

The Bryoflora of the Great Cypress Swamp Conservation Area, Sussex County, Delaware and Worcester County, Maryland

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Introduction

In 1998 the Delaware Natural Heritage Program (DNHP), with funding from the U.S. Environmental Protection Agency, completed a biological/ecological survey of the Great Cypress Swamp Conservation Area (GCSCA). The GCSCA is located in the central portion of the Delmarva Peninsula (a land area composed of the coastal plain counties of Delaware and the eastern shore counties of Maryland and Virginia) and lies on the border of Sussex County, Delaware and Worcester County, Maryland (Figure 1). Though the survey included a variety of inventories (avian, amphibian and reptile, natural community, and rare vascular plants), it is the data collected on bryophytes (mosses and liverworts) that are reported here.

The study of bryophytes on the Delmarva Peninsula has attracted very little interest over the years, and a search of the literature revealed only four pertinent papers. Owens (1949), while studying at the University of Maryland, submitted a graduate thesis titled *A Preliminary List of Maryland Mosses and their Distribution*. This annotated list, containing county distribution data and brief habitat notes, included 198 taxa of mosses for the state of Maryland, with 65 taxa attributed to the eastern shore counties of Delmarva. Owens's list was based solely on pre-1949 collections at US and MARY (Herbaria acronyms follow Holmgren et al. 1990). Confirmations and determinations were made by the author, as well as by numerous other authorities in the field of bryology (Owens 1949). Owens pointed out that "few, if any, specimens have been collected in certain distinctive areas, such as: the fresh marshes, the cypress swamps, and the dune areas of the coastal plain." It is assumed that this statement, at least in part, referred to Delmarva habitat on the eastern shore of the state. Davis (1976) composed an unpublished report at Salisbury State University titled *A Survey of the Bryophytes of Wicomico County, Maryland*. Davis listed 51 species of bryophytes (41 mosses and 10 liverworts) based on a single season of field work within 18 acres near his home, and at "a dozen other areas of the county" where "spot checks" were done. Specimens were verified by Dr. R. Pursell, Pennsylvania State University (Davis 1976). Both Owens's and Davis's work emphasized the limited amount of bryological study that has been done in Maryland, and the lack of publications on the subject (Owens 1949, Davis 1976).

Allen (1990) published a checklist of the mosses of Delaware containing 140 taxa. Allen's list was based on personal collections, and collections at DUKE, MO, NY, PAC, PH, and REED. Allen's list indicated that less than 200 specimens of mosses, including his own, were available from Delaware, with the majority made in the late 1800's by Albert Commons (Allen 1990). Karlin et al. (1991) published on the sphagnum flora of Delaware based on personal collections made during "numerous forays" to the state, and on collections from BING, DOV, DUKE, MARY, MO, NY, PH, REED, and US. Karlin noted that "almost all collections of sphagnum in Delaware have been made since 1960. Less than two dozen collections predating 1960 were observed and all of these were made by A. Commons and William Canby in the late 1800's." Karlin reported 21 species of sphagnum for Delaware, 12 of which were new to the state based on his collections. In contrast, Allen (1990) listed only 9 species of sphagnum for Delaware. Regarding hepatics (leafy and thalloid liverworts) on Delmarva, only Davis's (1976) report includes this group, with 10 taxa being listed. Herbaria studies by this author for both mosses and hepatics in Delaware and on the Delmarva Peninsula have not yet been completed, but initial searches, with a focus on hepatics, have revealed very few collections. The majority of those collections were made in the late 1800's by Albert Commons.

