TEXAS TRAILING PHLOX

(Phlox nivalis ssp. texensis)

RECOVERY PLAN

U.S. Fish & Wildlife Service
Albuquerque, New Mexico
1995

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Date: 3/28/95

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DISCLAIMER

Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect listed species. Plans are published by the U.S. Fish & Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish & Wildlife Service. They represent the official position of the U.S. Fish & Wildlife Service **only** after they have been signed by the Regional Director or Director as **approved**. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

This recovery plan was essentially completed when the Secretary of Interior's policy initiatives regarding public participation in recovery plan preparation and implementation was announced on July 1, 1994. Although there has been considerable communications with the public, experts on the species, and affected agencies, the implementation schedule has not been expanded to include a participation plan as envisioned in the Secretary's initiatives. As implementation continues, the U.S. Fish and Wildlife Service will work with the affected public to ensure recovery proceeds in a manner that minimizes social and economic costs to affected stakeholders while recovery is achieved. Future revisions will incorporate an expanded participation plan.

Literature Citations should read as follows:

U.S. Fish and Wildlife Service. 1994. Texas trailing phlox recovery plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 42 pp.

Additional copies may be purchased from:

Fish and Wildlife Reference Service
5430 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814

301-492-6403
or
1-800-582-3421

The fee for the Plan varies depending on the number of pages of the Plan.

ACKNOWLEDGEMENTS

The Texas Trailing Phlox Recovery Plan was prepared by Dr. Michael Warnock of Sam Houston State University in cooperation with The Nature Conservancy of Texas, Inc. (TNC) of San Antonio and the Clear Lake Ecological Services Field Office of the U.S. Fish and Wildlife Service (Houston, Texas).

EXECUTIVE SUMMARY

Current Status: The Texas trailing phlox is listed as endangered. Once occurring at 17 sites in Hardin, Polk, and Tyler Counties, only two populations are currently known to exist. These populations are small and scattered on properties owned by The Nature Conservancy and private landowners, and on highway rights-of-way.

Habitat Requirements and Limiting Factors: Texas trailing phlox is restricted to sandy soils of open pine woodlands. Suitable sites are limited, and many have been lost to disturbance. The species' habitat has been affected by housing development, pipeline and highway construction, fire suppression, and conversion to pine plantations. Reproduction of the plant appears to be sporadic and slow.

Recovery Objective: Downlisting.

Recovery Criteria: Maintain or establish a suitable number (at least 12) of self-sustaining, genetically viable populations, in locations in which their management and protection is relatively certain at the current time and in the future.

Actions Needed:

1. Monitor, protect, and manage existing populations.
2. Locate or establish additional populations of sufficient number to meet downlisting criteria.
3. Obtain biological data necessary to refine downlisting criteria.
4. Characterize suitable habitat of plant and determine the management regime needed to preserve suitable habitat.
5. Determine limiting factors on reproduction.
6. Establish captive populations to protect genetic integrity.

Estimated Costs of Recovery ($000's):

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Need 6	TOTAL
1994	66.0	25.5	8.0	77.0	24.0	11.5	212.0
1995	58.0	15.5	8.0	77.0	24.0	7.0	189.5
1996	51.0	15.5	8.0	77.0	24.0	0.0	175.5
1997	46.0	15.5	0.0	44.0	0.0	0.0	
105.5							
1998	46.0	15.5	0.0	44.0	0.0	0.0	105.5
1999	46.0	5.0	0.0	0.0	0.0	0.0	51.0
2000	46.0	5.0	0.0	0.0	0.0	0.0	51.0
2001	46.0	5.0	0.0	0.0	0.0	0.0	51.0
2002	46.0	5.0	0.0	0.0	0.0	0.0	51.0
2003	46.0	5.0	0.0	0.0	0.0	0.0	51.0
Total Cost:	497.0	112.5	24.0	319.0	72.0	18.5	1043.0

Date of Recovery: Downlisting should be initiated in 2005, if recovery criteria have been met.

PART I - INTRODUCTION

Brief Overview

Texas trailing phlox (*Phlox nivalis* Lodd. ssp. *texensis* Lundell) was listed on September 30, 1991, as an endangered species under the authority of the Endangered Species Act of 1973, as amended (U.S. Fish and Wildlife Service 1991). Critical habitat was not designated. The Texas trailing phlox is also listed as endangered by the State of Texas. The species has been assigned a recovery priority of 3 (on a scale of 1-18, with 1 being the highest priority for recovery).

Texas trailing phlox is presently known from only two sites, one each in Tyler and Hardin counties, Texas. It is restricted to sandy soils of open pine woodlands. Texas trailing phlox is primarily threatened by habitat loss due to canopy closure, encroachment of hardwood trees, and soil and vegetation disturbance associated with human activities.

DESCRIPTION

The Texas trailing phlox is an evergreen perennial that forms clumps (but seldom mats). The plants are herbaceous or subshruby. Stems tend to spread along the ground surface, and are erect only for the terminal 2-15 centimeters (0.8 - 5.9 inches). Leaves are needlelike to lanceolate, densely packed on the stem (producing an appearance somewhat like a juniper seedling), usually less than 1.5 centimeters (0.6 inch) long, and more or less glandular pubescent. Older stems have smaller and darker green leaves, and typically lie directly on the ground surface. Young stems produce the flowers, are more or less erect, and have longer, slightly wider, and lighter-green leaves. Inflorescences are 3-12 flowered cymes, terminal on (typically) the tallest stems. The calyx is tubular with five sepals, which are fused for

most of their length. The corolla is rotate, with a tube approximately 1.5 centimeters (0.6 inch) long. The five petals, each about 1 centimeter (0.4 inch) long, are pink to magenta in color, and darker near the throat. Petals are reported to be white in some individuals. Pistils have three styles, and the ovule is usually single. Fruits are achene-like, and apparently indehiscent (this character description of the fruit differs from previously published summaries). Flowering occurs from March to May.

For the purposes of this Recovery Plan, a plant is defined as a cluster of stems with no above-ground connection to other groups of stems, and separated from other such groups by at least 5 decimeters (1.6 feet). The frequency of asexual reproduction in Texas trailing phlox is not known. It is possible that underground connections between plants are quite extensive.

Vegetative plants of Texas trailing phlox look similar to Loeflingia squarrosa. However, Loeflingia is an annual with a much lower density of leaves on the stem, and usually much smaller than Texas trailing phlox. Seedlings of Juniperus virginiana appear somewhat like single stems of Texas trailing phlox. However, a juniper seedling soon becomes obviously woody, leaf density is lower, and its leaves have a darker green, or even bluish, cast to them. In contrast, the leaves of Texas trailing phlox are bright green to yellowish-green. Its flower color is similar to that of Verbena canadensis, which flowers at about the same time and can be mistaken for Texas trailing phlox if seen at a distance (more than 5 meters). However, the leaves and inflorescence structures of these two species are quite different and, if examined closely, should not be confused with each other.

