
Steward's Circle

Restoration of Pitcher Plant Bogs in Eastern Texas, USA

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ABSTRACT: Pitcher plant bogs, also referred to as hillside seepage bogs or hillside bogs, are extremely restricted on the West Gulf Coastal Plain. The number and extent of extant bogs is in the low hundreds, comprising no more than a few thousand hectares of habitat. These bogs support a large number of plant species of significant

conservation concern. Threats to existing bogs include: land use changes, silvicultural impacts, fire scarcity, vehicle damage, negative feral hog (*Sus scrofa*) impact, and ground water regime alterations. Two pitcher plant bogs on the Angelina National Forest were subjected to severe damage from vehicular impacts that eliminated herbaceous vegetation, disturbed the soil to substantial depths, and initiated severe erosion. A restoration effort that replaced lost soil, reduced erosion, and allowed subsequent revegetation was implemented. Approximately four years post-treatment, bogs are intact, soil erosion is controlled, revegetation is complete or progressing, and at least some species of conservation concern are present in the revegetated areas. These restoration projects have demonstrated that degraded pitcher plant bogs that have suffered severe damage due to vehicular impacts can be substantially restored if sufficient resources are available. However, pitcher plant bogs on the West Gulf Coastal Plain continue to be threatened by uncontrolled off road vehicles and other impacts. The most insidious threat may be the widespread lack of sufficient fire required to preclude or reverse succession to communities dominated by woody vegetation and the subsequent loss of the herbaceous bog species.

Index words: bogs, off road vehicle damage, pitcher plant, restoration, *Sarracenia*, Texas

INTRODUCTION

On the West Gulf Coastal Plain, pitcher plant bogs, also referred to as hillside seepage bogs and hillside bogs, are of limited extent. MacRoberts and MacRoberts (2001) estimate that pitcher plant bogs of the West Gulf Coastal Plain occupied 4000-8000 ha prior to European settlement and that less than 25% of this habitat remains. Although there are over 100 known examples, many of which occur on the Kisatchie National Forest in Louisiana (Smith, unpubl. data) and the Angelina National Forest in Texas, Bridges

and Orzell (1989) estimated that less than 30 of these bogs are relatively undisturbed, including those impacted by alteration of the fire regime. Folkerts (1982) estimates that throughout the southeastern United States, bog communities have declined by as much as 97% in extent compared to pre-European conditions.

Pitcher plant bogs on the West Gulf Coastal Plain typically occur on slopes of 1-10%, occasionally as great as 30%, and on acidic and nutrient poor soils (Nixon and Ward 1986, Bridges and Orzell 1989, MacRoberts and MacRoberts 2001). Pitcher plant bogs develop in areas where ground water moves laterally above an impermeable layer and ultimately discharges at the surface resulting in perennially hydric soils (Nixon and Ward 1986, Folkerts 1991). Frequent fire is required to maintain the open, herbaceous vegetation of pitcher plant bogs on the West Gulf Coastal Plain (Olsen and Platt 1995, Drewa et al. 2002, Keith and Carrie 2002, Gray et al. 2003).

The vegetation of intact bogs is dominated by a dense, species rich, graminoid-forb layer less than 1 m in height with a continuous to nearly continuous cover, typically 80-90%. *Sarracenia alata* Wood. is often a dominant of this community. Due to a rich herbaceous layer, West Gulf Coastal Plain bogs are important contributors to regional biodiversity despite their limited extent, having many species restricted to these communities. Endemism is low, but the incidence of rare and localized species is high (MacRoberts et al. 2002). Although the number of plant taxa present in bogs of the region varies considerably depending on size, degree of disturbance, and other factors, 200 or more species may be present in this community. Carnivorous species and the families Cyperaceae, Orchidaceae, Poaceae, Xyridaceae and Asteraceae are particularly well represented (Nixon and Ward 1986, Orzell 1990, MacRoberts and MacRoberts 2001). Thirty-four plant species occurring in pitcher plant bogs of the West Gulf Coastal Plain have been recognized as rare by one or more government agencies (MacRoberts and MacRoberts 2001), and numerous others are of conservation concern.

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Pitcher plant bogs are subject to a wide range of impacts that place their continued existence at risk. Land use changes can eliminate bogs. In addition, silvicultural practices, alteration of ground-water regimes, off-road vehicle impacts, feral hogs (*Sus scrofa* L.), and succession to other vegetation types due to alteration of fire regimes can result in detrimental impacts (Folkerts 1982, Martin and Smith 1993, MacRoberts and MacRoberts 2001, Glitzenstein et al. 2003).

