Minnesota Dwarf Trout Lily
(Erythronium propullans)

5-Year Review:
Summary and Evaluation

August 2011

Photo by Gary Hagemeister

U.S. Fish and Wildlife Service
Twin Cities Field Office
Bloomington, Minnesota

5-YEAR REVIEW

Species reviewed: Minnesota dwarf trout lily (*Erythronium propullans*)

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1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office: Carlita Payne, Midwest Region, (612) 713-5339

Lead Field Office: Phil Delphey, Twin Cities Field Office, (612) 725-3548

1.2 Methodology used to complete the review

This 5-year review was prepared by Phil Delphey, U.S. Fish and Wildlife Service (Service) – Twin Cities Field Office. New scientific or commercial data and information that may have a bearing on the species' classification of endangered was solicited from the public through a *Federal Register* notice (73 FR 21643). Mr. Delphey relied extensively on information and review provided by Nancy Sather and Derek Anderson of the Minnesota Department of Natural Resources (DNR). We did not carry out formal peer review of this 5-year review because scientific uncertainty or controversy is not high. The Service also reviewed reports and scientific papers that had been completed since the 1986 final rule listing and the Service's issuance of the species' recovery plan in 1987.

1.3 Background

1.3.1 FR Notice citation announcing initiation of this review

The Service notified the public of the initiation of the 5-year review in the *Federal Register* on April 22, 2008 (73 FR 21643-21645).

1.3.2 Listing history

Original Listing
FR notice: 58: 10521- 10523
Date listed: March 26, 1986
Entity listed: Species
Classification: endangered

1.3.3 Associated rulemakings: None

1.3.4 Review History

Minnesota dwarf trout lily was included in a 5-year review of all species listed before January 1, 1991 (56 FR 56882). The 5-year review resulted in no change to the listing classification of endangered.

1.3.5 Species' Recovery Priority Number at start of 5-year review: 5C

A recovery priority of 5C denotes that the degree of threat is high, the recovery potential is low, the listed taxon is a species (e.g., as opposed to a subspecies), and that the species may be in conflict with construction or other developmental projects or other forms of economic activity.

1.3.6 Recovery Plan

Name of plan: Minnesota Trout Lily (*Erythronium propullans* Gray) Recovery Plan

Date issued: December 16, 1987

Dates of previous revisions, if applicable: N/A

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?

No

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 Minnesota trout lily can be considered for reclassification to threatened status when a minimum of 400 naturally occurring colonies (clones) in at least 10 geographically and ecologically distinct sites are adequately protected and managed to assure their continued existence. **This criterion has not been met.**

> Delisting can be considered when a total of 500 colonies in at least 15 sites, representing the entire extant range of the species, are adequately protected and managed. **This criterion has not been met.**

According to the recovery plan (U.S. Fish and Wildlife Service 1987, p. 17), when boundaries of individual colonies were difficult to distinguish, "100 flowering plants" were to constitute one colony. Minnesota Department of Natural Resources (DNR) abandoned counts of colonies several years ago in favor of counts of blooming plants in permanent monitoring plots (Sather 2009b, p. 5). In this review, we primarily report counts of blooming plants to describe population trends, but in this section we also provide a brief summary of progress towards meeting the recovery criteria, as described in the recovery plan (U.S. Fish and Wildlife Service 1987).

A new method for monitoring and describing the status of *E. propullans* populations is needed. Using counts of colonies to assess size and viability of *E. propullans* populations has proven to be impractical and insufficient because distinguishing "colonies" in the field is too subjective and they often merge over time (N. Sather, Minnesota Department of Natural Resources, pers. comm., 8 December 2009). Sather (pers. comm. 2 July 2008) recommended an improved definition for a colony, but then found it to also be unworkable. Therefore, she later recommended establishing permanent monitoring areas that encompass some proportion of all plants in each monitored population (N. Sather, pers. comm. 8 December 2009). All plants could then be counted within each monitoring area at a fixed frequency – e.g., once every three years.

The recovery plan states that protection is adequate "when a public agency holds fee title, or long-term lease, to the habitat in which the colonies occur" and if "the protection and preservation of the population of the trout lily" is the primary management objective for the site. It also states that ownership by a private conservation organization is not adequate because it "can be easily condemned for public development projects" (U.S. Fish and Wildlife Service 1987:19). The plan states that only Scientific and Natural Areas administered by the Minnesota Department of Natural Resources meet the plan's standard of protection.

To ensure that management is adequate, "a detailed management plan must be prepared for each site"; voluntary, non-binding agreements are not adequate (U.S. Fish and Wildlife Service 1987:19). In addition, "(A)ny lease agreement must allow legal access for management purposes, and must also provide authority to control all non-compatible land use practices."

Progress towards Meeting Recovery Criteria

As is typical of recovery plans for plants, the recovery criteria may be split into two general parts – (1) protection of habitat and (2) appropriate management of

protected habitat. We understand now that colonies are inappropriate for measuring population status, but we will retain that concept in the discussion below to summarize progress in protecting *E. propullans* populations.

In the recovery plan, the Service assumed that only those colonies within Minnesota Department of Natural Resources Scientific and Natural Areas (SNA) would be sufficiently protected and managed to ensure the conservation of *E. propullans*. The species occurs within two SNAs – Cannon River Trout Lily SNA and Prairie Creek Woods SNA. The number of colonies in Cannon River Trout Lily SNA is unknown, but is at least twelve. One population of *E. propullans* in this SNA, which consists of approximately 28 colonies, is divided between the SNA and an adjacent property. The data available for this population do not allow us to determine how many of these 28 colonies are in the SNA. Therefore, Cannon River Trout Lily SNA contains 12-40 colonies (Minnesota DNR, unpubl. data). At Prairie Creek Woods SNA, surveys were not conducted for several years to avoid dispersing seeds of garlic mustard (*Alliaria petiolata*), which eventually invaded the site; 14 and 11 colonies were recorded there in 1986 and 2000. In 2009, however, Sather (pers. comm. 10 May 2010) found that plants occurred here "in one large mass" that could constitute one colony (see photo on the cover of Sather 2009a).

Recovery Criteria – Adequacy and Potential Revisions

Since 1987, DNR has compiled significant new information regarding this species and threats to its continued existence. This new information warrants the development of revised or new recovery criteria. Any new or revised criteria would need to address the following threats: exotic species, such as buckthorn (*Rhamnus cathartica*), developmental anomalies, increased flooding, and perhaps also the offsite application of (lawn) herbicides.

When developing new recovery criteria we should also review and revise the definition of what constitutes "protected" populations. Sather (2004b) summarized the geographic distribution, ownership, and protection status of *E. propullans* populations using a definition for „protected' less restrictive than that used in the recovery plan (U.S. Fish and Wildlife Service 1987, p. 18-19). In addition to populations on SNAs, she also defined populations in preserves owned by The Nature Conservancy (TNC) and those in Nerstrand-Big Woods State Park as "functionally protected." Based on this definition, the total number of colonies that are functionally protected is about 551 (DNR, unpubl. data) – about 71% of all recorded colonies. This would include some substantial populations outside of SNAs – e.g., in TNC's Trout Lily Preserve, which overlaps partly with the Cannon River Trout Lily SNA. Since 2005, about 7000 plants have been recorded outside of the SNA in this preserve (Minnesota DNR, unpubl. data).

