Core Map Documentation for the Longhorn Fairy Shrimp

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Draft Interim Core Map Developer: Center for Biological Diversity

Species Summary

The longhorn fairy shrimp is a species of freshwater crustacean endemic to the Central Valley of California and surrounding areas. These fairy shrimp live in vernal pools and other seasonal wetlands in the Valley. They spend most of their life as eggs or cysts in the dry sediment at the bottom of the vernal pools. They emerge and become active during wet periods when their vernal pools become inundated and feed mostly on detritus or other small animals in the pool. Their vernal pools historically existed throughout the Central Valley, but most have been lost to agricultural development and disruptions to natural flooding in the Valley. As of 2022, they are known to exist in five geographically distinct areas of California. Longhorn fairy shrimp are vulnerable to pesticide that can runoff fields and urban areas where pesticides can remain in the pools for extended periods of time.

EPA Review Notes

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

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

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

Description of Core Map

The core map is biological information type, based on a combination of critical habitat and the species' known locations. There are five geographically isolated areas that are considered occupied (**see Figure A1-4**).[1] Vernal pools in California and Oregon have been surveyed and mapped. Critical habitat, areas of

[1] FWS 2022 p. 3

public lands with current populations, and generalized locations of vernal pools that are considered occupied by the longhorn fairy shrimp constitute the basis for the core map.

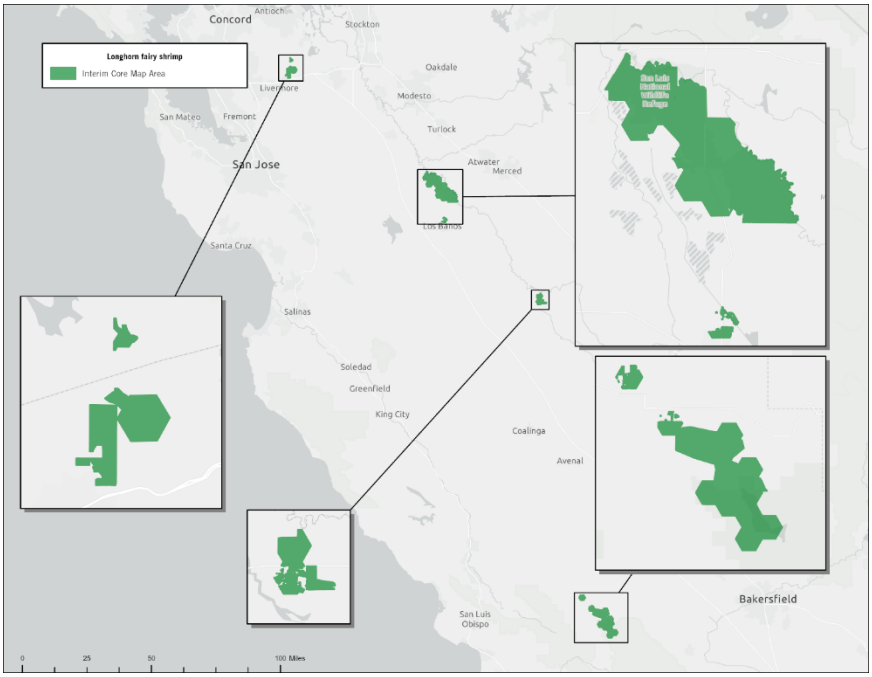

Figure 1. Longhorn fairy shrimp interim core map.

Table 1. Percentage of Interim Core Map Represented by 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	% of core map represented by example pesticide use
Forestry	Deciduous Forest (41)	0	0
Forestry	Evergreen Forest (42)	0	0
Forestry	Mixed Forest (43)	0	0
Agriculture	Pasture/Hay (81)	.2	2
Agriculture	Cultivated Crops (82)	1.8	2
Mosquito adulticide, residential	Open space, developed (21)	2.3	3.6
Mosquito adulticide, residential	Developed, Low intensity (22)	.8	3.6
Mosquito adulticide, residential	Developed, Medium intensity (23)	.5	3.6
Mosquito adulticide, residential	Developed, High intensity (24)	0	3.6
Invasive species control	Woody Wetlands (90)	.1	94.4
Invasive species control	Emergent Herbaceous Wetlands (95)	31.9	94.4
Invasive species control	Open water (11)	.3	94.4
Invasive species control	Grassland/herbaceous (71)	56.6	94.4

Example pesticide use sites/types	NLCD Landcover (Value)	% of core map represented by landcover	% of core map represented by example pesticide use
Invasive species control	Scrub/shrub (52)	1.6	94.4
Invasive species control	Barren land (rock/sand/clay; 31)	3.9	94.4

Evaluation of Known Location Information

Three sources of known location information were evaluated.

- General occurrence information and survey results presented in the 2022 5-year review
  Comment: The 2020 5-year review presents general descriptions of occupied areas. The occupied areas are presented as areas of public lands or lands that with a conservation agreement. The review does not present location information at a smaller scale than the names of general areas or preserves. The 5-year review describes the most recent survey effort for the species and indicates that potentially more than 100 individual pools are considered occupied. The general occupied areas based on named areas of public or protected lands were fully included in the core map.

- California Department of Fish and Wildlife (CDFW)vernal pools geodatabase
  Comment: Vernal pools are an Area of Conservation Emphasis for the CDFW and have received special attention that has resulted in a statewide geodatabase[2] of the known locations of vernal pools that can be filtered for the presence of the longhorn fairy shrimp. The geodatabase presents hexagonal regions with the occupied vernal pool(s) located somewhere within the hexagonal area. This dataset was produced and verified by the CDFW and presents a reliable source of location information for the longhorn fairy shrimp and supplemented or refined locations presented in the 2022 5-year review.
- California Natural Diversity Database (CNDDB)
  Comment: The CNDDB presents 23 occurrences dated from 1985 to 2018. Of these, 13 could be considered recent (newer than 2010). This dataset presents spatial information for occupied pools at various spatial scales. This dataset contains some, but not all, of the locations that were surveyed as described in the 2022 5-year review.

Approach Used to Create Core Map

The core map for the longhorn fairy shrimp was based on critical habitat, known occupied areas of public or conserved lands, and occupied hexagonal areas identified by the CDFW in their vernal pool geodatabase.
Evaluation of available data identified named areas of public or conserved lands and occupied hexagonal areas from the vernal pool dataset were both necessary to capture all currently occupied areas for the longhorn fairy shrimp.

Critical habitat areas are all considered currently occupied and were added to the core map.

[2] https://gis.data.ca.gov/search?q=vernal%20pool

Based on the 2022 5-year review, five areas were identified as having currently extant populations and were added to the core map: Brushy Peak Preserve, Vasco Caves Preserve, San Luis National Wildlife Refuge Preserve, Alkali Sink Conservation Bank, and the Carrizo Plain. Boundaries for these areas were extracted from the Public Areas Database of the U.S. (PADUS).

The core map was further expanded to include hexagonal areas with current known locations based on a query of the vernal pool geodatabase for the presence of the longhorn fairy shrimp.

Using the EPA's cultivated lands layer, we removed areas that were considered cultivated. Neither the Recovery Plan nor the 5-year review indicate that the longhorn fairy shrimp can survive in cultivated fields once they are established. However, the species has been observed in irrigation ditches. Considering the available location information includes critical habitat and other occupied areas of varying precisions we judge the uncertainty score of this core map to be 3 (average). Substantial additional areas were added to the core map outside of the critical habitat to expand the core map. Locations of occupied pools was available through the CDFW's vernal pool geodatabase, but with limited precision. No habitat modeling was required.

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

Range Map Approach for Core Map
A core map based on the species range was rejected because the ECOS range map contains only two occupied areas and is out of date with the 2022 5-year review which indicates that five areas contain occupied vernal pools.

Critical Habitat Approach for Core Map
A core map based on critical habitat was rejected because, of the known populations, only a subset is on the designated critical habitat.
Habitat Modeling Approach for Core Map

A core map based on modeled habitat was rejected because sufficient location information was available to describe the known locations. No preexisting habitat model exists to identify occupied vernal pools.

Other sources of information reviewed but not included
Location information from the CNDDB was evaluated, but these locations were not included in the core map. The CNDDB data included only a subset of currently occupied areas and only 13 could be considered as recent observations. The Center has also made a conscious effort to not rely on CNDDB data to create core maps when other data is available. Sharing CNDDB data on Bulletins Live Two has not been cleared under the terms of use of CNDDB data. The vernal pool dataset was judged to be of adequate resolution to form the basis of the core map.

Appendix 1. Information compiled for species during Step 1

1. Recent FWS documents

FWS. 2005. Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon. Available from https://ecos.fws.gov/docs/recovery_plan/Vernal%20Pool%20Ecosystem%20Final%20Recovery%20Plan.pdf.

FWS. 2022. 5-YEAR REVIEW Longhorn Fairy Shrimp (Branchinecta longiantenna). Available from https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/3969.pdf.

2. Background information

Status: ENDANGERED

Resiliency, redundancy, and representation (the 3Rs):
Resiliency – FWS has not formally assessed resiliency in the 2005 Recovery Plan or 2022 5-year review.
Redundancy – FWS has not formally assessed redundancy in the 2005 Recovery Plan or 2022 5-year review.
Representation – FWS has not formally assessed representation in the 2005 Recovery Plan or 2022 5-year review.

Habitat, Life History, and Ecology
Habitat:
The longhorn fairy shrimp inhabits ephemeral or vernal pools and rock pools as well as well as other seasonally inundated wetlands within its range.[3] The species does not appear to rely exclusively on a particular type of vernal pool.[4] In the Livermore Vernal Pool Region in Contra Costa and Alameda Counties, the longhorn fairy shrimp lives in sandstone outcrop pools that are smaller and sometimes no larger than one meter in diameter.[5] Elsewhere in the San Joaquin and Carrizo Vernal Pool Regions, the vernal pools occur in grassland ecosystems and are larger up to 62 meters in diameter.[6]

Similar to other listed vernal pool invertebrates, this species is adapted to the harsh and highly variable conditions of the vernal pool ecosystems. The longhorn fairy shrimp is active and reproduces when water levels are high and lay eggs, or cysts, that remain dormant in the soil at the bottom of the pool or wetland until wet conditions return.[7]

[3] Service 2005 p. II-189
[4] Vollmar Natural Lands Consulting. 2015. 2015 Vernal Pool Aquatic Surveys, San Luis National Wildlife Refuge Complex, Merced County, California. Report prepared for U.S. Fish and Wildlife Service, San Luis National Wildlife Refuge Complex, Los Banos, California. 17 pp. Page 15.
[5] FWS 2005 p. II-189
[6] FWS 2005 p. II-189
[7] FWS 2022 p. 1

Diet:
When active, their diet consists mostly of detritus, but they will opportunistically consume algae, bacteria, protozoa, rotifers, aquatic earthworms, aquatic insects, other fairy shrimp, frog eggs, and tadpoles.[8]

Taxonomy:
The longhorn fairy shrimp (*Branchinecta longiantenna*) is classified as a crustacean in the Branchinectidae family (Order:Anostraca). The species was formally described in 1990 based on a type specimen collected on the Souza Ranch in Contra Costa County, California.[9]

Taxonomic Hierarchy

Kingdom	Animalia – Animal, animaux, animals
Subkingdom	Bilateria – triploblasts
Infrakingdom	Protostomia
Superphylum	Ecdysozoa
Phylum	Arthropoda – artrópode, arthropods, arthropods
Subphylum	Crustacea Brunnich, 1772 – curtacés, crustáceo, crustaceans
Superclass	Altocrustacea
Class	Branchiopoda Latreille, 1817 – branchiopods, branchiopode
Order	Anostraca G. O. Sars, 1867 – brine shrimp, fairy shrimp
Suborder	Anostracina
Family	Branchinectidae Daday, 1910
Genus	Branchinecta Verrill, 1869
Species	Branchinecta longiantenna Eng, Belk and Eriksen, 1990- longhorn fairy shrimp

Figure A1-1. Taxonomy from ITIS.

