

Floristics of Ephemeral Ponds in East-central Texas

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Abstract - Beginning in 2009, we surveyed the vegetation of ephemeral ponds in Sabine and Nacogdoches counties in east-central Texas. These ponds are shallow and flat-bottomed, with a small but distinct flora dominated by grasses (Poaceae) and sedges (Cyperaceae). The floras of these ponds are most similar to those of flatwoods ponds located on the lower coastal plain. Once more common on the landscape, ponds of this type have been altered or destroyed by land-use changes and fire suppression, leading to massive encroachment of woody vegetation. The pond we sampled in Nacogdoches County has been regularly mowed for approximately 30 years to prevent woody encroachment. Currently, prescribed burning in late summer and mechanical removal of encroaching woody vegetation are being applied to better understand management options that will maintain and restore the ponds we sampled and similar sites in east-central Texas. These and other natural ponds in the West Gulf Coastal Plain have not been comprehensively studied.

Introduction

As part of a project to restore a damaged wetland in Sabine County, TX, we used aerial photographs to locate other wetlands in the vicinity and determine what the damaged site may have been like prior to disturbance. We found a number of open, elliptically shaped, graminoid-dominated, flat-bottomed depressions (ponds) associated with *Quercus* sp. (oak)-*Pinus* sp. (pine) forest stands on what appear to be old river terraces of the Sabine River. The ponds typically fill in fall, winter, and spring, and become dry in summer. Water depth varies through the year but is generally less than 30 cm. The ponds range in size from 0.1 ha to about 0.8 ha. We also located two similar ponds on the Stephen F. Austin Experimental Forest in Nacogdoches County, TX.

Based on a survey of the literature, we concluded that the morphology and vegetation of these wetlands had not been described. However, flatwoods ponds that occur farther south in Texas and Louisiana share many features with the ponds in our restoration project. Flatwoods ponds of the West Gulf Coastal Plain, while not extensively studied, have received some attention from conservation organizations such as the Louisiana Natural Heritage Program and The Nature Conservancy (Bridges 1988, Bridges and Orzell 1989, Lester et al. 2005, NatureServe Explorer 2009, Pyne 2005). These ponds occur on the outer coastal plain in the *Pinus*

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palustris Mill. (Longleaf Pine) savanna wetland ecosystem on Quaternary terraces from Evangeline Parish in southwestern Louisiana to Liberty and Polk counties in southeastern Texas. Flatwoods ponds appear to occur in swales and depressions in and adjacent to ancient Pleistocene stream channels. Individual ponds may be as large as 20 ha but generally are 0.5–2.0 ha in extent. They are graminoid-dominated, circular or elliptical, and are shallow (0.3 to 1.6 m deep). Some are flat-bottomed, but the majority have a depth gradient and become deeper toward the middle and show distinct vegetational zonation.

True flatwoods ponds are highly variable floristically and tend to support relatively few species. Surrounded by Longleaf Pine savanna wetlands, the shallow ponds, in particular, support many plant species characteristic of that community. Conditions caused by fluctuations in water level at these sites seem to favor predominantly rhizomatous, stoloniferous, and densely caespitose herbaceous species (Bridges 1988). Vegetation can become very dense, leading to accumulation of high fuel loads (Bridges 1988). The ponds are filled by precipitation and runoff from very small watersheds, with no input from stream flow and little or no outflow (Bridges 1988). A high water table and fire appear to be the predominant factors that prevent encroachment by woody species (Bridges and Orzell 1989). Soils are hydric, acidic, nutrient-poor sandy loams. Flatwoods ponds are very rare because of fire exclusion, grazing, excavation and filling, and silvicultural impacts; very few good examples remain (Bridges 1988, Bridges and Orzell 1989, Lester et al. 2005, NatureServe Explorer 2009, Pyne 2005).

The ephemeral ponds in Sabine and Nacogdoches counties resemble flatwoods ponds, but occur north of the known range of flatwoods ponds on a landscape with more topographic relief. Having determined that these new sites had not been documented or described, we decided to study them to determine how they compared with flatwoods ponds. The results of our study can inform discussions of management and restoration issues related to these ponds.

