Interim Core Map Documentation for the Florida Perforate Cladonia

Version 1
Date Reviewed: April 2026
Core Map Developer: U.S. Environmental Protection Agency (EPA), Office of Pesticide Programs

Species Summary

The Florida perforate cladonia (*Cladonia perforata,* Entity ID 1219) is an endangered lichen. The U.S. Fish and Wildlife Service (FWS) has not designated a critical habitat for the Florida perforate cladonia. This species is typically found growing around high, well-drained sands of rosemary scrub in Florida. Reproduction is typically by means of sexually produced spores or dispersal of vegetative fragments or simple fragmentation. Currently, the Florida perforate cladonia is found within four distinct metapopulations of Florida: the panhandle in Okaloosa County, Lake Wales Ridge in Polk and Highlands counties, the Atlantic Coastal Ridge in St. Lucie, Martin, and Palm beach counties, and the southwest coast in Manatee County. Additional information on the species is provided in **Appendix 1**.

Description of Core Map

The core map for the Florida perforate cladonia is based on biological information. The core map is defined by known locations that intersect with the Florida Natural Areas Inventory (FNAI) Biodiversity Matrix Square Mile Grid Units and is further refined by the removal of cultivated land and open water landcover.

Figure 1 depicts the resulting interim core map for the Florida perforate cladonia. The size of this core map is approximately 66,172 acres. Landcover categories within the core map area are included in **Table 1**. Landcover is predominantly woody wetlands, pasture/hay, low intensity developed lands, and scrub/shrub.

The core map developed for the Florida perforate cladonia is considered interim. This core map can be used to develop pesticide use limitation areas (PULAs) that include the Florida perforate cladonia. 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 species expert feedback from FWS. This interim core map has an “average” (3) best professional judgment classification to describe major uncertainties/limitations. The map is based on known locations described by FWS and EPA removed some additional areas based on biological needs of the species. This core map does not replace or revise any range or designated critical habitat developed by FWS for this species.

