Interim Core Map Documentation for the Butte County meadowfoam

Version 1
Review Completed: April 2026
Core Map Developer: U.S. Environmental Protection Agency (EPA) Office of Pesticide Programs (OPP)

Species Summary

The Butte County meadowfoam (*Limnanthes floccosa ssp. californica,* Entity ID 1081) is an endangered plant. The U.S. Fish and Wildlife Service (FWS) has designated a critical habitat for the Butte County meadowfoam. This vernal pool species occurs in California and is found primarily on the margins of vernal swales and to a lesser extent on the margins of vernal pools located on alluvial terraces in annual grasslands and mima mound topography. The species is restricted to a narrow 28-mile strip along the eastern flank of the Sacramento Valley from northwestern to central Butte County and occurrences are found at 120 to 1,200 feet in elevation. The pollinators of this annual species are unknown and based on low genetic diversity, it is thought they self-pollinate. Additional information on the species is provided in **Appendix 1**.

Description of Core Map

The core map for the Butte County meadowfoam is biological information type based on a combination of critical habitat, species' known locations, and areas of the range with suitable habitat. This species relies on vernal pools in California that have a distribution that is reasonably well understood and mapped. The combination of critical habitat, areas with current populations, and generalized locations of vernal pools that are considered occupied by the Butte County meadowfoam constitute the basis for the core map.

Figure 1 depicts the resulting interim core map for the Butte County meadowfoam. The size of this core map is approximately 43,344 acres. Landcover categories within the core map area are included in **Table 1**. Landcover is predominantly grassland/herbaceous and shrub/scrub. The hexagonal units in the map reflect vernal pools as a habitat type as identified in California's Department of Fish and Wildlife's Areas of Conservation Emphasis (ACE) database[1].

The core map developed for the Butte County meadowfoam is considered interim. This core map will be used to develop pesticide use limitation areas (PULAs) that include the Butte County meadowfoam. 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 uncertainties/limitations. The map is based on the range

[1] The ACE data compiled for freshwater wetlands "are presented in presence/absence from within 2.5-mile hexes. Significant habitat ranks are based on the number of significant habitat categories present within the hexagon." See: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=150834&inline.

and critical habitat described by FWS, with areas added based on the biological needs of the species. Known locations described by FWS and California Natural Diversity Database (CNDDB) were also included.

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

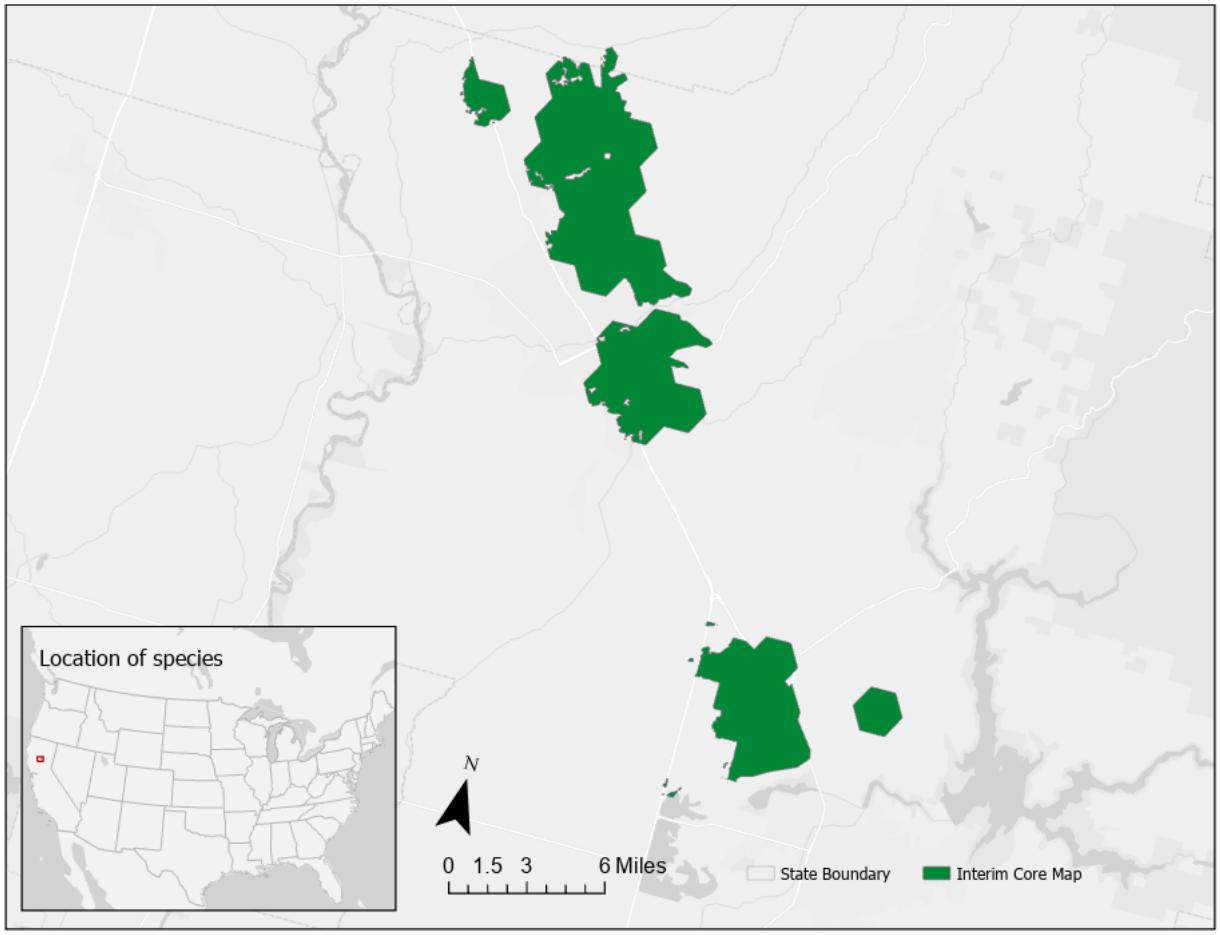

Figure 1. Interim core map for the Butte County meadowfoam. The total acreage of the interim core map is approximately 43,344 acres.

Table 1. Percentage of Interim Core Map Represented by National Land Cover Database (NLCD)[2] Land Covers and Associated Example Pesticide Use Sites/Types.