Study Sites

We studied the vascular flora of three ephemeral ponds in eastern Texas. The Sabine Ponds site consists of two adjacent ≈ 0.8 -ha ponds in Sabine County, on the Sabine National Forest (31°25'39.8"N, 93°45'55.9"W and 31°25'37.7"N, 93°45'46.3" W; Fig. 1). These two ponds will be referred to as one site, Sabine Ponds, throughout this paper. Their elevation is approximately 57 m. Geologically, the site features Quaternary alluvium on Gallime-Guyton soils in depressions on stream terraces (Griffith 2010). In Nacogdoches County, we located two ponds on the Stephen F. Austin Experimental Forest within the Angelina National Forest, approximately 92 km northwest of the Sabine County ponds. The geology at this site is characterized by Quaternary alluvium (Pleistocene terraces) on the Angelina River over Sparta Sand (Mollville loam). The elevation is approximately 75 m. Pond 1 (31°30'35.5"N; 94°46'02.9"W) is approximately 1.2 ha (Fig. 2) and Pond 2 (31°30'35.0"N; 94°45'40.4"W) is approximately 1.4 ha in area. Both Nacogdoches County ponds have been fire-suppressed for several decades. In Pond 1, periodic



Figure 1. Study pond in Sabine County, TX. Summer aspect.



Figure 2. Study pond # 1 in Nacogdoches County, TX. Winter aspect.

mowing over the last 30 yrs has prevented invasion by woody plants, and the pond remains dominated by herbaceous species. Woody vegetation has significantly encroached on Pond 2 during this same time period, and the pond now lacks most herbaceous vegetation; it was not included in our floristic survey.

These ponds are typically filled from late fall until late spring by rainfall and runoff from small local watersheds. Water levels fluctuate with local precipitation, and there is considerable annual variation. In some years (i.e., 2010–2011) the ponds remain empty. Sabine Ponds had a maximum water depth of 25 cm on 9 November 2009, and Nacogdoches Pond 1 had a maximum depth of 27 cm on 1 April 2010.

The general geology, topography, and climate of eastern Texas are described in Diggs et al. (2006). Summers are hot and humid; winters are mild. Mean annual temperatures are around 20 °C, and range from just below freezing in winter to about 38 °C in summer. Average annual precipitation is 122–138 cm and occurs relatively evenly throughout the year.

Our examination of topographic maps and aerial photographs suggests that several other ephemeral ponds occur in the area of the Sabine Ponds, but apparently, they are the only ponds of this type present in eastern Texas. Our examination of soils maps and field observations suggest that other ponds like the Nacogdoches Pond occurred in that region in the past, but these have all disappeared, likely due to encroachment by woody vegetation.

The forest surrounding the Sabine Ponds has been cut and thinned several times. In recent years, fire has become an important management tool used by the US Forest Service. In the winter of 2009, the area surrounding the Sabine Ponds was prescribe-burned, and we observed that due to high water levels the pond did not burn. The Stephen F. Austin Experimental Forest, where the Nacogdoches County ponds are located, is subject to periodic prescribed fire, typically in late winter or early spring. During this time period, the ponds generally contain water and the fires do not affect the pond vegetation.

Methods

Except for the winter months, we visited each pond monthly from May 2009 until July 2010 to collect plant samples. We collected specimens of most species in the ponds and deposited them at the Botanical Research Institute of Texas (BRIT) at the conclusion of our study. We collected soil samples from the center and upland edges of each pond and sent them to the Louisiana State University Soil Testing and Plant Analysis Laboratory, in Baton Rouge, LA for analysis. To determine species richness, we established nine evenly spaced 10-m² plots, each with a nested 1-m² plot, on a transect set along the length of Nacogdoches Pond. We did not conduct plot-sampling at the Sabine County ponds.

We listed the species in the plots, recorded vegetation height and percent cover within the plots, and measured water depth at irregular intervals. We used Sorensen's index of similarity (Sorensen 1948) to compare communities following the formula $IS = (2C / [A + B]) \times 100$, where C is the number of species in common to the two communities, A is the total number of species in community A, and B is the total number of species in community B.