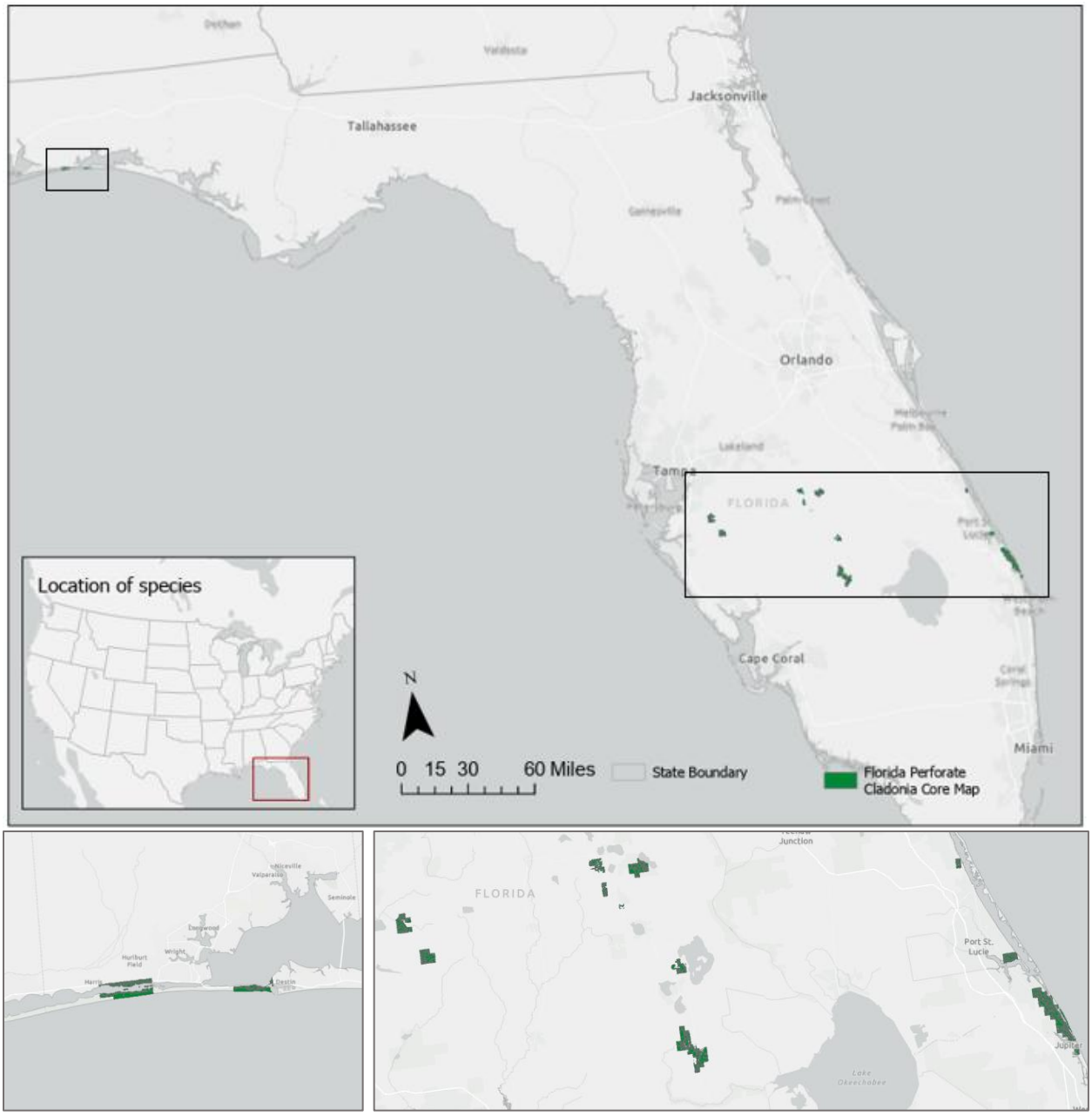

Figure 1. Interim core map for the Florida perforate cladonia.

Table 1. Percentage of Interim Core Map Represented by National Land Cover Database (NLCD)[1] Land Covers and Associated Example Pesticide Use Sites/Types.

Example pesticide use sites/types	NLCD Landcover (Value)	% of core map represented by landcover
Forestry	Deciduous Forest (41)	0%
Forestry	Evergreen Forest (42)	7%
Forestry	Mixed Forest (43)	1%
Agriculture	Pasture/Hay (81)	14%
Agriculture	Cultivated Crops (82)	2%
Mosquito adulticide, residential	Open space, developed (21)	8%
Mosquito adulticide, residential	Developed, Low intensity (22)	11%
Mosquito adulticide, residential	Developed, Medium intensity (23)	6%
Mosquito adulticide, residential	Developed, High intensity (24)	1%
Invasive species control	Woody Wetlands (90)	33%
Invasive species control	Emergent Herbaceous Wetlands (95)	4%
Invasive species control	Open water (11)	0%
Invasive species control	Grassland/herbaceous (71)	1%
Invasive species control	Scrub/shrub (52)	10%
Invasive species control	Barren land (rock/sand/clay; 31)	2%
Total Acres	**Interim Core Map Acres**	**~ 66,172**

Evaluation of Known Location Information

There are four datasets with known location information:

- Descriptions of locations provided by FWS (referenced locations from FNAI polygons)
- Occurrence locations in iNaturalist
- Occurrence locations in NatureServe
- Occurrence locations in Global Biodiversity Information Facility (GBIF)

EPA evaluated these four sets of data before selecting the type of and developing the core map. FWS appeared to have the finest resolution of the location information, providing a table of the 35 extant populations (55 sub-populations sites) within 4 distinct metapopulations (**Appendix 1**). FNAI provided location information for reference only in the format of Element Occurrence (EO) polygons and habitat model v. 5.3. The FNAI EOs are considered locations where the species is documented and has the most recent available data. The FNAI habitat model is a more complete coverage product that includes areas where the species is likely to be found, but does not include some recently found populations, as it was finalized in 2022.

Collectively, the occurrence data queried from iNaturalist, GBIF, and NatureServe are consistent with the FWS/FNAI location data used to identify the core map.

[1] Dewitz, J., 2023, National Land Cover Database (NLCD) 2021 Products: U.S. Geological Survey data release, https://doi.org/10.5066/P9JZ7AO3

- iNaturalist (available here) had 126 research grade observations for this species, all of which appear to be within the species range and consistent with FWS/FNAI location data used to identify the core map when accounting for positional accuracy.
- GBIF (available here; filter for present occurrences in the U.S.) included 146 human observations (from 1986-2025) with all observations also in iNaturalist or NatureServe. The 107 GBIF points with coordinate locations coincide with the range and core map given the positional accuracy of the information.
- NatureServe (linked here) occurrences were consistent with the range and other occurrence data.

