

## The Flora of Coastal Plain Pond Herbaceous Communities on the Delmarva Peninsula

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**ABSTRACT.** Coastal plain ponds on the Delmarva Peninsula are ecologically unique wetlands that support a diverse assemblage of plant species and are a prominent part of the peninsula's natural heritage. As such, conservation of these wetlands is critical in helping to maintain biodiversity on Delmarva. Very little has been published regarding the vegetation associated with Delmarva coastal plain ponds, both in terms of the natural community types and the individual plant species that are closely associated with them. This paper provides a general description of the natural community types, or vegetation zones, found in Delmarva coastal plain ponds and focuses on the flora of the most diverse vegetation zone, the herbaceous community. Particular attention is given to the rare and uncommon flora of these wetlands. The summary of the flora of herbaceous communities in Delmarva coastal plain ponds provides strong evidence regarding their importance for biodiversity conservation on the peninsula.

### INTRODUCTION

Akin to the well known Carolina Bays of the southeastern U.S., coastal plain ponds on the Delmarva Peninsula (also known as Delmarva Bays or "whale wallows") are a unique type of shallow, seasonally flooded, freshwater depressional wetland. Generally elliptical in shape and often with a pronounced sandy rim along the southeast side, these wetlands are typically inundated in the winter and spring and draw down in late summer or early fall (Phillips and Shedlock 1993). They are most commonly found as open, sunny depressions within areas of forested uplands. The majority of these ponds are small (most are less than one acre in size), but they are numerous—it is estimated that there are between 1,500 and 2,500 of these ponds on the Delmarva Peninsula (Stolt and Rabenhorst 1987b; McAvoy and Clancy 1994; Zankel and Olivero 1999).

Coastal plain ponds are recognized as a highly significant part of the Delmarva Peninsula's natural heritage (Sipple and Klockner 1984; Tyndall et al. 1990; Sipple 1999). Their uncommon ecological context and features provide irreplaceable habitat for an abundance of rare and uncommon species and unique natural communities. On Delmarva, coastal plain ponds are known to harbor 45 rare and uncommon plant species, including eight globally rare species and one federally listed species. Coastal plain ponds are also among the most threatened natural systems on the peninsula, with hundreds of ponds having been degraded or destroyed by anthropogenic activities (e.g., agricultural ditching and clear-cut timber harvesting methods [McAvoy and Clancy 1994]). Despite the estimate of thousands of ponds

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occurring on Delmarva, it is often difficult to find ponds of good to high quality (i.e., with intact and functioning water regimes, open canopy, high species diversity, and rare and uncommon species).

Coastal plain ponds on Delmarva typically consist of concentric zones of herbaceous, shrub, and forest natural community types. The most significant and floristically diverse zone is the herbaceous community. It is within this community that a distinct assemblage of plant species is found, and where rare and uncommon species are encountered. The focus of this paper is on the flora of the herbaceous communities of coastal plain ponds on the Delmarva Peninsula.

#### DISTRIBUTION OF COASTAL PLAIN PONDS

Coastal plain ponds can be found from Florida to Massachusetts. They are most conspicuous in North and South Carolina (the "true" Carolina Bays), where they are typically at their largest and most uniform in shape and orientation (Savage 1982), although smaller, irregular ponds occur there as well (Sipple 1999). From Virginia northward, they are typically smaller (usually less than 1 acre), and more variable in shape (Savage 1982). Although most numerous in the Carolinas, they are still quite abundant on the Delmarva Peninsula. Rangewide, it has been estimated that there are as many as 500,000 coastal plain ponds between Florida and Massachusetts (Savage 1982).

On the Delmarva Peninsula, the greatest concentrations of coastal plain ponds can be found in southwestern New Castle and northwestern Kent Counties, Delaware, the western portions of Queen Annes and Kent Counties, Maryland, and Caroline County, Maryland (Stolt and Rabenhorst 1987b). Outside this region, coastal plain ponds on Delmarva are scattered and infrequent. They are also locally abundant in portions of Sussex County, Delaware and Dorchester County, Maryland.

The Delmarva Peninsula (Figure 1) is an area lying entirely within the Atlantic Coastal Plain physiographic province of the eastern United States. The Peninsula lies south of the Fall Line (a term applied to the boundary between the Appalachian Piedmont province and the Atlantic Coastal Plain) of New Castle County, Delaware and Cecil County, Maryland, and is bordered on the east by the Delaware River, Delaware Bay and the Atlantic Ocean, and on the west by the Elk River and Chesapeake Bay. It includes the Coastal Plain province of the state of Delaware (three counties), the Eastern Shore of Maryland (nine counties), and the Eastern Shore of Virginia (two counties).

