

Interim Core Map Documentation for Tennessee Yellow-Eyed Grass

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Species Summary

Tennessee yellow-eyed grass (*Xyris tennesseensis*; Entity ID 1017) is a monocotyledonous endangered plant found primarily in the Southeastern United States. The U.S. Fish and Wildlife Service (FWS) has not assigned designated critical habitat for the Tennessee yellow-eyed grass. This species inhabits calcareous seeps, fens, and spring runs in Alabama, Georgia, and Tennessee. Additional habitat information is provided in **Appendix 1**.

Description of Core Map

The core map for the Tennessee yellow-eyed grass is biological information type, based on known location information of extant populations of the species within the range. The most recent 5-Year Review (FWS 2021) included textual descriptions of areas where the species has been documented. Known location information from the NatureServe and Global Biodiversity Information Facility (GBIF) databases provided corroboration of these general locations but were not otherwise used in core map development. Observation data from iNaturalist did influence the core map shape for the southernmost portion of the range in central Alabama.

The core map for the Tennessee yellow-eyed grass is based on biological information, which was used to refine an extent based on a combination of range and known location information of extant populations of the species. Within the core map extent, habitat areas were represented using the National Wetlands Inventory (NWI) water bodies with attributes matching descriptions of species habitat. Statewide habitat layers were combined, then had areas of contiguous cultivated areas > 25 acres removed from the core map.

The core map developed in this document for the Tennessee yellow-eyed grass spans 23,560 acres (Figure 1). A summary of acreage by National Landcover Database (NLCD 2021) land use type is provided in Table 1.

Based on the U.S Environmental Protection Agency's (EPA) "best professional judgment classification" system, CSI has graded this core map as "moderate" (4) because assumptions were made when connecting species life history and/or biological needs (habitat preferences) to a Geographical Information System (GIS) dataset, in this case the NWI dataset (FWS 2023). These assumptions involved associating the species' habitat— seeps, fens, and spring runs—with corresponding NWI classifications, in this case, select palustrine and riverine wetlands listed in **Appendix 2** Section 3. More information about the best professional judgment classification system and its definitions can be found in the core map process document (EPA 2024).

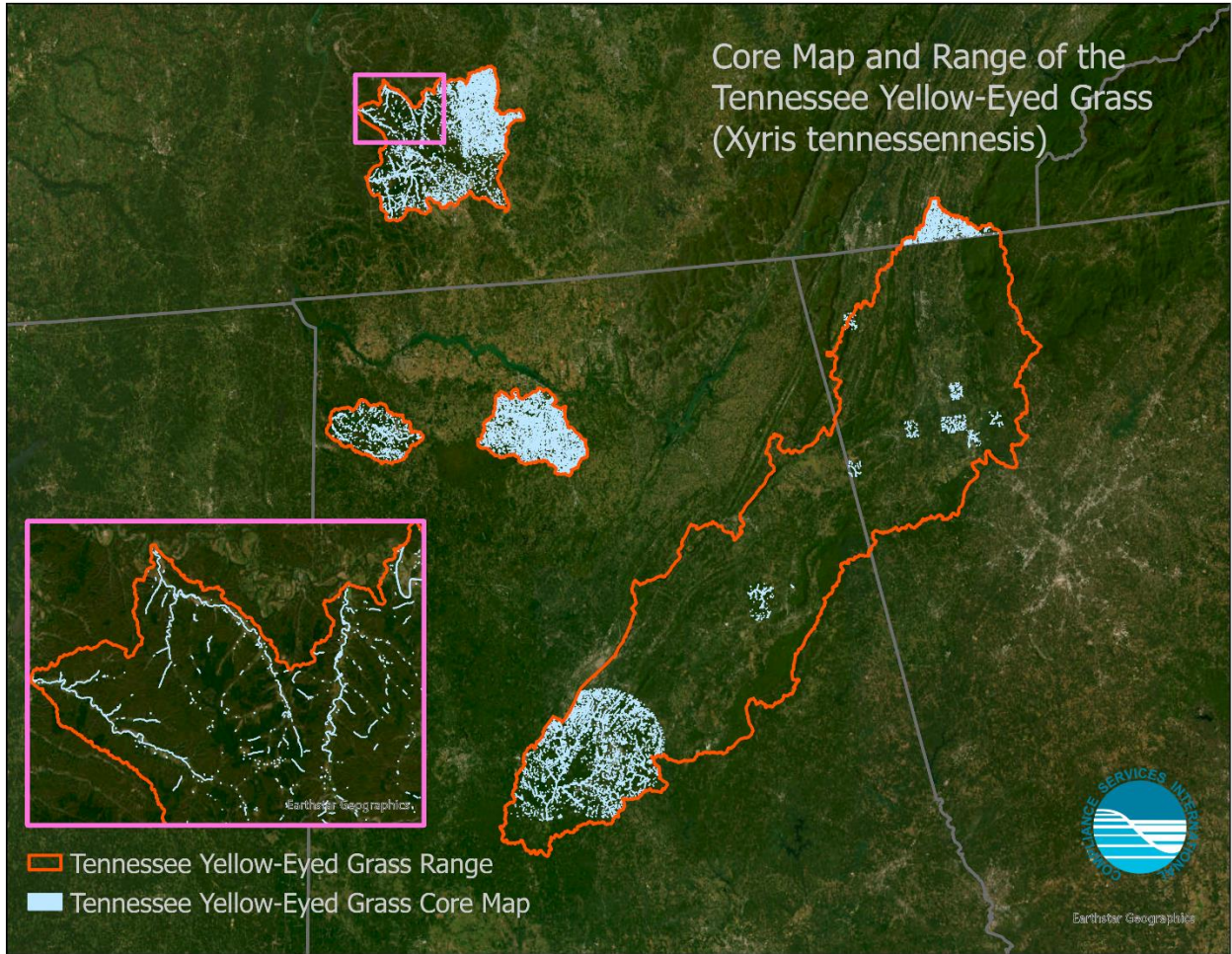


Figure 1. Interim core map for the Tennessee yellow-eyed grass (*Xyris tennesseensis*; Entity ID 1017). The core map spans 23,560 acres, while the range is 6,332,026 acres.

Table 1. Acres by National Land cover Database (NLCD 2021) class within the core map of the Tennessee yellow-eyed grass. Total core map area (based on NLCD pixel count): 23,505 acres¹.

NLCD_Land_Cover_Class	Acres
Hay/Pasture	5,499
Deciduous Forest	5,229
Open Water	4,245
Woody Wetlands	2,499
Mixed Forest	1,914
Evergreen Forest	1,011
Developed, Open Space	969
Developed, Low Intensity	482
Emergent Herbaceous Wetlands	436
Herbaceous	422
Developed, Medium Intensity	288
Shrub/Scrub	198
Barren Land	150
Developed, High Intensity	98
Cultivated Crops	65

Evaluation of Known Location Information

There were five evaluated datasets with known location information:

- Descriptions of locations provided by FWS;
- Occurrence locations in iNaturalist;
- Occurrence locations in GBIF;
- Occurrence locations in NatureServe; and
- Occurrence locations in the Georgia Department of Natural Resources Biodiversity Data Portal.

Compliance Services International evaluated these five datasets before developing the core map. Overall, there were nineteen usable research-grade observations found in iNaturalist². The GBIF dataset comprised twenty-eight georeferenced observations, seventeen of which were considered usable based on criteria described below. Both datasets were useful to identify extant population sites for the Tennessee yellow-eyed grass, but not comprehensive enough to be used as the primary source for core map development. The GBIF datasets was largely redundant because the iNaturalist observations comprised all the GBIF observations. Two iNaturalist observations in Central Alabama were determined to be a reasonable refinement for populations known to inhabit that region, but without precise location information.

¹ This acreage is slightly different from the core map acreage (23,560) due to the pixelation of NLCD land cover. The core map is not developed from raster data.

² According to iNaturalist, an observation is designated as “research grade” if it 1) is verifiable with date, coordinates, photos/sounds, and not captive; 2) achieves community agreement defined as “more than 2/3 of identifiers needs to agree on the species level ID or lower;” and 3) “must pass a data quality assessment, which includes checks for accurate date and location, evidence of a wild organism, and clear evidence of the organism itself” (<https://help.inaturalist.org/en/support/solutions/articles/151000169936-what-is-the-data-quality-assessment-and-how-do-observations-qualify-to-become-research-grade->).

FWS location information provided some refinement from species range. The identification of populations by name and owner enabled core map developers to identify some specific location information using U.S Geological Survey (USGS)'s Protected Areas Database of the United States (PAD-US), and more general location information corroborated by iNaturalist observations in Alabama.

NatureServe public element occurrence (EO) data were also evaluated and are considered by CSI to be a good corroboration of the datasets used.

One of NatureServe's natural heritage member programs, the Georgia Department of Natural Resources, maintains a public mapping tool with downloadable information of species location. The most precise of these datasets is the "quarter quad" layer, a shapefile of which was downloaded and incorporated into core map development. This is considered to be a high-quality dataset, suitable for use in core map development; however, its utility is limited to potential core map area in the state of Georgia.

Approach Used to Create Core Map

The core map was developed using EPA's process for developing core maps for species listed by the FWS and their designated critical habitat (referred to as "the process"). This core map was developed by CSI using the four steps described in the process document:

1. Compile available information for a species;
2. Identify core map type from among the following defined types: critical habitat, range, and biological information. From EPA, summaries of each core map type are provided below (EPA 2024).
3. Develop the core map for the species; and
4. Document the core map.

For step 1, CSI compiled available information for the Tennessee yellow-eyed grass from FWS, as well as observation information available from various publicly available sources including iNaturalist, GBIF, and NatureServe. The information compiled for the Tennessee yellow-eyed grass (*Xyris tennesseensis*) is included in **Appendix 1**. Influential information that impacted the development of the core map includes a description of the species habitat from the most recent 5-Year Review:

- "*Xyris tennesseensis* is an obligate wetland plant that is restricted to calcareous seeps, fens, and spring runs in Alabama, Georgia, and Tennessee. *Xyris tennesseensis* is not only at risk as a wetland plant, but is also extremely rare due to its unusual habitat requirement among North American xyrids for circum-neutral pH soils overlying calcareous substrates... the species is likely disturbance dependent and needs active management to main sites in suitable conditions for long-term viability (FWS 2021).

For step 2, CSI used the compiled information including the species range, known locations, and habitat location information to determine the core map type. Compliance Services International compared the known location data to the range and found that known locations from iNaturalist were usable as meaningful refinements of species range in central Alabama.

Review of the available data also suggested that the core map should exclude landcover types inconsistent with the Tennessee yellow-eyed grass habitat. To represent the species' habitat, the NWI dataset was

used to identify habitat classes associated with the species habitat description above; using the “ATTRIBUTE” field. The state-level habitat areas were merged and then had contiguous cultivated areas > 25 acres (EPA 2025) removed to develop the core map.

For step 3, CSI used the best-available data sources to generate the core map. Data sources are discussed in EPA’s core map process document. For this interim core map, CSI followed EPA’s decision framework to arrive at a core map type of biological information. Designated critical habitat was quickly eliminated as a core map type because the Tennessee yellow-eyed grass does not have critical habitat. The range core map type was not selected because the species range is neither refined nor endemic. **Appendix 2** provides more details on the GIS analysis and data used to generate the core map.

Discussion of Approaches and Data that were Considered but not Included in Core Map

Known Observation Datasets

Datasets such as GBIF and NatureServe were considered but not used. NatureServe public EOs are viewable in their mapper as hexagons corresponding to locations where the species may have been observed. The current range of the species intersects all the occurrences based on visual inspection. A different refinement from range (not based exclusively on known observation data) was selected as the outer extent and further refined with biological data. If known observation data is acquired that improves upon the extent used here—based on extant counties and ecoregions—then this could be a suitable alternative for core map use.

Additionally, iNaturalist data were considered for populations outside of central Alabama. Other core map areas were not represented by iNaturalist data because those areas were either not close matches to range (in northern Alabama) or not refinements of range (Tennessee). There were no iNaturalist data in Georgia.

Extant Counties

The most recent 5-Year Review includes a table listing extant populations and corresponding counties. While the extant populations were used to identify specific areas of known presence (*e.g.* the Anniston Army Depot), the extant counties were not used as a refinement of core map extent. This is because there was newly-published information—in this case, a recent expansion of species range—that precluded use of this refinement for at least part of the range. Visual inspection indicated that the proposed refinement on the previous range shape would have been modest. The use of extant counties in this instance would have decreased, rather than increased, confidence in the core map shape.

Appendix 1. Information compiled for Tennessee Yellow-Eyed Grass

1. Recent FWS documents

- 5-Year Review (2014): https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/2166.pdf.
- 5-Year Review (2021): https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/3303.pdf.
- Recovery Plan (1994): https://ecos.fws.gov/docs/recovery_plan/940624.pdf.

2. Background information

- Status: Federally listed as endangered in 1991.
- Resiliency, redundancy, and representation (the 3Rs) were not evaluated for this species.
- Habitat, Life History, and Ecology
 - '*Xyris tennesseensis* is an obligate wetland plant that is restricted to calcareous seeps, fens, and spring runs in Alabama, Georgia, and Tennessee. *Xyris tennesseensis* is not only at risk as a wetland plant, but is also extremely rare due to its unusual habitat requirement among North American xyrids for circum-neutral pH soils overlying calcareous substrates. In addition, it has been shown to be a poor competitor and quickly succumbs to ecological succession without periodic disturbance. This species is dependent on mycorrhizal fungi, especially for seed germination and for nutritional support before plants are capable of photosynthesis' (FWS 2014).
 - In the 2011, Boyd et al. (2000) reported that halictid bees and varying species of pollen-consuming syrphid flies frequented the flowering Tennessee yellow-eyed grass plants most often. In 2000, Boyd et al. (2000) determined solitary bees to be the most important pollinators of Tennessee yellow-eyed grass. However, the pollen supplementation study showed that flowers produce seeds without visitation by insects, likely by self-pollination (Boyd et al. 2011) SFWS 2021).
 - Current research indicates that flower production and (perhaps) seedling recruitment are most extensive in locations that are relatively sunny and lack an overstory of shrub or tree canopies. The species does best in relatively open moist sites (Baskin and Baskin 2003). According to Moffett (2008), woody and herbaceous vegetation that shades and competes with the species can suppress Tennessee yellow-eyed grass growth and reproduction. The tiny seedlings appear to need relatively well-lit moist soil to become established and grow to maturity. Thus, the species is likely disturbance dependent and needs active management to main sites in suitable conditions for long-term viability (Boyd and Moffett 2010) (FWS 2021).
 - Flowering occurs from August through September (FWS 2014).
- Taxonomy
 - 'Taxonomically, this species is nearest the *Xyris difformis* complex (Kral 1978, 1983, 1990). Species in this complex differ in having foliage which is generally more flattened and fanlike, leaves that are generally scabrid throughout, and more acute spikes with darker, fertile bracts (Kral 1983). In addition, those species in the *X. difformis* complex with farinose seeds (var. *floridana*) have a different seed sculpture from the farinose seeds of *X. tennesseensis* (Kral 1990)' (FWS 1994).

- Relevant Potential Pesticide Use Sites
 - ‘Off-road vehicles were impacting one of the Tennessee fens; timbering had recently occurred at the site with the largest population in Tennessee, and herbicide spraying for weed control had occurred at the Franklin County, Alabama site’ (FWS 1994)

- Relevant Recovery Criteria and Actions (FWS 2021)
 - Delisting Criteria

‘Recovery Criteria: Tennessee yellow-eyed grass will be considered for delisting when there are 15 adequately protected and managed, self-sustaining populations of the species distributed throughout the historical range and maintained for 10 years. A population will be considered adequately protected when it is legally protected and actively managed. A population will be considered “self- sustaining” if monitoring data support the conclusion that it is reproducing successfully and maintaining stable numbers or increasing. The minimum number of individuals necessary for a self-sustaining population should be determined by demographic studies implemented through the recovery plan.

Status: Criteria have not been met. Currently, the species is known from 26 sites with 21 populations that are considered extant. All are natural populations except for one that was created in Georgia in 2011 (Bluebird Springs). Only four of these sites occur on federally owned land. These four sites are protected and managed under the Fort McClellan INRMP and the Anniston Army Depot INRMP. There are two sites owned by the State of Georgia, one site owned by the State of Tennessee, one site registered as a Tennessee State Natural Area, and the remaining sites are in private ownership.’
 - Recommendations for Future Actions (FWS 2021)
 1. Initiate annual monitoring on sites with robust occurrences of the species to assess population trends, specifically in relation to habitat degradation.
 2. Initiate monitoring on sites with less robust occurrences and prioritize efforts to manage sites, due to the higher risk of extirpation.
 3. Conduct surveys to locate additional populations on seep-slopes, in springy meadows, and on the banks of small streams.
 4. Work to obtain protection for sites on privately-owned lands.
 5. Actively manage occupied sites to include woody plant competition control at staggered intervals.
 6. Investigate and identify potential sites for well-guided safeguarding opportunities for the species on protected public lands.
 7. Conduct more genetic research to determine if out-planting is advised or if there are specific sites that have weighted conservation priority.

3. Range

‘The known current and historic distribution of Tennessee yellow-eyed grass is restricted to the states of Alabama, Georgia, and Tennessee almost exclusively within the Valley and Ridge section

of the Interior Low Plateau Physiographic Province (Fenneman 1938; Moffett 2008). In Tennessee, the plant only occurs within the Western Highland Rim physiographic province (Tennessee Department of Environment and Conservation Division of Natural Areas, 2020). The distribution has not changed in Alabama, Georgia, and Tennessee since the last review' (FWS 2021).

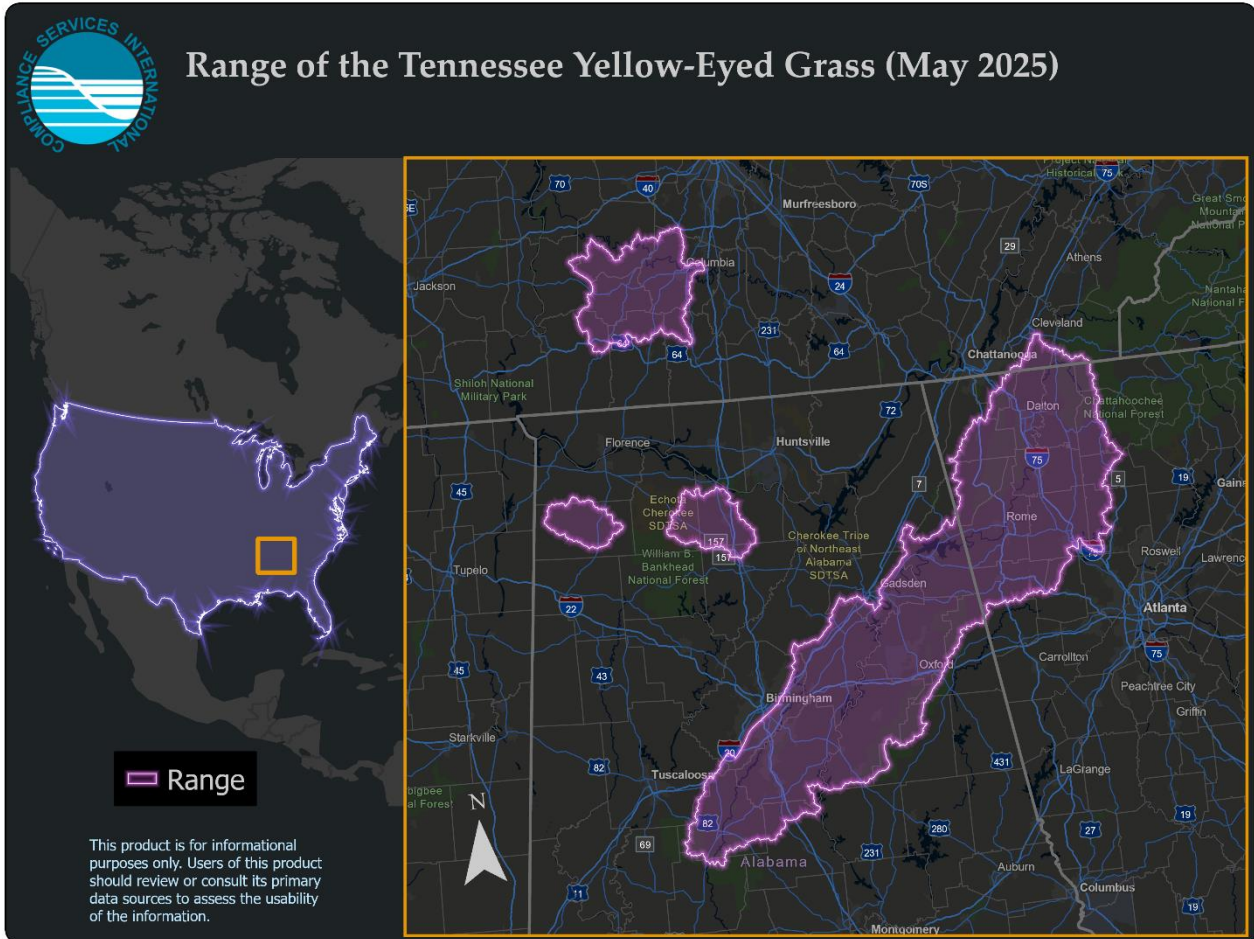


Figure 2. Range of the Tennessee yellow-eyed grass (FWS 2025).

4. Description of Critical Habitat

Critical habitat has not been designated for this species.

5. Known Locations

- Known populations by state (FWS 2021).
 - The most recent 5-Year Review document (FWS 2021) describes the counties with known extant populations by state as follows.
 - **Georgia:** Surveys of all known sites in Georgia were carried out in August 2019 by Dr. J.M. Moffett. Four natural populations and one created population of Tennessee yellow-eyed grass were determined to be extant. Since the last five-year review, two populations have been added to the records in Georgia. Soggy Bottom Fen was discovered 20 years ago but was not recorded into the Georgia Natural Heritage Program Biotics database at the time. There were

two surveys carried out at this site in 2009 and 2019 that showed zero plants and is determined to be likely extirpated. The other one, Bluebird Springs, was a site created by the Georgia Plant Conservation Association (GPCA) in 2011. The Mosteller Springs site in Georgia, which has been in decline for a decade or more, has rebounded due mostly to improved habitat conditions. Clear Creek Lake/Springs was another site, which had an increase. An estimated 60,000-70,000 flowering spikes were calculated. This site has been renamed to Shropshire Springs to reflect ownership, and to help avoid confusion with two other similarly named element occurrences. The site exhibited pristine habitat as well as great management. This site represents one of, if not the, largest Tennessee yellow-eyed grass populations in the world. (J. Moffett, pers. comm. 2021). However, the Tennessee yellow-eyed grass sites in Georgia are experiencing a decline overall since listing (J. Moffett, pers. comm. 2021).

- **Alabama:** There are ten extant populations in Alabama. A formal field survey of the two populations located on Anniston Army Depot (ANAD) in Alabama was conducted in September 2019, by Mr. Dan Spaulding of the Anniston Museum of Natural History. The survey revealed that the two populations are overall stable from the 2018 survey (ANAD INRMP 2018-2023). The sites located on Fort McClellan are monitored and managed by the onsite wildlife biologist. A new site was discovered in 2018, named Rock Creek. This site is located along Rock Creek, approximately 3 km downstream of the Gate #14 site. It has not been completely surveyed, counted, or sampled because of its location behind live fire ranges. It is unknown if the Rock Creek site is a separate population or is related genetically to the Gate #14 site. As for this review, we are including the Rock Creek population as part of the Gate #14 population. The Tennessee yellow-eyed grass sites in Alabama have declined overall since listing but have remained relatively stable since the last review (Leah Nerem Storino, pers. comm., 2021).
- **Tennessee:** There are six extant populations of Tennessee yellow-eyed grass in Tennessee. In 2004, eleven permanent monitoring plots were established at five sites in Lewis County. These plots are monitored annually and managed by the Tennessee Department of Environment and Conservation Division of Natural Areas. The Tennessee yellow-eyed grass sites in Tennessee are experiencing a decline overall since listing due to habitat destruction or modification (D. Lincicome, pers. comm. 2021; Tennessee Department of Environment and Conservation Division of Natural Areas, 2020).

Table 2. Summary of Tennessee yellow-eyed grass populations since listing. Copied from Table 1 of the most recent 5-Year Review (FWS 2021).

State	Extant sites at listing (1991)*	Extant populations in 2014	Extant populations as of 2021
Alabama	1	9 (4 counties)	10 (4 counties)
Georgia	1	6 (3 counties)	5 (3 counties)**
Tennessee	5	7 (1 county)	6 (1 county)
Total	7	22 (8 counties)	21 (8 counties)

* The listing rule in 1991 did not discuss populations but included sites.

** One Georgia population is an introduced safeguarding population.

- GBIF: <https://www.gbif.org/species/2692672>
 - GBIF includes 188 occurrence records; twenty-eight of which are georeferenced. Seventeen of these had usable coordinate data based on these criteria:
 - U.S. only (excludes Canada)
 - Latitude and longitude precision were both 3+ decimal places.
 - Coordinate uncertainty values no greater than 30 km.
 - Relative recency (2010-present)
 - Must include date information.
 - No “preserved specimen” observations; only “human observation.”
 - The seventeen usable coordinates were mapped against the species range to evaluate their utility in representing species extent (Figure 4). It was observed that all the usable GBIF coordinates are originally sourced from iNaturalist, which also had more records. Therefore, the GBIF dataset was not used for core map development.



Figure 3. GBIF occurrences for the Tennessee yellow-eyed grass (GBIF 2025).

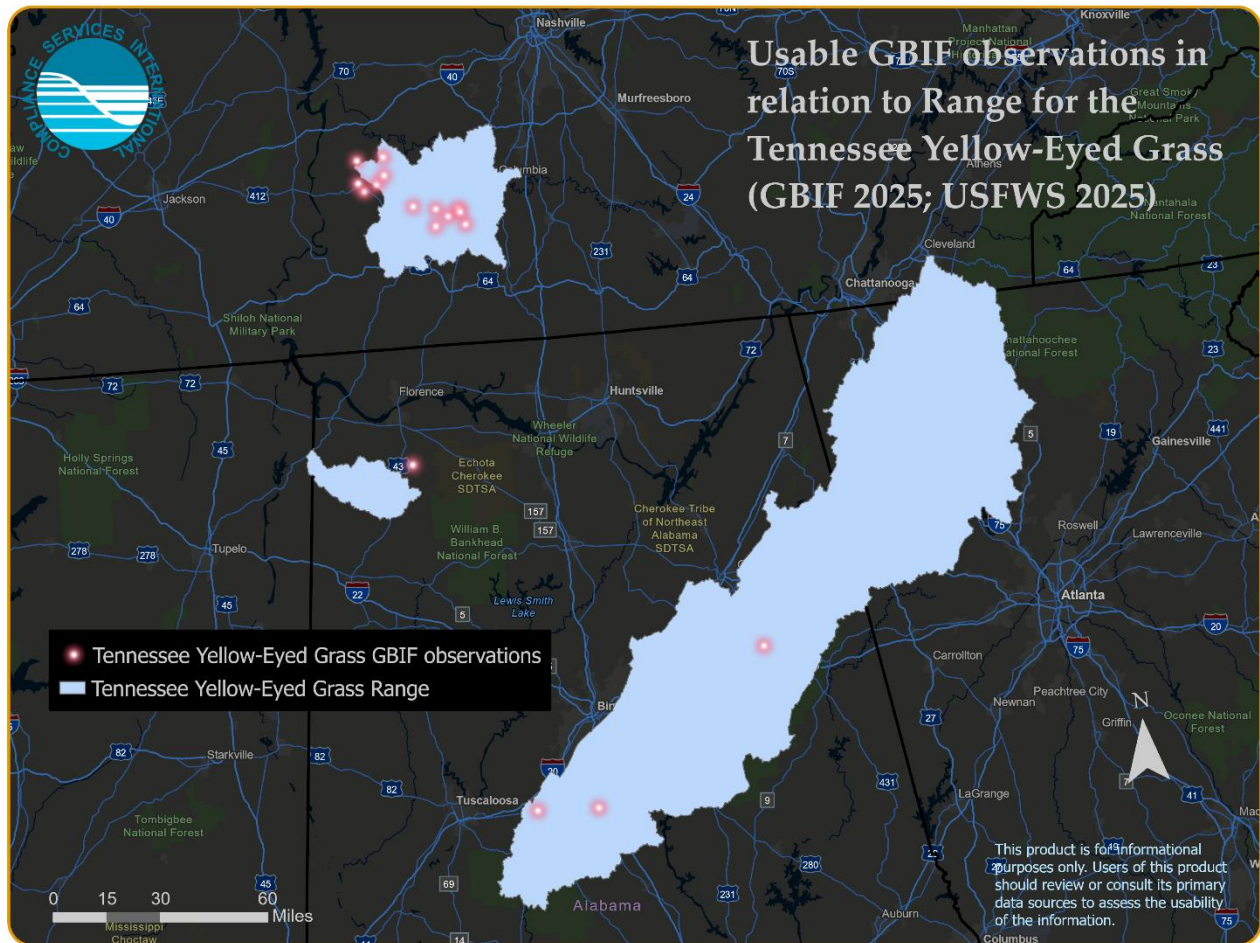


Figure 4. Usable GBIF occurrences (pink) in relation to the Range of the Tennessee yellow-eyed grass (GBIF 2025; FWS 2025).

- iNaturalist: https://www.inaturalist.org/observations?taxon_id=170378
 - iNaturalist includes thirty total observations (Figure 5), nineteen of which are research-grade with usable coordinate data based on these criteria:
 - U.S. only (excludes Canada)
 - Latitude and longitude precision were both 3+ decimal places
 - Relative recency (2010-present)
 - Observation description did not include the text “intentionally incorrect”
 - Public positional accuracy value no greater than 30 km³
 - This did not result in the exclusion of any records.
 - Locations are consistent with GBIF, which is expected because all the GBIF observations are imported from iNaturalist.
 - Five of the iNaturalist locations are just outside of the range of the Tennessee yellow-eyed grass; however, all of these intersect the range when accounting for the PPA uncertainty value.
 - The iNaturalist data are plentiful and their distribution provides general support for the use of current range as the outer boundary of analysis. These observations are not

³ For “obscured” observations, public positional accuracy (PPA) represents the diagonal of a 0.2 x 0.2 arc cell. See the iNaturalist geoprivacy page for more details on this and related terms [What is geoprivacy? What does it mean for an observation to be obscured? : iNaturalist Help](#).

usable as refinements of range in Georgia (where they are absent) or Tennessee (where they are voluminous and not a meaningful refinement of range). In the central portion of the range in Alabama, the known extant populations are identifiable in PAD-US as Fort McClellan and the Anniston Army Depot; therefore, iNaturalist data were not used. In northern Alabama, the iNaturalist data were not well-enough aligned with range, perhaps in part because the range was very recently updated (April 2025). However, populations in the southern portion of the range in Alabama were not easily identifiable by name but were confidently ascertained to be within the uncertainty distance associated with the iNaturalist observations; therefore, these data were used for this portion of the core map. Details about the iNaturalist observations and how the data were processed are provided in **Appendix 2**.

Observations

 Tennessee Yellow-eyed Grass

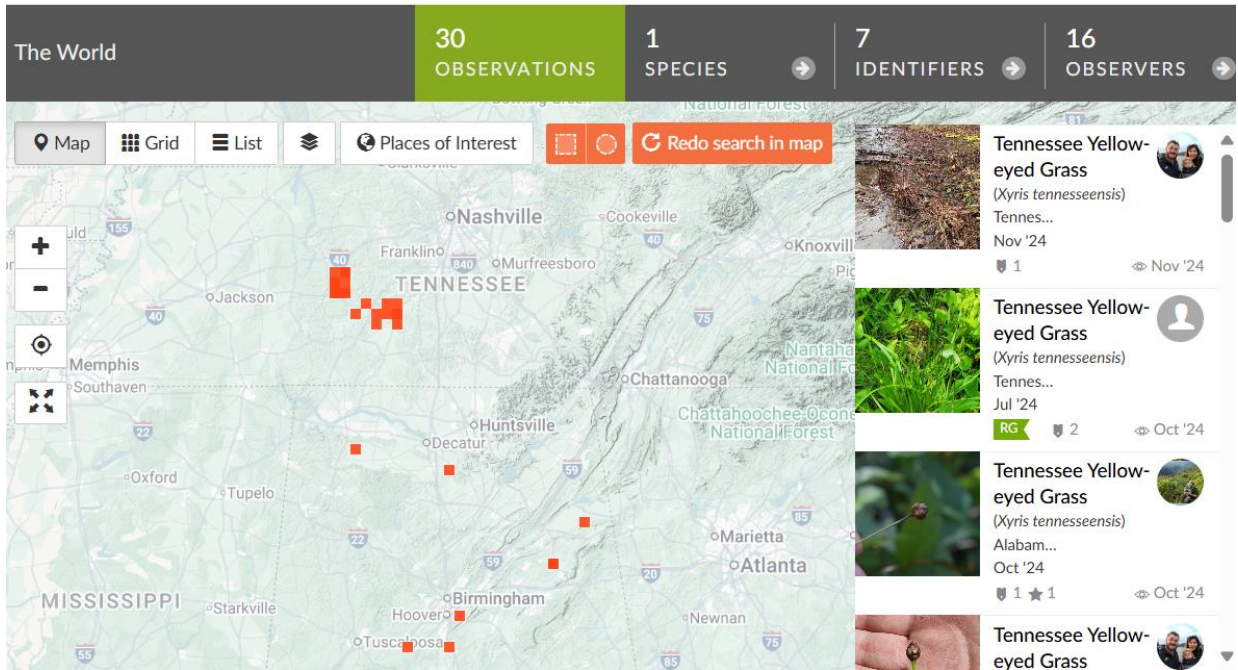


Figure 5. iNaturalist occurrences for the Tennessee yellow-eyed grass (iNaturalist 2025).

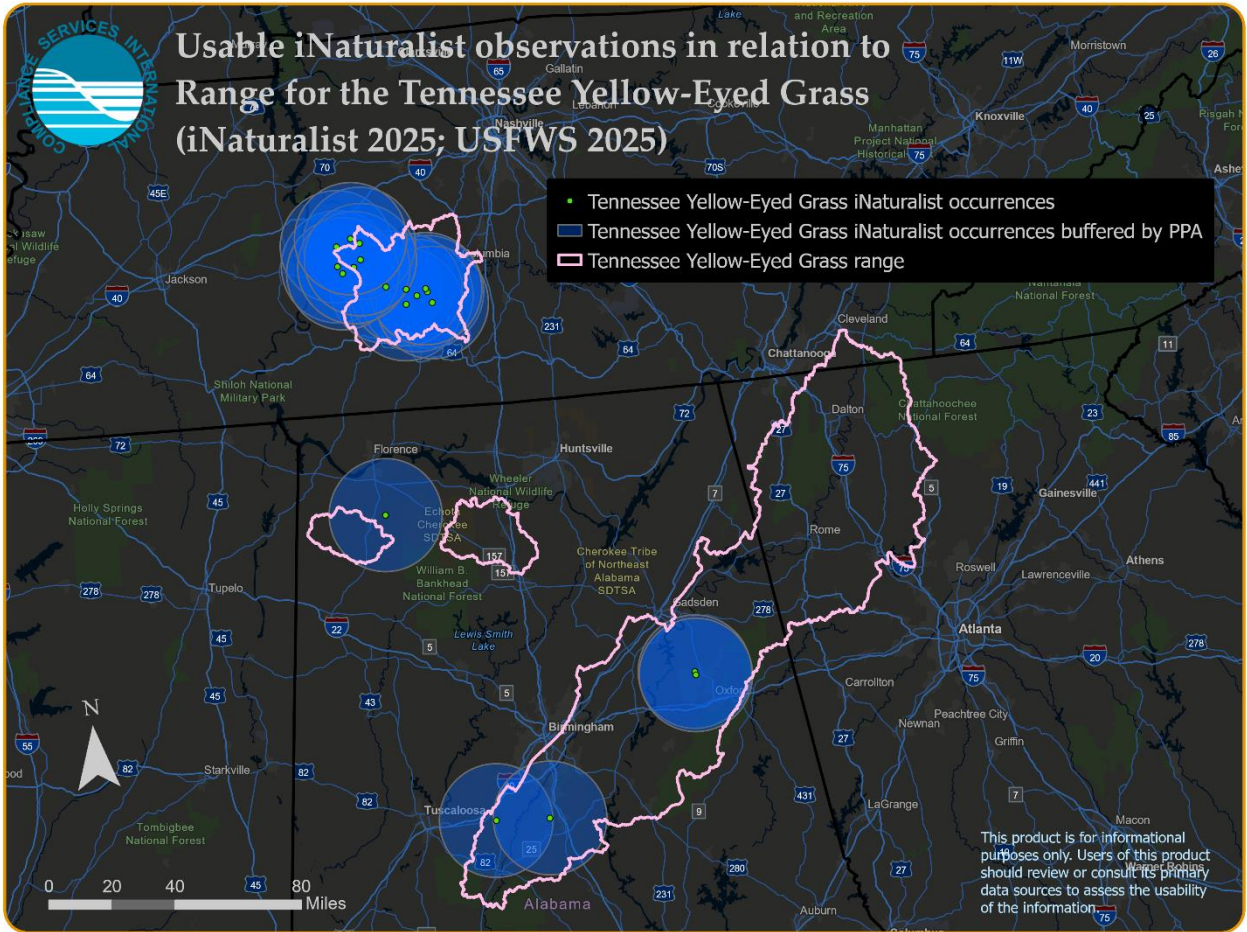


Figure 6. Usable iNaturalist observations, buffered by public positional accuracy (PPA), for the Tennessee yellow-eyed grass in relation to species range (iNaturalist 2025; FWS 2025).

- NatureServe Explorer: <https://explorer.natureserve.org/>
 - Available public occurrence information from NatureServe Explorer aligns with the information from iNaturalist and GBIF; additionally, areas of range in Alabama are better-represented than the iNaturalist or GBIF databases.
 - EOs were generally consistent with the range; however, these observations were not usable as a meaningful refinement of species range and therefore did not factor into the development of the core map.

Appendix 2. GIS Data Review and Method to Develop Core Map

The core map for this species is based on biological information, which includes the habitat used by this species found within a spatial extent of species range refined to include known observation data where possible. The core map identifies all areas within the extent matching the species' habitat description from **Appendix 1**. Within the extent, professional judgment was used to match "ATTRIBUTE" classes in the National Wetland Inventory (NWI) dataset as described below (FWS 2023). NWI is regarded as a high quality national-level dataset that is appropriate to identify habitat for aquatic species such as the Tennessee yellow-eyed grass.

1. References and Software

- Georgia Department of Natural Resources (GDNR) Biodiversity Portal: https://georgiabiodiversity.org/portal/rangemaps?es_id=17987.
- iNaturalist (2025): https://www.inaturalist.org/observations?taxon_id=170378.
- National Wetlands Inventory (FWS 2023): <https://www.fws.gov/program/national-wetlands-inventory>.
- U.S. Geological Survey (USGS) Protected Areas Database of the United States, PAD-US (2024): <https://www.sciencebase.gov/catalog/item/652d4fc5d34e44db0e2ee45e>.
- Software used: ArcGIS Pro version 3.2.
- FWS 5-Year Review (2021): https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/964.pdf.
- FWS Species Range: <https://ecos.fws.gov/ecp/species/6010>.

2. Datasets Used in Core Map Development

2.1. Range

The range for this species was last updated by FWS on April 29, 2025. A shapefile including species range for all listed species was downloaded from the FWS ECOS website on May 5, 2025. The shapefile was converted to a feature class stored in a file geodatabase and reprojected to WKID #102008 ("North America Albers Equal Area Conic").

1. Using an ArcGIS Web Map the species was queried based on the ECOS listed "Entity ID" of 1017 and exported as a feature class to a temporary file geodatabase as a standalone Entity ID-specific layer.
2. The area of the range was calculated automatically by loading it into the software (ArcGIS Pro version 3.2) and reading its area from the attribute table ("Shape_Area"), then converting its units (square meters) into acres with a conversion factor of 0.000247105.

This shapefile was added to an ArcGIS Pro map and compared against known location information and select shapes in the PAD-US dataset to find location information for extant populations listed in the FWS 5-year review (FWS 2021). The range was used to establish the outer boundary of the core map.

2.2. FWS 5-Year Review (2021)

The most recent 5-Year Review includes the most up-to-date list of extant populations of the Tennessee yellow-eyed grass that have been documented by FWS. These sites are catalogued in the document's Appendix B, which additionally includes information about population size, land ownership, and current status. The site names and ownership information were used to query the PAD-US layer for specific location

information.

The 5-Year Review also includes a list of extant counties, as of 2021. These align closely—though not entirely—with the counties currently intersected by the range. Strong consideration was given to refining the core map extent according to these counties. Ultimately, this refinement was not used because the FWS range was updated very recently (less than 2 months of this document’s date) to include the easternmost shape in Alabama, an area which had not been noted in the 5-Year Review and therefore could not be refined by county. CSI judged that because the proposed county refinement’s effect on the core map of the previous range would have been modest, and that it could not be meaningfully applied to the newly-added shape in Alabama, this refinement would not increase overall confidence in the core map.

2.3. Georgia Department of Natural Resources (GDNR) Biodiversity Portal

The GDNR Biodiversity Portal includes a mapping tool that was used to query and download known location information for the Tennessee yellow-eyed grass. A shapefile of the most detailed dataset available, “Quarter Quads,” was exported to a file geodatabase and queried for recent observations according to the procedure detailed in **Appendix 2** Section 3. The resulting shapes were ultimately used to represent the extent of the core map of the Tennessee yellow-eyed grass in Georgia.

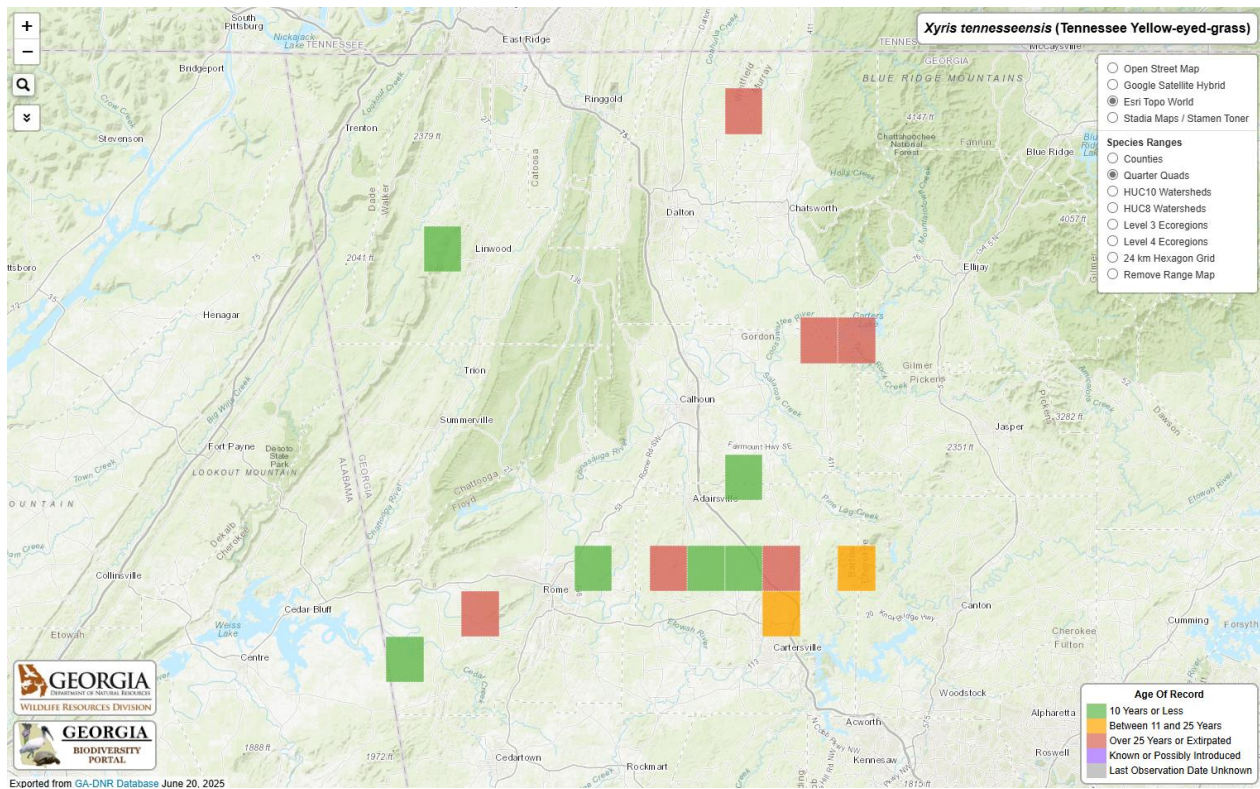


Figure 7. Quarter quads of the Tennessee yellow-eyed grass. Only observations within the last 25 years (green or yellow) contributed to the core map development process (GDNR 2025).

2.4. U.S. Geological Survey (USGS)'s Protected Areas Database of the United States, PAD-US

In Alabama, two of the extant population sites identified by FWS were military bases, which is a type of location that is often included in the PAD-US layer; thus, PAD-US was queried for both site name, Fort McClellan and the Anniston Army Depot. Where sites were positively identified, matching records were selected and exported as a standalone layer.

The Fort McClellan site was identified using a query of the PAD-US layer to identify sites with "Fort McClellan" in the Unit Name attribute field, but exclude the record associated with the Fort McClellan Post Cemetery. The Anniston Army Depot was identified using the same field, Unit Name. Both sites were identified using the SQL query below. This resulted in three records that contributed to the core map.

- Unit_Nm LIKE '%Anniston Army%' Or Unit_Nm LIKE '%Fort McClellan%' And Unit_Nm NOT LIKE '%Cemetery%'.

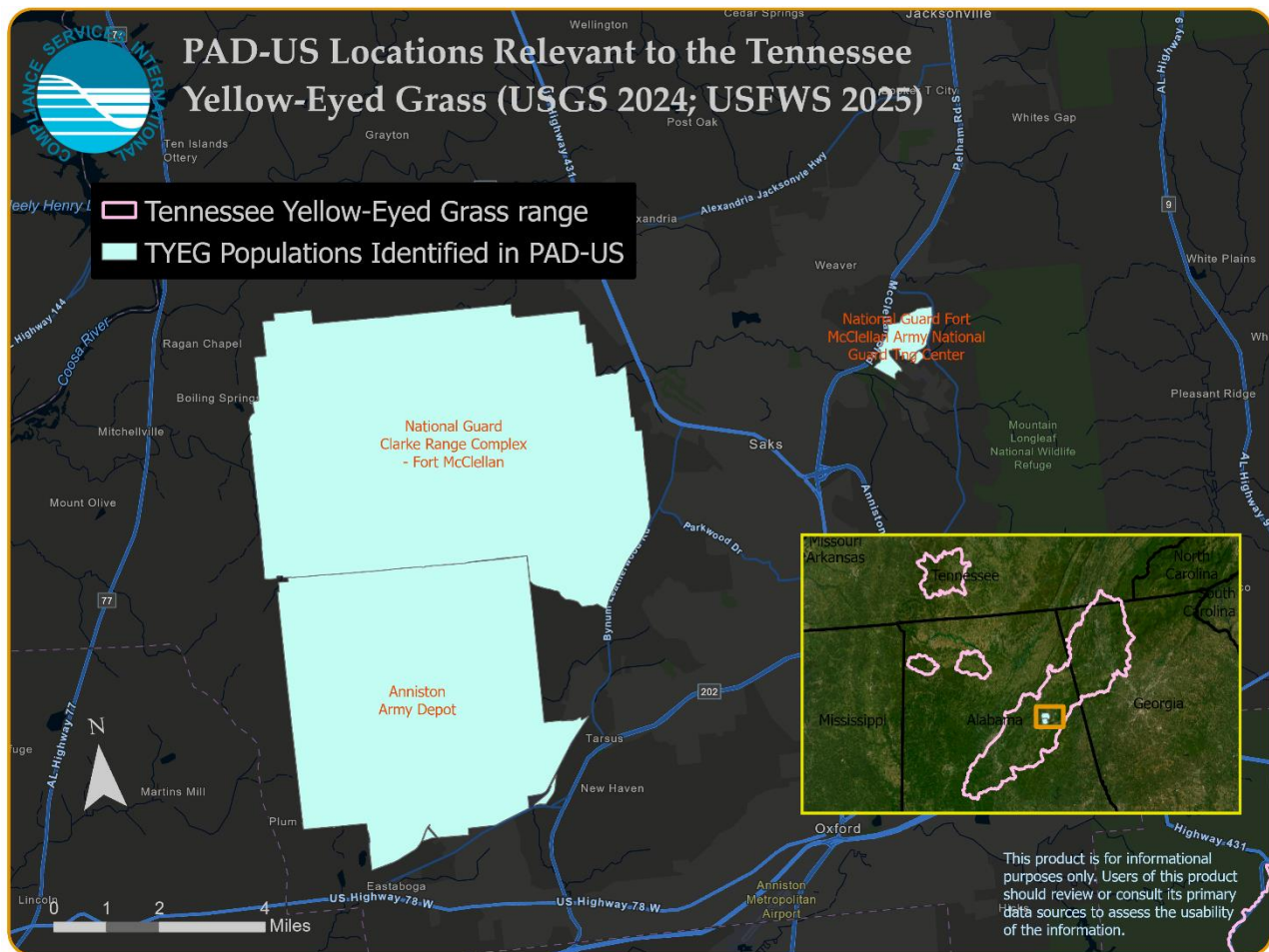


Figure 8. U.S. Geological Survey (USGS)'s Protected Areas Database of the United States, PAD-US, Locations Relevant to the Tennessee yellow-eyed grass (TYEG) (USGS 2024; FWS 2025).

Appendix 2 Section 3 describes how these layers were incorporated with others to form the core map extent.

2.5. iNaturalist

Appendix B of the most recent 5-Year Review (FWS 2021) lists the Tennessee yellow-eyed grass population names that were queried in PAD-US. The “Gate 14,” “Rock Creek (06C),” and “Rock Creek (06D)” populations are owned by an entity known as the “Pelham Range.” This ownership name was also queried in PAD-US; there were four matches on “Pelham” (which is the name of a city in Alabama) but these were not confidently matched to the species populations themselves. However, it was observed that these matching records all occur within the uncertainty distance (“public positional uncertainty”) associated with the iNaturalist records for the species (Figure 9).



Figure 9. PAD-US observations (highlighted aqua, USGS 2024) associated with the city of Pelham, AL in relation to iNaturalist observations (red) buffered by their PPA (blue, iNaturalist 2025).

These PAD-US records also occur within the public element occurrence hexagons from NatureServe (georeferenced but not shown); however, the use of NatureServe hexagons was ruled out for this core map because of data privacy concerns.

The geographic coordinates from the iNaturalist dataset were converted into a usable points layer and buffered by their public positional accuracy (PPA) distances. For usable observations (described in **Appendix 1** Section 5), these buffer distances ranged from 28,649 to 29,012 m (Figure 10). For the southern portion of the range associated with two observations, these buffered points were dissolved into a single shape and clipped to the species range. This area represents the core map area for this part of the range. Details about how the data were processed are provided in **Appendix 2** Section 3.

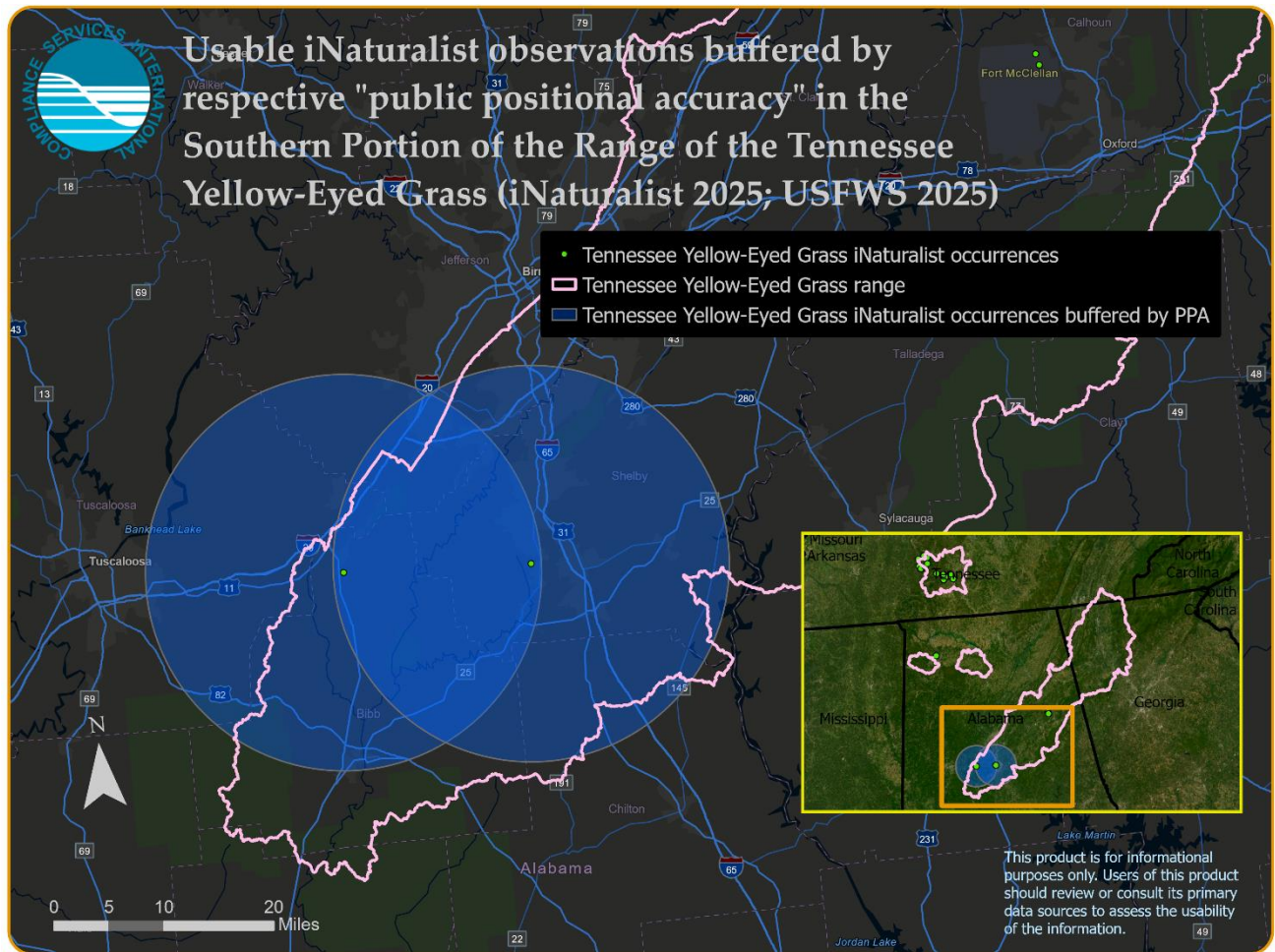


Figure 10. Usable iNaturalist observations buffered by respective "public positional accuracy" in the southern portion of the range of the Tennessee yellow-eyed grass (iNaturalist 2025; FWS 2025).

2.6. National Wetlands Inventory (NWI) Dataset

The NWI dataset was preliminarily vetted to determine its appropriateness in representing aquatic areas matching descriptions of the Tennessee yellow-eyed grass habitat. The species inhabits calcareous seeps, fens, and spring runs. CSI reviewed NWI attribute classes in relation to this description and determined that the species' potential habitat is best represented by a combination of riverine and palustrine systems:

- Riverine (NWI code = R)
 - Subsystems: Lower Perennial (2), Upper Perennial (3), and Streambed (5).
 - Classes: Unconsolidated Bottom (UB), Aquatic Bed (AB), Streambed (SB), Unconsolidated Shore (US), and Emergent (EM).
- Palustrine (NWI code = P)
 - Classes: Rock Bottom (RB), Unconsolidated Bottom (UB), Aquatic Bed (AB), Unconsolidated Shore (US), and Emergent (EM).

The NWI was clipped to the core map extent that was developed from GDNR, PAD-US, iNaturalist, and Range according to the methods described above, and the procedure given in **Appendix 2** Section 3.1. This subset of NWI water bodies was queried for the riverine and palustrine water body types listed above,

according to the following SQL query:

- ATTRIBUTE LIKE '%R2UB%' OR ATTRIBUTE LIKE '%R2AB%' OR ATTRIBUTE LIKE '%R2SB%' OR ATTRIBUTE LIKE '%R2US%' OR ATTRIBUTE LIKE '%R2EM%' OR ATTRIBUTE LIKE '%R3UB%' OR ATTRIBUTE LIKE '%R3AB%' OR ATTRIBUTE LIKE '%R3SB%' OR ATTRIBUTE LIKE '%R3US%' OR ATTRIBUTE LIKE '%R3EM%' OR ATTRIBUTE LIKE '%R5UB%' OR ATTRIBUTE LIKE '%R5AB%' OR ATTRIBUTE LIKE '%R5SB%' OR ATTRIBUTE LIKE '%R5US%' OR ATTRIBUTE LIKE '%R5EM%' OR ATTRIBUTE LIKE '%PRB%' OR ATTRIBUTE LIKE '%PUB%' OR ATTRIBUTE LIKE '%PAB%' OR ATTRIBUTE LIKE '%PUS%' OR ATTRIBUTE LIKE '%PEM%'

The selected water body features were dissolved into a single shape to represent potential habitat of the Tennessee yellow-eyed grass within the core map extent, and this was used to represent the habitat for the species.

