Spiranthes parksii **Navasota Ladies'-tresses**
Grimes County, Texas

TRANSPLANT METHODS FOR THE ENDANGERED ORCHID *SPIRANTHES PARKSII* CORRELL

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ABSTRACT

Spiranthes parksii (Navasota ladies' tresses) is an endangered terrestrial orchid endemic to the Post Oak Savanna ecosystem in central-east Texas. Methods of whole plant transplantation are needed to conserve individuals that will be destroyed by development activities. A soil-intact and a bare-root method were evaluated. *Spiranthes parksii* and its congener, *S. cernua* can be distinguished when in flower, but are indistinguishable from one another based on morphology of their leaf rosettes. Unknown leaf rosettes of *S. parksii* or *S. cernua* were transplanted into areas where *S. parksii* and *S. cernua* were known to co-occur. Compared to percent production of leaf rosette and flower production of undisturbed individuals on-site, transplanted individuals by both methods have been successful.

INTRODUCTION

Spiranthes parksii, **Navasota ladies'-tresses**, is an endangered orchid endemic to central-east Texas within the Post Oak Savanna Ecoregion where it co-occurs with its congener *S. cernua* which has a broad distribution across eastern North America (Pelchat, 2005; Brown, 2008). *Spiranthes parksii* has also been found further east in the Pineywoods Ecoregion, however, vegetation documented at these occurrences was similar to the Post Oak Savanna, and not typical of the Pineywoods (Bridges & Orzell, 1989). The Post Oak Savanna Ecoregion is dominated by native bunchgrasses and forbs with scattered clumps of trees and shrubs, primarily post oak (*Quercus stellata*) (TPWD, 2009). Other common woody species are blackjack oak (*Quercus marilandica*), black hickory (*Carya texana*), American beautyberry (*Callicarpa americana)*, yaupon (*Ilex vomitoria*), farkleberry (*Vaccinium arboreum*), winged elm (*Ulmus alata*), eastern redcedar (*Juniperus virginiana*), and water oak (*Quercus nigra*) (Brezanson, 2009). Common grass species are little bluestem (*Schizachyrium scoparium*), other bluestems (*Andropogon* spp.), Indiangrass (*Sorghastrum nutans*), purpletop (*Tridens flavus*), curly threeawn (*Aristida desmantha*), and longleaf spikegrass (*Chasmanthium sessilifloraum*). This system was originally maintained as a savanna by frequent fires and grazing by bison, and with their absence, tree/shrub species increase and grasses/forbs decrease (TPWD, 2009). Within the Post Oak Savanna, *Spiranthes parksii* typically occurs on sparsely vegetated areas along the upper reaches of ephemeral and intermittent drainages. Individuals are also found away from drainages along game/livestock trails and/or in small herbaceous openings at a tree/shrub dripline where a herbaceous patch meets a tree/shrub community (Hammons, 2008; USFWS, 2009). *Spiranthes cernua*, **nodding ladies'-tresses**, also occurs in these habitats.

A solid waste landfill is needed for Bryan/College Station, Texas and surrounding areas. During construction, an estimated 379 *Spiranthes parksii* plants will be destroyed. In order to meet mitigation requirements, the United States Fish and Wildlife Service (USFWS) Biological Opinion required 57 hectares of deed restricted areas be purchased around the landfill footprint to protect and conserve *S. parksii* plants that occurred in those areas and to serve as recipient sites for transplanted individuals. As well, the Biological Opinion permits research to develop procedures for successful transplantation of at-risk plants to protected areas. It is our goal to explore soil-intact and bare-root methods of transplantation.

METHODS

Both *Spiranthes parksii* and *S. cernua* are perennial and produce a leafless inflorescence during mid-fall (Oct.-Nov.). A basal rosette of leaves is produced between November and April, which is followed by a dormant underground stage until the next flowering season. Identification of the two species is apparent during flowering; however, they cannot be differentiated during the leaf rosette stage of growth.

All transplantations occurred at the end of leaf rosette growth to minimize disturbance during the growing period. Additionally, transplantation occurred when soil moisture was at field capacity. All were placed in deed restricted areas where other *Spiranthes parksii/S. cernua* flowering individuals were previously documented. Plant locations were marked in the field with survey flags and GPS positions so they could be re-visited to monitor survival. Additionally, several hundred undisturbed *S. parksii/S. cernua* leaf rosettes were marked in the same area to monitor survival compared with transplants. All transplanted individuals and between 22 and 540 undisturbed leaf rosettes were monitored for flowering and leaf rosette production each year after transplantation.