TAXONOMY

Texas trailing phlox belongs to the family Polemoniaceae, which includes such plants as sweet William, Jacob's ladder, Texas plume, and phlox. First collected in 1931 in Hardin County by Eula Whitehouse, it was described by Lundell (1942) as Phlox nivalis Loddiges ssp. texensis Lundell, but was later (1945) realigned as P. texensis (Lundell) Lundell. In a monographic treatment of Phlox, Wherry (1955) recognized the plant as P. nivalis ssp. texensis.

Texas trailing phlox is one of two subspecies recognized in P. nivalis. The nominal subspecies (ssp. nivalis) occurs in pine/oak barrens or scrub on the Coastal Plain or Piedmont, from Alabama to Florida and north to Virginia. Flowers of this subspecies are typically white or pale pink, with plants of forma roseiflora having deep rose or magenta flowers (Fernald 1970). According to Wherry (1955), the major difference between the two subspecies is the presence of minute glandular hairs on texensis, and their absence on nivalis. Currently, the nearest known populations of ssp. nivalis to those of texensis are located more than 1000 kilometers (600 miles) eastward in northern Florida. The taxonomic affinities of Phlox nivalis plants found in Louisiana (Bogler 1992) have not been determined but, will significantly add to the range of either subspecies.

Wherry included Phlox nivalis in series Subulatae, along with Phlox subulata and Phlox oklahomensis. Both of the latter species have gross morphological features similar to that of P. nivalis, but Bogler (1992) expressed the opinion that, based on Texas specimens, P. nivalis is most similar to P. oklahomensis. Populations of P. oklahomensis found in Texas are disjunct from the main range of P. oklahomensis (located further north in Oklahoma), lying approximately equidistant between it and range of P. nivalis ssp. texensis.

Careful examination of the relationship of Texas trailing phlox to Texas plants of P. oklahomensis and to Louisiana plants of P. nivalis should provide critical information regarding their respective taxonomic status.

DISTRIBUTION

Although its historic range includes Hardin, Polk, and Tyler Counties of Texas, the Texas trailing phlox is presently known from only two sites in southeast Texas, one each in Hardin and Tyler Counties (Figure 1). Since the Tyler County population contains only six plants, it is likely that only the Hardin County population, or population system, containing over 250 plants, is viable in a genetic or reproductive sense. Although once reported as locally abundant (Lundell 1942), Texas trailing phlox is, at best, now only locally common on very limited portions of the Roy E. Larsen Sandyland Sanctuary in Hardin County. The Hardin County population is primarily protected by ownership and management of The Nature Conservancy. A few plants occur on adjoining roadside rights-of-way and private property, and appear to be healthy. A cluster of ten plants are located on Temple-Inland Conservation Easement property and are being managed cooperatively by Temple-Inland and The Nature Conservancy to reduce threats. The Tyler County population currently has no formal protection.

Although nineteen collections of Texas trailing phlox are reported in historical records, these appear to originate from only six definable population systems. Two are the extant populations mentioned above, two apparently occurred on what is now National Park Service property, and the other two are apparently on private property. Historical occurrences of Texas trailing phlox in the Big Thicket National Preserve (National Park Service) in Hardin and Polk counties have not been relocated since 1980 (Hardin County)

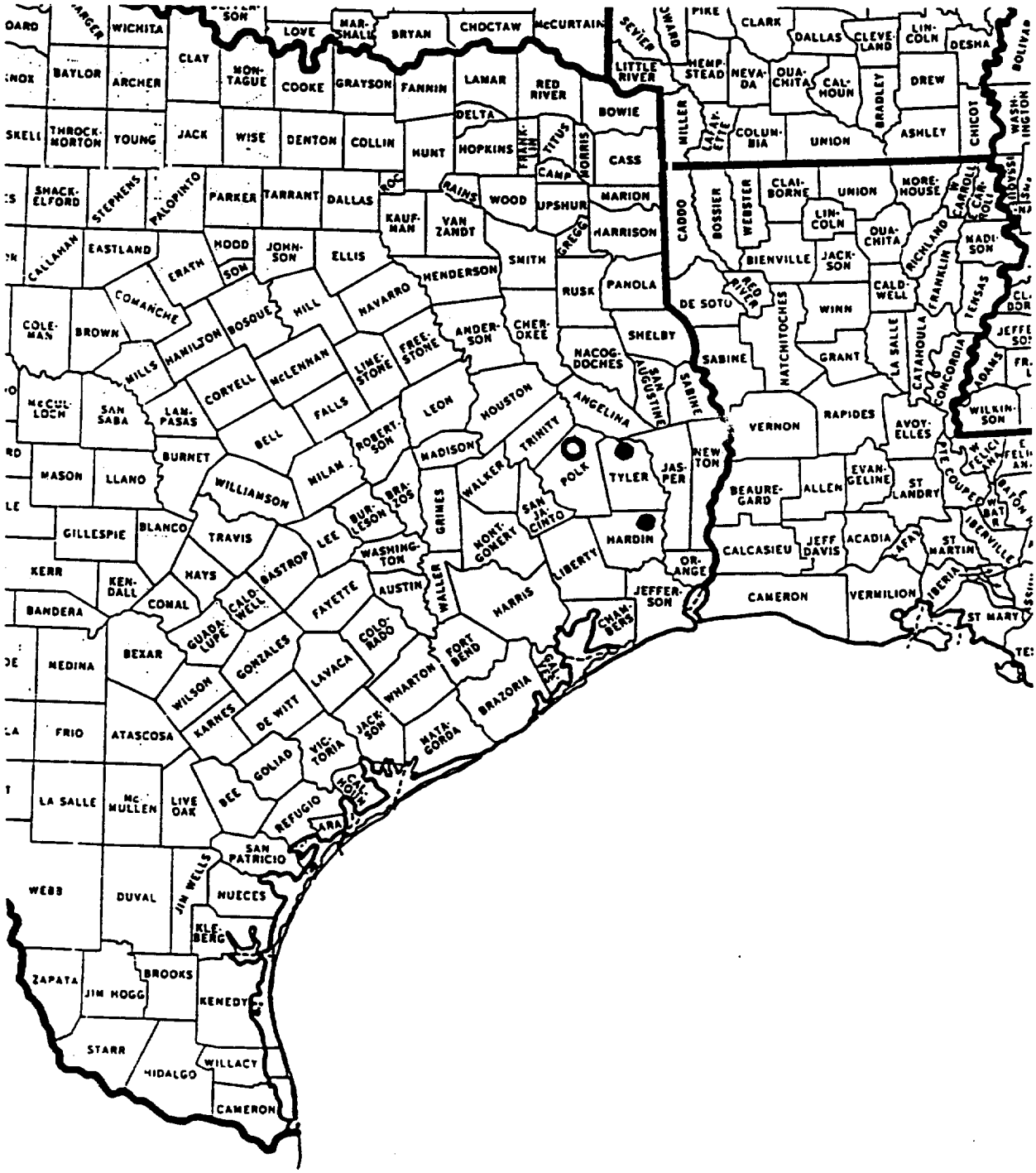

FIGURE 1. Counties of Texas trailing phlox occurrence. Solid circles represent extant populations. The hollow circle represents an historical site.

and 1937 (Polk County). The other two populations of Texas trailing phlox, both in Tyler County, were last observed in 1942 and 1970.