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

Until recently, it was assumed that *E. propullans* reproduces almost exclusively by forming a single runner from a bulb and that bulbs of non-blooming plants do not produce runners (Morley 1982). Data from introduced populations of *E. propullans* at Minnesota Landscape Arboretum (MLA) in Chaska, Minnesota are challenging those assumptions. *E. propullans* population dynamics may only be measured precisely where the species occurs in the absence of white trout lily (*E. albidum*) because non-blooming plants of the two species are often indistinguishable. If Morley's (1982) hypothesis was true, the maximum growth of *E. propullans* populations from *Year X* to *Year X + 1* would be equal to the number of blooming plants in *Year* X. Between 2002 and 2009 at MLA, however, annual population growth exceeded this rate 42% of the time among counts of plants in distinct groups (Sather 2009a).

To determine why populations at MLA were growing faster than expected, the DNR began counting fruits produced by blooming plants in 2007 (Sather 2009a). Plant and fruit counts indicate that growth of some *E. propullans* colonies at MLA exceed the expectation if each blooming plant and each fruit produced a single new plant in the following year (Sather 2009a). One or more of the following must be occurring: 1) multiple runners are produced from the bulbs of some blooming plants during a single year; 2) some *non-blooming plants* produce offshoots; or, 3) new plants grow from fruits produced in earlier years. On plants uprooted at MLA in 2005, Sather (2009a) documented production of runners from non-blooming plants and multiple bulbs on some plants; based on this, she concluded that the species is capable of greater belowground morphological variability and higher recruitment than was formerly believed.

Besides investigating the mode of reproduction in *E. propullans*, monitoring of the single-species colonies at MLA and Eloise Butler Wildflower Garden in Minneapolis, Minnesota has also allowed the DNR to record some basic life history data that could not be reliably obtained from wild populations. For example, Sather (N. Sather, pers. comm. 8 December 2009) was able to calculate the average rate of blooming – 15.6% – among ten groups of plants over an eight year period at MLA. In 2009, 26% of recorded plants bloomed – the highest proportion observed thus far (N. Sather, pers. comm. 8 December 2009).

In wild populations, fruits produced via hybridization with *E. albidum* may be markedly more common than fruits produced by intraspecific crosses. In 2004, the DNR marked 322 *E. propullans* plants when in bloom at Grace Nature Preserve, and revisited them to record fruit production. About 30% of non-anomalous plants produced distinctly large fruits, presumably the result of crosses

with *E. albidum*, whereas only about 8% produced medium/small fruits that may have resulted from intraspecific crosses (Sather 2004b:14-15). Large fruits resulting from interspecific crosses with *E. albidum* likely produce plants with hybrid characteristics (Morley 1993). The relative roles of intra- and interspecific fruit production may only be adequately understood by conducting genetic analyses of fruits.

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

In 1986, the DNR began intensive monitoring at three sites – Grace Nature Preserve, Nerstrand-Big Woods State Park, and River Bend Nature Center. At that time, these sites were thought to collectively contain about one-third of all *E. propullans* plants (Sather 2009b). At Nerstrand-Big Woods State Park, monitoring was discontinued in 1990 due to concerns about potential impacts of foot traffic, but it was resumed in 1999 to assess the impacts of a June 1998 flood and of "upslope land use" (Sather 2007). See Sather (2000; 2004a; 2009a) for descriptions of the methods used to search for *E. propullans* and to monitor populations.

In addition to the three primary monitoring sites, DNR also visits other *E. propullans* sites intermittently to assess the status of populations there (Sather 2004a). Demographic monitoring of wild populations is not feasible due to the inability to distinguish non-blooming *E. propullans* and *E. albidum* plants (Sather 2004a).

Summary of Intensive Monitoring

Nerstrand-Big Woods State Park – Since monitoring began at Nerstrand-Big Woods State Park, the numbers of both plants and colonies have declined (Fig. 1, Sather 2009a; Sather 2009b). Intensive monitoring occurs in two areas at the park – the "Boardwalk monitoring grid" and the "Oak Bridge Area" (Sather 2007). After initially monitoring plants at the „Boardwalk' site from 1986 to 1990, the DNR resumed intensive monitoring there in 1999 after it was affected by a 4.6 inch rainfall event that led to a major mid-summer flood in 1998. Monitoring in the Oak Bridge Area first began in 2001 (Sather 2007).

In the long-term monitoring (Boardwalk) grid, the decline in abundance has been greatest in a floodplain depression where the June 1998 flood "buried" *E. propullans* plants with sediment (Fig. 1, Sather 2004b:11). The flood also eroded away a streamside *E. propullans* habitat where 151 plants had been previously recorded (Fig. 1, Sather 2000, Sather, pers. comm. 4 Feb 2010). Some plants displaced by the flood appear to have established new colonies where they settled (Hensley 2005). Garlic mustard invasion, which is now a severe threat to the viability of this population (N. Sather, pers. comm. 8 December 2009; D.

Anderson, Minnesota Department of Natural Resources, in litt. 2011) has thus far hindered efforts to find any new colonies (Sather 2007).

