. Populations of eastern prairie fringed orchids in Michigan and Illinois have been impacted by removal of plants (USFWS 1989; K. Lah, USFWS, pers. comm. 2008).

2.3.2.3 Disease or predation:

Although no threats were identified under this listing factor when the species was listed (USFWS 1989), an increase in deer populations in portions of the species range has resulted in an increased impact from herbivory of eastern prairie fringed orchid flowers which reduces or eliminates the plants ability to reproduce.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Protection of threatened plants on privately-owned lands is extremely limited in most states throughout the eastern prairie fringed orchid's range, leaving those populations vulnerable to habitat destruction and extirpation (USFWS 1989). Currently, 23 populations have full legal protection (Bell 2008).

2.3.2.5 Other natural or manmade factors affecting its continued existence:

The eastern prairie fringed 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. Pollinator populations may be adversely affected by pesticides and loss of habitat (USFWS 1989). As identified in the species recovery plan, action 5.2 identifies the need for research to address the status of pollinators, their vulnerability to human impacts, and their life history requirements (e.g., habitat patch size, larval host plants, adult nectar plants, etc.) (USFWS 1999).

Climate change will be a particular challenge for endangered, threatened and other at-risk species because the interaction of additional stresses associated with climate change and current stressors may push them beyond their ability to survive (Easterling and Karl 2000). In addition, populations of some species that are near the southern end of the range may be at particular risk (IPCC 2007). While there is uncertainty about the exact nature and severity of climate change related impacts

anticipated within the eastern prairie fringed orchid's range, a number of scientific studies project that there will be increased duration and intensity of heat waves in summer, higher levels of humidity and evaporation; changing patterns of precipitation with fewer rain events of greater intensity; increased frequency and more severe dry spells; and more flooding from heavy rains (Easterling and Karl 2000; Ebi and Meehl 2007; Hall and Stuntz 2007; IPCC 2007). Research has suggested that climate change may also negatively impact pollinator species if plants and their pollinators respond differently to climate change (NRC 2007; Earthwatch Institute 2006). These climatic changes may threaten the eastern prairie fringed orchid in a variety of direct and indirect ways including: changes in the timing of blooming, loss of suitable habitat; loss of inter-specific relationships with pollinators and mycorrhizal associates; and increased threats from invasive species.

2.4 Synthesis

Overall, 17 more populations exist now than were known since the 1991 5-year review, the issuance of the recovery plan, and the completion of the last population viability assessment in 1999. The increase in the number of populations is due in part to efforts of hand pollinating plants and introducing seeds into suitable habitat to establish seven new populations in Illinois. In other cases, the increase is a result of the species receiving greater recognition and attention on private and public land. Five more populations are ranked highly viable than were identified in the 1999 population viability assessment. However, habitat loss and degradation continue to threaten the eastern prairie fringed orchid. Only 24% of the populations across the species range have adequate habitat to maintain a highly viable population. Only 30% of the populations in the United States have full legal protection. In addition, 83% of the eastern prairie fringed orchid populations across the species range have severe to moderate management needs and continue to be threatened by invasive species, woody vegetation encroachment, or changes in hydrology and development. Population trends for *Plantanthera leucophaea* indicate that 78% of the populations are either increasing or are stable; however, population fluctuations are variable across the species range and may be influenced by climatic conditions, such as precipitation.

Although progress has been made in protecting eastern prairie fringed orchid populations from invasive species encroachment, most areas are still threatened by invasive species and need to be managed on an ongoing basis with the best management practices available. Achievement of the delisting criteria continues. Under Criterion 1, eleven of the required twenty-two viable populations are distributed across plant communities and physiographic regions within the historic range of the species, but only the prairie community in the Lake Erie Lake Plain of Ohio and Michigan has met the recovery criterion. Under Criterion 2, only eleven of the required twenty-two populations are highly viable. The five-factor threats analysis demonstrates that threats are relevant (i.e., destruction, modification or curtailment of its habitat, overutilization, predation by deer, inadequate regulatory mechanisms on non-Federal land, and natural or manmade factors affecting its continued existence). This species may become endangered in the

foreseeable future throughout all or a significant portion of its range, and therefore, continues to meet the definition of threatened.

3.0 RESULTS

3.1 Recommended Classification:
No change is needed

3.2 New Recovery Priority Number: Not applicable

Brief Rationale: Seventeen more populations have been identified since the 1999 population viability assessment. There are now 11 populations ranked highly viable. Recovery Criterion 1 indicates 22 highly viable populations distributed across plant communities and physiographic regions within the historic range of the species. Of the eight communities and regions identified for recovery within the species' historic range, only the prairie community in the Lake Erie Lake Plain of Ohio and Michigan has met the recovery criteria. While the other communities and regions identified in the recovery criteria have viable populations, none of these areas have an adequate number of highly viable populations to meet the recovery criteria. Habitat loss and degradation continue to threaten the eastern prairie fringed orchid. In addition, deer herbivory to flowering plants appears to be increasing across the species range. Though more populations exist, the same threats at the same levels remain; therefore, no change in the recovery priority number is needed.