HABITAT

Texas trailing phlox occurs in southeast Texas in the southern portion of the Pineywoods vegetational area, as described by Gould et al. (1960). In addition to the Pineywoods, Hatch et al. (1990) associate Texas trailing phlox with the Gulf Prairies and Marshes vegetational area. However, this latter distribution is not confirmed by records of either extant or historical occurrences of Texas trailing phlox.

Within the range of Texas trailing phlox, annual precipitation averages 125 centimeters (49 inches), with no pronounced summer drought. The average frost-free period is 244 days (Bogler 1992), from early March through mid-December (Larkin and Bomar 1983). Elevation ranges from 9 to 75 meters (30-240 feet), and topography is nearly level.

Preliminary information indicates that the plant prefers deep sands, relatively open canopy, and at least some ground cover. Vegetational reports suggest that Texas trailing phlox prefers intermediate seral stages, rather than either very early-successional or late-successional stages. If the plant is tied to subclimax plant communities, maintenance and recovery of Texas trailing phlox will require active management. Recent and ongoing field studies suggest that sandy surface soil, coupled with moisture-bearing clays or sandy-clay soils at depths of 0.5-2 meters (1.6-6.6 feet), provide the best soil structure for Texas trailing phlox. Such sites are often on the sandy, drier and usually upslope side of transitional areas between sandy soils supporting longleef pine woodland (Pinus palustris), and clay or sandy-

clay soils supporting a mixed forest of hardwoods and pines, usually loblolly pine (P. taeda). Since Texas trailing phlox occurs on surface sand, the presence of subsurface clay layers is not always apparent by transition within short distances into surface clay soils. Such sites (surface sand with subsurface clay, but surrounded by deeper sand) do support populations of Texas trailing phlox, and are often associated with the presence of hardwoods, particularly black hickory (Carya texana) and southern red oak (Quercus falcata), among the pines. The slope at most plant sites is less than 5 percent, and the aspect of slope does not appear to be a critical factor determining the occurrence of Texas trailing phlox.

Overstory cover at sites of Texas trailing phlox occurrence typically ranges from 25 - 75 percent. The composition of overstory appears less important to the plant's growth than does the amount of overstory, with growth activity generally declining as canopy coverage approaches 100 percent. Understory and shrub cover is less than 25 percent at most plant sites, but ranges up to nearly 100 percent at some. However, the best growth of Texas trailing phlox is seen at the lower percentages of understory and shrub cover. The degree of ground cover associated with optimum growth of Texas trailing phlox appears to be 25-75 percent. Herbaceous groundcover primarily consists of grasses, with a number of annual and perennial forbs (see list of associated species). Litter depth is generally 3-5 centimeters (1.2-2.0 inches), and coverage is usually 75-100 percent. Although the litter at sites of Texas trailing phlox is usually dominated by pine needles due to its association with pines as canopy trees, the type of ground litter (pine, hardwood, or grass) does not appear to be as important as does its depth and degree of compaction. In order for Texas trailing phlox to grow successfully, litter must either be thin (sparse), or not compacted. Since

hardwood and grass leaves tend to compact less than pine needles, Texas trailing phlox can tolerate and grow through a greater depth of these types of litter. In contrast, as little as 2.5 centimeters (1.0 inch) of pure, densely compacted, pine needle litter can severely limit its growth.

ASSOCIATED SPECIES

The most common canopy trees associated with Texas trailing phlox are Pinus palustris, P. elliottii, P. taeda, Quercus incana, Q. falcata, and Q. stellata and Carya texana. Understory associates are Q. incana, Q. stellata, Sassafras albidum, C. texana, and Ilex vomitoria. Shrub associates are Q. incana, Rhus copallina, I. vomitoria, Asminia parviflora, C. texana, S. albidum, Ascyrum hypericoides, Toxicodendron radicans, Stillingia sylvatica, and Callicarpa americana. Herbaceous associates are Panicum anceps, Ambrosia psilostachya, Berlandiera pumila, Solidago odora, Solidago rugosa, Andropogon virginicus, Aristida longespica, Chamaecrista fasciculata, Eupatorium compositifolium, Centrosema virginianum, Fimbristylis autumnalis, Krigia virginica, Rudbeckia hirta, Tradescantia hirsutiflora, Euphorbia nutans, Helianthemum carolinianum, Hieracium gronovii, Eryngium yuccifolium, Oxalis priceae, Lespedeza hirta, Hedyotis nigricans, Silphium gracile, Tephrosia onobrychoides, Baptisia nuttalliana, Liatris elegans, Croton monanthogynus, Stipa leucotricha, and Sisyrinchium rosulatum. Most of these plants are common in similar areas of southeast Texas.

LIFE HISTORY/ECOLOGY

Texas trailing phlox plants are evergreen, apparently actively growing whenever sufficient rainfall and high enough temperatures occur simultaneously. New growth is most often seen in early spring, late February to late April, and in late summer to early autumn when rainfall increases relative to summer months. Flowering typically occurs from mid-March to mid-April, but may last well into May.

Texas trailing phlox appears very well adapted to fire. Aboveground parts of the plant are typically destroyed by fire, but underground parts are apparently undamaged by prescribed burns, as new growth is apparent on shoots within two weeks after a spring burn. If the fire occurs in April, even plants that had flowered before the fire will resprout and flower again in May. Plants burned during drier parts of the year, however, may not respond as quickly with new sprouts.

Little is known about reproduction of Texas trailing phlox. Flies, bees, and butterflies have been observed at flowers. Based on the plant's floral structure, butterflies are the most likely pollinators. If this is the case, factors which affect these and other pollinators may also have a significant effect on the plant's reproduction. It is not known whether flowers of Texas trailing phlox are either obligate or facultative outcrossers. Typically, no more than one seed is produced per flower and, based on limited field observation, fruit set is low. Individual flowers last 1-4 days, often limited by rainfall which can damage the flowers. An individual plant may have 3 to 50+ flowers and primarily depending on number of flowers, which is largely a function of plant size, may produce flowers over a period of one to 5 weeks. Seed germination has not been observed, but most likely occurs during the autumn or winter.

No information is available on the longevity of individual plants, their germination rate, elapsed time from germination to first flower production, seed dormancy requirements, length of seed viability, or seed dispersal agents. Plants are browsed by some animal, probably deer, and this browsing tends to reduce reproduction. Insect and/or fungal predators are not known.

IMPACTS AND THREATS

Historically, Texas trailing phlox was known from seventeen sites in three counties. Currently, plants are known from only one site in each of two counties. Its low population numbers are likely due to a combination of anthropogenic factors and a naturally low reproductive rate. At the time of its listing, Texas trailing phlox received no legal protection under state or federal law. Loss of habitat, low population levels, habitat disturbance, and lack of other forms of legal protection led to the listing of Texas trailing phlox as Federally endangered. Habitat loss has been caused by housing development; land-clearing and site preparation for pine plantations and pasture; encroachment of a closed canopy forest onto formerly open forest or savanna due to fire suppression; exposure to herbicides; and activities associated with pipeline, powerline, railroad, and highway construction. Factors adversely affecting the habitat of Texas trailing phlox, combined with other potentially adverse activities such as off-road vehicle use, illegal dumping, burning of debris, and commercial take of plants, may continue to restrict the species to critically low population levels.