Relevant Pesticide Use Sites:
Agricultural fields
Urban/residential areas

Relevant Recovery Criteria and Actions:
Objective:
From the 2005 Recovery Plan Page viii
The overall goals of this recovery plan are to:
• Achieve and protect in perpetuity self-sustaining populations of each species.
• Delist the 20 federally listed plant and animal species.
• Ensure the long-term conservation of the 13 species of special concern.

Interim goals of this recovery plan are to:
• Stabilize and protect populations to prevent further decline of each species.
• Conduct research necessary to refine reclassification and recovery criteria.
• Reclassify to threatened status those species listed as endangered

The overall objectives of this recovery plan are to:

[8] Helm BP, Vollmar JE. 2002. Large branchiopods. Wildlife and Rare Plant Ecology of Eastern Merced County's Vernal Pool Grasslands. University of California at Merced:151–190. Page 168.
[9] FWS 2005 p. II-186

• Ameliorate or eliminate the threats that caused the species to be listed as federally endangered or threatened, and to ameliorate any newly identified threats, in order to be able to delist or downlist these species.
• Ameliorate or eliminate the threats that affect the species of concern and ameliorate any newly identified threats in order to conserve these species.
• Confirm the status of Plagiobothrys hystriculus, a species of concern that is currently presumed extinct. If extant populations are discovered, the ultimate goal would be to ensure the long-term conservation of this species.
• Promote natural ecosystem processes and functions by protecting and conserving intact vernal pools and vernal pool complexes.

Criteria:
From the 2022 5-Year Review Page 12-14
General recovery criteria for longhorn fairy shrimp and 19 other listed plants and animals are described in the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (Recovery Plan) (Service 2005, entire). The Recovery Plan uses an ecosystem-level approach because many of the listed species and species of concern co-occur and are impacted by the same threats. The overarching recovery strategy for longhorn fairy shrimp is habitat protection and management. The five key elements that comprise this ecosystem-level recovery and conservation strategy are: (1) habitat protection; (2) adaptive management, restoration, and monitoring; (3) status surveys; (4) research; and (5) public participation and outreach.

Downlisting recovery criteria for the longhorn fairy shrimp include:
1. Habitat protection: Accomplish habitat protection that promotes vernal pool ecosystem function sufficient to contribute to population viability of the covered species.

1A. Suitable vernal pool habitats within each prioritized core area for the species is protected. Downlisting criteria 1A. specific to the longhorn fairy shrimp is protection of 95% of suitable species habitat within the North Carrizo Plain, South Carrizo Plain, Altamont Hills, and Grasslands Ecological Area vernal pool core areas.

1B. Species occurrences distributed across the species geographic and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there. Downlisting criteria 1B. specific to the longhorn fairy shrimp is protection of 100% of species occurrences. Table 5 summarizes the protection status of longhorn fairy shrimp populations.

1C. This is a general criterion for reintroductions and introductions that must be carried out and meet success criteria. However, for downlisting the longhorn fairy shrimp, no reintroductions or introductions are described. Reintroductions and introductions are described for delisting the species.

1D. Additional occurrences (i.e., localities) identified through future site assessments, GIS and other analyses, and status surveys that are determined essential to recovery are permanently protected.

1E. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average local rainfall, a multi- year drought, and a minimum of five years of post-drought monitoring.

2. Adaptive habitat management and monitoring:

2A. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected in 1A–E above.

2B. Mechanisms are in place to provide for management in perpetuity and long-term monitoring of 1A–E above (i.e., funding, personnel, etc.).

2C. Monitoring indicates that ecosystem function has been maintained in the areas protected under 1A–D for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of five years of post-drought monitoring.

3. Status surveys:

3A. Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of five years of post-drought monitoring.

3B. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated.

4. Research:

4A. Research actions necessary for recovery and conservation have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both specifically identified in the recovery actions and determined through the process) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats that have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions.

4B. Research on genetic structure has been completed for reintroduction and introduction efforts and results incorporated into habitat protection plans to ensure that within and among population genetic variation is fully represented by populations in 1A–E above. As described in 1C above, reintroductions and introductions are not described for downlisting the longhorn fairy shrimp, just for delisting the species.

4C. Research necessary to determine appropriate parameters to measure population viability for each species have been completed.

5. Participation and outreach:

5A. Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts.

5B. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts.

5C. Participation plans for each vernal pool region have been completed and implemented.

5D. Vernal pool region working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria 1–4.

<u>Recovery Actions:</u>

A variety of recovery actions have taken place since the species' listing in 1994. The remaining populations are now on public lands, or are otherwise protected except for populations on private lands on the Carrizo Plain. FWS and consulting companies have conducted surveys across the range from

2015-2019 and verified the presence of the species at all five locations, but more consistent monitoring is needed. A plan is in place for management at the Alkali Sink Conservation Bank.[10] A more detailed accounting of the impacts of recovery actions can be found in Table 7 of the 2022 5-year review.

Recommendations for Future Actions:

From the 2022 5-Year Review Page 18-19

1. Acquire and manage habitat. All populations of longhorn fairy shrimp should be protected. Resource agencies and private partner groups should work to ensure protection of localities on private lands in the Carrizo Plain population through acquisition or conservation easement.
2. Determine population status and implement regular population monitoring. Develop a standardized monitoring method to monitor the status and trend of occurrences to (a) track any threats, (b) estimate current population sizes and the number and distribution of populations, and (c) determine whether the species is stable, increasing, or declining. The monitoring method should account for all important population metrics, which may include presence, abundance of fairy shrimp and eggs, and number of generations present (i.e., instars, juveniles, and breeding adults). Work with landowners and managers to implement multi-year monitoring programs. Survey for additional localities within the five known populations.
3. Explore the effect of climate change on vernal pool hydrology and species viability. Assess how climate change, including increase in temperature and frequency of extreme weather events, will impact vernal pool hydrology through modeling. Determine how these impacts differ among pool types, i.e., rock outcrop pools versus soil-bottom pools. Work with partners to model current hydrology and vernal pool connectivity. Assess how future climate conditions will impact reproduction and, consequently, population dynamics. Determine which populations are most vulnerable to climate change to prioritize conservation actions.
4. Designate a suitable unit of assessment. Consult with species experts and land managers to develop a geographically and ecologically appropriate unit of assessment to describe a longhorn fairy shrimp population subcategory. Currently, the use of "locality" or "occurrence" is not standardized. Defining a unit of assessment will aid in more precise assessments of recovery criteria.
5. Develop habitat suitability criteria. Determine the role of microhabitat characteristics and local community structure in habitat suitability for longhorn fairy shrimp. Determine range of suitable abiotic conditions (e.g., turbidity, nutrient concentration, oxygen concentration, light availability, pool depth, hydroperiod) for the species. Model pool characteristics in relation to landscape and abundance. Work with partners to apply information towards (a) restoring and creating suitable habitat and (b) predicting vulnerability of localities as habitat conditions change due to climate change.
6. Develop research needs and actions. Support ongoing longhorn fairy shrimp research at Brushy Peak and Vasco Caves Preserves, and support other studies to fulfill research needs, including:
    - Genetic diversity within and among populations.
    - Whether genetic diversification occurs due to highly variable habitat features.
    - The use of environmental DNA, or eDNA, as a complementary survey tool to the use of dip nets and soil samples.
    - Biotic and abiotic parameters for species occurrence.
7. Assess recovery criteria. Consider reassessing longhorn fairy shrimp's recovery criteria to account for climate change impacts. Additionally, to continue tracking progress towards meeting recovery criteria, we need additional information about the species and its habitat, including:
    - Species characteristics, including environmental stimuli that trigger hatching of eggs, length of cyst viability, and stratification of cysts.

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- Percentage of protected land within identified core areas.
- Survey of localities on private lands.
- An assessment of the effectiveness of current habitat management plans.

3. Description of Species Range:

The longhorn fairy shrimp is endemic to California. Its habitat is vernal pools within the southern portion of California's Central Valley and the adjacent Carrizo Plain west of Bakersfield.