3.3 Listing and Reclassification Priority Number: Not applicable

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

The highest priority recovery actions for the eastern prairie fringed orchid are acquiring legal protection of habitat, and habitat management. Protecting habitat through legal designation is recovery action 1 and identified as a priority 1 action (i.e., an action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future) (USFWS 1999). In most states, the highest available form of legal protection consists of conservation easements under state nature preserve acts (Pearsall 1984). Because only 23 of the 76 (31%) extant eastern prairie fringed orchid populations have legal protection, protection under state nature preserve acts should be pursued. For states that do not have active nature preserve acts (e.g., Michigan), other forms of conservation easements that can be held by private organizations should be sought. Another option to willing private land-owners is conveyance of property rights to public or private conservation agencies that will provide legal protection and management.

Recovery action 2 addresses managing habitat (USFWS 1999). Because sites supporting orchid populations may require varying degrees of active management to maintain or enhance orchid populations, habitat management was identified in the species recovery plan as a priority 1 action. While 17 more extant sites are now known, there was a decrease of six sites in late-successional stage. This highlights the need for increased management at eastern prairie fringed orchid sites. Management techniques needed may include prescribed burns, or brush and weed removal depending on the site condition. While habitat is being managed at many eastern prairie fringed orchid sites across the species range, habitat management is an ongoing activity that will have varying degrees of need based on the level of woody species encroachment and invasion by non-native plant species.

Recovery action 3 needs to be implemented continuously -- increasing the size and number of populations. As discussed above, by removing woody vegetation that has encroached on a site, habitat may be increased which, in turn, may lead to population expansion. The number of pollinator visits to small orchid populations may be a limiting factor for seed production at a particular site. Hand-pollination should be used where natural pollination is infrequent or absent in order to maximize seed production. Hand-pollination and seed dispersal appear to provide cost effective methods for augmenting existing populations (action 3.1) and reintroducing or restoring new populations (action 3.2) in appropriate habitat that is legally protected (USFWS 1999).

Much has been learned about the eastern prairie fringed orchid since its listing and completion of the Federal recovery plan. However, there is still a need for greater understanding of the species life history requirements, specifically the species' pollinators and seed germination. Three species of hawkmoths (*Eumorpha pandorus*, *Eumorpha achemon*, and *Sphinx eremitis)* have been verified as eastern prairie fringed orchid pollinators (Cuthrell 1994, Crosson *et al.* 1999, Cuthrell *et al.* 1999, Pollack 2009). However, little is known about the hawkmoths' distribution, population levels, management needs, or reproduction. Research to gain greater understanding about these

aspects of the pollinators will assist in the recovery of the eastern prairie fringed orchid (USFWS 1999, action 5.2).

Another research need to advance the recovery of the eastern prairie fringed orchid is in relation to seed germination and inoculation. Research to date has determined that the mycorrhizal fungus *Ceratorhiza goodyerae-repentis* promotes the germination of eastern prairie fringed orchid seed (Zettler *et al.* 2005) and can sustain mature plants (Zettler *et al*. 2001). In addition, the fungus *C. pernacatena* has also been recovered from mature eastern prairie fringed orchids (Zettler *et al*. 2001), suggesting that the species may associate with both *C. goodyerae-repentis* and *C. pernacatena* when mature (Zettler *et al.* 2005). Further research is needed to determine the extent that eastern prairie fringed orchids require these fungal species throughout its range. In addition, research to determine if *C. goodyerae-repentis* can be used to inoculate seedlings, introduce into potential restoration sites, and propagate eastern prairie fringed orchids *ex situ* is needed (USFWS 1999, action 5.3).

The two population viability assessments cited in this review are based on field surveys conducted between 1990 and 1998 and again from 1999 to 2007 (USFWS 1999, Bell 2008). The data collected in the population viability assessments provide an accurate and distinct update of the status of the eastern prairie fringed orchid across the species' range and therefore has been extremely useful in completing this review. Assessment of the progress toward recovery through updates to the population viability assessment rankings should be completed annually, as described under action 6.1 (USFWS 1999).

5.0 REFERENCES

Bell, T. 2008. *Platanthera leucophaea* population viability reassessment. Unpublished data.

Bowles, M.L. 1983. The tallgrass prairie orchids *Platanthera leucophaea* (Nutt.) Lindl. and *Cypripedium candidum* Muhl. ex Willd.: Some aspects of their status, biology, and ecology, and implications toward management. Natural Areas Journal 3(4)14-37.