CONSERVATION AND RESEARCH EFFORTS

The Texas Plant Recovery Team is in place and a recovery outline for the Texas trailing phlox was approved on December 12, 1991. Records of Texas trailing phlox occurrence on the Roy E. Larsen Sandyland Sanctuary exist for the years 1984, 1989, and 1990. Current studies have been undertaken to obtain data on the plant's phenology, pollination, seed set, seed dispersal, seed dormancy, seed germination, perennial vs. deciduous vegetation, duration of flowering, number of flowers per plant, habitat characteristics, competing species, and the effects of various management practices on these various factors.

Management units and compartments on the Sandyland Sanctuary are managed by The Nature Conservancy in a manner designed to restore native vegetation on different parts of the preserve, appropriate to the edaphic conditions present in each area. The Nature Conservancy retains records of management practices carried out on each compartment on the preserve. These records include dates of burning, including which areas actually burned successfully, as opposed to simply being scheduled for burning, and the date and description of any other activity designed to reduce the degree of overstory. Management records have been maintained for the area since its acquisition in 1977 by The Nature Conservancy. More specifically, available management records overlap the dates of Texas trailing phlox inventories on the preserve. These two sets of records, supplemented with additional data to be collected during current studies, are being used to provide a reasonable estimate of the full effects of past management procedures on the population sizes of Texas trailing phlox.

A captive propagation program for Texas trailing phlox has recently been initiated through the cooperative efforts of Mercer Arboretum and Botanic Gardens, the National Park Service, the Roy E. Larsen Sandyland Sanctuary and others.

The program is using vegetative propagation of stem-tip cuttings to produce plants for reintroduction and study purposes. This captive propagation program is part of a draft plan to re-establish two subpopulations of Texas trailing phlox into it's historic range within the Turkey Creek Unit of the Big Thicket National Preserve.

PART II - RECOVERY

OBJECTIVE AND CRITERIA

The primary objective of this Recovery Plan is to maintain a sufficient number of Texas trailing phlox populations in natural habitat to insure that the species is safe from extinction. Due to the plant's presently limited distribution and our lack of knowledge on the species, the identification of criteria for downlisting or delisting is preliminary at best, and may be revised substantially in the future as new information on the plant is developed. Tasks outlined in this plan are designed to begin accumulating knowledge necessary to refine and clarify downlisting and delisting requirements. However, **preliminary** downlisting requirements can be identified.

The Texas trailing phlox will be considered for reclassification from endangered to threatened status when:

1. At least 12 self-sustaining populations, in at least three counties, have been established. A population will be considered self-sustaining if it reaches and maintains a population number of at least 100 plants. The numbers of plants and populations must be verified through adequate monitoring.

For the purposes of this Recovery Plan, a "population" is defined as: (1) a group of plants separated by a distance of at least 2 kilometers (1.2 miles) from any other plants of Texas trailing phlox; or (2) a group of at least 300 plants covering an area, at the maximum, of one square kilometer (247 acres). A "plant" is defined as a cluster of Texas trailing phlox stems with no above-ground connection to other groups of stems, and separated from other such groups by a distance of at least 5 decimeters (1.6 feet).

2. Sufficient, documented protection measures and management plans have been established for these 12 self-sustaining populations. Long-term, binding agreements are preferable for populations on private lands since they provide the management continuity necessary to achieve and ensure recovery.

If, at any point following downlisting, these requirements are no longer being attained, the Texas trailing phlox should be immediately returned to "endangered" status.

OUTLINE OF RECOVERY ACTIONS

1. Protect currently known populations and monitor their status. Efforts should be made to retain these populations at their present or increased levels. Monitoring of all populations should be completed at least twice annually for several years, after which monitoring may be less frequent.

   11. Continue protective management at the Roy E. Larsen Sandyland Sanctuary. This is currently the most important population site for Texas trailing phlox. The Nature Conservancy should continue current management of the Sanctuary with a research emphasis on the management needs of Texas trailing phlox.

   12. Provide immediate protection for existing habitat areas. Due to the extremely small number of individuals outside the Roy E. Larsen Sandyland Sanctuary, cooperative arrangements with landowners supporting Texas trailing phlox populations should be explored immediately in order to preserve as much genetic diversity as possible.

13. Contact landowners and land managers of all Texas trailing phlox sites. All parties must be made aware of the plant's existence on their properties in order to prevent inadvertent destrucion of any plants.

131. Educate private landowners as to the significance of Texas trailing phlox and its protection under the Endangered Species Act. All landowners should receive information about the known distribution and abundance of the plant to emphasize the importance of the population(s) on their property. All landowners should receive a thorough explanation of the Endangered Species Act and its protection of listed species. The differences in the degree of protection between listed animal and plant species on private land should be emphasized. Federal and state policies concerning the desired recovery of endangered plants should be explained.

132. Inform state highway department and utility companies of the exact locality of plants on rights-of-way. The highway department and public utility agencies must develop a system to make local workers and mowing crews aware of the plants on their rights-of-way. This system must take into account the possibility of frequent personnel changes. Mowing at critical times for the plant, dumping of materials on habitat areas, road maintenance in habitat areas, and non-specific use of herbicides, could all

damage or destroy Texas trailing phlox plants. Adequate protection may require modifying these activities to avoid unnecessary loss of plants, or fencing off important, but vulnerable, habitat areas.

14. Work with landowners to develop and implement compatible management for the Texas trailing phlox. An assessment of each site should be made with recommendations for specific management activities necessary to protect and maintain Texas trailing phlox at the site. A management plan should be developed that promotes growth and long-term health of the population.

    141. Determine landowner short-term and long-term land use goals. Working with the private landowner and understanding his/her plans for Texas trailing phlox sites will enhance the probability of successful implementation of management plans.

    142. Develop and implement management plans for Texas trailing phlox that are compatible with current and projected land-use activities. While protection for Texas trailing phlox is the primary goal of the recovery plan, that goal can more easily be achieved with the cooperation of the private landowner.

    143. Seek landowner assistance with monitoring activities. Landowner involvement in the planning and recovery process will enhance the likelihood of recovery success and

will provide a more efficient use of resources.

144. Encourage establishment of stewardship agreements. Formal agreements between the landowner and U.S. Fish and Wildlife Service, or other entities involved in the recovery process, will clarify responsibilities and address issues which may arise in future recovery efforts.

15. Monitor populations. Monitoring will consist of counting plants, counting reproductive parts, measuring the size of the plants and determining the frequency with which new individuals become established in the population.

2. Search for and determine the status of any new populations. Accurate information concerning the number and size of extant populations is critical to successful recovery.

21. Search for new populations in suitable East Texas habitat. Previously documented localities should be searched to determine if any remnant populations remain and if the habitat would presently support Texas trailing phlox. These localities should be visited several times at different seasons, unless the initial visit suggests that habitat alteration has made the persistence of any individual plants very unlikely. Other localities with suitable habitat should be searched, particularly those on public lands where management potential exists.