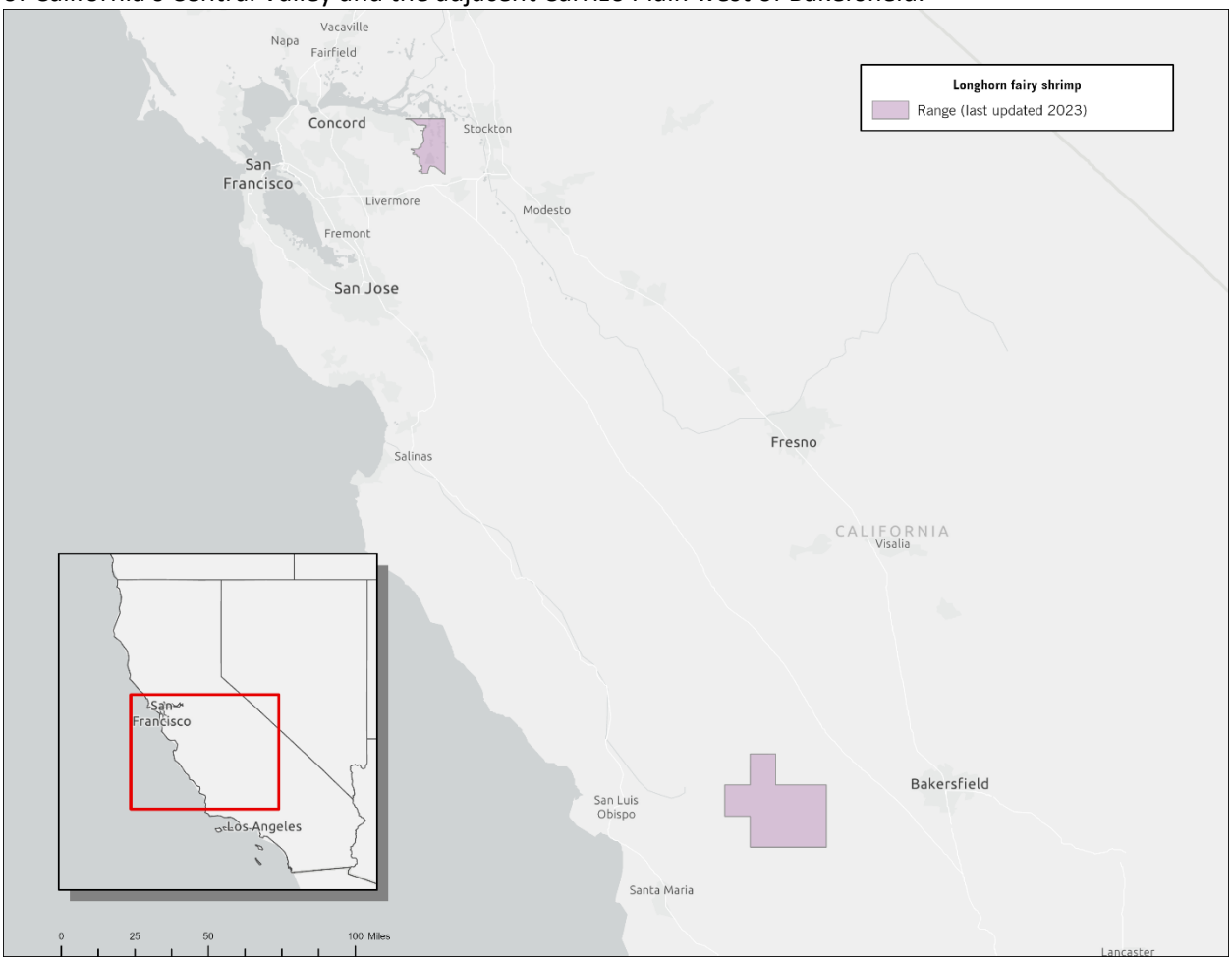

Figure A1-2. FWS range from ECOS last updated on March 19, 2018.
https://ecos.fws.gov/ecp/species/4294

4. Critical Habitat:

FWS designated critical habitat for the species in 2006.

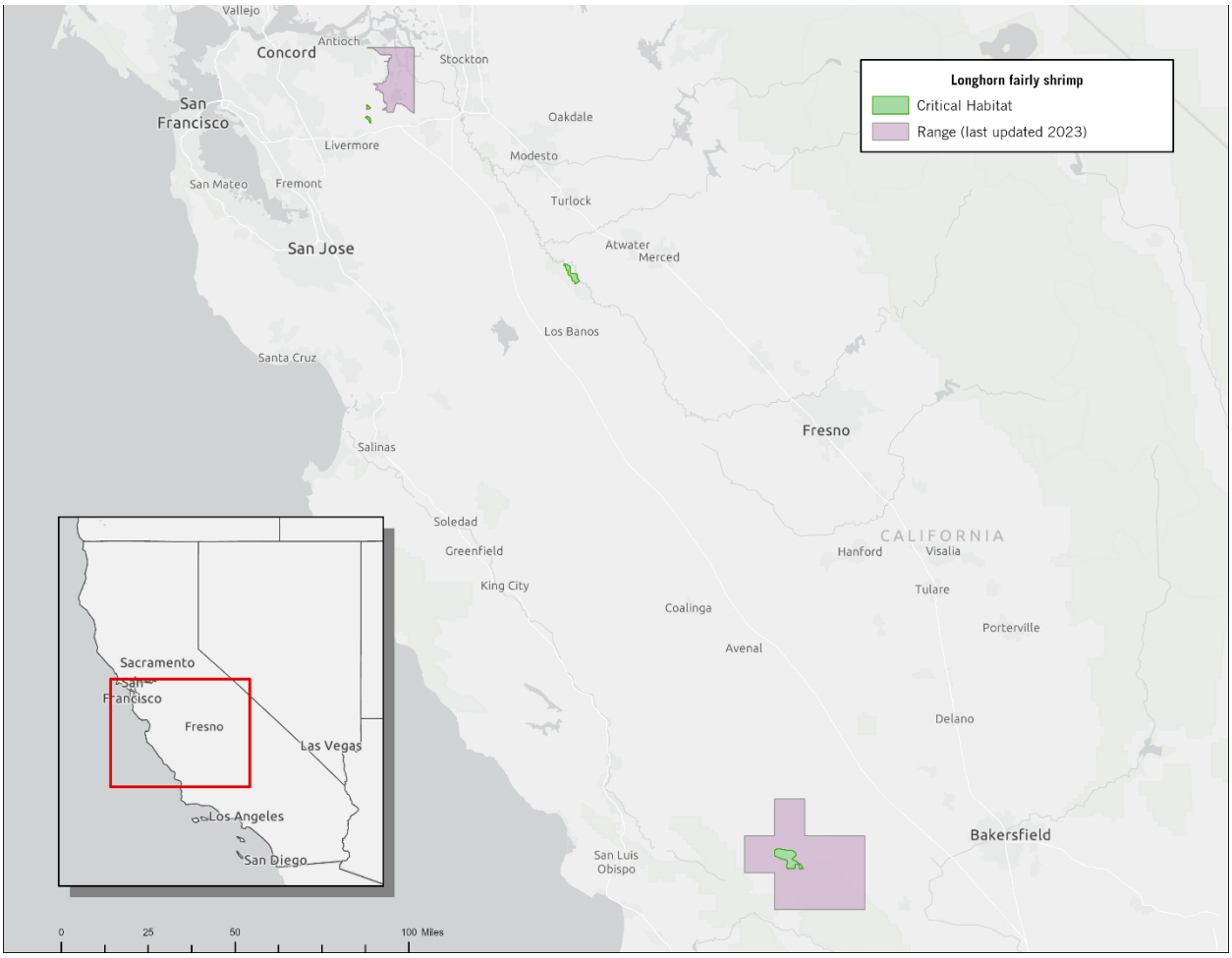

Figure A1-3. ECOS critical habitat for the longhorn fairy shrimp. The total acreage of the critical habitat is approximately 13,500 acres.

5. Known Locations

The longhorn fairy shrimp is currently known from five geographically isolated areas referred to as: Brushy Peak Preserve, Vasco Caves Preserve, San Luis National Wildlife Refuge Preserve, Alkali Sink Conservation Bank, and the Carrizo Plain.[11] The location of these five populations are depicted in Figure 1 from the 2022 5-year review (Figure A1-4).

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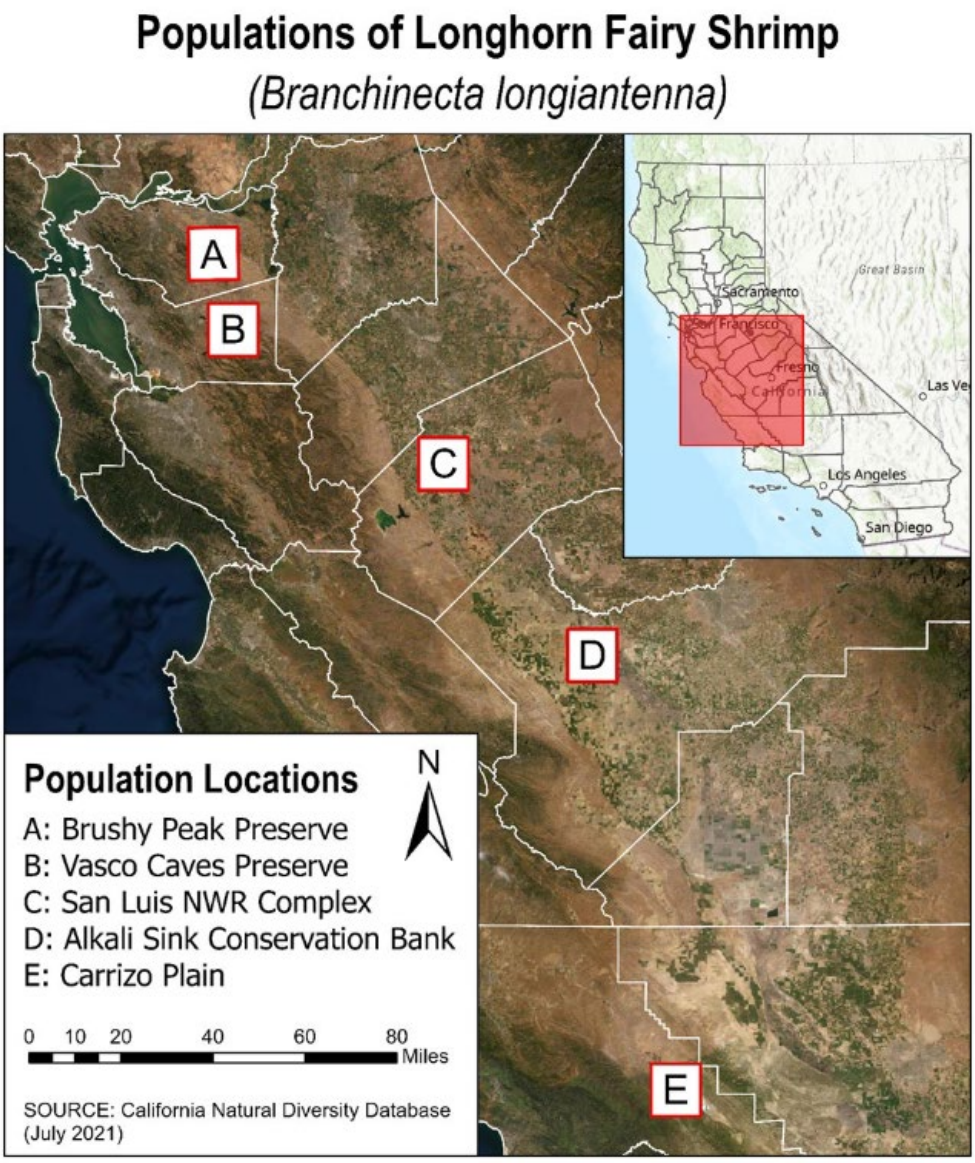

Figure 1. Longhorn fairy shrimp population map (Diversity Database 2021).

Figure A1-4. General locations of longhorn fairy shrimp from Figure 1 from the 2022 5-year review.

The 2022 5-year review provides information on the surveys that have been conducted at the five currently occupied areas. All five areas are considered occupied as of 2019. Refined location of the occupied pools is not available within the 2022 5-year review, but is presented in the CNDDB records. CNDDB records were reviewed, but not used in the creation of the PULA. A summary of the last known observations at each of the five areas is presented in Table A1-1.

Table A1-1. Summary of known occupied areas including ownership and the most recent occurrence records.