Bowles, M.L. and T. Bell. 1999. Establishing recovery targets for the eastern prairie fringed orchid (*Platanthera leucophaea*). Unpublished report to the Illinois Endangered Species Protection Board. 27p.

Bowles, M., R. Flakne, and R. Dombeck. 1992. Status and population fluctuations of the eastern prairie fringed orchid [*Platanthera leucophaea* (Nutt.) Lindl.] in Illinois. *Erigenia* (Illinois Native Plant Society Bulletin) 12:26-40.

Committee on the Status of Pollinators in North America, National Research Council (NRC). 2007. Status of Pollinators in North America. 322p.

Crosson, A.E., J.C. Dunford, D.K. Young. 1999. Pollination and other insect interactions of the eastern prairie fringed orchid (Platanthera leucophaea (Nuttall) Lindley) in Wisconsin. Report to the U.S. Fish and Wildlife Service, Barrington, IL. 13p.

Cuthrell, D.L. 1994. Insects associated with the prairie fringed orchids, *Platanthera praeclara* Sheviak & Bowles and *P. leucophaea* (Nuttall) Lindley . MS Thesis, North Dakota State University, Fargo, ND, 81p.

Cuthrell, D. L., P.J. Higman, M.R. Penskar, and J.L. Windus. 1999. The Pollinators of Ohio and Michigan populations of Eastern prairie fringed orchid *(Platanthera leucophaea).* Prepared for the U.S. Fish & Wildlife Service, Reynoldsburg, OH. 20pp.

Earthwatch Institute. 2006. Climate Change Threatens Pollination Timing. *Science Daily*. Retrieved August 20, 2009, from http://www.sciencedaily.com/releases/2006/08/060809234056.htm.

Easterling, D. and T. Karl. 2000. Potential Consequences of Climate Variability and Change for the Midwestern United States. In Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change, by the National Assessment Synthesis Team, US Global Change Research Program. Chapter 6, pp.167-188.

Ebi, K., and G. Meehl. 2007. Heatwaves & Global climate change - The Heat is On: Climate Change & Heatwaves in the Midwest. In: Regional Impacts of Climate Change: Four Case Studies in the United States. Prepared for the Pew Center on Global Climate Change. 20p.

Hall, N.D. and B. Stuntz. 2007. Climate Change and Great Lakes Water Resources. Prepared for the National Wildlife Federation. 44p.

Hamrick, J.L., M.J.W. Godt, D.A. Murawski, and M.D. Loveless. 1991. Correlations between species traits and allozyme diversity: implications for conservation biology. Pp. 75-86 in Genetics and Conservation of Rare Plants, D.A. Falk and K.E. Holsinger (eds.), Oxford University Press, New York. 283p.

Havens, K. and K. Bradford. 2001. A population genetic analysis of *Platanthera leucophaea* in northern Illinois. Final report to the Illinois Department of Natural Resources, Springfield, IL. 11p.

Havens K. and Buerkle A. 1999. A population genetic analysis of *Platanthera Leucophaea* in northeastern Illinois. U.S. Fish and Wildlife Service, Region 3, Fort Snelling, MN. 7p.

Huffman, R. 2009. Eastern Prairie Fringed Orchid Summary 2008. Unpublished data.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change 2007: Synthesis Report. Fourth Assessment Report. 52p.

Keibler, J. 1994. Restoration of the eastern prairie fringed orchid *Platanthera leucophaea* by seed broadcast and management initiates. Report to the U.S. Fish and Wildlife Service. 9p.

Keibler, J. 1995. Restoration of the eastern prairie fringed orchid *Platanthera leucophaea* by seed broadcast and management initiates. Report to The Nature Conservancy. 9p.

Keibler, J. 1996. Restoration of the eastern prairie fringed orchid (*Platanthera leucophaea*) by seed broadcast and management initiatives. Report to the U.S. Fish and Wildlife Service. 9p.

Keibler, J. 1997. Restoration of the eastern prairie fringed orchid (*Platanthera leucophaea*) by seed broadcast and management initiatives. Report to the U.S. Fish and Wildlife Service. 9p.

Keibler, J. 1998. Population and monitoring assessment results of Restoration of the eastern prairie fringed orchid (*Platanthera leucophaea*) by seed broadcast and management initiatives, a continuation of the study, "Restoration of the eastern prairie fringed orchid *Platanthera leucophaea* by seed broadcast and management initiatives." Report to The Nature Conservancy. 9p.

Keibler, J. 1999. Population and monitoring assessment results of Restoration of the eastern prairie fringed orchid (*Platanthera leucophaea*) by seed broadcast and management initiatives, a continuation of the study, "Restoration of the eastern prairie fringed orchid *Platanthera leucophaea* by seed broadcast and management initiatives." Report to The Nature Conservancy. 9p.

