

# Interim Core Map Documentation for Virginia Sneezeweed

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**Draft Interim Core Map Developer:** Compliance Services International (CSI) on behalf of the Soy Checkoff

## Species Summary

Virginia sneezeweed (*Helenium virginicum*; Entity ID 1028) is a dicotyledonous threatened plant found in Virginia, Indiana, and Missouri. The U.S. Fish and Wildlife Service (FWS) has not assigned designated critical habitat for the Virginia sneezeweed. In the latest 5-year review, FWS recommended the species for delisting (FWS 2020). This species inhabits poorly drained, acidic, silty loam soils, which are generally flooded from January to July, and its populations vary greatly due to water level fluctuations. 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 EPA'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. Some views in this documentation may not necessarily be the views of EPA or its staff.

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 Virginia sneezeweed is biological information type, based on the preferred habitat and known locations of this species including sinkholes, palustrine emergent and unconsolidated shore wetlands, and one nature preserve in Indiana. The species' 5-Year Review (FWS 2020) and Recovery Plan (FWS 2000) included textual descriptions of habitat that were used to develop the core map. The species range provided the outer boundary of the core map. Areas of potential habitat were clipped to the species range to develop the core map.

The core map developed in this document for the Virginia sneezeweed spans 327 acres (Figure 1). A summary of acreage by National Landcover Database (NLCD 2021) land use type is provided in

Based on EPA’s “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 National Wetlands Inventory (NWI) dataset (FWS 2023). These assumptions involved associating the species’ habitat—seasonally flooded sinkhole wetlands—with corresponding NWI classifications, in this case, palustrine emergent and unconsolidated shore wetlands. More information about this classification system and its definitions can be found in the core map process document (EPA 2024).

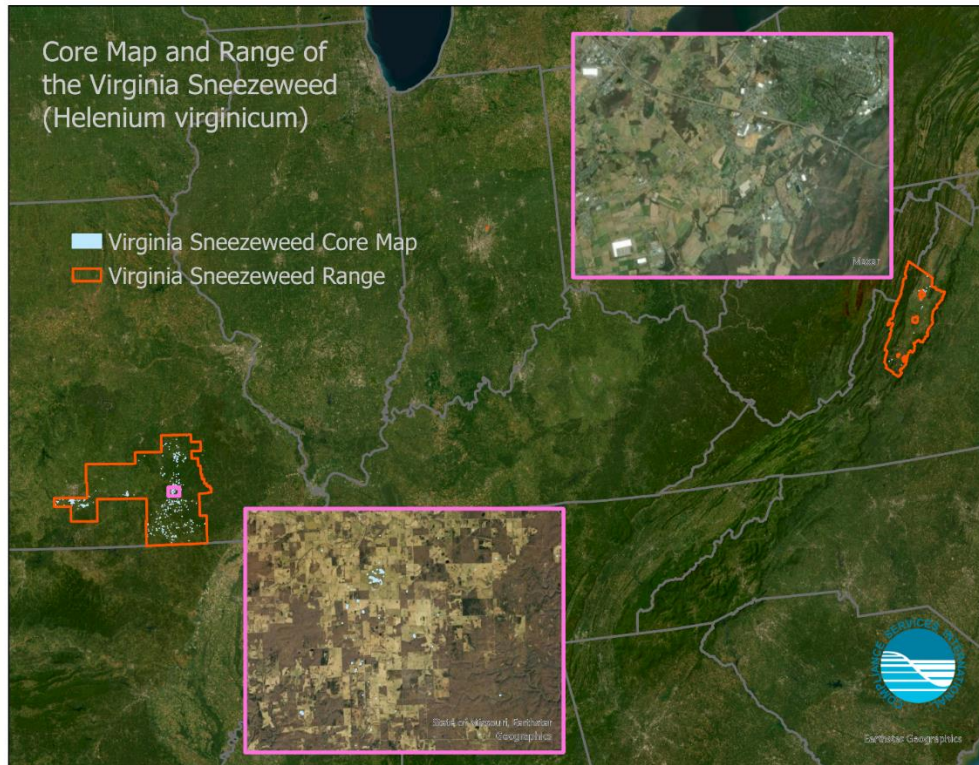


Figure 1. Interim core map for the Virginia sneezeweed (*Helenium virginicum*; Entity ID 1028). The core map spans 327 acres, while the range is 5,722,261 acres.

NLCD_Land_Cover_Class	Acres
Hay/Pasture	141
Deciduous Forest	83
Open Water	29
Emergent Herbaceous Wetlands	23
Woody Wetlands	19
Developed, Open Space	6
Developed, Low Intensity	6
Mixed Forest	5
Developed, High Intensity	4
Developed, Medium Intensity	3
Herbaceous	3
Evergreen Forest	1
Shrub/Scrub	-
Cultivated Crops	-

Table 1. Acres by National Land cover Database (NLCD 2021) class within the core map of the Virginia sneezeweed. Total core map area (based on NLCD pixel count): 323 acres<sup>1</sup>.

## Evaluation of Known Location Information

There were four evaluated datasets with known location information:

- Descriptions of one known location in Indiana provided by FWS;
- Occurrence locations in iNaturalist;
- Occurrence locations in the Global Biodiversity Information Facility (GBIF); and
- Occurrence locations in NatureServe.

Compliance Services International evaluated these four datasets before developing the core map. Overall, there were thirty-nine usable research-grade observations found in iNaturalist<sup>2</sup>. The GBIF dataset comprised eighty-nine georeferenced observations, thirty-two of which were considered usable based on the criteria described below. Both datasets were useful to identify extant population sites for the Virginia sneezeweed but were not comprehensive enough to be used in core map development. These datasets were redundant because the usable GBIF observations appear to be a subset of the usable iNaturalist dataset.

FWS location information provided information for the lone extant population in Indiana. The species occurs on the Ritchey Woods Nature Preserve; this textual description was matched to a national dataset of protected lands and used to identify the shape associated with habitat for this species.