Population	Landowner(s)	Notes
Brushy Peak Preserve	East Bay Regional Park District	Present in 76 pools total across Alameda and Contra Costa Counties as of 2021.[12]
Vasco Caves Preserve	Livermore Area Recreation and Park District	Present in 76 pools total across Alameda and Contra Costa Counties as of 2021.[13]
San Luis National Wildlife Refuge Complex	US Fish and Wildlife Service	Includes San Luis NWR, Merced NWR, San Joaquin NWR, and Grassland Wildlife Managment Area. Longhorn fairy shrimp observed in San Luis National Wildlife Refuge in 2018 and 2019, but not the other units of the complex.[14]
Alkali Sink Conservation Bank	Meyers Farming, LLC	First discovered in 2009. Presence verified at two pools within the conservation bank during 2017-2018 surveys.[15]
Carrizo Plain	Bureau of Land Management and Private	Presence verified in 19 pools within the Carrizo Plain monument based on surveys from 2015-2019.[16] No records are available after 2019. Potentially 20 additional occupied pools exist in private land outside of the monument.

[12] FWS 2022 p. 4
[13]FWS 2022 p. 4
[14] FWS 2022 p. 5
[15]FWS 2022 p. 5
[16] FWS 2022 p. 6

Appendix 2. GIS Data Review and Method to Develop Core Map (Step 3)

The core map type for this species is based on known California Natural Diversity Database (CNDDB) locations (occurrence searches), 2022 5-YR Longhorn fairy shrimp review and 2006 Critical Habitat report locations.

The Center for Biological Diversity developed the interim core map by taking all critical habitat units to represent some areas of the core map. Next four populations (Brushy Peak Preserve, Vasco Caves Preserve, San Luis National Wildlife Refuge Complex, and Carrizo Plain National Monument (Service 1994, p. 48137; Service 2007b, p. 3)). A fifth population was discovered in the Alkali Sink Conservation Bank prior to the 2012 status review (Service 2012, p. 2). Each five population locations were reviewed, and Alkali Sink Ecological Reserve, San Luis National Wildlife Refuge, and Brushy Peak Regional Reserve from the USGS PADUS layer were used to represent areas of the core map. Lastly, any remaining CNDDB polygons not already covered by either the Critical Habitat or PADUS Public Land, yet spatially coincident Vernal Pool hexagons were used to represent areas of the core map.

This section details the data and steps used to create the core map for the Longhorn Fairy Shrimp based on this biological information.

1. **References and Software**
   - World UTM Grid: https://services.arcgis.com/P3ePLMYs2RVChkJx/arcgis/rest/services/World_UTM_Grid/FeatureServer
   - Modified Cultivated Layer (Downloaded 01/27/2025) https://cdn.arcgis.com/home/item.html?id=159e70ce4c284f5b972c687037f8a668
   - BIOS California Natural Diversity Database (CNDDB) Government [ds45] cnddb.shp
   - BIOS Vernal Pools - ACE [ds2732] ds2732.shp
   - USGS PAD-US Data Download (National Geodatabase) Version 4.0: https://www.usgs.gov/programs/gap-analysis-project/science/pad-us-data-download
   - FWS Species critical habitat: https://ecos.fws.gov/docs/crithab/zip/FCH_Branchinecta_longiantenna_20050811.zip
   - FWS Species range: https://ecos.fws.gov/docs/species/shapefiles/usfws_K03E_I01_Branchinecta_longiantenna_current_range.zip
   - Software used: ArcGIS Pro version 3.2

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

   2.1. Take all four records from Longhorn fairy shrimp critical habitat (copy and paste)

   1. In ArcPro, create a copy of the template EPA polygon shapefile for the longhorn fairy shrimp, named “Longhorn_fairy_shrimp_Poly” (core map shapefile).
   2. Select all the records from the “FCH_Branchinecta_longiantenna_20050811” (Critical Habitat) shapefile. Copy and paste them into the newly created longhorn fairly shrimp shapefile from step 1. **(Figure A2-1)**

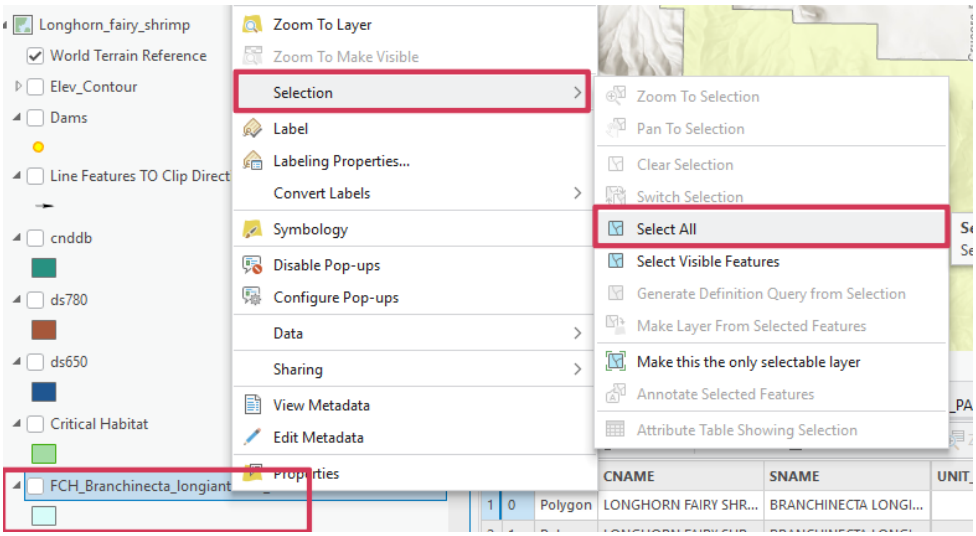

Figure A2-1. Screenshot of steps to select all records in a shapefile.

3. Set the definition query in the BIOS California Natural Diversity Database (CNDDB) Government [ds45] shapefile where "SNAME" = "Branchinecta longiantenna". This filter will show only polygons for Longhorn fairy shrimp and can be used to identify known locations. **(Figure A2-2)**

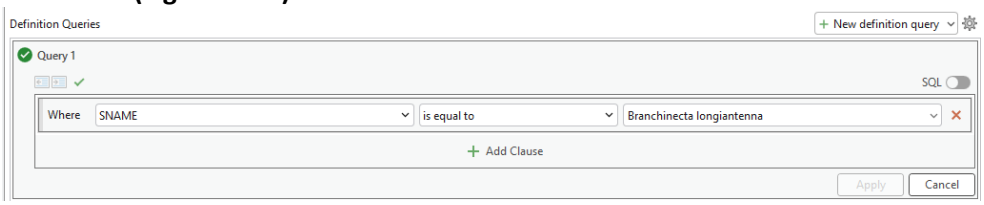

Figure A2-2. Screenshot of definition query

4. In the 2022 5-YR Review, five populations were named: Brushy Peak Preserve, Vasco Caves Preserve, San Luis National Wildlife Refuge Complex, Carrizo Plain National Monument and Alkali Sink Ecological Reserve. These are sites mentioned. The USGS PAD-US Data Download (National Geodatabase) Version 4.0 is given a definition query to show only these. *Unit_Nm IN ('Alkali Sink Ecological Reserve', 'Brushy Peak Regional Preserve', 'Vasco Caves Regional Preserve', 'San Luis National Wildlife Refuge', 'Carrizo Plain National Monument') And Category NOT LIKE '%Proclamation%'* **(Figure A2-3)**

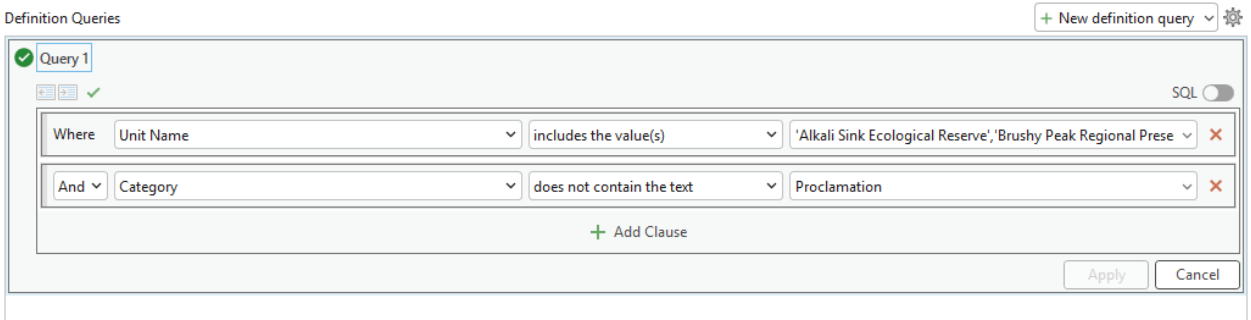

Figure A2-3. Screenshot of definition query

5. Zoom to each of the five areas listed in step 4. Look at both the PADUS area and review if there is a Critical Habitat that already covers the CNDDB polygons or if there are no CNDDB polygon located in the same area. The results of the five PADUS areas are below.
    a. **Alkali Sink Ecological Reserve**: Although there are no CNDDB polygons located in the same area, the 2022 5-YR review mentions that the longhorn fairly shrimp have been recently found. The PADUS record was copied and pasted.
    b. **Brushy Peak Regional Preserve**: Although there are no CNDDB polygons located in the same area, the 2022 5-YR review mentions that the longhorn fairly shrimp have been recently found. The PADUS record was copied and pasted.
    c. **Carrizo Plain National Monument**: There are CNDDB polygons located in the same area in the northern part of the Carrizo Plain National Monument. However, they are just a small percentage of the National Monument. Choose to use and copy the smaller hexagon polygons of the BIOS Vernal Pools - ACE [ds2732] to define the boundaries instead.
    d. **Vasco Caves Regional Preserve**: Critical Habitat is already in the same area and effectively defines the boundary.
    e. **San Luis National Wildlife Refuge**: The PADUS area matches the CNDDB area closely, so the PADUS record was copied and pasted. **(Figure A2-4)**

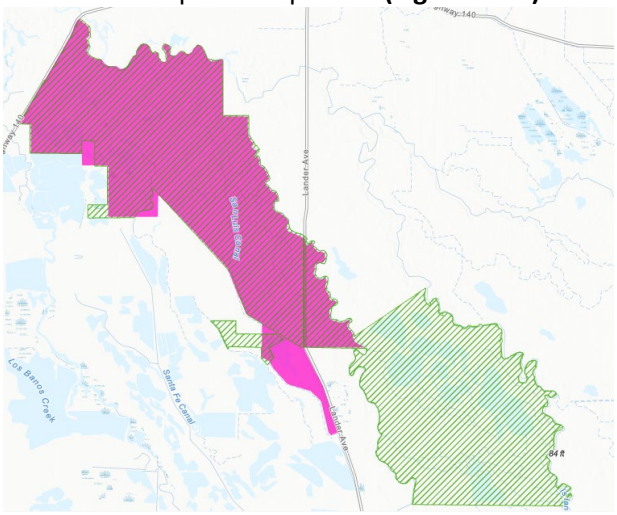

Figure A2-3. Screenshot of San Luis National Wildlife Refuge (green hatch) and CNDDB (pink)