22. Determine the status of Phlox nivalis in Louisiana. The taxonomic status of plants previously identified

as Phlox nivalis in Louisiana must be determined. If these are subspecies texensis, the extent and management needs of any populations should be assessed and appropriate management measures taken.

3. Implement captive propagation program. While maintenance of Texas trailing phlox in natural habitat is preferable to captive breeding programs, at least some natural populations are at such low levels that they could easily be eliminated by some natural or man-made disturbance. Such populations should be considered for establishment of a captive propagation program that can insure the preservation of their genetic material even if the populations are lost. Propagation may best be completed by cuttings rather than by seed.

   31. Insure highest possible level of genetic diversity. Material should be collected and propagated in a manner that insures the maximum amount of genetic diversity in captive populations, without sacrificing genetic diversity in natural populations.

   32. Maintain a seed source for possible reintroduction efforts. A goal of the captive breeding program should be to establish and maintain an adequate seed source for supporting possible future reintroduction efforts.

   33. Establish a monitoring and management plan. Captive populations should be periodically monitored, and such populations established and maintained in selected areas under the guidance of a formal management plan. The captive propagation program should be designed to identify habitat and cultural requirements that are necessary to successfully re-introduce the plants into a natural setting.

34. Explore the possibility of commercial production. One risk of identifying an attractive endangered species as the Texas trailing phlox is the possibility that the plant will become popular with horticultural enthusiasts. If this possibility arises, efforts should be made to satisfy demand for the plants with the use of artificially propagated plants, rather than native sources. Rickett (1975) states that Phlox nivalis ssp. nivalis is often cultivated.

4. Characterize suitable habitat at current, apparently healthy, Texas trailing phlox sites. Acquiring this type of essential information will allow development of suitable management regimes that will maintain preferred habitat for Texas trailing phlox. It will also allow determination of suitable reintroduction sites, and provide direction for the development of adequate conservation measures.

41. Determine soil type, slope, profile, and aspect. Although general information is available on soil characteristics for Texas trailing phlox populations, specific information is necessary for locating historical population sites, locating new sites, and identifying potential reintroduction sites.

42. Determine prevailing climate. Climatic variables, coupled with phenological observations, may be necessary to predicting the effects of various management activities. Such information should also allow refinement of management techniques to preserve or enhance conditions for the species, as well as allow the prediction of seasonal stresses on the plants, such as from unusually wet/dry or warm/cold years or seasons.

421. Temperature. Knowing the prevailing temperature patterns may be critical to determining potential impacts on crucial steps in the plant's reproduction such as germination, pollinator emergence, etc..

422. Rainfall. Knowing the amount and seasonal pattern of rainfall may be critical to determining potential impacts on crucial aspects of the plant's reproduction such as growth rates, flower bud production, germination, pollinator emergence, etc..

423. Regularity of climate. The timing and stability of temperature shifts, rainfall, and dry periods may be important in controlling various life history events (flowering, germination, seedling establishment, etc.) of Texas trailing phlox.

43. Determine extent of woody vegetative cover. Quantitative analysis of woody vegetation at Texas trailing phlox sites is necessary for identifying appropriate management practices. These data will also assist in searches for new populations.

431. Overstory. The type and amount of overstory appears to be an important factor in the occurrence of Texas trailing phlox. This level of vegetation is also easiest to assess by aerial photography in carrying out searches for new populations.

432. Understory. The amount of understory cover appears to be a limiting factor in

the occurrence of Texas trailing phlox. Knowledge of the degree of cover tolerated by the plant is essential to the development of proper management regimes.

433. Shrub layer. The degree and composition of shrub cover may be a limiting factor in the occurrence of Texas trailing phlox. Knowledge of the plant's tolerance of this habitat component may be important to the development of proper management regimes.

44. Determine extent of competition from other herbaceous species. Documentation of species and potential competitors associated with Texas trailing phlox is necessary to assess possible reintroduction sites and determining potential success of management practices. It is possible that herbaceous "indicator" plants can be identified so that potential management and/or reintroduction sites can be more easily located.

45. Determine microclimate characteristics. Local variations in soil, topography, moisture availability, nutrient availability, light level, and other factors may affect the growth and reproduction of Texas trailing phlox.

5. Investigate the reproductive biology of Texas trailing phlox. In order to develop an accurate plan for recovery, including suitable management activities, the reproductive biology of Texas trailing phlox must be understood.

51. Phenology and critical life stages. Understanding life history periodicity of Texas trailing phlox is

critical to the planning and timing of many management activities, as well as to the timing of other activities that may adversely affect the plants at specific times of the year. An attempt should also be made to identify any stages of the life cycle that are critical or consistently impaired and any known causes of impairment.

52. Pollination. Determining the type and mode of pollination, and the life history characteristics of pollinators, may be a critical factor in adequately managing Texas trailing phlox populations. If reproduction of the plants can be enhanced by management of the pollinator, this may represent an important management tool for the species.

53. Seed dispersal, soil seed bank, and germination. The mechanisms and efficiency of seed dispersal should be determined, some estimate of soil seed bank should be made, and factors affecting germination should be identified.

54. Colonization and recruitment. Factors affecting the colonization of new sites by Texas trailing phlox, and the recruitment of new individuals within established sites, should be identified and understood.

55. Longevity, mortality, and survival. Understanding the life-span of Texas trailing phlox, possible factors leading to its mortality, and factors influencing its survival, are critical to the development of a successful management regime for the plant.

56. Tolerance of habitat disturbance and stress. In order to recommend maintenance and long-term management strategies for Texas trailing phlox, an awareness of the response of the plants to various potential perturbations to its environment is required.

561. Timber harvest. Timber operations are the dominant historical land-use for areas in which Texas trailing phlox occurs. Knowledge of the effects of various timber harvest and management practices on the plants is critical in determining recommendations for timber harvesting operations near sites of Texas trailing phlox.

562. Cultivation. Row crop cultivation is not a major factor in areas of Texas trailing phlox occurrence. However, some pastureland does exist, and this land is often modified by cultivation of non-native pasture grasses. In addition, some site-preparation methods associated with timber production are, in effect, cultivation methods.

563. Construction. Construction of roads, pipelines, powerlines, and buildings all have potential negative effects on Texas trailing phlox. The magnitude of these effects, and the mitigating factors that can alleviate these effects, should be identified.

564. Off-road vehicle use. This activity has become increasingly popular, and its effects on Texas trailing phlox may be important to know in the development of management restrictions in areas of the plant's occurrence.

565. Herbivory. The effects of cattle, deer, insects, and other potential predators of the plant should be determined in order to provide suitable management recommendations.

566. Herbicide use. Herbicides are commonly used for weed control along railroads, pipelines, powerlines, fence-rows, roadsides, and in timber production areas. The potential effects of these chemicals on Texas trailing phlox should be determined in order to identify any needed protective restrictions.

567. Non-native species. The potential threat from non-native invasive grass species in phlox habitat should be determined. In addition, potential threats from animal species, such as fire ants or feral hogs, should be identified. Typically, feral hogs utilize moist hardwood bottomland environments, but can also cause excessive soil disturbance in upland areas.

