FIRE IN MOUNTAIN BOGS

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Abstract—Southern Appalachian montane wetlands are rare natural communities. Distributed throughout the Appalachians' high-elevation depressions, valley slopes, and basins, a highly variable combination of abiotic factors shape the character of each "bog." Most unaltered bogs are distinguished by a generally open vegetative structure and diverse herbaceous flora, but with a tendency toward succession to forests. Natural disturbances arrest some bogs in early seres. However, anthropogenic influence has increasingly precluded many such disturbance regimes, resulting in uninhibited succession, habitat homogenization, and the gradual demise of the specialized flora and fauna. To restore and maintain some bogs' naturally open character, land managers such as The Nature Conservancy (TNC) have chosen to mimic disturbance using a variety of methods, including prescribed burning. This paper provides insight into how two TNC-owned sites were historically influenced by fire, presents some of TNC's experience using prescribed fire in bogs, and describes trends in Green Pitcher Plant (*Sarracenia oreophila*) abundance as regular fire regimes were restored to the sites.

INTRODUCTION

Southern Appalachian montane wetlands, collectively known as bogs, are rare natural communities. Forming as small, wet concavities within high-elevation depressions, valley slopes, and basins, bogs contribute greatly to the biodiversity of the Southern Blue Ridge Ecoregion. Individual bogs can vary considerably in terms of geomorphic setting, hydrologic regime, and soil and water chemistry, yet most are characterized by a generally open vegetative structure with diverse herbaceous flora (Schafale 2012). Bogs can vary from permanently wet to intermittently dry, with hydroperiods driven largely by groundwater seepage. Habitat conditions are generally harsh, containing highly acidic, nutrient-poor, anoxic soil characteristics from which unique suites of plants are established. Through time, abiotic processes and disturbances have shaped these wetlands, including flooding driven both by beavers and by weather regimes, ungulate grazing, clearing by native people, and in some cases fire. In the absence of natural disturbance, bogs tend to rapidly succeed with shrub and tree invasion. Challenges commonly encountered with restoration of bogs' early seral conditions include the extirpation of grazers, shorter duration and less frequent flooding, absence of beavers, native and nonnative invasive species, urban and agricultural development, fire suppression, and altered soil and water chemistry from excessive nutrient input. In many cases, a combination of these factors impedes bog restoration and management. Due to the large scale destruction of these unique places, land managers must adapt and mimic these processes to conserve the few remaining sites and inherently rare species.

North Carolina's Department of Environment and Natural Resources Natural Heritage Program recognizes five types of bogs (Schafale 2012) based largely on vegetation composition differences. All are recognized by the Ecological Classification System as Southern and Central Appalachian Bogs and Fens (CES202.300; Federal Geographic Data Committee 2008). Southern Appalachian Fens are herb-dominated wetlands sustained by highly basic groundwater seepage. Swamp Forest Bog Complexes are tree-dominated communities that occur along streams within floodplains (Schafale 2012). French Broad Valley Bogs and Southern Appalachian Bogs are similar, but both contain a greater proportion of herbaceous vegetation, and French Broad Valley Bogs generally contain a proportion of Coastal Plain disjunct wetland plant species (Schafale 2012). The Low Mountain Seepage Bog is distinguished by a unique suite of Piedmont and Coastal Plain disjunct plants (Schafale 2012). It is important to account for these subtle variations when considering management using fire. Variables such as presence or absence of sphagnum and specific plant species can lend important information and likely prevent deleterious outcomes.

While preserve management and conservation easement monitoring are a significant part of The Nature Conservancy's (TNC) mission, TNC is continually building capacity to restore natural fire regimes in the appropriate places with the help of the Fire Learning Network. Similarly, efforts to share bog management experience is continually expanding. In light of the potential Mountain Bogs National Wildlife Refuge establishment, TNC and the U.S. Fish and Wildlife Service have partnered to establish the Bog Learning Network. The aim of the Bog Learning Network is to share experiences and help provide tools and techniques

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that can be used to restore and manage these unique places. The goal of this paper is to relate information, experiences, and results of burning in a specific type of Southern Appalachian montane wetland and generate dialogue among managers regarding the use of fire in Southern Appalachian wetlands.