<sup>1</sup> This acreage is slightly different from the core map acreage (327) due to the pixelation of NLCD land cover. The core map is not developed exclusively from raster data.

<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->).

NatureServe public element occurrence (EO) data were also evaluated and are considered by CSI to corroborate the datasets used.

## Approach Used to Create Core Map

The core map was developed using EPA's process for developing core maps for species listed by 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 Virginia sneezeweed from FWS, as well as observation information available from various publicly available sources including iNaturalist, GBIF, and NatureServe. The information compiled for Virginia sneezeweed is included in **Appendix 1**. Influential information that impacted the development of the core map includes descriptions of the species habitat from its ECOS webpage and the Recovery Plan:

- "This wetland plant is found on the shores of naturally occurring shallow, seasonally flooded limestone ponds (less than 0.1 to 8 acres in size) along the western edge of the Blue Ridge Mountains in the Shenandoah Valley. This plant inhabits poorly drained, acidic, silty loam soils, that are generally flooded from January to July. It cannot tolerate shade or long periods of flooding. Each year, Virginia sneezeweed populations vary greatly due to water level fluctuations" (FWS 2025).
- "[The Virginia Sneezeweed] can also be found in disturbed sites that appear as seasonally wet meadows, depressions in lawns, roadside ditches, and margins of farm ponds in VA. In MO, *H. virginicum* habitat also ranges from less disturbed sinkhole pond margins and wet meadows to temporary wetlands in hayfields, roadside ditches, cattle ranches, and rural airports" (FWS 2020).

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 the one known location from FWS in Indiana was a useful (but modest) refinement of species range in that state.

Review of the available data also suggested that the core map could be informed by mappable habitat descriptions for this species. To represent the species' habitat, the NWI dataset was used to identify wetland types associated with the species habitat description above; using the "ATTRIBUTE" field, palustrine emergent and unconsolidated shore wetlands were selected from within the core map extent. The core map extent is represented by sinkholes in Missouri and Virginia, the latter of which was based on a points layer that was buffered by 100 feet (ft). Sinkhole layers were converted to polygonal spatial data and clipped to the species range, then had selected water bodies identified to represent potential habitat. Finally, contiguous cultivated areas > 25 acres (EPA 2025) were removed from the core map because the species' hydrology and soil requirements are incompatible with cultivated lands.

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 Virginia sneezeweed does not have designated critical habitat. The range core map type was not selected because the species range is not refined in most geographic areas and not considered endemic.

Counties and one specific location in Indiana were identified in FWS documentation; these areas were not considered to be more specific refinements, so were not used to form the outer boundary ("extent") considered for core map development. The state-level sinkholes layers in Missouri and Virginia were used to clip selected NWI water body types to create a layer representing potential habitat for the Virginia sneezeweed; where needed, intermediate layers were converted to polygonal feature classes and incorporated together to form the core map. **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 iNaturalist, GBIF, and NatureServe were considered but not used as the basis for the core map.

## Appendix 1. Information compiled for Virginia sneezeweed

### 1. Recent FWS documents

- 5-Year Review (FWS 2020) [https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public\\_docs/species\\_nonpublish/2960.pdf](https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/2960.pdf)
- Draft Recovery Plan (FWS 2000) [https://ecos.fws.gov/docs/recovery\\_plan/001002.pdf](https://ecos.fws.gov/docs/recovery_plan/001002.pdf)
- ECOS Profile Page (FWS 2025) <https://ecos.fws.gov/ecp/species/6297>

### 2. Background information

- Status: Federally listed as threatened in 1998.
  - Recommended for delisting in latest 5-year review (FWS 2020)
- Resiliency, redundancy, and representation (the 3Rs) (FWS 2020)
  - Resiliency: In VA, 42 percent of the EOs are classified as having excellent to good viability, 32 percent as fair viability, and 26 percent as poor viability. In MO, 43 percent of the EOs are classified as having excellent to good viability, 43 percent as fair viability, and 14 percent as poor viability. Across the species range, 43 percent are classified as excellent to good, 39 percent as fair, and 17 percent as poor. Viability is currently estimated based on the persistence of above-ground plants over time, among other factors like habitat condition and evident threats. However, we now know that populations of adult plants can fluctuate significantly between observations due to the highly variable hydrology of their preferred habitat. In addition, seeds retain high germinability in the seed bank for at least 11 years providing the ability for the species to re-establish populations of flowering plants at sites following periods of unfavorable conditions. The combination of a self-incompatibility reproductive strategy and low gene flow between neighboring populations is cause for some concern regarding reproductive failure if individual populations get so small that there are only a limited number of compatible mates; however, there is no evidence of this occurring thus far in populations that have been observed over the course of 10 to 15 years, including those that have declined due to habitat disturbances.
  - Redundancy: At the time of listing (1998), there were 25 known populations in VA and one suspected occurrence in MO. Through additional survey work (and a revision of how EOs are defined), there are currently 76 EOs in 3 states spanning 4 physiographic provinces: 19 EOs in VA, 56 EOs in MO, and 1 EO in IN. Several recovery criteria are no longer relevant due to the increased distribution and number of occurrences. There has been no range contraction among the originally identified populations in VA, and significant range expansion in MO with the discovery of 55 additional EOs. Currently, many populations occur across a broad geographic range, increasing the species' ability to withstand catastrophic events. Redundancy has therefore increased significantly since listing.
  - Representation: The species shows a high level of genetic diversity and structuring, while there is evidence of low diversity within populations and low gene flow among populations. In VA, populations in close proximity have been demographically

asynchronous in the same year, despite experiencing similar climates and hydrology (Knox 1997, Adams et al. 2005) possibly indicating metapopulation structure. Populations in MO and VA show significant genetic differences indicating high representation for the species. The species has specific habitat requirements like variable hydrology and acidic soils; however, there are multiple circumstances under which those conditions occur including natural sinkhole ponds as well as human made features like roadside ditches, farm ponds, and other depressions or areas that act as seasonal wetlands. The species occurs in three states and four physiographic provinces, adding to its representation.