#### ORIGIN OF COASTAL PLAIN PONDS

Despite decades of research and debate, the geologic origins of coastal plain ponds are still unresolved. The debate actually began in 1933 (Savage 1982), when Melton and Schriever proposed that the presence of Carolina Bays were actually the result of meteorite strikes. They argued that the incredible uniformity in shape and orientation, along with the presence of a raised sandy rim around each bay, indicated a single widespread phenomenon, with the impacts of meteorites being the most plausible explanation. Over the years, this theory has been highly controversial, with many strong arguments both for and against, and it still has many adherents to this day (Savage [1982] provides an excellent overview of the development of the theories on the origin of Carolina Bays).

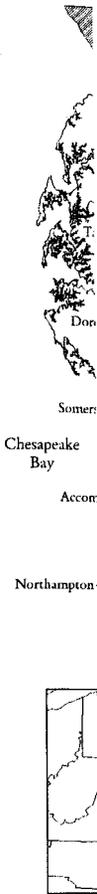


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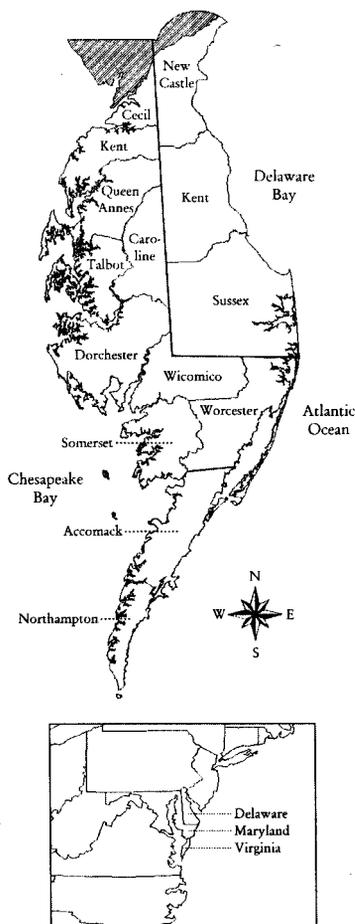


Figure 1. Delmarva Peninsula. Shaded areas of Cecil County, Maryland, and New Castle County, Delaware, are not part of the peninsula.

Whether or not the meteorite theory is true in the Carolinas, it is unlikely to be so on the Delmarva Peninsula (Stolt and Rabenhorst 1987b). The pond features that strengthen the meteorite theory—uniformity of shape and orientation, raised sandy rims, overlapping rims—are much less prevalent in coastal plain ponds on Delmarva. Currently, the most plausible theory is that Delmarva coastal plain ponds began forming between 15,000 and 20,000 years ago as depressions in coastal areas in a climate that was much colder and somewhat drier (Stolt and Rabenhorst 1987b). Stolt and Rabenhorst's theory suggests that strong winds created these depressions in unvegetated sandy dune areas and deposited the sand as the elevated rim found around many of the wetlands today.

GEOMORPHOLOGY, HYDROLOGY AND SOILS OF DELMARVA COASTAL PLAIN PONDS

Stolt and Rabenhorst (1987a) identified two basic types of coastal plain ponds on the Delmarva Peninsula: the basin-fill and the sandy bottom. Of the two types, the basin-fill ponds are generally deeper, with steeper slopes extending down to distinct low areas. These low areas are usually filled with loess deposits—silty loam material that was originally deposited by the wind when the ponds were forming. These basin-fill deposits are typically 1 to 3 m deep, but may be as deep as 5 m. The second pond type, the sandy bottom, usually has some basin-fill sediments as well, but in much smaller amounts. The sandy bottom ponds typically have a relatively flat bottom, with a thin layer of mucky loam over deep sands.

The two pond types also appear to differ in distribution. The steep-sided, basin-fill type is found in the northern part of the peninsula, especially in the southwestern region of New Castle County, Delaware and western Kent County, Maryland (pers. obs. by the first author; Frank Hirst and Ron Wilson, pers. comm.). As one moves south into Queen Annes and Caroline Counties, the sandy, flat-bottom ponds start appearing, and are the prevalent pond type in southern Delmarva (pers. obs. by the first author; Frank Hirst and Ron Wilson, pers. comm.).