568. Illegal dumping. The potential impact of illegal dumping and the ground fires associated with attempting to burn the debris should be identified, since the intense heat from the debris, the burning

of household materials and the season of the fires may jeopardize the plant's health._

57. Vegetative reproduction. Vegetative reproduction may be an important, or possibly dominant, mode of reproduction for Texas trailing phlox. The potential implications of this form of reproduction must be taken into consideration when determining recovery strategies.

6. Investigate response of Texas trailing phlox to various management techniques and types of disturbance. Knowledge of the effects of various management regimes and options on the species is critical to determining a suitable management plan.

61. Prescribed burning. Texas trailing phlox appears well adapted for survival of frequent fires. However, the effects of the timing of burns, threshold intensities of burns, frequency of burns, and other factors associated with this management tool must be identified and understood.

62. Mowing. The level, timing, and frequency of mowing tolerated by Texas trailing phlox plants must be understood. This information is particularly important for plants growing in the rights-of-way of highways, powerlines, and pipeline structures.

63. Thinning of overstory. Canopy closure appears to be a limiting factor on the growth and survival of Texas trailing phlox. The optimal amount and type of canopy coverage needs to be specifically identified in order to carry out suitable management actions.

64. Removal of competitors. The presence and potential impact of competitors on the Texas trailing phlox, and methods of modifying this impact, need to be identified.

7. Enforce the rules and regulations of the Endangered Species Act and the Texas Parks and Wildlife Code. Federal and state laws regarding commercial trade, acquisition of permits, collection of specimens, and destruction of habitat should be enforced. Landowners should be encouraged to enforce trespassing laws in order to carry out protection of Texas trailing phlox populations on their properties.

8. If necessary to meet recovery goals, develop and establish a reintroduction program. Evaluation of the need and potential for reintroduction will be facilitated by the research needs described above. In the event that reintroduction is deemed a credible option, the following steps will be necessary.

81. Determine potential reintroduction sites. Efforts should concentrate on the Roy E. Larsen Sandyland Sanctuary (The Nature Conservancy) and on the Big Thicket National Preserve (National Park Service), since these areas are protected by their ownership from many potential disturbances.

82. Identify landowners or land-managing agencies willing to allow introduction of the species on their property. Reintroductions will not be attempted on property without the full consent and cooperation of the landowner.

83. Design a reintroduction plan for each site. In order to increase the probability of success,

reintroduction management plans should be tailored to the specific site where reintroduction is being attempted.

84. Monitor reintroduction sites and determine degree of success. Reintroduction sites should be closely monitored to determine the degree of success at various sites and various management activities, and the resulting information should be used to guide additional reintroduction efforts.

9. Implement public education efforts. A public awareness of the existence and importance of Texas trailing phlox in particular, and endangered species protection in general, will affect the probability of success of this and other species' recovery efforts. Environmental groups, garden clubs, civic organizations, and the general public, all have a role to play in encouraging the preservation of threatened and endangered species.

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PART III - IMPLEMENTATION SCHEDULE

The following implementation schedule outlines actions and costs for the Texas trailing phlox recovery program. It is a guide for meeting the objectives discussed in Part II of this plan. The schedule indicates task priorities, task numbers, task descriptions, duration of tasks, responsible agencies and estimated costs. These actions, when accomplished, should bring about the recovery of Texas trailing phlox and protect its habitat. It should be noted that this implementation schedule estimates monetary needs for all parties involved in recovery for the first 3 years only, and therefore does not reflect total recovery costs. Total recovery costs are estimated in the EXECUTIVE SUMMARY (page iii) of this plan. The costs estimated are intended to assist in planning. This recovery plan does not obligate any involved agency to expend the estimated funds. Though work with private landowners is called for in the plan, private landowners are not obligated to expend any funds.

Task Priorities

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

Priority 1• -An action that by itself will not prevent extinction or an irreversible decline, but which is necessary to carry out a task that is a priority 1 as defined above.

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

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

Abbreviations Used

DOT - Texas State & County Highway Departments
FWS - USDI Fish and Wildlife Service
ES - Ecological Services
LE - Law Enforcement
MABG - Mercer Arboretum and Botanic Gardens
PVT - Private Landowners
TNC - The Nature Conservancy
TPWD - Texas Parks and Wildlife Department

RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION YEARS	RESPONSIBLE PARTY FWS Region	FWS Program	OTHER	COST ESTIMATES ($000) YEAR 1	YEAR 2	YEAR 3	COMMENTS
1	11	Continue protective management at the Roy E. Larsen Sandyland Sanctuary	ongoing			TNC	25.0	27.0	30.0	
1	12	Provide immediate protection for existing habitat areas	2	2	ES	PVT	10.0	10.0		
1	131	Educate private landowners about Texas trailing phlox and Endangered Species Act	1	2	ES	PVT	1.0 1.0			
1	132	Inform & educate highway departments and utility companies	1	2	ES	PVT DOT	1.0 1.0 1.0			
1	142	Develop & implement management plans for private lands	ongoing	2	ES	PVT	3.0 -0-	1.0 -0-	1.0 -0-	
1	143	Seek landowner assistance with monitoring activities	ongoing	2	ES	PVT	5.0 -0-	5.0 -0-	5.0 -0-	
1	144	Encourage establishment of stewardship agreements	3	2	ES	PVT	5.0 -0-	5.0 -0-	5.0 -0-	
1	21	Search for new populations in East Texas	5	2	ES		5.0	5.0	5.0	
1	22	Determine the status of Phlox nivalis in Louisiana	1	4	ES		10.0			
1	15	Monitor natural populations	ongoing	2	ES		2.0	2.0	2.0	
1●	51	Determine phenology & critical life stages	3	2	ES		5.0	5.0	5.0	
1●	52	Determine type & mode of pollination	3	2	ES		6.0	6.0	6.0	

RECOVERY PLAN IMPLEMENTATION SCHEDULE (Continued)

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION YEARS	RESPONSIBLE PARTY FWS Region	FWS Program	OTHER	COST ESTIMATES ($000) YEAR 1	YEAR 2	YEAR 3	COMMENTS
1●	53	Study seed dispersal, soil seed bank and germination	3	2	ES		6.0	6.0	6.0	
1●	54	Study colonization & recruitment	3	2	ES		4.0	4.0	4.0	
1●	55	Determine longevity, mortality & survival	3	2	ES		4.0	4.0	4.0	
1●	57	Study vegetative reproduction	3	2	ES		7.0	7.0	7.0	
1●	61	Investigate response to prescribed burning	5	2	ES		5.0	5.0	5.0	
2	141	Determine landowner land use goals	1	2	ES		1.0			
						PVT	-0-			
2	41	Determine soil type, slope, profile and aspect	3	2	ES		4.0	4.0	4.0	
2	421	Determine prevailing temperature patterns	3	2	ES		3.0	3.0	3.0	
2	422	Determine rainfall pattern	3	2	ES		3.0	3.0	3.0	
2	423	Determine regularity of climate	3	2	ES		3.0	3.0	3.0	
2	431	Determine type & amount of overstory	3	2	ES		4.0	4.0	4.0	
2	432	Determine amount of understory cover	3	2	ES		4.0	4.0	4.0	
2	433	Determine degree & composition of shrub cover	3	2	ES		4.0	4.0	4.0	
2	44	Determine extent of competition	3	2	ES		5.0	5.0	.0	
2	563	Determine effect of construction	5	2	ES		3.0	3.0	3.0	