- Habitat, Life History, and Ecology
  - Habitat: 'This wetland plant is found on the shores of naturally occurring shallow, seasonally flooded limestone ponds (less than 0.1 to 8 acres in size) along the western edge of the Blue Ridge Mountains in the Shenandoah Valley. This plant inhabits poorly drained, acidic, silty loam soils, that are generally flooded from January to July. It cannot tolerate shade or long periods of flooding. Each year, Virginia sneezeweed populations vary greatly due to water level fluctuations' (FWS 2025).
  - 'Populations of *H. virginicum* occurring in VA and MO are found in open (unshaded) growing conditions. The Draft Recovery Plan (Service 2000) cites the species as being limited to seasonally flooded sinkhole ponds (Knox et al. 1995, 1997), which is a globally rare habitat. Additional observations by Van Alstine (2009) indicate that it can also be found in disturbed sites that appear as seasonally wet meadows, depressions in lawns, roadside ditches, and margins of farm ponds in VA. In MO, *H. virginicum* habitat also ranges from less disturbed sinkhole pond margins and wet meadows to temporary wetlands in hayfields, roadside ditches, cattle ranches, and rural airports (Rimer and Summers 2006). These habitats act as temporary/seasonal wetlands, and some are dependent on groundwater inputs while others rely on precipitation for recharge. The species' habitat needs seem to be met naturally in sinkhole ponds by the variable hydroperiod, soil chemistry, pond basin morphology, and water depth; other sites where the species occurs may be the result of human activities that keep the sites open and help to meet the hydrologic needs of *H. virginicum*, which explains its occurrence in highly altered habitats such as cattle ranches, airports, and roadside ditches (Knox et al. 2016). Rimer and Summers (2006) found that the species occurs more often at high elevations which could be linked to the geology (limestone or dolomite bedrock) and associated low soil pH. The species occurs only in acidic soils throughout its range in VA (Knox 1997). Rimer and Summers (2006) also observed that within the Ozark Highlands section of MO, the Central subsection was most likely to support the species due to a higher proportion of open lands supporting karst features' (FWS 2020).
  - 'In VA, two of the highest quality, relatively undisturbed wetlands with significant *H. virginicum* populations and three wetlands with smaller populations were protected in state-owned Natural Area Preserves established in 2001. Van Alstine (2007, 2009) documented degradation of habitat at six disturbed wetland sites on private lands due to hydrologic modifications from deepening portions of ponds and digging of drainage ditches or other actions taken by landowners. Several wetland sites representing two EOs in VA where the species occurs on USFS lands have active unauthorized all-terrain vehicle (ATV) use, which has degraded habitat and been challenging to mitigate' (FWS 2020).
  - 'In MO existing populations are primarily in rural areas on private lands, and overall numbers appear stable. Invasive plants, particularly spotted knapweed (*Centaurea stoebe* L. *micranthos*), have been observed encroaching into certain sites on or adjacent to road

rights-of-way, potentially affecting up to six EOs. The *H. virginicum* site in IN is protected; however, the area around the preserve is developing rapidly, there are invasive plants on the preserve, and human disturbance could impact the site in the future (D. Stolz, Fishers Parks and Recreation, email to J. Stanhope, Service, February 27, 2019). Specific threats to habitat in each region are discussed further below in section 2.3.2.1' SFWS 2020).

- 'Flowering occurs from July through November after the plant is one year old. It appears that the primary insect pollinators for this species are bees, wasps, butterflies, and hoverflies. Seeds are dispersed in late fall and winter and germination occurs in late summer or early fall of the following year if conditions are suitable' (FWS 2025).
- 'Soils in the Shenandoah Valley sinkhole pond habitat in Virginia have been described as gray clay lens. Analyses of soil samples from 19 of the *H. virginicum* pond sites indicated that the soils are acidic (4.5) with high concentrations of aluminum and arsenic but low profiles of boron, calcium, potassium, magnesium, and phosphorous (Knox, 1997). The soil from the Pomona, Missouri, site is also whitish gray clay. (J.S. Knox pers. Comm.). A soil sample taken from the Missouri site exhibited normal levels of aluminum, boron, phosphorous, magnesium, calcium, potassium and arsenic, but copper levels seven times the normal maximum level. The pH was low (5.1) but six times higher than the average pH at the Virginia *Helinium virginicum* sites (Knox, 1994)' (FWS 2000).
- '*Helinium virginicum* is a perennial herbaceous plant. It employs a breeding system of self-incompatibility, meaning plants can mate successfully only with individuals that differ by at least one allele at the Slocus (Messmore and Knox 1997). This breeding strategy can further limit the availability of suitable mates in already small populations. The species has a tendency to experience short-term local extirpation of plants due to its specialized adaptive tolerances for stress associated with high fluctuations in water levels and specific soil chemistry. Water depth and duration of standing water in *H. virginicum* habitats varies greatly year-to-year (Knox et al. 1999); population sizes and stage class abundances also vary greatly from year-to-year (Knox et al. 1999). Some years, following long continuous inundations accompanied by abundant living and dead flotsam, a population may crash from tens of thousands to zero or near zero individuals. Additionally, drought conditions could contribute to the species not being detected during certain years' (FWS 2020).
- Taxonomy
  - 'Fernald (1950) and Gleason (1952) recognized *H. virginicum* as being distinct from *H. autumnale* on the basis of cauline leaf and pappus distinctions and, in Gleason (1952), the presence of basal leaves, but recognition of the species has not been universal, as Rock (1956), Bierner (1972), and Cronquist (1980) placed *H. virginicum* in synonymy with *H. autumnale*. Roe (1977) distinguished *H. virginicum* from *H. autumnale* on the basis of cauline leaves not being numerous, reduced up the stem, and lanceolate to lance-linear pappus scales 1.5-2.0 mm long; and basal leaves usually present at antithesis vs. cauline leaves numerous and not reduced up the stem, lanceolate to elliptic; pappus scales 1 mm long or less; and basal leaves usually absent at anthesis. Cronquist (1980) originally mentions *H. virginicum* as being only doubtfully distinct from *H. autumnale*, but after a visit to a *H. virginicum* population, Cronquist apparently became convinced that it was a distinct species (pers. Comm., reported in Johnson and Porter 1991). Gleason and

Cronquist (1991) distinguished *H. virginicum* from *H. autumnale* on the basis of the leaves being basally disposed rather than chiefly or all cauline and numerous. Kartesz (1999) treated *H. virginicum* as a separate species' (FWS 2000).