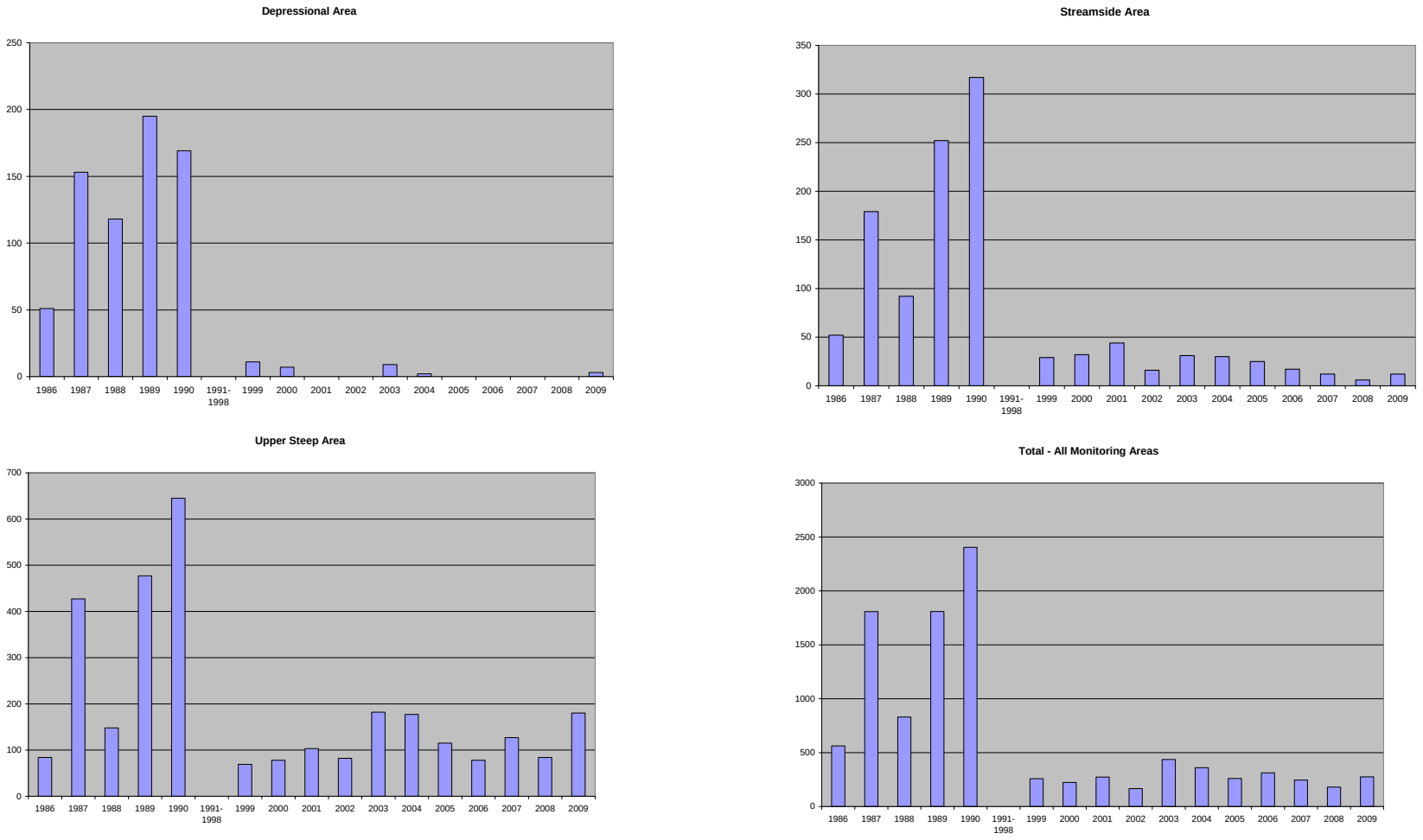

Figure 1. Boardwalk monitoring area blooming plant counts – counts of blooming plants in the depressional area (upper left), streamside area (upper right), lower gentle slope area (lower left), and all portions of the Boardwalk monitoring area at Nerstrand-Big Woods State Park. After a period of no monitoring from 1991 through 1998, monitoring resumed in 1999. Impacts of the 4.6 inch rain event and subsequent flood removed entire colonies of *E. propullans* from streamside areas, deposited sediment on top of plants in the depressional area, and eroded soil from steep slopes, resulting in steep declines in overall numbers of blooming plants.

Since 2002, DNR has monitored 14 colonies in the Oak Bridge area at the state park. *E. propullans* that are close to the footpath in the monitoring area have declined (N. Sather, pers. comm. 10 May 2010). Data from only one colony (nicknamed "Ed") may be useful for assessing trends in an area where human perturbations have not had a clear impact. The number of blooming plants in this colony seems to have been stable since 2002 (Fig. 2). "Ed" "is far enough from the trail to assure that observed trends are unrelated to trampling (N. Sather, pers. comm. 10 May 2010).

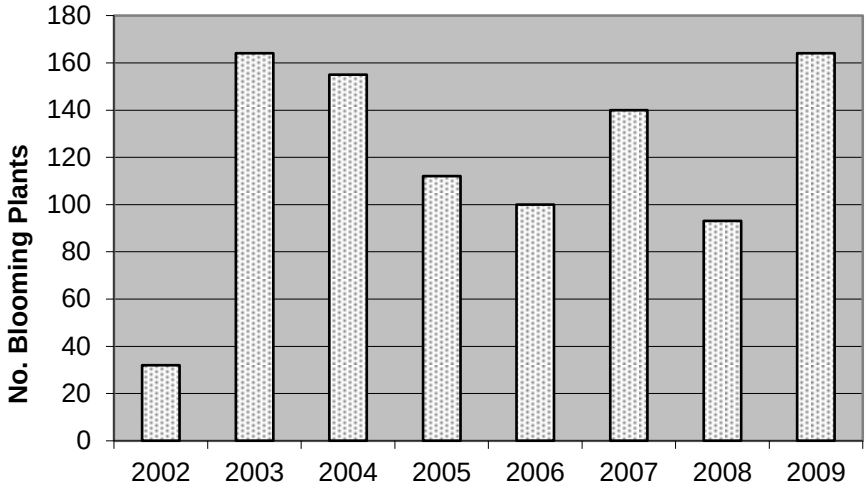

Figure 2. Oak Bridge monitoring area blooming plant counts. Numbers of blooming *E. propullans* counted in the "Ed" monitoring cell within the Oak Bridge monitoring area at Nerstrand-Big Woods State Park, 2002-2009.

River Bend Nature Center

As at the state park, there was also a period – 1990 through 2001 – when no plant counts were conducted at River Bend Nature Center (RBNC). Counts resumed in 2002 and 12 colonies were monitored each year through 2008. In 2006, counts of blooming plants declined – to 268 – and remained at low levels through 2008 (Fig. 3). Counts were not conducted in 2009, but data "from selected colonies in 2010 shows that the decline continues" (N. Sather, pers. comm. 10 May 2010). Aggressive buckthorn removal may be partly to blame, although a colony that was outside of the buckthorn removal area has also declined – from 433 plants in 2003 to 116 in 2009, and then to only 18 blooming plants in 2010.

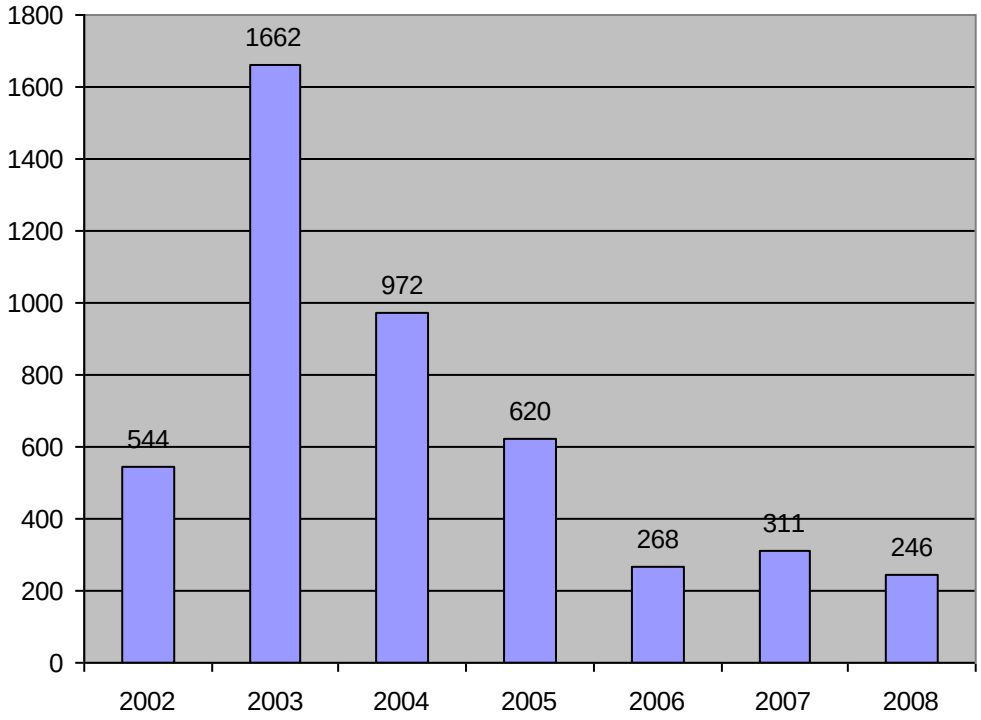

Figure 3. River Bend Nature Center blooming plant counts. Counts of blooming *E. propullans* plants within twelve colonies continuously searched and monitored at River Bend Nature Center, Faribault, Minnesota during the years 2002 - 2008. No plant counts were made in the years 1990-2001 and in 2009.

Grace Nature Preserve

The DNR began intensive monitoring of *E. propullans* at Grace Nature Preserve in 1987 (Sather 2004b:12) and resumed monitoring in 1999. After reaching a peak in 2004, the number of blooming plants counted within consistently monitored colonies declined (Fig. 4). In 2009 the number of *E. propullans* plants declined from the previous year in two colonies that had a high frequency of anomalies. In 2005, 34% of blooming plants in these colonies had exhibited anomalies in development (Fig. 5). Colonies with fewer anomalous plants, however, remain relatively vigorous at this site (Sather 2009a).