Results

Appendix 1 lists the species we collected from ephemeral ponds in Sabine and Nacogdoches counties. There were 40 species in the former (Sabine Ponds) and 32 species in the latter (Nacogdoches Pond 1); together, the ponds had a total of 55 species. There were 18 species in common between the two ponds, giving a Sorensen's index of similarity of 50, which indicates that while they are not identical, the two ponds support the same plant community type. *Triadica sebifera* (Chinese Tallow), which occurred in or on the periphery of each pond, was the only non-native species observed. The nine 1-m² plots averaged 7.8 (range: 6–10) species per plot, and the nine 10-m² plots averaged 11.1 (range: 9–15) species per plot. Generally, vegetation was dense and tall (up to about 90 cm; Figs. 1, 2), with nearly 100% ground cover except where disturbed. *Rhynchospora* sp. (beaksedge) and *Panicum hemitomon* (Maidencane), both rhizomatous and colonial, often grew in dense pure or near-pure stands. Cespitose species such as *Saccharum giganteum* (Sugarcane Plumegrass) and *Eleocharis quadrangulata* (Squarestem Spikerush) also formed monospecific clumps.

The ponds were surrounded by shrubs and woody vegetation (Figs. 1, 2). Major woody species surrounding the Nacogdoches County pond included *Berchemia scandens* (Alabama Supplejack), *Brunnichia ovata* (American Buckwheat Vine), *Campsis radicans* (Trumpet Creeper), *Cephalanthus occidentalis* (Buttonbush), *Crataegus opaca* (Western Mayhaw), *Diospyros virginiana* (Common Persimmon), *Liquidambar styraciflua* (Sweetgum), *Pinus taeda* (Loblolly Pine), *Quercus phellos* (Willow Oak), *Styrax americanus* (American Snowbell), *Smilax bona-nox* (Saw Greenbrier), and Chinese Tallow. Woody species surrounding the Sabine Ponds included Buttonbush, Western Mayhaw, Common Persimmon, Sweetgum, *Nyssa biflora* (Swamp Tupelo), Loblolly Pine, Willow Oak, and Chinese Tallow.

Water levels in the ponds varied throughout the year. We measured water depths in the pools from June 2009–September 2010. Water began to accumulate in October (2–8 cm), and the pond retained water in November (9–28 cm), February (10–29 cm), March (17–22 cm), and April (10–20cm). There was no standing water from late May through September. These figures would vary between years depending on rainfall.

Table 1 shows the results of the soil analysis. The soils were classified as acidic, nutrient poor, fine sandy loams.

Table 1. Soil analysis results for Sabine 3, Sabine 4, and Nacogdoches 1 ephemeral ponds. All numerical values except pH are ppm. M = middle of pond, and E = edge of pond.

Sample	pH	Ca	Cu	Mg	P	K	Na	S	Zn	Soil texture
Sabine 3M	4.3	113.0	0.7	36.4	6.1	17.1	9.9	11.9	0.9	Fine sandy loam
Sabine 3E	4.3	61.9	0.4	29.1	2.9	12.3	6.6	9.7	0.5	Fine sandy loam
Sabine 4M	4.5	75.9	0.4	23.1	5.8	12.0	7.8	9.1	0.5	Fine sandy loam
Sabine 4E	4.5	65.1	0.5	29.6	3.5	11.9	6.5	9.2	0.6	Fine sandy loam
Nacog 1M	4.4	275.2	1.0	75.0	8.3	53.9	13.3	16.1	1.4	Loam
Nacog 1E	4.7	238.7	0.6	69.3	14.4	49.3	132.9	15.3	0.8	Fine sandy loam
Nacog 1E	4.2	87.4	0.4	34.8	8.9	16.2	8.0	9.2	0.8	Fine sandy loam

Discussion

Superficially, the ephemeral ponds we studied resemble flatwoods ponds (see descriptions in Lester et al. 2005, NatureServe Explorer 2009, Pyne 2005, Turner 1999, but especially Bridges and Orzell 1989).