Root Tuber Distribution and Bare-Root Transplantation

Based on size and length of rosette leaves, six small and four large individuals were excavated in spring 2007. Length of each leaf and root tuber was measured, and each were summed to give total leaf length and total root tuber length to 1) determine if leaf size and root tuber size are correlated, and 2) determine the size and extent of root tubers so that root tubers would not be damaged during transplantation. For this study, a root tuber constitutes any underground structure growing from the bud zone. Soil was removed from the root tubers, individuals were wrapped in a wet paper towel and transplanted to deed restricted areas within two hours following excavation (Fig. 1).

In spring 2008, an additional cohort of 57 *Spiranthes cernua/S. parksii* leaf rosettes and two known *S. parksii* were re-located and transplanted. In spring 2009, 14 known *S. parksii* individuals were transplanted. Of these, six had <5 cm of one root tuber taken for examination of mycorrhizal fungi infection and isolation in the laboratory.

Soil-intact Transplantation

In spring 2007, a 20 cm diameter PVC pipe was used to excavate individuals while keeping the soil intact around root tubers. The PVC pipe was cut into 15 cm lengths and beveled at the bottom so it could be hammered into the soil around a leaf rosette. A shovel was then placed underneath the PVC pipe so that soil within the PVC pipe could be excavated. After excavation, plants were transplanted to deed restricted areas within approximately two hours. A hole was carefully dug in the deed restricted areas to fit the diameter and depth of the transplant inside the PVC pipe. After placing the transplant and PVC pipe in the pre dug hole, the PVC pipe was removed and soil was fed into the cracks around the transplant to fill any large air spaces (Fig. 2).

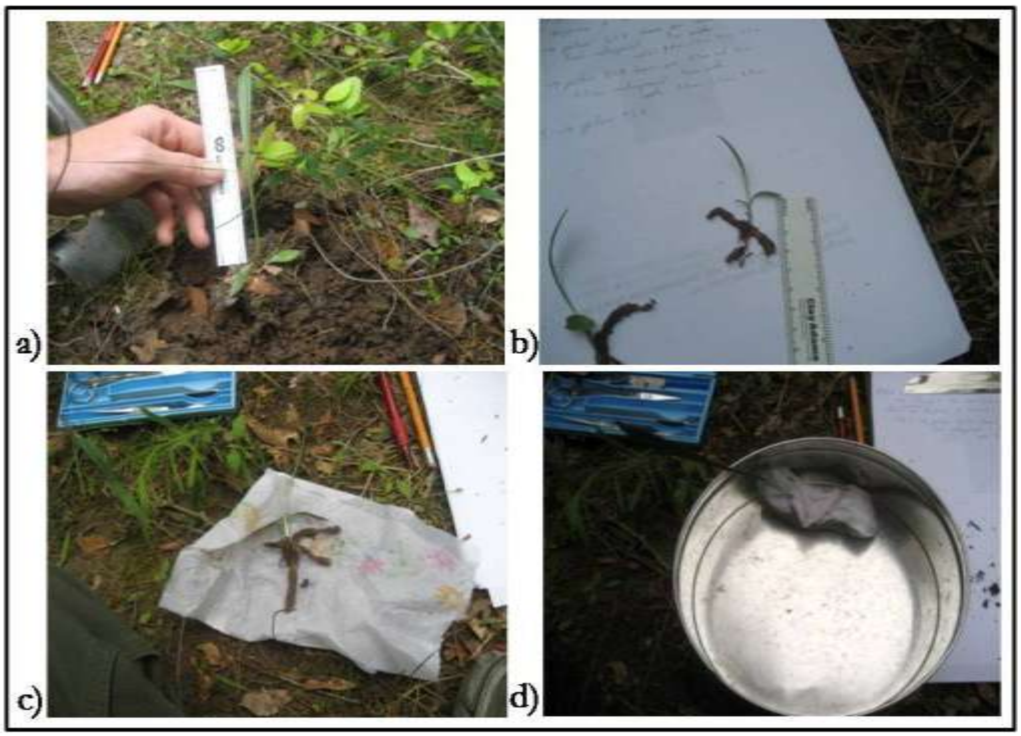

Fig. 1. Methodology for bare-root transplantation. a) shovel buried deep beneath plant and soil slightly raised, b) individual carefully taken out of soil with most soil removed so measurements could be taken, c) root tubers wrapped in a wet paper towel, and d) stored for transport to deed restricted areas.