- Relevant Potential Pesticide Use Sites
  - Pesticides are not mentioned as a threat to this species.
- Relevant Recovery Criteria and Actions (FWS 2020)
  - Delisting Criteria:
    1. *Twenty self-sustaining populations and their habitats are permanently protected across this species' Virginia range.*

This criterion has not been met, but new information obtained since the Draft Recovery Plan (Service 2000) was written provides new context for assessing species viability. When this criterion was written, the species was confirmed only in VA. The Draft Recovery Plan indicates that if the need for additional survey work in MO and intervening states is indicated by the genetic confirmation of the first MO site as *H. virginicum*, the number of populations to be protected would be reassessed. The species has since been confirmed to also occur in MO and IN; however, this recovery criterion was not revised or finalized to reflect and consider the new information. Here we provide a summary of the current state of protection of populations across the species range. Below in section 2.4 we consider this information in combination with other recovery criteria, influences, and the species current and future conditions to determine its viability and whether the species meets the definition of Threatened or Endangered. Overall, a total of 76 EOs have been identified across the current known species range.

2. *Monitoring over 15-years indicates that populations in the 20 sites have long-term viability.*

Regular monitoring of EOs over 15 years has not been carried out at the majority of sites; 12 EOs in VA have been observed multiple times over at least 15 years. No EOs in MO have been observed multiple times over 15 years, but 19 EOs have been observed multiple times over at least 10 years. Overall, a total of 12 EOs (16 percent of all EOs) have been observed multiple times at varying intervals over 15 years (all in VA), and 34 EOs (45 percent of all EOs) have been observed multiple times over at least 10 years. The EO in IN was discovered in 2018, so 10 to 15 years of monitoring data for this EO are not available.

3. *Life history and ecological requirements are understood sufficiently to allow for effective protection, monitoring, and, as needed, management.*

This criterion has been met. Extensive research on the VA populations (Knox 1997, Knox et al. 1999) and MO populations (Rimer and Summers 2006) has expanded knowledge of the life history and ecological requirements of *H. virginicum* allowing for effective protection, monitoring, and management.'

4. *Seeds representing the range of genetic diversity in H. virginicum are placed in long-term storage to provide a source of genetic material in the event of in situ extinction.*

This criterion has not been met. Seeds have been acquired and placed in long-term storage from six EOs from four counties in MO. The [Virginia Department of Conservation and Recreation-Division of Natural Heritage] (VDCR-DNH) is unaware of any seeds that have been collected and stored from VA EOs (J. Townsend, VDCR, email to A. O'Donnell, Service, June 21, 2019). New information on the genetics of the species indicates that to represent the entire range of genetic diversity, seeds would likely need to be collected and placed in storage from every EO. As discussed in section 2.3.1.3, Knox et al. (2016) found high levels of genetic variation at the species level, moderately low diversity within populations, and high population structure in 17 sampled *H. virginicum* populations from VA and MO. In addition, their results indicate that VA populations were more diverse than MO populations and there was more total genetic variation in VA versus MO, among other differences between the two regions genetically (Knox et al. 2016). The authors suggest that efforts should be made to protect clusters of populations in both VA and MO so that diversity (i.e., representation) will be conserved. As such, seeds from VA populations and additional MO populations should also be placed in long-term storage to meet this criterion as written.

5. *The population and habitat of the Missouri Helenium sp., if it is determined to be H. virginicum, are permanently protected and seeds placed in long-term storage*

The original intent of this criterion has been met. It was developed prior to the discovery of the additional 55 EOs in MO. This new information renders this criterion duplicative of criteria (1) and (4) above. The referenced MO population 8 was determined to be *H. virginicum* (Simurda and Knox 2000, Simurda et al. 2005). The Center for Plant Conservation, in cooperation with the Missouri Botanical Garden and the [Missouri Department of Conservation] (MDC), collected seeds from the site in the early 2000s, and they have been placed in long-term storage (R. Rimer, MDC, email to J. Stanhope, Service, December 6, 2018). This site is owned by the Howell County Road Commission and is not permanently protected. It is a managed site and the responsible agency works with [Missouri Natural Heritage Program] (MONHP) and the Service to minimize impacts to *H. virginicum* from mowing, spraying, and other activities. It is unclear whether this coordination would continue if *H. virginicum* were no longer a federally listed species; however, this is 1 of 56 EOs in MO. In terms of preserving genetic material and habitat in MO, the six EOs in MO on protected state lands and the collection of seeds for long-term storage from six EOs in MO meet this

criterion's original intent.

- Recommendations for Future Actions
  1. Develop a post-delisting monitoring plan and continue monitoring EOs for viability over time.
    - Develop and implement methodology to survey and monitor the seed bank instead of relying on observations of above ground plants for improved viability estimates.
  2. Conduct surveys in IN in suitable habitat near the EO in Hamilton County. In addition, complete genetic analysis of the IN EO to help determine whether it is a natural or introduced occurrence.
  3. Opportunistically collect seeds from VA populations, additional MO populations, and IN populations if more are discovered, representing adequate genetic diversity and place them in long-term storage.
  4. Conduct additional genetic analysis with larger sample sizes from VA and MO populations using both contemporary plants and seed bank samples.

