

U.S. FISH AND WILDLIFE SERVICE SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

Scientific Name:

Dichanthelium (=panicum) hirstii

Common Name:

Hirst Brothers' Panic grass

Lead region:

Region 5 (Northeast Region)

Information current as of:

06/06/2014

Status/Action

Funding provided for a proposed rule. Assessment not updated.

Species Assessment - determined species did not meet the definition of the endangered or threatened under the Act and, therefore, was not elevated to the Candidate status.

New Candidate

Continuing Candidate

Candidate Removal

Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status

Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species

Range is no longer a U.S. territory

Insufficient information exists on biological vulnerability and threats to support listing

Taxon mistakenly included in past notice of review

Taxon does not meet the definition of "species"

Taxon believed to be extinct

Conservation efforts have removed or reduced threats

___ More abundant than believed, diminished threats, or threats eliminated.

Petition Information

___ Non-Petitioned

X Petitioned - Date petition received: 05/11/2004

90-Day Positive:05/11/2005

12 Month Positive:05/11/2005

Did the Petition request a reclassification? **No**

For Petitioned Candidate species:

Is the listing warranted(if yes, see summary threats below) **Yes**

To Date, has publication of the proposal to list been precluded by other higher priority listing?
Yes

Explanation of why precluded:

Higher priority listing actions, including court-approved settlements, court-ordered and statutory deadlines for petition findings and listing determinations, emergency listing determinations, and responses to litigation, continue to preclude the proposed and final listing rules for this species. We continue to monitor populations and will change its status or implement an emergency listing if necessary. The Progress on Revising the Lists section of the current Candidate Notice of Review (<http://endangered.fws.gov/>) provides information on listing actions taken during the last 12 months.

Historical States/Territories/Countries of Occurrence:

- **States/US Territories:** Delaware, Georgia, New Jersey, North Carolina
- **US Counties:** Sussex, DE, Calhoun, GA, Sumter, GA, Onslow, NC, Atlantic, NJ, Burlington, NJ
- **Countries:**Country information not available

Current States/Counties/Territories/Countries of Occurrence:

- **States/US Territories:** Delaware, New Jersey, North Carolina
- **US Counties:** Sussex, DE, Onslow, NC, Atlantic, NJ, Burlington, NJ
- **Countries:**Country information not available

Land Ownership:

Both North Carolina populations occur on Federal lands. The Delaware population occurs on a State-owned wildlife management area. All three of the New Jersey populations, with the April 10, 2014, transfer of ownership of two sites from The Nature Conservancy (TNC), now occur on State-owned land.

Lead Region Contact:

ARD-ECOL SVCS, Krishna Gifford, 413-253-8619, krishna_gifford@fws.gov

Lead Field Office Contact:

NJ ESFO, Ron Popowski, 609 241 7065, ron_popowski@fws.gov

Biological Information

Species Description:

Dichanthelium hirstii (Hirst Brothers panic grass) is a perennial grass that produces erect, leafy, flowering stems from May to October. These stems may develop from over-wintering rosettes (a cluster of leaves arranged in a circle or disk, usually at the base of the plant), or from nodes of stems remaining from the previous year (Schuyler 1998a, p. 1). The culms (the aerial stem of a grass or sedge), are 55 to 80 centimeters (cm) (21.7 to 31.5 inches (in)) tall with flat leaf blades that are stiffly erect or narrowly ascending and without hairs (sometimes sparsely pilose (bearing minute, long, soft, straight hairs) at the summit of the sheaths). Leaves are yellow-green in color and often tinged with purple, and are 4.5 to 11 cm (1.8 to 4.3 in) long and 3 to 5.5 millimeters (mm) (0.12 to 0.22 in) wide. The 1.8 to 2.1 mm (0.07 to 0.08 in) long flowers (spikelets) are produced terminally on a narrowly branched inflorescence (a cluster of flowers/spikelets). The branched inflorescence is produced at the terminal end of the culm and is called a panicle. The branches are upwardly appressed (pressed close or flat against the culm) or strongly ascending, up to 2.5 cm (1.0 in) long. The panicle is 4.5 to 9 cm (1.8 to 3.5 in) long and 2 to 5 mm (0.08 to 0.2 in) wide. Spikelets are 1.8 to 2.1 mm (0.07 to 0.08 in) long and without hairs. The first glume (one of two paired bracts at the base of the spikelet) is 0.3 to 0.4 mm (0.01 to 0.02 in) long and is short, broadly obtuse to truncate in shape.

Toward the middle or latter part of the growing season, plants are sparingly branched with axillary panicles that often remain concealed within the leaf sheath. Also during this time, leafy rosettes develop from the basal (bottom or base) parts, or from rooting of decumbent (reclining on the ground, but with the tip ascending) culm nodes of existing plants (Walz 2012a). Seeds will also germinate and produce leafy rosettes during the middle or latter parts of the season (Schuyler 1998a, p. 1). Seeds presumably persist in seed banks (Schuyler 1998a, p.1) similar to those of related species (e.g., *Dichanthelium wrightianum* = *Panicum wrightianum* and *D. tenue* = *P. acuminatum* var. *uniciphyllum*) found in seed banking studies by Kirkman and Sharitz (1994, pp. 181-183, 185) and Wisheu and Keddy (1991, p. 184-185).

Taxonomy:

Hirst Brothers panic grass was described as the distinct species *Panicum hirstii* by Swallen (1961, p. 235) from a specimen collected in 1958 by brothers Frank and Bob Hirst, active amateur botanists in southern New Jersey. Prior to his death in 2009, Frank Hirst requested that the species common name be changed from Hirsts panic grass to Hirst Brothers panic grass to recognize his brother Bob who discovered the plant with him (McAvoy 2010; Walz 2012b). Therefore, the species common name (plural possessive) honors both Frank Hirst and his brother Bob Hirst as codiscoverers. According to a taxonomic review conducted by Schuyler (1996, pp. 9596), the plant had first been collected in 1900 in Sumter County, Georgia, and had been doubtfully described by Hitchcock and Chase (1910, p. 197) as *P. roanokense* Ashe. Others considered the plant to be a variant of *P. neuranthum* Griseb (Kral 1983, p. 76) or conspecific with *P. aciculare* Desv. (Gleason and Cronquist 1991, p. 804). In his taxonomic review, Schuyler (1996, pp. 95 to 96) concurred with the findings of Swallen (1961, p. 235), concluding that *P. hirstii* was taxonomically distinct. More recently, systematists have split a group of species from the genus *Panicum* into the genus *Dichanthelium*. In North America, *Dichanthelium* can be recognized easily by the presence of a basal rosette of leaves during the winter and a clear foliar dimorphism (two forms of leaves). This character is not seen in the Central and South American taxa, which led some taxonomists to treat *Dichanthelium* as a subgenus of *Panicum* (Aliscioni et al. 2003, p. 797). There is agreement among botanists working with Hirst Brothers panic grass that *D. hirstii* (Swallen) Kartesz is the appropriate nomenclature for the species (LeBlond 1990, 2004; Schuyler 2004; Natural Resources Conservation Service 2004). The U.S. Fish and Wildlife Service (Service)

accepts the Kartesz treatment of the taxonomy. The Service has carefully reviewed the available taxonomic information and has concluded the species is a valid taxon.

Habitat/Life History:

All known sites of *Dichanthelium hirstii* are wetlands within a matrix of pine/oak forest, and the habitats are variously described as intermittent/seasonal ponds, meadows, or savannas (Schuyler 1998a, p. 2). Ecological communities that support *D. hirstii* in Delaware and New Jersey include the following National Vegetation Classification System (NVCS) types (Walz and Cartica 2010, p. 13).

- Yellow Spikerush (*Eleocharis flavescens*) - Bog Yellow-eyed Grass (*Xyris difformis*) Herbaceous Vegetation
- Virginia Meadowbeauty (*Rhexia virginica*) - Warty Panicgrass (*Panicum verrucosum*) Herbaceous Vegetation
- Smooth Sawgrass (*Cladium mariscoides*) - Wrinkled Jointgrass (*Coelorachis rugosa*) Herbaceous Vegetation

In North Carolina, ecological communities that support *Dichanthelium hirstii* include the following NVCS types (Walz and Cartica 2010, p. 14).

- Pond-cypress (*Taxodium ascendens*) / Maidencane (*Panicum hemitomon*) - Tall Pinebarren Milkwort (*Polygala cymosa*) Temperate Woodland
- *Taxodium ascendens* / Titi (*Cyrilla racemiflora*) - Honeycups (*Zenobia pulverulenta*) Woodland
- *Taxodium ascendens* / Virginia Chainfern (*Woodwardia virginica*) Woodland

The species requires habitats that are at least seasonally or intermittently (irregularly) wet, receiving full sun to light shade, and with substrates that are organic but firm (Kral 1983, p. 76; Schuyler 1998a, p. 2) or shallow muck over quartzite sand (Walz 2012a). The plant occurs in flat-bottomed depressions with substantial water level fluctuations dependent on rainfall and ground water dynamics. The species relies on periods of standing water to keep competing species at a minimum (Schuyler 1998a, p. 2). The New Jersey pinelands pond systems in which *Dichanthelium hirstii* is found periodically burn during dry cycles, and this may be a factor in suppressing competition from woody vegetation (Kral 1983, p. 76). In New Jersey, a new population was discovered at a site that had experienced a prolonged drought followed by a turf-burning fire during the growing season and subsequent flooding (Walz 2012a).

Historical Range/Distribution:

The species historical range included eight sites within Delaware, Georgia, New Jersey, and North Carolina (Schuyler, 1996, p.96). Of the eight known sites, two are believed to be extirpated; *Dichanthelium hirstii* has not been observed at the known sites in Calhoun and Sumter Counties, Georgia, for over 50 years. In the summer of 1985, suitable habitat in the area of the Sumter County, Georgia, site was searched, but no plants were found. Surveys were also conducted in 2013 in Calhoun and Sumter Counties, Georgia in areas where the species was historically known, as well as in suitable habitat in Baker, Dougherty, and Lee Counties where the species could likely occur. Though suitable habitat for *D. hirstii* was found, no plants were discovered (McAvoy 2013). Additional surveys are planned for 2014. One population (Barkwoods Pond, Atlantic County, New Jersey) has not been seen in the last 21 years (last observed in 1992) but is still considered extant because it is possible a viable seedbank can persist for years or even decades (Walz 2012a, 2012b). The six extant sites are Starrets Meadow and Lyman Road, Onslow County, North Carolina; Assawoman Pond, Sussex County, Delaware; Barkwoods Pond and Labounsky Pond, Atlantic County, New Jersey; and Hampton Furnace Pond at Wharton State Forest, Burlington County, New Jersey.

