Xyris chapmanii

Chapman's Yellow-eyed-grass

Xyridaceae

Xyris chapmanii by Brett Budach, 2021

***Xyris chapmanii* Rare Plant Profile**

New Jersey Department of Environmental Protection
State Parks, Forests & Historic Sites
State Forest Fire Service & Forestry
Office of Natural Lands Management
New Jersey Natural Heritage Program

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Life History

Xyris chapmanii (Chapman's Yellow-eyed-grass) is a perennial herb in the Xyridaceae. *X. chapmanii* has slender, fibrous roots and clusters of distinctive, yellowish lateral buds are present at the base of the plants. The leaves are basal, linear, and typically 47–58 cm long—they are maroon or pinkish-purple at their bases and the color often extends up into the lower part of the blades. Leaf surfaces and margins are smooth. The thread-like scape of the inflorescence is 48–92 cm in height. Both the scapes and the leaves are spirally twisted. The flowering spikes of *Xyris* plants are dense and somewhat conelike with a number of overlapping bracts; those of *X. chapmanii* are ovoid and 10–11 mm long. The small yellow flowers have three petals and they are solitary in the axils of the bracts. *Xyris* flowers have three unequal sepals which are partially or completely concealed behind the bracts: The innermost one is membranous but the features of the two lateral sepals are often helpful in distinguishing species. Both the petals and the innermost sepal are deciduous while the lateral sepals remain attached to the fruit. The lateral sepals of *X. chapmanii* are smooth or irregularly jagged along the keels but they are not ciliate or fringed. The narrow seeds are 0.6–0.8 mm long and light-colored near the middle with darker tail-like appendages at both ends. (See Bridges and Orzell 1990 and 2003, Moyer and Bridges 2015, LeGrand et al. 2023).

Left: A. C. Moore Herbarium. Center and Right: Brett Budach, 2021.

Bridges and Orzell (1990) observed that the habitats favored by *Xyris chapmanii* are often utilized by many other *Xyris* species. *Xyris* flowers are ephemeral, usually blooming for just a few hours, and the time of day that the flowers are open varies between species (Kral 1983). *X. chapmanii* flowers begin to expand 2–3 hours after sunrise and close around the middle of the day. The species blooms during August and September and the seeds become mature during September and October (Bridges and Orzell 1990). In New Jersey it can be difficult to distinguish *Xyris chapmanii* from similar yellow-eyed-grasses in the field so microscopic examination of sepals or seeds may be required (Moyer and Bridges 2015).

Pollinator Dynamics

No specific pollination mechanism has been identified for *Xyris chapmanii*. Bees are the primary pollinators in the Xyridaceae (Kral 1998) and both bees and flies have been observed visiting the flowers of *Xyris* species (Kral 1983, Les 2020). Self-compatibility reportedly varies within the genus (Les 2020). Some yellow-eyed-grasses are thought to be capable of developing seeds without fertilization (apomixis), and wind may also play a role in the pollination of some *Xyris* flowers (Kral 1983).

The North American species of *Xyris* do not have nectaries or a scent, and they produce relatively small amounts of pollen (Kral 1966, 1983). The ephemeral nature of *Xyris* flowers seems likely to limit the opportunity for cross-fertilization of any kind. However, a pollination study of *X. tennesseensis* showed that the flowers did receive a number of insect visitors during the brief time that they were open (Boyd et al. 2011). In fact, one bee species (*Lasioglossum zephyrum*) did not wait for the flowers of *X. tennesseensis* to open but removed the sheathing lower sepal as the flower bud emerged in order to gain early access to the pollen (Wall et al. 2002). The research conducted on *X. tennesseensis* by Boyd et al. (2011) indicated that both halictid bees and syrphid flies visited the flowers to obtain pollen but only the bees transported a significant amount of pollen to other flowers. However, the authors concluded that the role of insects in pollination was not essential because there was no significant difference in seed set between insect-pollinated flowers and those from which insects had been excluded.

While some insects exploit *Xyris* flowers for their pollen, there is another organism that exploits the insect visitors of some yellow-eyed-grasses. *Fusarium xyrophilum* is a fungus that infects *Xyris* plants, inhibits their floral development, and produces showy yellow pseudoflowers on the spikes. Insects attracted to the pseudoflowers then disperse the spores of the fungus to other *Xyris* plants. To date, the fungus has only been reported on *Xyris* species in South America (Slot and Kasson 2021).

Seed Dispersal and Establishment

Xyris fruits are many-seeded capsules with thin walls that rupture at maturity (Fernald 1950, Kral 1966). The seeds fall or are shaken from the capsules by the spreading of bracts and sepals or the toppling of old scapes. *Xyris* seeds are often buoyant so they may drift if they land on water (Kral 1998), and both wind and post-consumption mammalian dispersal have been reported in the genus (Les 2020). Kral (1960) noted that the fruiting spikes of yellow-eyed-grasses can also be an important seasonal food source for Wild Turkeys (*Meleagris gallopavo*).