Occurrences in iNaturalist, GBIF, and NatureServe did not support expanding the core map outside of boundaries used to create the core map. **Appendix 1** includes more information on the available known location information.

Approach Used to Create Core Map

The core map was developed using the "Process EPA Uses to Develop Core Maps for Draft Pesticide Use Limitation Areas for Species Listed by the U.S. Fish & Wildlife Service (FWS) and their Designated Critical Habitats"[2] (referred to as "the process"). EPA developed the core map using the four steps described in the process document:

1. Compile available information for a species
2. Identify core map type
3. Develop the core map for the species
4. Document the core map

For step 1, EPA compiled available information for the Florida perforate cladonia from FWS, as well as observation information available from various publicly available sources. The information compiled for the Florida perforate cladonia is included in **Appendix 1**. Influential information that impacted the development of the core map included:

- Occurrences and known locations of the Florida perforate cladonia.

For Step 2, EPA used the compiled information to identify the core map type including species range and known locations. FNAI EO polygons and a habitat model provided EPA with a reference map for known locations across the species range. To obscure location information, EPA selected FNAI Biodiversity Matrix Square Mile Grid Units that intersected with the EO polygons and habitat model for core map development. Because the grid layer includes Florida waterbodies, open water landcover was removed from the area since the Florida perforate cladonia is not an aquatic species. EPA also further refined this area by removing cultivated lands as standard for biological information core maps. The entire range of the species was not used as the core map because the range contains areas where the species does not occur.

For step 3, EPA used the best available data sources to generate the core map. Data sources are discussed in the process document. For this core map, EPA selected FNAI Biodiversity Matrix Square Mile Grid Units that intersected with the FNAI habitat model v. 5.3 (December 2024) and FNAI EO polygons

[2] Dated 2024, available online at: https://www.epa.gov/endangered-species/process-epa-uses-develop-core-maps-pesticide-use-limitation-areas

(received 8/18/2025) for the Florida perforate cladonia. EPA used EPA's Modified Cultivated Layer to remove cultivated land and NLCD to remove Open Water landcover. **Appendix 2** provides more details on the Geographic Information System (GIS) analysis and data used to generate the core map.

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

EPA considered refining the species range by a shrub/scrub habitat type since that is descriptive of the Florida perforate cladonia typical habitat. However, this may have introduced more uncertainty than the benefit of this refinement would justify because the known locations included areas that would have been removed using the shrub/scrub habitat refinement. Therefore, refinement by shrub/scrub areas was not used for this map because it could possibly remove relevant habitat.

Appendix 1. Information Compiled for the Florida perforate cladonia

1. **Recent FWS documents/links and other data sources**
   - Five Year Review (2021) – https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/3484.pdf
   - Recovery Plan (2019) – https://ecos.fws.gov/docs/recovery_plan/Florida%20Perforate%20Cladonia%20Recovery%20Plan%20Amendment_2.pdf

2. **Background information**
   - **Status**: Federally listed as endangered in 1993
   - **Resiliency, redundancy, and representation** (the 3Rs)
     - Resiliency = To meet the resiliency delisting criterion, the species must have "at least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple size classes" (Recovery Plan, 2019). This criterion has not been met as only 35 extant populations and 2 extirpated populations exist. "Detailed demographic data on natural recruitment or size classes are not being collected at any of the populations to determine trends, and only a few (10) populations are regularly monitored for abundance" (Five Year Review, 2021).
     - Redundancy = To meet the redundancy delisting criterion the species "must be protected via a conservation mechanism and/or managed such that enough suitable habitat is present to remain for the foreseeable future" and "withstand stochastic events such as hurricanes or fire" (Recovery Plan, 2019). Introductions and newly discovered populations "have increased the species' redundancy within its range and expanded the range of the two largest metapopulations (Lake Wales Ridge and Atlantic Coastal Ridge), though populations are still fragmented and experiencing low gene flow and genetic diversity (Yahr 2000a; Yahr 2004)" (Five Year Review, 2021).
     - Representation = To meet the representation delisting criterion, the species must have "populations occur in white sand rosemary and sand pine habitats and are distributed across the historical range of the species" (Recovery Plan, 2021). This criterion has been partially met. "Surveys and introductions have increased the known range... However, many acres of suitable habitat exist between populations and metapopulations which are either unoccupied by the species or have yet to be surveyed" (Five Year Review, 2021).