We were unable to locate complete plant lists for any flatwoods ponds on the West Gulf Coastal Plain to compare with our findings, but we found partial lists based on surveys of many ponds. A comparison of the 51 species listed by Bridges and Orzell (1989) for flatwoods ponds with our list of 55 species for ephemeral ponds shows only 20 in common, giving a Sorensen's index of similarity of 38, which is below the value considered to signify the same community (threshold value = 50; Sorensen 1948). Because the flatwoods ponds that have been surveyed all occur in the wetland pine savanna region of southwestern Louisiana and southeastern Texas and are thus embedded in the pine savanna ecosystem, which does not extend into the areas where the ponds we studied occur, we do not consider the results of this comparison definitive.

Virtually all commentators on flatwoods ponds have noted the high species variability among ponds (Bridges 1988, Bridges and Orzell 1989, Lester et al. 2005, NatureServe Explorer 2009, Pyne 2005). This variability is likely the result of differences in surrounding community type, disturbance history, pond depth and hydroperiod, the relative isolation of many of the ponds, and variations in fire regime.

Compared with other open habitats such as bogs, prairies, and pine savannas that generally have about 25–30 species in a 10-m² area, and 15–20 species in 1-m² area (see MacRoberts and MacRoberts 2001, MacRoberts et al. 2007, 2009), the Nacogdoches and Sabine ponds are not species-rich, an observation also made by Bridges and Orzell (1989) for flatwoods ponds.

One taxon of particular interest in Sabine and Nacogdoches Ponds is beaksedge, which is rhizomatous and colonial. The beaksedge we collected, which did not key unequivocally to either *Rhynchospora corniculata* (Lam.) Gray (Shortbristle Horned Beaksedge) or *R. careyana* Fern. (Broadfruit Horned Beaksedge), was found to be very common in the Sabine and Nacogdoches ponds, and in all of the ephemeral ponds we surveyed in the Sabine National Forest. Broadfruit Horned Beaksedge, which differs from Shortbristle Horned Beaksedge by the presence of rhizomes, is a species of the Gulf Coastal Plain east of the Mississippi River. Therefore, further study is needed to determine the identity of the beaksedge species present.

Jason Singhurst (Texas Parks and Wildlife Department, Austin, TX, pers. comm.) has made observations on ephemeral ponds on Campbell Timber Corporation land in Sabine County adjacent to the ponds we studied. His findings parallel ours for most species, but he has also documented *Eriocaulon compressum* Lam. (Flattened Pipewort), a new county record and a species characteristic of the more southern flatwoods ponds.

Ephemeral ponds also support other organisms, notably amphibians. Studies of amphibians in Nacogdoches County and on the Stephen F. Austin Experimental

Forest, where Nacogdoches Pond is located, show that of the 25 amphibian species that occur in the county, at least 16 (64%) and perhaps 18 (72%) of them breed in Nacogdoches Pond (D. Saenz, USDA Forest Service, Southern Research Station, Nacogdoches, TX, pers. comm.). These ponds support high amphibian diversity because predaceous fish are not present, a point emphasized in studies of ephemeral ponds in Florida (Means 2010).

The factors responsible for the creation of these wetland depressions remain unclear. We suggest that the ponds may be old stream channels, the remains of *Castor canadensis* Kuhl (Beaver) activity, swales paralleling old river channels, or old ox-bow lakes. In any case, the ponds are subject to loss as erosional dissection of the old river terraces proceeds. We assert that fire has been important in the maintenance of herbaceous vegetation and the prevention of encroachment by woody species.

Subsequent to the collection of floristic data reported herein, restoration and management activities were initiated on the two ponds in Nacogdoches County. Pond 1, last mowed in late summer 2008, was divided into three segments, each approximately 0.4-ha in area. In September 2010, one segment was mowed, one was prescribe-burned, and one was left untreated. Pond 2, heavily encroached by trees, and with very little herbaceous vegetation remaining, was cleared using mechanical means (mulchers, chainsaws) in October–December 2010. Periodic mowing and/or prescribed fire are planned to prevent future woody encroachment. Floristic surveys will continue in these two ponds to assess the efficacy of current management protocols.