6. A definition query was assigned in the BIOS Vernal Pools - ACE [ds2732] shapefile to only show hexagons that are assigned to contain a vernal pool. **(Figure A2-4)**

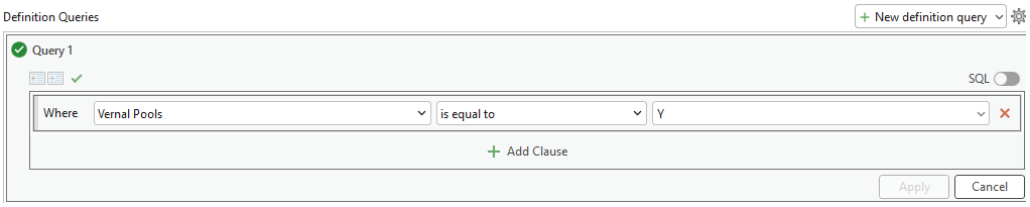

Figure A2-4. Screenshot of definition query

7. Pan and zoomed to remaining delta CNDDB polygons (CNDDB polygons minus any areas where they do not intersect with vernal pools). Because they are sources that indicate presence and suitable habitat for the longhorn fairly shrimp, the vernal pools were copied and pasted into the core map shapefile.
8. For CNDDB polygons that were partially inside and outside Critical Habitat and PADUS areas listed in the 2022 5-YR review, the "Measure" tool was used to determine how far the polygon existed outside these areas. If the measurement was 100 meters or greater and a vernal pool existed in the area, then that vernal pool was added to the core map. If it was less than 100 meters, the core map was left as is.
9. Two CNDDB polygons did not have a vernal pool in the same existing area, so no polygon was created. One other CNDDB polygon existed inside and outside a vernal pool, the area outside the vernal pool (167 meters) did not have an adjacent hexagon, so it was left as is. **(Figure A2-5)**

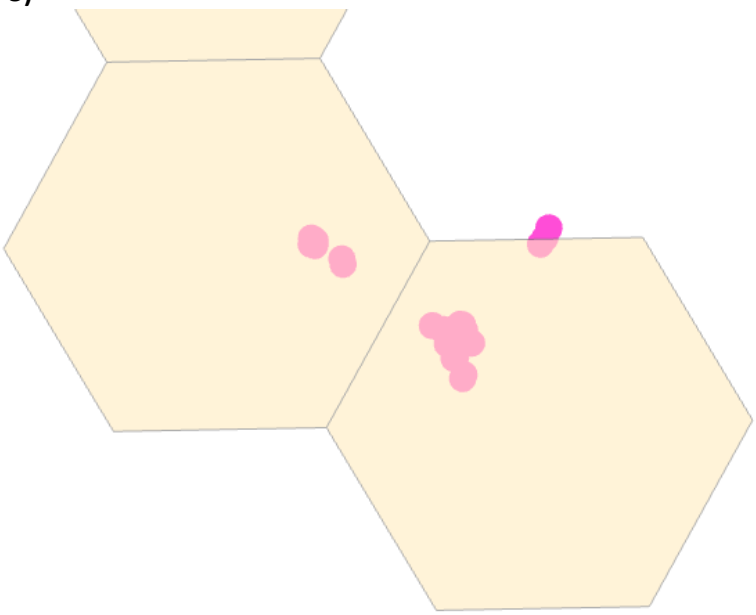

Figure A2-5. Screenshot of Vernal Pools (beige) and CNDDB polygon (pink)

2.2. Use EPA's "CultivatedAreas_Over25acres" to "Pairwise Erase" Longhorn_fairy_shrimp_Poly

1. As an effort to refine the core map boundaries, use "Pairwise Erase" to erase the core map "Longhorn_fairy_shrimp_Poly" by "CultivatedAreas_Over25acres". The resulting layer is named, "Longhorn_fairy_shrimp_NoCultLand".
2. Investigated the CNDDB areas that are not covered by the core map. Saw no direct indication of a vernal pool, so left this as is.

2.3. Use EPA's QA/QC process to remove small, disconnected patches less than 2 acres

1. Buffer "Longhorn_fairy_shrimp_NoCultLand" by 1,000 US survey feet, with the option "Dissolve all output features into a single feature" choice. The output feature class is named, "Longhorn_fairy_shrimp_NoCultLand_Buffer". **(Figure A2-6)**

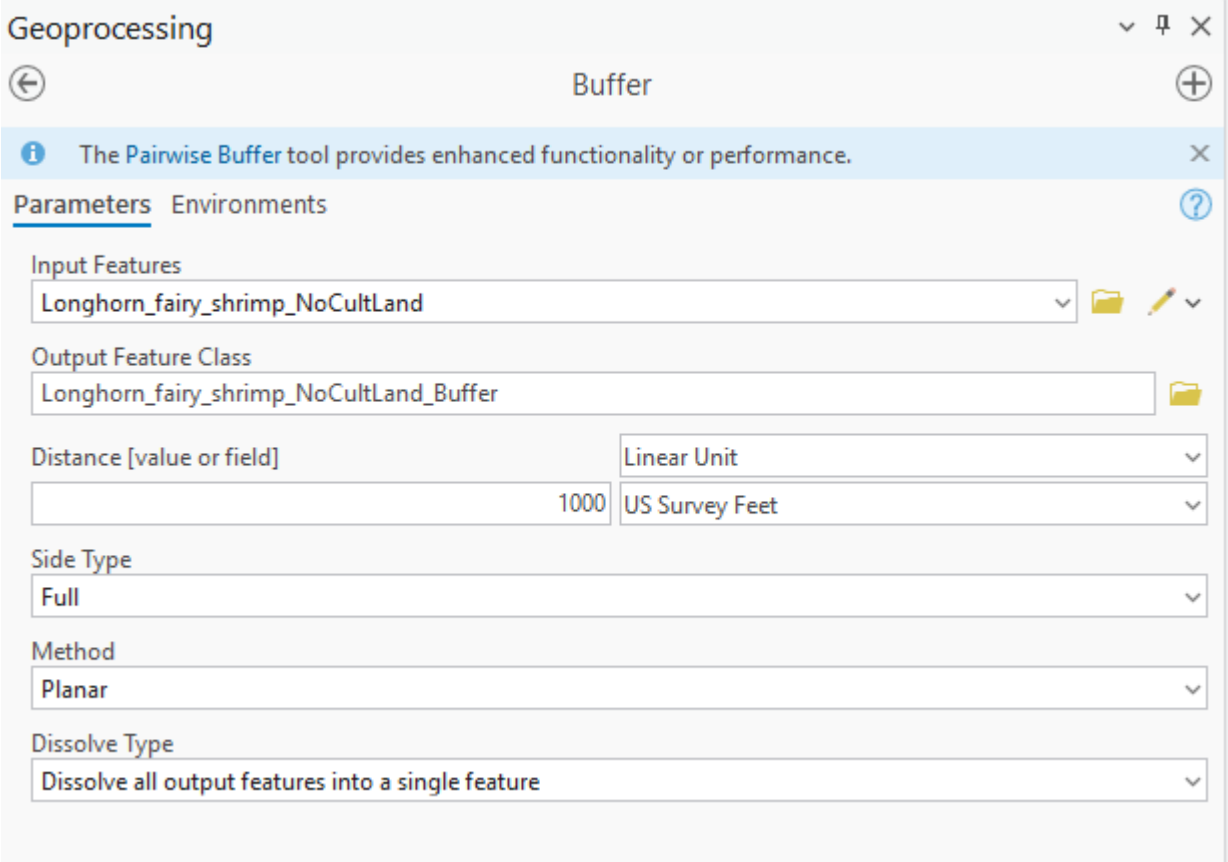

Figure A2-6. Screenshot of "Buffer" tool

2. Use the "Eliminate Polygon Part" tool as step 1 to eliminate polygon parts that are less than 2 acres and more than 1,000 feet away from another polygon. The resulting output is named, "Longhorn_fairy_shrimp_No2Acre". **(Figure A2-7)**

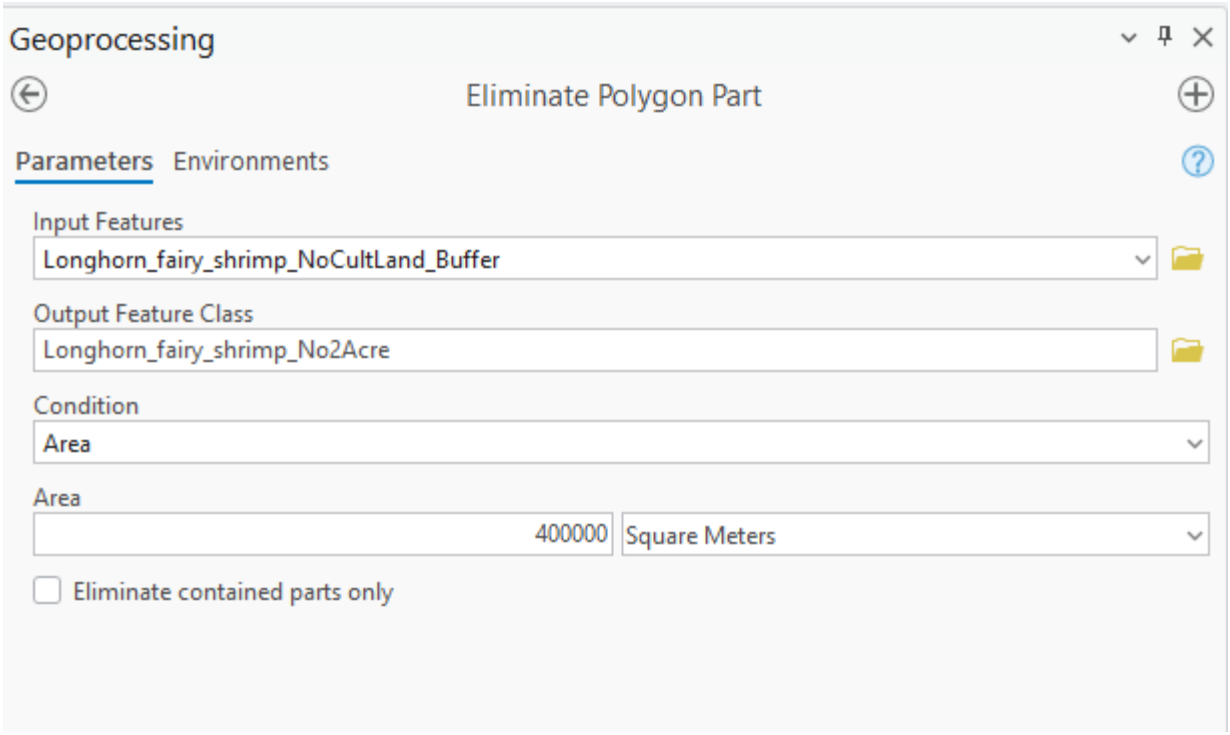

Figure A2-7. Screenshot of "Eliminate Polygon Part" tool

3. Use "Pairwise Clip" tool as step 2 to remove any polygon parts that are less than 2 acres and more than 1,000 feet away from another polygon. The resulting output is named, "Longhorn_fairy_shrimp_Poly_Clip". **(Figure A2-8)**