In April, 1999, off-road vehicle damage was reported at a pitcher plant bog (hereafter Phoenix Bog) located on the Angelina National Forest. Following evaluation and consultation, biologists from the National Forests and Grasslands in Texas made the decision to attempt restoration of Phoenix Bog. A second bog, Milstead Bog, also on the Angelina National Forest, had been subject to chronic vehicle damage for more than two decades. The decision was also made to prevent future vehicle impacts and attempt restoration of Milstead Bog. In this paper, we discuss the extent of damage to these two bogs, describe the restoration activities that were conducted, and assess the condition of the bogs approximately four years post-restoration.

STUDY AREA AND METHODS

Seventy known pitcher plant bogs and seepage slope bogs occur on the Angelina National Forest. Phoenix Bog (31°5'N, 94°14'W) is a small, less than 0.25 ha, pitcher plant bog located on the Angelina National Forest in Jasper County, Texas. Before the most recent vehicle damage, Phoenix Bog was a high quality bog (Figure 1a) known to contain at least seven plant species listed as Sensitive Species by the U.S. Forest Service (Table 1). In addition, it supported populations of numerous additional species (*Sarracenia alata*, *Eriocaulon decangulare* L., *Xyris* spp. L., *Aletris aurea* Walter, *Centella erecta* L., *Rhexia petiolata* Walter, *Viola primulifolia* L., etc.) primarily restricted to pitcher plant bogs. It was given a quality rating of A+ (open aspect with minimal woody vegetation, species rich including one or more rare species, absence of exotic species,



Figure 1. Phoenix Bog on the Angelina National Forest, Texas in May 1995 prior to all-terrain vehicle damage (a), and in April 2003 approximately 4 years after restoration (b).

and lacking major soil disturbance) in a 1995 bog inventory by Bog Research (740 Columbia Ave., Shreveport, LA 71104), a consultancy under contract to the U.S. Forest Service.

The off-road vehicle damage consisted of a series of deep ruts primarily in the open, central portion of the bog (Figure 2), directly affecting an estimated 30% of the bog surface. Extensive bare soil was

exposed and active erosion was occurring, rapidly increasing the extent of the damage. Damaged portions of the bog surface were 10-50 cm below the original contours. In addition, alteration of the water regime was resulting in drying of the remaining intact bog surface with additional detrimental impacts to the vegetation.

Milstead Bog, as described by Orzell (1990), is approximately 1 ha in extent and

Table 1. Plant species of conservation concern present at Phoenix Bog, Angelina National Forest, Texas prior to vehicle damage and post-restoration.		
Species	Common Name	Present post-restoration
<i>Rhychospora macra</i> (Clark) Small	large beakrush	yes
<i>Xyris drummondii</i> Malme	Drummond's yellow-eyed grass	yes
<i>Pogonia ophioglossoides</i> (L.) Ker	rose pogonia	?
<i>Calopogon tuberosus</i> (L.) B. S. P.	grass-pink	yes
<i>Plantanthera ciliaris</i> (L.) Brown	orange-fringed orchid	?
<i>Eriocaulon texense</i> Korn.	Texas pipewort	?
<i>Rudbeckia scabrifolia</i> L. E. Brown	Sabine coneflower	yes

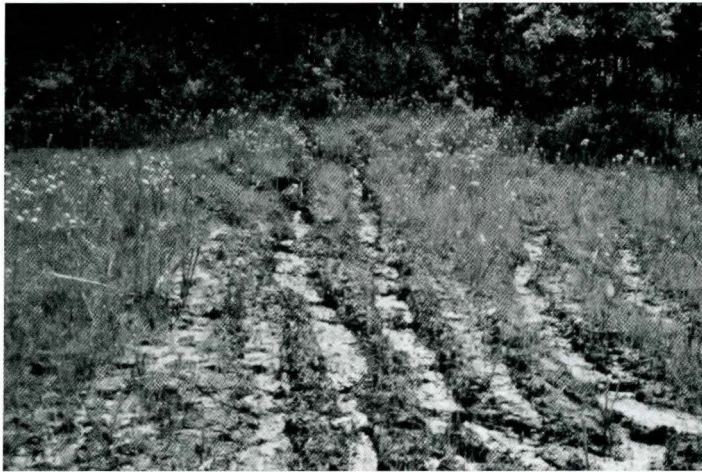


Figure 2. Phoenix Bog on the Angelina National Forest, Texas in April 1999 showing extent of off-road vehicle damage. Note the initiation of mass erosion in the tire ruts trending primarily up and down the slope.

supports at least six plant species listed as sensitive by the U.S. Forest Service. In addition to the vehicle damage, it has been substantially degraded due to lack of frequent fire. An unimproved road has existed for many years across the central portion of the bog. By the late 1990's, a strip approximately 15 m wide and 15-65 cm below original contours was actively eroding and lacked vegetation. Active erosion was occurring on the damaged areas, and de-watering of adjacent areas was increasing the area of impact.