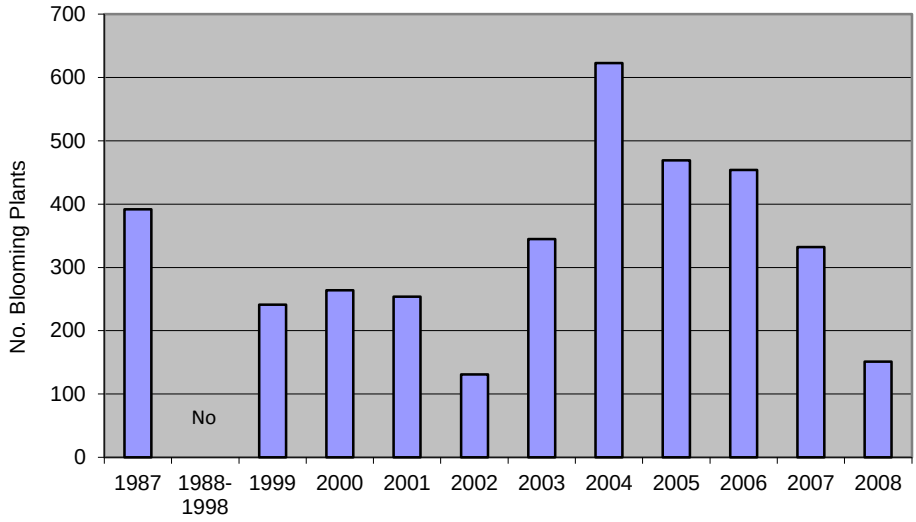

Figure 4. Grace Nature Preserve Colony Data – data for colonies at Grace Nature Preserve that have been consistently counted by Minnesota DNR every between 1987 and 2008, except for 1988-1998, when no monitoring was conducted.

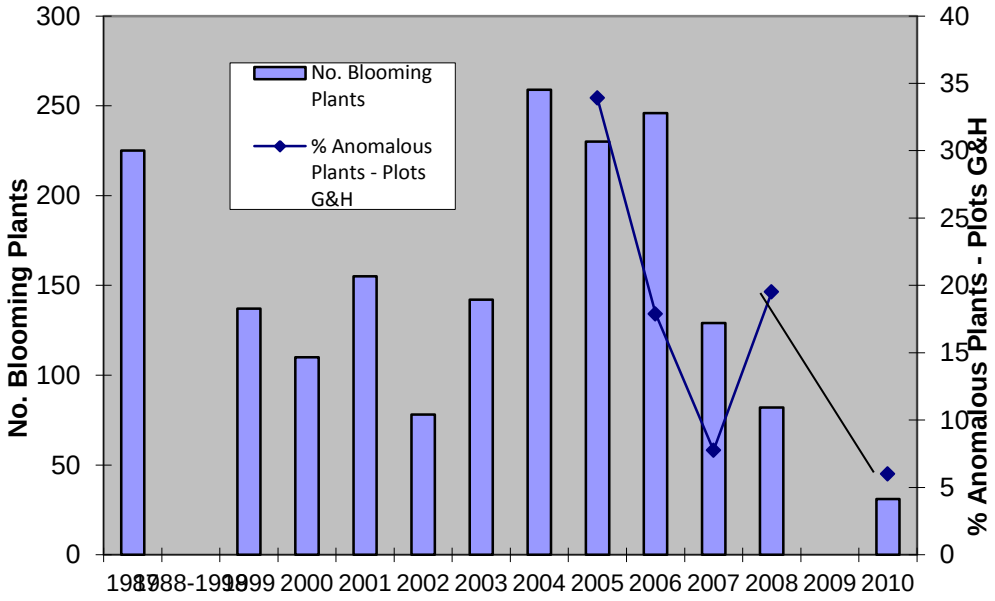

Figure 5. Grace Nature Preserve monitoring data – data for two monitoring plots within Grace Nature Preserve – areas G&H – in which declines have been especially abrupt after 2006. In 2005, 34% of blooming plants exhibited anomalous floral development.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

E. propullans is less genetically diverse than *E. albidum*, from which it is derived, but it appears to possess high genetic diversity compared to other species with small historical ranges that reproduce mostly or entirely vegetatively (Pleasants & Wendel 1989). The low level of sexual reproduction in *E. propullans* may have led to significant genetic differentiation – "sites which are geographically very close to each other are markedly different in genetic composition" (Pleasants & Wendel 1989).

2.3.1.4 Taxonomic classification or changes in nomenclature:

No new information.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range, etc.):

E. propullans is restricted to portions of the Straight River, Cannon River, Little Cannon River, Zumbro River, and Prairie Creek watersheds in Minnesota (Figs 6 & 7). When the recovery plan was issued in 1987, there were 19 recorded populations. After an increased search effort, the DNR now recognizes 40 element occurrences of the species. These additional occurrences include newly discovered populations and "extensions" of sites that were already documented in 1987 (Fig. 6; N. Sather, in litt. 2 July 2008). The sum total of the area covered by extant populations – 57 hectares[1] (DNR, unpubl. data) – is greater than what was described in 1987 as a „liberal' estimate of the area inhabited by *E. propullans* – 30 hectares (U.S. Fish and Wildlife Service 1987:7) and the known range has been extended significantly upstream along the Straight River (Fig. 6; N. Sather, pers. comm. 8 December 2009). Occurrences discovered after the species was listed in 1986 also seem to have extended the known range significantly downstream along the Cannon River and the North Fork Zumbro River (Fig. 6; Minnesota Department of Natural Resources, Division of Ecological Resources, unpubl. data). Undiscovered populations of *E. propullans* may exist along "(P)ortions of the Straight River and its tributaries upstream of the Steele County line" where landowner permission to conduct searches of suitable habitat has yet to be secured "in this highly developable corridor" (Sather 2009a).

[1] This includes only those occurrences whose boundaries have been mapped and whose boundaries have been entered into Minnesota DNR's natural heritage information system. Minnesota DNR has not yet mapped the boundaries of each occurrence. Therefore, 57 ha may represent an underestimate of the area currently inhabited by the species.