State botanists currently rank *Dichanthelium hirstii* populations in Calhoun and Sumter Counties, Georgia, as possibly extirpated. According to NatureServes definition of the subnational conservation status rank,

Possibly Extirpated (SH), is a species known from only historical records but still some hope of rediscovery. There is evidence that the species or ecosystem may no longer be present in the jurisdiction, but not enough to state this with certainty. Examples of such evidence include (1) that a species has not been documented in approximately 20 to 40 years despite some searching and/or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is no longer present in the jurisdiction. Whereas, the definition of Presumed Extirpated (SX) is a species or ecosystem believed to be extirpated from the jurisdiction (i.e., nation or state/province). Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered. If a *D. hirstii* population is classified as possibly extirpated, as opposed to presumed extirpated, it is due to the fact that it may take many years or even decades for the potential reappearance of plants from the seed bank in this floristically dynamic habitat (Walz 2012a, 2012b).

Additional potential habitat for this species was found to be extensive in southwest Georgia based on field and aerial surveys conducted in 2013. Additional survey work is being considered, however much of the suitable habitat is on private lands which may limit access to the sites. However, if access is granted, the likelihood of finding *Dichantheium hirstii* is still high.

Current Range Distribution:

Of the six extant sites, Assawoman Pond (Sussex County, Delaware), Hampton Furnace Pond (Burlington County, New Jersey), and Lyman Road (Onslow County, North Carolina) were documented in 2013 (McAvoy 2013). The population at Starrets Meadow (Onslow County, North Carolina) was last sighted in 2006. The population at Labounsky Pond (Atlantic County, New Jersey) was last sighted in 2002. The population at Barkwoods Pond (Atlantic County, New Jersey) was last sighted in 1992 (NatureServe 2008). *Dichantheium hirstii* exists in wetlands that are floristically diverse and dynamic, and the reappearance of plants from the seed bank is potentially high when environmental conditions favor germination and survival (Walz 2012a). For example, the population at Labounsky Pond in New Jersey was not observed for 16 years, from 1984 to 2002, before reappearing.

Population Estimates/Status:

Individual populations of *Dichantheium hirstii* can naturally vary dramatically in size from year to year. In some years, plants may not appear (Schuyler 1998a, p. 2). The status of each population is described below.

Delaware

The Assawoman Pond site on State-owned land in Sussex County, Delaware, is approximately 0.8 hectare (ha) (2 acres (ac)) in size (McAvoy 2011a, 2011b). The site is classified as a Coastal Plain seasonal pond, which is a nontidal, freshwater depression wetland. Typically, these ponds are flooded in spring when the ground water table is high and gradually draw down and are dry in late summer when the ground water table is low. Usually, these seasonal ponds are open and sunny in the center, with a fringe of trees and shrubs on the perimeter (McAvoy 2012b). *Dichantheium hirstii* was discovered here by Frank Hirst in 1984. Data clearly show that the number of individuals of *D. hirstii* at this site fluctuates annually (see tables 1 and 2 (McAvoy 2012b)). The greatest number of plants recorded was in 2000, when 190 plants were found. The lowest number of plants recorded was in 2009, when only eight plants were found. In a June 2009 survey, when Assawoman Pond was still flooded, three flowering culms were counted. Monitoring in 2013 found only 11 plants, and the pond stayed flooded throughout the growing season. After an August drawdown of the same year, the pond was resurveyed, and eight vegetative plants with no autumnal flowering were observed (McAvoy 2010). A key environmental factor that influences plant species composition and distribution in seasonal ponds is the fluctuating ground water levels (flooding and draw down). These fluctuating ground water levels may also have an effect on the population size and vigor (measured by the number of culms per plant and length of inflorescence) of *D. hirstii*, but continued data collection and analysis are needed in order to answer this question. Although the number of plants at the site fluctuates and

is a natural function of the type of habitat it occupies, the Delaware population is believed to be relatively stable (McAvoy 2004, 2005, 2009, 2012b, 2013 pers. comm.; McAvoy and Bennett 2000, p. 4). In addition, unlike other populations in New Jersey and North Carolina, the Delaware population has been present every year since monitoring began in 1984 (see tables 1 and 2).

New Jersey

The known sites on the former TNC property, now State-owned as of April 10, 2014, in Atlantic County, New Jersey, Barkwoods Pond and Labounsky Pond (collectively known as Hirsts Ponds), are separated by approximately 1 kilometer (km) (0.6 mi). Barkwoods Pond is approximately 0.6 ha (1.6 ac) in size, and Labounsky Pond is approximately 2.3 ha (5.8 ac) in size. The population size at Hirsts Ponds has fluctuated depending on water levels, with the species being more abundant in dry years. In the late 1950s and early 1960s, there were years in which *Dichantheium hirstii* covered large portions of both ponds. Plants were easily found with little effort. By the 1970s, the species was difficult to find and often absent (Snyder 2010).

Dichantheium hirstii was first discovered at Barkwoods Pond by Frank and Bob Hirst in 1958. The species has not been seen at Barkwoods Pond since 1992, at which time only nine plants were found after a thorough search. No *D. hirstii* plants were found in Barkwoods Pond during spring surveys conducted in 1995, 1997, 2000, 2001, 2003, 2007, 2008, 2009, 2010, and 2011 (see table 2) (Schuyler 2001; Gordon 2004, 2012; Juelg 2004; Walz and Cartica 2008, p. 1; Noe 2010; Snyder 2010; Walz and Cartica 2010, p. 5). Subsequent autumnal (fall) surveys by TNC in 2010 and 2011, by Pine Barrens Inventories in 2011 (Gordon 2012), and by Walz (2013) in 2013 resulted in a failed to find status of this population.

The species was first recorded at Labounsky Pond in 1960 by Frank and Bob Hirst (Walz 2012b). Two clumps (large rhizomatous patches) were observed and photo-documented in 1984. The plant was not found at Labounsky Pond from 1985 to 2001 after thorough surveys in 1992, 1995, 1997, and 2000 (see table 2) (Schuyler 1998a, p. 3; Schuyler 2001; Cartica 2005, p. 1; Gordon 2008). In June 2002, 1 vegetative plant and 6 fruiting plants with a total of 34 fruiting culms were found (Snyder 2010), representing the first confirmed sighting of the species at this site in 17 years. In July 2003, five *Dichantheium hirstii* culms were found at Labounsky Pond (Gordon 2008). A 2007 search for the species proved negative, but this result may be attributed to higher water levels in the pond (Gordon 2008, Walz and Cartica 2008, p. 1; Snyder 2010). Annual searches of the pond conducted by TNC in 2007, 2008, and 2009 found no *D. hirstii* plants (Noe 2010). Extensive searches at Labounsky Pond were also conducted in June 2010 by the New Jersey Department of Environmental Protection Office of Natural Lands Management (ONLM) with particular emphasis on areas with previous records, but no *D. hirstii* plants were found (Walz and Cartica 2010, p. 5). Subsequent autumnal surveys in 2010 and 2011 conducted by TNC resulted in failed to find status of this population. An additional survey by Pine Barrens Inventories confirmed the same for 2011 (Gordon 2012). Autumn surveys in 2013 resulted in "failed to find" (Walz 2013).

The Hampton Furnace Pond site in Wharton State Forest is located in Burlington County, New Jersey, approximately 29 km (18 mi) north-northwest of the Hirsts Ponds in Atlantic County, New Jersey. Hampton Furnace Pond is approximately 1.2 ha (2.9 ac) in size, and *Dichantheium hirstii* covers an area of 0.10 ha (0.25 ac) at the southern end of the pond (Walz 2011). The Hirst brothers searched for *D. hirstii* at this pond in the 1950s but did not find it. During the summer and fall of 2002, surveys by the New Jersey Natural Heritage Program were conducted at this pond, but *D. hirstii* was not found. In July 2004, a *D. hirstii* population of at least 28 fruiting culms was discovered by Russell Juelg and identified by Ted Gordon during a joint Philadelphia Botanical Club and Torrey Botanical Club Field Trip. Identification of *D. hirstii* was confirmed by A.E. Schuyler (Walz 2012a). The site was revisited by ONLM in August 2004, and a total of 28 clumps supporting 131 culms with 114 inflorescences in fruit were observed with 1 to 6 plants per clump. During subsequent surveys of Hampton Furnace Pond in 2006, approximately 30 fruiting culms were found (Gordon 2006, p. 63; Gordon 2007; Gordon 2008; Snyder 2010). In September and October of 2007, a complete census of all *D. hirstii* plants was conducted by ONLM, and the numbers of clumps, genets (a group of genetically identical individuals, all originating vegetatively, not sexually, from a single ancestor),

ramets (an individual within a genet), culms, inflorescences, and seedlings were recorded. The location of each plant was mapped using a global positioning system (GPS). In 2007, 20 plants were documented supporting 161 vernal inflorescences and 152 autumnal inflorescences for a total of 313 fruiting culms; only 1 plant did not produce an inflorescence with fruit (Walz and Cartica 2008, p. 1; Walz and Cartica 2010, p. 5). In September 2008, the population was stable at 20 clumps. In June 2010, the vernal (spring) inflorescence survey was conducted at Hampton Furnace Pond, and 32 clumps with 427 vernal inflorescence culms were documented.

Population census surveys at Hampton Furnace Pond were conducted in October 2010, when 303 plants were documented with 1,268 culms (average 4 per plant, range 1 to 83 per plant) and 2,498 autumnal inflorescences (average 8 per plant, range 1 to 216 per plant) (Walz 2011). Observations were made of rooting at nodes on decumbent culms and new autumnal rosette formations, suggesting the presence of clonal reproduction (asexual vegetative reproduction from a genetically identical ancestor through a process by which new individuals arise without production of seeds or spores) as well as autumnal seedling establishment (via sexual reproduction with flower and seed production). Water depth adjacent to each plant was recorded, and individual plants were located using GPS (Walz and Cartica 2010, p. 5).