   - **Habitat**
     - "Restricted to the high, well-drained sands of rosemary scrub in Florida" (Recovery Plan, 2019).
     - "Typical habitat for the Florida perforate cladonia is found on the high sand dune ridges of Florida's peninsula, including the Atlantic Coast and the Lake Wales Ridges. In these areas it is restricted to the highest, xeric white sands in sand pine scrub and rosemary scrub, which is characterized in part by persistent, open patches of sand. The Florida perforate cladonia typically occurs in open patches of sand between shrubs in areas with sparse or no herbaceous cover" (Recovery Plan, 2019).

- **Pollinator/reproduction**
    - "Reproduction in these lichens is typically by means of sexually produced spores or dispersal of vegetative fragments or simple fragmentation" (Recovery Plan, 2019).

- **Taxonomy**
    - FWS Category: Lichen (CONUS-1), Cladoniaceae family

- **Relevant Pesticide Use Sites**
    - No information specific to pesticides in FWS documents.

- **Recovery Criteria/Objectives (Recovery Plan, 2019)**
    - Recovery Priority Number: 5C
    - Delisting Criterion 1 = "At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple size classes."
    - Delisting Criterion 2 = "Populations occur in white sand rosemary and sand pine habitats and are distributed across the historical range of the species."
    - Delisting Criterion 3 = "Must be protected via a conservation mechanism and/or managed such that enough suitable habitat is present to remain for the foreseeable future."

- **Recovery Actions (Five Year Review, 2021)**
    - Identify suitable habitat for introductions and establish new populations
    - Restore scrub habitat within the range of each metapopulation for potential introduction sites
    - Continue and enhance management practices on conservation lands, including reduction of hardwoods, creation of sandy openings, targeted prescribed fire, and removal of invasive species
    - Continue application of prescribed fire while using protection measures to prevent harm
    - Continue or enhance protections on conservation lands from human disturbances
    - Protect populations and suitable habitat on private land. Conduct outreach to private landowners. Encourage and assist with land management activities.
    - Consider translocating populations in danger of extirpation from human disturbance or development to protected sites
    - Continue ex situ tissue bank efforts with collections from each metapopulation
    - Continue and expand monitoring/research activities

3. Description of Species Range

- Figure A1-1 depicts the FWS range. The range was last updated on 2/17/2022.