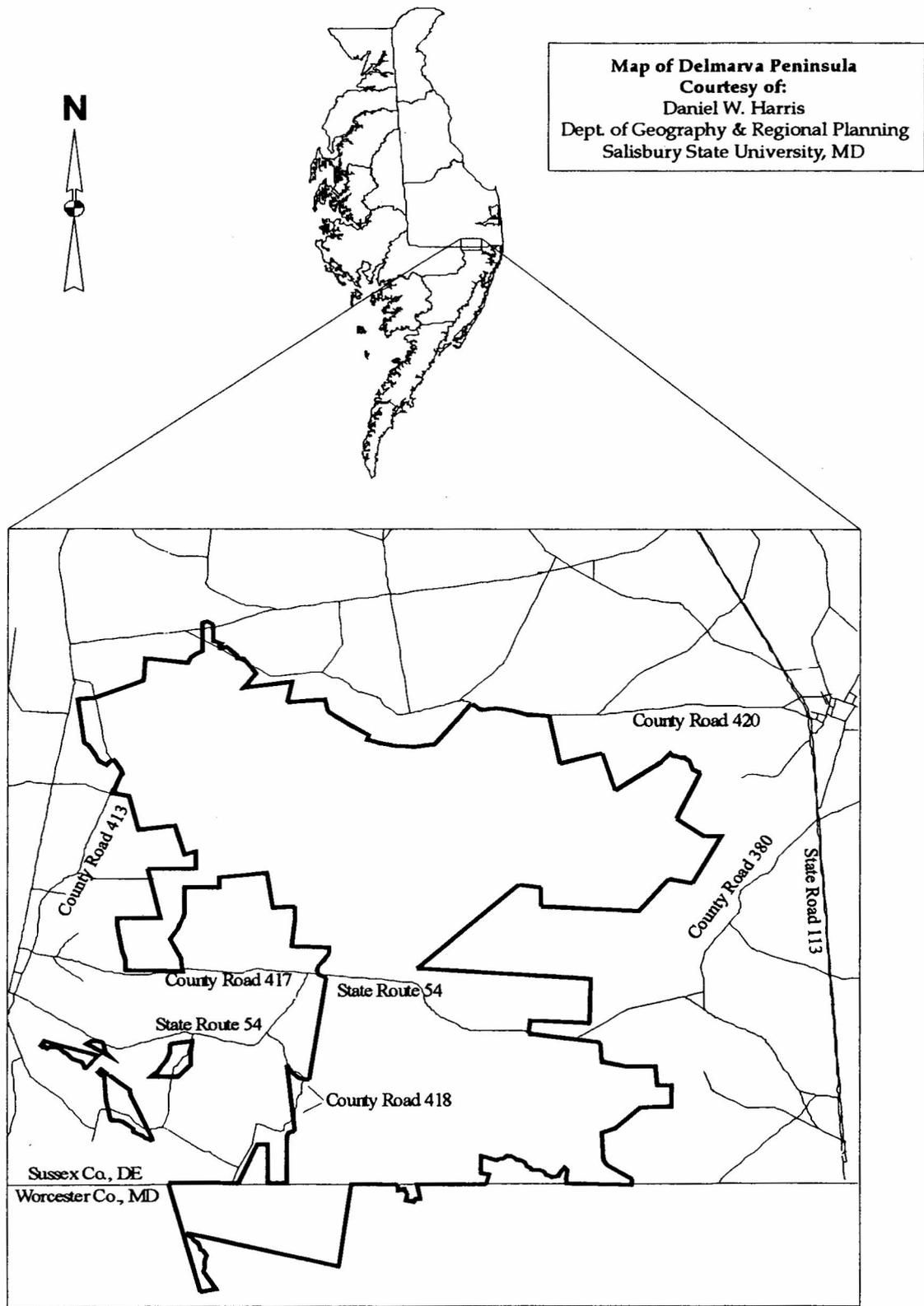


Figure 1. Location of the Great Cypress Swamp Conservation Area, Sussex County, Delaware and Worcester County, Maryland. Map of Delmarva Peninsula courtesy of Daniel W. Harris, Department of Geography & Regional Planning, Salisbury State University.

This survey of the GCSCA marks the first study of bryophytes in Delaware and on the Delmarva Peninsula since the work of Allen (1990) and Karlin (1991). Furthermore, collections of bryophytes from the GCSCA will be the first entries into a database that the DNHP is developing on the bryoflora of Delaware. This database will aid in efforts to conserve the floristic diversity of the region.

Site Description

The majority of the GCSCA lies within the headwaters of the Pocomoke River, which originates in Sussex Co., Delaware, flows through Worcester and Somerset Counties, Maryland and empties into the Chesapeake Bay. Originally, the swamp covered an estimated 20,000 ha, but due to timber harvesting, clearing for agriculture, ditching and draining, and two devastating fires that took place in 1782 and 1931 (Anonymous 1797, Higgins 1932) the swamp has been reduced to its present size. The GCSCA is the largest block of forest remaining on the Delmarva Peninsula and is estimated to include 5,000 ha (ca. 4,400 ha in Delaware and ca. 600 ha in Maryland). Four thousand (4,000) hectares are owned by Delaware Wild Lands Incorporated, a private conservation group.