Example pesticide use sites/types	NLCD Class/Value	% Area
Forestry	Deciduous Forest (41)	0%
Forestry	Evergreen Forest (42)	1%
Forestry	Mixed Forest (43)	0%
Agriculture	Pasture/Hay (81)	0%
Agriculture	Cultivated Crops (82)	2%
Mosquito adulticide, residential	Developed Open Space (21)	4%
Mosquito adulticide, residential	Developed Low Intensity (22)	4%
Mosquito adulticide, residential	Developed Medium Intensity (23)	5%
Mosquito adulticide, residential	Developed High Intensity (24)	2%
Invasive species control	Woody Wetlands (90)	1%
Invasive species control	Emergent Herbaceous Wetlands (95)	2%
Invasive species control	Open Water (11)	0%
Invasive species control	Grassland/Herbaceous (71)	66%
Invasive species control	Shrub/Scrub (52)	12%
Invasive species control	Barren Land (31)	1%
Total Acres	Interim Core Map Acres	43,344

Evaluation of Known Location Information

There are five datasets with known location information for this species:

- Descriptions of locations provided by FWS
- Occurrence locations included in California Natural Diversity Database (CNDDB)
- Occurrence locations included in iNaturalist
- Occurrence locations included in the Global Biodiversity Information Facility (GBIF)
- Occurrence locations included in NatureServe

EPA evaluated these sets of data before selecting and developing the type of core map. CNDBB appeared to have the finest resolution of the location information, which FWS relied on in their documentation (FWS, 2008; FWS, 2023). Occurrences in iNaturalist, GBIF, and NatureServe were consisted with those discussed in FWS documentation and seen in CNDDB. **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

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

Habitats[3]" (referred to as "the process"). This core map was developed by EPA using the 4 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 Butte County meadowfoam from FWS, as well as observation information available from various publicly available sources (including iNaturalist, GBIF, NatureServe, and CNDDB). The information compiled for the Butte County meadowfoam is included in **Appendix 1**. Influential information that impacted the development of the core map included:

- Some occurrences and known locations of the Butte County meadowfoam are outside of the FWS critical habitat.
- FWS published the critical habitat in 2006 and after that point, 2 additional populations were discovered (FWS 2023). An additional occurrence which was thought to be extirpated prior to listing in 1992 is extant as of 2010 (FWS 2023). Thus, the current critical habitat does not encompass all observations of the species (this is confirmed when comparing CNDDB observations to the critical habitat).

For step 2, EPA used the compiled information to identify the core map type. EPA compared known location data to the range and critical habitat and found that there are known locations outside of the designated critical habitat. Thus, the core map type is biological information and is comprised of the critical habitat combined with known locations from CNDDB and suitable vernal pool habitat identified by California's Department of Fish and Wildlife's (CDFW) ACE database[3] in **Appendix 1**.

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 used CNDDB known locations, CDFW's ACE hexagons, and the FWS critical habitat for this species to create the core map. **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 did not explore approaches other than those described in this documentation.

[3] https://wildlife.ca.gov/Data/Analysis/Ace

Appendix 1. Information Compiled for Species

1. **Recent FWS Documents**
   2023 5-year review
   2008 5-year review
   2006 Critical Habitat designation
   2005 Recovery plan

2. **Background information on Species**

- **Status:** Federally listed as endangered in 1992
- **Taxonomy**: Dicot; FWS Plant Group CONUS-10
- **Resiliency**
    a. "Quantitative information on the number of plants and area occupied by Butte County meadowfoam at each occurrence has not been collected in a consistent or systematic manner since listing in 1992. Because of the lack of survey data, it is difficult to conclusively determine overall abundance trends or compare current abundance to the abundance at the time of listing or the 2008 status review." (FWS 2023, p. 7)
- **Redundancy**
    a. There are 20 occurrences of the species, with all occurrences currently presumed extant. (FWS 2023, p. 3)
- **Representation**
    a. Sloop et al. (2011) analyzed the genetic variation among Butte County meadowfoam plants from 21 sample sites across the range of the species. The study found high genetic structure among 20 distinct population clusters based on the sample sites but concluded that the loss of any of the distinct population clusters would result in a *significant loss* to the species' genetic diversity. (FWS 2023, p. 7)

- **Habitat Description**
    a. "The range of the Butte County meadowfoam lies entirely within Butte County, California. The Butte County meadowfoam is found primarily on the margins of vernal swales and to a lesser extent on the margins of vernal pools located on alluvial terraces in annual grasslands and mima mound topography. Mima mounds are soil mounds of unknown origin that are a few feet in height. The species is restricted to a narrow 28-mile strip along the eastern flank of the Sacramento Valley from northwestern to central Butte County and occurrences are found at 120 to 1,200 feet in elevation." (FWS 2023, p. 1)
    b. "The swales that support the species are generally less than 10 centimeters (3.9 inches) deep and pools are typically less than 30 meters (100 feet) long. In vernal pools, it more often grows on the margins than in the bottom, but the pattern is reversed in swales, with the plants more often growing in the center. It has also been found occasionally in disturbed areas, such as drainage ditches, firebreaks, and graded sites." (FWS 2005, p. 94)
    c. "It grows in soils of the Tuscan-Anita and the Redding-Igo complexes, specifically on the Anita and Igo soils, which are confined to the pools and swales. Tuscan and Redding soils are restricted to the mounds. Anita soils can be up to 50 centimeters (19.7 inches) deep, whereas Igo soils are no more than 18 centimeters (7.1 inches) deep; the two soils are underlain by iron-silica cemented and indurated hardpan, respectively. It has been

observed on Anita clay soils annually regardless of rainfall but appears on Igo soils only in years of above average rainfall, presumably because the former can hold roughly twice as much moisture." (FWS 2005, p. 95)

- **Relevant Life History Information**
    a. A genetic study of the Butte County meadowfoam (Sloop et al. 2011) found very low levels of genetic diversity, confirming that currently the species is primarily self-pollinating. (FWS 2023, p. 8)
    b. The species begins flowering in February, reaches peak flowering in March, and may continue into April if conditions are suitable. Nutlets are produced in March and April, and the plants die back by early May. Seeds germinate in the late fall after the rainy season begins. Seeds that do not germinate in the first year following their production may still be viable. Seedlings develop into rosettes, which do not begin producing flowering stems immediately. (FWS 2005, p. 91-92)
    c. Seedlings can tolerate short periods of submergence (Recovery Plan 2005, p. 91)
    d. "The Butte County meadowfoam has floral adaptations that allow for cross-pollination by insects, but self-pollination mechanisms take over to ensure seed set if insect pollination is unsuccessful. Insects are attracted by the large flowers and production of nectar." (FWS 2005, p. 92)
    e. Most populations have bisexual flowers, but some populations contain male-sterile plants. For these plants, pollination can only be achieved by insects. The particular pollinators of the Butte County meadowfoam have not been identified. Other meadowfoam species are pollinated by the native burrowing bees, honeybees, beetles, flies, true bugs (order Hemiptera), butterflies, and moths. (FWS 2005, p. 92)
    f. Reproduction may be reduced by insufficient moisture or inappropriate livestock grazing practices. (FWS 2005, p. 93)