Brief visits to the Hampton Furnace Pond site in December of 2011, 2012, and 2013 confirmed presence of the plants. While the water was too deep to conduct an accurate count, the population was observed in the same area (based on GPS coordinates) documented in 2010; plants were healthy and had remnants of autumnal inflorescences above the water surface. These data mark a significant increase in population size at this pond site from 28 plants in 2004 to 303 plants in 2010 (Walz and Cartica 2010, p. 1). The population appears to remain stable based on observation during the 2011, 2012, and 2013 site visits.

In the years 2007 to 2013, levels of ground water and pond surface water were recorded hourly. These data revealed that the pond surface water level in the Hampton Furnace Pond is neither perched nor isolated, but represents the local ground water table in this sandy aquifer. Further analysis of ground water and precipitation data shows that the ground water levels respond rapidly to rain events and that precipitation is driving the local aquifer (Walz and Cartica 2010, p. 6). The duration, timing, and depth of standing water in the pond at known occurrences in New Jersey during the growing season appear to be key factors in the annual presence or absence of the species and may account for dramatic fluctuations in population size (Gordon 2008, Walz 2012b).

North Carolina

The two sites in North Carolina occur on the Camp Lejeune Marine Corps Base in Onslow County. One site, referred to as Lyman Road Cypress Savanna, consists of plants scattered over an area of approximately 0.05 ha (0.12 ac) (Schuyler 1998a, p. 4). Approximately 80 to 100 *Dichantherium hirstii* plants were counted at the Lyman Road Cypress Savanna site in June 1990. The species was confirmed present during surveys conducted in June 1997 and May 2000, but available records do not provide information on the number of plants observed (see table 2).

Dichantherium hirstii was not seen during surveys conducted by North Carolina Natural Heritage Program (NCNHP) and Camp Lejeune biologists at the Lyman Road Cypress Savanna site in June 2005, June 2006, and July 2006. During a survey in June 2013, one robust, fruiting individual with two culms was documented for the first time since 2000 (Tenbrink 2014). Conditions necessary for production of fruiting culms may not have been present in previous years at this site (NCNHP 2008). The Lyman Road Cypress Savanna appears to be progressing towards a closed canopy, possibly due to affects to the hydrology of the site (McAvoy 2013). Despite the species long absence and recent singular reappearance, the species is considered extant at the Lyman Road Cypress Savanna site. This is consistent with sightings of *D. hirstii* at other coastal plain intermittent ponds (e.g. Labounsky Pond site in New Jersey) that have also been separated by a decade or more (Buchanan 2010), reappearing when conditions are favorable.

The second Camp Lejeune site, referred to as Starretts Meadow, occurs over an area of about 0.03 ha (0.074 ac) (Schuyler 1998a, p. 4). Approximately 28 to 35 basal rosettes and 150 to 200 fruiting clumps were counted at the Starretts Meadow site in July 1990 and June 1994, respectively. Several fruiting clumps were observed at the site in May 2000 (LeBlond 2004). No plants were found during a survey of the site in 2005. Cool dry conditions may have affected the phenology (recurring biological phenomena such as plant budding, especially as influenced by climatic conditions) of the species at the North Carolina sites in 2005. One clump with four fruiting culms was observed during surveys of the Starretts Meadow site in 2006 (NCNHP 2008). No plants were observed during surveys in 2010 (Walz 2011) and 2013 (Tenbrink 2014).

Georgia

In Georgia, *Dichanthelium hirstii* was first documented in August 1900 by R.M. Harper at the margin of a pine barren pond in Sumter County. The record is not specific enough to conduct a search for this species. In May 1947, the species was documented by R.H. Thorne in a cypress swamp in Calhoun County, 1 mile north of Leary. In the summer of 1985, suitable habitat in the area of this record was searched but no plants were found. Notes made at that time indicate that not all likely habitats were searched; additional survey is merited. Botanists are confident that the Thorne location was found during surveys in 2013, but the site has succeeded to a closed canopy of pond cypress, making conditions unsuitable for *D. hirstii* (McAvoy 2013). However, suitable habitat still exists in the area and additional surveys for *D. hirstii* are planned for 2014. All land in the vicinity of the 1947 record is private property. Aerial photos in 2013 indicate that the wetlands still exist without obvious hydraulic alteration, although they are likely shaded by trees or other woody vegetation (Kruse 2013). In 1959, *D. hirstii* was reported from Early County, but the record lacks detail and remains questionable (Swallen 1961). *Dichanthelium hirstii* is considered as Historical (not Extirpated) in Georgia.

Table 1. Annual population data for *Dichanthelium hirstii* at Assawoman Pond including the year, number of individuals counted, and if the pond drew down and was dry (Yes, with month when no standing water was first recorded, No if the pond never drew down during the growing season, or ND if no data available).

Year	Number of Individuals	Draw-down	Year	Number of Individuals	Draw-down
1984	17	ND	1999	164	Yes (August)
1985	20	ND	2000	190	No
1986	70	ND	2001	90	Yes (August)
1987	70	ND	2002	129	Yes (August)
1988	70	ND	2003	57	No
1989	34	ND	2004	52	No
1990	14	ND	2005	81	Yes (August)
1991	25	Yes (August)	2006	51	Yes (August)
1992	44	No	2007	55	Yes (August)
1993	104	ND	2008	39	Yes (July)
1994	32	No	2009	8	Yes (September)

1995	73	Yes (August)	2010	18	Yes (June)
1996	73	No	2011	21	Yes (August)
1997	63	Yes (August)	2012	32	Yes (July)
1998	68	Yes (August)	2013	11	No

Table 2: *Dichantheium hirstii* Rangewide Population Data 1982 to 2012

	North Carolina		Delaware	New Jersey		
Year	Onslow Co.: Starretts	Onslow Co.: Lyman	Sussex Co.: Assowoman	Atlantic Co.: Barkwoods	Atlantic Co.: Labounsky	Burlington Co.: Hampton
1982				24		
1984			17		2	
1985			20		?	
1986			70			
1987			70			
1988			70			
1989			34			
1990	28-35 plants scattered and in groups over 100x60 ft area	80-100 plants in groups of 5-10 plants over 100x80 ft area	14			
1991	75-100 plants scattered and in groups over 100x60 ft area	200-300 plants, loosely grouped in most graminoid openings beneath larger pond cypress trees	25			
1992			44	9	Failed to find	
1993			104			
1994	150-200		32			
1995			73	Failed to find	Failed to find	

1996			73			
1997	Present	Present	63	Failed to find	Failed to find	
1998			68			
1999			164	Failed to find	Failed to find	
2000	2	80-100	190	Failed to find	Failed to find	
2001			90		Failed to find	
2002			129		7	
2003			57	Failed to find		
2004			52			12
2005	Failed to find	Failed to find	81			
2006	1	Failed to find	51			
2007			55	Failed to find	Failed to find	20
2008			39	Failed to find	Failed to find	32
2009			8	Failed to find	Failed to find	
2010	Failed to find	Failed to find	18	Failed to find	Failed to find	303
2011			21	Failed to find	Failed to find	Present
2012						Present
2013	Failed to find	1	11	Failed to find	Failed to find	Present

Present = observed but population size not recorded; when (number) provided it is assumed present at last previously counted population size based on field visit that included walk around population but no counts; Failed to find = search conducted but no plants found; Blank = no documented search conducted.

Table 3: *Dichantheium hirstii* Rangewide Maximum and Minimum Population Size and Year by State

State	Site	Year First Observed	Year Last Observed	Max. Pop. Size (Year)	Min. Pop. Size (Year)
Georgia	Sumter Co.	1990	1990	N/A	N/A
Georgia	Calhoun Co.	1947	1947	N/A	N/A
North Carolina	Onslow Co. (Starretts Meadow)	1990	2006	150-200 (1994)	1 (2006)
North Carolina	Onslow Co. (Lyman Road)	1990	2013	80-100 (1990)	1 (2013)

Delaware	Sussex Co. (Assawoman)	1984	2013	190 (200)	8 (2009)
New Jersey	Atlantic Co. (Barkwoods)	1958	1992	24 (1982)	9 (1992)
New Jersey	Atlantic Co. (Labounsky)	1960	2002	7 (2002)	2 (1984)
New Jersey	Burlington Co. (Hampton)	2004	2013	303 (2010)	28 (2004)

Table 4. List of species associated with *Dichantheium hirstii* by state and site

Species Name	DE	NJ	NJ	NJ	NC	NC
	Assawoman	Barkwoods	Labonsky	Hampton	Lyman	Starretts
<i>Acer rubrum</i> var. <i>trilobum</i>	x	x	x		x	x
<i>Agalinis linifolia</i>					x	x
<i>Agalinis virgata</i>					x	
<i>Amphicarpum amphicarpon</i> (= <i>A. purshii</i>)			x		x	x
<i>Andropogon glomeratus</i>				x		x
<i>Andropogon virginicus</i> var. <i>virginicus</i>			x	x	x	x
<i>Anthaenantia rufa</i>					x	x
<i>Aristida palustris</i>					x	x
<i>Bartonia paniculata</i>				x		
<i>Bartonia verna</i>					x	
<i>Bartonia virginica</i>					x	x
<i>Bidens connata</i>		x				x
<i>Bidens frondosa</i>			x			
<i>Bigelovia nudata</i>						x
<i>Boltonia asteroides</i>	x					x
<i>Brasenia schreberi</i>				x		x
<i>Burmannia biflora</i>					x	x
<i>Calapogon tuberosus</i>					x	
<i>Calopogon pallidus</i>					x	
<i>Carex barratii</i>			x	x		
<i>Carex glaucescens</i>						x
<i>Carex striata</i> var. <i>brevis</i>	x	x	x	x	x	
<i>Carex verrucosa</i>					x	
<i>Centella erecta</i>					x	x
<i>Cephalanthus occidentalis</i>	x					
<i>Chamaecrista nictitans</i> ssp. <i>nicitans</i>					x	x
<i>Chamaecyparis thyoides</i>		x	x			