Prior to disturbances, the GCSCA was largely composed of Atlantic white cedar, *Chamaecyparis thyoides*, and bald cypress, *Taxodium distichum* (Anonymous 1797, Tatnall 1939). Presently, only small remnant populations of Atlantic white cedar and bald cypress remain in the GCSCA. Today, the swamp is composed of a mosaic of seasonally flooded to poorly drained, mesic to dry habitat types. In general, the canopy is composed of a mix of deciduous species, red maple (*Acer rubrum*), sweet gum (*Liquidambar styraciflua*), swamp black gum (*Nyssa biflora*), American holly (*Ilex opaca*) and loblolly pine (*Pinus taeda*). Common species in the shrub layer include, highbush blueberry (*Vaccinium corymbosum*), sweet pepper bush (*Clethra alnifolia*), sweet leaf (*Symplocos tinctoria*), and sweet bay magnolia (*Magnolia virginiana*). The often sparse herb layer contains Virginia chain fern (*Woodwardia virginica*), Walter's sedge (*Carex striata*), and wood fern (*Dryopteris intermedia*).

Methods

Bryophyte surveys were conducted from June to September 1998, and were done entirely within the boundaries of the property owned by Delaware Wild Lands in Sussex County, Delaware, and Worcester County, Maryland. Surveys were conducted along trails leading to permanent survey points originally established by the DNHP from 1996-98 for the purpose of conducting biological inventories of the swamp (Bennett et al. 1999). These survey points were established to facilitate repeatability of future surveys and to allow for direct comparison with future data for long-term monitoring of the GCSCA. Trails to the points were established to aid in access to more remote areas of the swamp. Because these trails were used as a sampling unit in this survey, they will hereafter be referred to as "transects" or "transect lines." Surveys and collections were made along 53 transect lines and at 76 survey points.

Survey points were placed throughout the swamp in order to capture the variety of different natural community types found in the swamp. At several locations in the swamp, transects connected more than one survey point. Points that were positioned along the same transect line were about 200 m apart. Points were mapped using a Corvallis Global Positioning System unit. To increase the accuracy of this data, Corvallis Personal Computer-Global Positioning System software was used to perform differential corrections on the location data collected in the field. These data were downloaded to GIS and the transect lines were drawn on the same coverage. The length of each transect was determined by the GIS program. Overall, transect lines covered about 11,755 m. The average length of transect lines was approximately 220 m; the longest line was 910 m and the shortest line was 35 m.

Surveys consisted of walking transect lines and recording the presence of each bryophyte species encountered within approximately 5 m of either side of the line and within a 50 m radius of each survey point. If a species was present along a transect or near a point, it was recorded only once. No attempt was made to determine the abundance of each species along transects, or to distinguish between observations made along transect lines versus survey points. Relative frequency of occurrence (i.e., percentage of transects where each species was observed) was determined for each species encountered.

Results and Discussion

Bryophytes were identified in the laboratory from voucher specimens made during surveys. A large number of duplicate collections and observations were made, suggesting that an appropriate level of sampling was done to document the bryoflora of the swamp thoroughly. Determinations were made by the author with the exception of *Cryphaea glomerata*, which was determined by Dr. Norton G. Miller of the New York State Museum. Dr. Miller also confirmed the identifications of *Forsstroemia trichomitria*, *Isopterygium tenerum*, and *Steerecleus serrulatus*. At least one voucher specimen was made by the author for all bryophyte taxa encountered. Voucher specimens are currently housed in the reference herbarium of the DNHP, and duplicate specimens of *Cryphaea glomerata*, *Forsstroemia trichomitria*, *Isopterygium tenerum*, and *Steerecleus serrulatus* are deposited at the New York State Museum, Albany, New York (NYS). Nomenclature for mosses follows Anderson, Crum, and Buck (1990). Nomenclature for sphagnum follows Anderson (1990). Nomenclature for hepatics follows Stotler and Crandall-Stotler (1977). Distributional data for mosses are based on Crum and Anderson (1981), sphagnum on Crum and Anderson (1981) and Karlin et al. (1991), and hepatics on Ireland and Bellolio-Trucco (1987) and Redfearn (1979).