Clearly, study of the geomorphology and further floristic work are needed at all of these ponds; we have been impressed by the paucity of information on them. Ephemeral ponds are obvious on the landscape and clearly of conservation interest: many conservation organizations have pointed out that these wetland communities are increasingly rare (Smith 1996). Bridges and Orzell (1989) located fewer than 100 flatwoods ponds in their extensive survey, of which fewer than 20 were deemed to be of high quality. The ponds we studied in Sabine and Nacogdoches counties are on federal lands, are of high quality, and should be preserved. Further work is needed to inventory and map additional ephemeral ponds in the region and assess their quality and restoration potential.

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Appendix 1. Checklist of vascular plants of Sabine and Nacogdoches ponds. (S) = Sabine Ponds, (N) = Nacogdoches pond 1, MM = B.R. and M.H. MacRoberts; CR = D.C. Rudolph. Unless otherwise indicated, the species were common in the pond. The vouchers numbers are for specimens deposited at BRIT.

Acanthaceae

Justicia ovata (Walt.) (Lindau) (Looseflower Water-mallow) (S) MM 8390, 8438

Aceraceae

Acer saccharum L. (Sugar Maple) (N) MM 8487

Alismataceae

Sagittaria graminea Michx. (Grassy Arrowhead) (N) MM 8512; (S) MM 8395, 8503

Sagittaria lancifolia L. (Bulltongue Arrowhead) (S) MM 8428

Amaryllidaceae

Hymenocallis liriosme (Raf.) Shinnery (Spring Spiderlily) (S) MM 8499, 8502

Apocynaceae

Amsonia tabernaemontana Walt. (Eastern Bluestar) (N) CR 09-2, MM 8484; (S) MM 8396, 8423

Araceae

Sabal minor (Jacq.) Pers. (Dwarf Palmetto) (S) MM 8424, 8441 (uncommon)

Asteraceae

Boltonia diffusa Elliot (Smallhead Doll's Daisy) (N) MM 8464, 8486

Eupatorium semiserratum DC. (Smallflower Throughwort) (S) MM 8432, 8478

Pluchea foetida (L.) DC. (Stinking Camphorweed) (S) MM 8421, 8439

Symphotrichum dumosum (L.) Nesom (Rice Button Aster) (N) MM 8481, 8483

Callitricaceae

Callitriche heterophylla Persh (Twoheaded Water-starwort) (N) MM 8511

Cyperaceae

Carex jorii Bailey (Cypress Swamp Sedge) (N) MM 8508, 8515, 8622; (S) MM 8434, 8452 (uncommon in S, abundant in N)

Eleocharis quadrangulata (Michx.) Roem. & Schult. (Squarestem Spikerush) (S) MM 8403 (uncommon)

Eleocharis tuberculosa (Michx.) Roem. & Schult. (Conecup Spikerush) (S) MM 8446, 8447, 8613

Fuirena breviseta (Coville) Coville (Saltmarsh Umbrella-sedge) (S) MM 8413, 8436

Rhynchospora sp. (see text) (beaksedge) (N) CR 09-1, MM 8666, 8668; (S) MM 8410, 8415, 8451, 8453, 8454, 8455, 8457, 8459

Rhynchospora filifolia Gray (Threadleaf Beaksedge) (S) MM 8405, 8406, 8407, 8435, 8429b

Rhynchospora globularis (Chapm.) Small (Globe Beaksedge) (N) CR 09-17; (S) MM 8399, 8402, 8429a

Rhynchospora rariflora (Michx.) Ell. (Fewflower Beaksedge) (S) MM 8400

Scleria baldwinii (Torr.) Steud. (Baldwin's Nutrush) (S) MM 8391, 8408, 8611

Ebenaceae

Diospyros virginiana L. (Common Persimmon) (N) CR 09-24; (S) MM 8444

Euphorbiaceae

Triadica sebifera (L.) Small (Chinese Tallow) (N) CR 09-19, MM 8482; (S) not collected (uncommon).