RESULTS

Root Tuber Demographics and Bare-Root Transplantation

For the 10 bare-root transplants in spring 2007, total leaf length for the small individuals ranged from 5 to 11 cm, while total leaf length for the large individuals ranged from 22 to 32 cm. The number of root tubers per individual ranged from 2 to 8. Total leaf length and total root tuber length were positively correlated (R^2 = 0.84; p= .000). The maximum depth of a root tuber from the base of the stem was 9 cm, while the maximum lateral distance was 8 cm. Root tubers were found to be both exhausted and not exhausted in *S. parksii/S. cernua* individuals, as noted by Wells et al. (1991; Fig. 3).

Fig. 2. Methodology for soil-intact transplantation. a) PVC section centered around plant and hammered into ground, b) shovel slid underneath PVC section to be lifted out, c) transplants placed for transportation, and d) hole dug to fit PVC, transplant placed in pre-dug hole, PVC removed, and soil fed into cracks where PVC was to rid of any air spaces.

Fig. 3. *Spiranthes* rosette individual that does not have remnants of an exhausted root tuber (left) and one with two exhausted root tubers (right).

With the exception of leaf rosette production in 2008, subsequent production of the 10 bare-root transplants have had a higher percent production than undisturbed *Spiranthes cernua/S. parksii* individuals also originally found in spring 2007 (Fig 4). Individual plants show no consistent pattern. One individual remained dormant for 2 flowering and 2 leaf rosette stages, but emerged as a leaf rosette in fall 2009. Another has formed a flowering stalk and leaf rosette for all stages of growth monitored thus far. However, none flowered as *S. parksii*.

Soil-Intact Transplants – Spring 2007

Flower and leaf rosette production of soil-intact transplants has been similar to undisturbed *Spiranthes parksii/S. cernua* leaf rosettes on site, and has surpassed percent production of undisturbed individuals (Fig. 4). These plants have also exhibited considerable variability. Some have remained dormant for as many as four growing seasons before emerging as a flowering stalk or leaf rosette. Five flowered as *S. parksii*, of which two have flowered all three consecutive years. Other individuals have flowered as *S. cernua* or remain unknown as to the species due to herbivory before identification could be confirmed.