A total of 50 species and varieties of mosses (37) and liverworts (13) were documented during this survey of the GCSCA. These include 30 taxa of mosses (Class Bryopsida), 7 taxa of peat mosses (Class Sphagnopsida), 2 taxa of thalloid liverworts (Class Hepaticopsida, Order Metzgeriales), and 11 taxa of the leafy liverworts (Class Hepaticopsida, Order Jungermanniales). A total of 20 families are represented within Subdivision Musci (includes both the true mosses and the peat mosses) and a total of 9 families within Subdivision Hepaticae (includes both the thalloid and leafy liverworts). Twenty-seven genera are found within Subdivision Musci, and 10 genera within Subdivision Hepaticae. Table 1 contains a list of taxa arranged taxonomically and in alphabetical order, with brief habitat notes.

Table 1. Bryophytes of the Great Cypress Swamp Conservation Area, Sussex County, Delaware and Worcester County, Maryland.

SUBDIVISION – MUSCI (Mosses)	
Class – Bryopsida (True Mosses)	Habitat
AMBLYSTEGIACEAE	
<i>Amblystegium varium</i> (Hedw.) Lindb.	Bases of trees
ANOMODONTACEAE	
<i>Anomodon attenuatus</i> (Hedw.) Hub.	Trunks and bases of trees
AULACOMNIACEAE	
<i>Aulacomnium palustre</i> (Hedw.) Schwaerg.	Decomposing logs and stumps; bases of trees
BRACHYTHECIACEAE	
<i>Bryoandersonia illecebra</i> (Hedw.) Robins.	Bases of trees
<i>Steerecleus serrulatus</i> (Hedw.) Robins.	Decomposing logs and stumps; bases of trees
CLIMACIACEAE	
<i>Climacium americanum</i> Brid.	Bases of trees above water line

Table 1. Continued.

CRYPHAEACEAE	
<i>Cryphaea glomerata</i> Bruch & Schimp. ex Sull.	Trunks of trees
DICRANACEAE	
<i>Dicranum flagellare</i> Hedw.	Decomposing logs and stumps; bases of trees
<i>D. scoparium</i> Hedw.	Moist to well drained soils
ENTODONTACEAE	
<i>Entodon seductrix</i> (Hedw.) C. Mull.	Decomposing logs and stumps; bases of trees
FISSIDENTACEAE	
<i>Fissidens dubius</i> P. Beauv.	Bases of trees
HYPNACEAE	
<i>Hypnum imponens</i> Hedw.	Decomposing logs and stumps; bases of trees
<i>Isopterygium tenerum</i> (Sw.) Mitt.	Decomposing logs and stumps
<i>Platydictya subtilis</i> (Hedw.) Crum	Decomposing logs and stumps
<i>Platygyrium repens</i> (Brid.) Schimp. in B.S.G.	Decomposing logs and stumps
<i>Pylaisella selwynii</i> (Kindb.) Crum, Steere & Anders.	Trunks of trees
LEPTODONTACEAE	
<i>Forsstroemia trichomitria</i> (Hedw.) Lindb.	Trunks of trees
LEUCOBRYACEAE	
<i>Leucobryum albidum</i> (Brid. ex P. Beauv.) Lindb.	Moist to well drained soils; logs and stumps
MNIACEAE	
<i>Mnium hornum</i> Hedw.	Moist soil
<i>M. stellare</i> Hedw.	Bases of trees
<i>Plagiomnium cuspidatum</i> (Hedw.) T. Kop	Moist soil; bases of trees
ORTHOTRICHACEAE	
<i>Orthotrichum ohioense</i> Sull. & Lesq. in Aust.	Trunks of sweet gums (<i>Liquidambar styraciflua</i>)
POLYTRICHACEAE	
<i>Atrichum angustatum</i> (Brid.) Bruch & Schimp. in B.S.G.	Moist sandy soil
<i>Polytrichum commune</i> Hedw. var. <i>commune</i>	Moist to well drained soil
<i>P. commune</i> Hedw. var. <i>perigoniale</i> (Michx.) Hampe	Moist to well drained soil
<i>P. ohioense</i> Ren. & Card.	Moist to well drained soil
SEMATOPHYLLACEAE	
<i>Sematophyllum adnatum</i> (Michx.) E.G. Britt.	Trunks of trees
TETRAPHIDACEAE	
<i>Tetraphis pellucida</i> Hedw.	Decomposing logs and stumps; bases of trees
THELIACEAE	
<i>Thelia hirtella</i> (Hedw.) Sull. in Sull. & Lesq.	Trunks and bases of trees
THUIDIACEAE	
<i>Thuidium delicatulum</i> (Hedw.) Schimp. in B.S.G.	Decomposing logs and stumps; bases of trees
Class – Sphagnopsida (Peat Mosses)	
SPHAGNACEAE	
Section Acutifolia	
<i>Sphagnum bartlettianum</i> Warnst.	Low, wet depressions or swales
Section Cuspidata	
<i>Sphagnum cuspidatum</i> Ehrh. ex Hoffm.	Low, wet depressions or swales
Section Sphagnum	
<i>Sphagnum affine</i> Ren. & Card.	“banks of roadside ditches” (Karlin et al. 1991)
<i>S. magellanicum</i> Brid.	Moist, sandy soil
<i>S. palustre</i> L.	Edge of low, wet depressions or swales
<i>S. perichaetiale</i> Hampe	Moist, sandy soil
Section Rigida	
<i>Sphagnum strictum</i> Sull.	Moist, sandy soil
Section Subsecunda	
<i>Sphagnum lescurii</i> Sull. in Gray	Wet ground along roadside