### 3. Range

- Historical Range (FWS 2000)
  - 'First found in Augusta County, Virginia, in 1935 (Blake 1936), the known range of *Helenium virginicum* was expanded to Rockingham County by C.E. Stevens in 1967 (Roe 1977). Up until the late 1970's, fewer than ten occurrences were known, but six more occurrences were documented in the 1970's (Virginia Department of Conservation and Recreation Division of Natural Heritage [VADCR-DNH] database. Surveys in 1987 (Knox, 1987), 1990 (Van Alstine and Ludwig 1991), 1991 (Van Alstine et al. 1972), and 1995 (Longbottom and Van Alstine 1995) resulted in the discovery of 15 additional occurrences. Knox (1987), Van Alstine and Ludwig (1991), and Van Alstine (1995) also conducted status assessments of known occurrences'.
- Current Range (FWS 2020)
  - '*Helenium virginicum* populations exhibit a 1,130 km disjunct spatial distribution between the Ozark plateau in MO and the Southern Appalachian mountains in VA. In MO, 56 EOs occur in 8 contiguous counties distributed over 150 km (figure 1). In VA, 19 EOs occur across 3 counties distributed over 88 km (figure 1). The origin of the one EO discovered in 2018 in Hamilton County, IN (figure 1) is unknown; Simurda et al. (2019) indicate that the population is probably naturally occurring for a variety of reasons; however, personnel from the IN Division of Nature Preserves think it was more likely inadvertently introduced during a site restoration project (M. Homoya, IN Division of Nature Preserves, email to L. Pruitt, 14 Service, December 3, 2018). The current distribution of extant populations occurs within four physiographic provinces: the Blue Ridge and Ridge and Valley provinces in VA, the Plains province in IN, and the Ozark Plateau in MO.'

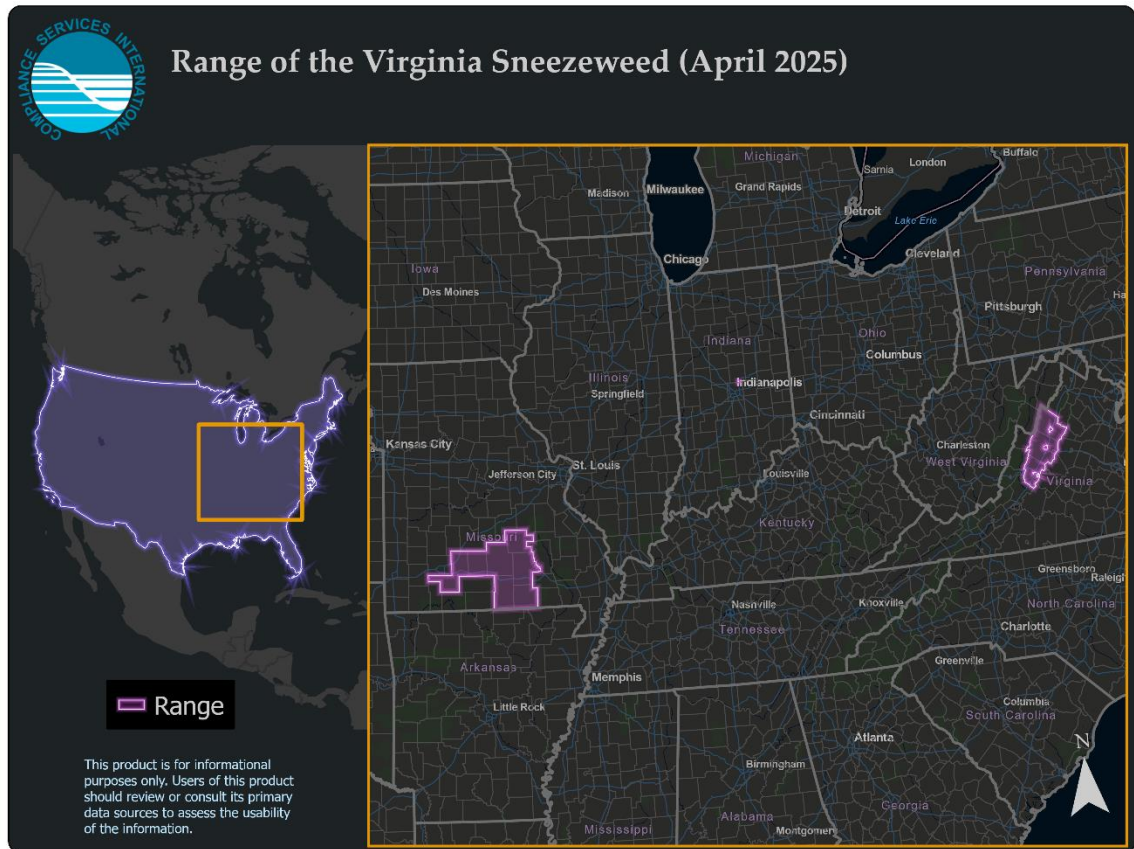


Figure 2. Range of the Virginia sneezeweed (FWS 2025).

#### 4. Description of Critical Habitat

- Critical habitat has not been designated for this species.