- **Ecology**
    a. "In most of the occupied habitat within the City of Chico, *Limnanthes floccosa ssp. californica* grows with *Layia fremontii* (Fremont's tidy-tips), *Navarretia leucocephala* (whiteflower navarretia), *Blennosperma nanum* (yellow carpet), and *Lasthenia californica* (California goldfields). In the Shippee area, it is associated most frequently with *Juncus bufonius* (toad rush), *Erodium botrys* (long-beak heron's bill), and *Eryngium vaseyi ssp. vallicola* (Vasey's coyote thistle). It also co-occurs with *Limnanthes alba* at two occurrences and with *Limnanthes douglasii ssp. rosea* at five occurrences." (FWS 2005, p. 95)

- **Taxonomy**
    a. *Limnanthes floccosa ssp. californica* is a narrowly distributed annual plant in the meadowfoam or false mermaid family (Limnanthaceae). (FWS 2008, p. 4)

- **Relevant Pesticide Use Sites**
    a. See **Threats** below

- **Threats**
    a. Currently, the primary threat to the Butte County meadowfoam throughout its range continues to be habitat loss and degradation due to urbanization. FWS (2008) identifies additional threats including inappropriate grazing regimes, competition from nonnative

grasses, garbage dumping, off-road vehicle use, drought, and climate change. (FWS 2023, p. 8)

b. FWS noted that potential impacts to pollinators could impact this species. Pollinators of the Butte County meadowfoam have not been identified but other meadowfoam species are pollinated by native burrowing bees, honeybees, beetles, flies, true bugs (order Hemiptera), butterflies, and moths. The Butte County meadowfoam has floral adaptations that allow for cross-pollination by insects, but may self-pollinate when insect pollination is unsuccessful. However, permanent loss of pollinators and long-term reliance on self-pollination may result in inbreeding depression and loss of population viability. (FWS 2023, p. 9)

- **Relevant Recovery Criteria and Actions (Source: FWS 2005)**
  The Recovery Plan for this species uses an ecosystem-level approach to account for species in the same natural ecosystem—vernal pool ecosystems in California and southern Oregon—that share the same threats. The recovery criteria therefore include both generalized and individualized criteria:

  At the ecosystem level:
    - Protection from further habitat loss, fragmentation, and incompatible uses of the habitat to protect and maintain the full range of genetic and geographic variation in each species;
    - Development and implementation of appropriate habitat management plans for each species and area identified for protection;
    - Achievement of self-sustaining populations as determined through species monitoring and status surveys;
    - Completion of research necessary to refine measures to ameliorate or eliminate threats, and incorporation of results into habitat protection, management, and species monitoring efforts; and
    - Establishment of regional recovery implementation working groups and development of outreach and education programs to ensure public support and participation in recovery efforts.

  - **Downlisting criteria include (p. 386):**
    - 100% of occurrences protected
    - 95% of four locations of suitable habitat protected (Chico, Doe Mill, Oroville, and Vina Plains)
    - Seeds collected from every population for seed banking
    - Additional down-listing criteria are included in the 2023 5-year review (p. 11-12)

  - **De-listing criteria include:**
    - Specific de-listing criteria are not detailed in the 2005 Recovery Plan

  - **Recovery actions include (p. 295-302):**
    - Habitat protection
    - Adaptive management, restoration, and monitoring
    - Status surveys

- Research
- Public participation and outreach

3. Description of Species Range

- The current geographic range encompasses 220,651 acres.
- **Figure A1-1** depicts the current FWS species range map (last updated 10-20-2015).

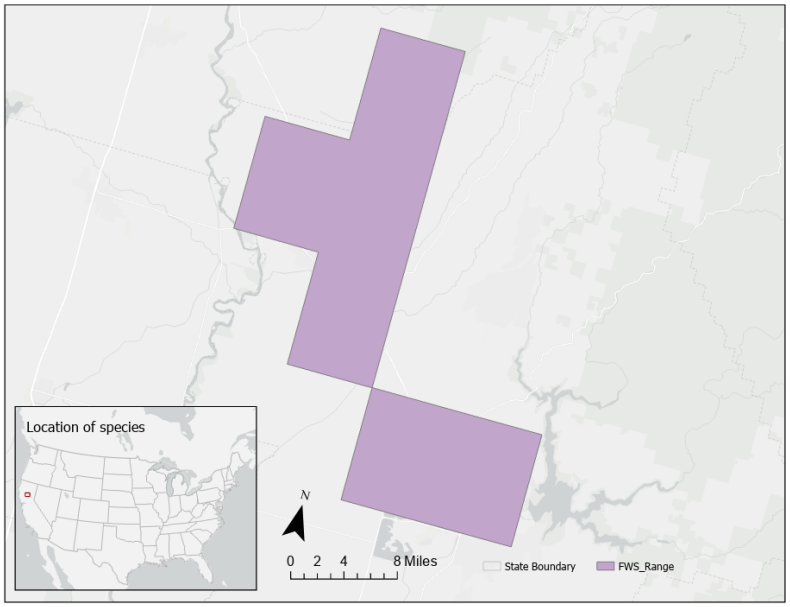

Figure A1-1. Map of FWS Butte County meadowfoam range (220,651 acres).

4. Critical Habitat

- The current critical habitat encompasses 16,644 acres.
- **Figure A1-2** depicts the current FWS critical habitat map (last updated 02-10-2006).