SUBDIVISION – HEPATICAE (Liverworts & Hornworts)

Class – Hepaticopsida (Liverworts)

Order – Metzgeriales (Thalloid Liverworts)

ANEURACEAE

Aneura pinguis (L.) Dum. Wet, decomposing logs and stumps

PALLAVICINIACEAE

Pallavicinia lyellii (Hook.) Carruth. Wet, decomposing logs and stumps

Order – Jungermanniales (Leafy Liverworts)

ADELANTHACEAE

Odontoschisma denudatum (Mart.) Dum. Wet, decomposing logs and stumps

O. prostratum (Sw.) Trev. Wet, decomposing logs and stumps

CEPHALOZIACEAE

Cephalozia bicuspidata (L.) Dum. Wet, decomposing logs and stumps

C. connivens (Dicks.) Linb. Wet, decomposing logs and stumps

Nowellia curvifolia (Dicks.) Mitt. Wet, decomposing logs and stumps

JUBULACEAE

Frullania eboracensis Gottsche Trunks of American holly (*Ilex opaca*)

F. tamarisci (L.) Dum. var. *asagrayana* (Mont.) Hatt. Trunks of American holly

LEJEUNEACEAE

Leucolejeunea clypeata (Schwein.) Evans Decomposing logs and stumps; bases of trees

LEPIDOZIACEAE

Bazzania trilobata (L.) S. Gray Decomposing logs and stumps

LOPHOCOLEACEAE

Lophocolea heterophylla (Schrad.) Dum. Wet, decomposing logs and stumps

PORELLACEAE

Porella platyphylloidea (Schwein.) Lind Trunks of trees

Karlin (1991) listed two species of sphagnum from the GCSCA (*Sphagnum affine* and *S. lescurii*) that “commonly occur on the banks of road side ditches, along the sides of Road 418.” Because transect lines and survey points were not placed along roadsides and edges, these two species were not observed during this survey and are not included in data analysis. However, they do appear in the full list of taxa as part of the bryoflora of the GCSCA. An effort was made during this survey to confirm these reports, but only *S. lescurii* was relocated.

Four species of bryophytes documented from the Delaware portion of the GCSCA were not listed by Allen (1990) and Karlin et al. (1991), and are reported here as new records for the state of Delaware: *Fissidens dubius*, *Platydictya subtilis*, *Mnium stellare*, and *Sphagnum strictum*. A search of the literature dealing with bryological studies in Maryland focused only on studies that included, or were restricted to the eastern shore counties of the state. As a result, state record determinations cannot be made within the context of this paper.

Bryophytes considered to be common in the swamp were encountered on 50% or more of the transect lines and survey points. They include the following (Table 2 contains a complete list of taxa with the relative frequency of occurrence for each): *Leucobryum albidum* 89%, *Sematophyllum adnatum* 76%, *Dicranum flagellare* 70%, *Thelia hirtella* 70%, *Thuidium delicatulum* 66%, *Lophocolea heterophylla* 64%, *Odontoschisma prostratum* 64%, *Steerecleus serrulatus* 62%, and *Sphagnum cuspidatum* 57%.