TNC manages two Low Mountain Seepage Bogs that occur near the banks of Lake Chatuge (fig. 1). Eller Seep Preserve contains a 2.9-acre wetland that represents North Carolina's only Low Mountain Seepage Bog and supports one of the largest known populations of *Sarracenia oreophila* (Green Pitcher Plant). Just south of the Georgia state line lies Reed Branch Wet Meadow Preserve, which contains a 3.5-acre Low Mountain Seepage Bog and supports Georgia's only naturally occurring *S. oreophila* population. Over the last several thousand years, fire, flooding, and grazing have shaped the flora and fauna of these bogs, and the fact they still exist is a result of continued disturbance. *S. oreophila* and associated herbaceous vegetation indicates open conditions likely occurred here historically, as *S. oreophila* seeds must fall on bare, moist mineral soil in order to germinate and become established. In the absence of such conditions, seedling recruitment decreases, reproduction becomes primarily asexual, and populations inevitably decline (Folkerts 1992).

Prior to the damming of the Hiawassee River and creation of Lake Chatuge Reservoir in 1942, this region contained a series of seepage bogs that supported *S. oreophila* (Carlson 1994), and evidence indicates the region's wetlands withstood periodic fire. Adjacent uplands are comprised of Mesic Oak-Hickory (Simon 2011), and pre-settlement forests suggest low intensity fires occurred every 10-15 years with occasional more intense fires help to maintain and regenerate fire tolerant oaks (Landfire 2010). Both of these sites lie near the base of western-facing slopes within the Hiawassee River Valley. Further, Native Americans inhabited the valley from about 2000 years before present and were known to use fire for agriculture and hunting purposes (Govus 1990). The previous landowner of Eller Seep burned the site annually from 1908-1972 to keep the land open for grazing (Govus 1990). This is perhaps the most critical factor for *S. oreophila* existence at the site. Following his death in 1972, burning ceased until the early 1990's. During this time hydrologic modifications were made in an attempt to drain the site. These activities resulted in rapid hardwood invasion and subsequent decline of *S. oreophila*. Reed Branch was burned annually for at least 20 years until 1990 (Tollner 1997), during which time it was used as a pasture. The hydrology of the area was disturbed when a ditch was installed to drain an adjacent pasture, and at least one tile drain was installed on the property.

TNC's management goals for these bogs are to maintain the open character, increase *S. oreophila* populations, and promote the continued existence of diverse and rare seepage bog plant communities. Thus, the primary strategy is to limit hardwood encroachment to the center of the bog and expand the herbaceous zone. The restoration methods used by TNC are controlled burning every 1-3 years and mechanical and/or chemical treatment of encroaching hardwoods that would otherwise outcompete, such as red maple (*Acer rubrum*) and smooth alder (*Alnus serrulata*).

MATERIALS AND METHODS

Eller Seep

Since the acquisition of Eller Seep in 1992, TNC has conducted seven controlled burns: April 1992, March 1997, April 2002, January 2005, April 2007, April 2009, and April 2011. Approximately 3 months following the burns, the number of *S. oreophila* leaves (i.e., pitchers) and flowers was then counted by sampling along ten permanent belt transects (fig. 2). The beginning of the baseline was marked by a 23-cm diameter at breast height tulip poplar (*Liriodendron tulipifera*) and was established by running a metric tape from this point out at 310°. The ten 5 m by 40 m belt transects ran perpendicular to this baseline. Each transect was divided into 5 m by 5 m sections. Transect sections were labeled based on the starting distance from the baseline. Thus, Section 0 identified the first section 0-5 m from the line. Section 5 is for 5-10 m from the line, etc. (fig. 2). In addition, there was a high density area on transects 7 and 8 which was divided into 2.5 m by 2.5 m sampling plots. This area was located between 0 and 12.5 m from the baseline in a block which includes portions of transects 7 and 8. Separate counts of a subsample of plots were made within this area but not included in the transect counts for years before 2007. More intensive data were collected in these high density plots, including size classes to gather greater detail. However, separate monitoring of the high density area did not provide significant additional information, and it was discontinued in 2007. In 2007–2008, counts for transects 7 and 8 included all plants within the entire length of the transects, including the high density area. Therefore, the total transect counts prior to 2007 are not directly comparable to the total counts for 2007–2008 because they do not include this high density area. In order to compare the older transect data with the more recent data, data for transects 7 and 8 are excluded. While some transect data are lost, the comparison gives a better picture of the trends and changes in the sampled area. To compare data for the portions of the transects in the high density area, comparisons would need to be made between sample counts in earlier years and total counts in 2007 and 2008, which would be of questionable value.