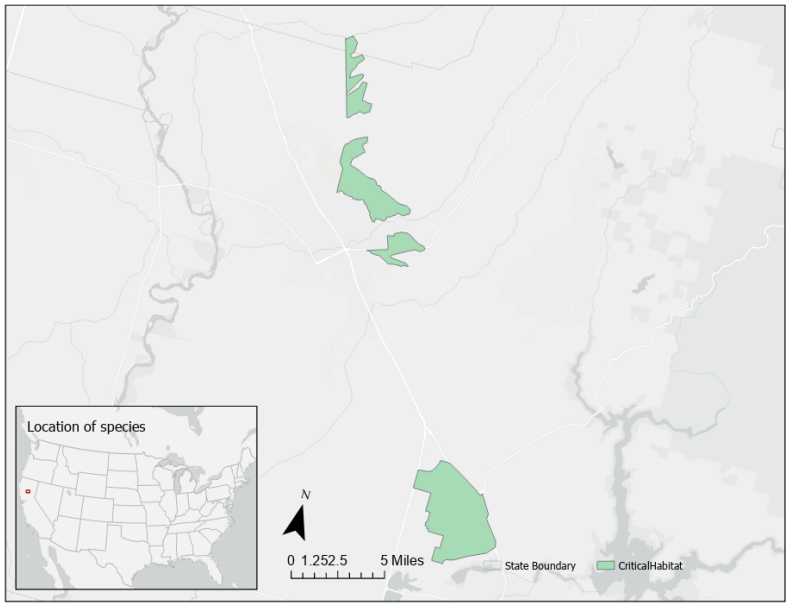

Figure A1-2. Map of FWS Butte County meadowfoam critical habitat (16,644 acres).

5. Known Locations

- **Occurrences Described in FWS Documents**
  - "At the time of listing in 1992, the species was known from 18 extant populations and 3 extirpated populations within a narrow 25-mile strip along the eastern flank of the Sacramento Valley from central Butte County to the northern portion of the city of Chico. The 2005 Recovery Plan and the 2008 status review reported 21 natural occurrences (20 extant and 1 extirpated prior to listing) and 1 introduced occurrence." (FWS 2023, p. 3)
  - "The current distribution of the Butte County meadowfoam is similar to that described in the 2005 Recovery Plan and 2008 status review. The Diversity Database currently reports a total of 20 occurrences including 19 natural occurrences and the introduced occurrence at the Tuscan Preserve (**Table A1-1**). All occurrences of the species are currently presumed extant." (FWS 2023, p. 3)
  - "Seven occurrences (occurrence numbers 44, 45, 46, 47, 48, 50, and 51) have been added to the Diversity Database since the 2008 status review. Two of these occurrences (occurrence numbers 50 and 51) were discovered after 2008, while the other five occurrences were known prior to 2008 but were not added to the Diversity Database until recently." (FWS 2023, p. 3)

Table A1-1. Butte County meadowfoam occurrence information primarily from the Diversity Database (2023), 2008 status review, and Sloop et al. (2011, entire). Additional sources of occurrence data are noted within the table. (FWS 2023, p. 4-6)

Vernal Pool Core Area	2023 Diversity Database Occurrence Number	Name of Occurrence in 2008 5-Year Review (2008 Diversity Database Occurrence Number)	Associated Sloop et al. (2011) sample sites, if applicable	Presumed Status of Occurrence	Year Last Observed	Protection Status
Vina Plains	46	Tuscan Preserve (no Diversity Database number)	Wurlitzer	Extant (introduced population)	2008	Fully protected on the Tuscan Preserve/Wurlitzer Ranch. This preserve was created in 1992 to mitigate impacts on the Doe Mill site (part of occurrence #20).
Vina Plains	13	Rock Creek (13) and Unnamed drainage (41)	None	Extant	2019	The occurrence is partly protected on the Lowe Natural Resources Conservation Service Easement land and the Chico State research site. The remaining portion of the occurrence is unprotected. Some of the unprotected areas may be protected in the future through a Section 6 grant with the California Department of Fish and Wildlife.
Vina Plains	45	None	None	Extant	2010	Partly protected on the Lowe Natural Resources Conservation Service Easement land and partly unprotected.
Chico	38	Cohassett Road (38)	Stone Ridge Ecological Reserve	Extant	2023 (Stanfield, California Department of Fish and Wildlife, *in litt.* 2023)	Fully protected on the Stone Ridge Ecological Reserve.
Chico	37	Chico airport (37)	Butte Co. Airport-North	Extant	2008	None
Chico	39	Diesel (39)	None	Unknown	2010	This occurrence was listed as possibly extirpated in the 2008 Diversity Database and extirpated in the 2008 status review. The status was changed to extant in the Diversity Database in 2023. This occurrence is not protected.
Chico	44	Chico airport (36)	Butte Co. Airport-West	Extant	2008	None
Chico	36	Chico airport (36)	Butte Co. Airport-South Runway	Extant	2018	Eastern portion of occurrence is currently protected within a City of Chico protected area and the western portion is within the proposed Sycamore Conservation Creek conservation bank. The entire occurrence will be protected if the conservation bank is approved.
Chico	35	Rancho Arroyo (35)	Bidwell Ranch	Extant	2008	Fully protected by conservation easements on Rancho Arroyo and Bidwell Ranch.
Chico	Not listed in Diversity Database	None, sample site in Sloop et al. 2011	Butte Co. Airport- South	Extant	N/A	None, this sample site is located next to but outside of a City of Chico protected area. Nearest Diversity Database occurrence is #36 located 0.6 mile to the northwest.
Doe Mill	7	EO 7- Assembly of God/N. Enloe/ Bruce Rd./ Stilson Canyon (7)	Church, North Enloe, and Stilson Canyon	Extant	2021	Partly protected on the Meriam Park Preserve and partly unprotected outside the Preserve.
Doe Mill	20	EO 20- North of Skyway/ Bruce Rd. (20), EO 34- Doe Mill/ Bruce Rd. (34), and EO 43- Humbug Rd/Skyway (43)	Doe Mill Reserve, Schmidbauer-East, Schmidbauer-Southeast, and Schmidbauer-West	Extant	2022	Partly protected on the Doe Mill Preserve, and partly unprotected west of the Preserve. If the proposed Stonegate project occurs, the occurrences on the west side will be transplanted into preserve land on the east part of the site.
Doe Mill	51	None, this occurrence was discovered after 2008.	None	Extant	2017 (Dudek 2022, p. 73)	None, this occurrence is within the footprint of the proposed Valley's Edge Specific Plan Project.
Oroville	1	State Highway 149 (1)	None	Extant	2018 (Wildlands 2019, p. 7)	Partly protected, this occurrence is partly within the Butte County Association of Government Preserve, partly in the Dove Ridge Conservation Bank, and partly in adjacent, unprotected areas along Hwy 149.