<i>Chamaedaphne calyculata</i>		x	x	x		
<i>Cladium mariscoides</i>	x	x	x	x		
<i>Clethra alnifolia</i>	x				x	x
<i>Coelorachis rugosa</i>	x				x	x
<i>Coreopsis falcata</i>					x	x
<i>Coreopsis rosea</i>						x
<i>Cuscuta corylii</i>		x				
<i>Cyperus retrorsus</i>			x			
<i>Cyrilla racemiflora</i>					x	
<i>Dichanthelium dichotomum</i> var. <i>mattamuskeetense</i>			x			x
<i>Dichanthelium ensifolium</i> var. <i>ensifolium</i>					x	
<i>Dichanthelium erectifolium</i>					x	x
<i>Dichanthelium hirstii</i>	x	x	x	x	x	x
<i>Dichanthelium longiligulatum</i>					x	x
<i>Dichanthelium portoricense</i> ssp. <i>patulum</i>						x
<i>Dichanthelium scabriusculum</i>						x
<i>Dichanthelium sphaerocarpon</i>			x			
<i>Dichanthelium spretum</i>	x	x	x	x		
<i>Dichanthelium wrightianum</i>					x	x
<i>Diospyros virginiana</i>	x				x	
<i>Drosera capillaris</i>						x
<i>Drosera intermedia</i>		x	x	x	x	x
<i>Dulichium arundinaceum</i>	x					
<i>Echinocloa crusgali</i>			x			x
<i>Eleocharia tuberculosa</i>		x				x
<i>Eleocharis equisetoides</i>					x	x
<i>Eleocharis microcarpa</i> var. <i>filiculmis</i>	x		x	x		
<i>Eleocharis obtusa</i>		x	x			
<i>Eleocharis olivacea</i>			x	x		
<i>Eleocharis robbinsii</i>		x	x	x		x
<i>Eleocharis tenuis</i>		x	x			
<i>Eleocharis tuberculosa</i>			x	x		
<i>Eragrostis refracta</i>					x	x
<i>Erichtites hieracifolia</i>			x	x		x
<i>Erigeron canadensis</i>			x			
<i>Erigeron vernus</i>					x	x
<i>Eriocaulon aquaticum</i>				x		x
<i>Eriocaulon compressum</i>	x				x	x
<i>Eriocaulon decangulare</i>				x	x	x

<i>Eubotrys racemosa</i>		x	x			
<i>Eupatorium leucolepis</i>						x
<i>Eupatorium mohrii</i>					x	x
<i>Euthamia caroliniana</i>			x			x
<i>Euthamia graminifolia</i>			x			
<i>Fimbristylis autumnalis</i>	x					x
<i>Gratiola aurea</i>		x	x			
<i>Hypericum boreale</i>		x	x			
<i>Hypericum canadense</i>			x			
<i>Hypericum cistifolium</i>						x
<i>Hypericum denticulatum</i>	x		x	x		
<i>Hypericum mutilum</i>			x			
<i>Ilex myrtifolia</i>					x	x
<i>Iris prismatica</i>			x			
<i>Iris virginica</i>					x	x
<i>Itea virginica</i>					x	
<i>Juncus acuminatus</i>		x	x			
<i>Juncus canadensis</i>			x	x		x
<i>Juncus debilis</i>			x			
<i>Juncus pelocarpus</i>			x	x		x
<i>Juncus repens</i>	x	x	x			
<i>Lachnanthes caroliniana</i>			x	x	x	x
<i>Leersia oryzoides</i>		x	x			
<i>Lilium catesbaei</i>						x
<i>Lindernia dubia var. analgallidia</i>		x	x			
<i>Liquidambar styraciflua</i>	x				x	x
<i>Lobelia boykinii</i>	x	x	x		x	x
<i>Lobelia canbyi</i>			x	x		x
<i>Lophiola aurea</i>			x	x		
<i>Ludwigia linearis</i>		x	x			x
<i>Ludwigia palustris</i>		x	x			
<i>Ludwigia pilosa</i>					x	x
<i>Lycopodiella alopecuroides</i>					x	x
<i>Lycopus americanus</i>			x			x
<i>Lycopus amplexans</i>		x	x	x		
<i>Lycopus uniflorus</i>			x			x
<i>Lycopus virginicus</i>			x			
<i>Lyonia lucida</i>					x	x
<i>Lysimachia loomisii</i>					x	
<i>Magnolia virginiana</i>					x	x
<i>Muhlenbergia torreyana</i>				x	x	x
<i>Muhlenbergia uniflora</i>				x		

<i>Nymphaea odorata</i>			x	x	x	x
<i>Nymphoides cordata</i>		x	x	x		x
<i>Nyssa biflora</i>	x				x	
<i>Nyssa sylvatica</i>		x	x			
<i>Panicum capillare</i>			x			
<i>Panicum hemitomon</i>					x	x
<i>Panicum longifolium</i>				x		x
<i>Panicum rigidulum var. combsii</i>					x	
<i>Panicum rigidulum var. pubescens</i>		x	x			x
<i>Panicum tenerum</i>					x	x
<i>Panicum verrucosum</i>		x	x	x	x	
<i>Panicum virgatum var. virgatum</i>			x	x	x	x
<i>Paspalum praecox</i>					x	x
<i>Paspalus dissectum</i>		x	x			x
<i>Persea palustris</i>					x	x
<i>Pinus rigida</i>		x	x	x		
<i>Pinus serotina</i>					x	x
<i>Platanthera cristata</i>			x			
<i>Pluchea rosea</i>					x	x
<i>Pogonia ophioglossoides</i>			x			
<i>Polygala cruciata</i>					x	x
<i>Polygala cymosa</i>					x	x
<i>Polygonum hydropiperoides</i>		x	x			
<i>Proserpinaca pectinata</i>	x	x	x	x	x	x
<i>Pterocaulon pycnostachyum</i>					x	
<i>Quercus palustris</i>	x					x
<i>Rhexia aristosa</i>	x				x	x
<i>Rhexia nashii</i>						x
<i>Rhexia petiolata</i>					x	x
<i>Rhexia virginica</i>	x	x	x	x		
<i>Rhynchospora alba</i>				x		
<i>Rhynchospora cephalantha var. cephalantha</i>				x	x	x
<i>Rhynchospora chalarocephala</i>						x
<i>Rhynchospora elliottii</i>						x
<i>Rhynchospora fascicularis var. fascicularis</i>						x
<i>Rhynchospora filifolia</i>	x				x	x
<i>Rhynchospora fusca</i>		x		x		x
<i>Rhynchospora harperi</i>	x				x	x
<i>Rhynchospora inundata</i>	x					
<i>Rhynchospora latifolia</i>						x

<i>Rhynchospora macrostachya</i>					x	x
<i>Rhynchospora nitens</i>			x	x		x
<i>Rhynchospora perplexa</i>						x
<i>Rhynchospora torreyana</i>						x
<i>Rhynchospora tracyi</i>					x	x
<i>Rhynchospora wrightiana</i>					x	
<i>Sabatia difformis</i>	x		x		x	x
<i>Saccharum giganteum</i>		x		x	x	x
<i>Sagittaria graminea</i> var. <i>graminea</i>					x	x
<i>Sagittaria teres</i>			x			
<i>Sarracenia flava</i>					x	x
<i>Scleria georgiana</i>					x	x
<i>Scleria reticularis</i>	x	x	x	x		x
<i>Sclerolepis uniflora</i>	x					
<i>Seymeria cassioides</i>					x	x
<i>Solidago rugosa</i>			x			x
<i>Sphagnum cuspidatum</i>		x	x	x		
<i>Sphagnum macrophyllum</i>	x					
<i>Sphagnum pulchrum</i>				x		
<i>Sphagnum pylaesii</i>				x		
<i>Sphagnum</i> sp.			x			
<i>Spiranthes laciniata</i>					x	x
<i>Spiranthes praecox</i>					x	
<i>Symphiotrichum nemoralis</i>				x		
<i>Symphiotrichum novi-belgii</i>			x	x		x
<i>Taxodium ascendens</i>					x	
<i>Thelypteris palustris</i>		x				x
<i>Triadenum virginicum</i>		x	x	x		x
<i>Utricularia gibba</i>		x	x			
<i>Utricularia juncea</i>		x				
<i>Utricularia purpurea</i>			x			x
<i>Utricularia radiata</i>					x	x
<i>Utricularia striata</i>			x			
<i>Utricularia subulata</i>					x	
<i>Vaccinium corymbosum</i>	x	x	x			
<i>Vaccinium macrocarpon</i>			x			
<i>Vaccinium tenellum</i>					x	x
<i>Viola lanceolata</i>		x	x			x
<i>Woodwardia virginica</i>		x	x	x	x	x
<i>Xyris ambigua</i>						x
<i>Xyris baldwiniana</i>					x	
<i>Xyris difformis</i>			x	x		x

<i>Xyris fimbriata</i>			x		x	x
<i>Xyris smalliana</i>	x		x	x		x

Table 5 Species common to all ponds rangewide and clustered by states

Species Name	Common To All Ponds	Common To DE & NJ	Common To DE & NC	Common To NJ & NC
<i>Dichantheium hirstii</i>	x	x	x	x
<i>Proserpinaca pectinata</i>	x	x	x	x
<i>Lobelia boykinii</i>	x (all but NJ Hampton)	x	x	x
<i>Carex striata</i> var. <i>brevis</i>		x		
<i>Cladium mariscoides</i>		x		
<i>Dichantheium spretum</i>		x		
<i>Rhexia virginica</i>		x		
<i>Scleria reticularis</i>		x		
<i>Acer rubrum</i> var. <i>trilobum</i>			x	
<i>Clethra alnifolia</i>			x	
<i>Coelorachis rugosa</i>			x	
<i>Eriocaulon compressum</i>			x	
<i>Liquidambar styraciflua</i>			x	
<i>Rhexia aristosa</i>			x	
<i>Rhynchospora filifolia</i>			x	
<i>Rhynchospora harperi</i>			x	
<i>Sabatia difformis</i>			x	
<i>Drosera intermedia</i>				x
<i>Woodwardia virginica</i>				x

Threats

A. The present or threatened destruction, modification, or curtailment of its habitat or range:

Encroachment of woody and herbaceous vegetation

At Labounsky Pond in New Jersey, woody vegetation is encroaching into the portion of the pond inhabited by *Dichanthelium hirstii*. If not removed, woody vegetation will cause shading that will decrease habitat suitability of the pond for *D. hirstii* (Gordon 2008), because the plants cannot survive in full shade.