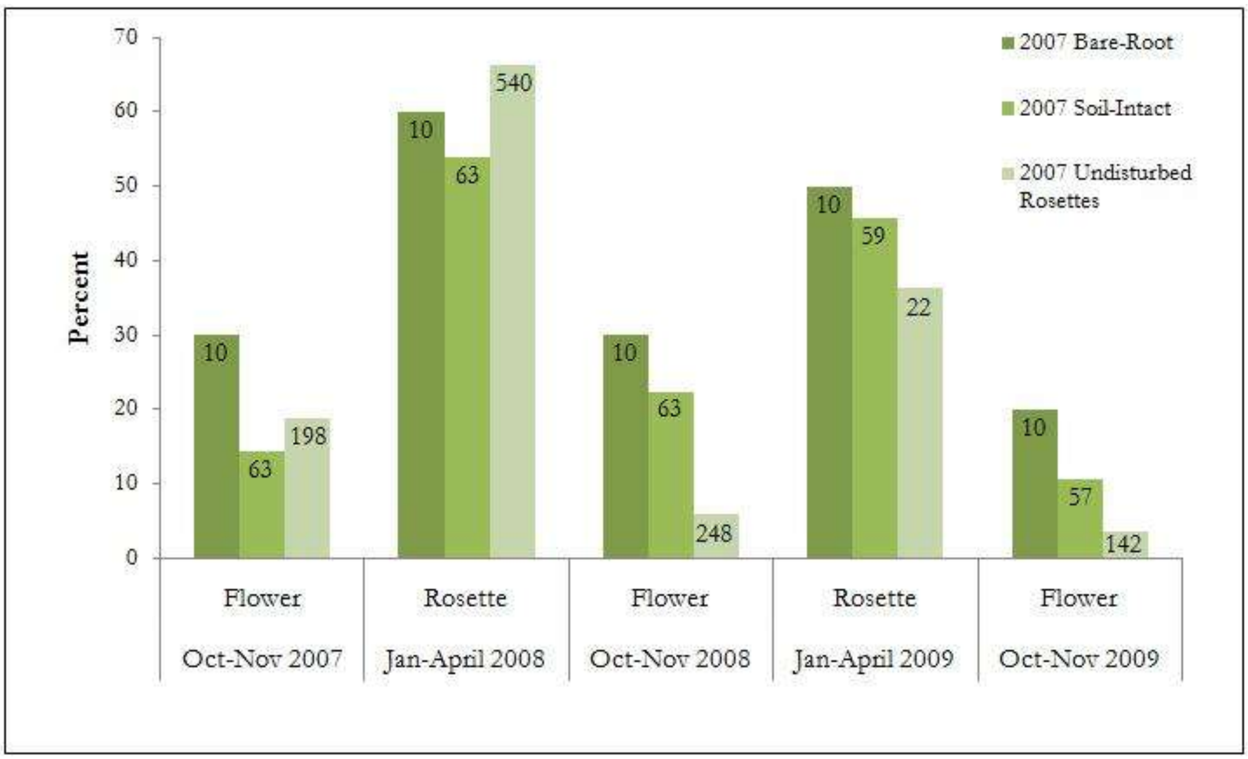

Fig. 4. Percent production of *S. parksii/S. cernua* transplanted and undisturbed leaf rosettes (spring 2007) each growing season post-transplantation. Numbers in bars represent the number of individuals observed each growing season.

Bare-Root Transplants – Spring 2008

Percent leaf rosette and flower production of these transplants have been consistently lower than undisturbed leaf rosettes on site (Fig. 5). However, one individual flowered as *Spiranthes parksii* in 2008, and other individuals are still producing vegetatively including one of the known *S. parksii*. Sixteen appeared to be destroyed by feral hogs during winter of 2008 after transplantation. Despite this disturbance, three individuals transplanted the area emerged as leaf rosettes in 2009.

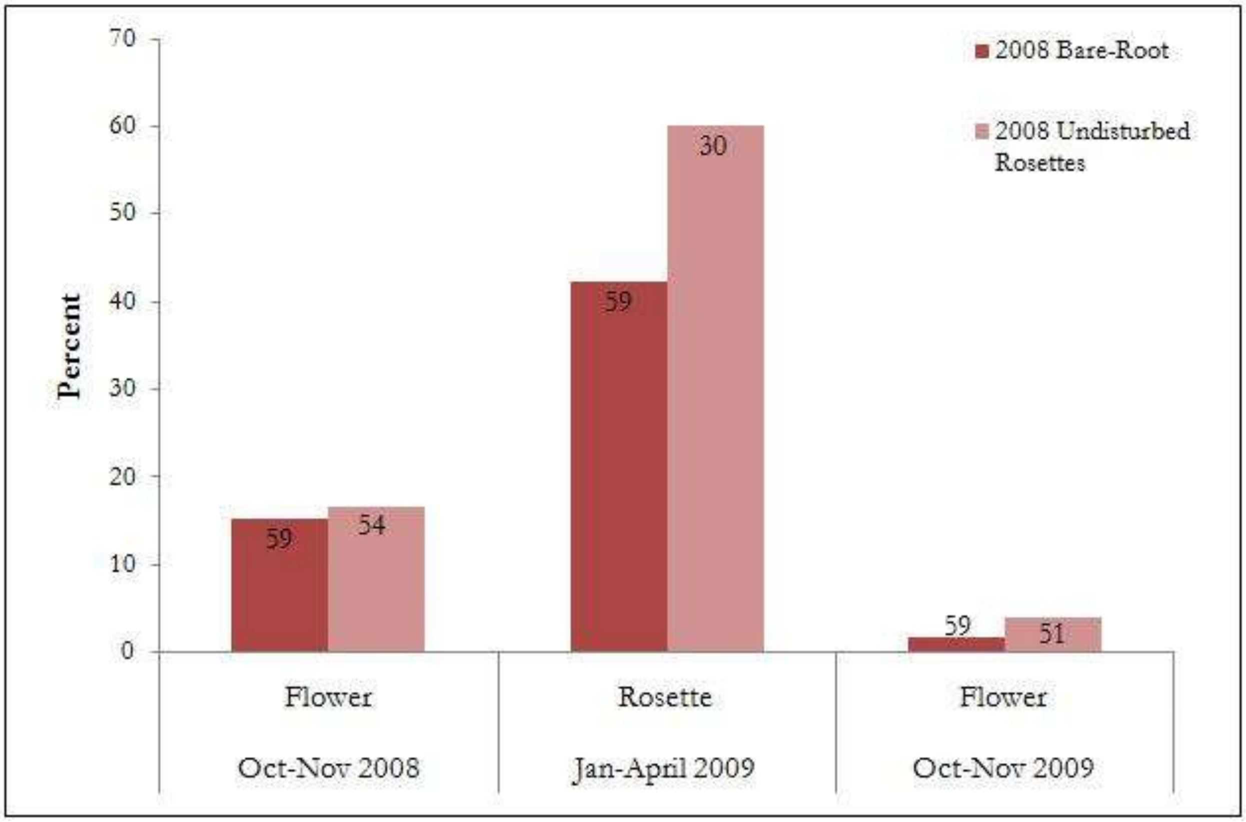

Fig. 5. Percent production of *S. parksii/S. cernua* transplants and undisturbed leaf rosettes each growing season post-transplantation. Numbers in or above bars represent the number of individuals observed each growing season.