In 1990–1994, only a 5 m by 27.5 m section of transects 7 and 8 was counted, which excluded the high density area from 0 to 12.5 m from the baseline. In 1995–1998, transect data appear to exclude the high density area, but tabular data are not available, only a summary report, so no transect data are presented. Data were not collected from 1999–2001. In 2002–2006, transect data were collected which excluded the high density area. In 2007–2008, the entire 5 m by 40 m length of transects 7 and 8 were counted, including the high density area. Clump counts may not be a reliable measure of population size changes because it is unclear how clumps merge and separate over time.

Reed Branch Wet Meadow

Since TNC acquired Reed Branch in 1992, eight controlled burns have been conducted: September 1998, January 2002, March 2004, March 2006, March 2008, December 2009, March 2012, and October 2013. Monitoring at Reed Branch consisted of complete *S. oreophila* pitcher and flower counts in late spring. From 1998–2008, monitoring occurred annually with one hiatus, 2000–2002. In 2009, monitoring was only conducted in the second growing season following fire to allow comparisons between years, since counts of pitchers and flowers varied greatly between fire years and non-fire years. It also allowed counts of flowers, since flowering is generally suppressed in the season following fire. Lastly, monitoring is easier since numbers of pitchers are high in the season following fire. Monitoring has since taken place in 2011 and 2013. Regression models show that numbers of both pitchers and flowers have steadily increased in the population since management and monitoring began in 1998.

RESULTS

The number of *S. oreophila* clumps at Eller Seep remained relatively stable from 1990 to 1994. However, when monitored again following an eight-year hiatus, the number of clumps had dropped sharply when measured in 2002. The numbers then continually increased through 2007 (fig. 3). Clump count dropped again in 2007 and 2008. However, it was determined that clump counts may not be a reliable measure of population size changes because it is unclear how clumps merge and separate over time.

From an initial count of 777 in 1990, the number of *S. oreophila* pitchers continually increased through 2008, with relatively minor declines in 2002 and 2006 (fig. 4). The number of flowers was variable from 1990–2008, but increased sharply the year after each fire (fig. 5). The number of flowers counted increased from 40 in 1990 to 135 in 2008. Late frosts hinder flowering and thus account for some of the variability

Reed Branch monitoring data show a steady increase in number of pitchers each year in both fire and non-fire years, appearing as linear growth. (fig. 6). There was a sharp increase in number of pitchers from 2006 to 2008, which affected the R^2 value. An exponential model was used, but it only increased the value slightly and it was still below 0.90. There was a steady increase in flowers counted from 1998–2006 (fig. 7). After 2006, however, flower numbers began to decline. There are 250 less flowers counted in 2008 when compared to the next lowest year in 1999. There are 795 less flowers counted in 2008 when compared to 2006. There was a statistically significant increase in number of pitchers during fire years compared to non-fire years ($p = 0.022$). However, there was no statistically significant increase in flower production during non-fire years when compared to fire years ($p = 0.085$).

CONCLUSIONS

Restoration of an appropriate fire regime has effectively reversed the decline of *S. oreophila* populations at both Eller Seep and Reed Branch. *S. oreophila* and native herbaceous species that inhabit Low Mountain Seepage Bogs benefit from controlled burning (U.S. Fish and Wildlife Service 1994) and appear to thrive if burned in one- to three-year intervals. Flowering was noticeably more prolific in the year after burning. Brush cutters have been used to remove hardwoods at Eller Seep, which helps increase continuity of the fuel bed and limits hardwood growth in years when the bog may not burn. The aim at Eller Seep is to further suppress hardwood growth by possibly shifting the timing of controlled burns to the late spring or early summer, in combination with cutting and chemical treatments. These results pertain specifically to Low Mountain Seepage Bogs, a rare type of montane wetland with characteristic fire-adapted species. Implementation of a fire program in sphagnum-dominated wetlands and/or those with other *Sarracenia* species should be approached with caution. TNC staff hopes that this paper will encourage other land managers to share experiences, not only with fire, but with all management techniques that help conserve rare plants and animals supported by bogs.

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REFERENCES

Carlson, B. 1994. RBWM site conservation plan. Unpublished report. On file with: The Nature Conservancy-Southern Blue Ridge Office, 46 Haywood Street, Asheville, NC 28801.

Faber-Langendoen, D.; Keeler-Wolf, T.; Meidinger, D. [and others]. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Reston, VA; Arlington, VA: Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey and NatureServe. 216 p.

Federal Geographic Data Committee. 2008. Vegetation classification standard. FGDC-STD-005. 119 p. http://usnvc.org/wp-content/uploads/2011/02/NVCS_V2_FINAL_2008-02.pdf. [Date accessed: January 20, 2014].