Table 2. Relative frequency of occurrence of bryophytes along transect lines and survey points in the Great Cypress Swamp Conservation Area, Sussex County, Delaware and Worcester County, Maryland.

Scientific Name	Frequency (%)
<i>Leucobryum albidum</i>	89
<i>Sematophyllum adnatum</i>	76
<i>Dicranum flagellare</i>	70
<i>Thelia hirtella</i>	70
<i>Thuidium delicatulum</i>	66
<i>Lophocolea heterophylla</i>	64
<i>Odontoschisma prostratum</i>	64
<i>Steerecleus serrulatus</i>	62
<i>Sphagnum cuspidatum</i>	57
<i>Cephalozia connivens</i>	49
<i>Dicranum scoparium</i>	47
<i>Frullania eboracensis</i>	47
<i>Aulacomnium palustre</i>	45
<i>Odontoschisma denudatum</i>	41
<i>Hypnum imponens</i>	40
<i>Sphagnum palustre</i>	40
<i>Anomodon attenuatus</i>	30
<i>Frullania tamarisci</i> var. <i>asagrayana</i>	28
<i>Leucolejeunea clypeata</i>	28
<i>Pallavicinia lyellii</i>	28
<i>Isopterygium tenerum</i>	23
<i>Nowellia curvifolia</i>	20
<i>Polytrichum commune</i> var. <i>commune</i>	20
<i>Tetraphis pellucida</i>	17
<i>Mnium hornum</i>	15
<i>Mnium stellare</i>	15
<i>Platygyrium repens</i>	13
<i>Polytrichum ohioense</i>	13
<i>Orthotrichum ohioense</i>	9
<i>Atrichum angustatum</i>	8
<i>Forsstroemia trichomitria</i>	8
<i>Plagiomnium cuspidatum</i>	8
<i>Sphagnum perichaetiale</i>	8
<i>Polytrichum commune</i> var. <i>perigoniale</i>	6
<i>Bazzania trilobata</i>	4
<i>Bryoandersonia illecebra</i>	4
<i>Cephalozia bicuspidata</i>	4
<i>Climacium americanum</i>	4
<i>Entodon seductrix</i>	4
<i>Platydictya subtilis</i>	4
<i>Pylaisella selwynii</i>	4
<i>Sphagnum magellanicum</i>	4
<i>Amblystegium varium</i>	2
<i>Aneura pinguis</i>	2
<i>Cryphaea glomerata</i>	2
<i>Fissidens dubius</i>	2
<i>Porella platyphylloidea</i>	2
<i>Sphagnum bartlettianum</i>	2
<i>Sphagnum strictum</i>	2

Seven species of bryophytes were observed or collected on only one transect line or survey point: *Amblystegium varium*, *Aneura pinguis*, *Cryphaea glomerata*, *Fissidens dubius*, *Porella platyphylloidea*, *Sphagnum bartlettianum*, and *S. strictum*. *Porella platyphylloidea* was collected from the portion of the swamp that lies within Worcester County, Maryland, the remaining six were all collected from the Sussex County, Delaware side of the swamp. The low frequency of these seven taxa indicate that they may be of conservation concern. Further studies of the bryoflora of Delaware and Maryland are needed before the status of these species can be determined.

Comparing overall plant species diversity of the GCSCA, 155 species and varieties of vascular plants (Bennett et al. 1999) were documented from the swamp during this survey versus 50 species of bryophytes.

Of the 50 species and varieties of bryophytes documented during this survey of the GCSCA, three species have a southern distribution and are in the GCSCA near their northern limit of geographical distribution in eastern North America. These include *Cryphaea glomerata* (New Jersey south to Florida and Texas), *Sphagnum bartlettianum* (along the coast from Maryland south to Florida, reported from New Jersey), *Sphagnum strictum* (coastal plain of New Jersey south to Florida, and west to Louisiana). One species, *Platydictya subtilis*, has a northern distribution and occurs in the GCSCA near its southern coastal plain limit in eastern North America (Nova Scotia south to New York and Michigan, and in the mountains of North Carolina). The remaining 46 species of bryophytes from the GCSCA are generally widespread in eastern North America.

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