Xyris seeds can germinate within two weeks if they land on a moist substrate, but in dry conditions they are able remain dormant for years (Kral 1998). Baskin and Baskin (2003) observed that *X. tennesseensis* had a small but persistent seed bank. Germination may occur regardless of the season as long as there is adequate moisture, warmth, and sunlight (Kral 1966). An absolute light requirement was reported for *X. tennesseensis* (Baskin and Baskin 2003), and a study of *X. difformis* found that germination success was affected by microsite characteristics such as substrate and position relative to the water level (Wilson et al. 1985). Following

germination, *Xyris* seed husks often remain attached to the linear cotyledons for several weeks. After about a month, the seedlings form small, usually fan-shaped rosettes of five or more leaves. Most species flower within a year, so seeds released during the fall may develop into blooming plants by the following summer (Kral 1966). Seeds of a closely related species (*X. scabrifolia*) that were planted in March flowered during the summer of the same year (Les 2020).

Habitat

Xyris chapmanii can be found in comparable habitats throughout its entire range. The species is restricted to mucky seepage bogs with a steady groundwater supply. *X. chapmanii* often grows in the lowest, wettest parts of the habitats. The bases of the plants are deeply set in the substrate, which may consist of *Sphagnum* mosses or saturated peat. Many of the natural communities where *X. chapmanii* occurs are maintained by fire, but the yellow-eyed-grass has also been documented in boggy sections of utility right-of-ways (Bridges and Orzell 1990, Sheridan et al. 1997, Sorrie et al. 1997, Lee 1998, McMillan et al. 2002, Poole et al. 2007, Moyer and Bridges 2015, Weakley et al. 2022, Le Grand et al. 2023).

In New Jersey, *Xyris chapmanii* is restricted to wetland habitats in the Pine Barrens. Extant occurrences are situated in riverside shrub savannas, streamside seepage areas in Atlantic White Cedar (*Chamaecyparis thyoides*) swamps, along the border of an intermittent pond, and on the hummocks and edges of a beaver-created pond (NJNHP 2022). In addition to Atlantic White Cedar, typical flora at New Jersey sites includes an assortment of ericaceous shrubs, graminoids, and carnivorous plants (Moyer and Bridges 2015). Moyer and Bridges noted that most of the New Jersey communities where *X. chapmanii* occurs are best described as Pine Barrens Riverside Shrub Savanna and Pine Barrens Riverside Bog Asphodel Savanna (see Walz 2004a, 2004b).

In North Carolina, characteristic habitats for *Xyris chapmanii* include Sandhill Seeps and Sandhill/Streamhead Pocosin Ecotones (Sorrie et al. 2006). Georgia communities where the species occurs include Coastal Plain Seepage Slope Herb Bogs and Coastal Plain Seepage Swamp and Shrub Bogs (Chafin 2013). Although the dominant plants may vary from one site to the next, all of the habitats where *X. chapmanii* has been found are similar in structure and a number of common associates have been identified in locations ranging from New Jersey to Texas (Moyer and Bridges 2015).

Wetland Indicator Status

Xyris chapmanii is an obligate wetland species, meaning that it almost always occurs in wetlands (U. S. Army Corps of Engineers 2020).

USDA Plants Code (USDA, NRCS 2023)

XYCH

Coefficient of Conservancy (Walz et al. 2020)

CoC = 10. Criteria for a value of 9 to 10: Native with a narrow range of ecological tolerances, high fidelity to particular habitat conditions, and sensitive to anthropogenic disturbance (Faber-Langendoen 2018).

Distribution and Range

The global range of *Xyris chapmanii* is restricted to the southern and eastern United States (POWO 2023). The map in Figure 1 depicts the extent of the species in North America. *X. chapmanii* has also been reported in Louisiana (NatureServe 2023), while disjunct occurrences have been documented in New Jersey (Moyer and Bridges 2015) and Maryland (Mid-Atlantic Herbaria 2023).