Folkerts, G.W. 1992. Identification and measurement of damage caused by flower and seed predators associated with *Sarracenia oreophiIa* and recommended management/control measures deemed appropriate. Unpublished Report. On file with: The Nature Conservancy-Southern Blue Ridge Office, 46 Haywood Street, Asheville, NC 28801.

Govus, Thomas E. 1990. Land use history, population study methods and management recommendations for the Eller Preserve, Clay County, North Carolina. Unpublished Report. On file with: The Nature Conservancy-Southern Blue Ridge Office, 46 Haywood Street, Asheville, NC 28801.

Hodges, Malcom. 2013. Conservation Management Plan: Reed Branch Wet Meadow Preserve. Unpublished Report. On file with: The Nature Conservancy-Southern Blue Ridge Office, 46 Haywood Street, Asheville, NC 28801.

LANDFIRE. 2010. [Homepage of the LANDFIRE Program, U.S. Department of Agriculture Forest Service; U.S. Department of the Interior]. [Online.] Available: http://www.landfire.gov/index.php. [Date accessed: January 20, 2014].

NCWRC [North Carolina Wildlife Resources Commission]. 2010. Bogs and Associated Wetlands-Southern Blue Ridge Mountains. http://www.ncwildlife.org/Portals/0/Conserving/documents/Mountains/SBR_Bogs_and_associated_wetlands.pdf. [Date accessed: January 20, 2014].

Roe, Andrew; Croll, Phil. 2009. Monitoring summary of Green Pitcher plant (*Sarracenia oreophila*) at Eller Seep. Unpublished Report. On file with: The Nature Conservancy-Southern Blue Ridge Office, 46 Haywood Street, Asheville, NC 28801.

Schafale, M.P. 2012. Guide to the Natural Communities of North Carolina Fourth Approximation. Raleigh, NC: NC Natural Heritage Program. 208 p.

Simon, S.A. 2011. Ecological zones in the Southern Blue Ridge: 3rd approximation. Unpublished report. On file with: National Forests in NC, 160 Zillicoa Street, Asheville, NC 28801.

Tollner, B. 1997. Report of visit to the Reed Branch proposed site for pitcher plant preservation. Internal report. Athens, GA: The University of Georgia.

U.S. Fish and Wildlife Service. 1994. Green Pitcher Plant Recovery Plan. Jackson, MS: U.S. Fish and Wildlife Service. 23 p.

Wilson, David B. 2008. Data analysis of green pitcher plant (*Sarracenia oreophilia*) at Reed Branch Meadow. Unpublished Report. On file with: The Nature Conservancy-Southern Blue Ridge Office, 46 Haywood Street, Asheville, NC 28801.