Spiranthes parksii Bare-Root Transplants – Spring 2009

Four of the 14 (28%) flowered and four (28%) produced a rosette of leaves in fall 2009 following transplantation. One of the six which had <5 cm of a root tuber taken flowered, while three produced a rosette of leaves.

DISCUSSION

Transplanted individuals for both methods appeared in subsequent years. Bare-root transplants from spring 2007 have had a higher percentage of post-production than those in spring 2008 and soil-intact in spring 2007. However, this could be due to a low sample size. While percentages are consistently lower for bare-root transplants in spring 2008, one of 59 has flowered as *Spiranthes parksii* and some are still persisting vegetatively. Soil-intact transplants have produced the best results for *S. parksii* since five individuals have flowered as *S. parksii*, of which two have flowered all three flowering seasons monitored. Additionally, percent production of these has been higher than undisturbed plants in the last three growing seasons. Bare-root transplantation of 14 known *S. parksii* from spring 2009 which flowered at least once in the previous two years have produced inflorescences and leaf rosettes after transplantation, including those that had <5 cm of a root tuber removed.

Pileri (1998) noted that after excavating five *Spiranthes cernua* plants to analyze the root tubers for mycorrhizal infection, all but one plant that was destroyed by a small mammal survived transplantation by reappearing the next year. She also noted that they were better able to survive when transplanted during the vegetative or early reproductive phases. However, others believe, or have found, that bare-root transplanting of terrestrial orchids is unsuccessful (Ferry, 2008; Steinauer, 2008). In this study, *S. cernua* (spring 2007) and *S. parksii* (spring 2008 and spring 2009) responded positively to bare-root transplantation. The three *S. cernua* that flowered after bare-root transplantation in spring 2007 were of the larger leaf rosettes. The success of these could be due to large underground root tubers which could be used to offset the effects of disturbance caused by transplantation. As well, mature *S. parksii* transplanted in spring 2009 could also be using underground reserves to offset the effects of transplantation.

Previous efforts of soil-intact transplantation of *Spiranthes parksii* using 15 cm diameter irrigation pipe at the TMPA Gibbons Creek Lignite Mine conservation areas yielded positive results (Parker 2006). However, quantitative data and long-term observations were not made. Efforts of soil-intact transplanting in other terrestrial orchids have been unsuccessful, as with *Isotria medeoloides* (Brumbeck, 1996). In this study, both *Spiranthes parksii* and *S. cernua* responded well to this method. In fact, compared to undisturbed leaf rosettes at the study site, percent production of soil-intact transplants have been greater in the last three growing seasons. This might be due to placement of transplants since they were placed in areas of ideal habitat of *S. parksii/S. cernua*. Undisturbed leaf rosettes may be persisting in areas which have become unfavorable for flowering due to woody encroachment. However, quantitative data would need to be collected to verify this.

While all transplants were placed in areas where *Spiranthes parksii/S. cernua* occurred, placement could possibly be influencing post-production since microhabitats vary greatly within a savanna patchwork. Additionally, initial size of leaf rosettes prior to transplantation could affect post-production. However, detailed analysis of microhabitats and plant sizes would need to be conducted to pursue these hypotheses.

CONCLUSIONS

While both methods of transplantation have yielded positive post-production in individuals, if given the time and labor, the soil-intact method would be preferred. Not only has this method yielded higher survival, but the intact soil may contain tubers of plants other than the target individual. Upon digging up one *Spiranthes parksii* for bare-root transplanting in spring 2009, another individual was found dormant as a root tuber. This was also seen when taking soil samples around individual plants. Upon returning to the laboratory to sieve soil samples, a *Spiranthes* spp. root tuber was found.

Comparison of transplanted individuals to undisturbed plants of the same species is critical in giving accurate results of success or failure. If given only the results of transplanted individuals in this study, one might conclude individuals are dying due to transplantation. However, transplanted and undisturbed individuals have both declined and/or fluctuated in subsequent production after transplanting was initiated. Long-term monitoring of these individuals is crucial to clarify life history characteristics and environmental variables that influence the persistence of undisturbed and transplanted individuals.

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