At Hampton Furnace Pond, encroachment by native species, such as *Cladium mariscoides* (smooth sawgrass) and *Saccharum giganteum* (sugarcane plumgrass), may be a threat if they continue to migrate from the upper pond edge into the pond and crowd out *Dichanthelium hirstii* (Walz 2012a). In 2011, both of these perennial native species were in higher abundance within the *D. hirstii* zone of the pond than in previous years, and were observed to be competing for space on the same hummocks with *D. hirstii*. Fire is likely the ecological process that keeps these species in check; fire has not occurred at the site since 1999.

Encroachment of woody vegetation at Assawoman Pond in Sussex County, Delaware, will always be a concern, but it is being actively managed by Delaware Natural Heritage Program (DNHP) staff (McAvoy 2004; 2008a; 2010; 2012a; 2012b). This woody vegetation includes *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweet gum), and *Diospyros virginiana* (American persimmon) (Bennett 1998; McAvoy 2008a). An adjacent sandpit, which is lower in elevation than the pond bottom, may be pulling ground water away from the pond. This could result in an early and prolonged draw down, which would allow woody vegetation to become established (McAvoy 2012a), but hydrological studies are needed to know conclusively. Annual, or usually biennial, management efforts are conducted to control woody vegetation in the pond using both manual and chemical methods.

Carex striata (Walters sedge), a native sedge, was documented at Assawoman Pond in 1995 and was found to be expanding in 2009 (McAvoy 2010). If not controlled, *C. striata* will outcompete *Dichanthelium hirstii* within the pond (McAvoy 2007). However, DNHP staff monitor the size and distribution of *C. striata* within the pond and apply chemical control when needed. In 2009, competition with the native, but extremely aggressive species *Sclerolepis uniflora* (bog button) within Assawoman Pond was identified as a serious threat (McAvoy 2010). However, after further observations since 2009, it is now believed that *S. uniflora* and *D. hirstii* occupy different elevations within the pond, so perhaps displacement by *S. uniflora* is not occurring. This issue will continue to be considered and monitored annually to determine if reduction of the *S. uniflora* population in the pond is needed in the future (McAvoy 2012a).

In addition to the encroachment affecting New Jersey sites, *Dichanthelium hirstii* habitat at the North Carolina extant sites, as well as the historical site in Georgia, are also affected. As mentioned above for North Carolina, the Lyman Road Cypress Savanna appears to be progressing towards a closed canopy (McAvoy 2013). For Georgia, aerial photos in 2013 indicate that the wetlands where the historical *D. hirstii* population occurred do still exist without obvious hydraulic alteration, although they are likely shaded by trees or other woody vegetation (Kruse 2013).

Based on the observed impacts to *Dichanthelium hirstii* populations, we find encroachment of woody and herbaceous vegetation (specifically *Carex striata*) is a significant threat to *D. Hirstii*, especially at Assawoman Pond. Maintaining habitat for *D. hirstii* requires consistent, annual monitoring to determine the degree and types of management needed to control undesirable vegetation.

Development

All known populations of *Dichanthelium hirstii* are located on public or conservation lands and therefore are generally protected from development activities. *Dichanthelium hirstii* habitat at Labounsky Pond in New Jersey has been effected by an illegally constructed ditch since the mid-to-late 1990s. This ditch drains surface water from a heavy equipment storage yard into Labounsky Pond. Runoff of oil, fuel, and lubricants from this storage yard poses a threat to water quality within the pond (Eisenhauer 1998; Patt 2000). The Nature Conservancy, when they owned the property, had worked with the construction company to address

the effects from the ditch. We have no other information indicating that development activities are affecting *D. hirstii* habitat and therefore conclude that development activities do not constitute a threat to the species.

Off-road vehicle use

Off-road vehicle (ORV) use has occurred in the vicinity of the *Dichantheium hirstii* population at Hampton Furnace Pond in New Jersey. This population is surrounded by a network of roads (within a few hundred meters) that lead to a nearby area where all the vegetation has been destroyed by illegal ORV traffic. The roads were created for the purpose of fighting a 1999 wildfire but quickly became regular thoroughfares for ORVs. While remote, Hampton Furnace Pond is accessible to ORVs and effects there are similar to other intermittent ponds with ORV use (Juelg 2011). There has been no documented damage to *D. hirstii* plants from ORVs to date. Increased surveillance and signage are being used to try to deter ORV use of the roads surrounding the pond. We conclude that ORV use is not a significant threat to the species.

Military training

The two known populations of *Dichantheium hirstii* on Camp Lejeune in North Carolina are within areas zoned for military training exercises, but the specific locations occupied by these populations are not likely to be affected. The federally endangered red-cockaded woodpecker (*Picoides borealis*) also occurs at one of these sites. While the protective measures for the red-cockaded woodpecker do not provide specific protection to *D. hirstii* sites, the presence of protective buffers for the woodpecker may result in less use of these areas. Although the protections do not exclude Marines on foot or in vehicles, the *D. hirstii* populations are in wet areas that are unfavorable for training and land vehicles. Consequently, the potential for effects from military training is low (Marine Corps Base Camp Lejeune, NC 2006, Appendix D, Tenbrink 2012). Therefore, we conclude that military training is not a significant threat to the species.

In summary, we find that *Dichantheium hirstii* is threatened by the present or threatened destruction, modification, or curtailment of its habitat or range due to the encroachment of woody and herbaceous vegetation.

B. Overutilization for commercial, recreational, scientific, or educational purposes:

We have no information indicating that overutilization poses a threat to *Dichantheium hirstii*.

C. Disease or predation:

Disease is not a known threat to *Dichantheium hirstii*. In the late 1990s, at both the Labounsky and Barkwoods Ponds in New Jersey, grazing by resident Canada geese (*Branta canadensis*) affected vegetation in the ponds. However, we have no information indicating that impacts from Canada geese constitute a threat to *D. hirstii*. In 2007, deer browse was observed on herbaceous vegetation at Barkwoods Pond in New Jersey, but because no *D. hirstii* plants were observed that year, it is uncertain whether deer browse of *D. hirstii* had occurred (Snyder 2010). We are not aware of any other information indicating that deer browse of *D. hirstii* poses a threat to the species. Therefore, we conclude that disease and predation are not significant threats to *D. hirstii*.

D. The inadequacy of existing regulatory mechanisms:

Dichantheium hirstii has varying levels of State protection across its range. Below, we describe the regulatory mechanisms for each State and evaluate their adequacy.

Delaware

In Delaware, *Dichantheium hirstii* is included on the States rare plant list. The State of Delaware does not

have a State endangered species law. The State has a rare plant conservation program, but no legal protection is given to plants or their habitats under the program; any protection is strictly voluntary (McAvoy 2012a). The occurrence of the species within a State wildlife management area (Assawoman Pond) provides protection from development. In addition, any activities in the surrounding State-owned area must first be reviewed to determine any potential effects to the site or population (McAvoy 2012a). Given that only one population of *D. hirstii* is extant in Delaware and that the population is on State land, the existing regulatory mechanism is adequately achieving its purpose for the Delaware population.

New Jersey

In New Jersey, *Dichanthelium hirstii* is State-listed as endangered. It is against State law to collect plant species occurring on State land. Therefore, the Wharton State Forest (Hampton Furnace Pond) site and the newly acquired Hirsts' Pond are protected from collection. The New Jersey Pinelands Protection Act prohibits development within the Pinelands Area unless it is designed to avoid irreversible adverse impacts on habitats that are critical to the survival of any local populations of federally or State-listed plant or animal species (N.J.A.C. 7:50-6.27 and 6.33). Protections afforded by the Pinelands Protection Act apply only within the Pinelands Area, specifically that area encompassed by the Pinelands Comprehensive Management Plan (N.J.S.A. 13:18A-1 *et seq.*). Pinelands regulations require 300-foot wetland buffers (N.J.A.C. 7:50-6.14). All New Jersey *D. hirstii* sites are within the New Jersey Pinelands Area and are afforded protection under the Pinelands Comprehensive Management Plan. Given that all of the *D. hirstii* populations occur on State-owned land and are within the Pinelands Area, existing regulatory mechanisms are adequately protecting the New Jersey populations.

North Carolina

In North Carolina, *Dichanthelium hirstii* is State-listed as endangered. Any person wishing to collect a listed plant species must have written permission from the property owner as well as a permit from the North Carolina Department of Agriculture's Plant Conservation Program. If species are illegally collected, the penalty is a fine of up to \$2,000 per plant collected. Additionally, both North Carolina sites occur on a Federal military installation with no public access (Gadd 2012). Both sites occur in areas that are generally incompatible with military training and therefore have not been affected historically by training activities. The existing regulatory mechanism is adequately achieving its purpose for the North Carolina populations.

Georgia

In Georgia, although *Dichanthelium hirstii* is considered Historical, the species is protected by the State under provisions of the Wildflower Preservation Act of 1973 (O.C.G.A. 12-6-170). The species cannot be removed from public land without authorization; a tag is required to transport protected species, and selling protected species is illegal without permission of the landowner.

In summary, based on our conclusions that development, ORV use, military training, and collection are not significant threats to *Dichanthelium hirstii* (see Factors A and B above), we find that inadequacy of regulatory mechanisms is not a threat to the species with respect to these factors. Effects from illegal ORV use are only a minor threat since there has been no documented damage to *D. hirstii* plants to date. The regulatory mechanism is sufficient, but enforcement has been lacking. Also, we find that there are no existing regulatory mechanisms addressing the threats of encroachment of woody and herbaceous vegetation, competition from rhizomatous perennials, fluctuations in hydrology, and stochastic events (see Factors A and E).

E. Other natural or manmade factors affecting its continued existence:

Competition from rhizomatous perennials

Competition from rhizomatous perennials, particularly *Eleocharis Robbinsii* (Robbins spikerush) that dominates the turf covering the pond bottoms, is a threat to *Dichantheium hirstii* in Barkwoods and Labounsky Ponds in New Jersey. Dense growth of *Utricularia fibrosa* (humped bladderwort) and algae may be retarding growth of *D. hirstii* plants at Barkwoods Pond when less water is present (Schuyler 1998a, p. 4). *Cladium mariscoides* and *Saccharum giganteum* at Hampton Furnace Pond in New Jersey may compete with *D. hirstii*. At Assawoman Pond in Delaware, *D. hirstii* does not occur in areas dominated by dense carpets of *Sclerolepis uniflora*, a native rhizomatous perennial that is a State-rare plant. *Sclerolepis uniflora* is aggressive at Assawoman Pond and may be outcompeting *D. hirstii* at the site (McAvoy 2004; McAvoy 2008b, p.1). Evidence suggests that *S. uniflora* and *D. hirstii* occupy different levels of elevations within the pond, so perhaps displacement by *S. uniflora* is not occurring (McAvoy 2012a). At one of the Camp Lejeune sites in North Carolina, *Utricularia inflata* (swollen bladderwort) and algae in the water were present and *D. hirstii* plants were much smaller than at the other site, which had deeper and clearer water (Schuyler 1998a, p. 4). Given that populations are small, the vulnerability of the species to competition from rhizomatous perennials is exacerbated.

