The Upland Sinkhole Swamps and Ponds of Harrison County, Indiana

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Introduction

Recent field exploration by members of the Indiana Natural Heritage Program has resulted in a better understanding of two little known natural communities in Indiana—the upland sinkhole swamp and pond. These natural communities, while studied extensively in surrounding states, have received little attention in Indiana. An inventory and study were initiated to provide a more complete understanding of these significant wetlands.

A sinkhole swamp is defined here as a forested wetland occupying a sinkhole depression, while a sinkhole pond is usually quite open and devoid of woody vegetation, also in a depression.

An inspection of Harrison County Soil Survey maps, aerial photos, and U.S.G.S. 7.5 minute topographic maps has revealed at least fourteen sinkhole swamp sites and a large number of sinkhole ponds, all in the Mitchell Plain region of the County. Those sites examined are quite small, varying from a quarter of an acre to five acres in size. They also vary considerably in natural quality and species diversity. A few sites yield a remarkable variety of Gulf Coastal Plain species, many currently known in Indiana from these sites only.

Methods

The U.S.G.S. 7.5 minute topographic maps and the S.C.S. Soil Survey aerial photos were inspected to locate potential sites for sinkhole swamps and ponds. While the topographic maps normally illustrate these environments well, they are not as revealing as the aerial photo base maps in the *Soil Survey of Harrison County, Indiana* (10). The photos, taken in winter, reveal areas of standing water in forests quite clearly. Those areas appear much darker on the photo than do the surrounding better drained sites. For example, some areas which simply appear green (as forest) with little or no contour on the topographic map were found by this method to contain fine quality sinkhole swamps.

Sites were field checked in the summer of 1982 to determine their natural community, degree of natural quality, and species composition. Specimen collections were made of rare or infrequently collected species to document their occurrence, while common species were recorded in field notes. The nomenclature used follows Fernald (3) with the exception of *Lorinseria*, which follows Cranfill (1). Voucher specimens will be deposited in the Deam Herbarium of Indiana University at Bloomington.

The Study Area

Sinkhole swamps and ponds are restricted in Indiana to the karst region, most of which occurs on the Mississippian limestones of the Mitchell Plain Subsection of the Highland Rim Section in the Interior Low Plateaus Physiographic Province (6,9). Our inventory concentrated on Harrison County, the southernmost county of the region. Exact locations for the sites are not given, but are on file with the Indiana Natural Heritage Program. The scattered local areas of karst

on Devonian limestone of Clark, Jefferson, and Jennings counties were not investigated.

The sinkhole swamps and ponds are not specifically associated with one soil type, but occur on a number of types, including Bartle, Bedford, Haymond, and Newark silt loams (10). However, a number of swamps in northern Harrison County do appear to be associated with one type—Bartle silt loam, which is described as an ". . . old alluvium in large basins in uplands." This soil type is found primarily in association with an unusually thick deposit of *terra rossa* soil which occurs as a one-to-two mile wide band running longitudinally through the middle of the County.

Water enters the swamps and ponds via small intermittant streams and from direct precipitation. There is usually no outlet due to the depressional nature of the sink, so seasonal fluctuation of water levels can sometimes be great. Depending on the size of the watershed, water levels can fluctuate from a few inches to several feet. During late summer many of the swamps have dried, though most retain some pockets of water. Most of the sinkhole ponds retain water the year around, due primarily to their concave shape which facilitates greater storage capacity than the more level swamp sites. For unknown reasons, the water level in a swamp may remain high for extended periods. All woody species and selected herbaceous species are subsequently killed, resulting in a significant loss of the swamp community. It may be only a temporary loss however, for most of the swamp species remain present on the periphery of the newly formed pond, ready to invade as suitable habitat becomes available. This process was noted where peat accumulation on the border of one pond was providing for the encroachment of woody species.

While sinkhole ponds are considered as distinct from sinkhole swamps in this paper, they appear to be essentially the same natural community type with the exception that ponds have deeper water. In fact, most undisturbed ponds are bordered by swamp and in turn, most swamps contain a pond in some portion.