Keibler, J. 2000. Population and monitoring assessment results of Restoration of the eastern prairie fringed orchid (*Platanthera leucophaea*) by seed broadcast and management initiatives, a continuation of the study, "Restoration of the eastern prairie fringed orchid *Platanthera leucophaea* by seed broadcast and management initiatives." Report to The Nature Conservancy. 9p.

Keibler, J. 2001. Population and monitoring assessment results of Restoration of the eastern prairie fringed orchid (*Platanthera leucophaea*) by seed broadcast and management initiatives, a continuation of the study, "Restoration of the eastern prairie fringed orchid *Platanthera leucophaea* by seed broadcast and management initiatives." Report to The Nature Conservancy. 9p.

Keibler, J. 2002. Population and monitoring assessment results of Restoration of the eastern prairie fringed orchid (*Platanthera leucophaea*) by seed broadcast and management initiatives, a continuation of the study, "Restoration of the eastern prairie fringed orchid *Platanthera leucophaea* by seed broadcast and management initiatives." Report to The Nature Conservancy. 9p.

Keibler, J. 2003. Population and monitoring assessment results of Restoration of the eastern prairie fringed orchid (*Platanthera leucophaea*) by seed broadcast and management initiatives, a continuation of the study, "Restoration of the eastern prairie fringed orchid *Platanthera leucophaea* by seed broadcast and management initiatives." Report to The Nature Conservancy. 9p.

Keibler, J., A. Orton-Palmer, and L. Ross. 1993. Restoration of the eastern prairie fringed orchid *Platanthera leucophaea* by seed broadcast. Report to the U.S. Fish and Wildlife Service.9p.

Pearsall, S. 1984. Public dedication of nature preserves. Natural Areas Journal 4(1):11-23.

Piskin, K.A., J.J. Hartstock, L.W. Zettler, and M.L. Bowles. 2003. Seed germination requirements of a federally-threatened orchid (*Platanthera leucophaea*) in nature, and a technique to establish leaf-bearing seedlings onto soil. *Southeastern Biology* 50(2):170.

Pollack, C. 2009. Restoration of the eastern prairie fringed orchid (*Platanthera leucophaea*): Natural pollinators and the abundance of larval host plants. MS Thesis, Northeastern Illinois University, Chicago, IL. 61p.

Sheviak, C.J. 1990. Biological considerations in the management of temperate terrestrial orchids. Pp.194-196 in Mitchell, R.S., C.J. Sheviak, and D.J. Leopold, editors. Ecosystem management: Rare species and significant habitats. Proceedings of the 15th annual Natural Areas Conference. New York State Museum Bulletin No. 471. 314p.

The Nature Conservancy (TNC). 2007. Restoration of the eastern prairie fringed orchid (*Platanthera leucophaea*) by seed broadcast and management initiatives. 5p.

Wallace, L.E. 2002. Examining the effects of fragmentation on genetic variation in *Platanthera leucophaea* (Orchidaceae): Inferences from allozyme and random amplified polymorphic DNA markers. *Plant Species Biology* 17:37-49.

Wallace, L.E. 2003. The cost of inbreeding in *Platanthera leucophaea* (Orchidaceae). *American Journal of Botany* 90(2):235-242.

White, J. 1978. Illinois natural areas inventory technical report. Volume I: Survey methods and results. Illinois Natural Areas Inventory, Urbana, IL. 426p.

U.S. Fish and Wildlife Service (USFWS). 1989. Endangered and threatened wildlife and plants: Determination of threatened status for eastern and western prairie fringed orchids: Final rule. Federal Register 54(187):39857-39862.

U.S. Fish and Wildlife Service (USFWS). 1999. Eastern prairie fringed orchid (*Platanthera leucophaea* [Nuttall] Lindley) Recovery Plan. Fort Snelling, MN. 62p.

Vitt, P. 2001. Effect of hand pollination on reproduction and survival of the eastern prairie fringed orchid: Report to the U.S. Fish and Wildlife Service and the Nature Conservancy. 6p.

Vitt, P. 2003. Effects of hand pollination on reproduction and survival of the eastern prairie fringed orchid. Final report to the U.S. Fish and Wildlife Service, Barrington, IL. 8p.

Zettler L.W., S.L. Stewart, M.L. Bowles, and K.A. Jacobs. 2001. Mycorrhizal fungi and cold-assisted symbiotic germination of the Federally threatened eastern prairie fringed orchid, *Platanthera leucophaea* (Nuttall) Lindley. *American Midland Naturalist* 145: 168–175.