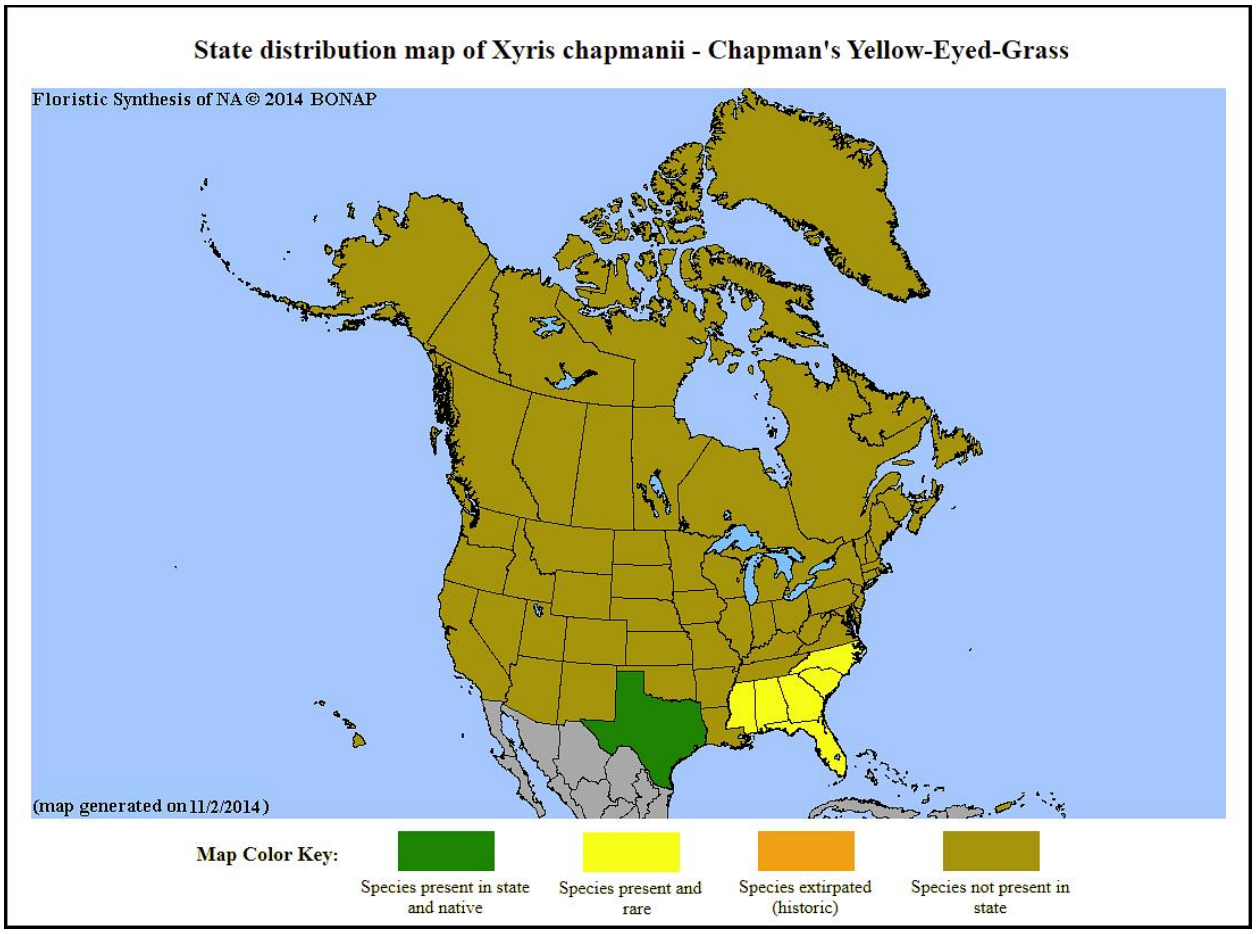

Figure 1. Distribution of X. chapmanii in North America, adapted from BONAP (Kartesz 2015).

The USDA PLANTS Database (2023) shows records of *Xyris chapmanii* in two New Jersey counties: Burlington and Ocean (Figure 2). The data reflect the state distribution of the species as it is currently understood.