#### 5. Known Locations (FWS 2020)

- 'VA - As of 2018, the species has been observed at least once at 39 sites (grouped into 19 EOs as explained above). The most recent surveys for *H. virginicum* at selected sites were conducted by VDCR-DNH in 2006, 2008, and 2016-2018. In 2006, they visited 13 wetland sites representing 9 EOs and received data on 6 additional wetland sites representing 3 EOs. Compared with previous observations at these sites, plant numbers were higher or the same at 11 of the sites and lower at 3 of the sites (Van Alstine 2007). At five sites they documented substantial declines in numbers of observed plants between the 1986-1990 and 1995-2006 time periods, which appeared to be correlated with hydrologic modifications (Van Alstine 2007). In 2008, VDCR-DNH visited an additional 15 wetland sites representing 8 EOs and found the species at 12 of the 15 sites. Eleven of the sites where plants were present had previous observations for comparison, and of those, 9 had higher or similar population numbers compared to 1995, and 2 were lower (Van Alstine 2009). However, despite higher numbers since 1995, several of the sites displayed significant reductions compared to abundance reported in the 1970s and 1980s. One additional site was reported as experiencing disturbance from farming activities in 2008. Total number of plants observed at the sites surveyed in 2006 and 2008 were estimated in the 30,000 to 50,000 range (Van Alstine 2009). In 2016-2018, VDCR-DNH surveyed 7 EOs documenting continued presence of

- the plant at 11 sites. A more detailed synthesis of the most recent surveys is not available.
- MO - Since the species was listed in 1998, 55 EOs have been discovered, in addition to the single EO referenced in the Draft Recovery Plan (Service 2000), resulting in increased representation and redundancy. The core area of the EOs is located in the south-central Missouri Ozarks (Howell, Shannon, and Texas counties) and likely contains more EOs than have been documented, according to MDC staff. Habitat in southwest MO has been searched extensively, and only one EO in Christian County and four EOs in Webster County have been found. Of the 55 EOs identified since 2000, 6 are considered reintroduced meaning they were planted in a county where the species is thought to have occurred historically. Of the six reintroduced populations, two are experimental and were monitored for several years (Rimer and McCue 2005). One of these reintroduction sites has flourished to the point where surveys of numbers of individual plants are no longer feasible since there are too many to count. Of the 56 EOs, 6 are categorized as EO Rank A (excellent viability), 18 are EO Rank B (good viability), 24 are EO Rank C (fair viability) and 8 are EO Rank D (poor estimated viability) (table 1). Rimer (email to J. Stanhope, Service, December 6, 2018) stated that the majority of the sites are found in rural areas and numbers are stable. Monitoring records for MO EOs show the same high levels of variability in numbers of plants observed from one visit to the next as VA EOs. Numbers of plants observed can range from thousands of plants at one site to less than 100 at other sites, and a site may contain several hundred plants during one visit and then no plants during the next visit. Generally, monitoring visits report 50 to several hundred plants at a given site (MONHP 2018).
  - IN - *H. virginicum* was discovered in Hamilton County, IN on 8/14/2018. On 11/29/2018 a DNA analysis conducted by Dr. John Knox confirmed that the species was *H. virginicum* (D. Stolz, Fishers Parks and Recreation, email to J. Stanhope, Service, February 27, 2019). Upon the initial observation of this occurrence, Fishers Parks and Recreation personnel estimated the number of plants to be less than 100 (D. Stolz, Fishers Parks and Recreation, email to K. Maison, Service, July 15, 2019). The EO has been assigned a rank of B-i (B indicates 'Good' viability, and the 'i' is a sub-rank indicating the belief that it is introduced at the site and not a natural occurrence, since it is suspected strongly that it came within a seed mix during restoration activities on site; however, additional work is underway to determine the origin of the population). Additional surveys have been proposed in IN given the possibility that this is a natural occurrence, and there may be other natural occurrences in the area (Simurda et al. 2019), but the status of this additional work is unknown.

State	Total # of EOs	# of EOs Permanently Protected	EO Rank			
			Excellent	Good	Fair	Poor
VA	19	8	5	3	6	5
MO	56	6	6	18	24	8
IN	1	1	-	1	-	-
Total	76	15	11	22	30	13

Table 2. *Helenium virginicum* EO protected status and rank summarized by state. Copied from Table 1 of the 5-Year Review (FWS 2020).