Zettler, L.W., K.A. Piskin, S.L. Stewart, J.J. Hartsock, M.L. Bowles and T.J. Bell. 2005. Protocorm mycobionts of the Federally threatened eastern prairie fringed orchid, *Platanthera leucophaea* (Nutt.) Lindley, and a technique to prompt leaf elongation in seedlings. *Studies in Mycology* 53: 163–171.

Expert consulted:
Dr. Timothy Bell, Professor of Botany at Chicago State University and Research Associate at the Morton Arboretum, provided population viability data for the eastern prairie fringed orchid across the species range.

U.S. FISH AND WILDLIFE SERVICE 5-YEAR REVIEW
Species: Eastern prairie fringed orchid (*Platanthera leucophaea*)

Current Classification: Threatened

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X__ No change needed

Appropriate Recovery Priority Number: __8__

Review Conducted By: Kristopher Lah

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve Peter Fasbender, Acting Date 26 January 2010

REGIONAL OFFICE APPROVAL:

Lead Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Midwest Region

Approve Lynn M Lewis Date 3/16/10

REGIONAL CONCURRENCE:

Acting **Regional Director, U.S. Fish and Wildlife Service, Northeast Region**

AUG 10 2010

Signature Anthony R Leger Date _____

APPENDIX 1

Variables Used in Eastern Prairie Fringed Orchid Population Viability Index

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. Mean annual flowering plant census data is assigned a value and applied to the index as follows: 0 = fewer than 10 flowering plants; 1 = 10 to <25 flowering plants; 2 = 25 to <50 flowering plants, 3 = greater than 50 flowering plants (USFWS 1999; Bowles *et al.* 1992).

Population extirpation simulations indicate that populations with 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 a 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 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. This variable is a correlation of annual population size with time and is assigned values and applied in the index as follows: 0 = plants absent; 1 = decreasing or significant negative correlations; 2 = stable or no significant correlation; 3 = increasing or significant positive correlation (USFWS 1999; Bowles *et al.* 1992).

Population reproduction frequency: Reproduction population trend statistics are 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. The frequency of years in which 10% or more of the flowering plants within a population produce seed is the measure for this variable and is a in the index as follows: 0 = frequency less than 33%; 1 = frequency between 33-50%; 2 = frequency between 50-67%; 3 = frequency greater than 67% (USFWS 1999; Bowles *et al.* 1992). However, data is rarely available to apply to this variable, so it has not been applied in population viability assessments conducted to date on the eastern prairie fringed orchid.

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. Values assigned to habitat size in the population viability index are applied as follows: 0 = habitat less than 2.5 acres; 1 = habitat

2.5 to <62.5 acres; 2 = habitat 62.5 <125 acres; 3 = habitat greater than 125 acres (USFWS 1999; Bowles *et al.* 1992).

Habitat successional stage and condition: The successional stage, or "natural quality" (White 1978), is an indicator of past or current disturbance impacts to vegetation. Highly viable eastern prairie fringed orchid populations occur in late-successional habitat in high quality natural areas that are free of invasive species. Fire and other management techniques that mimic natural disturbance may be required to control or eliminate invasive species and to maintain stable late-successional vegetation. 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). Values assigned to this variable are based on the degree of disturbance (i.e. natural quality grade) or habitat successional stage and are as follows: 0 = very heavily disturbed (grade D) or early successional; 1 = heavily disturbed (grade C) or early successional; 2 = moderately disturbed (grade B) or mid-successional; 3 = lightly or undisturbed (grade A) or late-successional (USFWS 1999; Bowles *et al.* 1992).

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. Public land that is preserved in perpetuity and/or provides for regulatory protection would be examples of land that would be considered highly viable. 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. This variable is assigned a value based on ownership and legal deed restrictions as follows: 0 = private ownership with no protection; 1 = private ownership with informal protection agreements but without legally binding protection; 2 = private or public ownership with formal but not legal protection; 3 = private or public ownership with legally binding protection (USFWS 1999; Bowles *et al.* 1992).

Management condition: The eastern prairie fringed orchid occurs in grass- and sedge dominated communities that require fire to prevent woody vegetation encroachment. Fire and other management techniques that mimic natural disturbance may be required to control or eliminate invasive species and to maintain stable late-successional vegetation. Most sites within the species range will need almost continual management. 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 canary grass, 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. This variable is assigned a value based on the degree of management needed to maintain the plant community as follows: 0 = severe; 1 = moderate; 2 = low; 3 = none (USFWS 1999; Bowles *et al.* 1992).