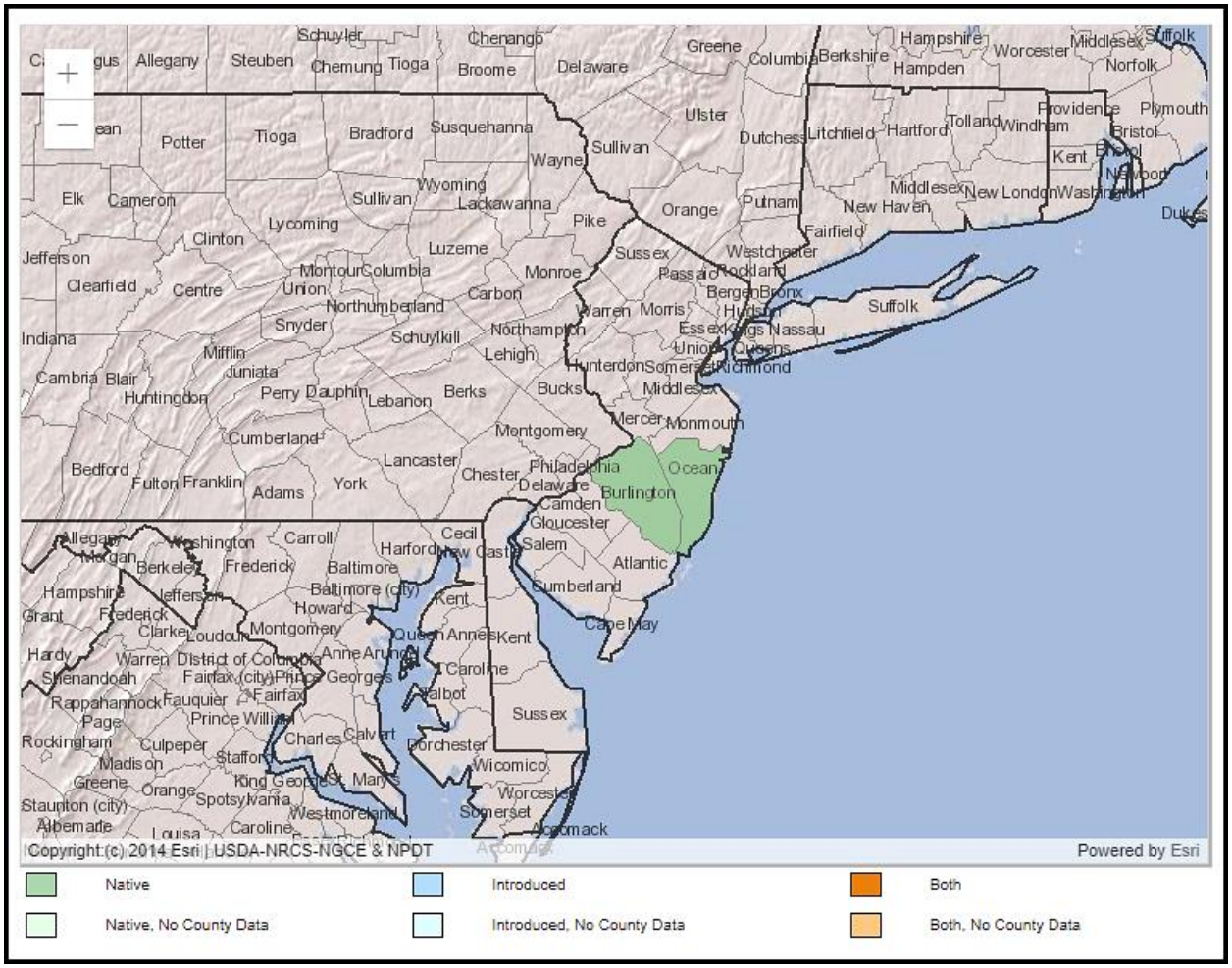

Figure 2. County records of X. chapmanii in New Jersey and vicinity (USDA NRCS 2023).

Conservation Status

Xyris chapmanii is globally vulnerable. The G3 rank means the species has a moderate risk of extinction or collapse due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors (NatureServe 2023). The map below (Figure 3) illustrates the conservation status of *X. chapmanii* throughout its range. Chapman's Yellow-eyed-grass is critically imperiled (very high risk of extinction) in four states, imperiled (high risk of extinction) in one state, and vulnerable (moderate risk of extinction) in two states. *X. chapmanii* is also very rare in Florida, where it was previously listed as an endangered species (Ward 2007), but that state now views it as conspecific with *X. scabrifolia* (FDACS 2023).

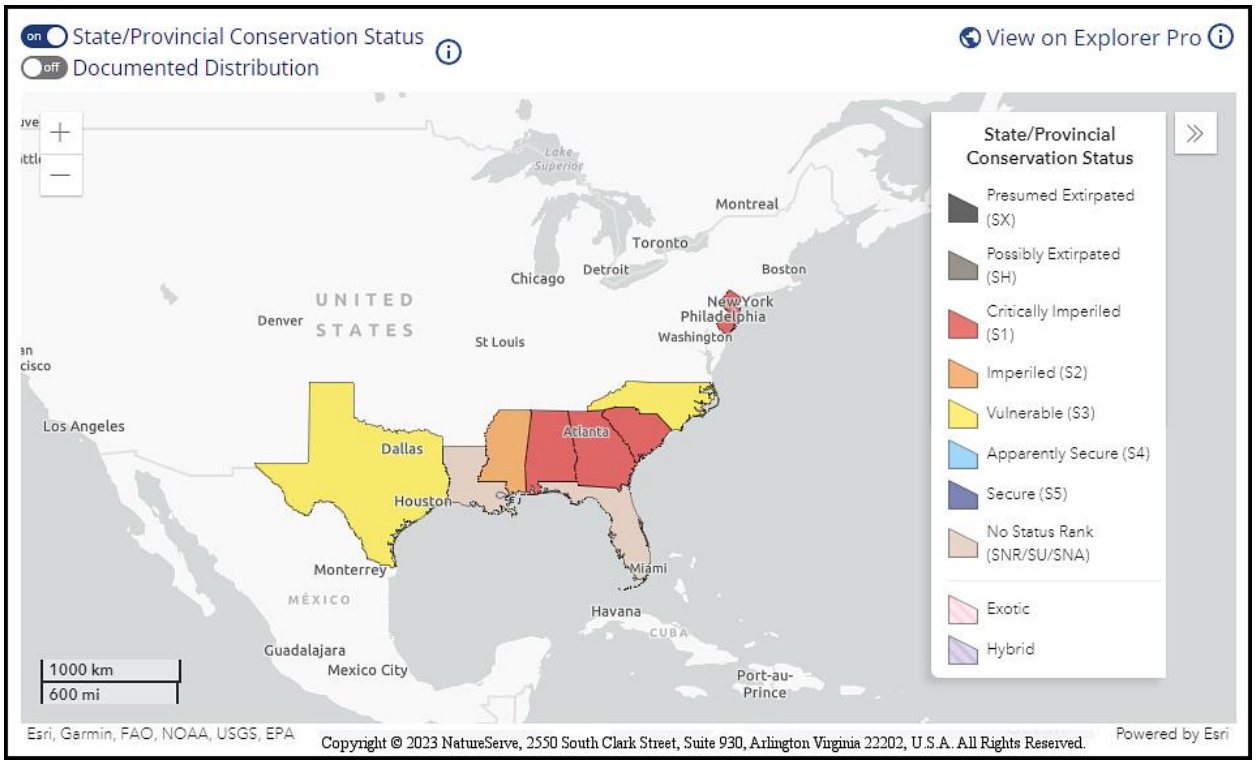

Figure 3. Conservation status of X. chapmanii in North America (NatureServe 2023).