In a study of hydrology in coastal plain ponds in Delaware, Phillips and Shedlock (1993) state that Delmarva coastal plain ponds function as seasonally inundated wetlands. Typically, they are full in the winter, often to a depth of more than 1 m. In the summer,

as temperature and evapotranspiration increase, the water level drops. The amount and the timing of drawdown depend on annual weather patterns, with the substrate being completely exposed in hotter, drier years. In wetter, cooler years, many ponds remain inundated (though not full) throughout the summer.

Studies of water chemistry in Delmarva coastal plain ponds have typically found the waters to be very soft and acidic (Stolt and Rabenhorst 1987a; Newman and Schalles 1990). Rasmussen (1958) reported near neutral (6.2 to 7.1) pH values for a site in Sussex County, Delaware; Phillips and Shedlock (1993) found the pH to be below 5.0 at sites in southwestern New Castle County, Delaware.

#### DELMARVA COASTAL PLAIN POND NATURAL COMMUNITIES

Historically, the vegetation dynamics of Delmarva coastal plain ponds have been poorly documented, although a few studies have been conducted in recent years (Tyndall et al 1990; Berdine and Gould 1999; Tyndall 2000). The natural vegetation communities of Delmarva coastal plain ponds cover a wide range of variation, from closed-canopy forests to dense shrublands to communities dominated by herbaceous plants (Berdine and Gould 1999). Most commonly, these different community types occur as a complex of concentric vegetation zones within an individual pond (Tyndall et al 1990; Berdine and Gould 1999; Tyndall 2000). The center of the pond is usually open and dominated by herbaceous species. Moving away from the center and toward the upland perimeter of the pond, there is typically a transition to a shrub-dominated zone and finally to a forested community. Each of these zones is defined by the Delaware and Maryland Natural Heritage Programs as an individual community type (i.e., comprised of a characteristic suite of dominant plant species occurring in a consistent, repeating pattern on the landscape). Although zones are defined as individual community types, they occur as a complex, which exhibit repeating patterns from pond to pond. However, it is possible to find Delmarva coastal plain ponds that have succeeded to purely shrub or forest communities, although they are less common than the pattern described above (pers. obs. by the first author).

#### FOREST COMMUNITIES

Forested communities can occupy the entire depression, but more frequently are found at the perimeters of pond openings. Whether they dominate the depression or are at the periphery, these communities typically have a rather dense shrub layer of *Clethra alnifolia*, *Vaccinium corymbosum*, *Rhododendron viscosum* and *Leucothoe racemosa*, and are usually very low in herbaceous species diversity. The canopy is typically composed of *Acer rubrum*, *Liquidambar styraciflua*, *Nyssa sylvatica*, *Pinus taeda* (in southern Delmarva), *Quercus palustris*, and *Quercus phellos* (Berdine and Gould 1999; Bowman 2000).

#### SHRUB COMMUNITIES

There are several shrub communities that occupy Delmarva coastal plain ponds, but they all feature the same shrub species: buttonbush (*Cephalanthus occidentalis*). This extremely wide-ranging species can be found in a variety of wetland habitat types throughout the peninsula, but is characteristic for Delmarva coastal plain ponds (pers. obs. by the first author). In many cases, buttonbush is the sole dominant in the pond, and essentially forms a monoculture with few other species present (Bowman 2000).

#### HERBACEOUS

Delmarva coastal plain ponds community types species composition ponds (pers. obs. species composition precipitation differences between species

Despite the various studies (Clancy 1994; describe these differences between communities (Table 1). The first author; I

The vascular plants throughout the pond while records contained rare assemblages a frequently collected Program. In the Herbarium, I (1990). The vascular individuals (Gould 1999; literature (Table 1)

The flora represented by 29 species and *Rhynchospora* of herbaceous percent of the annuals.

Twelve species have been collected and are in the databases of the first author; Francis The DCPI

*HERBACEOUS COMMUNITIES*

Delmarva coastal plain pond herbaceous communities (DCPPHC) are unique wetland community types on the peninsula. Classifying these communities is often a challenge, as species composition and abundance can vary significantly from year to year in individual ponds (pers. obs. by the first author; Ron Wilson, pers. comm.). These fluctuations in species composition and abundance are almost certainly attributable to variation in precipitation and temperature. However, no studies to date have looked at the correlation between species composition and weather data.