APPENDIX 2

2007 Population Viability Assessment

Community	Physiographic Region	Site name	State	Population size	Population trend	Habitat size	Protection status	Successional status	Management needs	PVI	Viability
Prairie	Kansan till	Garden Grove Prairie	IA	1	2	2	0	3	2	0.56	Moderate
Prairie	Kansan till	Williams Prairie	IA	0	0	2	3	2	2	0.50	**Extirpated**
Prairie	Kansan till	Muskrat Slough	IA	3	1	1	2	2	2	0.61	Moderate
Prairie	Lake Erie lake plain	Monroe Co. #1	MI	3	2	1	2	1	1	0.56	Moderate
Prairie	Lake Erie lake plain	Mallard Club Wildlife Area	OH	3	3	2	2	2	2	0.78	High
Prairie	Lake Erie lake plain	Maumee Bay	OH	1	1	1	2	2	2	0.50	Low
Prairie	Lake Erie lake plain	Metzger	OH	3	1	1	0	2	2	0.50	Low
Prairie	Lake Erie lake plain	Ottawa National Wildlife Refuge	OH	3	2	3	3	2	2	0.83	High
Prairie	Lake Erie lake plain	Pickerel Creek	OH	3	2	1	2	1	2	0.61	Moderate
Prairie	Lake Erie lake plain	Wightman's Grove	OH	2	3	1	2	1	3	0.67	Moderate
Prairie	Lake Erie lake plain	Yodonta Rd	OH	1	1	1	0	2	2	0.39	Low
Prairie	Lake Huron lake plain	St. Clair County #2	MI	0	1	1	2	2	2	0.44	**Extirpated**
Prairie	Lake Huron lake plain	Huron County #1	MI	3	3	3	2	3	3	0.94	High
Prairie	Lake Huron lake plain	Tuscola County #1	MI	3	2	3	2	3	3	0.89	High
Prairie	Lake Huron lake plain	Bay County #1	MI	1	1	1	1	1	1	0.33	Low
Prairie	Lake Huron lake plain	Bay County #2	MI	0	2	1	2	1	1	0.39	Low
Prairie	Lake Huron lake plain	Bay County #3	MI	2	2	1	0	1	1	0.39	Low
Prairie	Lake Huron lake plain	Saginaw County #1	MI	1	2	1	0	0	1	0.28	Low

Community	Physiographic Region	Site name	State	Population size	Population trend	Habitat size	Protection status	Successional status	Management needs	PVI	Viability
Prairie	Lake Huron lake plain	St. Clair County #1	MI	1	2	0	1	2	2	0.44	Low
Prairie	Lake Huron lake plain	Tuscola County #2	MI	2	1	1	0	1	1	0.33	Low
Prairie	Lake Huron lake plain	Tuscola County #3	MI	0	0	1	2	3	3	0.50	Low
Prairie	Lake Michigan lake plain	Miami Woods FP	IL	0	0	1	2	2	2	0.39	**Extirpated**
Prairie	Lake Michigan lake plain	Gensburg-Markham Prairie	IL	0	2	1	0	3	1	0.39	Low
Prairie	Lake Michigan lake plain	Paintbrush Prairie*****	IL	0	1	1	3	1	2	0.44	Low
Prairie	Lake Michigan lake plain	Sundrop Prairie*****	IL	0	2	1	3	1	2	0.50	Low
Prairie	Lake Michigan lake plain	Illinois Beach	IL	0	2	2	3	3	3	0.72	Moderate
Prairie	Lake Michigan lake plain	Chiwaukee Complex	WI	3	2	3	3	3	3	0.94	High
Prairie	Lake Michigan lake plain	Bain Station	WI	1	0	2	1	1	1	0.33	Low
Minerotrophic /Spahgnum Peatland	n/a	Crystal Bog	ME	1	2	1	2	3	3	0.67	Moderate
Minerotrophic /Spahgnum Peatland	n/a	Livingston County #1	MI	0	2	1	2	1	1	0.39	Extirpated
Minerotrophic /Spahgnum Peatland	n/a	St. Joseph County #1	MI	1	2	0	0	2	2	0.39	Low
Minerotrophic /Spahgnum Peatland	n/a	St. Joseph County #2	MI	0	0	1	1	2	2	0.33	Low