Xyris chapmanii is critically imperiled (S1) in New Jersey (NJNHP 2022). The rank usually signifies five or fewer occurrences in the state. A species with an S1 rank is typically either restricted to specialized habitats, geographically limited to a small area of the state, or significantly reduced in number from its previous status. *X. chapmanii* has also been assigned a regional status code of HL, signifying that the species is eligible for protection under the jurisdiction of the Highlands Preservation Area (NJNHP 2010).

The first New Jersey population of *Xyris chapmanii* to be found after the species was described by Bridges and Orzell in 1990 was discovered during 2007, although some specimens had been collected in southern New Jersey between 1936–1959 and labeled as other yellow-eyed-grasses prior to the description (Moyer and Bridges 2015). Since 2007, fourteen additional populations of *X. chapmanii* have been found in the state, many of which comprise multiple subpopulations (NJNHP 2022). Throughout its range, populations of *Xyris chapmanii* are usually fairly small: Gray et al. (2003) reported a mean stem count of 31.2 for 26 populations in North Carolina and Amoroso et al. (2018) noted that most occurrences include less than 100 individual plants. However, several of the New Jersey populations contain hundreds of plants and at one site the estimated number of flowering scapes ranged from 1,000–1,700 (Moyer and Bridges 2015, NJNHP 2022).

Threats

Habitat loss and degradation are significant threats to *Xyris chapmanii* throughout much of its range. Past and present causes of direct habitat destruction include development, agriculture,

resource extraction, and forestry practices; and when similar activities are conducted on adjacent lands that can also disrupt natural hydrologic regimes (Chafin 2013, Johnson and Walz 2013, Amoroso et al. 2018). Chafin (2013) also noted that some seepage bogs have been degraded by exotic flora and fauna such as invasive plants or feral hogs. However, many of the extant *X. chapmanii* populations in New Jersey are situated on protected land and no immediate threats to the communities have been reported (NJNHP 2022).

As previously mentioned, *Xyris chapmanii* inhabits communities that are naturally maintained by fire. In the absence of active management natural succession is likely to threaten some of the populations. Chafin (2013) observed that many of Georgia's seepage bogs had been destroyed by fire suppression and Amoroso et al. (2018) indicated that proactive control of succession is required at many *X. chapmanii* sites. A recent study of New Jersey's Pine Barrens savanna communities by Smith (2012) documented extensive habitat losses and the decline appeared to have been driven by the alteration of natural disturbance regimes. McFarland et al. (2020) investigated the effects of a prescribed burn regime on a Mississippi community, and more than 250 species that were not present before the project was initiated—including *Xyris chapmanii*—were documented following a decade of the new management strategy. Four other *Xyris* species that occur in comparable habitat have also been found to respond positively to fire, increasing in abundance (Keith and Carrie 2002), and *X. tennesseensis* significantly increased both flowering and seedling production after a shrub-cutting program was implemented (Boyd and Moffett 2003).

Fusarium xyrophilum, the fungus that sterilizes *Xyris* plants and forms pseudoflowers on them to spread its own spores, has only recently been discovered and described (Laraba et al. 2020). While it is currently known to infect just two *Xyris* species in Guyana (Suszkiw 2021) it is possible that the fungus can (or has already) spread to other yellow-eyed-grasses. As more information becomes available it will be easier to assess whether the organism might become a threat to *Xyris* species in North America.

Nearly all of the North American *Xyris* species are obligate wetland plants (U. S. Army Corps of Engineers 2020) and Kral (1966) indicated that members of the genus are sensitive to substrate desiccation: If a habitat becomes overly dry during the growing season the plants are likely to set seed but may fail to produce the lateral buds required for overwintering. As a result of global warming, New Jersey is experiencing higher temperatures and shifting precipitation patterns which are increasing the frequency and intensity of both droughts and floods in the region (Hill 2020). Although the Pine Barren savannas habitats utilized by *Xyris chapmanii* may remain relatively stable as the climate changes they are susceptible to altered hydrologic conditions (Johnson and Walz 2013). It is impractical to assess the vulnerability of *X. chapmanii* to climate change because so few details are known regarding the species' life history but it seems likely that populations located at sites which are subjected to extended periods of drying could experience declines. Studies have shown that outcrossing is infrequent in *X. tennesseensis* (Boyd et al. 2011), and limited genetic diversity has been reported in that species (Downey and Baskauf 2020). That is likely also the case for many North American *Xyris* species because they make such a limited investment in attracting pollinators, and one potential consequence of low genetic variability is reduced adaptability in the face of rapidly changing conditions (Schierenbeck 2017).