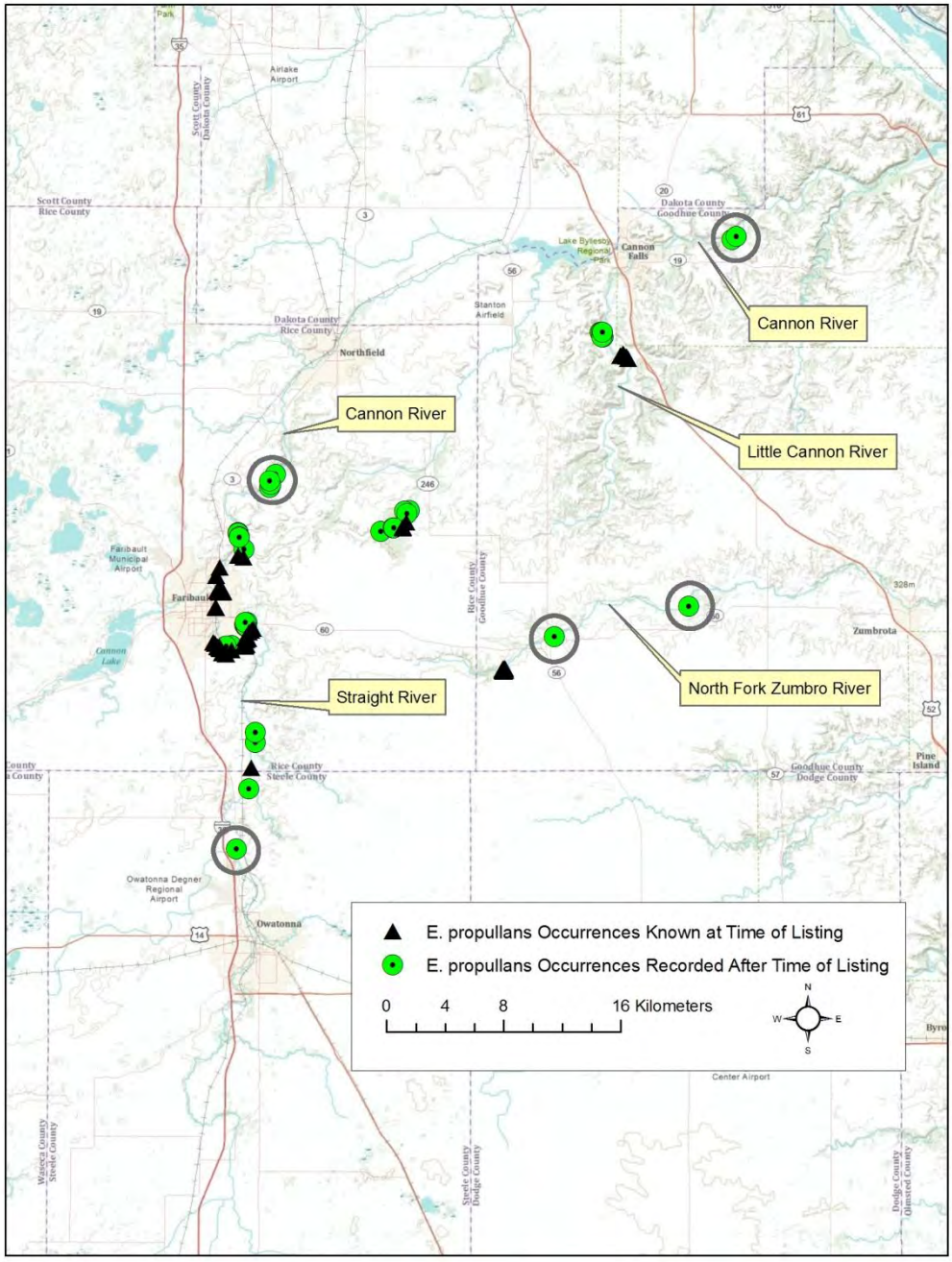

Figure 6. Distribution of *Erythronium propullans* point occurrence records. Occurrences recorded outside of the species' known distribution at the time of its 1986 listing as endangered are circled. Data included here were provided by the Division of Ecological Resources, Minnesota Department of Natural Resources, and were current as of 25 March 2011. These data are not based on an exhaustive inventory of the state. The lack of data for any geographic area shall not be construed to mean that no significant features are present.

In 2004 Sather helped the Service to define the area that may contain unrecorded populations of *E. propullans* (Fig. 7). *E. propullans* may occur in this area on

private land with *E. propullans* habitat and where landowners have thus far refused permission to conduct surveys. The area was defined by overlaying the distribution of Decorah shale, plant communities of which *E. propullans* is an associate, and extant populations of *E. propullans*. *E. propullans* does "poorly in coarser soils" and may be restricted to areas underlain by Decorah shale bedrock, "probably because of the finer texture soils derived from this stratum" (N. Sather in litt. 2 July 2008, Sather 2009a). Negative surveys for *E. propullans* also helped to restrict the area where unrecorded populations may still occur.

Figure 7. Predicted Potential Range of Minnesota Dwarf Trout Lily. Predicted potential range of Minnesota dwarf trout lily based on the distribution of Decorah shale, certain plant communities of which the species is an associate, extant populations of the species, and negative surveys.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

E. propullans typically occurs in "rich north-northwest or northeast-facing slopes dominated by maple-basswood stands and adjoining flood plains dominated by lowland hardwoods" (Sather 2009b:2). The Service identified American elm (*Ulmus americana*), box elder (*Acer negundo*), sugar maple (*A. saccharum*), and American basswood (*Tilia americana*) as typical dominant tree species in *E. propullans* habitat (U.S. Fish and Wildlife Service 1987:6). Based on a plant community study conducted in 2000, Sather (2001) concluded that green ash (*Fraxinus pennsylvanica*), red elm (*U. rubra*), eastern hackberry (*Celtis*

occidentalis), and American basswood typically dominated the canopies in lowland *E. propullans* habitats. In five of eight "lowland" sites, diseased and dying red elm and butternut (*Juglans cinerea*) trees were "common." The butternuts may have been succumbing to butternut canker (*Sirococcus clavigignenti-juglandacearum*), which has affected "nearly all" butternuts in Minnesota (Smith 2008:42). Sugar maple, American basswood, red oak (*Quercus rubra*), and American elm were canopy dominants in upland *E. propullans* habitats. Upland *E. propullans* sites were less affected by exotic and native ruderal species (weedy species or indicators of disturbance) than were lowland sites, but some upland sites contained as many as nine exotic species (Sather 2001).

2.3.1.7 Other:

Plants with anomalous developmental traits (Sather 2004b:13-14) have been observed regularly since 1999 in several natural populations and in both of the populations established outside of the species' historical range (Sather 2004a; 2009b, p. 3). Anomalies may now affect about 50% of plants at some sites where they may be related to observed declines in numbers of blooming plants (N. Sather, in litt. 2 July 2008, Sather 2009b, N. Sather, pers. comm. 10 May 2010). Anomalous plants may have shorter life-spans (N. Sather, pers. comm. 10 Aug 2009), be less likely to successfully reproduce than normal plants, or both.

The cause of the anomalies is unknown, but Rosendahl's (1919) reports of variations in floral parts may have foretold these more recent observations (N. Sather, in litt. 2 July 2008). Mutations in homeotic box genes that may be linked to some anthropogenic factor and viruses are two potential causes, but neither has been investigated scientifically. Anomalies take a variety of forms (Sather 2009a, p. 28). Sather (2009b:7) noted a "precipitous" increase in anomalies in 2008 from previous years, primarily due to a sharp increase in plants with anomalous „underdevelopment' – plants with "buds that were extremely small, often appearing to have only two developing petals." Sather (2009b:15) recorded seven categories of anomalies in addition to "underdeveloped" at Grace Nature Preserve.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

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

There are at least two other threats to *E. propullans* habitat that are mentioned in documents completed after approval of the recovery plan – vegetation management within a power line corridor at Rice County Park – Cannon River Wilderness Area (Sather 1998) and residential development upslope of populations on the east side of the Cannon River "in and north" of Faribault, MN

(Sather 1998). Sather (1998, p. 10) stated that "customary vegetation management" in the power line corridor could directly impact the *E. propullans* and indirectly affect them by increasing erosion. Increased residential development may threaten *E. propullans* if it leads to increased runoff and erosion.

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

"Horticultural collection" was described as a "significant threat" in the recovery plan (U.S. Fish and Wildlife Service 1987:14), but there is little or no mention of it in any reports or other documents completed later. No additional threats under this factor have been identified since the publication of the final listing rule in 1986.