Vernal Pool Core Area	2023 Diversity Database Occurrence Number	Name of Occurrence in 2008 5-Year Review (2008 Diversity Database Occurrence Number)	Associated Sloop et al. (2011) sample sites, if applicable	Presumed Status of Occurrence	Year Last Observed	Protection Status
Oroville	47	None	Dove Ridge-East	Extant	2018 (Wildlands 2019, p. 7)	Fully protected, and is located within the Dove Ridge Conservation Bank.
Oroville	48	None	Dove Ridge-Southeast and Dove Ridge-Southwest	Extant	2019 (Wildlands 2020, p. 6)	Fully protected, and is located within the Dove Ridge Conservation Bank.
Oroville	5	Dove Ridge 5 localities (5)	Dove Ridge-West	Extant	2017 (Wildlands 2018, p. 7)	Partly protected, this occurrence is located both within and adjacent to Dove Ridge Conservation Bank.
Outside of core areas	6	Shippee Road (6)	None	Extant	1991	None, but is located adjacent to the Dove Ridge Conservation Bank.
Outside of core areas	31	Occurrence along Highway 99 north of Thermalito Afterbay (31)	None	Extant	1999	None
Outside of core areas	42	North Table Mountain Ecological Reserve (42)	Table Mountain	Extant	2022	Fully protected on the North Table Mountain Ecological Reserve.
Outside of core areas	50	None, this occurrence was discovered after 2008.	None	Extant	2008	None, located outside of North Table Mountain Ecological Reserve.

- **Occurrences in California Natural Diversity Database (CNDDB)**
  - Searched on 9/4/2025
  - Due to data guidelines, EPA is not presenting a figure showing the locations of the Butte County meadowfoam from CNDDB. Unmasked occurrence data from the CNDDB was received and overlaid with the FWS range and critical habitat. These observations supported expanding the core map outside of the critical habitat and are consistent with FWS documents stating additional populations were discovered after the publication of the critical habitat in 2006.

- **Occurrences in iNaturalist**
  - Searched on 9/4/2025
  - Search Results
  - There are 24 research grade observations available from 2016 to 2025.
  - Coordinates were downloaded from iNaturalist and imported into ArcGIS with the coordinate system GCS_North_American_1983 and overlaid with the critical habitat.
  - These observations are all obscured by 29 km. When accounting for the obscuring, these observations could be considered as within the FWS range and critical habitat.

- **Occurrences in GBIF**
  - Searched on 9/4/2025
  - Search Results
  - There were 107 observations available for this species, 71 of which had coordinates, and 50 which were not included in iNaturalist and are “preserved specimens” from 1940 to 2024. Of these, 31 observations are from 1987 to 2024.
  - Coordinates were downloaded from GBIF and imported into ArcGIS with the coordinate system GCS_North_American_1983 and overlaid with the critical habitat.
    - The observations are consistent with the FWS species range and are consistent with the CNDDB observations which are slightly outside of the critical habitat.

- **Occurrences in NatureServe**
  - NatureServe was searched on 9/5/2025
  - https://explorer.natureserve.org/pro/Welcome

- NatureServe did not have any additional locations and showed a range consistent with that of the current critical habitat.

Collectively, the occurrence data are consistent with the core map being the FWS critical habitat with the addition of known locations from CNDDB. Two new populations were discovered after the publication of the critical habitat and these populations exist outside of the current critical habitat.

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

EPA developed the interim core map by refining the species range and critical habitat based on where vernal pools occur and combining that with known locations. This core map was created based on biological information, including occupied locations. iNaturalist, GBIF, and NatureServe data were considered and visually compared to the range and named locations but were not used to refine the interim core map as only GBIF had observations outside of the critical habitat and these observations aligned with CNDDB observations. CNDDB data were used to refine the core map as they were more specific locations than those provided in FWS.

1. **Dataset References and Software**
   - **1.1.** FWS Species Range (last updated 10/20/2015)
   - **1.2.** FWS Critical Habitat (last updated 02/10/2006)
   - **1.3.** California Department of Fish and Wildlife (CDFW) Areas of Conservation Emphasis (ACE) Terrestrial Significant Habitats
   - **1.4.** Occurrences from California Natural Diversity Database, information downloaded 9/2025
   - **1.5.** USEPA Modified Cultivated Layer

Software used: ArcGIS Pro, version 3.5.0

2. **Creating the Core Map**
   - **2.1. Determining the outside extent of the core map**

     The species range and critical habitat were downloaded from ECOS, and the critical habitat was used as the base of the core map with the range as the outer extent of the core map.
   - **2.2. Refining species range based on suitable habitat**

     A review of FWS's documentation discovered several key aspects of the suitable habitat for this species, this included:
     - This species is dependent on vernal pools, vernal lakes, and swales for survival (FWS, 2023)

     Therefore, the ACE Significant Terrestrial Habitat layer was used to select areas where vernal pools may occur (at a 2.5 mile hexagon resolution) (CDFW, 2020). Initially, *vernal pools* were the only area of conservation emphasis (ACE) selected. All known locations occurred inside these hexagons.

3. **GIS Process Used**
   - **3.1. Refining ACE Terrestrial Significant Habitats**

     Suitable habitat (freshwater wetlands) was selected using the "Select by Attributes" tool:

     Select by Attributes (tool):
     - Input rows: *Freshwater Wetlands _ ACE _ ds2725*
     - Selection Type: New Selection
     - Expression structured as follows: Where VernalPool is equal to Y
     - Output, saved by right clicking on the input layer, selecting "Data" from the dropdown menu, then "Export Features": *Freshwater Wetlands_selection*

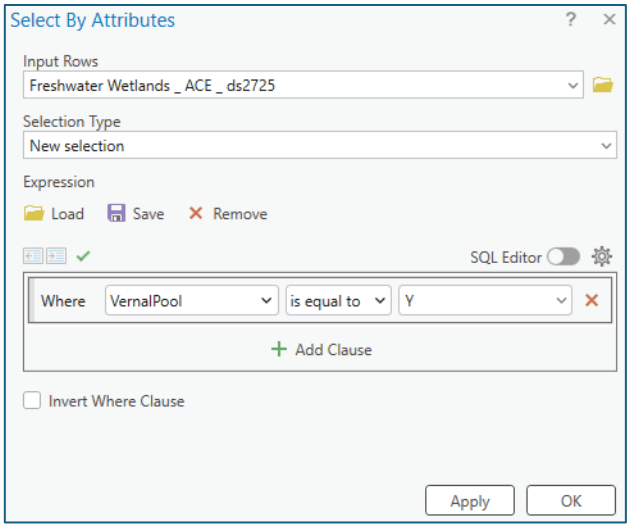

Figure A2-1. Screenshot of the setup for the Select by Attribute tool.