Management Summary and Recommendations

Xyris chapmanii is endangered, threatened or vulnerable in most of the states where it is known to occur. New Jersey has a number of populations that are apparently well above average in size for the species, making them particularly worthy of conservation. The occurrences are also notable for their disjunct location at the northernmost end of the range. Land protection is an issue for *X. chapmanii* in some other states but many of the New Jersey populations are on property that has already been preserved.

Long-term conservation of *Xyris chapmanii* in New Jersey should focus on habitat maintenance. Amoroso et al. (2018) recommended prescribed burns at intervals of two to five years, suggesting mechanical removal of woody species as an alternative for sites where the use of fire is not feasible. Fire history studies in North Carolina have indicated that *X. chapmanii* thrives under fire regimes with two or three year intervals (Gray et al. 2003, Wall et al. 2021). Fires that occur during the growing season have proven most effective for other *Xyris* species in comparable habitat: Four yellow-eyed-grasses, including *X. scabrifolia*, significantly increased in abundance following a growing season burn but only one of them showed a slight increase as the result of a winter burn (Keith and Carrie 2002).

Because *Xyris chapmanii* was described fairly recently and is globally rare, little specific information is available regarding its life history characteristics. Research needs for Chapman's Yellow-eyed-grass include identification of pollination mechanisms, dispersal strategies, and establishment requirements. Managers should also pay heed as new information becomes available regarding the extent and spread of *Fusarium xyrophilum* in order to determine whether action will be needed to protect North American *Xyris* species from the fungus.

Synonyms

The accepted botanical name of the species is *Xyris chapmanii* Bridges & Orzell. Orthographic variants, synonyms, and common names are listed below (POWO 2023, USDA NRCS 2023). Kral (2020) and ITIS (2023) treat *X. chapmanii* as a synonym of *Xyris scabrifolia* and that viewpoint has also been adopted in Florida (FDACS 2023).

Botanical Synonyms	**Common Names**
	Chapman's Yellow-eyed-grass

References

A. C. Moore Herbarium. 2011. Scan of *Xyris chapmanii* specimen collected in South Carolina, September 24, 2011. Public domain image, courtesy of vPlants https://www.vplants.org/portal/collections/index.php. Image modified to remove location information.

Amoroso, J. L., L. Morse, and A. Treher. 2018. *Xyris chapmanii* conservation status factors. NatureServe, Arlington, VA. Accessed November 14, 2023 at https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.142794/Xyris_chapmanii

Baskin, Carol C. and Jerry M. Baskin. 2003. Seed germination and propagation of *Xyris tennesseensis*, a federal endangered wetland species. Wetlands 23(1): 116–124.

Boyd, Robert S. and J. Mincy Moffett, Jr. 2003. Management of *Xyris tennesseensis* (Tennessee Yellow-eyed Grass), a federally-endangered plant. GDOT Research Project No. 2003. Report prepared for the Georgia Department of Transportation and the U. S. Department of Transportation, Federal Highway Administration. 24 pp. Available at http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.484.1025&rep=rep1&type=pdf

Boyd, Robert S., Allison Teem, and Michael A. Wall. 2011. Floral biology of an Alabama population of the federally endangered plant, *Xyris tennesseensis* Kral (Xyridaceae). Castanea 76(3): 255–265.

Bridges, E. L. and L. Orzell. 1990. *Xyris chapmanii*, a new species from the Gulf Coastal Plain of the southern United States. Phytologia 68: 382–389.

Bridges, Edwin L. and Steve W. Orzell. 2003. Two new species and a new combination in southeastern United States *Xyris* (Xyridaceae) from Florida. Novon 13(1): 16–25.

Budach, Brett. 2021. Three photos of *Xyris chapmanii* from Florida. Shared via iNaturalist at https://inaturalist.nz/observations/95106137, licensed by https://creativecommons.org/licenses/by-nc/4.0/

Chafin, Linda. 2013. Georgia's Natural Communities and Associated Rare Plant and Animal Species: Thumbnail Accounts. Georgia Nongame Conservation Section. Wildlife Resources Division, Georgia Department of Natural Resources. Available at https://georgiawildlife.com/sites/default/files/wrd/pdf/rare-data/natural_communities_thumbnail_accounts.pdf

Downey, Kala M. and Carol J. Baskauf. 2020. Population genetics of a rare wetland species, the Tennessee Yellow-eyed grass (*Xyris tennesseensis*, Xyridaceae). Conservation Genetics 21(4): 735–746.

Faber-Langendoen, D. 2018. Northeast Regional Floristic Quality Assessment Tools for Wetland Assessments. NatureServe, Arlington, VA. 52 pp.