Despite these challenges, numerous attempts have been made to describe DCPPHCs, with various studies identifying five to ten different types (Tyndall et al. 1990; McAvoy and Clancy 1994; Berdine and Gould 1999). While it is beyond the scope of this paper to describe these various communities, it is worth noting that these studies have identified differences between communities occupying basin-fill ponds and sandy-bottom ponds. There seems to be a greater variety of sandy-bottom pond communities (Bowman 2000), and these communities often have species with a southern affinity as dominants or co-dominants (Table 1). These species are much less common in the basin-fill type ponds (pers. obs. by the first author; Frank Hirst and Ron Wilson, pers. comm.).

THE VASCULAR FLORA OF  
DELMARVA COASTAL PLAIN POND HERBACEOUS COMMUNITIES

The vascular flora of DCPPHCs (Table 1) is based primarily on observations made through the years by the first author while visiting an abundance of coastal plain ponds throughout the peninsula. A site visit usually consisted of traversing through the DCPPHC while recording each species observed. Certain sites that were high in species diversity or contained rare and uncommon taxa were visited annually to record observations on species assemblages and the presence/absence of rare and uncommon taxa. Voucher specimens were frequently collected and deposited in the herbarium of the Delaware Natural Heritage Program. In the future, these specimens will be transferred to the Claude E. Phillips Herbarium, Delaware State University (DOV; herbarium acronyms follow Holmgren et al. 1990). The vascular flora of DCPPHCs is also based on consultations with knowledgeable individuals (primarily Frank Hirst and Ron Wilson), natural community data from the Delaware and Maryland Natural Heritage Programs (McAvoy and Clancy 1994; Berdine and Gould 1999; Bowman 2000), herbarium specimens (primarily PH and DOV), and the literature (Tatnall 1946; Sipple and Klockner 1984; Tyndall et al. 1990; Tyndall 2000).

The flora of DCPPHCs includes 78 native species and varieties of vascular plants, represented by 22 families and 41 genera (Table 1). The largest families are Cyperaceae with 29 species and Poaceae with 15 species. The largest genera represented are *Carex* (9 species) and *Rhynchospora* (8 species). Graminoids (grasses, sedges, and rushes) comprise the majority of herbaceous plants with 47 species, or 62% of the typical flora of DCPPHCs. Eighty-five percent of the typical flora of DCPPHCs are perennials (66 species) and 16% (12 species) are annuals.

Twelve species appear to be regionally restricted to DCPPHCs (Table 1), and have not been collected from any other habitat type on the peninsula (Tatnall 1946; rare species databases of the Delaware and Maryland Natural Heritage Programs; pers. obs. by the first author; Frank Hirst and Ron Wilson, pers. comm.).

The DCPPHC flora has strong affinities to the southeastern U.S., as 43 species (55%) have



TABLE 1. Flora of Delmarva Coastal Plain Pond Herbaceous Communities.

The list is arranged alphabetically by family. With some exceptions, nomenclature follows Kartesz (1994). Synonyms are listed in brackets where necessary for clarification. Taxa considered to be rare and uncommon on the Delmarva Peninsula by the Delaware and Maryland Natural Heritage Programs are highlighted in bold. The following indicators follow the scientific name: G = considered to be globally rare by The Nature Conservancy, a private international conservation organization (globally rare species are known from only 1 to 100 populations worldwide); 1 = known from only a single occurrence or population on Delmarva; R = restricted to DCPPHCs on Delmarva; S-B = occurs primarily in sandy, flat-bottom type ponds on Delmarva (when no indicator is given, the species is common to both pond types); B-F = occurs primarily in steep-sided, basin-fill type ponds on Delmarva; S = southern affinities; N = northern affinities.

## ALISMATACEAE

***Sagittaria graminea*** Michx. var. *graminea* (S-B)

## APIACEAE

***Oxypolis canbyi*** (Coul. & Rose) Fern. (G, 1, R, S-B, S)

## ASTERACEAE

*Bidens frondosa* L.

***Boltonia asteroides*** (L.) L'Her. (S-B, S)

***Coreopsis rosea*** Nutt. (G, R, S-B, N)

***Sclerolepsis uniflora*** (Walt.) B.S.P. (S-B, S)

## BLECHNACEAE

*Woodwardia virginica* (L.) Sm.