Hydrology fluctuations

Persistent standing water during the *Dichantheium hirstii* growing season resulted in high mortality of established plants at the Assawoman Pond site where 111 plants died from 2000 and 2001 (McAvoy and Bennett 2002). Persistent standing water may prevent all germination and establishment of seedlings (McAvoy and Bennett 2002, p. 3). The duration, timing, and depth of standing water on the pond bottom at known occurrences in New Jersey during the growing season appear to be key factors in the annual presence or absence of the species and may account for dramatic fluctuations in population size. Changes to hydrology at *D. hirstii* habitats significantly impact persistence of the species (Gordon 2008). Intermittent ponds have naturally fluctuating seasonal water levels, exhibiting high water in the winter and spring and low water in the summer and fall as the local ground water levels drop. Changes in hydrology can also occur when water withdrawal is increased through residential well use or water diversions occurring in the local watershed. Precipitation events drive sand aquifer water table levels; therefore, major storm events can increase the depth and duration of flooding in these ponds.

Fire

While there is no direct evidence that fire is an ecological process that affects *Dichantheium hirstii* populations, this species was discovered at Hampton Furnace Pond in New Jersey in 2004 after a peat-burning fire in 1999 and subsequent flooding in 2002, which indicates that fire may affect population dynamics. Additional research is needed on fire history and seed bank dynamics.

Climate change

The Northeast Climate Impact Assessment (Frumhoff et al. 2007) models of future precipitation rates in the Northeast (assessment includes New Jersey, not Delaware or North Carolina) suggest a steady increase in annual precipitation, with a total increase of 10 percent by the end of the century. Under higher emissions scenarios, winter precipitation could increase an average of 20 to 30 percent. Little change is projected in summer precipitation. *Dichantheium hirstii* habitat could be affected if climate change causes altered patterns of precipitation, increased evapotranspiration from warmer temperatures, or increased human water demands. Sea level rise and saltwater intrusion into the ground water that flows to the Assawoman Pond may be a threat to the Delaware population in the future. The pond is about 0.6 km (0.4 mi) from the closest tidal river. The Assawoman Wildlife Area is bordered by the Assawoman Bay, a tidal, saltwater system, and freshwater seasonal ponds in the area that are much closer to tidal waters have turned brackish over time (McAvoy 2012a). There are currently no indications that saltwater has intruded into the *D. hirstii* site. Other ponds in the area show signs of salinity but not the pond that supports *D. hirstii*.

In New Jersey the effects of climate change are projected to include an increase in average temperature with

prolonged heat waves in the summer, an increase in precipitation particularly in the winter months, more extreme weather events such as storms and droughts, and sea level rise (Johnson and Walz 2013). A Climate Change Vulnerability Index analysis (Young 2011; Ring *et al.*, 2013) was conducted for 17 state endangered species, including *Dichanthelium hirstii*, that occur in coastal plain intermittent pond habitat in New Jersey. The authors conclude that *D. hirstii* is moderately vulnerable to climate change for a variety of reasons, including poor dispersal ability, dispersal constrained by natural and anthropogenic barriers, dependence on isolated wetland habitat, and dependence on natural disturbance regimes (hydrology) that may be altered by climate change.

In 2010, the North Carolina Department of Environment and Natural Resources conducted an assessment of the likely effects of climate change on North Carolinas ecosystems and species (NCNHP 2010). In North Carolina, *Dichanthelium hirstii* occurs in cypress savannas. These natural communities are typically seasonally or intermittently (irregularly) wet, and prolonged drought from climate change may have serious effects to species that occur there and that are not adapted to drought conditions. However, the magnitude of any changes that may occur to *D. hirstii* habitat due to climate change factors is highly uncertain.

Threats associated with small population number and size

Species that occur within a single small population or a small number of small populations are inherently more vulnerable to extinction than are widespread species because of the increased risk of genetic bottlenecks, random demographic fluctuations, and localized catastrophes such as hurricanes, drought, and disease outbreaks. Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (e.g., Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Very small, isolated plant populations, such as *Dichanthelium hirstii*, are also more susceptible to reduced reproductive vigor due to ineffective pollination, inbreeding, genetic depression, and hybridization. Small, isolated populations face an increased likelihood of stochastic extinction due to changes in demography, the environment, genetics, or other factors (Gilpin and Soulé 1986, pp. 2434). The problems associated with small populations are further magnified by synergistic interactions with other threats, such as those discussed above (see Factors A and C, above).

Summary of Factor E: We find that *Dichanthelium hirstii* is threatened by natural or manmade factors affecting its continued existence, specifically encroachment of woody and herbaceous vegetation, competition from rhizomatous perennials, fluctuations in hydrology, and threats associated with small population number and size.

Conservation Measures Planned or Implemented :

The Delaware Division of Fish and Wildlife (DDFW) and DNHP have conducted periodic removal of encroaching native, but aggressive, *Carex striata* and woody vegetation at Assawoman Pond. *Carex striata* was effectively managed at the site through 2004 (McAvoy 2004). Ongoing control of *C. striata* is planned by the DNHP (McAvoy 2010; McAvoy 2012a). It is presumed that the DNHP will continue to address existing and future threats to the species (McAvoy 2010; McAvoy 2012). However, concerns about encroachment by *Acer rubrum* and *Liquidambar styraciflua* and changes to hydrology of the site remain (McAvoy and Bennett 2000, pp. 5 to 6). In 2005, a small patch of *C. striata* was found in Assawoman Pond and had expanded in 2009. If not controlled, competition by *C. striata* could eliminate habitat for *Dichanthelium hirstii* (McAvoy 2007; 2010). Although still present in the pond, *C. striata* is at controllable levels and is currently not competing with *D. hirstii* (McAvoy 2012). In November 2004, 55 potted plants of *D. hirstii* were planted in Assawoman Pond by the DDFW and DNHP. These plants originated from seed collected from the site, which were germinated and reared by the Mt. Cuba Center in Hockessin, Delaware. The plants were randomly placed and planted within sunny open areas of the pond. Each plant was individually marked, and GPS point locations were recorded. Of the 55 nursery grown plants, 42 were observed to have survived the planting on the day following planting (McAvoy 2007). In 2006, 4 of the 55

plants were documented to have survived (McAvoy and Bennett 2007, p. 1). None of the nursery grown plants have been found since 2006 (McAvoy 2011a). It is unknown why the introductions did not survive (McAvoy 2012a).

At the Camp Lejeune, North Carolina sites, the Marine Corps has cooperated in *Dichantheium hirstii* protection efforts by avoiding activities that would adversely affect the species. One site at Camp Lejeune is within a protected zone maintained for red-cockaded woodpecker (LeBlond 1998). The protective measures for the red-cockaded woodpecker do not provide specific protection to *D. hirstii* sites, but the presence of protective buffers for the woodpecker may result in less use of an area. As indicated in the Integrated Natural Resources Management Plan, military training, controlled burning, and canopy vegetation management (hand or mechanical) activities within *D. hirstii* sites are reviewed for potential affects to the species (Marine Corps Base Camp Lejeune, NC 2006, Chapter 5, p. 2 and Appendix D; Tenbrink 2012).

In New Jersey, TNC had worked with a construction company to eliminate affects from the illegally constructed ditch near Labounsky Pond. Active management by the State will be necessary to ensure that effects are eliminated or minimized now that the site is on State land.

Experimental scarification treatments (light to heavy raking) of the pond bottoms at Labounsky and Barkwoods Ponds were initiated in 1999 in an attempt to stimulate any naturally occurring seed bank of *Dichantheium hirstii* at these sites (Patt 2000). In the summer of 2002, a small number of *D. hirstii* plants were found at the Labounsky Pond site (Gordon 2004; Juelg 2004). From 2005 to 2007, in a joint effort between TNC, New Jersey Department of Parks and Forestry, and New Jersey Geological Survey, hydrologic monitoring equipment (piezometers and data loggers) was installed at Labounsky and Hampton Furnace Ponds to monitor natural ground water fluctuations in the ponds and surrounding uplands and relate hydrologic fluctuations to population data (Cartica 2006, pp. 12; Cartica 2007, pp. 12; Walz and Cartica 2010, pp. 67). However, at Labounsky Pond, repeated vandalism to the locked well housings and destruction of water level monitoring equipment has hampered hydrologic assessment of the site. Alternative ways to monitor hydrology have been explored. Monitoring at Hampton Furnace Pond has provided a multiyear (2007 to 2011) data set of regional and local ground water hydrology. Monitoring continues with automated, remote, hourly data collection (Walz 2012a). To address the potential impacts of ORVs to *D. hirstii* at Hampton Furnace Pond, the New Jersey Conservation Foundation is working with Wharton State Forest to maintain No Motorized Vehicles signage in the area and encourage the Wharton State Park conservation officers to regularly patrol the area and enforce the State Park regulations that prohibit driving off of designated roads. Volunteer help is also being organized to help move these conservation efforts forward (Juelg 2011).

Summary of Threats :

The major threats to *Dichantheium hirstii* are encroachment of woody and herbaceous vegetation, competition from rhizomatous perennials, fluctuations in hydrology, and threats associated with small population number and size. The threat to *D. hirstii* from climate change factors, primarily changes in hydrology, is probable but the magnitude is uncertain.

The Service finds that listing this species is warranted throughout all of its range.

For species that are being removed from candidate status:

_____ Is the removal based in whole or in part on one or more individual conservation efforts that you determined met the standards in the Policy for Evaluation of Conservation Efforts When Making Listing Decisions(PECE)?

Recommended Conservation Measures :

Continue to monitor and manage known *Dichantheium hirstii* populations.