Community	Physiographic Region	Site name	State	Population size	Population trend	Habitat size	Protection status	Successional status	Management needs	PVI	Viability
Minerotrophic /Spahgnum Peatland	n/a	Washtenaw County #1	MI	0	2	1	3	2	2	0.56	Moderate
Minerotrophic /Spahgnum Peatland	n/a	Cedarburg	WI	3	2	2	2	3	2	0.78	High
Prairie	Wisconsinan drift	Burlington Prairie*	IL	0	2	0				0.11	**Extirpated/ Low**
Prairie	Wisconsinan drift	Churchill Prairie	IL	0	0	2	2	1	1	0.33	**Extirpated**
Prairie	Wisconsinan drift	Lincolnshire	IL	0	2	1	2	2	2	0.50	Low
Prairie	Wisconsinan drift	Wolf Road Prairie	IL	0	2	1	3	2	2	0.56	**Extirpated**
Prairie	Wisconsinan drift	Grant Creek	IL	0	3	2	3	3	3	0.78	High
Prairie	Wisconsinan drift	Munson Cemetery	IL	3	3	1	3	3	3	0.89	High
Prairie	Wisconsinan drift	Abbott Park	IL	1	1	1	1	1	1	0.33	Low
Prairie	Wisconsinan drift	Baxter	IL	1	3	1	1	1	1	0.44	Low
Prairie	Wisconsinan drift	Carpentersville	IL	0	2	1	0	1	1	0.28	Low
Prairie	Wisconsinan drift	Florsheim NP	IL	0	1	1	3	1	1	0.39	Low
Prairie	Wisconsinan drift	Hybernia NP	IL	0	2	1	3	1	1	0.44	Low
Prairie	Wisconsinan drift	Nippersink + DeRose-Glacial Park	IL	0	2	2	2	1	2	0.50	Low
Prairie	Wisconsinan drift	Rudd Farm	IL	0	3	1	0	1	1	0.33	Low
Prairie	Wisconsinan drift	Schiller Woods FP	IL	0	2	1	2	1	2	0.44	Low
Prairie	Wisconsinan drift	Somme Woods FP	IL	0	3	1	2	1	2	0.50	Low
Prairie	Wisconsinan drift	Swift Prairie	IL	0	3	1	2	1	0	0.39	Low
Prairie	Wisconsinan drift	Wayside Prairie	IL	0	2	1	2	1	1	0.39	Low

Community	Physiographic Region	Site name	State	Population size	Population trend	Habitat size	Protection status	Successional status	Management needs	PVI	Viability
Prairie	Wisconsinan drift	Loda Cemetery	IL	0	3	1	3	3	2	0.67	Moderate
Prairie	Wisconsinan drift	Lone Grove*	IL	1	2	1	2	2	2	0.56	Moderate
Prairie	Wisconsinan drift	Lyons Woods	IL	2	2	1	3	2	2	0.67	Moderate
Prairie	Wisconsinan drift	Middlefork Savanna	IL	0	2	1	3	3	3	0.67	Moderate
Prairie	Wisconsinan drift	Somme NP*	IL	0	2	1	3	2	2	0.56	Moderate
Prairie	Wisconsinan drift	W. Chicago Prairie	IL	0	3	2	2	2	2	0.61	Moderate
Prairie	Wisconsinan drift	Wadsworth Prairie	IL	3	2	3	3	1	1	0.72	Moderate
Prairie	Wisconsinan drift	Wrigley tract	IL	2	2	2	1	1	2	0.56	Moderate
Prairie	Wisconsinan drift	Rock1 (Koshkonong)	WI	3	3	3	2	2	3	0.89	High
Prairie	Wisconsinan drift	Taylor Creek Prairie	WI	0	0	0	0	2	2	0.22	Low
Prairie	Wisconsinan drift	White River Marsh	WI	0	2	1	2	2	2	0.50	Low
Prairie	Wisconsinan drift	Faville-Snapper	WI	1	2	2	3	3	2	0.72	Moderate
Prairie	Wisconsinan drift	Greene	WI	0	2	2	2	3	3	0.67	Moderate
Prairie	Wisconsinan drift	Newark Rd	WI	1	2	1	2	3	2	0.61	Moderate
Prairie	Wisconsinan drift	Oshkosh-Larsen	WI	1	2	1	2	2	3	0.61	Moderate
Prairie	Wisconsinan drift	Scuppernong	WI	1	1	2	3	2	1	0.56	Moderate
Prairie	Wisconsinan drift	Young	WI	0	2	2	3	2	1	0.56	Moderate
Sedge Meadow	Wisconsinan drift / unglaciated	Baldwin Marsh	IA	3	1	1	1	1	2	0.50	Low
Sedge Meadow	Wisconsinan drift / unglaciated	Harrison Benwell	IL	0	0	1	2	1	1	0.28	**Extirpated**