## CAMPANULACEAE

***Lobelia canbyi*** Gray (S-B, S)

## CLUSIACEAE

***Hypericum adpressum*** Raf. ex W. Bart. (G, S-B, S)

***Hypericum denticulatum*** Walt. (S-B, S)

*Hypericum mutilum* L.

## CYPERACEAE

***Carex barrattii*** Schwein. & Torr. (B-F)

***Carex bullata*** Schkuhr ex Willd. (B-F)

***Carex gigantea*** Rudge (B-F, S)

***Carex jorii*** Bailey (S-B, S)

***Carex lupuliformis*** Sartwell ex Dewey (B-F)

*Carex lupulina* Muhl. ex Willd.

***Carex pellita*** Muhl. ex Willd. (B-F, N) [*Carex lanuginosa* Michx. misapplied]

*Carex striata* Michx. var. *brevis* Bailey

***Carex vesicaria*** L. (B-F, N)

*Cladium mariscoides* (Muhl.) Torr. (S-B)

*Cyperus erythrorhizos* Muhl. (N)

*Dulichium arundinaceum* (L.) Britt.

***Eleocharis melanocarpa*** Torr. (S-B, S)

*Eleocharis microcarpa* Torr. (S)

*Eleocharis quadrangulata* (Michx.) Roemer & J.A. Schultes (S-B, S)

***Eleocharis robbinsii*** Oakes (S-B)

***Eleocharis tricostata*** Torr. (S-B, S)

*Fimbristylis autumnalis* (L.) Roemer & J.A. Schultes

***Fimbristylis perpusilla*** Harper ex Small & Britt. (G, R, B-F, S)

Table 1 (cont'd)

- Rhynchospora chalarocephala* Fern. & Gale (S-B, S)  
*Rhynchospora corniculata* (Lam.) Gray (S)  
*Rhynchospora filifolia* Gray (1, R, S-B, S)  
*Rhynchospora harperi* Small (G, S-B, S)  
*Rhynchospora inundata* (Oakes) Fern. (S-B, N)  
*Rhynchospora macrostachya* Torr. ex Gray var. *macrostachya* (S)  
*Rhynchospora nitens* (Vahl) Gray (S-B, S) [*Psilocarya nitens* (Vahl) Wood]  
*Rhynchospora scirpoides* (Torr.) Gray (S-B, N) [*Psilocarya scirpoides* Torr.]  
*Scirpus cyperinus* (L.) Kunth  
*Scleria reticularis* Michx. (S-B, S)
- GENTIANACEAE
- Sabatia difformis* (L.) Druce (S-B, S)
- HAEMODORACEAE
- Lachnanthes caroliana* (Lam.) Dandy (S-B, S)
- HALORAGACEAE
- Proserpinaca pectinata* Lam.
- JUNCACEAE
- Juncus canadensis* J. Gay ex Laharpe (N)  
*Juncus debilis* Gray (S)  
*Juncus repens* Michx. (S)
- LAURACEAE
- Litsea aestivalis* (L.) Fernald (G, 1, R, S-B, S)
- LENTIBULARIACEAE
- Utricularia fibrosa* Britt. (S-B, S)  
*Utricularia geminiscapa* Benj. (B-F, N)  
*Utricularia gibba* L. (B-F)  
*Utricularia inflata* Walt. (S-B, S)  
*Utricularia purpurea* Walt. (S-B)  
*Utricularia radiata* Small (S-B, S)
- MELASTOMATACEAE
- Rhexia aristosa* Britt. (S-B, S)  
*Rhexia virginica* L.
- NYMPHAEACEAE
- Nymphaea odorata* Ait. ssp. *odorata*
- ONAGRACEAE
- Ludwigia linearis* Walt. (S-B, S)  
*Ludwigia sphaerocarpa* Ell.
- POACEAE
- Coelorachis rugosa* (Nutt.) Nash (R, S-B, S) [*Manisuris rugosa* (Nutt.) Kuntze]  
*Dichantherium hirstii* (Swallen) Kartesz, comb. nov. (G, 1, R, S-B, S) [*Panicum hirstii* Swallen]  
*Dichantherium spretum* (J.A. Schultes) Freckmann (S-B) [*Panicum spretum* J.A. Schultes]  
*Dichantherium wrightianum* (Scribn.) Freckmann (S-B, S) [*Panicum wrightianum* Scribn.]  
*Eragrostis hypnoides* (Lam.) B.S.P. (R, B-F)  
*Glyceria acutiflora* Torr. (R, B-F, N)  
*Glyceria septentrionalis* A.S. Hitchc. (B-F)  
*Leersia hexandra* Sw. (1, R, S-B, S)  
*Muhlenbergia torreyana* (J.A. Schultes) A.S. Hitchc. (G, 1, R, S-B, S)  
*Panicum dichotomiflorum* Michx. (B-F)  
*Panicum hemitomom* J.A. Schultes (S-B, S)