RECOVERY PLAN IMPLEMENTATION SCHEDULE (Continued)

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION YEARS	RESPONSIBLE PARTY FWS Region	FWS Program	OTHER	COST ESTIMATES ($000) YEAR 1	YEAR 2	YEAR 3	COMMENTS
2	45	Determine microclimate characteristics	3	2	ES		3.0	3.0	3.0	
2	561	Determine effect of timber harvest	5	2	ES		3.0	3.0	3.0	
2	562	Determine effect of cultivation	5	2	ES		3.0	3.0	3.0	
2	564	Determine effect of off-road vehicle use	5	2	ES		3.0	3.0	3.0	
2	565	Determine effect of herbivory	5	2	ES		3.0	3.0	3.0	
2	566	Determine effect of herbicide use	5	2	ES		3.0	3.0	3.0	
2	567	Determine effect of non-native species	5	2	ES		3.0	3.0	3.0	
2	568	Determine effect of illegal dumping	5	2	ES		3.0	3.0	3.0	
2	62	Investigate response to mowing	5	2	ES		5.0	5.0	5.0	
2	63	Investigate response to thinning of overstory	5	2	ES		5.0	5.0	5.0	
2	64	Investigate response to removal of competitors	5	2	ES		5.0	5.0	5.0	
2	7	Enforce the ESA & state endangered plant laws	ongoing	2	ES		2.0	2.0	2.0	
					TPWD	2.0	2.0	2.0		
						LE	1.0	1.0	1.0	
2	81	Determine potential reintroduction sites	5	2	ES		1.0	1.0	1.0	
2	82	Identify landowners or agencies willing to allow introductions	5	2	ES		0.5	0.5	0.5	
2	83	Design a reintroduction plan for each site	5	2	ES		2.0	2.0	2.0	

RECOVERY PLAN IMPLEMENTATION SCHEDULE (Concluded)

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION YEARS	RESPONSIBLE PARTY FWS Region	FWS Program	OTHER	COST ESTIMATES ($000) YEAR 1	YEAR 2	YEAR 3	COMMENTS
2	84	Monitor reintroduction sites and determine degree of success	ongoing	2	ES		5.0	5.0	5.0	
						PVT	-0-	-0-	-0-	
2	9	Implement public education efforts	ongoing	2	ES		4.0	2.0	2.0	
						TPWD	1.0	1.0	1.0	
2	31	Establish genetically diverse captive population	2	2	ES		3.5	3.5		
						MABG	3.5	3.5		
2	32	Maintain a seed source for reintroduction efforts	5	2	ES		0.5	0.5	0.5	
						MABG	1.5	1.5	1.5	
2	33	Establish monitoring & management plan for captive population	1	2	ES		0.5			
						MABG	1.0			
2	34	Explore possibility of commercial production	1	2	ES		3.0			

Appendix

Summary of Comments Received on the Texas Trailing Phlox Technical/Agency Draft Recovery Plan.

The availability of the draft Texas Trailing Phlox Recovery Plan for review and comment was announced in the Federal Register on July 27, 1994 (59 FR 38199). The Service also distributed over 80 copies of the draft recovery plan to landowners, recovery team members, agencies, academic researchers, botanical gardens, conservation organizations and interested individuals. In addition, press releases announcing the plan's availability were provided to the newspapers serving the vicinity where the plant is currently known to occur. At the end of the public comment period, written comments had been received from the four respondents listed below.

Dr. Kent E. Holsinger, Center for Conservation and Biodiversity, Department of Ecology and Evolutionary Biology, The University of Connecticut

Ms. Gena K. Janssen, Endangered Resources Branch, Texas Parks and Wildlife Department

Mr. Ike McWhorter and Ms. Wendy Ledbetter, The Nature Conservancy of Texas, East Texas Field Office

Mr. Greg Wieland, Mercer Arboretum and Botanic Gardens, Humble, Texas

All comments were considered when finalizing the recovery plan. The Service appreciates the time that each of the commenters took to review the draft and to submit their comments. The comments discussed below represent a composite of those received. Comments of a similar nature are grouped together. Substantive comments

that question approach, methodology, or financial needs called for in the draft plan, or suggest changes to the plan, are discussed here. Comments regarding simple editorial suggestions such as better wording or spelling and punctuation changes, etc., were incorporated as appropriate without further discussion.

All comments received are retained as a part of the Administrative Record of recovery plan development in the Houston, Texas, Ecological Services office.

Comment: The discussion of habitat losses in the overview section should include soil and vegetation disturbance associated with human activities.

Response: We agree. Recommended changes have been incorporated into the document.

Comment: Information about the cluster of ten plants recently discovered on Temple-Inland Easement, Tract 5, in Silsbee, Hardin County should be included in the document.

Response: Information on the cluster of plants located on the Temple-Inland Easement have been incorporated into the Distribution section.

Comment: The impacts and threats section should include a discussion of illegal dumping and associated ground fires as a result of humans attempting to light piles of debris. The burning of household materials, the season of the fires and multiple fires may jeopardize plants health, their ability to flower and fruit or to reproduce vegetatively. This dumping has threatened the plants located on the Temple-Inland Conservation Easement.

Response: The threats of illegal dumping and associated ground fires have been included in the document.

Comment: There is a slight contradiction in the statement on page 7 that phlox is generally found in litter of 1.2 - 2.0 inches of litter, but on page 8 it states that 1.0 inches of pine litter severely limits the growth of phlox.

Response: The statement on page 8 refers to the fact that the degree of litter compaction influences the depth of litter that the phlox can tolerate. Due to their straight shape, litter consisting of pine needles only can compact easily and may become very densely packed. In contrast, the curves and curls associated with grass and hardwood leaves results in a less dense litter mass containing more small air pockets. The wording has been changed to clarify this point.

Comment: The section which discusses compatible management should emphasize the importance of fire management for sustaining populations of Phlox nivalis subsp. texensis, which is characteristic of subclimax plant communities. The season in which to burn and the frequency of prescribed burning also needs to be identified and understood.

Response: While fire management is the major tool for maintaining longleaf pine uplands that provide optimum habitat for Phlox nivalis subsp. texensis, this management technique may not always be compatible with current and projected land-use activities. Therefore, the emphasis of fire management in a recovery plan task designed to work with landowners to develop and implement compatible management may not be appropriate.

Comment: The section on tolerance of habitat disturbance and stress should include illegal dumping and subsequent ground fires as a separate item. Potential threat from non-native invasive grass species in phlox habitat should be mentioned. Currently this issue may not be identified as a priority, but all potential threats should be listed in the recovery plan. Threats from animal species such as fire ants, or feral hogs, should be mentioned.

Typically feral hogs utilize moist hardwood bottomland environments, but can do extensive soil disturbance in upland areas as well.