Community	Physiographic Region	Site name	State	Population size	Population trend	Habitat size	Protection status	Successional status	Management needs	PVI	Viability
Sedge Meadow	Wisconsinan drift / unglaciated	Hildy Prairie	IL	3	3	1	1	2	2	0.67	Moderate
Sedge Meadow	Wisconsinan drift / unglaciated	Long Grove	IL	1	3	1	3	2	2	0.67	Moderate
Sedge Meadow	Wisconsinan drift / unglaciated	Dayton (Medway)	OH	3	2	1	0	2	2	0.56	Moderate
Sedge Meadow	Wisconsinan drift / unglaciated	Killbuck SM (Cemetary Rd)	OH	1	2	3	2	2	2	0.67	Moderate
Sedge Meadow	Wisconsinan drift / unglaciated	Killbuck SM (Holmesville)	OH	1	2	3	2	2	2	0.67	Moderate
Sedge Meadow	Wisconsinan drift / unglaciated	Killbuck SM (State Rt 83 site)	OH	2	3	3	2	2	2	0.78	High
Sedge Meadow	Wisconsinan drift / unglaciated	Leadingham	OH	3	1	1	1	2	2	0.56	Moderate
Sedge Meadow	Wisconsinan drift / unglaciated	South River SM	VA	0	0	3	0	2	1	0.33	**Extirpated**
Sedge Meadow	Wisconsinan drift / unglaciated	Uihlein (Waukau)	WI	3	3	1	3	3	2	0.83	High
Sedge Meadow	Wisconsinan drift / unglaciated	Desplaines	WI	0	1	3	1	2	2	0.50	Low
Sedge Meadow	Wisconsinan drift / unglaciated	Pell Lake	WI	0	1	0	0	2	1	0.22	Low
Prairie	Illinoisan drift	Nachusa*****	IL	0	3	1	3	2	2	0.61	Moderate
Sedge Meadow	Wisconsinan drift	Ascension Sedge Meadow	IL	0	1	1	2	2	2	0.44	Low
Sedge Meadow	Wisconsinan drift	Silver Lake	IL	0	0	1	1	2	2	0.33	Low

Community	Physiographic Region	Site name	State	Population size	Population trend	Habitat size	Protection status	Successional status	Management needs	PVI	Viability
Sedge Meadow	Wisconsinan drift	Standlee Fen/Slough Creek Sedge Meadow	IL	0	2	1	0	1	1	0.28	Low

* = Site reintroduced by scattering or broadcasting seeds.

APPENDIX 3

Summary of comments received

We sent a preliminary draft version of the 5-year review along with supporting references to the cooperating Service field offices within the range of the orchid, and to three recognized experts. We received comments from staff in three other Service offices and from one recognized expert. The table below summarizes the comments received and our responses to those comments.

Issue	Number of Observations	USFWS Response
Follow the template	3	Template followed.
Various minor editorial comments	4	Mostly incorporated
Habitat issue – EPFO requiring late-successional stage, coupled with needing occasional disturbance seems contradictory. Grade "A" prairie not appropriate	2	The successional stage, or "natural quality", is an indicator of past or current disturbance impacts to vegetation. Grade "A" prairies are relatively stable or lightly disturbed communities. "Disturbance impacts" refer to ground disturbance (e.g., plowed or tilled). However, fire and other management techniques that mimic natural disturbance may be required to control or eliminate invasive species and to maintain stable late-successional vegetation.
Should reevaluate and clarify protection status. In many cases, Federal ownership just as good as nature preserve designation. Ohio NWR should be given highest land protection status.	2	Reevaluated original data from 2007 PVA and adjusted variable for protection status to reflect highest level of protection. Federally listed plants receive the highest level of protection on Federal land.
Should clarify whether the habitat patch size for the PVA represents occupied habitat or potential habitat.		Habitat patch size represents suitable habitat.

Issue	Number of Observations	USFWS Response
Should consider changing the number of flowering plants in the PVA from 50. Some populations now have thousands of individuals, and in that regard 50 seems small.		We agree that when compared to thousands of flowering plants, 50 seems small. 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. In any case, we will continue to monitor orchid populations, and our assumptions in setting recovery criteria. At this time, a change in recovery criteria does not seem appropriate, in part because we are so far below achieving even these low numbers.
Should use all population trend data available. With a species with population numbers that can wildly fluctuate, two points in time may be insufficient to get a real trend.		The Service uses all data available. If we have 20 years worth of surveys, we rely on that, if we only have two, we rely on that.
Clarify management need portion of PVA -- no site is without management needs.	2	Orchid populations are at risk unless management actions can sustain the plant community. Management needed is a determination made based on the degree of habitat degradation from fire suppression and woody plant succession, non-native plant species invasion, hydrology alteration, and other impacts.
Table 3 should be supported with Dr. Bells work in an appendix.	1	Done
Clearly indicate which populations were introduced through hand pollination and seed scattering.	1	Paragraph added explaining which populations likely introduced through pollination/seed scatter project. Introduced populations are marked with an asterisk in appendix.
Include new information on genetics (e.g., Wallace study).		Done

Issue	Number of Observations	USFWS Response
Add citation for statement about habitat patch size and pollinators.	1	Checked with Cathy Pollack, her research shows no correlation between habitat size and pollinator populations, though it seems like there should be a relationship. Sentence deleted.