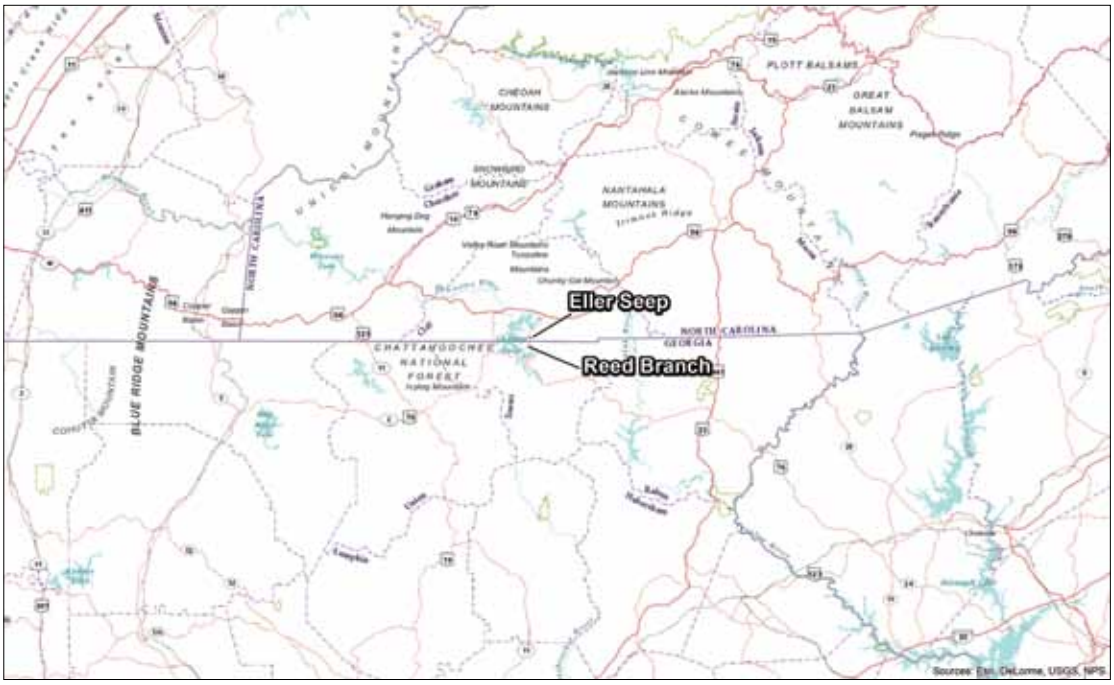

Figure 1—Eller Seep Preserve and Reed Branch Wet Meadow Preserve.

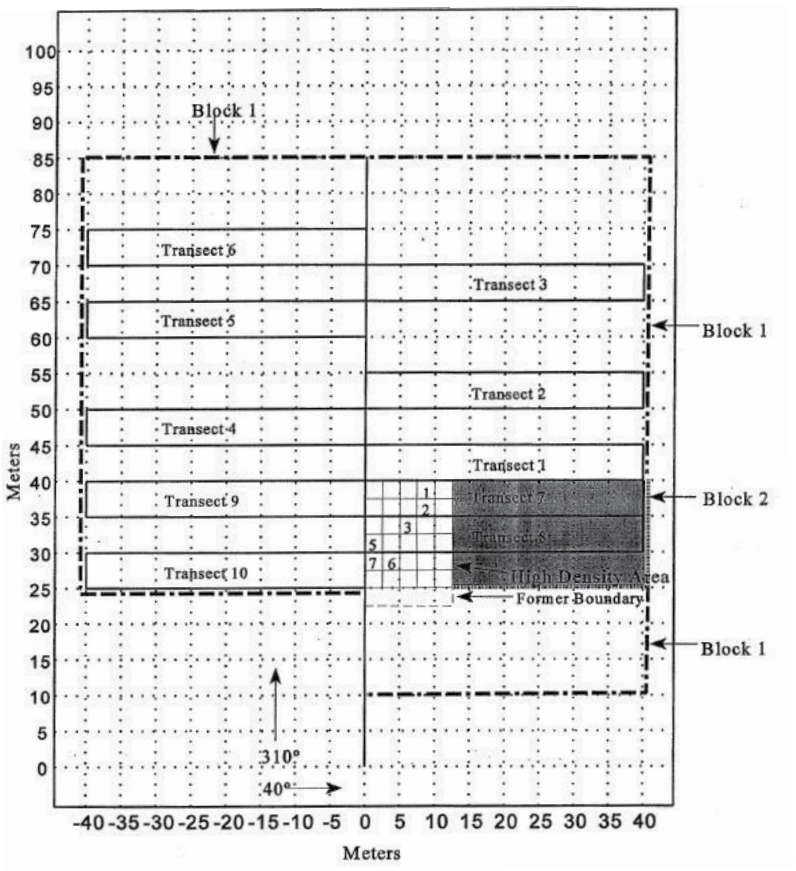

Figure 2—Sampling design at Eller Seep Preserve (from Rudd and Sutter, 1998 Monitoring Report). Low and high density areas sampled with numbered transects and plots, respectively.