History

The earliest written account of the occurrence of sinkhole wetlands can be found in the surveyor's field notes of the original land survey of the State in 1806 (12). At 67.5 chains north along the line between sections 32 and 33, T1S, R4E a surveyor noted: "A swamp 3 chains, 50 links wide full of scrubby water willows." A number of references were made by the surveyors concerning swamps, and most all mention willows. Interestingly, willow is not one of the major species of the swamps in this study, making one wonder if the sites have changed or if the surveyors were referring to something other than *Salix*.

Geologists have long recognized the sinkhole as a typical karst feature, but Clyde Mallott was especially skilled in noting and describing natural features associated with karst (6,7). He describes areas of poor surface drainage as solution pans, and when swampy, ". . . may be termed karst swamps or karst fens."

Botanist Charles Deam was interested in sinkhole ponds and kept a special list of plant species associated with them (2). It does not appear however that he was particularly impressed with them as natural areas. This is determined by his statement: "I have never seen any vegetation in them when they are located in deep woodland, doubtless because the decay of many leaves prevent it. Those in fields are disturbed more or less by stock which destroys much of their vegetation." With few exceptions our findings support his statements, for the great majority of the sinkhole ponds examined in this study are highly disturbed.

Deam's major contribution to our understanding of sinkhole swamps consists of collection data recorded for species he found at a site southeast of Palmyra. These data describe a swamp environment harboring such species as *Carex gigantea*, *Populus heterophylla*, *Rhynchospora corniculata*, and *Ranunculus pusillus*. During a visit to the site on June 24, members of the Heritage Program were able to reverify the existence of many of the species he found there in 1926. In addition, *Carex decomposita* and *Lorinseria areolata* were found, the latter new to the State.

After studying the geographic distribution of the species seen near Palmyra, it became apparent that the swamp had a high number of Gulf Coastal Plain species. This would have been viewed as merely interesting were it not for the knowledge that sinkhole environments in Kentucky and Missouri also contain notable assemblages of Gulf Coastal Plain species (11,5). Recognition that an association between sinkhole wetlands and coastal plain species is also true in Indiana inspired the intensive search that followed.

Plant Communities

The sinkhole swamps in Harrison County are characterized by the occurrence of water tolerant woody species, typically *Populus heterophylla*, *Liquidambar styraciflua*, *Nyssa sylvatica*, *Acer rubrum*, and *Quercus palustris*. *Populus heterophylla* appears to be the most tolerant of extended wetness, as it is usually found in the deepest water of the swamp. Here it often occurs with another woody species characteristic of these swamps, *Cephalanthus occidentalis*. At one site another shrub, *Itea virginica*, frequently appears as clonal thickets growing on tree roots, logs, stumps, and soil.

The herbaceous species appear to occur in distinct zones, responding to the degree and duration of wetness. Certain species appear to be restricted to the peripheral sections of the swamp where standing water is only a winter and spring phenomenon. Species seen most frequently in this zone include *Carex gigantea*, *c. lupulina*, *C. intumescens*, *C. crus-corvi*, *C. grayii*, *Habenaria peramoena*, *Glyceria striata*, *Galium tinctorium*, *Lorinseria areolata*, *Cinna arundinacea*, *Leersia oryzoides*, *Iris virginica*, *Impatiens biflora*, *Rhynchospora corniculata*, *Triadenum walteri*, and *Sphagnum* sp. In the zone where water is found standing for most if not all months of some wet years, another set of species can be observed. These include *Bidens cernua*, *Polygonum hydropiperoides*, *Glyceria septentrionalis*, *Proserpinaca palustris*, *Peltandra virginica*, *Ludwigia palustris*, *Lemna* sp., *Wolffia* sp., and *Spirodela* sp. Here also *Rosa palustris*, *Lycopus rubellus*, *Triadenum walteri*, and *Carex decomposita* are often found growing on floating logs, stumps, and bases of living trees, most often *Populus heterophylla*.