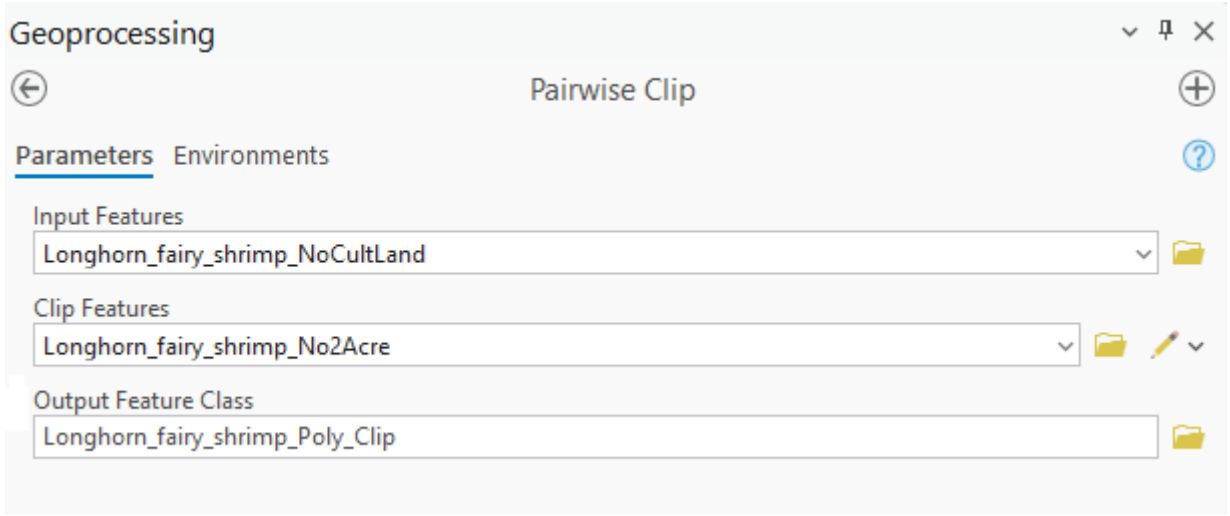

Figure A2-8. Screenshot of "Pairwise Clip" tool.

2.4. Use EPA's QA/QC process to "smooth" by filling in gaps or holes and update attributes

1. Use the "Dissolve" tool to merge polygons from "Longhorn_fairy_shrimp_Poly_Clip" into one polygon. The resulting output is named, "Longhorn_fairy_shrimp_Poly_Dissolve" **(Figure A2-9)**

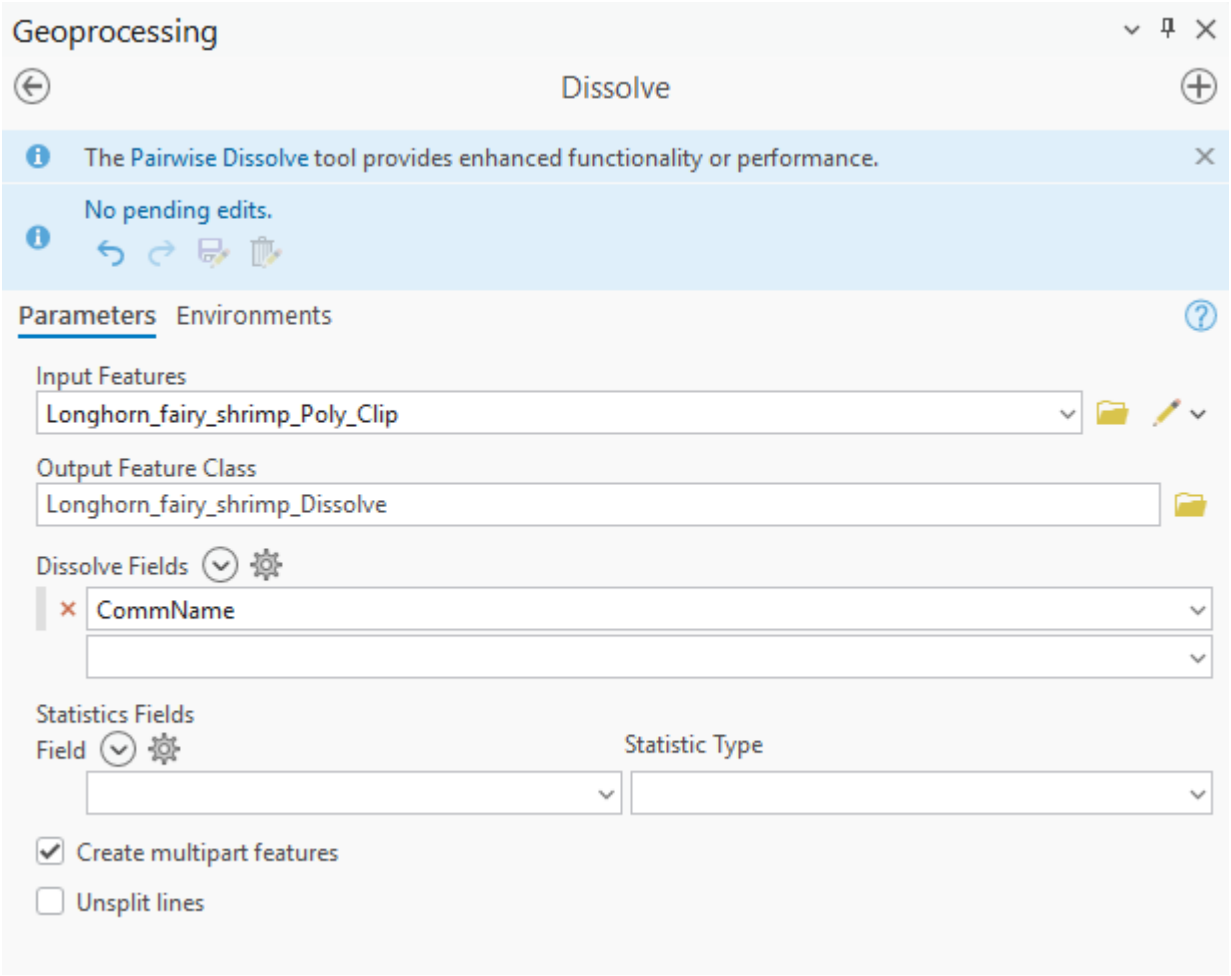

Figure A2-9. Screenshot of "Dissolve" tool

2. Use "Eliminate Polygon Part" tool to fill in gaps and holes less than 25 acres. Resulting output is named, "Longhorn_fairy_shrimp_Poly_smooth". **(Figure A2-10)**

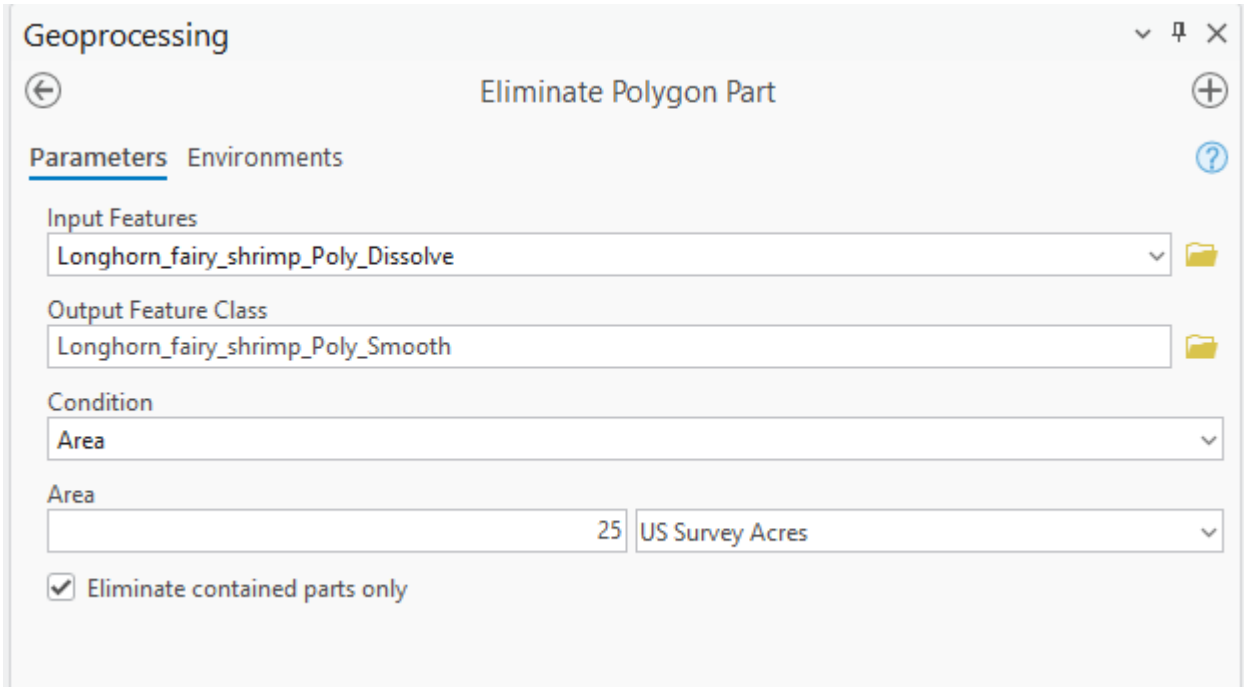

Figure A2-10. Screenshot of "Eliminate Polygon Part" tool

3. Although the "Eliminate Polygon Part" tool did remove internal gaps and holes less than 25 acres, there were narrow strips that are less than 2 meters wide that can be removed by deleting vertices manually. **(Figure A2-11) (Figure A2-12)**