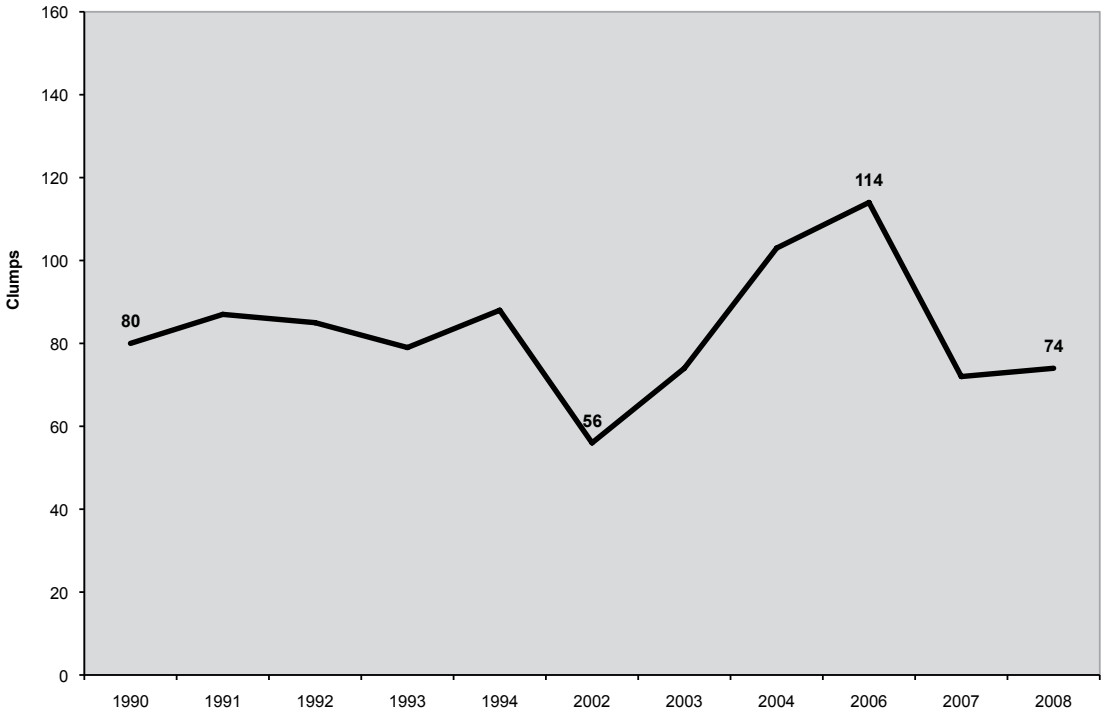

Figure 3—Trend in the number of *S. oreophila* clumps at Eller Seep Preserve (1990–2008). Controlled burns were conducted in 1992, 1997, 2002, 2005, 2007, 2009, and 2011.

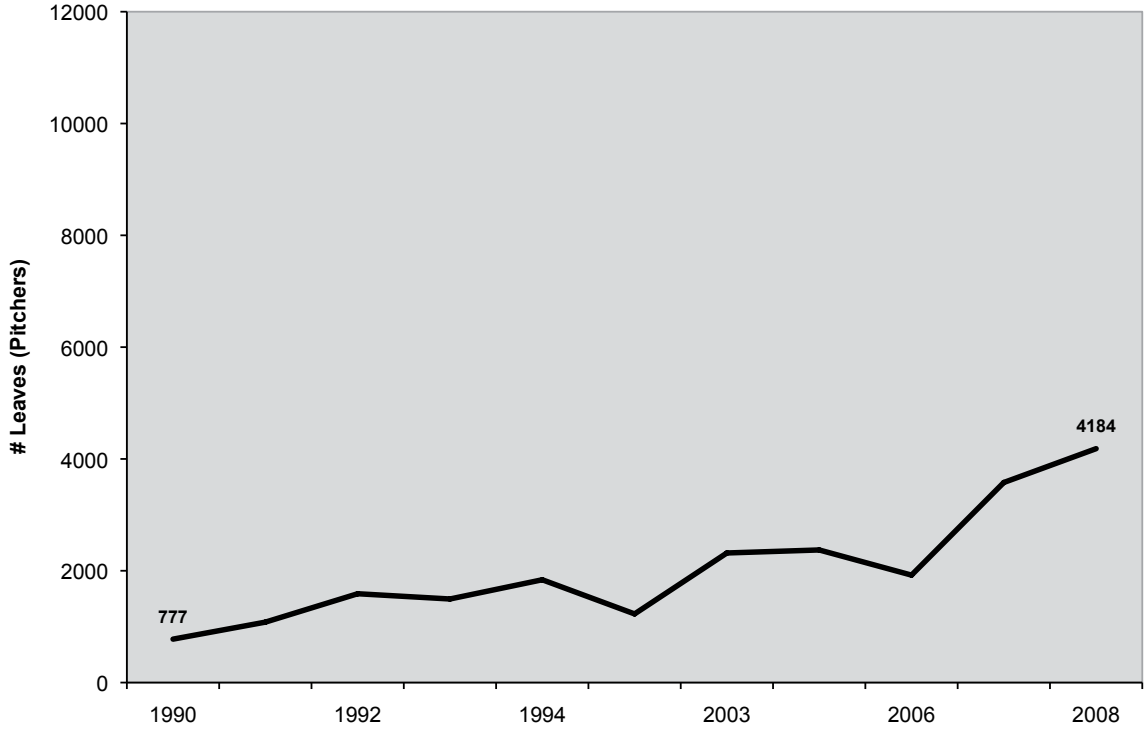

Figure 4—Trend in the number of *S. oreophila* pitchers at Eller Seep Preserve (1990–2008). Controlled burns were conducted in 1992, 1997, 2002, 2005, 2007, 2009, and 2011.