Conduct research on species life history. High priority life history research needs include the following:

- o Continue hydrologic monitoring at Hirsts and Hampton Furnace Ponds in New Jersey and Assawoman Pond in Delaware and initiate hydrologic monitoring at the North Carolina sites to correlate changes in hydrology to species abundance and persistence.

- o Continue to develop a comprehensive monitoring plan for *D. hirstii* populations, associated ecological communities, and hydrology rangewide.

- o Conduct genetics research on the reproductive biology of *D. hirstii*, including ploidy (the number of sets of chromosomes in a cell or organism) level analysis of microsatellite markers (a specific sequence of DNA bases or nucleotides used to determine relatedness between individuals or vegetative parentage) critical for the genetic identification of clonal (asexual reproduction) plants and demographic analyses and for the determination of genetic variation to assess local and regional differences within and among populations.

- o Conduct research on the effects of fire on seed bank dynamics.

Conduct de novo (over again from the beginning) surveys within suitable coastal plain habitats throughout the species range.

Conduct a survey at the Georgia site located in a cypress swamp in Calhoun County, 1 mile north of Leary. The species was documented in May 1947, and in the summer of 1985 suitable habitat in the area of this record was searched, but no plants were found. Notes made at that time indicate that not all likely habitat was searched; additional survey is merited. Based on surveys in 2013, researchers are confident that the Thorne location was found, but the site has succeeded to a closed canopy of pond cypress, making conditions unsuitable for *Dichantheium hirstii* (McAvoy 2013). Conduct additional search for Mossy Pond.

Manage encroachment of woody vegetation and rhizomatous perennials by controlled burning or hand removal.

Eliminate impacts from an illegally constructed ditch near Labounsky Pond containing runoff of oil, fuel, and lubricants.

Enforce restriction of ORVs at Hampton Furnace Pond with the assistance of the New Jersey Conservation Foundation and Wharton State Forest.

Priority Table

Magnitude	Immediacy	Taxonomy	Priority
High	Imminent	Monotypic genus	1
		Species	2
		Subspecies/Population	3
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies/Population	6
Moderate to Low	Imminent	Monotype genus	7
		Species	8
		Subspecies/Population	9
	Non-Imminent	Monotype genus	10
		Species	11
		Subspecies/Population	12

Rationale for Change in Listing Priority Number:

Magnitude:

While all six extant *Dichantheium hirstii* populations are located on public land, threats to the species from encroaching vegetation, competition from rhizomatous perennials, fluctuations in hydrologic conditions, and threats associated with small population number and size are significant. Given the naturally fluctuating number of plants found at each site and the isolated nature of the wetlands (limiting dispersal opportunities), even small changes in the species habitat could result in local extirpation. Loss of any known sites would constitute a significant contraction of the species range. The small number of populations and their small sizes make this species highly vulnerable.

Imminence :

Because most of the significant threats to *Dichantheium hirstii* impact the species over a period of years and, in some cases, are being managed to some extent, we consider the threats to be nonimminent.

Yes No Have you promptly reviewed all of the information received regarding the species for the purpose of determination whether emergency listing is needed?

Emergency Listing Review

No Yes Is Emergency Listing Warranted?

Based on the best available scientific information, emergency listing is not warranted at this time. Although there are few populations, they are widely scattered such that there is no single threat likely to result in extirpation simultaneously.

Description of Monitoring:

Information regarding the status of the species is being monitored through annual coordination with New Jersey, Delaware, and North Carolina Natural Heritage Program staff, species experts, and local professional and amateur botanists.

The last comprehensive status survey for the species was conducted in 1998 (Schuyler 1998a, p. 1). The New Jersey populations are monitored sporadically on a voluntary basis by interested botanists and naturalists. Many of these monitoring efforts go unreported. For example, the Service did not learn until June 2004 that *Dichanthelium hirstii* had been rediscovered at Labounsky Pond in the summer of 2002 by local botanists. However, the Hampton Furnace Pond site population has been monitored regularly and intensively by the NJDEP since its discovery in 2004. The Delaware population is monitored annually by the DNHP. The States of New Jersey and Delaware are now cooperating to conduct consistent monitoring. In 2009 and 2010, New Jersey and Delaware developed a draft monitoring protocol to coordinate population and hydrology monitoring methodology and population data analysis. New Jersey added vernal inflorescence and water depth monitoring at each clump to their existing protocol and Delaware added counts of the number of inflorescences per culm and nodal spouts. The draft protocol includes the following objectives (Walz and Cartica 2010, pp. 810).

1. Conduct an annual census of *D. hirstii* at each location. The census effort needs to follow an adaptive monitoring strategy (e.g., if census creates too much physical disturbance to the habitat and plants, less frequent monitoring should be considered).
2. Conduct monthly (June, July, August, and September) population demographic surveys each year.
3. Conduct monthly water level measurement as depth of water at each clump (at time of population sampling).
4. Conduct annual vegetation community monitoring using multiple transects across the pond gradient within the *D. hirstii* population.
5. Conduct a survey of threats to each population noting species encroachment (e.g., *Cladium mariscoides*, *Carex striata* var. *brevis*), drought chlorotic plants, fire, flooding duration hydroperiod, herbivory, trampling, erosion, sedimentation.
6. Annually note the dates of anthesis, flower, fruit (vernal and autumnal), and senescence.
7. Annually conduct winter surveys for the presence of overwintering basal rosettes.

Botanists from New Jersey, Delaware, North Carolina and Georgia are working together on a comprehensive protocol entitled Range-wide Monitoring Protocol for Hirst Brothers Panic Grass (*Dichanthelium hirstii*). Details on sampling design, metrics, data collection and management, as well as roles and responsibilities will be completed in June 2014 (Sutter et al. 2014). The goals, objectives and assumptions in the new protocol include:

Goals:

1. To ensure the continued persistence of known populations through management and restoration.
2. To understand the threats and key ecological processes that determines the numbers and condition of the species.
3. To locate extant historically known and new populations within the range of the species.

Objectives:

1. Assess the status and trend of species numbers and condition in known populations.
2. Correlate hydrology (duration, timing, depth), species composition, and habitat condition with population status and trend.
3. Correlate site and regional threats with changes in population status and trend.
4. Search for historic and new populations during appropriate hydrologic years.

Assumptions:

1. A consistent and coordinated monitoring approach across multiple populations rangewide will provide greater insight into the factors that maintain numbers and condition of the species than monitoring populations individually.
2. Each state will adhere to the monitoring protocol, annually collecting data on population numbers and condition and the habitat and hydrologic covariates.

3. All states will work together in the management, analysis, and interpretation of the data and the identification of management and research actions.
4. All states will work together to ensure that adequate funding, as feasible, is available to annually complete the monitoring protocol in all populations.

The North Carolina populations are not regularly monitored. The level of monitoring across the different states is not appropriate to provide an adequate update of the species current status at this time. Given the low numbers of plants found at only six known locations, loss of any known sites would constitute a significant contraction of the species range.

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment:

Delaware, New Jersey, North Carolina

Indicate which State(s) did not provide any information or comment:

none

State Coordination:

We coordinated with biologists or botanists or both from Delaware, Georgia, New Jersey, and North Carolina. Delaware, Georgia, New Jersey, and North Carolina provided new information and comments.

Literature Cited:

Literature Cited:

(* Indicates electronic mail correspondence, unpublished reports, submitted manuscripts, or other grey literature)

Aliscioni, S.S., L.M. Giussani, F.O. Zuloaga, and E.A. Kellogg. 2003. A molecular phylogeny of *Panicum* (Poaceae: Paniceae): tests of monophyly and phylogenetic placement within the Panicoideae. *American Journal of Botany* 90(5): 796821.

Barrett, S. C. H., and J. R. Kohn. 1991. Genetic and evolutionary consequences of small population size in plants: implications for conservation. In D. A. Falk and K. E. Holsinger [eds.], *Genetics and conservation of rare plants*, 330. Oxford University Press, New York, NY.

*Bennett, K. 1998. Delaware Natural Heritage Program, Smyrna, Delaware.

*Buchanan, M. 2010. Electronic mail record of 3/30/2010. Botanist, North Carolina Natural Heritage Program, Raleigh, North Carolina.

*Cartica, R.J. 2005. I-8 Survey and monitoring of Hirsts panic grass (*Panicum hirstii*) in New Jersey, Project No: E-2-18. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of Natural Lands Management, Trenton, New Jersey. 4 pp.

*Cartica, R.J. 2006. I-8 Survey and monitoring of Hirsts panic grass (*Panicum hirstii*) in New Jersey, Project No: E-2-19. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of Natural Lands Management, Trenton, New Jersey. 3 pp.

*Cartica, R.J. 2007. I-8 Survey and monitoring of Hirsts panic grass (*Panicum hirstii*) in New Jersey, Project

No: E-2-R-1. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of Natural Lands Management, Trenton, New Jersey. 3 pp.

*Eisenhauer, S. 1998. The Nature Conservancy, Eldora, New Jersey.

Frumhoff, P.C., J.J. McCarthy, J.M. Melillo, S.C. Moser, and D.J. Wuebbles. 2007. Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions. Synthesis report of the Northeast Climate Impacts Assessment (NECIA). Cambridge, MA: Union of Concerned Scientists .

*Gadd, L. Electronic mail record of 4/2/2012. Botanist, North Carolina Natural Heritage Program, Raleigh, North Carolina.

Gilpin, M. E. & Soulé, M. E. "Minimum viable populations: Processes of species extinction." In Conservation Biology: The Science of Scarcity and Diversity, ed. M. E. Soulé (Sunderland: Sinauer & Associates, 1986): 1934.

Gleason, H.A. and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada, Second Edition. The New York Botanical Garden, Bronx, New York. P. 804.

*Gordon, T. 2004. Pine Barren Inventories, Southampton, New Jersey.

Gordon, T. 2006. 2003-2004 field trips. *Bartonia* 63:5367.

*Gordon, T. 2007. Pine Barren Inventories, Southampton, New Jersey.

*Gordon, T. 2008. Electronic mail record of 3/29/2008. Pine Barren Inventories, Southampton, New Jersey.

*Gordon, T. 2012. Electronic mail record of 3/1/2012. Pine Barren Inventories, Southampton, New Jersey.

Hitchcock, A.S. and A. Chase. 1910. Contributions from the United States National Herbarium, Volume 15, The North American species of *Panicum*. Smithsonian Institution, United States National Museum, Washington, D.C. 408 pp.