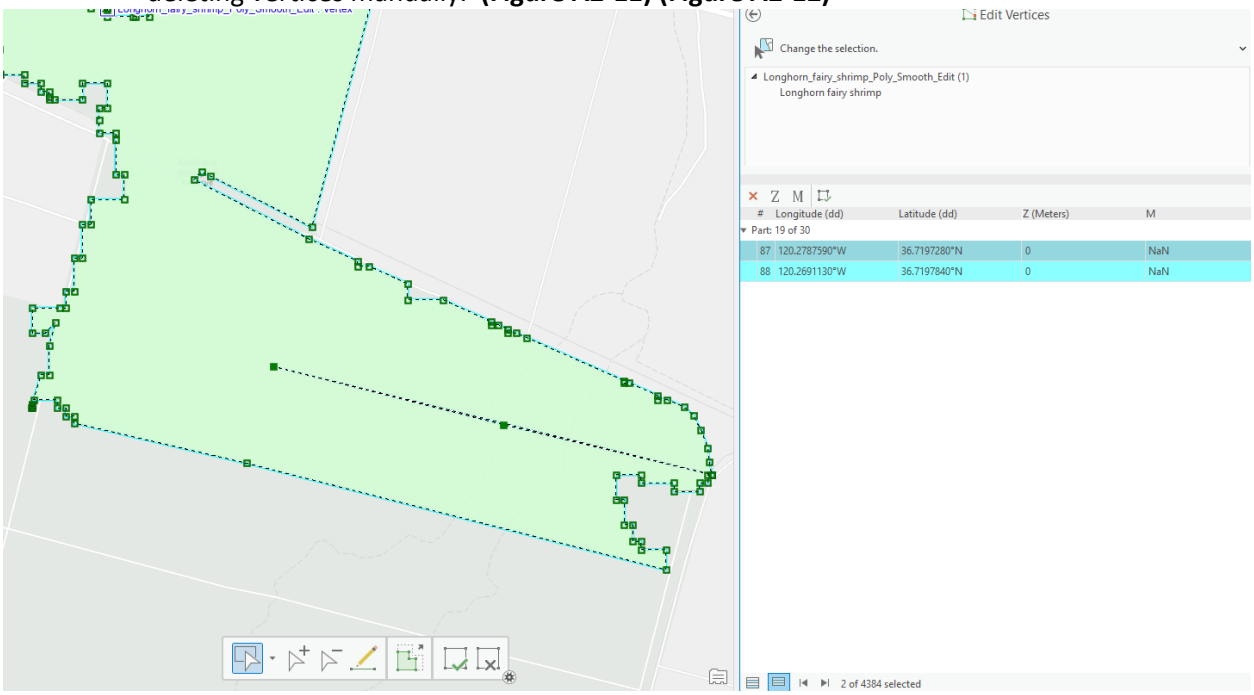

Figure A2-11. Screenshot Example of Selected Vertices to be deleted

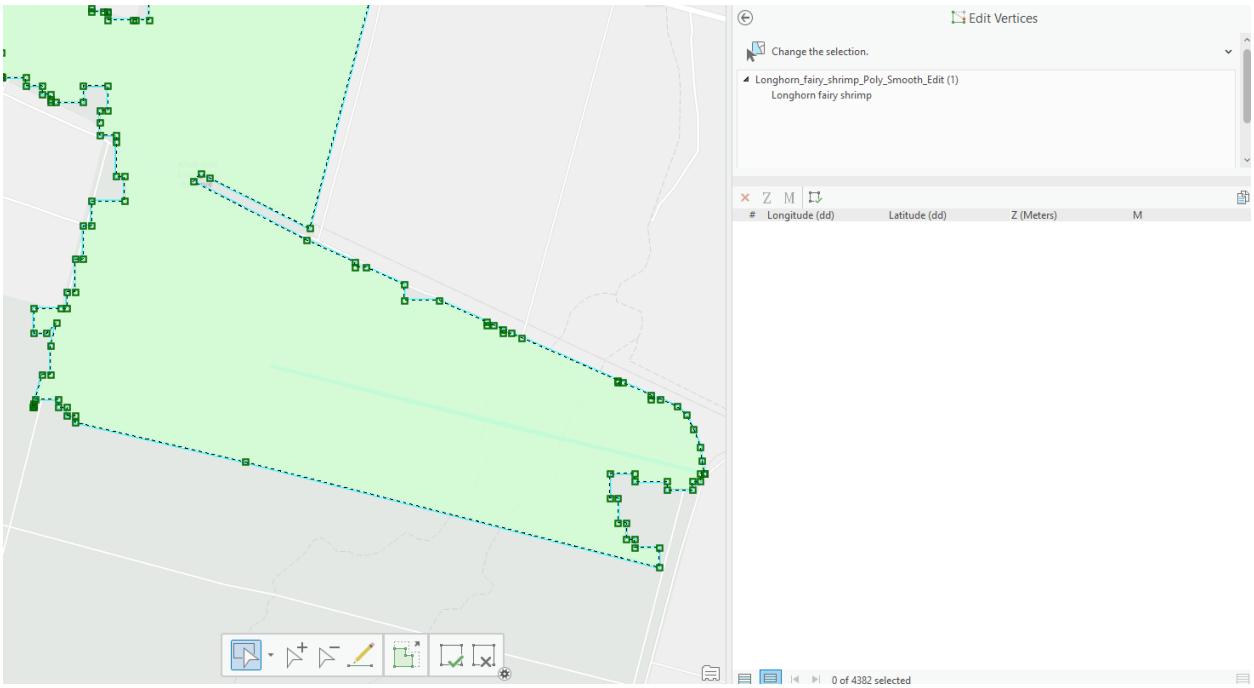

Figure A2-11. Screenshot Example of Selected Vertices after they were deleted

2.5. Update Attributes and "Calculate Geometry"

1. Create a copy of the template EPA polygon shapefile for the longhorn fairy shrimp, named "Longhorn_fairy_shrimp_Poly_Final" (core map shapefile). Copy and paste record from "Longhorn_fairy_shrimp_Poly_smooth" to "Longhorn_fairy_shrimp_Poly_Final".
2. Since there is only one record in "Longhorn fairy shrimp", update each field manually with
   a. CommName = " Longhorn fairy shrimp"
   b. SciName = "Branchinecta longiantenna"
   c. Description = "Area of USFWS Longhorn fairy shrimp (LFS) critical habitat, known LFS locations w/in USGS PADUS, and CDFW Vernal pool hexagons overlapping a CNDDB occurrences outside of critical habitat. All clipped by EPA Cultivated Land."
   d. Category = "Area of occupancy"
   e. EPA_Code = "491"
   f. FWS_Code = " K03E"
   g. CBD_Code = " 1917"
   h. Heritage = "0"
   i. ECOS_WebPg = https://ecos.fws.gov/ecp/species/4294
2. Turned on the "World UTM Grid" layer and identified the UTM zone as "10". Right-clicked on the "Acres" fieldàleft-clicked on "CalculateGeometry". "Calculate Geometry" dialog box appears. Selected "Area" under "Property", "US Survey Acres" in "Area Unit" and "NAD_1983_UTM_Zone_10N" in the Coordinate System" boxes. Click Apply. Click OK. **(Figure A2-12)**

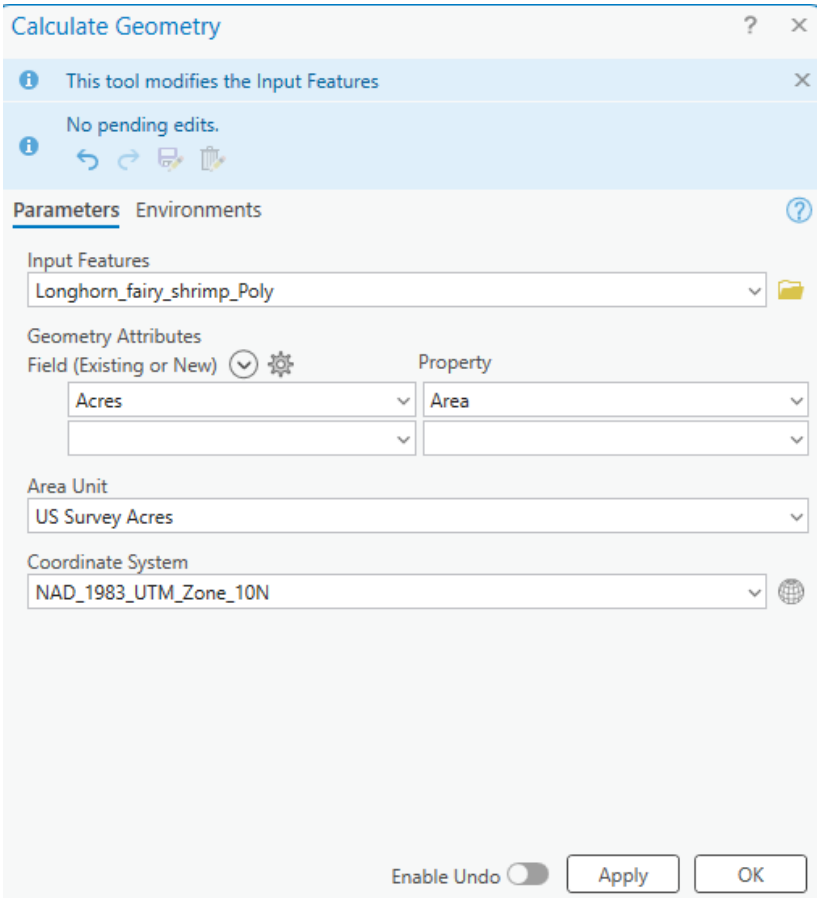

Figure A2-12. Screenshot "Calculate Geometry"

2.6. Use Download USA NLCD Land Cover raster process to determine Percentage of Interim Core Map Represented by NLCD Land Covers

1. Using the MRLC viewer (https://www.mrlc.gov/viewer/) and uploaded a shapefile of area to use as an extent to download the NLCD that covers all the "Longhorn_fairy_shrimp_Poly" records. **(Figure A2-13)** The file was downloaded and added to ArcPro and renamed, "NLCD_LFS_Area.tiff."