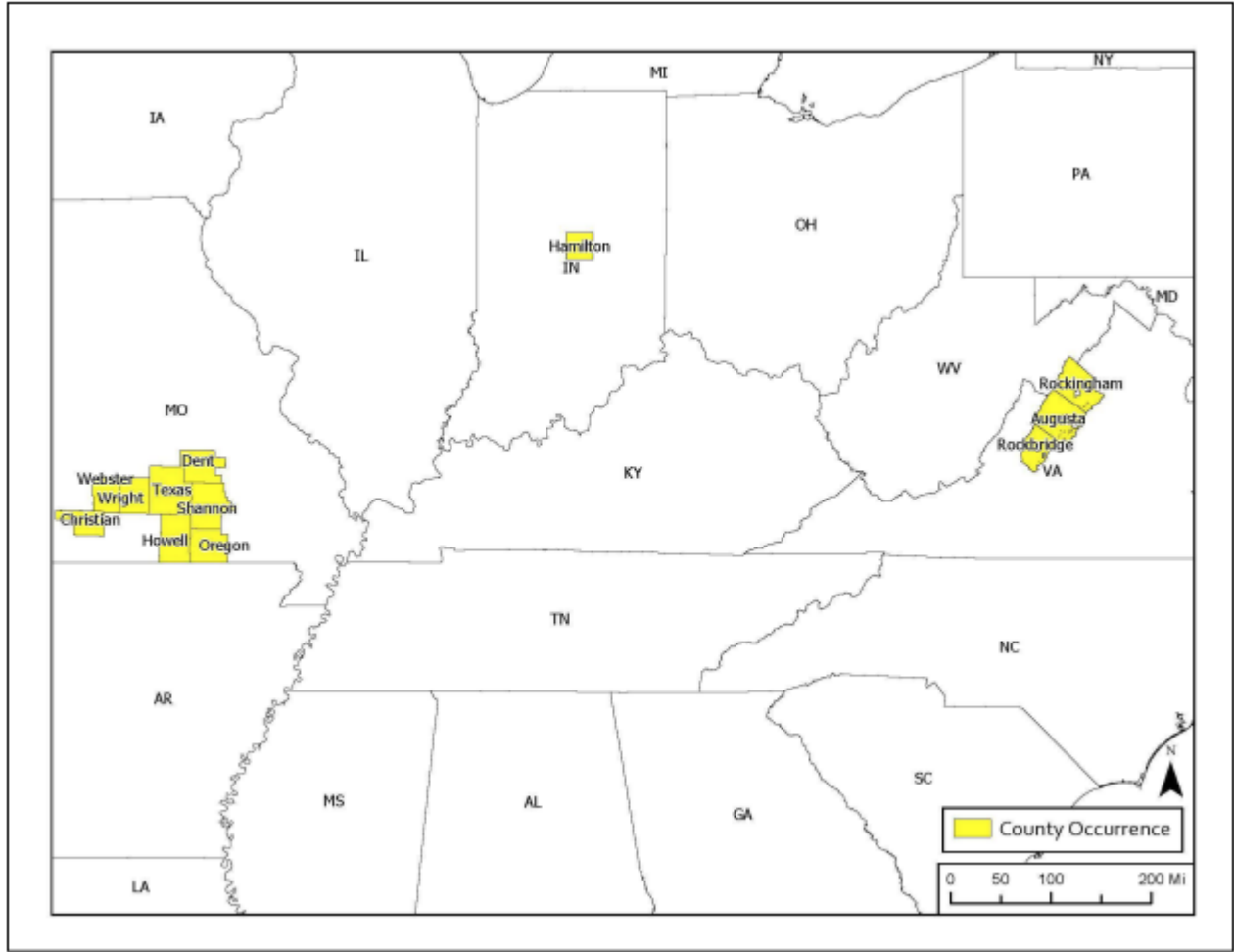


Figure 3. Distribution of *H. virginicum* as of 2019. Copied from Figure 1 of the most recent 5-Year Review (FWS 2020).

- iNaturalist: [https://www.inaturalist.org/observations?taxon\\_id=163594](https://www.inaturalist.org/observations?taxon_id=163594)
  - 62 verifiable observations; thirty-nine of which are research-grade and meet the following 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 is no greater than 30 kilometers<sup>3</sup>.
      - This did not result in the exclusion of any records.
      - The PPA value represents the positional uncertainty of the coordinate. This value was used as the buffer distance for iNaturalist points, to ensure that the actual position of the observation is captured. This is shown in **Error! Reference source not found.**, but did not factor into core map development.
  - These locations include the two main areas in which the species is found (Missouri and Virginia) and exclude the population in Indiana. The locations in Missouri and Virginia are consistent with the range in general given the positional uncertainty of the datapoints.
- GBIF: <https://www.gbif.org/species/5401858>
  - GBIF includes 252 records, 32 of which are georeferenced and had usable coordinate data based on lat/long precision (3+ decimal places) and relative recency (2010-present). These are all attributed to human observation and appear to be a subset of the iNaturalist observations catalogued above.
- NatureServe Explorer: <https://explorer.natureserve.org/>
  - Public EO location information from NatureServe also was consistent with the other data sources given the scale and positional accuracy of the data. The data are consistent with the species range.

## 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 based on range. The core map identifies all areas within the extent (described below) matching the species habitat description from **Appendix 1**. The NWI dataset is regarded as a high quality national-level dataset that is appropriate to identify aquatic habitat for wetland species such as the Virginia sneezeweed. Relevant water body type selections were limited to waters within sinkholes inside the range of the species. State-level spatial datasets of sinkhole locations in Missouri and Virginia were used to bound the selected NWI water bodies. In Indiana, the single location known to contain Virginia sneezeweed was identified in the Protected Areas Database of the United States, PAD-US, dataset and contributed to the core map.

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<sup>3</sup> 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](#).

## 1. References and Software

- Missouri DNR Sinkhole Areas (MDNR 2025): <https://gis-modnr.opendata.arcgis.com/datasets/sinkhole-areas/explore>.
- National Wetlands Inventory (FWS 2023): <https://www.fws.gov/program/national-wetlands-inventory>.
- PAD-US v. 4.1 (USGS 2024): <https://www.sciencebase.gov/catalog/item/652d4fc5d34e44db0e2ee45e>.
- Software used: ArcGIS Pro version 3.2.
- USFWS 5-Year Review (FWS 2020): [https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public\\_docs/species\\_nonpublish/964.pdf](https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/964.pdf).
- USFWS Species Range (USFWS 2025): <https://ecos.fws.gov/ecp/species/6297>.
- Virginia Department of Energy (VDOE 2025b): <https://energy.virginia.gov/gis/rest/services/DGMR/KarstView/MapServer/4>

## 2. Datasets Used in Core Map Development

### 2.1. Range

The range for this species was last updated by FWS on March 16, 2020. 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 1028 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 the counties with known extant populations as described in the USFWS 5-year review (FWS 2020). The range was used to establish the outer boundary of the core map.

### 2.2. Missouri Department of Natural Resources

The Missouri Department of Natural Resources (MDNR) has produced a spatial layer of linear features representing sinkhole locations statewide (MDNR 2025). This land cover type is consistent with descriptions of potential habitat for the Virginia sneezeweed. These linear features represent the perimeters of the sinkholes themselves, so sinkholes were represented as the polygonal features contained within these lines.

### 2.3. Virginia Department of Energy

The Virginia Department of Energy (VDOE) has created a geospatial layer of sinkhole locations in the Karst region, derived from a 1-meter LIDAR raster and an automated fill-difference raster geoprocessing toolset and manually edited (VDOE 2025b). Although the dataset is limited to the Karst region, CSI determined it was a reasonable representation of sinkholes in Virginia more generally; in Virginia, the principal area affected by sinkholes is the Valley and Ridge Province, an extensive karst terrain underlain by limestone and dolomite (VDOE 2025a). This spatial layer was used to represent sinkhole areas in Virginia; CSI applied a 100-ft buffer to

render the data as polygons; this distance was chosen from a list of conservation measures identified for this species in a 2021 Biological Opinion (FWS 2021). The buffer was not added to sinkhole features in Missouri, which were downloaded as linear data then converted to a polygonal feature class.