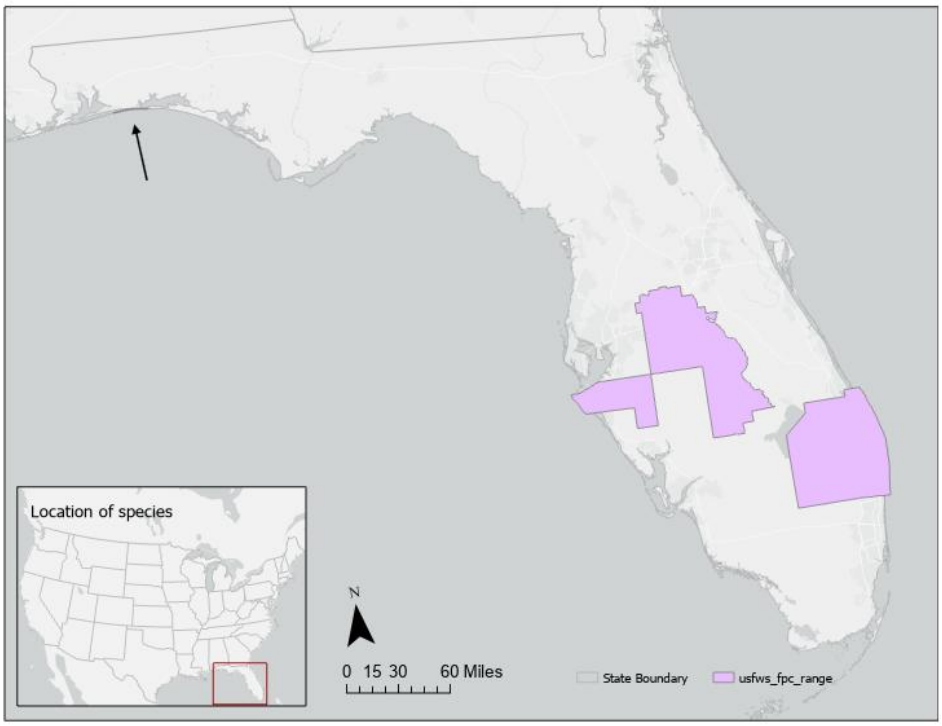

Figure A1-1. FWS range for the Florida perforate cladonia. The total acreage is around 4,583,178 acres. The arrow indicates the Santa Rosa Island population that is within the FWS range.

4. Critical Habitat

- No critical habitat designation for this species.

5. Known Locations

- "There are currently 35 extant populations [55 sub-populations sites] within 4 distinct metapopulations... However, only 14 of the 35 extant populations are known (8) or estimated (6) to be stable or increasing, and 21 are declining or have unknown status" (Five Year Review, 2021).
    - Three sites on the North Gulf Coast
    - Four sites on the West Coast
    - 23 sites on the Lake Wales Ridge
    - 25 sites on the Atlantic Coastal Ridge

- **Occurrences Included in Public Databases (**EPA queried iNaturalist, GBIF, and NatureServe)
    - iNaturalist (available here) had 126 research grade observations for this species, all of which appear to be within the species range when accounting for positional accuracy.
    - GBIF (available here; filter for present occurrences in the USA) included 146 human observations (from 1986-2025) with all observations also in in iNaturalist or NatureServe. The 107 GBIF points with coordinate locations coincide with the range when accounted for the resolution of the location data.
    - Occurrences in NatureServe were consistent with other occurrence data and the range (linked here).

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

This core map was created based on biological information, including occupied location.

1. **Dataset References and Software**

- Square Mile Grid Units for FNAI's Biodiversity Matrix Map Server (last updated on 4/15/2020)
- Florida Natural Areas Inventory (FNAI), Element Occurrence Polygons (received 8/18/2025) and Habitat Model v. 5.3 (December 2024)
  - Data request: https://www.fnai.org/publications/data-requests
  - Habitat Model Technical Report: https://www.fnai.org/PDFs/FFCNA_TechReport_v53.pdf
- USA National Land Cover Database (NLCD) 2001-2021 (last updated 11/20/2025)
- EPA OCSPP's Office of Pesticide Program Modified Cultivated Layer (last updated 12/16/2024)
- FWS Species Range from ECOS (last updated on 2/17/2022)
- Software used: ArcGIS Pro 3.5.4

2. **Datasets Used in Core Map Development**

All datasets used in core map development are described in EPA's process document.

3. **Core Map Development**

- EPA started with the FWS species range compared to FWS known locations available as FNAI element occurrence (EO) polygons and FNAI habitat model. Both data sets are found within the range. The habitat model covers areas where species are likely to be found but does not include some recently found populations, as data inputs were finalized in 2022. The EO polygons includes more recently known locations. This data is for reference only and was used to select square mile grids where the Florida perforate cladonia may occur. This map was further refined by removal of cultivated lands and open water landcover.
  - Upload and merge FNAI habitat model and element occurrence polygons.
  - Upload the Square Mile Grid Units for FNAI's Biodiversity Matrix Map Server.
  - Use the "Select Feature by Location" tool to select grids that are intersected by FNAI known locations.
    - Input Features = FNAI_BioMatrix_SqMile_Grid
    - Relationship = Intersect
    - Selecting Features = Known locations (merged FNAI EOs and habitat model map)
    - Selection type = New Selection
  - Under the Data tab, use "Layer from Selection" to create a new layer of the selected grids that intersect with known locations.
  - Upload EPA's Modified Cultivated Layer and remove cultivated lands from the map using the Pairwise Erase tool.
  - Upload NLCD raster, clip raster to map, convert raster to polygons, and pairwise dissolve by ClassName.
  - Select and remove the feature ClassName=Open Water.
  - Final core map generated as "Florida Perforate Cladonia Core Map.shp".