2.3.2.3 Disease or predation:

In the range of *E. propullans*, white-tailed deer (*Odocoileus virginianus*) grazing on spring ephemeral forbs is mainly focused on *Erythronium* species (*E. propullans* and *E. albidum*). At high deer densities (25-35/km^2) grazing appears to reduce the number of *Erythronium* plants (Augustine 1997:126). At high (25-35/km^2) and low (4-11/km^2) deer densities, Augustine (1997:22) found that about 8% and 1% of *Erythronium* stems were grazed, respectively. "Adequate availability of alternative forage sources in early spring such as alfalfa, clover, and old fields combined with limitations imposed on deer consumption of spring ephemerals due to their low stature and small per plant leaf size" may reduce grazing intensity on *Erythronium* spp. (Augustine 1997:126-127). Sather (2002) included the high density of white-tailed deer trails as a „management consideration' for the Grace Nature Preserve population and Anderson (D. Anderson, in litt. 2011) stated that exotic earthworms can exacerbate the detrimental impacts of deer browse.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Development and Surface Water Management in Faribault, Minnesota

In 2004 the City of Faribault completed a Comprehensive Plan (City of Faribault 2004a) and a Surface Water Management Plan (City of Faribault 2004b) that contain measures that could mitigate the impacts of future development on *E. propullans*. Increased flooding and erosion may affect *E. propullans* in floodplain and hillslope habitats as a result of increases in the area of connected impervious surfaces and increased frequency of extreme rainfall events. The City of Faribault contains and is in close proximity to significant *E. propullans* populations, including those in The Nature Conservancy's Straight River Wildflower Preserve, Trout Lily Preserve, and at River Bend Nature Center. Future development may threaten *E. propullans* in these areas if they result in

excessive stormwater runoff, erosion, and further spread of invasive species. Ongoing activities in areas already developed, such as application of lawn herbicides, may also threaten other populations further north in and near Faribault.

The comprehensive plan identifies six "key growth areas", which would direct most growth to the north and west – areas without known occurrences of *E. propullans*. The comprehensive plan's "urban reserve area" on the city's southwest side, however, encompasses areas containing *E. propullans* populations in River Bend Nature Center and Straight River Wildflower Preserve. The comprehensive plan recognizes the "large amount of vacant land along the Highway 60 and Western Avenue corridors" in this area and states that when these corridors are "substantially developed and proper planning has taken place", this land could be made available for development.

The comprehensive plan's "natural resource protection and enhancement policies" (City of Faribault 2004a, p. 10-7 to 10-8) suggest that growth could be managed in a way that avoids or minimizes adverse effects to *E. propullans*. Key aspects of these policies include the following:

- Requiring natural vegetation buffers along undeveloped streams, waterways and wetlands, and encouraging restoration efforts along developed streams, waterways and wetlands.
- Studying application of alternative storm water management techniques (utilizing infiltration and overland flow for example) in locations where direct outlet of surface or storm water into a water body will have detrimental impacts on the quality of the water body.
- Discouraging the use of chemicals and fertilizers within buffer areas of streams and water features, especially in areas that are already developed and have manicured lawns.
- Prohibiting development in flood plains unless flood-proofing techniques can be implemented without imposing negative consequences downstream or on surrounding lands.
- Utilizing a regional storm water management approach where feasible and appropriate, as opposed to individual on-site management facilities to control storm water discharge rates and provide necessary storage volumes.
- Prohibiting channeling of untreated storm water runoff through buffer areas of streams.
- Maintaining standards and regulations to control development on steep slopes (generally those over 12%), to control soil erosion and sedimentation and to minimize the removal of natural vegetation.
- Incorporating and requiring the use of performance standards consistent with "Best Management Practices" (as defined in the handbook titled Protecting Water Quality, MPCA) to provide specific controls related to erosion, sediment and water quality issues during and after construction.

Faribault's Surface Water Management Plan (City of Faribault 2004b) indicates that the city intends to manage surface water in some ways that may benefit *E. propullans*. The surface water management plan describes "critical ravine rate control areas" and states that flow into these "ravines should be restricted by means of local ponds to pre-cultural rates." It goes on to state, "(I)n order to protect high quality ravines, future development must meet strict rate and erosion control guidelines and setbacks" and that a "steep slope ordinance should be created to protect these critical ravine areas." If effective, these measures may mitigate effects of connected impervious surfaces on high flows into ravines where *E. propullans* is present.

These plans provide several assurances that growth and development of The City of Faribault may occur in concert with conservation of *E. propullans*. Detailed information on the implementation and effectiveness of the city's comprehensive and surface water management plans, however, is not readily available. Therefore, the Service should work with the city to better understand the potential impacts of the city's activities on *E. propullans* and to mitigate those impacts.

Minnesota Endangered Species Statute

E. propullans is listed as endangered under Minnesota's Endangered Species Statute. This statute imposes a variety of restrictions, a permit program, and several exemptions pertaining to species designated as endangered or threatened. A person may not take, import, transport, or sell any portion of an endangered or threatened species without a permit issued by the DNR. Plants on certain agricultural lands and plants destroyed as a result of certain agricultural practices are exempt, as is the accidental, unknowing destruction of designated plants. If control of noxious weeds is necessary, it takes priority over the protection of endangered plant species, as long as a reasonable effort is taken to preserve the endangered plant species first. In addition, accidental destruction of endangered plants as a result of herbicide applications on agricultural lands is exempt if reasonable care is taken in the application of the pesticide or other chemical to avoid impact on adjacent lands.

Minnesota's endangered species statute provides significant and necessary protection for *E. propullans* and authorizes the DNR to carry out studies and actions to conserve the species. This statute is inadequate, however, to alleviate all of the threats to *E. propullans* that are described above.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Flooding – Impacts of Intense Rain Events

Flooding was considered a "potential threat" in the recovery plan, especially where it was likely to be "exacerbated by upslope clearing and development that

increases the erosional process" (U.S. Fish and Wildlife Service 1987:14). About 42 percent of *E. propullans* populations occur in floodplains within the species' narrow geographic range (Sather 2009a). Movement of plants dislodged by floods may have been an effective mode of dispersal historically (Pleasants & Wendel 1989:1146; U.S. Fish and Wildlife Service 1987:6). The likelihood of a propagule settling in suitable habitat after being transported by floods today, however, may be low due to habitat fragmentation. It now seems clear that increased flooding poses a significant threat to the species (N. Sather, in litt. 2 July 2008).

Increases in the extent of impervious surfaces, climate change, and habitat fragmentation are all factors that may have transformed flooding from an episodic disturbance with relatively neutral and, potentially, beneficial impacts to *E. propullans* into a threat to its persistence. Floods resulting from intense rain events may have devastating impacts on *E. propullans* populations in floodplains. In June 1998, for example, flooding that resulted from a 3-4 inch rainfall killed entire colonies of *E. propullans* at Nerstrand-Big Woods State Park and "at practically all sites" where the number of colonies was known (Sather 2000). Daily rainfalls greater than 4 inches are not uncommon in the historical record within the range of *E. propullans* (Sather 2000). The floods that result from these rainfall events, however, may now be greater in magnitude due to increases in the extent of impervious surfaces upstream of *E. propullans* populations. Adverse effects of extensive coverage of impervious surfaces have been demonstrated in other species. For example, streams in which 10% or more of the watershed's upland area is covered by connected impervious surfaces, support lower numbers of fish species; this is due, in part, to "more frequent and larger floods" (Wang *et al.* 2000). Climate change in the Midwest may result in precipitation becoming "more intense throughout the year" with more frequent flooding (Karl *et al.* 2009).