The initiation of the restoration of Phoenix Bog occurred in June 1999 with four goals: (1) re-establishment of original soil surface contours, (2) reduction of erosion to pre-impact levels, (3) protection of residual vegetation, and (4) revegetation of the reconstructed areas. The estimated cost of materials and labor used in the restoration of Phoenix bog was \$7770. U.S. Forest Service personnel and volunteers provided a total of 282-person hours, not including time spent on planning and travel.

Retrieval of soil lost through erosion was not possible at either site. We chose clean construction sand from a nearby quarry as the basic fill material to provide the best match to the original material and to reduce the introduction of seeds. Sand was delivered to the restoration site by dump truck, but it needed to be "pack-

aged" before being applied to the sites to prevent rapid erosion. We transported sand and other materials to the bog from the nearest road, several hundred meters distant, using all-terrain vehicles (ATVs). Within the bog, we used sheets of plywood to construct access routes for the ATVs to disperse vehicle weight and prevent additional damage. We removed the plywood at the end of each day to minimize damage to underlying vegetation.

We placed sand in biodegradable burlap bags, which were then placed in all wheel

ruts and eroded channels. We placed sandbags in ruts beginning at the upslope end. The layer of sandbags provided access to damaged areas not directly accessible from the plywood paths. Approximately 12 cubic yards of sand and 400-500 burlap bags were required to restore the original surface contours of the bog. To reduce continued erosion, we covered restored areas with erosion control matting consisting of biodegradable netting embedded with shredded aspen (*Populus* sp.) wood. Matting was held in place using wooden stakes. Approximately 30% of the bog surface required restoration (Figures 2, 3).

Specific restoration activities to revegetate damaged areas were not undertaken. Vegetative regeneration and seed dispersal from adjacent undamaged areas were relied on to restore herbaceous cover of the appropriate species.

Restoration of Milstead Bog was initiated in July 1999. Damage to Milstead Bog was much more extensive than was the case for Phoenix Bog. A much greater volume of soil had been lost from a much more extensive area during the many years of chronic vehicle damage. In addition, small patches of residual vegetation and developing revegetation existed within the damaged area. Consequently, it was decided to attempt to stabilize the existing soil contour rather than attempt to restore the original surface



Figure 3. Phoenix bog on the Angelina National Forest, Texas, depicting restoration actions undertaken to restore the surface contours and stabilize the soil surface reducing the potential for erosion.

contour. The four goals set for the restoration of Milstead Bog were: (1) prevention of further impact from vehicle traffic, (2) reduction of erosion to pre-impact levels, (3) protection of residual vegetation, and (4) revegetation of damaged areas.

We addressed the ongoing impact by closing the bog to vehicular use, and mitigated existing damage by adding limited amounts of loose sand to partially fill some of the most heavily eroded portions of the bog. Fiber matting was used, as in Phoenix Bog, to reduce erosion and allow revegetation to occur. No other restoration activities were undertaken.

Ongoing vehicular damage to bogs, and other sensitive sites on the Angelina National Forest, needed to be addressed at the forest level. Prior to the damage to Phoenix Bog, the Angelina National Forest was open to unrestricted off-road vehicle use with the exception of sensitive areas, including pitcher plant bogs, which were specifically closed to vehicle use. The most intensive off road vehicle use occurred in the southern longleaf pine (*Pinus palustris* Mill.) dominated portion of the forest, and effective enforcement of sensitive area closures, typically small and often adjacent to established off-road vehicle trails, was impossible. This was especially true since severe damage to sites such as bogs could occur with a single vehicle incursion. Consequently, in the spring of 1999, the portion of the Angelina National Forest south of Highway 63 was closed to all off-road vehicle use. The Forest anticipates expanding this policy forest-wide in the future, except for maintained trails specifically designated for off-road vehicle use. These closures will include the most sensitive areas on the Angelina National Forest, including all known pitcher plant bogs.