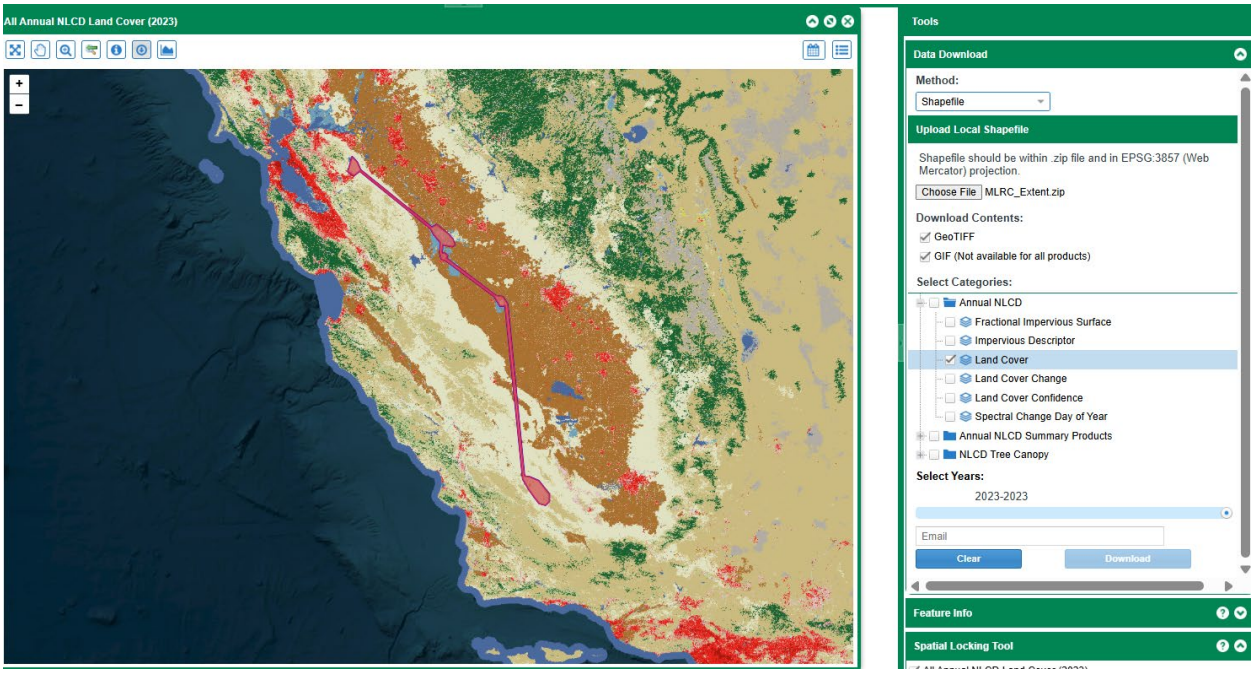

Figure A2-13. Screenshot MLRC Viewer with Shapefile extent

2. The “Extract by Mask” tool was used with “NLCD_LFS_Area.tiff” filtered by the same area within “Longhorn_fairy_shrimp_Poly” as the extent. (Figure A2-61) In the “Environments” tab, changed the output coordinate system to match “Longhorn_fairy_shrimp_Poly”, which in this case is “USA_Contiguous_Albers_Equals_Area_Conic_USGS_version”. The output was named, “NLCD_MaskArea1.” **(Figure A2-14) (Figure A2-15)**

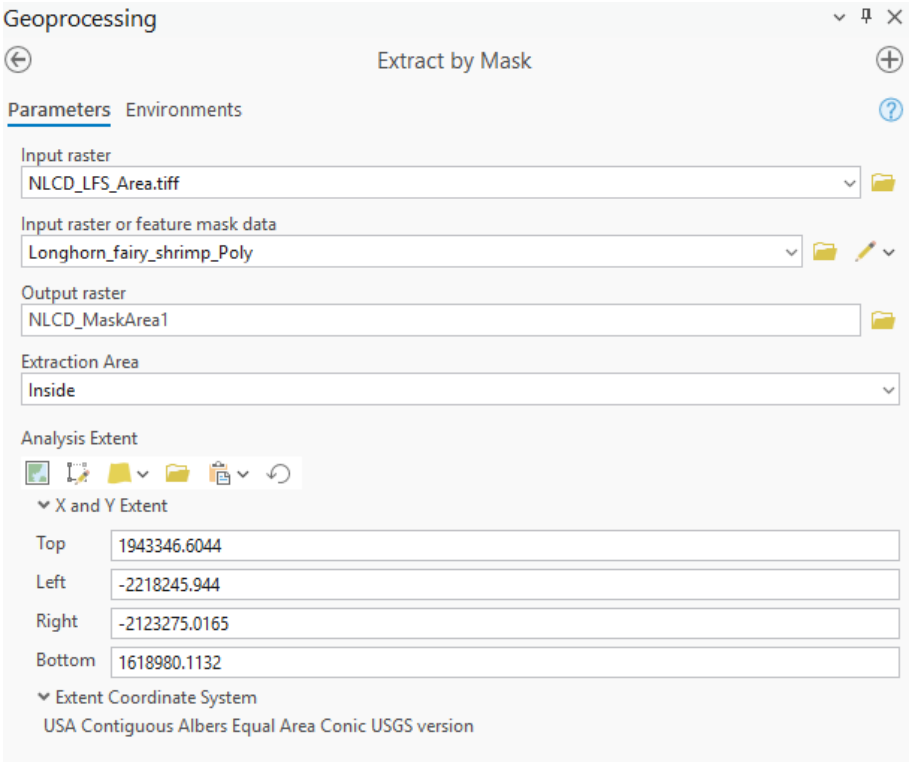

Figure A2-14. Screenshot "Extract by Mask" tool Parameters

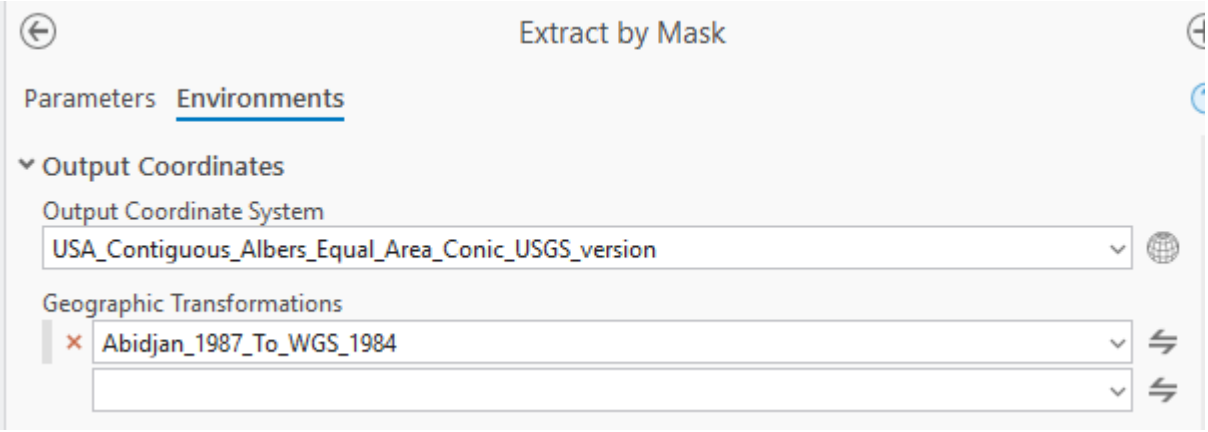

Figure A2-15. Screenshot "Extract by Mask" tool Environment

3. Used the "Tabulate Area" tool to determine the count of area for each NLCD code. **(Figure A2-16)**

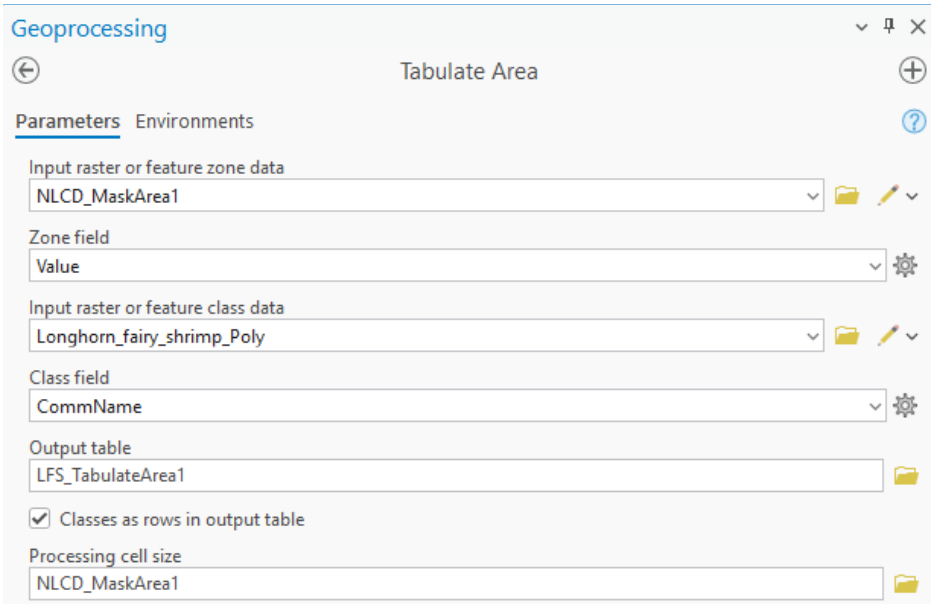

Figure A2-16. Screenshot "Tabulate" tool

4. Add a double field named, "Per" to the "LFS_TabulateArea1" table. Right clicked on field and selected "Calculate Field." Entered the formula "(!Count!/ 254692)*100." This calculated the percentage of NLCD within the core map area. **(Figure A2-17)** Review results and input into (Table 1. Percentage of Interim Core Map Represented by NLCD Land Covers and Associated Example Pesticide Use Sites/Types.)

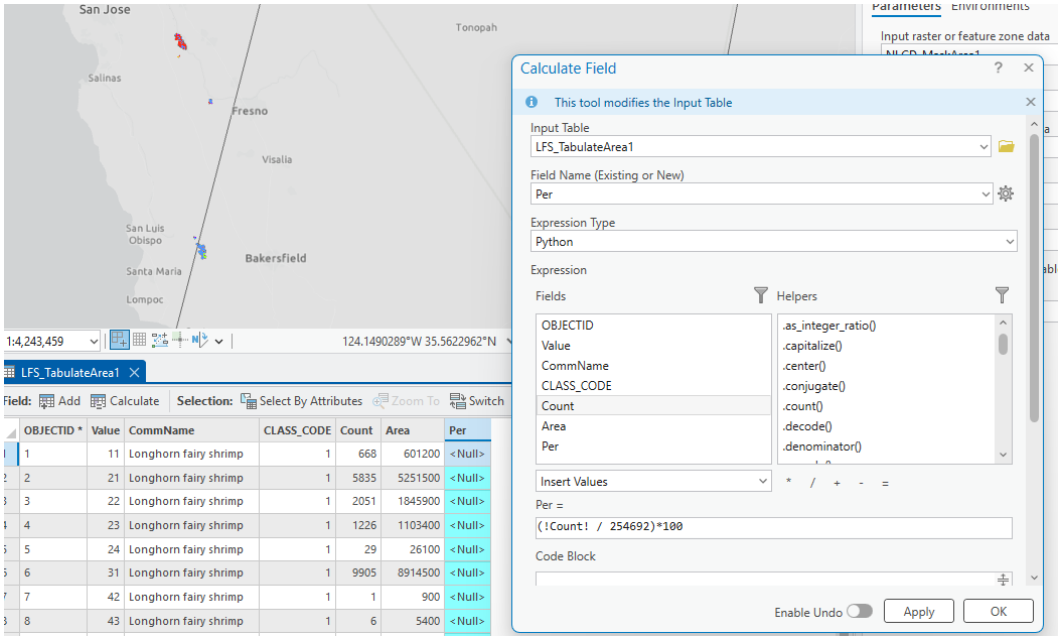

Figure A2-32. Screenshot "Tabulate" tool