The documented flood impacts to lowland populations have further clarified the importance of conserving *E. propullans* in a diversity of topographic habitats and in multiple watersheds. All sites on steep slopes and in lowland areas, for example, may be vulnerable to erosion and siltation caused by heavy rainfall, whereas populations on "gentle midslopes" or in ravines may escape major damage (Sather 1998). Sather (1998), for example, identified at least two important sites that may have little vulnerability to "catastrophic flooding."

Erosion, especially gully formation, may also be an impact of increased urbanization where it affects runoff. About 37 percent of *E. propullans* populations occur on highly erodible slopes (Sather 2009a); several are in areas near developed urban areas (Fig. 8). In addition, coarsening of soils that may result from increases in flood frequency and intensity could degrade floodplain habitats of *E. propullans* (N. Sather, pers. comm. 1 July 2008).

Figure 8. *E. propullans* habitat in densely developed area – Faribault, MN. E. *propullans* occurs in the forested area shown above, which is along the Straight River and is downhill and in close proximity to developed areas in Faribault, Minnesota.

Invasive Species and Their Control

The recovery plan described the loss of elm trees (*Ulmus* spp.) on *E. propullans* habitat as a "potential threat", but did not mention common buckthorn, Tartarian honeysuckle, or garlic mustard as threats. The threat posed by common buckthorn and honeysuckle is not new. In 1988 buckthorn and honeysuckle formed a "nearly impenetrable understory" at River Bend Nature Center (Minnesota Department of Natural Resources 1989:6). Buckthorn and Tartarian honeysuckle leaf-out when *E. propullans* is photosynthetically active (Sather 2004a) and are now present in most or all *E. propullans* habitats. Buckthorn is "highly competitive with native species", which it can suppress to establish itself under low light conditions (Tanentzap & Bazely 2009:306). A variety of practices may be implemented, at considerable cost, to control buckthorn (Delanoy & Archibold 2007; Pergams & Norton 2006). Effective control may require herbicide use. In addition, some actions that remove established buckthorn plants may harm *E. propullans* by disturbing soil, facilitating garlic mustard invasion, and damaging or dislodging *E. propullans* and other native herbaceous plants (Sather 2009b).

In 2006, the Minnesota Department of Agriculture (MDA) implemented a study of the potential effects of herbicides applied to freshly cut buckthorn stumps and secondary impacts to *E. albidum* (C. Graddick, Minnesota Department of Agriculture, in litt. 2008). Preliminary analysis of results indicated that three herbicides used - fosamine (Krenite®), glysophate (Roundup®), and triclopyr (Garlon®) effectively suppressed resprouting of buckthorn and did not adversely affect nearby *E. albidum* plants (C. Graddick, in litt. 2008).

At Prairie Creek Woods SNA, which is within the boundaries of Nerstrand-Big Woods State Park, park staff is attempting to control garlic mustard by physical removal and by applying herbicides before *E. propullans* emerges in the spring. Sather (2009a) saw no damage to *E. propullans* from the herbicide "where some false rue-anemone (*Isopyrum biternatum*) exhibited yellowing and erratic growth form" after herbicide application.

Human foot traffic off and along trails at Nerstrand-Big Woods State Park and River Bend Nature Center is directly affecting *E. propullans* and may indirectly affect the species by spreading seed of invasive species (e.g., garlic mustard) (N. Sather, in litt. 2 July 2008). In 2009, DNR plant ecologists again observed adverse effects of foot traffic to the "Oak Bridge" colonies at the state park and reported that a barrier "was placed too far back from the edge of the trail to protect vegetative plants" (N. Sather, pers. comm. 10 Aug 2009). In response to the report, park staff moved the barrier to a more effective location.

Herbicides applied to lawns in residential areas near and upstream of *E. propullans* populations may pose a threat not clearly considered in the recovery plan. MDA surveyed homeowners in two neighborhoods uphill of *E. propullans* populations and found that at least 60% of homeowners in these neighborhoods apply weed killers to their lawns (few knew where storm runoff from their property flowed). About 80% of respondents knew that the Minnesota Dwarf Trout Lily is a rare and endangered plant (C. Graddick, in litt. 2008).

Non-native earthworms are also emerging as a threat to *E. propullans*. At Nerstrand-Big Woods State Park, for example, exotic earthworms may be "contributing to sheet erosion, the spread of garlic mustard and buckthorn, and general decline of the ground flora of the woodland" (D. Anderson, in litt. 2011). According to Frelich *et al*. (2006), "Earthworms reduce the thickness of organic layers, increase the bulk density of soils and incorporate litter and humus materials into deeper horizons of the soil profile, thereby affecting the whole soil food web and the above ground plant community." The magnitude of these effects depends on the earthworm species that are present (Frelich *et al*. 2006). Exotic earthworms also may exacerbate "the detrimental impacts of deer browse" (D. Anderson, in litt. 2011).

2.4 Synthesis

At the time of listing, there were 26 known populations of *E. propullans*; 22 of which were unprotected on private land (U. S. Fish and Wildlife Service 1986, p. 10522). Today, a substantial proportion of *E. propullans* populations – about 70% – occur on areas that are under some type of secure ownership and newly discovered populations have expanded the range of the species along three river systems (Fig. 6).

Benefits afforded the species under the various forms of protective ownership, however, are currently insufficient by themselves to address important threats to *E. propullans*. Neither the 1986 final rule listing the species nor the 1987 recovery plan mentioned common buckthorn, Tartarian honeysuckle, or garlic mustard as threats. Those invasive species now constitute significant threats that are not fully addressed by protective ownership. Likewise, the developmental anomalies that have affected several populations were not documented until 1999 (Sather 2004a, p. 13) and were not anticipated at the time of listing. In addition, the significant adverse impacts to populations that sometimes occur as a result of severe flooding were also not recognized as an important threat in either the 1986 listing final rule or the recovery plan – they were described only as a potential threat in the recovery plan (U.S. Fish and Wildlife Service 1987, p. 14). Exotic earthworms are also emerging as a threat (D. Anderson, in litt. 2011).

In addition to the apparent increase in threats to the species since 1987, both long- and short-term population trends are mostly negative at consistently monitored sites. Since monitoring began at Nerstrand-Big Woods State Park, the numbers of both plants and colonies have declined overall. At Grace Nature Preserve numbers of *E. propullans* counted in areas with high levels (34%) of developmental anomalies has declined since 2006. The species has also declined in monitoring plots at River Bend Nature Center by 85% since 2003 (Fig. 3). Numbers have been stable in one monitoring area at Nerstrand-Big Woods State Park since 2002 (Figs. 1 and 2, Sather 2009a; Sather 2009b) and populations with few anomalous plants at Grace Nature Preserve remained vigorous through 2009 (Sather 2009a). Declines appear to be rooted in the impacts of a major 1998 flood, increases in invasive species, unintended impacts of invasive species control (e.g., ground disturbance), and sharp increases in developmental anomalies.

For the reasons summarized above, *E. propullans* is still an endangered species – defined under the Endangered Species Act of 1973 as "any species which is in danger of extinction throughout all or a significant portion of its range." Although the majority of populations are under protective ownership, major threats to the species are not addressed in the species' recovery plan – most notably, invasive species, developmental anomalies, and severe floods. These threats, in combination with the declines in monitored populations, warrant maintaining the species' status as endangered.