FDACS (Florida Department of Agriculture and Consumer Services). 2023. Endangered, Threatened and Commercially Exploited Plants of Florida. Accessed November 16, 2023 at https://www.fdacs.gov/Consumer-Resources/Protect-Our-Environment/Botany/Florida-s-Endangered-Plants/Endangered-Threatened-and-Commercially-Exploited-Plants-of-Florida

Fernald, M. L. 1950. Gray's Manual of Botany. Dioscorides Press, Portland, OR. 1632 pp.

Gray, Janet Bracey, Thomas R. Wentworth, and Cavell Brownie. 2003. Extinction, colonization, and persistence of rare vascular flora in the Longleaf Pine-Wiregrass ecosystem: Responses to fire frequency and population size. Natural Areas Journal 23(3): 209–219.

Hill, Rebecca, Megan M. Rutkowski, Lori A. Lester, Heather Genievich, and Nicholas A. Procopio (eds.). 2020. New Jersey Scientific Report on Climate Change, Version 1.0. New Jersey Department of Environmental Protection, Trenton, NJ. 184 pp.

ITIS (Integrated Taxonomic Information System). Accessed November 14, 2023 at http://www.itis.gov

Johnson, Elizabeth A. and Kathleen Strakosch 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 prepared for NatureServe #DDCF-0F-001a, Arlington, VA. 140 pp.

Kartesz, J. T. 2015. The Biota of North America Program (BONAP). Taxonomic Data Center. (http://www.bonap.net/tdc). Chapel Hill, NC. [Maps generated from Kartesz, J. T. 2015. Floristic Synthesis of North America, Version 1.0. Biota of North America Program (BONAP) (in press)].

Keith, Eric L. and N. Ross Carrie. 2002. Effects of fire on two pitcher plant bogs with comments on several rare and interesting plants. SIDA 20(1): 387–395.

Kral, Robert. 1960. The genus *Xyris* in Florida. Rhodora 62(743): 295–319.

Kral, M. 1966. *Xyris* (Xyridaceae) of the continental United States and Canada. Sida 2: 177–260.

Kral, Robert. 1983. The Xyridaceae of the southeastern United States. Journal of the Arnold Arboretum 64(3): 421–429.

Kral, R. 1998. Xyridaceae. In Klaus Kubitzki and T. Stuzel (eds). The Families and Genera of Vascular Plants, Volume 4: Flowering Plants, Monocotyledons: Alismatanae and Commelinanae (Except Gramineae). Springer-Verlag, Berlin. 521 pp.

Kral, Robert. Page updated November 5, 2020. *Xyris scabrifolia* R. M. Harper. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico [Online]. 22+ vols. New York and Oxford. Accessed November 14, 2023 at http://floranorthamerica.org/Xyris_scabrifolia

Laraba, Imane, Hye-Seon Kim, Robert H Proctor, Mark Busman, Kerry O'Donnell, Frederick C. Felker, M. Catherine Aime, Rachel A. Koch, and Kenneth J. Wurdack. 2020. *Fusarium xyrophilum*, sp. nov., a member of the *Fusarium fujikuroi* species complex recovered from pseudoflowers on yellow-eyed grass (*Xyris* spp.) from Guyana. Mycologia 112(1): 39–51.

Lee, Jim. 1998. The yellow-eyed grass family in Florida. The Palmetto 18(2): 14–16.

LeGrand, H., B. Sorrie, and T. Howard. 2023. Account for Chapman's Yellow-eyed-grass - *Xyris chapmanii* E. L. Bridges & Orzell. Vascular Plants of North Carolina, North Carolina Biodiversity Project and North Carolina State Parks, Raleigh, NC. Accessed November 14, 2023 at https://auth1.dpr.ncparks.gov/flora/species_account.php?id=4103

Les, Donald H. 2020. Aquatic Monocotyledons of North America: Ecology, Life History and Systematics. CRC Press, Boca Raton, FL. 568 pp.

McFarland, William J., Danielle Cotton, Mac H. Alford, and Micheal A. Davis. 2020. The vascular flora of the Lake Thoreau Environmental Center, Forrest and Lamar counties, Mississippi, with comments on compositional change after a decade of prescribed fire. Journal of the Botanical Research Institute of Texas 14(2): 413–433.

McMillan, Patrick D., Robert K. Peet, Richard D. Porcher, and Bruce A. Sorrie. 2002. Noteworthy botanical collections from the fire-maintained pineland and wetland communities of the coastal plain of the Carolinas and Georgia. Castanea 67(1): 61–83.

Mid-Atlantic Herbaria. 2023. Accessed at https://midatlanticherbaria.org/portal/index.php on November 14, 2023.

Moyer, Robert D. and Edwin L. Bridges. 2015. *Xyris chapmanii*, an overlooked *Xyris* species of the New Jersey Pine Barrens. Bartonia 67: 58–74.

NatureServe. 2023. NatureServe Explorer [web application]. NatureServe, Arlington, VA. Accessed November 14, 2023 at https://explorer.natureserve.org/

NJNHP (New Jersey Natural Heritage Program). 2010. Explanation of Codes Used in Natural Heritage Reports. Updated March 2010. Available at https://nj.gov/dep/parksandforests/natural/docs/nhpcodes_2010.pdf

NJNHP (New Jersey Natural Heritage Program). 2022. Biotics 5 Database. NatureServe, Arlington, VA. Accessed February 1, 2022.