3.2. Adding known locations

Known locations (shapefiles) were downloaded from the CNDBB "Data Updates for Government Subscribers" and uploaded into ArcGIS as polygons. Using the process described in Section 3.1, Butte County meadowfoam observations were selected using the "Select by Attribute" tool (SNAME is equal to *Limnanthes floccose ssp. californica*). This output was saved as a separate layer: *cnddb_occurrences*

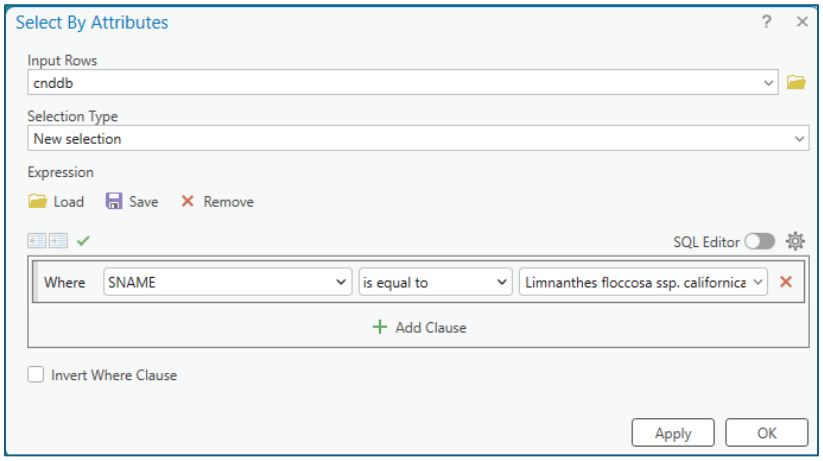

Figure A2-2. Screenshot of the setup for the Select by Attribute tool.

3.3. Overlap known locations with ACE hexagons

The core map was further expanded to include hexagonal areas from the CDFW ACE data layer. The ACE data layer was filtered to only include hexagonal areas with current known locations from CNDDB. If a hexagonal area had an occurrence of the Butte County meadowfoam, then the entire hexagonal area was included. This was done using the "Select Layer by Location" tool.

Select Layer by Location (tool):

- Input features: *Freshwater Wetlands_selection*
- Relationship: Intersect
- Selecting features: *cnddb_occurrences*

- Search distance: 0 meters
- Selection type: New selection
- Output, saved by right clicking on the input layer, selecting “Data” from the dropdown menu, then “Export Features”: *FreshwaterWetlands_cnddb*

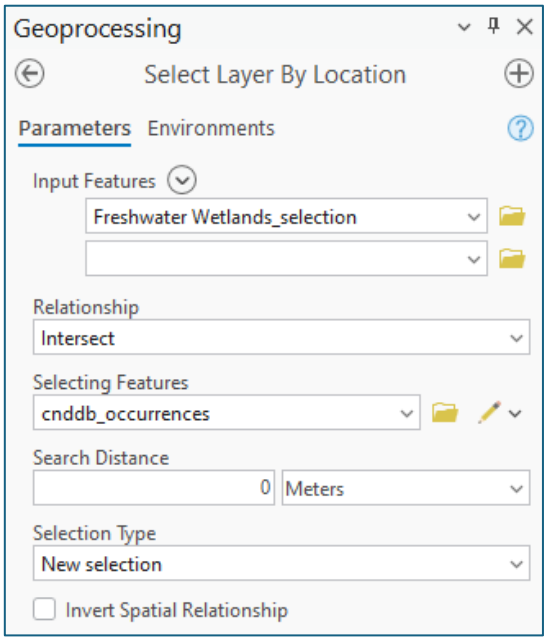

Figure A2-3. Screenshot of the Select Layer by Location tool

3.4. Combine ACE hexagons and critical habitat

Combined ACE hexagons with the critical habitat to encompass all known locations and occupied critical habitat using the “Merge” tool.

Merge (tool):

- Input datasets: *FreshwaterWetlands_cnddb, CriticalHabitat*
- Output feature class: *ACE_CH_merge*

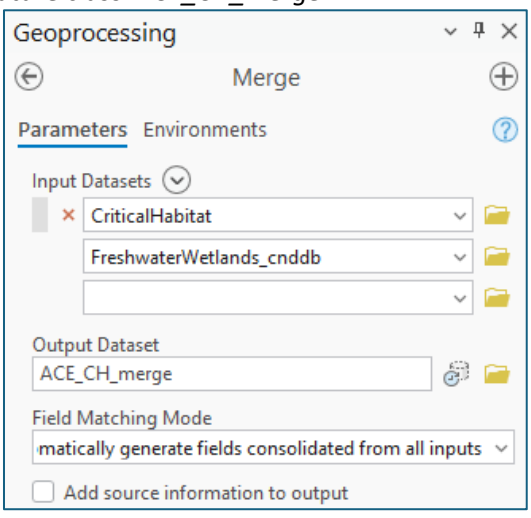

Figure A2-4. Screenshot of the Merge tool

3.5. Refining based on EPA Cultivated Lands Data

3.5.1. EPA has developed and published its own modified cultivated layer (fields > 25 acres) for use in core map development as a potential refinement of extent (EPA 2024). The extent of the map was refined by this layer because no FWS documents indicate that the Butte County meadowfoam can survive in cultivated fields once they are established. Refinement was done using the “Pairwise Erase” tool.

Pairwise Erase (tool)

- Input features: *ACE_CH_merge*
- Erase features: *CultivatedAreas_Over25acres*
- Output Feature Class: *ACE_CH_merge_NoCultLand*

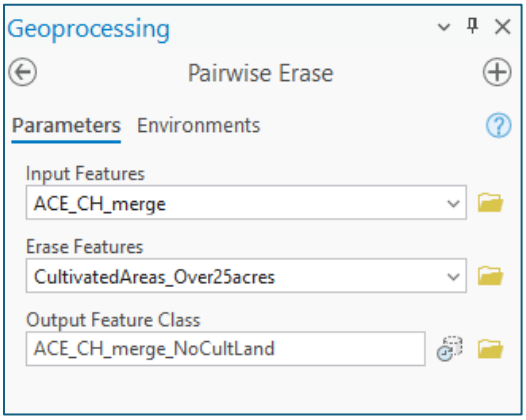

Figure A2-5. Screenshot of the Pairwise Erase tool

3.5.2. Checked to see if any CNDDB observations are now not covered after removing cultivated lands. To do this, used the “Select layer by Location” tool using “invert spatial relationship.”