Johnson, E.A. and K.S. Walz. 2013. Integrated Management guidelines for Four Habitats and Associated State Endangered Plants and Wildlife Species of Greatest Conservation Need in the Skylands and Pinelands landscape Conservation Zones of the New Jersey State Wildlife Action Plan. Report by American Museum of Natural History and New Jersey Natural Heritage Program for NatureServe, Arlington, VA. 140 pp.

*Juelg, R. 2004. Pinelands Preservation Alliance, Southampton, New Jersey.

*Juelg, R. 2011. Electronic mail record of 3/03/2011. New Jersey Conservation Foundation, Shamong, New Jersey.

Kirkman, L. K. and R. R. Sharitz. 1994. Vegetation disturbance and maintenance of diversity in intermittently flooded Carolina bays in South Carolina. *Ecological Applications* 4(1): 177-188.

Kral, R. 1983. *Panicum hirstii* Swallen. A report on some rare, threatened, or endangered forest-related vascular plants of the south, Volume I. Technical Publication R8-TP2. U.S. Department of Agriculture, Forest Service, Atlanta, Georgia. pp. 75-77.

*Kruse, L. 2013. Electronic mail record of 3/25/2013. Botanist, Georgia Department of Natural Resources, Social Circle, Georgia.

*LeBlond, R. 1990. North Carolina Natural Heritage Program, Richlands, North Carolina.

- *LeBlond, R. 1998. North Carolina Natural Heritage Program, Richlands, North Carolina.
- *LeBlond, R. 2004. North Carolina Natural Heritage Program, Richlands, North Carolina.
Marine Corps Base Camp Lejeune, North Carolina. 2006. Final Integrated Natural Resources Management Plan. <http://www.lejeune.marines.mil/OfficesStaff/EnvironmentalMgmt/INRMP.aspx> (Accessed: May 20, 2013).
- *McAvoy, W.A. and K. Bennett. 2000. Survey and protection of federally listed and candidate plant species in Delaware, 2000 Project Report, Federal Aid Project E-2-15. Delaware Department of Natural Resources and Environmental Control, Natural Heritage Program, Smyrna, Delaware. 22 pp.
- *McAvoy, W.A. and K. Bennett. 2002. Survey and protection of federally listed and candidate plant species in Delaware, 2001-2002 Project Report, Federal Aid Project E-2-17. Delaware Department of Natural Resources and Environmental Control, Natural Heritage Program, Smyrna, Delaware. 22 pp.
- *McAvoy, W.A. 2004. Telephone conversation record of 6/10/2004. Botanist, Delaware Natural Heritage Program, Smyrna, Delaware.
- *McAvoy, W.A. 2005. Electronic mail record of 9/10/2005. Botanist, Delaware Natural Heritage Program, Smyrna, Delaware.
- *McAvoy, W.A. 2007. Electronic mail record of 4/16/2007. Botanist, Delaware Natural Heritage Program, Smyrna, Delaware.
- *McAvoy, W.A. 2008a. Electronic mail record of 4/21/2008. Botanist, Delaware Natural Heritage Program, Smyrna, Delaware.
- *McAvoy, W.A. 2008b. Job 2: Research and habitat enhancement of Hirsts panic grass (*Dichanthelium hirstii*). Excerpt from survey and protection of federally listed and candidate plant species in Delaware, 2007-2008 Project Report, Federal Aid Project E-2-23. Delaware Department of Natural Resources and Environmental Control, Natural Heritage Program, Smyrna, Delaware. 2 pp.
- *McAvoy, W.A. 2009. Electronic mail record of 4/13/2009. Botanist, Delaware Natural Heritage Program, Smyrna, Delaware.
- *McAvoy, W.A. 2010. Electronic mail record of 3/18/2010. Botanist, Delaware Natural Heritage Program, Smyrna, Delaware.
- *McAvoy, W.A. 2011a. Electronic mail record of 5/12/2011. Botanist, Delaware Natural Heritage Program, Smyrna, Delaware.
- *McAvoy, W.A. 2011b. Delawares Rare Plant Conservation Program, 2010-2011 Project Report, Federal Aid Project Agreement E-2-24. Delaware Natural Heritage and Endangered Species Program, Smyrna, Delaware.
- *McAvoy, W.A. 2012a. Electronic mail records of 3/7/2012 ; 4/2/2012 and 6/15/2012. Botanist, Delaware Natural Heritage Program, Smyrna, Delaware.
- McAvoy, W.A. 2012b. Delawares Rare Plant Conservation Program, 2011-2012 Project Report, Federal Aid Project Agreement E-2-25. Delaware Natural Heritage and Endangered Species Program, Smyrna, Delaware.
- *McAvoy, W.A. and K. Bennett. 2007. Job 2: Research and habitat enhancement of Hirsts panic grass (*Dichanthelium hirstii*). Excerpt from survey and protection of federally listed and candidate plant species in

Delaware, 2006-2007 Project Report, Federal Aid Project E-2-22. Delaware Department of Natural Resources and Environmental Control, Natural Heritage Program, Smyrna, Delaware. 2 pp.

Natural Resources Conservation Service. 2004. The PLANTS database, Version 3.5. U.S. Department of Agriculture, Natural Resources Conservation Service, National Plant Data Center, Baton Rouge Louisiana. <http://plants.usda.gov> (Accessed June 16, 2004).

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. <http://www.natureserve.org/explorer> (Accessed: April 14, 2008).

Newman, D., Pilson, D., 1997. Increased probability of extinction due to decreased genetic effective population size, experimental populations of *Clarkia pulchella*. *Evolution* 51, 354362.

*Noe, D. 2010. Electronic mail record of 3/26/2010. Estuary Enhancement Program Coordinator, The Nature Conservancy, Delmont, New Jersey.

*North Carolina Natural Heritage Program (NCNHP). 2008. Unpublished data from Biotics database accessed March 4, 2008 by Suzanne Mason, Environmental Biologist, North Carolina Natural Heritage Program, Raleigh, North Carolina.

North Carolina Natural Heritage Program (NCNHP). 2010. North Carolina Ecosystem Response to Climate Change: DENR Assessment of Effects and Adaptation Measures, NCDENR, Raleigh, North Carolina.

*Patt, J. 2000. The Nature Conservancy, Delmont, New Jersey.

Ring, R.M., E.A. Spencer, K.S. Walz. 2013. Vulnerability of 70 Plant Species of Greatest Conservation Need to Climate Change in New Jersey. Report by New York Natural Heritage Program and New Jersey Natural Heritage Program for NatureServe, Arlington, VA, 38 pp.

Schuyler, A.E. 1996. Taxonomic status of *Panicum hirstii* Swallen. *Bartonia* 59: 9596.

*Schuyler, A.E. 1998a. Status survey for *Panicum hirstii* (Hirsts panic grass) in New Jersey and Delaware. Report prepared for U.S. Fish and Wildlife Service, New Jersey Field Office, Pleasantville, New Jersey. 8 pp + maps.

*Schuyler, A.E. 1998b. Academy of Natural Sciences, Philadelphia, Pennsylvania.

*Schuyler, A.E. 2001. Academy of Natural Sciences, Philadelphia, Pennsylvania.

*Schuyler, A.E. 2004. Academy of Natural Sciences, Philadelphia, Pennsylvania.

*Snyder, D. 2010. Electronic mail record of 3/15/2010. Botanist, New Jersey Natural Heritage Program, Trenton, New Jersey.

Sutter, R., K. Walz, and W. McAvoy. 2014. Range-wide Monitoring Protocol for Hirst Brothers Panic Grass (*Dichanthelium hirstii*). 59 pp.

Swallen, J.R. 1961. A new species of *Panicum* from New Jersey. *Rhodora* 63(753): 235236.

*Tenbrink, C. 2012. Electronic mail record of 4/23/2012. Wildlife Biologist, MCB Camp Lejeune, North Carolina.

*Tenbrink, C. 2014. Electronic mail record of 04/23/2014. Wildlife Biologist, MCB Camp Lejeune, North

Carolina.

USDA-NRCS. 2013. PLANTS Database. <http://plants.usda.gov/java/>. (Accessed May 1 2013).

*Walz, K.S. and R.J. Cartica. 2008. I-8 Survey and monitoring of Hirsts panic grass (*Panicum hirstii*) in New Jersey, Project No: E-3-R-2. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of Natural Lands Management, Trenton, New Jersey. 3 pp.

*Walz, K.S. and R.J. Cartica. 2010. I-8 Survey and monitoring of Hirsts panic grass, *Dichanthelium* (= *Panicum*) *hirstii* in New Jersey Year 4, Project No: E-3-R-4. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of Natural Lands Management, Trenton, New Jersey. 15 pp.

*Walz, K.S. 2011. Electronic mail record of 5/12/2011. Ecologist, New Jersey Natural Heritage Program, Trenton, New Jersey.

*Walz, K.S. 2012a. Electronic mail records of 3/19/2012. Ecologist, New Jersey Natural Heritage Program, Trenton, New Jersey.

Walz, K.S. 2012b. The legacy of Hirst Brothers panic grass. United States Fish and Wildlife Service, Endangered Species bulletin, November-December 2012. <http://www.fws.gov/endangered/news/episodes/bu-11-2012/story4/index.html>

Walz, K.S. 2013. Field notes from surveys of June 2013 to Laboundky and Barkwoods Ponds in Atlantic County, NJ and survey of December 2013 to Hampton Furnace Pond in Burlington County, NJ. Ecologist, New Jersey Natural Heritage Program, Trenton, NJ.

*Walz, K.S. 2014. Electronic mail record of 6/6/14. Ecologist, New Jersey Natural Heritage Program, Trenton, New Jersey.

Wisheu, I.C. and P.A. Keddy. 1991. Seed banks of a rare wetland plant community: distribution patterns and effects of human-induced disturbance. *Journal of Vegetation Science* 2(2): 181188.

Yound, B., K. Byers, K. Gravuer, K. Hall, G. Hammerson, and A. Redder. 2011. Guidelines for using the NatureServe climate change vulnerability index v2.1. natureServe, Arlington, VA. <https://connect.natureserve.org/science/climate-change/ccvi>

Approval/Concurrence:

Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve:

Approve:


Regional Director, Fish and Wildlife Service

06/17/2014

Date

Concur:



11/18/2014

Date

Did not concur:

Date

Director's Remarks: