

# Interim Core Map Documentation for the Swamp Pink

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**Draft Interim Core Map Developer:** Compliance Services International (CSI)

## Species Summary

The swamp pink (*Helonias bullata*; Entity ID 946) is a monocotyledonous endangered plant found along inland portions of Atlantic coastal states in the United States. The U.S. Fish and Wildlife Service (FWS) has not designated critical habitat for the swamp pink. This species occurs in a variety of wetland habitats such as swampy forested wetlands, dense swamps, and spring seepage areas. Specific hydrology requirements of the species limit its occurrence within these wetlands to areas that are perennially saturated, but not inundated, by floodwater. Additional habitat information is provided in **Appendix 1**.

## EPA Review Notes

The developers created this core map using the U.S Environmental Protection Agency's (EPA) process available at: <https://www.epa.gov/endangered-species/process-epa-uses-develop-core-maps-pesticide-use-limitation-areas>. EPA reviewed the draft interim map and documentation and evaluated if: (1) the map and documentation are consistent with the agency's process; (2) areas included or excluded from the interim core map are consistent with the biology, habitat, and/or recovery needs of the species; (3) data sources are documented and appropriate; and (4) the GIS data and mapping process are consistent with the stated intention of the developer. EPA agrees that this map is a reasonable depiction of core areas for this species and was consistent with the agency's mapping process. This documentation was not prepared by EPA, but EPA may have edited this documentation for clarity or other purposes.

The core map developed for this species is considered interim and can be used to develop pesticide use limitation areas (PULAs). This core map incorporates information developed by FWS and made available to the public; however, the core map has not been formally reviewed by FWS. This interim core map may be revised in the future to incorporate expert feedback from FWS.

This core map does not replace or revise any range or designated critical habitat developed by FWS.

## Description of Core Map

The core map for the swamp pink is based on biological information, which was used to refine an extent determined by known location information for the species, and other limiting boundaries such as counties known to contain extant populations and physiographic regions known to host the species. The extant population sites were obtained from the Protected Areas Database of the United States (PAD-US) and the Georgia Department of Natural Resources (GDNR), while counties with extant populations were obtained from the most recent 5-Year Review (FWS 2021). Other available known location information from the Global Biodiversity Information Facility (GBIF) and iNaturalist databases, and other types of datasets were not used for core map development due to inaccuracies or simply in favor of more complete and recent datasets.

The biological information was obtained from the National Wetlands Inventory (NWI) dataset, which was considered appropriate as the species lives in wetlands. The species habitat description was matched to classifications in the NWI dataset. The habitat information used for North Carolina was adopted from a species-specific habitat model developed by the North Carolina Department of Transportation (NCDOT), which was used instead of the NWI for reasons discussed in **Appendix 1** and **Appendix 2**

The core map developed in this document for the swamp pink spans 360,557 acres (Figure 1 Figure 1). A summary of acreage by National Landcover Database (NLCD) land use type is provided in Table 1.

Based on EPA’s “best professional judgment classification” system, Compliance Services International (CSI) has graded this core map as “moderate” (4) because assumptions were made when connecting species life history and/or biological needs (habitat preferences, water body descriptions, and foraging needs) to a GIS dataset, in this case the NWI (NWI 2023). Additionally, the extant population location data was acquired from different sources and various scales. More information about this classification system and its definitions can be found in the core map process document (EPA 2024).

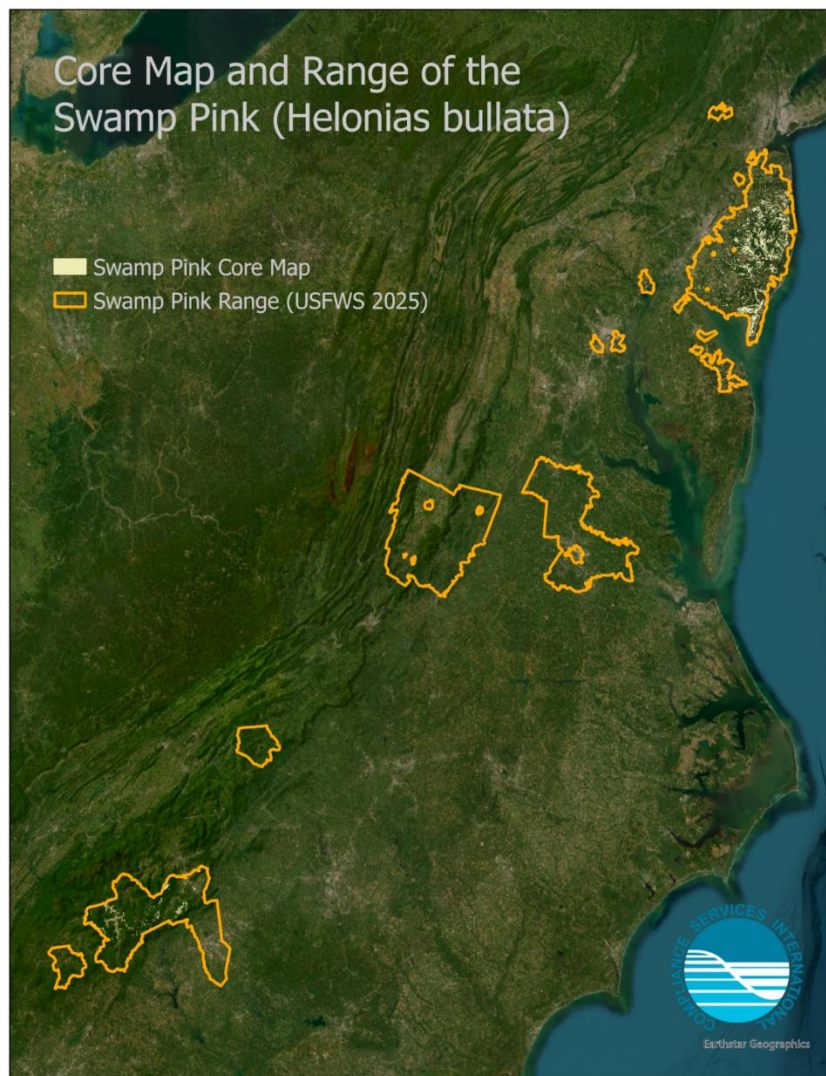


Figure 1. Interim core map for the swamp pink.

<b>NLCD_Land_Cover_Class</b>	<b>Acres</b>
Woody Wetlands	214,934
Mixed Forest	29,936
Evergreen Forest	21,322
Deciduous Forest	18,854
Developed, Open Space	18,039
Emergent Herbaceous Wetlands	12,671
Developed, Low Intensity	11,863
Hay/Pasture	8,915
Cultivated Crops	6,757
Developed, Medium Intensity	6,010
Open Water	4,891
Herbaceous	2,246
Shrub/Scrub	1,964
Developed, High Intensity	1,297
Barren Land	809

*Table 1. Acres by National Land Cover Database (NLCD) class within the core map of the swamp pink. Total core map area (based on NLCD pixel count): 360,508 acres<sup>1</sup>*

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<sup>1</sup> This acreage is slightly different from the core map acreage (360,557 acres) due to the pixelation of NLCD land cover. The core map is not developed from raster data.

## Evaluation of Known Location Information

There were four evaluated datasets with known location information:

- Descriptions of locations provided by FWS;
- Occurrence locations in iNaturalist;
- Occurrence locations in GBIF; and
- Occurrence locations in NatureServe.

Compliance Services International evaluated these four datasets before developing the core map. Overall, there were 330 research-grade observations found in iNaturalist<sup>2</sup>, while the GBIF dataset comprised 239 georeferenced observations. Both datasets were useful as comparison against other datasets, but did not otherwise contribute to the core map development process.

FWS location information includes textual descriptions of some landforms containing the species; these descriptions were mostly used to identify habitat types and land formations that could be queried for relevant areas for core map development. The textual description of the lone extant population in South Carolina positively identified the Watson-Cooper Heritage Preserve as its full extent in that state.

Additionally, textual descriptions of species location from the FWS 5-Year Review included a table listing 30 counties across the states with the swamp pink, that include extant populations. These counties were used as boundaries limiting the core map extent.

NatureServe public element occurrence (EO) data were also evaluated and are considered by CSI to be a good approximation of species extent. Ultimately, these data were not used because core map extent could be refined from a combination of known locations and other limiting factors such as counties with extant populations and physiographic features known to restrict extent of the swamp pink.

## Approach Used to Create Core Map

The core map was developed using the process EPA developed for developing core maps for species listed by FWS and their designated critical habitat (if any)<sup>2</sup> (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: Designated 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.

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<sup>2</sup> 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->).

For step 1, CSI compiled available information for the swamp pink from FWS, as well as observation information available from various publicly available sources including iNaturalist, GBIF, and NatureServe. The information compiled for the swamp pink is included in **Appendix 1**. Influential information that impacted the development of the core map includes a description of the species habitat from the FWS 5-Year Review:

- “Swamp pink occurs in a variety of wetland habitats, including: swampy forested wetlands bordering meandering streams; headwater wetlands; sphagnous, hummocky, dense, Atlantic white cedar swamps; Blue Ridge swamps; meadows; bogs; and spring seepage areas. Specific hydrologic requirements of swamp pink limit its occurrence within these wetlands to areas that are perennially saturated, but not inundated, by floodwater. The water table must be at or near the surface, fluctuating only slightly during spring and summer months. Groundwater seepage with lateral groundwater movement are common hydrologic characteristics of swamp pink” (FWS 2021).

For step 2, CSI used the compiled information including the species range, known location descriptions, 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 larger databases (iNaturalist and GBIF) were somewhat limited in extent compared to the range to be used as more than validation in core map development. By contrast, known location information from FWS—specifically sites and counties known to include extant populations—were consistent with range and presented an opportunity for use in this effort. Review of the available data also suggested that the core map should exclude some areas within the extent, corresponding to landcovers inconsistent with the swamp pink habitat. First, the species resides in specific wetlands and, therefore, the extent does not span entire counties and/or physiographic regions. Second, the species is not known to inhabit agricultural areas and therefore was judged by CSI to be an “off-field” species. When weighing that information together, CSI selected the biological information core map type, limited to an extent more refined than its range. Compliance Services International used a combination of range, known observation/occurrence location data, known counties with extant populations, physiographic areas conducive to species habitat, species-specific habitat information, and EPA’s Cultivated areas > 25 acres layer to derive this core map (EPA 2025).

For step 3, CSI used the best-available spatial 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 swamp pink does not have assigned critical habitat. The range core map type was not used because the species range is neither refined nor endemic. However, CSI judged that there were known occurrence/location data that would better represent the areas of potential extant populations of the species and used these data to refine the extent of the core map to an area smaller than the species range. The NWI dataset was queried for classes relevant to the swamp pink within its range to form the basis of core map areas within the core map extent (see Section 2.6 for a list of these selected classes). In North Carolina, the species-specific model developed for the swamp pink was chosen over the NWI dataset. Finally, cultivated lands were removed from this area; this removed only 2.4% of area. **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

### **Soil Survey Geographic (SSURGO) Database**

The decision to use the NWI dataset instead of the Soil Survey Geographic Database (SSURGO) for refining habitat areas for the swamp pink was driven by several key considerations. Firstly, the NWI dataset provides a comprehensive classification of wetland types, which is important for identifying the diverse wetland habitats where the swamp pink thrives. In contrast, SSURGO focuses primarily on soil characteristics, which may not capture the full range of wetland habitats necessary for this species. Using SSURGO could potentially exclude areas that are critical for the swamp pink but are not defined by soil properties alone. The NWI dataset's detailed mapping of wetland types ensures that all relevant habitats are included, thereby providing a more accurate representation of the species' habitat requirements. Additionally, the hydrologic conditions described in the NWI are essential for the swamp pink, which requires perennially saturated but not inundated wetlands. By relying on the NWI, we ensure that these specific hydrologic conditions are adequately represented, supporting the conservation efforts for the swamp pink. Therefore, the NWI was chosen to avoid the risk of excluding vital habitat areas that SSURGO might overlook.

The species-specific habitat model for the swamp pink from NCDOT was selected over the SSURGO dataset to inform potential swamp pink habitat in North Carolina. The NCDOT model utilizes a random forest machine-learning approach, which provides a high-resolution probability map of potential habitat based on current presence locations (as of its release in 2021). This model is specifically tailored to the swamp pink, incorporating detailed environmental variables and habitat preferences unique to this species, thereby offering a more accurate and reliable identification of suitable habitats. The SSURGO dataset primarily focuses on soil characteristics and lacks the species-specific nuances used in the more precise habitat modeling.

### **Other Known Location Datasets: NatureServe, GBIF, iNaturalist**

The known locations used to represent extant population sites (or counties) for the swamp pink were from FWS. NatureServe public EOs are also available as hexagons, anywhere in which the species may have been observed. Where coordinate data were available, the reported precision of the observations were approximately 30 kilometers (km), which is greater than the uncertainty distance of the georeferencing process used to develop this core map.

## Appendix 1. Information compiled for the swamp pink

### 1. Recent FWS documents

- 5 Year Review (2021): [https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public\\_docs/species\\_nonpublish/3597.pdf](https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/3597.pdf)
- ECOS Page (Undated): <https://ecos.fws.gov/ecp/species/4333>
- Recovery Plan (1991): [https://ecos.fws.gov/docs/recovery\\_plan/910930c.pdf](https://ecos.fws.gov/docs/recovery_plan/910930c.pdf)

### 2. Background information

- Status: Federally listed as threatened in 1988.
- Resiliency, redundancy, and representation (the 3Rs) from the 2019 SSA
  - The 3Rs were not specifically described in the species recovery plan or most recent 5-year review for this species and there is no species status assessment.
- Habitat, Life History, and Ecology
  - Habitat: “Swamp pink occurs in a variety of wetland habitats, including: swampy forested wetlands bordering meandering streams; headwater wetlands; sphagnous, hummocky, dense, Atlantic white cedar swamps; Blue Ridge swamps; meadows; bogs; and spring seepage areas” (FWS 2025).
  - Specific hydrologic requirements of the swamp pink limit its occurrence within these wetlands to areas that are perennially saturated, but not inundated, by floodwater. The water table must be at or near the surface, fluctuating only slightly during spring and summer months. Groundwater seepage with lateral groundwater movement are common hydrologic characteristics of the swamp pink.
  - Pollinators: “Orcutt (2019) conducted a 2-year study of swamp pink pollinators in Virginia and documented 41 unique insect taxa visiting swamp pink flowers. Insects of the order Hymenoptera made up 91 percent of the total insect visitors. Within Hymenoptera, taxa in the family Halictidae (sweat bees) accounted for 50 percent of all visitors and likely have the highest pollination value for swamp pink due to their intentional pollen-collecting habits (Orcutt 2019). Swamp pink flowers are self-compatible and not reliant solely on pollinators for reproduction; however, it is likely that these insect visitors facilitate cross-pollination and assist with the transfer of genes between swamp pink plants and populations” (5 Year Review, 2021).
- Taxonomy
  - “There continues to be disagreement among taxonomic literature regarding the composition of the genus *Helonias* and the taxonomic status of closely related genera *Heloniopsis* and *Ypsilandra*. As described in the previous 5-year review (FWS 2014), several studies by Tanaka (1997a, b, c, d, 1998) have described the morphological similarities among the *Helonias*, *Heloniopsis*, and *Ypsilandra* taxa. Tanaka (1998) recommended the reduction of the genera *Heloniopsis* and *Ypsilandra* to synonymy under the genus *Helonias*; however, phylogenetic analysis by Fuse and Tamura (2000) indicated a taxonomic reduction of the genera may be unnecessary. Subsequent publications vary, with several studies (e.g., Givnish et al. 2016, Hsu et al. 2011, Kim et al. 2016) continuing to present *Helonias*, *Heloniopsis*, and *Ypsilandra* as separate genera and other studies (e.g.,

Chakraborty et al. 2012, Kawano et al. 2007, Mochizuki et al. 2019) using the Tanaka's (1998) congeneric taxonomic interpretation" (5-Year Review, 2021).

- Relevant Potential Pesticide Use Sites
  - Pesticides are not specified as threats to this species. However, runoff from development is listed as a threat (5 Year Review, 2021).
  
- Relevant Recovery Criteria and Actions
  - 5-Year Review (2021) – Delisting Criteria (According to the recovery plan, the swamp pink will be considered for delisting when the following (in Italics) conditions are achieved):
    - *Permanent habitat protection is secured for those occurrences that: (a) are ranked as "A" or "B" according to the quality specifications in Appendix B (which follow the Nature Conservancy's ranking system<sup>1</sup> [and which reflect both habitat conditions and population size/vigor]), or (b) are representative of the species' range-wide distribution, or (c) are representative of habitat or genetic diversity.*
      - As a preliminary quantitative objective, 80 sites must be permanently protected to achieve condition 1 (FWS 1991). Habitat will be considered permanently protected when: (1) adequate acreage is secured through acquisition or easement by government agencies or conservation organizations with primary responsibilities for resource protection; (2) sites on public lands are formally designated as protected areas; and (3) preserve designs and/or management stipulations, based on definitive research results, are in place for each site
    - *Regulatory protection is sufficiently strong at the Federal, state, and/or local levels to ensure continued rangewide conservation of viable populations and their habitat (including an adequate buffer zone) after the protection afforded by the Endangered Species Act is withdrawn.*
      - The necessary level of regulatory protection has not been fully achieved to satisfy this criterion.
    - *As necessary, representative genotypes are established and maintained in cultivation at plant breeding facilities.*
      - As described in the Swamp Pink Recovery Plan (FWS 1991), imperiled swamp pink occurrences that contain unique or representative genotypes will have ex-situ collections established to safeguard the species' genetic representation. Several priority swamp pink occurrences have been identified throughout the range but detailed genetic analysis across the species range is lacking, so additional priority sites may exist. The Recovery Plan does not contain delisting criteria. However, the 5-Year Review (FWS 2019a) and the SSA (FWS 2019b) both suggest that the swamp pink does not meet the definition of threatened or endangered.

### 3. Range

The current range-wide protection status of the swamp pink is summarized below (Figure 2). In total, 114 of the 235 known extant occurrences of the swamp pink (48.5%) occur at least partly on public or otherwise protected land (New Jersey: 65, Delaware: 4, Virginia: 27, North Carolina: 13, South Carolina: 1, Georgia: 4) (see Table 1 in Section 2.3.1.2). This is over three times the number of swamp pink occurrences known to exist at least partly on protected land in 1991 (5-Year Review, 2021).

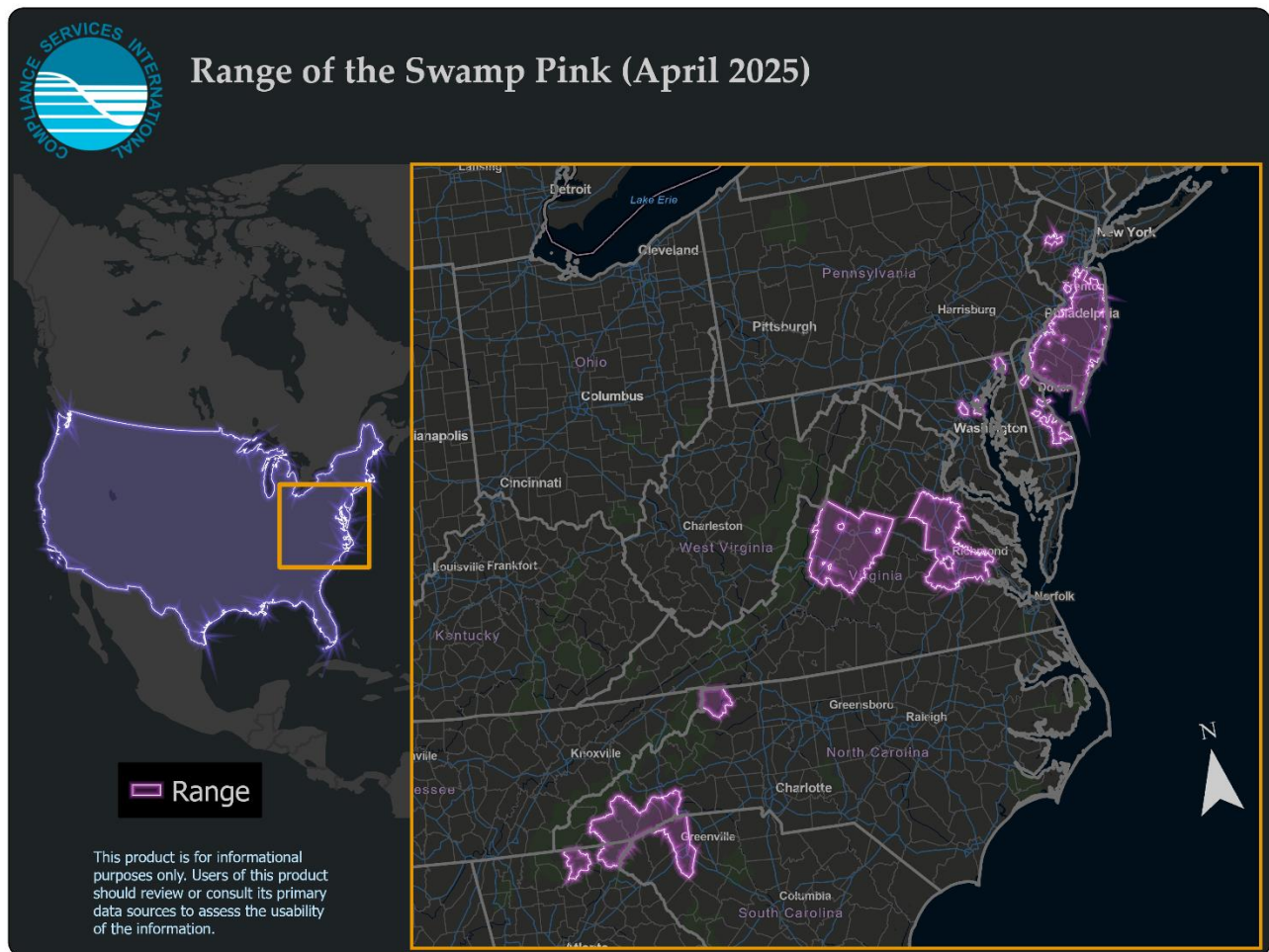


Figure 2. Range of the swamp pink. Range size is 8,922,213 acres (FWS 2025).

#### 4. Critical Habitat

The swamp pink does not have designated critical habitat.

#### 5. Known Locations

- FWS
  - Range wide, the swamp pink persists across seven states in 27 of the 28 counties in which it was known to occur in 2007, but is currently extirpated in Dorchester County, Maryland

(Table 6). The swamp pink occurrence in Dorchester County had 12 rosettes<sup>3</sup> observed in May 1999; however, at least two surveys were conducted since then which failed to find any swamp pink plants (5-Year Review, 2020).

Table 2. Counties with extant occurrence of the swamp pink. Copied from Table 6 of the 5-Year Review (FWS 2021).

State	County	2007	2011	2020
New Jersey	Atlantic	5	6	7
New Jersey	Burlington	10	13	12
New Jersey	Camden	28	29	25
New Jersey	Cape May	13	13	11
New Jersey	Cumberland	14	14	14
New Jersey	Gloucester	13	17	14
New Jersey	Middlesex	1	1	1
New Jersey	Monmouth	10	10	10
New Jersey	Morris <sup>1</sup>	2	1	2
New Jersey	Ocean	24	30	35
New Jersey	Salem	20	19	17
Delaware	Kent	4	3	2
Delaware	New Castle	1	1	1
Delaware	Sussex	14	22	19
Maryland	Anne Arundel	4	5	4
Maryland	Cecil	2	3	3
Maryland	Dorchester	1	1	0
Virginia	Augusta	21	21	15
Virginia	Caroline	16	14	15
Virginia	Henrico	5	5	3
Virginia	Nelson	1	1	1
North Carolina	Ashe	1	1	1
North Carolina	Henderson	2	2	2
North Carolina	Jackson	1	1	1
North Carolina	Transylvania	12	12	13
North Carolina	Macon <sup>2</sup>	0	0	1
South Carolina	Greenville	1	1	1
Georgia	Rabun	2	3	3
Georgia	Union	1	1	1
Georgia	White	0	0	1
<b>Total</b>		<b>229</b>	<b>250</b>	<b>235</b>

<sup>1</sup>The 2020 Morris County count includes an outplanted population.

<sup>2</sup>The Macon County occurrence is an outplanted population.

<sup>3</sup>2007: One each in Rabun and Union counties are outplanted.

2011: Two in Rabun County and 1 in Union County are outplanted.

2020: Two in Rabun., 1 in Union, and 1 in White County are outplanted.

- iNaturalist: [https://www.inaturalist.org/observations?taxon\\_id=59568](https://www.inaturalist.org/observations?taxon_id=59568)

<sup>3</sup> Rosettes are clusters of leaves in a circular pattern, resembling a rose in shape.

- 359 verifiable observations, 330 of which are research-grade with public coordinate data.
- These locations align well enough with species range and the known extant populations in the 2021 5-Year Review to corroborate those data; however, the iNaturalist observations are less robust and so are limited in their utility beyond comparison with other datasets.
- GBIF: <https://www.gbif.org/species/2741669>
  - GBIF includes 377 occurrence records; 239 of which are georeferenced. However, 181 of these had usable coordinate data based on latitude/longitude precision (3+ decimal places) and relative recency (2010-present).
- NatureServe Explorer: <https://explorer.natureserve.org/>
  - Available public EOs from NatureServe Explorer is generally consistent with iNaturalist and GBIF databases, and consistent with FWS range. However, NatureServe EOs were not judged to be as useful for refining extent as were the textual descriptions from FWS of extant population locations, counties, and physiographic regions of relevance (FWS 2021).
- South Carolina Department of Natural Resource: Watson-Cooper Heritage Preserve and Wildlife Management Area: <https://public-lands-scdnr.hub.arcgis.com/pages/watson-cooper-hp-wma>

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

The core map for the swamp pink is based on biological information, which was used to refine an extent determined by known location information for the species, and other limiting boundaries such as counties known to contain extant populations and physiographic regions known to host the species. The extant population sites were obtained from PAD-US and the Georgia Department of Natural Resources (GDNR), while counties with extant populations were obtained from the most recent 5-Year Review (FWS 2021). Other available known location information from the GBIF and iNaturalist databases, and other types of datasets were not used for core map development due to preferred use of textual descriptions in FWS documents. Polygons were buffered by 300 feet; this distance was selected based on text in the species' 5-Year Review stating that 300 feet is a minimum distance necessary to protect the species habitat from surrounding land-use changes (FWS 2021). Finally, areas of contiguous cultivated land > 25 acres were removed.

### 1. References and Software

- Georgia Department of Natural Resources:  
[https://georgiabiodiversity.org/portal/profile?group=all&es\\_id=21147](https://georgiabiodiversity.org/portal/profile?group=all&es_id=21147)
- National Wetlands Inventory:  
<https://www.fws.gov/program/national-wetlands-inventory>.
- North Carolina Department of Transportation:  
<https://xfer.services.ncdot.gov/gisdot/AtlasData/AtlasSpeciesModels/ATLASPlantMachineLearningModels/>
- Software used: ArcGIS Pro version 3.2.
- EPA Ecoregions:  
<https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states>.
- EPA Modified Cultivated Layer:  
<https://cdn.arcgis.com/home/item.html?id=159e70ce4c284f5b972c687037f8a668>.
- FWS Species Range: <https://ecos.fws.gov/ecp/species/4333>.
- USGS Protected Areas Database of the United States (PAD-US):  
<https://catalog.data.gov/dataset/protected-areas-database-of-the-united-states-pad-us-3-0-ver-2-0-march-2023>.

### 2. Datasets Used in Core Map Development

#### 2.1. Range

The range for this species was last updated on November 23, 2021. A shapefile including species range for all listed species was downloaded from the FWS ECOS website on January 24, 2025. The shapefile was converted to a feature class stored in a file geodatabase and reprojected to WKID #4269 ("North America Albers Equal Area Conic").

1. Using an ArcGIS Web Map the species was queried based on the ECOS listed "Entity ID" of 946 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 rate of 0.000247105.
3. This shapefile was added to an ArcGIS Pro map and compared against the available known locations described in the FWS Species Status Assessment (SSA), and the available occurrence information

from the GBIF, iNaturalist, and NatureServe databases.

## **2.2. 5-Year Review**

The most recent 5-Year Review was used to identify counties within the range with one or more extant populations of the swamp pink. Although much of the species' range appears to have been developed from county boundaries, some counties are partially or wholly excluded from this process. See Table 2 for the full list of counties included in this analysis. The included counties represent one of the boundaries used to determine core map extent.

Additionally, textual descriptions of population locations and physiographic regions inhabited by the species are provided in the 5-Year Review. These were converted into usable spatial data using other datasets such as Level 3 Ecoregions and PAD-US, as described below.

## **2.3. Ecoregions**

Textual descriptions of physiographic regions inhabited by the species are given in the 5-Year Review (FWS 2021). These regions were identified in a spatial dataset produced by EPA for the Level 4 Ecoregions of the United States. Level 4 regions represent a level of geomorphic precision greater than that used in the 5-Year Review; however, the Level 4 spatial layer was successfully queried for Level 3 formations based on corresponding attribute fields of "US\_L3CODE" and "US\_L3NAME" as appropriate. Level 3 names relevant to the swamp pink were: Atlantic Coastal Pine Barrens, Blue Ridge, Northeastern Highlands, Piedmont, Ridge and Valley, Southeastern Plains, and various "Coastal Plains."

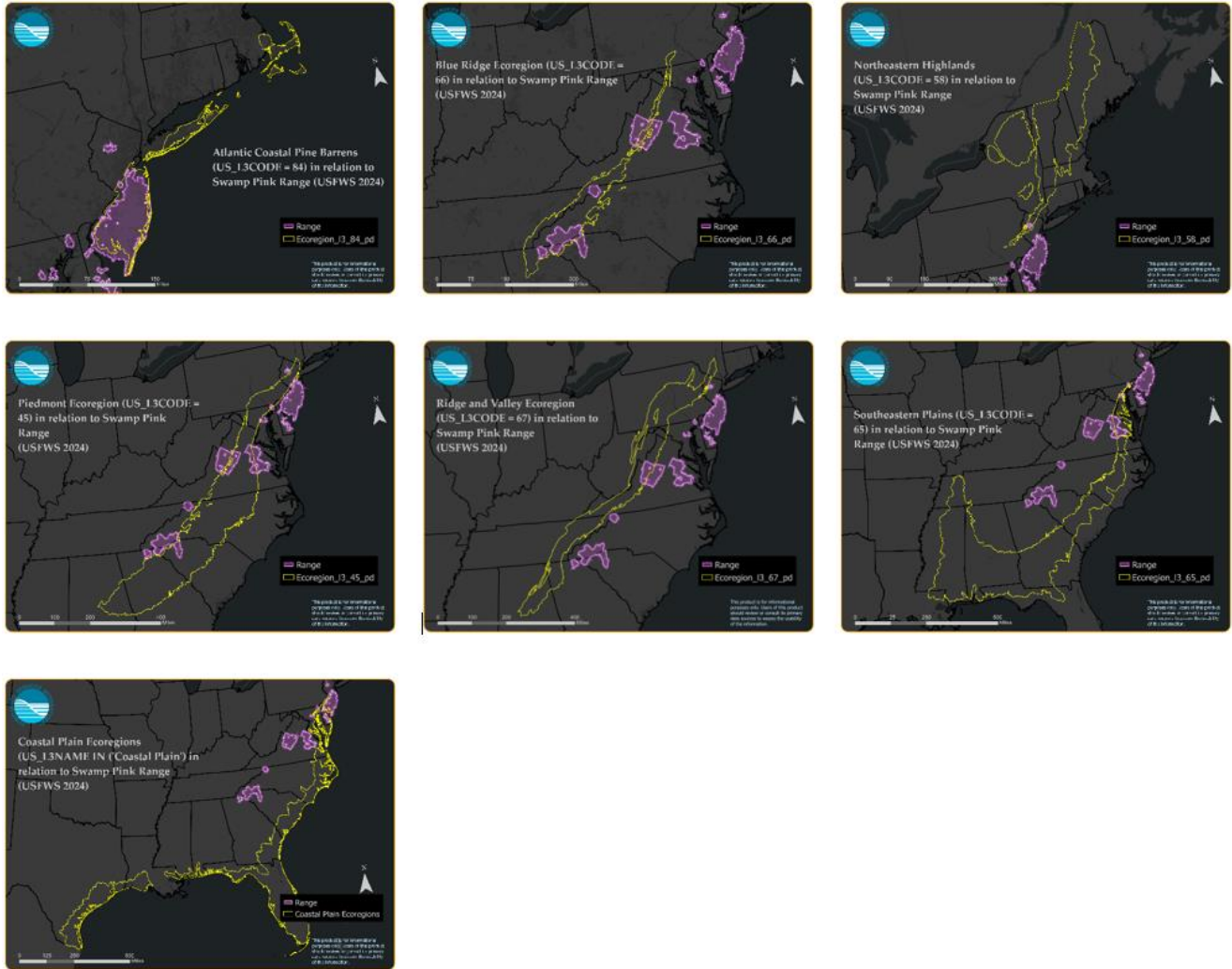


Figure 3. Level 3 Ecoregions relevant to the swamp pink. Top row, left to right: Atlantic Coastal Pine Barrens, Blue Ridge, Northeastern Highlands. Middle row: Piedmont, Ridge and Valley, Southeastern Plains. Bottom row: various Coastal Plains (EPA 2024).

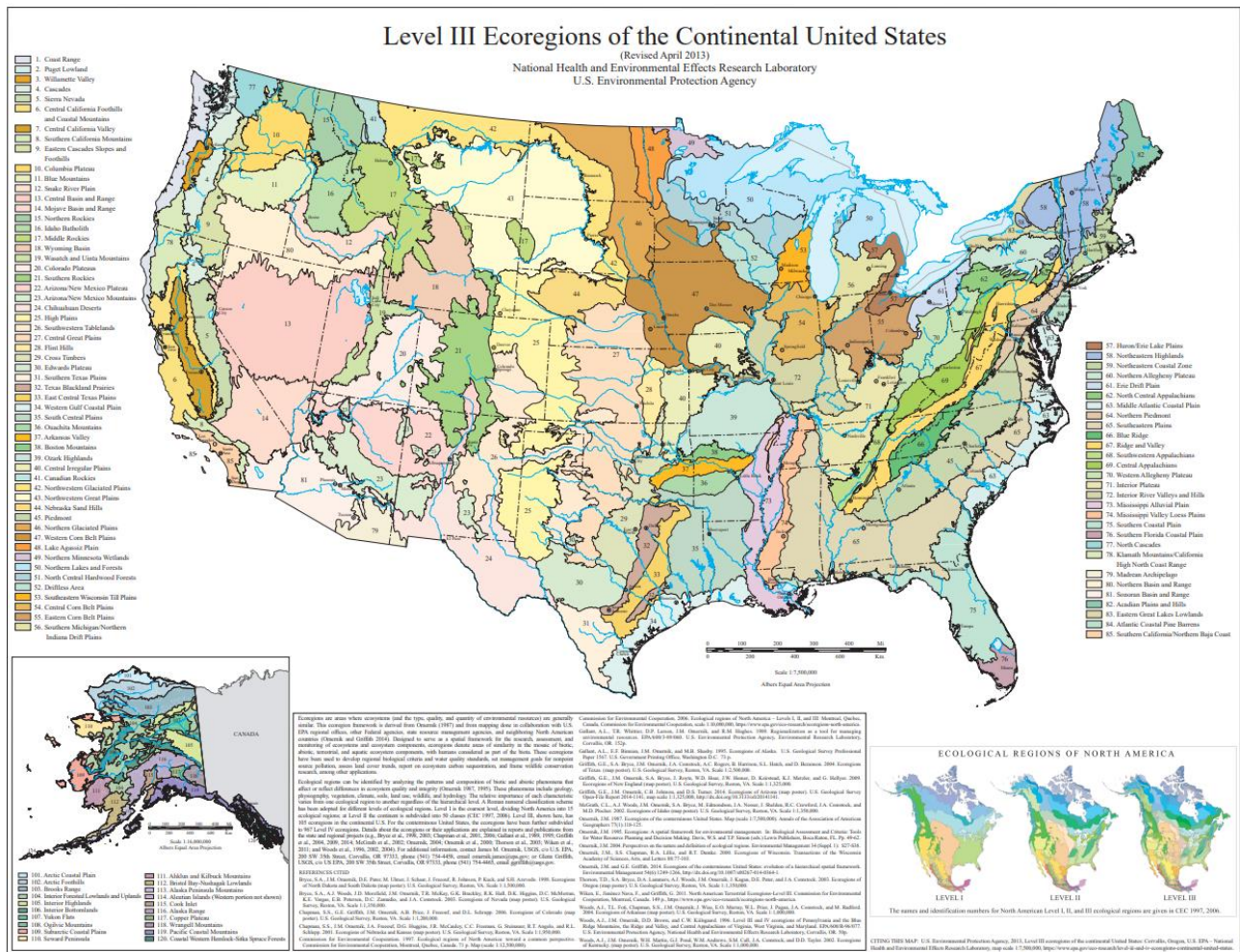


Figure 4. Level 3 Ecoregions of the United States (EPA 2024).

## 2.4. PAD-US

According to USGS, PAD-US is “America’s official national inventory of U.S. terrestrial and marine protected areas that are dedicated to the preservation of biological diversity and to other natural, recreation and cultural uses, managed for these purposes through legal or other effective means. PAD-US also includes the best available aggregation of federal land and marine areas provided directly by managing agencies, coordinated through the Federal Geographic Data Committee Federal Lands Working Group.”

In the case of the swamp pink, the PAD-US dataset was used to extract the shape of the Watson-Cooper Heritage Preserve and Wildlife Management Area in South Carolina. This preserve is the only known occurrence of the species in South Carolina. This shape was extracted from the dataset and save as its own layer for analysis (Figure 9).

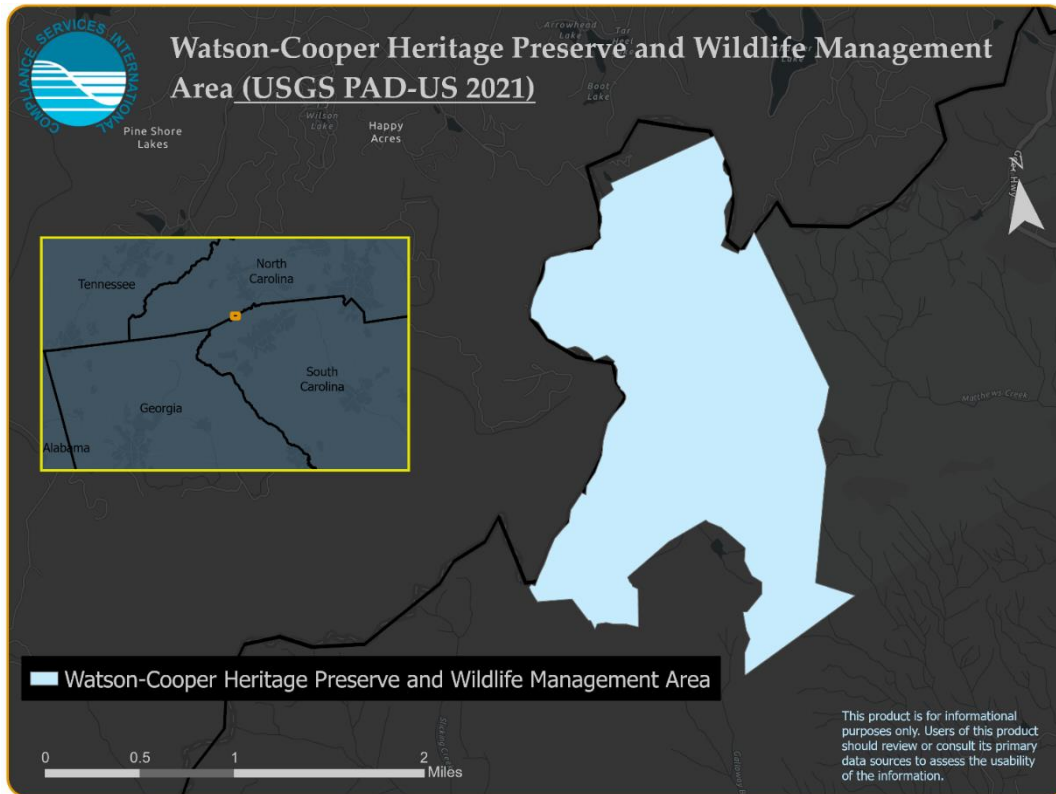


Figure 5. Map of the Watson-Cooper Heritage Preserve and Wildlife Management Area (USGS 2021).

## 2.5. Georgia Department of Natural Resources

The GDNR Biodiversity Portal includes a mapping tool that was used to query and download known location information for the swamp pink (Figure 6). 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 Section 3. The resulting shape was later merged with others to form the extent of the core map.

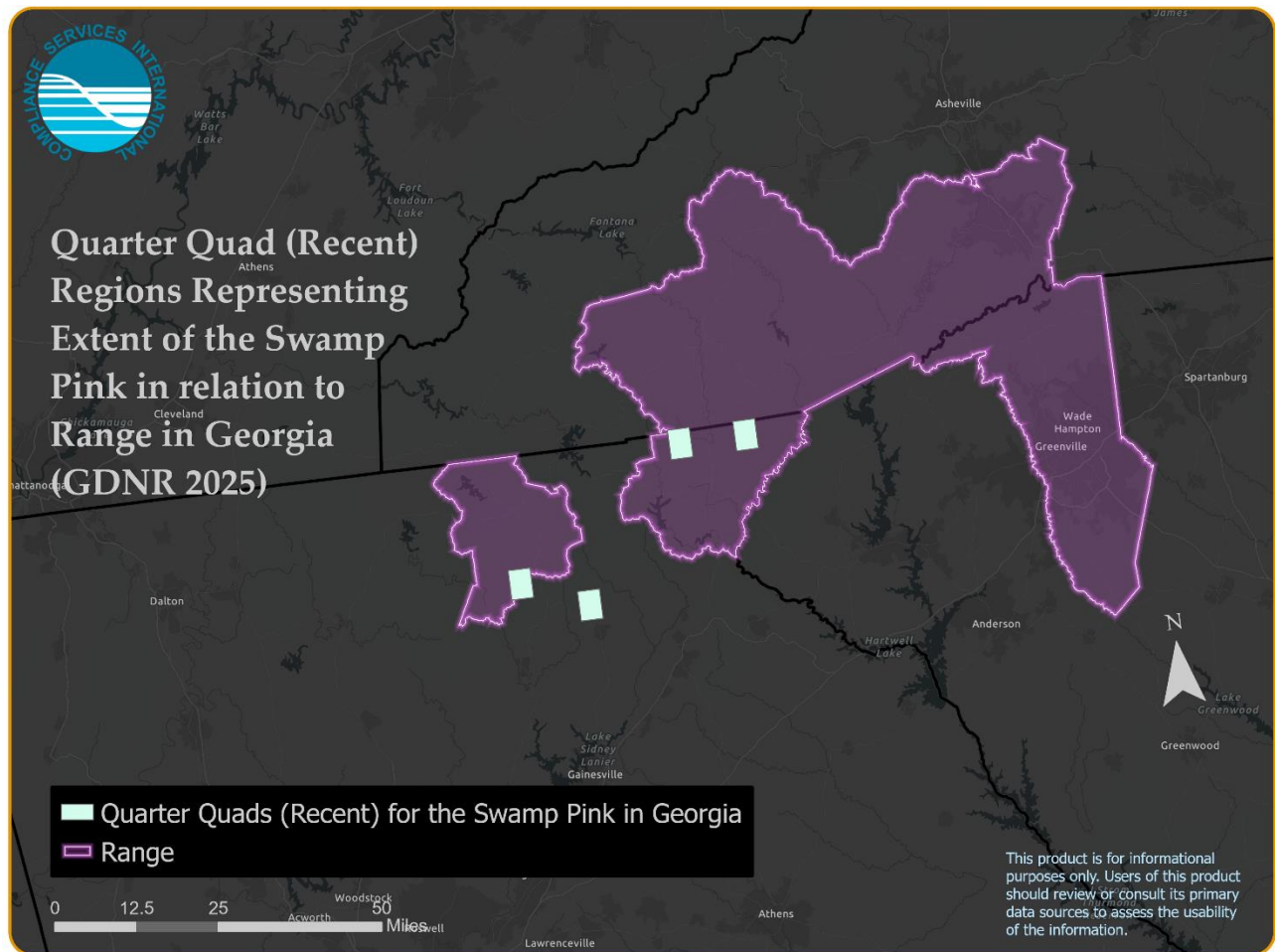


Figure 6. Swamp pink quarter quads (recent) representing core map extent in Georgia, in relation to local range (GDNR 2025).

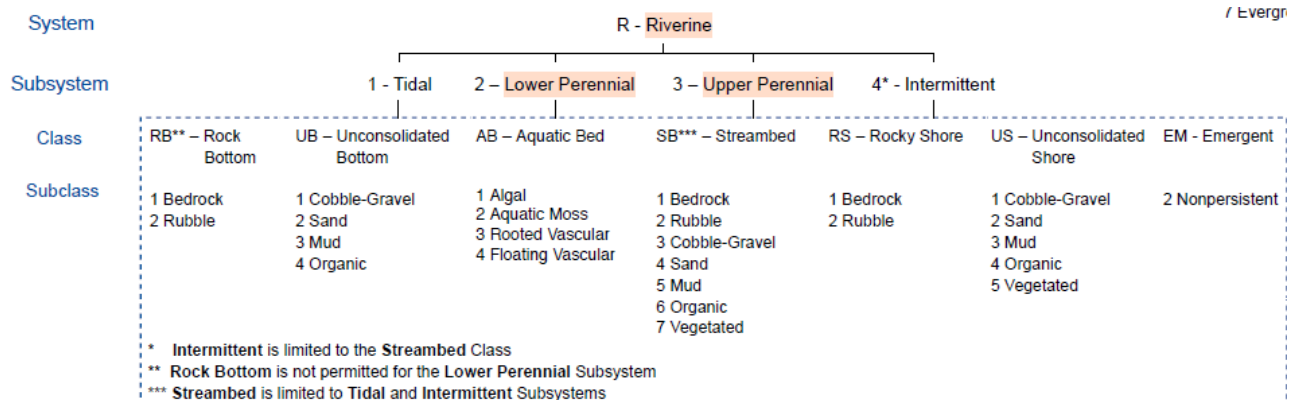
## 2.6. National Wetlands Inventory

The NWI dataset was preliminarily vetted to determine its appropriateness in representing aquatic areas matching descriptions of the swamp pink habitat. The swamp pink inhabits different types of wetland areas as described in Section 2 above, all of which are included in the NWI dataset.

The NWI is publicly available as state-level downloads. For each state intersecting the species range besides North Carolina (Delaware, Georgia, Maryland, New Jersey, South Carolina, and Virginia), layers were merged and clipped to the species extent. This process required an intermediate step of clipping to all states besides North Carolina, as the NWI datasets sometimes extent beyond state boundaries (this is not a projections issue). In the subsequent processing of NCDOT data described below, it was observed that that dataset did not include Macon County, NC. As a result, the NWI dataset for North Carolina was used for that county. The specific methods and tools used are provided in below and in Section 3.

Professional judgment was used to select only water body types matching the habitat description for the swamp pink (FWS 2013). Riverine systems included only “Lower Perennial” and “Upper Perennial” subsystems, while palustrine systems included “Moss-Lichen,” “Emergent,” “Scrub-Shrub,” and “Forested” systems. The complete list of selections is shown in Figure 7. These were the resulting “ATTRIBUTE” classes:

- 'PEM1/SS1F','PEM1E','R2UBF','PEM1/5Cd','PEM1/5Ed','PEM1/FO1C','PEM1/SS1C','PEM1/SS1Ed','PEM1/UBF','PEM1/UBFx','PEM1B','PEM1Bd','PEM1Bh','PEM1C','PEM1Cd','PEM1Ed','PEM1Ex','PEM1F','PEM1/FO5F','PEM1/SS1E','PEM1Eh','PEM1Fh','R3UBF','PFO4/1E','PFO4C','PEM1Cx','PEM1/5E','PEM1/FO1B','PEM1/SS1B','PFO4B','PEM1/SS4C','PEM1Ch','PSS3/EM1C','PEM1/SS1Fh','PFO4E','PEM1/SS1Eb','PEM1Fb','PEM1/FO1Ch','PEM1/FO1Eh','PEM1/SS1Cd','PEM1/SS3C','PEM1Cs','PEM1Fx','PFO4/1C','PSS3/FO1C','PSS3/FO4E','PEM1/FO5Fx','PEM1/SS1Eh','PEM1/FO1E','PSS3Ba','PFO4/1Bd','PEM1/5F','PEM1/SS1Bd','PSS4C','PFO4/SS4E','PSS4/FO4E','PEM1/SS1Fx','PEM1/SS1Ch','PEM1/SS1Ex','PEM1/SS4E','PEM1Eb','PFO4/SS1Ex','PSS3/1C','PSS4/3Ehg','PSS4E','PEM1/SS3Eda','PFO4Eg','PSS3/1Eha','PEM','PSS4/EM1E','PSS4Eg','PFO4/1B','PFO4Bd','PFO4Bg','PFO4Cg','PSS4B','PSS4/1C','PFO4/1Bh','PFO4Ch','PFO4/1Eg','PFO4/1Eh','PSS3E','PSS4/1Eg','PSSF','PEM1Bx','PFO3E','PFO4/1Ed','PFO4/SS4C','PFO4/SS4Eg','PFO4Eh','PSS3/1Ba','PSS4/3E','PSS4Edg','PSS4Eh','PSS3/1E','PFO4/1Ch','PFO4/1Ehg','PEM1/FO5Fh','PFO4/1Bg','PSS4/1B','PEM1/FO4B','PEM1/SS4B','PFO4/EM1E','PFO4Bh','PSS4/1E','PSS4/1Bd','PSS4/1Bg','PSS4Bg','PSS4/1Ed','PEM1/FO4C','PFO4/1Cg','PFO4/SS4Cg','PSS4/FO4Eg','PEM1Eg','PFO4/SS1B','PSS4/EM1B','PSS4/1Eh','PSS4Ehg','PFO4/SS1C','PFO4Ehg','PSS4/1Ehg','PFO4/1Edg','PEM1/SS3Ed','PFO4/SS1E','PFO4/1Cd','PSS4Bh','PSS4/3B','PEM1/SS3E','PFO4/1Exg','PFO4Ex','PSS3/1Eh','PEM1/SS3Eh','PEM1/SS4Eh','PFO4/1Ex','PFO4/SS1Ed','PFO4/SS4Ehg','PFO4/SS4Ex','PSS3/4E','PSS3/FO4Eh','PSS4/EM1Eg','PSS4/FO4Eh','PFO4/EM1Eh','PFO4/SS3E','PSS3Eh','PFO4/SS1Eh','PSS3/4Ba','PSS3/EM1Eh','PSS4/3Eg','PSS4/EM1Ehg','PFO4/SS3Eg','PSS4/FO4Ehg','PEM1/FO4E','PEM1/SS4Ed','PFO4/2E','PFO4/2Eg','PFO4Ed','PSS3Bda','PFO4/2Ed','PFO4/EM1Ed','PSS4/EM1Ed','PFO3/1E','PFO4Exg','PSS3/EM1E','PEM1/SS4Cd','PEM1Ba','PFO4/EM1Eg','PSS4/1Edg','PSS4/EM1Eh','PEM1/SS1Ba','PSS3C','PSS4/FO1E','PSS4Bd','PFO3/1B','PFO4/3B','PFO4/EM1C','PEM1/SS3Ba','PSS3/FO4Ba','PSS4Ch','PFO4/SS1Eg','PFO3/4B','PFO3B','PEM1/SS3Eb','PFO4/SS4Edg','PFO4Eb','PFO4Ebg','PSS3/4Ehg','PSS3/EM1Ba','PSS4/3Ba','PSS4Exg','PFO4/SS4Eh','PFO4Edg','PSS4/FO4Ba','PSS4Ed','PEM1/SS3Ch','PEM1/SS4Eg','PEM1/SS4Ex','PFO4/SS3Ba','PFO4/SS3Eh','PFO4/SS4Ba','PSS3/4Eg','PSS3/4Eh','PSS3/4Ex','PSS3Ed','PSS4/EM1Edg','PSS4Ba','PEM1Bda','PEM1Fa','PEM1/SS5Fh','PSS3/FO1E','PEM1/FO4Eg','PEM1/SS3Ex','PEM1/SS4Cx','PEM1/SS4Ehg','PFO4/3E','PFO4/EM1B','PFO4/3C','PFOFg','PSS4/1Cg','PEM1/SS1Cx','PFO4/SS4B','PSS3/1B','PSS4/EM1Cx','PEM1Es','R2UBFx','R2USC','PEM1/FO1Fx','R2EM2F','PEM1Fs','PEM1/5Fh','PEM1Cb','PFO4/1Cx','R3USC','PSS4/FO4Bg','PSS4Cg','PFO3/1C','PSS4/FO4B','PEM1/SS1Cb','PFO/SS1C','PFO/SS1E','PSS3/EM1Cx','PSS4/1Cx','PSS4/EM1C','PSS4/1Ch','PSS4/FO4C','PSS4/FO4Ch','PSS4/EM5C','PFO4/EM1Ch','PEM1/5Eh','PEM1/SS4Ch','PFO3C','PEM1/5C','PEM1/FO1F','PEM1/5Ch','PSS4/EM5Ch','PSS4Cd','PFO4Cx','PEM1/SS1Bs','PEM1Bs','PEM1/FO1Fb','PSS4/1Bs','PEM1/SS1Fb','PFO4Cd','PEM1/SS4Bd','PSS4/EM1Ex','PFO4/SS1Bd','PFO4/EM1Bd','PSS4/EM1Bd','PSS4Cx','PEM1/FO1Fh','PSS4/FO1B','PFO4/SS1Cd','PFO4Bx','PEM1/FO2Fh','PEM1/FO4Ex','PSS4/FO1C','PEM1/FO5Fb','PSS/EM1C','PSS/EM1B','PSS/EM1Ch','PFO/EM1Cd','PFO/EM1E','PSS/EM1E'.



System	P - Palustrine							
Class	RB - Rock Bottom	UB - Unconsolidated Bottom	AB - Aquatic Bed	US - Unconsolidated Shore	ML - Moss-Lichen	EM - Emergent	SS - Scrub-Shrub	FO - Forested
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	1 Moss 2 Lichen	1 Persistent 2 Nonpersistent 5 <i>Phragmites australis</i>	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen

MODIFIERS						
In order to more adequately describe the wetland and deepwater habitats, one each of the water regime, water chemistry, soil, or special modifiers may be applied at the class or lower level in the hierarchy.						
Water Regime			Special Modifiers	Water Chemistry		Soil
Nontidal	Saltwater Tidal	Freshwater Tidal		Halinity/Salinity	pH Modifiers for Fresh Water	
A Temporarily Flooded	L Subtidal	Q Regularly Flooded-Fresh Tidal	b Beaver	1 Hyperhaline / Hypersaline	a Acid	g Organic
B Seasonally Saturated	M Irregularly Exposed	R Seasonally Flooded-Fresh Tidal	d Partly Drained/Ditched	2 Euhaline / Eusaline	t Circumneutral	n Mineral
C Seasonally Flooded	N Regularly Flooded	S Temporarily Flooded- Fresh Tidal	f Farmed	3 Mixohaline / M Ixosaline (Brackish)	i Alkaline	
D Continuously Saturated	P Irregularly Flooded	T Semipermanently Flooded-Fresh Tidal	m Managed	4 Polyhaline		
E Seasonally Flooded / Saturated		V Permanently Flooded-Fresh Tidal	h Diked/Impounded	5 Mesohaline		
F Semipermanently Flooded			r Artificial Substrate	6 Oligohaline		
G Intermittently Exposed			s Spoil	0 Fresh		
H Permanently Flooded			x Excavated			
J Intermittently Flooded						
K Artificially Flooded						

Figure 7. National Wetlands Inventory (NWI) attributes matched to the swamp pink habitat description (highlighted, FWS 2013).

## 2.7. NCDOT

Regions of suitable habitat were used to refine the core map based on biological information. NCDOT completed a project named “ATLAS” in 2021 that categorized land within the range as low, moderate, or high suitability for species habitat for the swamp pink. Ultimately, regions of low and medium suitability were excluded from the core map, while high suitability was included. Categories of “low” and “high” for this species are defined as follows (“moderate” was not defined; NCDOT 2021):

- Low: Regions and sites where biologists would be very surprised to find this species and its habitat (occurrence here should be extremely rare).
- High: Biologists expect to frequently encounter areas that look like potential habitat based on visible environmental and vegetation community characteristics.

The thresholds for this species in the underlying continuous variable model are: Low-Moderate (0.25) and Moderate-High (0.74).

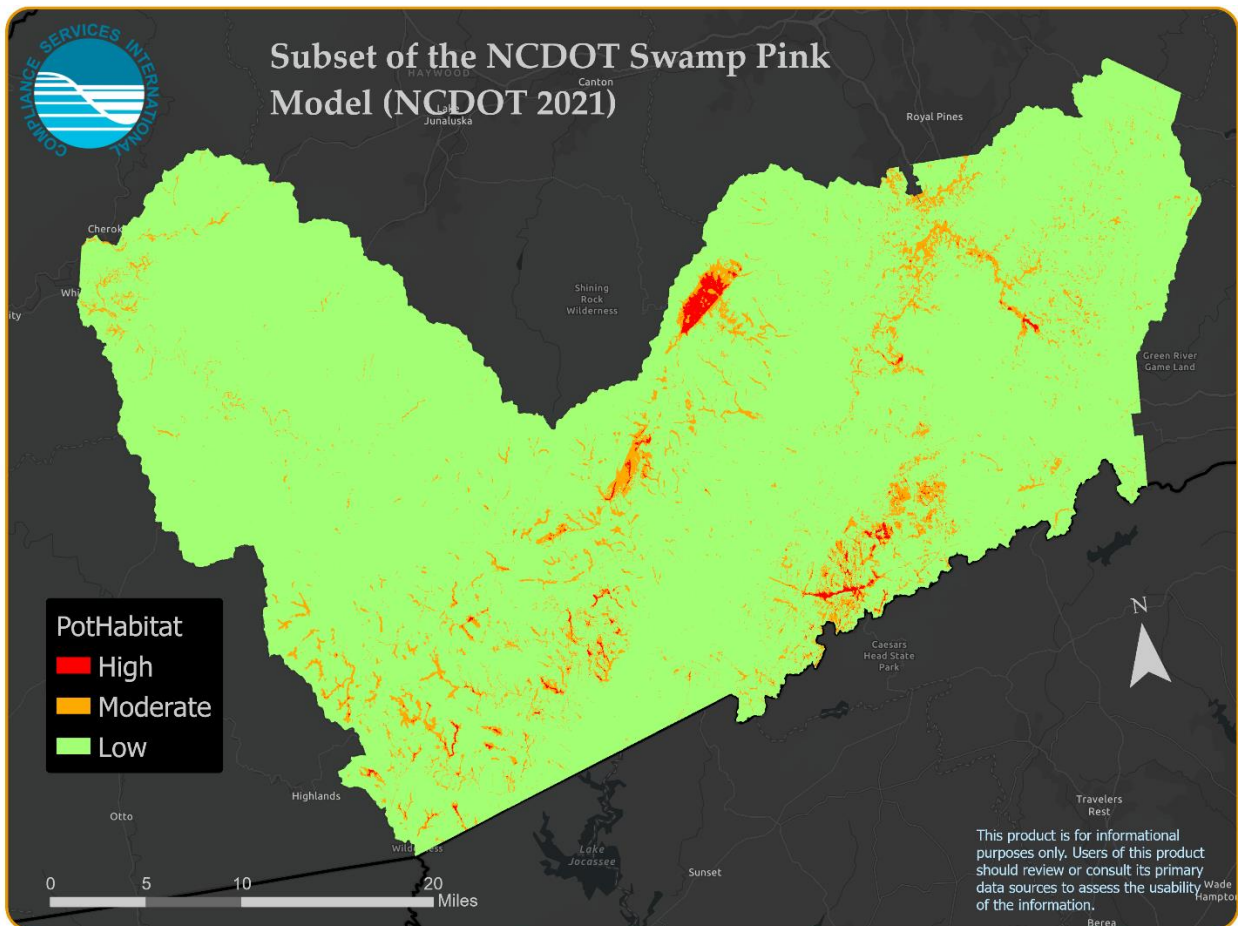


Figure 8. Map of areas of low, moderate, and high habitat suitability for a subset of the swamp pink extent (NCDOT 2021).

## 2.8. EPA Cultivated Lands Layer

EPA has developed and published its own cultivated layer for use in core map development as a potential refinement of extent. For the swamp pink, extent was refined by this layer using the Pairwise Erase tool to remove significant areas of agriculture because the species habitat is not consistent with cultivated land and is therefore considered by CSI to be an “off-field” species. This removed 2.4% of area but is considered a reasonable refinement for core map development for off-field species.

## 3. Creating the Core Map

### 3.1. Developing Extent

The swamp pink core map type is based on biological information/habitat. As the first part of the processing of developing this core map, a methodology was developed to define the outer contours of core map extent. In researching whether suitable alternatives existed for this extent besides species range, CSI determined that the species extent could be represented by a combination of known sites and counties known to contain extant populations (Table 2). Additionally, the species is known to inhabit specific physiographic areas corresponding to “Ecoregions” developed by EPA, which was used in refining the core map extent (Figure 4, EPA 2024). The specific methods and datasets used varied by state, as described below.

## Delaware, Maryland, New Jersey

Core map extent in Delaware, Maryland, and New Jersey was limited to the following Level 3 Ecoregions:

- Coastal Plain (Note: some did not intersect the 3 states)
  - Western Gulf Coastal Plain (Level 3 code 34)
  - Middle Atlantic Coastal Plain (63)
  - Southern Coastal Plain (75)
  - Southern Florida Coastal Plain (76)
- Piedmont (45)
- Northeastern Highlands (58)
- Southeastern Plains (65)
- Atlantic Coastal Pine Barrens (84)

These regions and the counties list provided in **Error! Reference source not found.** were used to refine species extent as follows:

1. Use the Merge tool to merge the 5 Ecoregion layers above into a single layer (“CoastalPlain\_Piedmont\_Northeast\_Atlantic\_Southeaste\_merge”).
2. Use the Pairwise Dissolve tool to dissolve the previous layer (“CoastalPlain\_Piedmont\_Northeast\_Atlantic\_Southeaste\_merge”) into a single feature and save as a new layer (“CoastalPlain\_Piedmont\_Northeast\_Atlantic\_Southeaste\_pd”).
3. Use **Error! Reference source not found.** to identify/select counties relevant to the swamp pink in these states.
4. Use the Pairwise Clip tool to clip the previous layer (“CoastalPlain\_Piedmont\_Northeast\_Atlantic\_Southeaste\_pd”) by the selected counties and save as a new layer “CoastalPlain\_Piedmont\_Northeast\_Atlantic\_Southeaste\_SelCounties”.

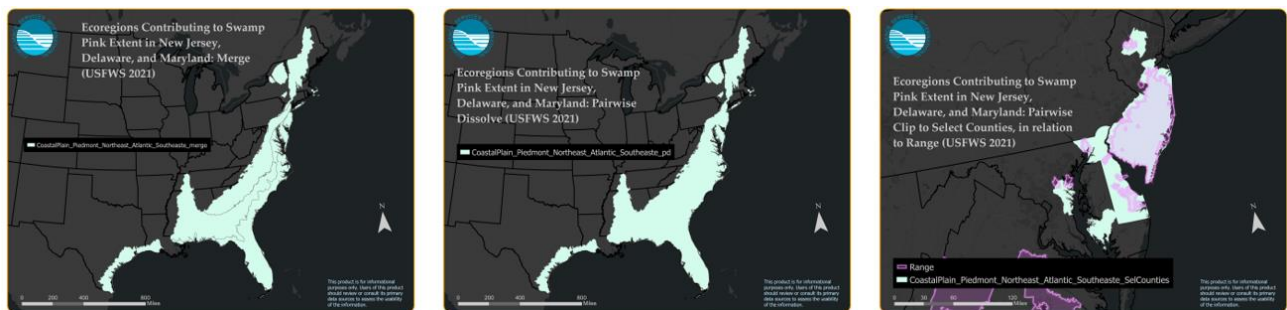


Figure 9. Development of the core map extent of the swamp pink. The merged Ecoregions (left) were dissolved (middle) and clipped to the relevant counties in these states (right). Species range provided in final panel for reference (EPA 2024).

## Virginia

Core map extent in Virginia was limited to the following Level 3 Ecoregions:

- Coastal Plain (Note: some did not intersect the 3 states)
  - Western Gulf Coastal Plain (34)
  - Middle Atlantic Coastal Plain (63)
  - Southern Coastal Plain (75)

- Southern Florida Coastal Plain (76)
- Blue Ridge (66)
- Ridge and Valley (67)

These regions and the counties list provided in **Error! Reference source not found.** were used to refine species extent as follows:

1. Use the Merge tool to merge the 3 Ecoregion layers above into a single layer (“CoastalBlueridgeValley\_merge”).
2. Use the Pairwise Dissolve tool to dissolve the previous layer (“CoastalBlueridgeValley\_merge”) into a single feature and save as a new layer (“CoastalBlueridgeValley\_merge\_pd”).
3. Use **Error! Reference source not found.** to identify/select counties relevant to the swamp pink in Virginia.
4. Use the Pairwise Clip tool to clip the previous layer (“CoastalBlueridgeValley\_merge\_pd”) by the selected counties and save as a new layer “CoastalBlueridgeValley\_merge\_pd\_SelCounties”.

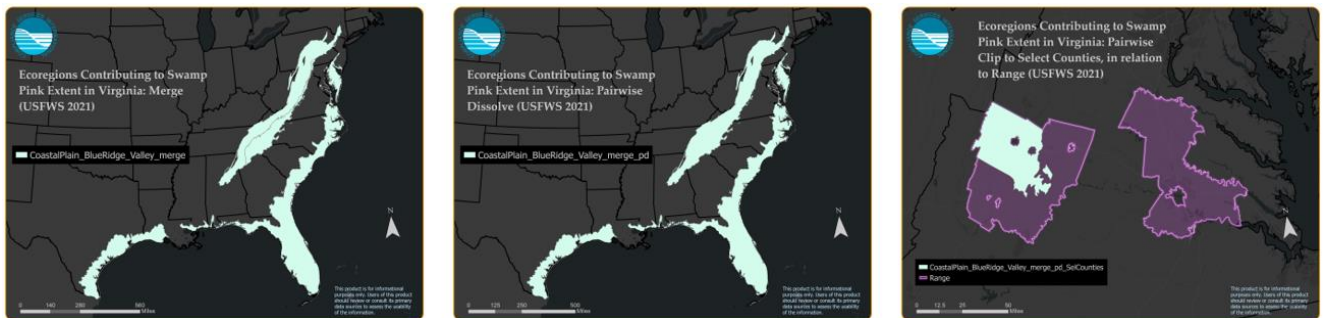


Figure 10. Development of the core map extent of the swamp pink. The merged Ecoregions (left) were dissolved (middle) and clipped to the relevant counties in Virginia (right). Species range provided in final panel for reference (EPA 2024).

### North Carolina

In North Carolina, only the Blue Ridge Ecoregion was appropriate for the swamp pink. However, this Ecoregion entirely encompasses the range and so was not used for refinement. Rather, the range (“SP\_range”) was clipped the **Error! Reference source not found.** counties in North Carolina, using the Pairwise Clip tool, and saved as a new layer (“Counties\_NC”).

### South Carolina

In South Carolina, the most recent PAD-US layer of protected areas was queried to identify site(s) with both “Watson” and “Cooper” in the site name. Only one record was identified. This shape was validated against shapes in Google Maps and ESRI basemaps and exported as a standalone layer (“WatsonCooper”).

### Georgia

In Georgia, extant populations were identified using “quarter quads” downloaded from the GDNr swamp pink website (GDNr 2025). The downloaded shapefile was exported as a feature class (“GDNr\_quarter\_quads”) and queried to identify only recent quads: age\_text2 IN ('10 Years or Less', 'Between 11 and 25 Years'). Selected quads were exported as a new feature class (“GDNr\_quarter\_quads\_recent”).

### 3.2. Combining Extent

The five extent shapes created and described above were merged and processed as follows:

1. Use the Merge tool to merge the five layers below into a single layer ("SP\_extent\_merge").
  - a. CoastalPlain\_Piedmont\_Northeast\_Atlantic\_Southeaste\_SelCounties
  - b. CoastalBlueridgeValley\_merge\_pd\_SelCounties
  - c. Counties\_NC
  - d. WatsonCooper
  - e. GDNR\_quarter\_quads\_recent
2. Use the Pairwise Dissolve tool to dissolve the previous layer ("SP\_extent\_merge") into a single feature ("SP\_extent\_merge\_pd").

### 3.3. Habitat-based Refinement

#### North Carolina (except Macon county)

In North Carolina, the species-specific model for the swamp pink was used to represent habitat areas.

1. Download the species-specific model for the swamp pink from NCDOT. There was no need to clip the model to the extent developed above because the layer is complete contained within the extent.
2. Use an SQL query to select features from the swamp habitat layer that are high potential habitat: PotHabitat IN ('High'). Export selected features as a new layer ("NCDOT\_sel"). This resulted in 1,570 unique shapes.

#### Outside of North Carolina, and Macon County, NC

Outside of North Carolina, the NWI dataset was used to represent habitat areas. A custom layer was developed as follows:

1. Download NWI state-level data for six states: Delaware, Georgia, Maryland, New Jersey, South Carolina and Virginia.
2. Merge the state-level NWI datasets into a single layer, saved as "NWI\_merge\_noNC."
3. Because the state-level NWI datasets sometimes include features outside the state boundaries (not due to projections), the use the Pairwise Clip tool to clip the previous layer ("NWI\_merge\_noNC") by a selection of all states except North Carolina. Save as a new layer ("NWI\_merge\_noNC\_pcNoNC").
4. Use the Pairwise Clip tool to clip the previous dataset ("NWI\_merge\_noNC\_pcNoNC") by the species extent ("SP\_extent\_merge\_pd"). Save as a new layer ("NWI\_pcExtent\_noNC").
5. Using professional judgment as detailed in Section 2.6, apply a SQL query to the NWI dataset to select only wetland types matching habitat description for the swamp pink. Export selected features as a new layer ("NWI\_pcExtent\_noNC\_sel"). This resulted in 29,496 unique shapes.

## Macon County, NC

It was observed that the NCDOT habitat model for the swamp pink did not include Macon County, NC. As a result, the process for developing habitat area that was applied to states outside of North Carolina was repeated for Macon County only, as follows:

1. Download the NWI state-level data for North Carolina. Verify that the layer encompasses all of Macon County (it does).
2. Use the Pairwise Clip tool to clip the NWI dataset in North Carolina to Macon County. The entirety of this county is within the species extent developed earlier. Save as a new layer ("NWI\_pcMacon").
3. Using professional judgment as detailed in Section 2.6, apply an SQL query to the NWI dataset to select only wetland types matching habitat description for the swamp pink. Export selected features as a new layer ("NWI\_pcMacon\_sel"). This resulted in 74 unique shapes.

## Combining Habitat Features and Finalizing Interim Core Map

The intermediate layers developed above were combined to produce the finalized interim core map as follows:

1. Use the Merge tool to aggregate all the potential habitat features above ("NCDOT\_sel", "NWI\_pcExtent\_noNC\_sel", "NWI\_pcMacon\_sel") into a single layer ("SP\_habitat\_merge").
2. Use the Pairwise Buffer tool to buffer the previous layer by 300 feet. This is to encompass areas along the edges of water bodies where the species may reasonably be found to occur. Select the option to dissolve output into a single feature. Save as a new layer ("SP\_habitat\_merge\_pb300ft").
3. Use the Pairwise Clip tool to clip the previous layer ("SP\_habitat\_merge\_pb300ft") by the species range ("SP\_range") and save as a new layer ("SP\_habitat\_merge\_pb300ft\_pcRange").

### **3.4. Cultivated Lands-based Refinement**

1. Use the Pairwise Erase tool to exclude cultivated areas > 25 acres according to a layer developed by EPA ("CultivatedAreas\_Over25acres"). Save as a new layer ("SP\_habitat\_merge\_pb300ft\_pcRange\_peCultivated25ac").
2. (Optional) Export previous layer as a new layer identifiable as the species core map ("SP\_CoreMap").

## **4. Datasets Considered but Not Used in Core Map Development**

### **4.1. Soil Survey Geographic (SSURGO) Database**

The decision to use the NWI dataset instead of SSURGO for refining habitat areas for the swamp pink was driven by several key considerations. Firstly, the NWI provides a comprehensive classification of wetland types, which is crucial for identifying the diverse wetland habitats where the swamp pink thrives. In contrast, SSURGO focuses primarily on soil characteristics, which may not capture the full range of wetland habitats necessary for this species. Using SSURGO could potentially exclude areas that are critical for the swamp pink but are not defined by soil properties alone. The NWI's detailed mapping of wetland types ensures that all relevant habitats are included, thereby providing a more accurate representation of the

species' habitat requirements. Additionally, the hydrologic conditions described in the NWI are essential for the swamp pink, which requires perennially saturated but not inundated wetlands. By relying on NWI, we ensure that these specific hydrologic conditions are adequately represented, supporting the conservation efforts for the swamp pink. Therefore, the NWI was chosen to avoid the risk of excluding vital habitat areas that SSURGO might overlook.

A species-specific habitat model for the swamp pink from NCDOT was selected over the SSURGO dataset. The NCDOT model utilizes a random forest machine-learning approach, which provides a high-resolution probability map of potential habitat based on current presence locations. This model is specifically tailored to the swamp pink, incorporating detailed environmental variables and habitat preferences unique to this species, thereby offering a more accurate and reliable identification of suitable habitats. In contrast, the SSURGO dataset primarily focuses on soil characteristics and lacks the species-specific nuances necessary for precise habitat modeling.

#### **4.2. Other Known Location Datasets: NatureServe, GBIF, iNaturalist**

The species extent that was used represented known location sites and physiographic regions for the swamp pink. One reason the location data from NatureServe, GBIF, and iNaturalist were not used to develop the core map was that observations were not publicly disclosed as important sites for the continued health of the species or its populations (*e.g.*, a breeding site).

Additionally, these datasets provide known locations without associated accuracy information. NatureServe public EOs are available as hexagons, anywhere in which the species may have been observed. To incorporate the public EOs, provided in maps, these hexagons would need to be georeferenced for use in core map development, adding uncertainty. Compliance Services International does not consider this general approach to be inappropriate in core map development—and indeed can be very useful in refining a species spatial extent—but the location information was not sufficiently inclusive of areas where the swamp pink might be present.

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- Software used: ArcGIS Pro version 3.2.