Haloragaceae

Myriophyllum sp. (water millfoil) (N) MM 8510

Myriophyllum pinnatum (Walt.) B.S.P. (Cutleaf Watermilfoil) (S) MM 8501

Proserpinaca palustris L. (Marsh Mermaidweed) (S) MM 8392a, 8409

Proserpinaca pectinata Lam. (Combleaf Mermaidweed) (N) not collected; (S) MM 8392b, 8404, 8612

Hamamelidaceae

Liquidambar styraciflua L. (Sweetgum) (S) MM 8477 (uncommon)

Hydrophyllaceae

Hydrolea ovata Nutt. (Ovate False Fiddleleaf) (N) CR 09-22; (S) MM 8412, 8450

Juncaceae

Juncus effusus L. (Common Rush) (N) CR 09-9; MM 8466, 8626 (uncommon)

Juncus nodatus Coville (Stout Rush) (N) MM 8625 (uncommon)

Juncus repens Michx. (Lesser Creeping Rush) (N) CR 09-6 (uncommon)

Lamiaceae

Lycopus americanus Muhl. ex Bart. (American Water Horehound) (S) MM 8471 (uncommon)

Lentibulariaceae

Utricularia radiata Small (Little Floating Bladderwort) (N) MM 8513

Loganiaceae

Mitreola petiolata (Geml.) Torr. & Gray (Lax Hornpod) (N) CR 09-7

Malvaceae

Hibiscus moscheutos L. (Crimson-eyed Rosemallow) (S) MM 8393, 8421

Melastomataceae

Rhexia mariana L. (Maryland Meadowbeauty) (N) CR 09-3; (S) MM 8398, 8417

Onagraceae

Ludwigia peploides (Kunth) P.H. Raven (Floating Primrose-willow) (N) MM 8494, 8509; (S) MM 8500

Ludwigia pilosa Walt (Hairy Primrose-willow) (N) not collected; (S) MM 8431

Pinaceae

Pinus taeda L. (Loblolly Pine) (S) MM 8443 (uncommon)

Poaceae

Andropogon virginicus L. (Broomsedge Bluestem) (S) MM 8473, 8476

Coelorachis rugosa (Nutt.) Nash (Wrinkled Jointtail Grass) (S) MM 8445

Dichanthelium dichotomum (L.) Gould (Cypress Panicgrass) (N) CR 09-4, 09-13; MM 8620, 8621; (S) MM 8427, 8418, 8430, 8440, 8610

Panicum hemitomon Schult. (Maidencane) (N) MM 8463, 8619

Panicum virgatum L. (Switchgrass) (S) MM 8472 (uncommon)

Paspalum praecox Walt. (Early Paspalum) (S) MM 8411, 8389, 8608

Saccharum giganteum (Walt.) Pers. (Sugarcane Plumegrass) (N) CR 09-23; MM 8485, 8492

Polygonaceae

Brunnichia ovata (Walt.) Shinnars (American Buckwheat Vine) (N) MM 8465

Polygonum hydropiperoides Michx. (Swamp Smartweed) (N) CR 09-5, 09-12; (S) MM 8449

Ranunculaceae

Ranunculus laxicaulis (T. & G.) Darby (Mississippi Buttercup) (N) MM 8624 (uncommon)

Rosaceae

Crataegus opaca Hook. & Arm. (Western Mayhaw) (N) CR 09-21, MM 8514, 8516; (S) MM 8424; 8470, 8469, 8497, 8498 (uncommon)

Rubiaceae

Cephalanthus occidentalis L. (Buttonbush) (N) CR 09-11, 09-18; (S) MM 8425

Scrophulariaceae

Gratiola brevifolia Raf., (Sticky Hedgehyssop) (N) CR 09-14, 09-16; (S) MM 8397, 8414, 8416

Styracaceae

Styrax americanus Lam. (American Snowbell) (N) CR 09-8, 09-15; MM 8479

Xyridaceae

Xyris laxifolia (Chapm.) Kral (Laxleaf Yelloweyed-grass) (S) MM 8388, 8401, 8437, 8461, 8468