RESULTS AND DISCUSSION

Four years post-restoration, results for Phoenix Bog are very encouraging. The restored contours of the bog surface have remained intact and are completely revegetated with appropriate herbaceous species (Figure 1b). The initial restoration activities were remarkably successful, and follow-up

restoration activities were not required. The four initial goals of the restoration project have been fully met.

Detailed baseline floristic information is not available for Phoenix Bog; however, the restored areas of the bog are dominated by a mix of species characteristic of those present before impact and characteristic of other bogs on the Angelina National Forest (Nixon and Ward 1986). In addition, at least four of the sensitive species known to be present prior to impact are still present in the bog, and individuals of one of these, Sabine coneflower (*Rudbeckia scabrifolia* L. E. Brown), occur within the restored area. We anticipate that continued successional changes and colonization within the restored area will occur in the herbaceous community but that these changes will increasingly resemble those naturally occurring in all bogs in the region.

The restoration goals for Milstead Bog were less ambitious than those for Phoenix Bog due to the more extensive damage. Four years post-restoration, these goals have been only partially achieved. Closing of the bog to off-road vehicle use has prevented additional damage and allowed revegetation to begin. The placing of sandbags and matting in critical areas has reduced the levels of erosion and further enhanced the rate of revegetation. Visual examination suggests that herbaceous vegetation will reclaim the disturbed areas, although this will take additional time and may require some additional erosion control measures. The fully restored bog surface will be at a substantially lower contour level than was present pre-impact, and this may influence the composition of the herbaceous community due to changes in hydrology.

Lack of floristic data for Phoenix and Milstead Bogs before disturbance precludes a detailed evaluation of restoration efforts. However, the impacted portions of Phoenix Bog have been restored to a functioning bog community with a dense herbaceous cover, including characteristic and sensitive bog species, within a four-year period. Restoration of Phoenix Bog can be considered completed and successful. Restoration of Milstead Bog is a work in progress,

although initial results are encouraging. The bog has been stabilized, and revegetation with characteristic bog species is occurring. It is anticipated that complete revegetation will occur and a functioning bog community will be restored, although this process will likely take years.

It is encouraging that restoration of pitcher plant bog communities on the West Gulf Coastal Plain following severe disturbance is possible. However, restoration efforts are costly, complete success is not guaranteed, and loss of rare species following disturbance is always a possibility. Prevention of detrimental impacts is preferred. Given the limited number and extent of these bogs on the West Gulf Coastal Plain, preventing damage to these bogs is crucial if important components of biodiversity are to be maintained. Protection from land use changes, restriction of vehicle access, and alteration of local ground water regimes are crucial. In addition, damage due to feral hogs, as noted in Phoenix Bog in 2003, may need to be addressed.

The most pervasive detrimental impact to existing pitcher plant bogs is lack of frequent fire. Gray et al. (2003) and Provencher et al. (2003) document the positive relationship between fire, species richness, and the persistence of rare vascular plants in the longleaf pine ecosystem, including the various wetland communities. As a result of effective suppression, wildfire is no longer a significant ecological process on the West Gulf Coastal Plain. The continued existence of pitcher plant bogs in the region is currently dependent on an effective prescribed fire regime (Olsen and Platt 1995, Drewa et al. 2002, Keith and Carrie 2002, Gray et al. 2003). Insufficient personnel, inadequate funding, air quality and smoke management regulations, lawsuits by environmental groups, and numerous other factors constrain the use of prescribed fire by public and private land managers in the West Gulf Coastal Plain. Implementation of an effective prescribed fire regime, given these constraints, is the major challenge facing land managers. Lack of frequent prescribed fire remains the greatest threat to the continued existence of pitcher plant bogs on the West Gulf Coastal Plain.

ACKNOWLEDGMENTS

Several organizations and individuals provided support and labor necessary to accomplish the restoration of these two bogs. We thank Richard Donovan and John Finne of the Texas Committee on Natural Resources, Rick Turner of the Nature Conservancy, and U.S. Forest Service employees Doug Born, Thad Choate, Walter Cooper, Terry Harris, Steve King, Shane Neil, Don Sowell, Jamie Sowell, Greg Stockton, Clifton Wade, and Bobby Warner. Sylvia Ferguson provided compliance with archeological regulations. We also thank R.A. Thill, J.A. Neal, and J. Singhurst for constructive comments on an early draft of this manuscript.

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