Table 1 (con)

*Panicum rig.*  
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*Saccharum* §  
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*Polygonum* c  
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*Ranunculus*  
 RUBIACEAE  
*Oldenlandia*  
 XYRIDACEA  
*Xyris smalli*

Table 2. Add not typical f

*Amphica.*  
*Asclepias*  
*Carex ty*  
*Centella*  
*Eriocaulo*  
*Euthamia*  
*Fuirena s*  
*Iris prism.*  
*Juncus pe*  
*Nymphoi*  
*Polygala*  
*Rhynchos*  
*Rhynchos*  
*Sagittaria*  
*Trachelos,*

(Godfrey and in coastal pl: thought to be collected from "border of pe a small comp surveys by th documentatio Delmarva, an included on t An additic DCPPHCs (

Table 1 (cont'd)

*Panicum rigidulum* Bosc ex Nees var. *pubescens* (Vasey) Lelong (S-B, S) [*Panicum longifolium* Torr.]  
*Panicum verrucosum* Muhl. (S)  
*Paspalum dissectum* (L.) L. (S)  
*Saccharum giganteum* (Walt.) Pers. (S-B, S) [*Erianthus giganteus* (Walt.) P. Beauv.]  
 POLYGONACEAE  
*Polygonum amphibium* L. var. *emersum* Michx. (B-F) [*Polygonum coccineum* Muhl. ex Willd.]  
 PRIMULACEAE  
*Hottonia inflata* Ell. (B-F, S)  
 RANUNCULACEAE  
*Ranunculus flabellaris* Raf. (R, B-F, N)  
 RUBIACEAE  
*Oldenlandia uniflora* L. (S)  
 XYRIDACEAE  
*Xyris smalliana* Nash (S-B, S)

Table 2. Additional rare and uncommon plant species documented from DCPPHCs that are not typical for the community type on Delmarva.

*Amphicarpum purshii* Kunth  
*Asclepias lanceolata* Walt.  
*Carex typhina* Michx.  
*Centella erecta* (L. f.) Fern.  
*Eriocaulon compressum* Lam.  
*Euthamia tenuifolia* (Pursh) Nutt. var. *microcephala* Greene  
*Fuirena squarrosa* Michx.  
*Iris prismatica* Pursh ex Ker-Gawl.  
*Juncus pelocarpus* E. Mey.  
*Nymphoides cordata* (Ell.) Fern.  
*Polygala cruciata* L. var. *aquilonia* Fern. & Schub.  
*Rhynchospora cephalantha* Gray var. *cephalantha*  
*Rhynchospora cephalantha* Gray var. *microcephala* (Britt.) Kukenth.  
*Sagittaria engelmanniana* J.G. Sm.  
*Trachelospermum difforme* (Walt.) Gray

(Godfrey and Wooten 1981; Weakley 1999). Therefore, it is highly likely that they did occur in coastal plain ponds on Delmarva prior to human disturbance. Another species, also thought to be extirpated on Delmarva, *Echinodorus parvulus* Engelm., may also have been collected from a coastal plain pond. The habitat description given on the specimen label is, "border of pond, Canterbury" (W. Canby, 1874, Kent County, Delaware, PH). At present, a small complex of degraded coastal plain ponds still exists in the Canterbury area, but field surveys by the first author have failed to rediscover *E. parvulus* at this site. Lacking clear documentation that these five species actually occurred in coastal plain ponds on Delmarva, and with no evidence that they still occur anywhere on Delmarva, they were not included on the overall species list (Table 1).

An additional 15 species of rare and uncommon plants have been documented from DCPPHCs (Table 2), but their occurrence in this community type is anomalous, for they

are usually found in other wetland types on the peninsula (Tatnall 1946; pers. obs. by the first author; Frank Hirst and Ron Wilson, pers. comm.).

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