Response: Task 567 has been added to the plan to address the potential impacts of non-native species upon Texas trailing phlox habitat. The potential impacts of illegal dumping and the associated ground fires are addressed in Task 568.

Comment: Under the heading Actions Needed and Estimated Cost, the costs seem quite inflated. The Service should examine what it is actually funding for recovery work versus what it believes it will cost to implement recovery actions. I believe there is a more realistic dollar amount somewhere between what the Service thinks it will cost and what will be available to accomplish recovery.

Response: Congress requires that recovery plans contain estimates of the costs to recover the species. Therefore, recovery plans must estimate the total cost for all Federal and State agencies and private organizations involved in affecting recovery. Phlox nivalis ssp. texensis is characteristic of a subclimax plant community and thus requires active habitat manipulations for its' long-term persistence. The fire management necessary for maintaining this system requires a large outlay of money for capital equipment and is labor intensive. The cost estimates to carry out the tasks detailed in the plan were based on the assumption that all of the equipment necessary to do a management burn would have to be purchased and would only be used to perform phlox habitat work. The costs to carry out the tasks detailed in the plan would be reduced if the equipment is already available and if the equipment costs are spread among various activities. The associated labor costs can also vary, depending on whether volunteers, graduate students or professionals do the work. The Service emphasizes that these are projections based on the best information available at today's prices. All cost savings will be

accurately reflected as recovery progresses and the recovery plan is revised to reflect progress in recovering this species.

Comment: The plan states that there were 17 historical sites and now only two extant populations. The Element Occurrence Log Sheet maintained by the Texas Natural Heritage Program lists 12 historical sites and two extant populations for the Texas trailing phlox.

Response: The copy of the Element Occurrence Log Sheet in our files has 17 element occurrence records. However, two of the records contain a notation that they were merged with a third record. Thus, the discrepancy appears to be related to a question of record keeping and of what constitutes a separate location.

Comment: Nowhere in the plan is a concerted effort made to identify the life-history stages most critical to continued persistence of the species. Studies are needed to determine whether declines in existing populations reflect recruitment failures or unusually high rates of death in adults. Therefore, tasks should be added to determine whether recruitment from seed or vegetation reproduction is more important and to determine whether adult survival rates are unusually low.

Response: Determining the factors affecting the recruitment of new individuals within established sites is addressed in Task 54. The monitoring of adult plant survival rates has been included in Task number 1.

Comment: I encourage you to adopt the bullet convention, where bullets refer to "an action that by itself will not prevent extinction or an irreversible decline, but which is necessary to carry out a task that is a priority 1..." In fact, it would be useful to add a category 1• just for such tasks.

Response: We agree. The implementation schedule has been modified to include such designation.

Comment: As currently written, condition 1 of the recovery criteria appears to be self contradictory. One place states that a population will be considered self-sustaining if it maintains a population of at least 100 plants and a few lines later it states that a population is defined as a group of at least 300 plants.

Response: The definition of a population in the draft plan contained an error. It should state that a population is defined as: (1) a group of plants separated by a distance of at least 2 kilometers (1.2 miles) from any other plants of Texas trailing phlox; or (2) a group of at least 300 plants covering at the maximum an area of one square kilometer (247 acres). A population can consist of only a few plants but would not be considered self-sustaining. The latter condition is a somewhat arbitrary condition set for management purposes. In actuality, there appears to be a gradual change in the genetics of the plants on the Roy E. Larsen Sandyland Sanctuary from the southern to the northern border. There is no clear line dividing the northern and southern plants, though they are obviously two different populations.

Comment: Monitoring should include efforts to determine the frequency with which new individuals become established in the population and to determine whether they are recruited from seed or from vegetative offshoots.

Response: Task 15 has been added to detail the types of information to be gathered during the monitoring process. Determining the recruitment rate of new individuals into the population is included in this task. However, it may be extremely difficult to determine through monitoring activities whether new individuals are recruited from seed or from vegetative offshoots, since there is the possibility that Phlox nivalis subsp. texensis utilizes underground runners. Thus, this factor is best addressed

in task 5, which investigates the reproductive biology of Texas trailing phlox.

Comment: Historic Phlox nivalis subsp. texensis sites should be visited several times at different seasons, unless the initial visit suggests that habitat alteration has made persistence of any individuals very unlikely.

Response: We agree. Task 21 has been amended to include this recommendation.

Comment: Although cuttings may be the most efficient way to establish a captive propagation program, a set of crosses among genotypes held in a botanical garden will produce a much greater variety of genotypes that can then be stored long-term as seed.

Response: The possibility of utilizing a set of crosses among genotypes held in a botanical garden to produce a greater variety of genotypes that can be stored long-term as seed will be investigated as part of the captive propagation program. However, preliminary data indicates that presently seed set in natural populations is extremely low.

Comment: A re-introduction plan should consider the best method to establish a population. Also, the captive propagation program should be designed to identify habitat and cultural requirements for establishment of new populations and to identify the difficulties associated with sowing seed, outplanting seedlings, or transplanting cuttings.

Response: We agree. Task 33 has been amended to include this recommendation.

Comment: The studies to characterize suitable habitat should be focused on determining impact of habitat and environmental

variation on critical life-history stages of Phlox nivalis subsp. texensis.

Response: At this time, not enough information is known about the subspecies to identify its critical life-history stages. Once this information is obtained, studies can then begin to focus on how the critical life stages are impacted habitat and environmental variation.

Comment: Section 132 leads the reader to believe that the roadside population mentioned is along a Texas highway which is the responsibility of the Texas Department of Transportation (TXDOT). This section, and all references in the plan to this roadside population, should clearly state whether it a state, county, or city road.

Response: This roadside population is along a Farm to Market road and according to information provided by TXDOT, it's maintenance is the responsibility of the respective maintenance office of TXDOT. This task reflects the need for a ongoing program to protect roadside populations by informing personnel from the responsible agency of the plants' locations and of potential threats to the plants caused by actions that might be taken by the TXDOT.

Comment: The plan should include the captive propagation work that Mercer Arboretum, in cooperation with other organizations, is undertaking for the reintroduction of Phlox nivalis subsp. texensis into Big Thicket.

Response: Information on the captive propagation program has been included in the Conservation and Research Efforts section of the document.

Comment: Is herbicide use truly a threat or only a perceived threat, especially since the Texas Department of Agriculture and

the EPA are working on protective restrictions for commonly used chemicals?

Response: While the efforts of EPA and the Texas Department of Agriculture to establish protective restrictions are laudable, the program has not yet been implemented. Also, the effectiveness of the proposed program has not yet been determined. The proposed program also contains exclusions and does not address the issue of protecting either newly discovered or re-established plant populations. Since land planners and managers need to be aware of all potential threats to the plant, the responsible approach is to include the potential threat of herbicide use in the recovery plan.

Comment: Mercer Arboretum and Botanic Gardens can assist in the implementation of several of the tasks identified in the recovery plan.

Response: Mercer Arboretum and Botanic Gardens has been identified in the implementation schedule as a responsible party for accomplishing tasks 31, 32, 53 and 33. The Service looks forward to working with all willing cooperators to conserve the Texas trailing phlox.