3.0 RESULTS

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist*:*
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X_ No change is needed

3.2 New Recovery Priority Number: No change

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Actions to conserve *E. propullans* are needed on several fronts. Methods to control invasive species that do not adversely affect *E. propullans* must be implemented at sites already affected, and measures must be implemented to prevent invasion of *E. propullans* habitats that are not yet invaded. Continued monitoring of development anomalies should continue and we should determine the underlying cause of this trend. If feasible, we should pursue any remedies or actions that may mitigate effects on viability of populations (e.g., see items listed below).

The existence of two artificially established populations outside of the species' natural range provides an opportunity to conduct scientific studies that may benefit the species' recovery. These studies may include examining factors contributing to developmental anomalies, effects of herbicides, etc. Finally, public agencies should coordinate to ensure that any further urbanization is implemented in a manner that avoids direct and indirect adverse impacts to *E. propullans* habitats. The adverse effects of flooding to *E. propullans* habitats may be exacerbated by natural and manmade factors. It is essential that infrastructure projects do not contribute to an increase in the frequency or severity of floods in these habitats.

1. Cooperate with a plant developmental morphologist or geneticist to identify potential causes of abnormal floral development.
2. Review the recovery criteria (U.S. Fish and Wildlife Service 1987:17) and revise it to include clear and measurable criteria to ensure the protection of *E. propullans* populations in a variety of habitat types and geographic areas. For example, describe the specific habitat types (*e.g.,* hill and floodplain) and watersheds or other geographic units within which a certain number of populations should be protected. Sather's (1998) six "conceptual metapopulations" and „highest priority sites' may be a good starting point for this review.
3. Review the recovery criteria (U.S. Fish and Wildlife Service 1987:17) and revise it to include an appropriate metric and set of methods to monitor population status. As describe above, the use of "colonies" to monitor population status is not sufficiently

objective and is often impractical to implement in the field. The establishment of permanent monitoring plots and periodic monitoring may be the best solution. At River Bend Nature Center, Sather (2009b) recommends "initiating a student project in conjunction with the Nature Center to count only the colonies along the path each year, with periodic DNR counts of colonies in the grid, perhaps on a three to five year cycle."

4. Review the recovery criteria (U.S. Fish and Wildlife Service 1987:17) and current protection status of all *E. propullans* habitats to determine whether it would be appropriate to consider *E. propullans* habitats outside of SNAs to be sufficiently protected. Describe mechanisms, as appropriate, that may be necessary to ensure protection of habitats outside SNAs. A memorandum of understanding (MOU), for example, between DNR Division of Ecological Resources and another DNR division, agency or organization may be sufficient to ensure appropriate levels of habitat protection and management into the foreseeable future. MOUs used for this purpose, however, should include mechanisms to ensure implementation of appropriate management and other critical elements. Any new or revised recovery criteria should be accompanied by a clear description of the types of ownerships or conditions (*e.g.,* easements) that would be sufficient to consider *E. propullans* habitat to be protected. Sather's (2004b) protection analysis and a comprehensive review of current ownership and conservation status of *E. propullans* habitats may serve as a model for considering potential revisions to the recovery criteria.

5. Identify any specific habitats that must be protected to conserve *E. propullans*. Confirm and describe the current ownership of these habitats and develop plans – site-specific, if necessary – to describe actions necessary to ensure conservation of *E. propullans* in each area. Identify governmental and non-governmental organizations that may have the capability to implement necessary protection and management.

6. Evaluate watersheds containing *E. propullans* habitats to determine the proportion of surface area in each that is covered by connected impervious surfaces. Monitor flooding event intensity and duration in watersheds containing *E. propullans*. Study the effects of flooding events on *E. propullans.*

7. Work with governmental units, as necessary, to ensure that protection of *E. propullans* habitat is considered before any government-owned sites are sold or transferred.

8. Review the distribution of anomalous developmental traits among *E. propullans* habitats and consider revising recovery criteria to emphasize protection of a minimum number of sites with few or no anomalies. The southernmost site on the Straight River, just north of Clinton Falls in Steele County, for example, may currently be free of anomalous plants (N. Sather, pers. comm. 1 July 2008).

9. Review the best available information regarding the distribution of genetic diversity among *E. propullans* populations. Determine whether additional genetic studies should be conducted and, if warranted, revise the recovery criteria to emphasize protection of habitats that are important to the conservation of the species' genetic diversity.

10. Use a Global Positioning Device to record the boundaries of colonies at all sites to which observers have access, except where data collection may damage the habitat – i.e., where foot traffic on steep slopes would damage vegetation and soils, and where seed of garlic mustard or other invasive species is present and likely to be spread by observers.
11. Determine whether any additional research is necessary to better understand which invasive species compete with *E. propullans* and to understand the nature of this competition; dames rocket (*Hesperis matronalis*) at River Bend Nature Center may be a focus of this review and may be integrated into the environmental education program there.
12. Develop strong general recommendations for addressing invasive species threats to *E. propullans* that would be applicable to all sites. Evaluate control methods to ensure that they would not harm viability of *E. propullans* populations. In these efforts, coordinate with potential partners (e.g., Rice-Scott County Weed Management Area) to maximize benefits to *E. propullans*.
13. Ensure that regular monitoring is adequate to track trends in anomalous plant development. Where abnormal flower development is observed, permanent plots should be established within which the number of anomalous plants (and their types) should be counted along with the number of normal plants.
14. Determine whether *E. propullans* genetic material should be added to the existing genetic bank at Holden Arboretum. It may be prudent, for example, to add material from additional populations – most or all material now in bank may be from one population. Berry Botanical Garden may help to estimate costs associated with this action.
15. Public education efforts may be important in and near Faribault, Minnesota. Consider the development of „citizen science' programs that would allow private citizens to participate in *E. propullans* monitoring and conservation activities.
16. Prepare a plan to comprehensively survey areas where undiscovered populations of *E. propullans* may exist along "(P)ortions of the Straight River and its tributaries upstream of the Steele County line" where landowner permission to conduct searches of suitable habitat has yet to be secured. Carry out surveys "in this highly developable corridor" (Sather 2009a).
17. Describe the role that the two *ex situ* populations of *E. propullans* should play in the species' recovery in light of the Service's *Policy Regarding Controlled Propagation of Species Listed Under the Endangered Species Act* (65 Federal Register 56916-56922). Consider working with the managers of the habitats occupied by these populations at Minnesota Landscape Arboretum and Eloise Butler Wildflower Garden to maximize their value to the species' conservation – e.g., as reservoirs of genetic material, sources for reintroductions, research into effects of herbicides, developmental anomalies, etc.
18. Evaluate the vulnerability of *E. propullans* to potential climate change. As a start, use the NatureServe Climate Change Vulnerability Index.

19. Work with the City of Faribault to better understand the impacts of the city's activities on *E. propullans* and to explore opportunities for the city to contribute to the species' recovery.

20. Evaluate the nature (e.g., species composition) and extent of invasion by non-native earthworm species in the range of *E. propullans*. Determine whether actions should be taken to protect *E. propullans* habitats from earthworms.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Minnesota Dwarf Trout Lily (*Erythronium propullans*)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist**
X **No change is needed**

Appropriate Recovery Priority Number: 5C
Appropriate Listing/Reclassification Priority Number, if applicable: _____ (*delete if not applicable*)

Review Conducted By: Phil Delphey

FIELD OFFICE APPROVAL:
Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve _____ Date 4 August 2011
Tony Sullins, Field Supervisor

REGIONAL OFFICE APPROVAL:
Acting **Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Midwest Region**

Approve _____ Date 8/24/11