3. Creating the Core Map

3.1. Defining Extent

The core map for the Tennessee yellow-eyed grass was developed using range, selected PAD-US sites, buffered iNaturalist observations, and recent (< 25 years) quarter quads from the GDNR. The extent used for core map development was created as follows:

Georgia

1. Load a layer of GDNR quarter quads for the Tennessee yellow-eyed grass. Export these data to a geodatabase, saved as a new layer “GDNR”. Choose to export this layer—and all subsequent layers—into the preferred projection (WKID #102008).
2. Use the Select by Attributes tool to select quarter quads that are considered recent (observed within the last 25 years), using the SQL query below. Export features as a new layer, “GDNR_recent”.
 - age_text2 IN ('10 Years or Less', 'Between 11 and 25 Years')

East Alabama

1. Load a layer of PAD-US version 4.1 (“PADUS 4.1 Combined Proclamation, Marine, Fee, Designation, Easement”).
2. Use the Select by Attributes tool to select features associated with the Anniston Army Depot and Fort McClellan, using the SQL query below. Export features as a new layer, “TYEG_PADUS”.
 - Unit_Nm LIKE '%Anniston Army%' Or Unit_Nm LIKE '%Fort McClellan%' And Unit_Nm NOT LIKE '%Cemetery%'

Central Alabama

1. Load a layer of iNaturalist observations (“iNat”).
2. Use the Pairwise Buffer tool to buffer the previous layer (“iNat”) by each record’s PPA coordinate uncertainty value; save output as a new layer, “iNat_pbPPA”.
3. Use the Select tool to select the two records from the previous layer (“iNat_pbPPA”) that are associated with the southernmost portion of the species range. Export selected features as a standalone layer, “iNat_pbPPA_south”.

4. Use the Pairwise Clip tool to clip the previous layer (“iNat_pbPPA_south”) by the species range (“TYEG_range”), and save as a new layer, “iNat_pbPPA_south_pcRange”.

Northern Alabama and Central Tennessee

1. Use the Multipart to Singlepart tool to convert the species range (“TYEG_range”) from a multipart feature class to a singlepart feature class and save as a new layer (“TYEG_range_mp2sp”). This is done to facilitate the next step.
2. Use the Select tool to select the three isolated range features located in northern Alabama and Tennessee from the previous layer (“TYEG_range_mp2sp”). Export selected features as a standalone layer, “TYEG_range_mp2sp_sel”.

Southeast Tennessee

1. Use the Select tool to select the largest range shape from the singlepart feature class (“TYEG_range_mp2sp”).
2. Use the Select tool to select the state of Tennessee from a layer of US state boundaries.
3. Use the Pairwise Clip tool to clip the selected range feature by the selected state of Tennessee, and save as a new layer, “TYEG_range_mp2sp_sel_pcTN”.

3.2. Combining Elements of Core Map Extent

1. Use the Merge tool to combine the following five datasets into a single feature class representing the core map extent, “TYEG_extent”.
 - “GDNR_recent”
 - “TYEG_PADUS”
 - “iNat_pbPPA_south_pcRange”
 - “TYEG_range_mp2sp_sel”
 - “TYEG_range_mp2sp_sel_pcTN”
2. Use the Pairwise Dissolve tool to dissolve features from the previous layer (“TYEG_extent”) into a feature class with a single shape, “TYEG_extent_pd”.

3.3. Refinement based on Biological Information

The total extent of the Tennessee yellow-eyed grass core map—which comprises elements of range, selected PAD-US sites, buffered iNaturalist observations, and GDNR quarter quads—includes a significant area and number of different land cover types that do not align with descriptions of the Tennessee yellow-eyed grass habitat. To improve confidence in the core map, a refinement based on biological information was applied to the core map extent.

The best-available dataset for suitable species habitat was found to be the NWI dataset. This spatial layer was used as a refinement of the core map area as follows:

1. Download state-level NWI datasets for the states intersecting the range of the Tennessee yellow-eyed grass: Alabama, Georgia, and Tennessee.
2. For each NWI state-level dataset, use the Pairwise Clip tool to clip the water bodies to the dissolved core map extent (“TYEG_extent_pd”), each saved with a name recognizable as a state-specific dataset:

- “NWI_AL_pcExtent”
 - “NWI_GA_pcExtent”
 - “NWI_TN_pcExtent”
3. In the case of Alabama and Georgia, because these states are adjacent and the state-level downloads of NWI often include some water bodies extending into adjacent states, an additional refinement was made to make each state-level dataset representative of just the waterbodies (or portions thereof) actually occurring in those states. Use the Pairwise Clip tool to clip these layers by state boundaries, to produce the following layers:
 - “NWI_AL_pcExtent_pcAL”
 - “NWI_GA_pcExtent_pcGA”
 4. Use the Merge tool to merge the following datasets into a single feature class representing water bodies within the core map extent for the Tennessee yellow-eyed grass. Save the merged layer as “NWI_pcExtent”.
 - “NWI_AL_pcExtent_pcAL”
 - “NWI_GA_pcExtent_pcGA”
 - “NWI_TN_pcExtent”
 5. (Optional) Delete all intermediate layers of NWI, except for “NWI_pcExtent” from the working geodatabase. This was done to reduce file size and facilitate data transfer and is not necessary to finish development of the core map.
 6. Use the Select by Attributes tool to select NWI water body types matching the description of the habitat of the Tennessee yellow-eyed grass. Use the following SQL query to identify these features. Export selected features as a standalone layer, “NWI_pcExtent_sel”.
 - ATTRIBUTE LIKE '%R2UB%' OR ATTRIBUTE LIKE '%R2AB%' OR ATTRIBUTE LIKE '%R2SB%' OR ATTRIBUTE LIKE '%R2US%' OR ATTRIBUTE LIKE '%R2EM%' OR ATTRIBUTE LIKE '%R3UB%' OR ATTRIBUTE LIKE '%R3AB%' OR ATTRIBUTE LIKE '%R3SB%' OR ATTRIBUTE LIKE '%R3US%' OR ATTRIBUTE LIKE '%R3EM%' OR ATTRIBUTE LIKE '%R5UB%' OR ATTRIBUTE LIKE '%R5AB%' OR ATTRIBUTE LIKE '%R5SB%' OR ATTRIBUTE LIKE '%R5US%' OR ATTRIBUTE LIKE '%R5EM%' OR ATTRIBUTE LIKE '%PRB%' OR ATTRIBUTE LIKE '%PUB%' OR ATTRIBUTE LIKE '%PAB%' OR ATTRIBUTE LIKE '%PUS%' OR ATTRIBUTE LIKE '%PEM%'
 7. Use the Pairwise Dissolve tool to dissolve the previous layer (“NWI_pcExtent_sel”) into a feature class with a single shape, “NWI_pcExtent_sel_pd”.

3.4. Cultivated Lands-based Refinement

The Tennessee yellow-eyed grass is not expected to be found in agricultural areas, so a refinement to exclude areas of agriculture was applied. Here agricultural areas are represented by EPA’s modified cultivated layer, which includes areas spanning at least 25 acres. This was done as follows:

1. Use the Pairwise Erase tool to exclude cultivated areas > 25 acres from the previous layer (“NWI_pcExtent_sel_pd”) according to a layer developed by EPA (“CultivatedAreas_Over25acres”). Save as a new layer (“NWI_pcExtent_sel_pd_peCultivated25ac”).
2. (Optional) Export features from the previous layer (“NWI_pcExtent_sel_pd_peCultivated25ac”) into a new layer recognizable as the Tennessee yellow-eyed grass core map, “TYEG_CoreMap”.

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