Select Layer by Location

- Input feature: *cnddb_occurrences*
- Relationship: intersect
- Selecting Features: *ACE_CH_merge_NoCultLand*
- Invert spatial relationship: checked this box

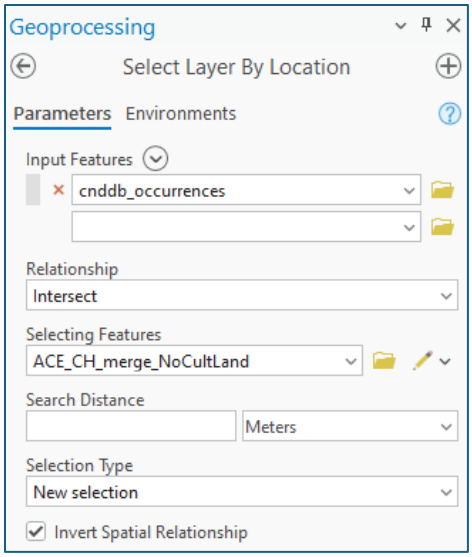

Figure A2-6. Screenshot of the Pairwise Erase tool

Two polygons were selected when this was run (CNDDB occurrence numbers 6 and 31, and visual inspection of the map showed a third polygon from CNDDB that was partially removed (occurrence number 20). These observations were last updated in 2010, 2003, and 2023, respectively. Satellite imagery was used in combination with metadata (including population counts across time and ecological threats) to determine whether these occurrences should be added back into the core map.

- Satellite imagery shows occurrence 6 is currently a crop field and the last collections at this site were made in 1991 so this site was not added back in.
- Satellite imagery combined with last date of collection and CNDDB metadata shows occurrence 31 and 20 hold potential populations, so these were added back into the core map.

Figure A2-7. Screenshot showing example CNDDB occurrence (in cyan) removed from the core map due to overlap with EPA cultivated lands that is currently be an agricultural site so was not added back into the core map after it was removed in Step 3.5.

3.5.3. CNDDB occurrences 31 and 20 were added back into the core map by first selecting the two occurrences and then using the "Merge" tool.

Merge (tool):

- Input datasets: *ACE_CH_merge_NoCultLand, cnddb_occurrences (use selected records)*
- Output feature class: *CoreMap_Merge*

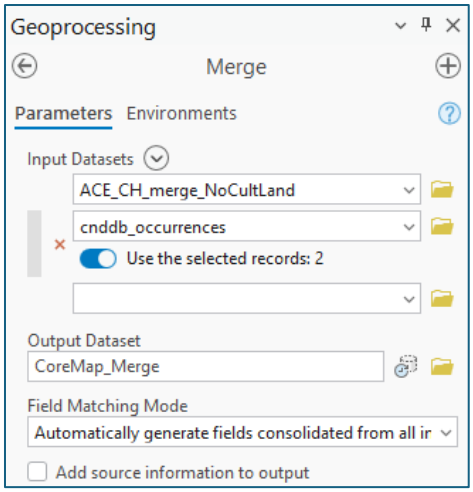

Figure A2-8. Screenshot of the Merge tool

3.5.4. Adding CNDDB occurrences back to the core map did not add in enough area around one of the CNDDB occurrences (20) to protect this population (**Figure A2-9**) so the entire ACE hexagon was added back to the map using the merge tool and the steps above with *CoreMap_Merge* and *ACE_CH_merge* (with hexagon 14049 selected) as the inputs and *CoreMap* as the output.

Figure A2-9. CNDDB population not protected by merging above.

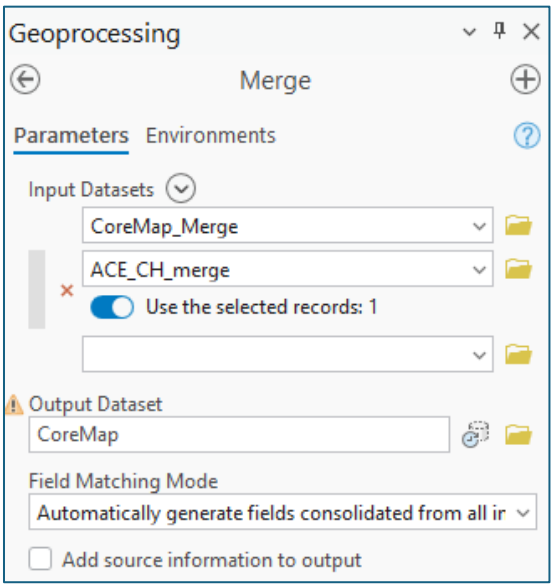

Figure A2-10. Screenshot of the Merge tool.

3.6. Remove small, disconnected patches less than 2 acres

3.6.1. Buffer "*CoreMap*" by 1,000 US survey feet using the "Pairwise Buffer" tool, with the option, "Dissolve all output features into a single feature" choice.

Pairwise Buffer (tool)

- Input Features: *CoreMap*
- Output feature class: *CoreMap_Buffer*
- Distance: 1000 US Survey Feet (linear unit)
- Method: planar
- Dissolve type: Dissolve all output features into a single feature

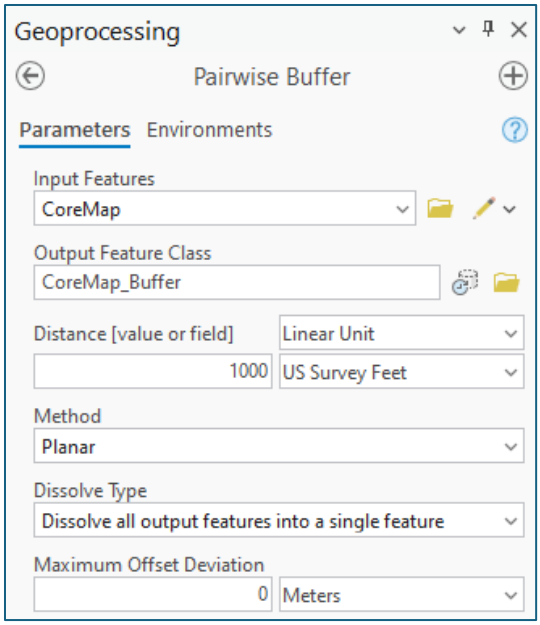

Figure A2-9. Screenshot of Pairwise Buffer tool.

3.6.2. Use the "Eliminate Polygon Part" tool to eliminate polygon parts that are less than 2 acres and more than 1,000 feet away from another polygon.