Three exceptionally fine examples of a sinkhole pond community can be found just northwest of Laconia in southern Harrison County. The ponds occur no more than a few hundred yards from one another, yet each is unique. The first pond, an acre in size, is best characterized by a three inch thick mat of organic detritus which floats on one to two feet of water. This mat harbors such species as *Dulichium arundinaceum*, *Carex comosa*, *Leersia oryzoides*, *Utricularia gibba*, and *Bidens* spp. On the border of the pond *Nuphar advena*, *Salix nigra*, *Typha latifolia*, *Hibiscus palustris*, and *Cephalanthus occidentalis* occur. This border grades outwardly to a *Quercus palustris* swamp.

The second pond, slightly larger than the first, is dominated by a nearly impenetrable thicket of *Decodon verticillatus*. Within this thicket one small opening occurs where *Nuphar advena* and *Carex comosa* predominate. On the hum-

mocks formed at the base of *Decodon* large growths of *Carex decomposita* can be found. On the periphery a variety of species can be found, including *Alisma subcordatum, Impatiens biflora, Rosa palustris, Eupatorium perfoliatum, Glyceria striata, G. septentrionalis, Triadenum walteri, Nuphar advena, Cephalanthus occidentalis, Sparganium androcladum, Dulichium arundinaceum,* and *Carex comosa.* This peripheral area grades into swamp, where *Liquidambar styraciflua, Quercus palustris, Q. bicolor, Nyssa sylvatica,* and *Populus heterophylla* occur.

The third pond, about five acres in size, is mostly an expanse of marsh surrounding a small, open body of water. Plants in the shallow section include *Dulichium arundinaceum, Proserpinaca palustris, Alisma subcordatum,* and *Eleocharis* spp. while in the deeper section *Sparganium androcladum, Typha latifolia, Scirpus validus,* and *Nuphas advena* can be found.

Results and Discussion

The sinkhole wetlands in Indiana appear to be similar to those in Missouri and Kentucky. Steyermark (11) and Haefner (4) describe a number of species associated with sinkhole wetlands in the Ozarks of Missouri. Species they list as characteristic of sinkhole wetlands that are also in such environments in Indiana include *Carex decomposita, C. comosa, Dulichium arundinaceum, Glyceria acutiflora, Decodon verticillatus, Galium tinctorium, Cephalanthus occidentalis, Rosa palustris, Isoetes englemannii, Lycopus rubellus, Triadenum walteri,* and *Utricularia gibba.* The sinkhole wetlands in Kentucky also contain species known to occur in similar Indiana sites. Some of these are *Isoetes engelmannii, Carex crus-corvi, Rhynchospora corniculata, Quercus palustris, Polygonum hydropiperoides, Ranunculus pusillus, Liquidambar styraciflua, Triadenum walteri, Ludwigia palustris, Bacopa rotundifolia,* and *Itea virginica* (5,8).

In both Missouri and Kentucky a number of species found in sinkhole wetlands have Gulf Coastal Plain affinities. This is true in Indiana also, as indicated by the presence of *Carex gigantea, C. decomposita, Triadenum walteri, Lorinseria areolata, Rhynchospora corniculata, Itea virginica,* and *Ranunculus pusillus.* Coastal Plain species in sinkhole wetlands are suggested by Steyermark (11) and Hannan (5) to be relicts of the Teriary Period, when the Ozark and Mississippian Plateaus were low, swampy peneplains and the climate subtropical. The sinkhole wetlands are just remnants of the once vast swamp, now providing refugia for these relict species. This hypothesis may also explain the occurrence of Coastal Plain species in Indiana sinkhole wetlands. It is not however within the scope of this paper to provide an hypothesis or to confront the problems of plant geography. However, the occurrence of these species with Coastal Plain affinities in the karst regions of the three states does tend to indicate a common hypothesis concerning their past and present distribution.

Human disturbance has significantly reduced the sinkhole wetlands to only a few good examples of their former character. Timber harvest, drainage, and conversion to cattle ponds have all but eliminated them as natural areas. Of the fourteen sinkhole swamps identified in this study, only four have some semblance of natural quality with only three sinkhole ponds exhibiting little or no disturbance. It appears that they, like so many other natural features in the State, are being eliminated at an alarming rate.

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