Poole, Jackie M., William R. Carr, Dana M. Price, and Jason R. Singhurst. 2007. Rare Plants of Texas. Texas A&M University Press, College Station, TX.

POWO. 2023. Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Accessed November 14, 2023 at http://www.plantsoftheworldonline.org/

Schierenbeck, Kristina A. 2017. Population-level genetic variation and climate change in a biodiversity hotspot. Annals of Botany 119: 215–228.

Sheridan, P. M. S. L. Orzell, and E. L. Bridges. 1997. Powerline easements as refugia for state rare seepage and pineland plant taxa. In The Sixth International Symposium on Environmental

Concerns in Rights-of-Way Management. Edited by J.R. Williams, J.W. Goodrich-Mahoney, J.R. Wisniewski, and J. Wisniewski. Elsevier Science, Oxford, England.

Slot, Jason C. and Matt T. Kasson. 2021. Ecology: Fungal mimics dupe animals by transforming plants. Current Biology 31(5): 250–252.

Smith, David C. 2012. Succession dynamics of Pine-Barrens riverside savannas: A landscape survey approach. Master's Thesis, Rutgers University, New Brunswick, NJ. 69 pp.

Sorrie, Bruce A., Brian V. Eerden, and Mary J. Russo. 1997. Noteworthy plants from Fort Bragg and Camp MacKall, North Carolina. Castanea 62(4): 239–259.

Sorrie, Bruce A., Janet Bracey Gray, and Philip J. Crutchfield. 2006. The vascular flora of the Longleaf Pine ecosystem of Fort Bragg and Weymouth Woods, North Carolina. Castanea 71(2): 127–159.

Suszkiw, Jan. 2021. Fungus commits floral fraud to fool insects into spreading it. USDA Agricultural Research Service, Research News. Available at https://www.ars.usda.gov/news-events/news/research-news/2020/fungus-commits-floral-fraud-to-fool-insects-into-spreading-it/

U. S. Army Corps of Engineers. 2020. National Wetland Plant List, version 3.5. https://cwbi-app.sec.usace.army.mil/nwpl_static/v34/home/home.html U. S. Army Corps of Engineers Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, NH.

USDA, NRCS (U. S. Dept. of Agriculture, Natural Resources Conservation Service). 2023. PLANTS profile for *Xyris chapmanii* (Chapman's Yelloweyed Grass). The PLANTS Database, National Plant Data Team, Greensboro, NC. Accessed November 14, 2023 at http://plants.usda.gov

Wall, Michael A., Allison P. Teem, and Robert S. Boyd. 2002. Floral manipulation by *Lasioglossum zephyrum* (Hymenoptera: Halictidae) ensures first access to floral rewards by initiating premature anthesis of *Xyris tennesseensis* (Xyridaceae) flowers. Florida Entomologist 85(1): 290–291.

Wall, Wade A., Matthew G. Hohmann, Michael G. Just, and William A. Hoffman. 2021. Characterizing past fire occurrence in Longleaf Pine ecosystems with the mid-infrared burn index and a random forest classifier. Forest Ecology and Management 500: Article 119635.

Walz, K. Strakosch. 2004a. *Chamaecyparis thyoides / Gaylussacia dumosa / Andropogon glomeratus* var. *glomeratus* Fen conservation status factors. NatureServe, Arlington, VA. Accessed November 17, 2023 at https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.736386/Chamaecyparis_thyoides_-_Gaylussacia_dumosa_-_Andropogon_glomeratus_var_glomeratus_Fen

Walz, K. Strakosch. 2004b. *Chamaecyparis thyoides* / *Narthecium americanum* - *Sarracenia purpurea* - *Drosera filiformis* / *Sphagnum pulchrum* Fen conservation status factors. NatureServe, Arlington, VA. Accessed November 17, 2023 at https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.736389/Chamaecyparis_thyoides_-_Narthecium_americanum_-_Sarracenia_purpurea_-_Drosera_filiformis_-_Sphagnum_pulchrum_Fen

Walz, Kathleen S., Jason L. Hafstad, Linda Kelly, and Karl Anderson. 2020. Floristic Quality Assessment Index for Vascular Plants of New Jersey: Coefficient of Conservancy (CoC) Values for Species and Genera (update to 2017 list). New Jersey Department of Environmental Protection, New Jersey Forest Service, Office of Natural Lands Management, Trenton, NJ.

Ward, Daniel B. 2007. Keys to the flora of Florida - 16, *Xyris* (Xyridaceae). Phytologia 89(2): 167–177.

Weakley, A. S. and Southeastern Flora Team. 2022. Flora of the Southeastern United States. University of North Carolina Herbarium, North Carolina Botanical Garden, Chapel Hill, NC. 2022 pp.

Wilson, Scott D., Paul A. Keddy, and Deborah L. Randall. 1985. The distribution of *Xyris difformis* along a gradient of exposure to waves: An experimental study. Canadian Journal of Botany 63: 1226–1230.