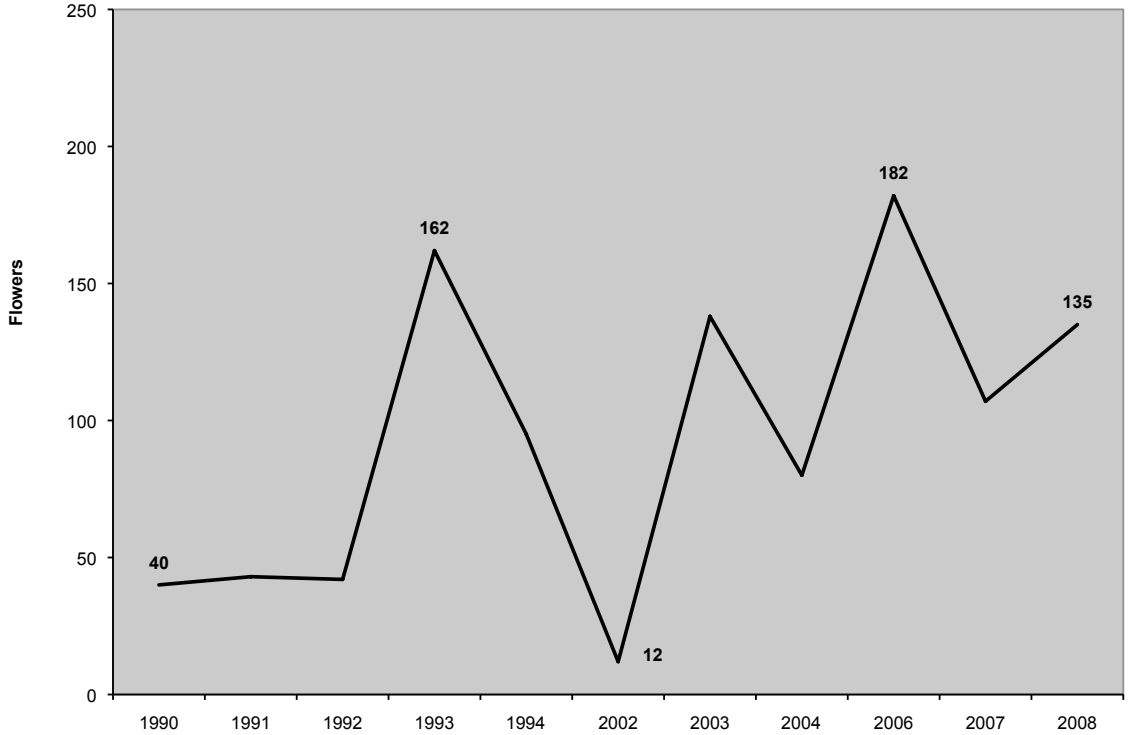

Figure 5—Trend in the number of *S. oreophila* flowers at Eller Seep Preserve (1990–2008). Controlled burns were conducted in 1992, 1997, 2002, 2005, 2007, 2009, and 2011.