#### **2.4. U.S. Geological Survey (USGS) Protected Areas Database of the United States (PAD-US)**

The Virginia sneezeweed is considered by FWS to be associated with seasonally flooded sinkhole ponds; precise site locations are unavailable to the public. However, the lone population occurring in Indiana is known to inhabit the Ritchey Woods Nature Preserve. Nature preserves are generally well-catalogued in the PAD-US layer; this dataset was queried in SQL as follows: Unit\_Nm = 'Ritchey Woods Nature Preserve'. The resulting query produced one record, which was verified to be consistent with species range and exported as a standalone layer, "RWNP". This shape was incorporated into the core map development process as described in Section 3.

#### **2.5. National Wetlands Inventory (NWI) Dataset**

The NWI dataset was preliminarily vetted to determine its appropriateness in representing aquatic areas matching descriptions of the Virginia sneezeweed habitat. The Virginia sneezeweed inhabits seasonally flooded sinkhole ponds and disturbed sites that appear as seasonally wet meadows, depressions in lawns, roadside ditches, and margins of farm ponds (FWS 2000). CSI reviewed NWI attribute classes in relation to this description and determined that the species' potential habitat is best represented by palustrine emergent and unconsolidated shore wetlands. These possible site location types were selected in the NWI dataset using a SQL query: ATTRIBUTE LIKE '%PEM%' OR ATTRIBUTE LIKE '%PUS%'.

The NWI is publicly available as state-level downloads. The state-level NWI datasets were downloaded for the two main states intersecting the species range (MO and VA), clipped to sinkhole boundaries, and queried for palustrine emergent and unconsolidated shore wetlands, as described above. These water bodies were merged, along with the core map extent in Indiana, according to the procedure given in Section 3.

### **3. Creating the Core Map**

#### **3.1. Defining Extent and Applying Biological Information Refinement**

The core map for the Virginia sneezeweed was developed using range, PAD-US in Indiana, and sinkholes and NWI wetlands data in Missouri and Virginia. The core map was created as follows:

##### Indiana

1. Load the PAD-US v. 4.1 layer "PADUS4\_1Combined\_Proclamation\_Marine\_Fee\_Designation\_Easement" into a GIS. Use the Select by Attributes tool to use a SQL query to find the Ritchey Woods Nature Preserve: Unit\_Nm = 'Ritchey Woods Nature Preserve'.
2. Export the lone selected feature as a standalone layer, saved as "Ritchey\_Woods\_Nature\_Preserve".

##### Missouri

1. Load a layer of sinkholes in Missouri from the Missouri Department of Natural Resources. Use the Feature to Polygon tool to convert these linear features representing the boundaries of known sinkholes into polygonal shapes. Save as "MO\_sinkholes\_f2p".
2. Use the Pairwise Clip tool to clip the previous layer ("MO\_sinkholes\_f2p") by the species range

("VS\_range") and save as a new layer, "MO\_sinkholes\_f2p\_pcRange".

3. Download the state-level dataset of NWI wetlands in Missouri. Use the Pairwise Clip tool to clip all NWI wetlands in Missouri by the sinkholes layer ("MO\_sinkholes\_f2p\_pcRange") and save as a new layer, "NWI\_MOWetlands\_pcSH".
4. Use the Select by Attributes tool to select only palustrine emergent and unconsolidated shore wetlands from the NWI wetlands layer in Missouri, using the following SQL query: ATTRIBUTE LIKE '%PEM%' OR ATTRIBUTE LIKE '%PUS%'. Export selected features to a new feature class, "NWI\_MOWetlands\_pcSH\_sel".

### Virginia

1. Load a layer of sinkholes in Virginia from the Virginia Department of Energy. Use the Pairwise Buffer tool to buffer these points by 100-ft and save as a new layer, "VA\_sinkholes\_pb100ft".
2. Use the Pairwise Clip tool to clip the previous layer ("VA\_sinkholes\_pb100ft") by the species range ("VS\_range") and save as a new layer, "VA\_sinkholes\_pb100ft\_pcRange".
3. Download the state-level dataset of NWI wetlands in Virginia. Use the Pairwise Clip tool to clip all NWI wetlands in Virginia by the sinkholes layer ("VA\_sinkholes\_pb100ft\_pcRange") and save as a new layer, "NWI\_VAWetlands\_pcSH".
4. Use the Select by Attributes tool to select only palustrine emergent and unconsolidated shore wetlands from the NWI wetlands layer in Virginia, using the following SQL query: ATTRIBUTE LIKE '%PEM%' OR ATTRIBUTE LIKE '%PUS%'. Export selected features to a new feature class, "NWI\_VAWetlands\_pcSH\_sel".

### Combining Extent

1. Use the Merge tool to merge the following three datasets into a single feature class, saved as "VS\_extent".
  - Ritchey Woods Nature Preserve ("Ritchey\_Woods\_Nature\_Preserve")
  - Missouri palustrine emergent and unconsolidated shore wetlands, clipped to Missouri sinkholes ("NWI\_MOWetlands\_pcSH\_sel")
  - Virginia palustrine emergent and unconsolidated shore wetlands, clipped to Virginia sinkholes ("NWI\_VAWetlands\_pcSH\_sel")
2. Use the Pairwise Dissolve tool to dissolve the previous layer ("VS\_extent") into a layer with a single feature, saved as "VS\_extent\_pd".

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

The Virginia sneezeweed 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 according to a layer developed by EPA ("CultivatedAreas\_Over25acres"). Save as a new layer ("VS\_extent\_pd\_peCultivated25ac").
2. (Optional) Export features from the previous layer ("VS\_extent\_pd\_peCultivated25ac") into a new layer recognizable as the Virginia sneezeweed core map, "VS\_CoreMap".

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### Documents

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