Eliminate Polygon Part (tool)

- Input Features: *CoreMap_Buffer*
- Output feature class: *CoreMap_Buffer_Extent*
- Condition: Area
- Area: 400,000 square meters

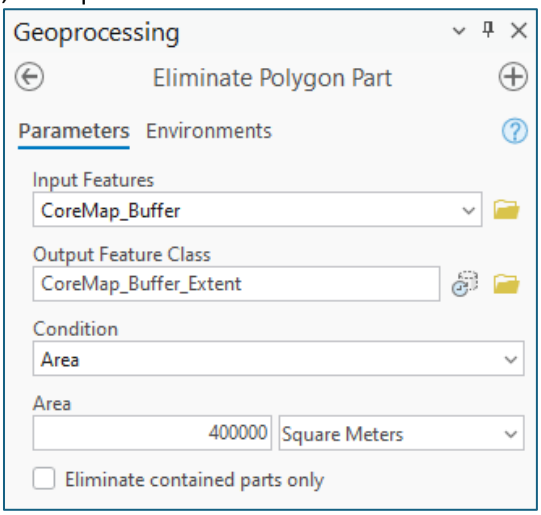

Figure A2-10. Screenshot of Eliminate Polygon Parts tool.

3.6.3. Use the "Pairwise Clip" tool to remove any polygon parts that are less than 2 acres and more than 1,000 feet away from another polygon.

Pairwise Clip (tool)

- Input features: *CoreMap*
- Clip features: *CoreMap_Buffer_Extent*

- Output feature class: *CoreMap_PairwiseClip*

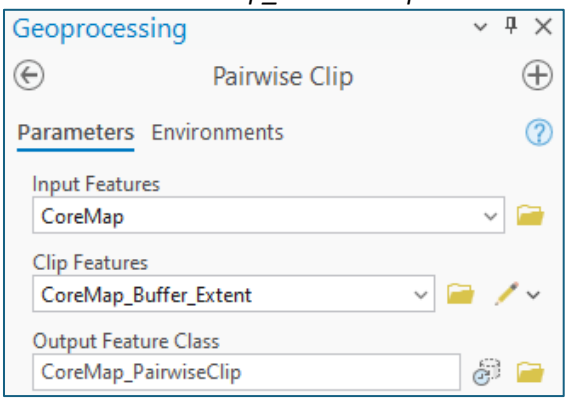

Figure A2-11. Screenshot of Pairwise Clip tool.

3.7. "Smooth" the Core Map by filling in gaps or holes

3.7.1. Use the "Dissolve" tool to merge polygons into one polygon.

Dissolve (tool)

- Input features: *CoreMap_PairwiseClip*
- Output features: *CoreMap_Dissolve*
- Dissolve Fields: CommName

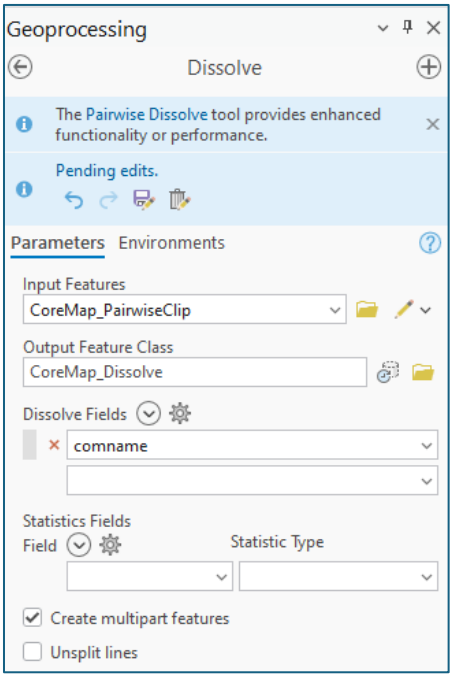

Figure A2-12. Screenshot of Dissolve tool.

3.7.2. Use the "Eliminate Polygon Part" tool to fill in gaps and holes less than 25 acres.

Eliminate Polygon Part (tool)

- Input features: *CoreMap_Dissolve*
- Output features: *CoreMap_Smooth*
- Condition: Area
- Area: 25 US Survey Acres

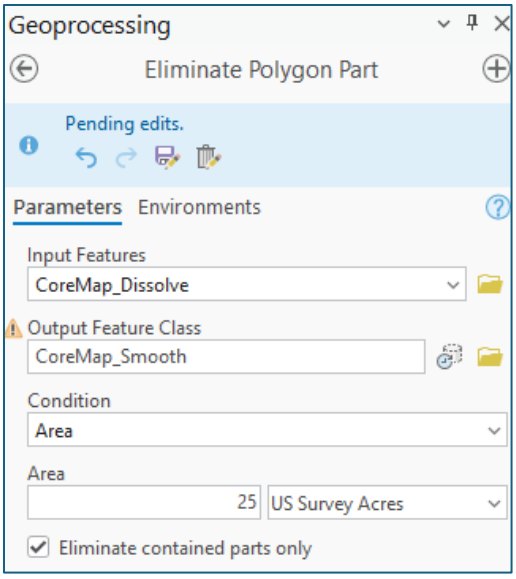

Figure A2-12. Screenshot of Eliminate Polygon Parts tool.

3.7.3. Update attributes and "calculate geometry"

Export "*CoreMap_Smooth*" as "*ButteCountyMeadowfoam_CoreMap_Final*". Manually update fields to the following:

CommName: Butte County meadowfoam

SciName: *Limnanthes floccosa ssp. Californica*

EntityID: 1081

ECOS_WebPg:

Area_Acres: Use Calculate Geometry tool with US Survey Acres and GCS_WGS_1984 coordinate system to calculate the area of the core map

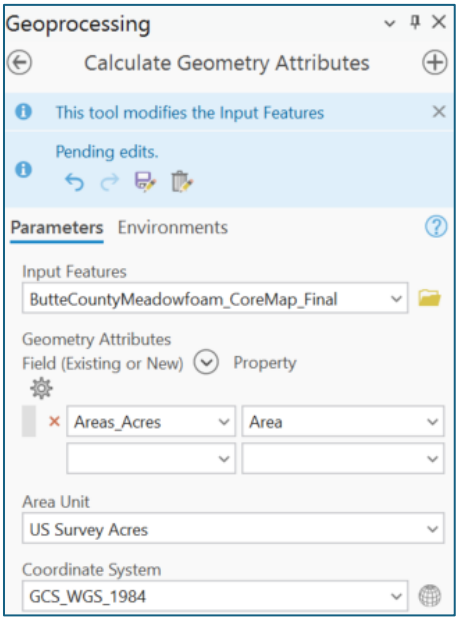

Figure A2-13. Screenshot of the Calculate Geometry tool.