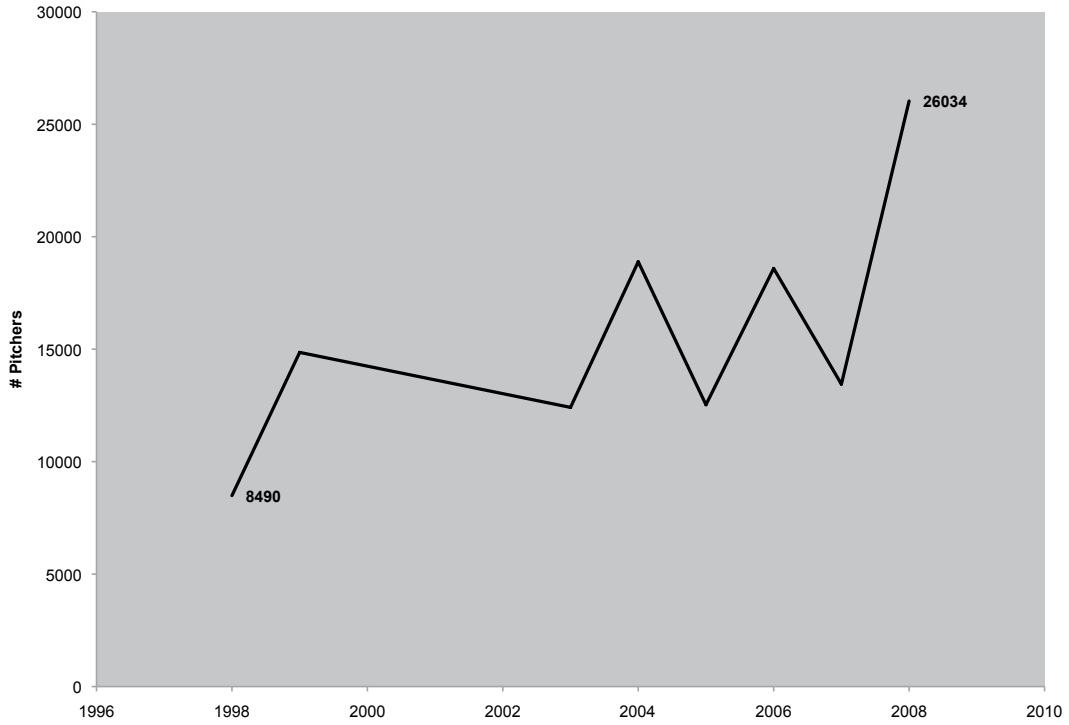

Figure 6—Trend in the number of *S. oreophila* pitchers at Reed Branch Wet Meadow Preserve (1996–2008). Controlled burns have been conducted in 1998, 2002, 2004, 2006, and 2008.

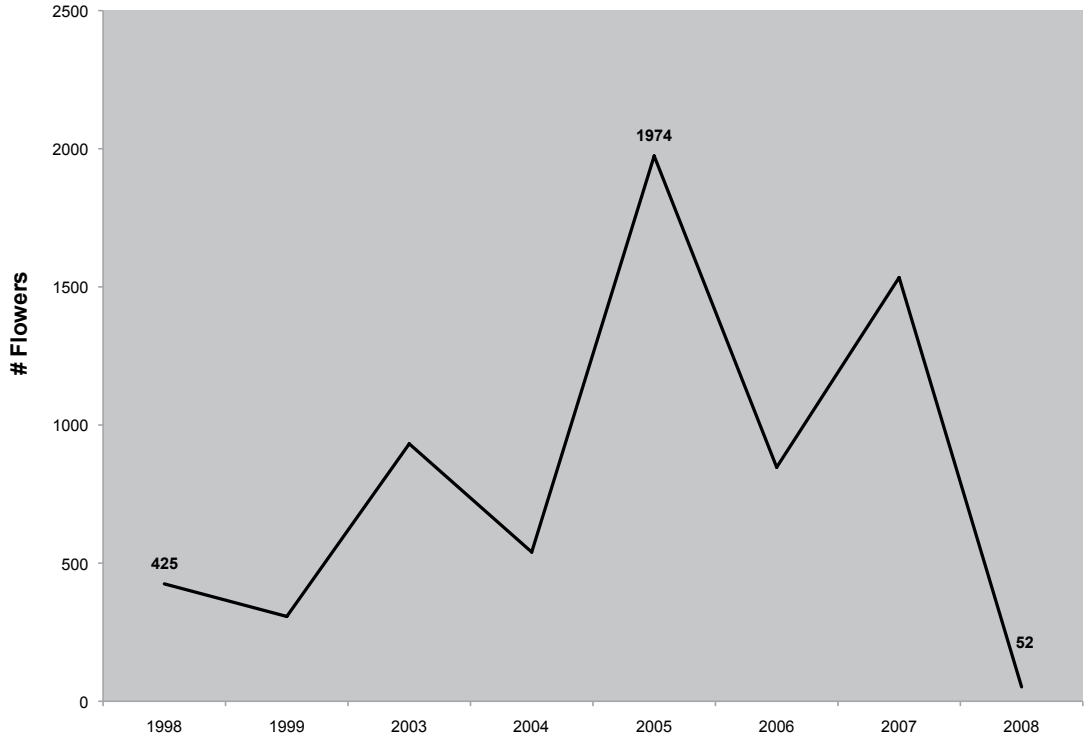

Figure 7—Trend in the number of *S. oreophila* flowers at Reed Branch Wet Meadow Preserve (1996–2008). Controlled burns have been conducted in 1998, 2002, 2004, 2006, and 2008.