Interim Core Map Documentation for the San Diego Fairy Shrimp

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Interim Core Map Developer: U.S. Environmental Protection Agency (EPA), Office of Pesticide Programs

Species Summary

The San Diego fairy shrimp (*Branchinecta sandiegonensis,* Entity ID 495) is an endangered aquatic invertebrate. This species is restricted to vernal pools and other ephemeral basins in coastal Orange and San Diego Counties in southern California and in northwestern Baja California, Mexico. Pesticide use risk for the species is related to insecticide use for mosquito larvae control in or around vernal pools and herbicide use to control weeds outside of vernal pools (*e.g.,* along roads, farms, and residential landscaping) and within vernal pools themselves (*e.g.,* for enhancement/restoration projects). Additional information on the species is provided in **Appendix 1**.

Description of Core Map

The core map for the San Diego fairy shrimp is based on biological information, which includes 1) vernal pools (habitat type) that are within the U.S. Fish and Wildlife Service (FWS)-defined range or intersects with known locations from FWS (if the habitat is outside of the range), and 2) clusters of FWS observations of this species (for 5 areas that were outside of the California Department of Fish and Wildlife (CA FWS)-identified vernal pool areas dataset). The range map and many of the known locations and species range are available from FWS. Vernal pool habitat locations are taken from CA FWS Areas of Conservation Emphasis (ACE) habitat data, version 3.0. The outer extent of this core map is defined by the vernal pool locations from the ACE plus several known locations from FWS found outside of this dataset. Cultivated land was not explicitly removed from the core map because these areas are identified as potential locations for vernal pools. Additional information on the data used is provided in **Appendix 2.**

Figure 1 depicts the resulting interim core map for the San Diego fairy shrimp. The size of this core map is approximately 169,000 acres. Landcover categories within the core map area are included in **Table 1**. Landcover is predominantly scrub/shrub, grassland/herbaceous, emergent herbaceous wetlands and developed areas.

The core map developed for the San Diego fairy shrimp is considered interim. This core map will be used to develop pesticide use limitation areas (PULAs) that include the San Diego fairy shrimp. 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 a "average" best professional judgment classification to describe major uncertainties/limitations. The map is based on habitat type and known locations described by FWS, iNaturalist and the Global Biodiversity Information Facility (GBIF). This core map does not replace or revise any range or designated critical habitat developed by FWS for this species.

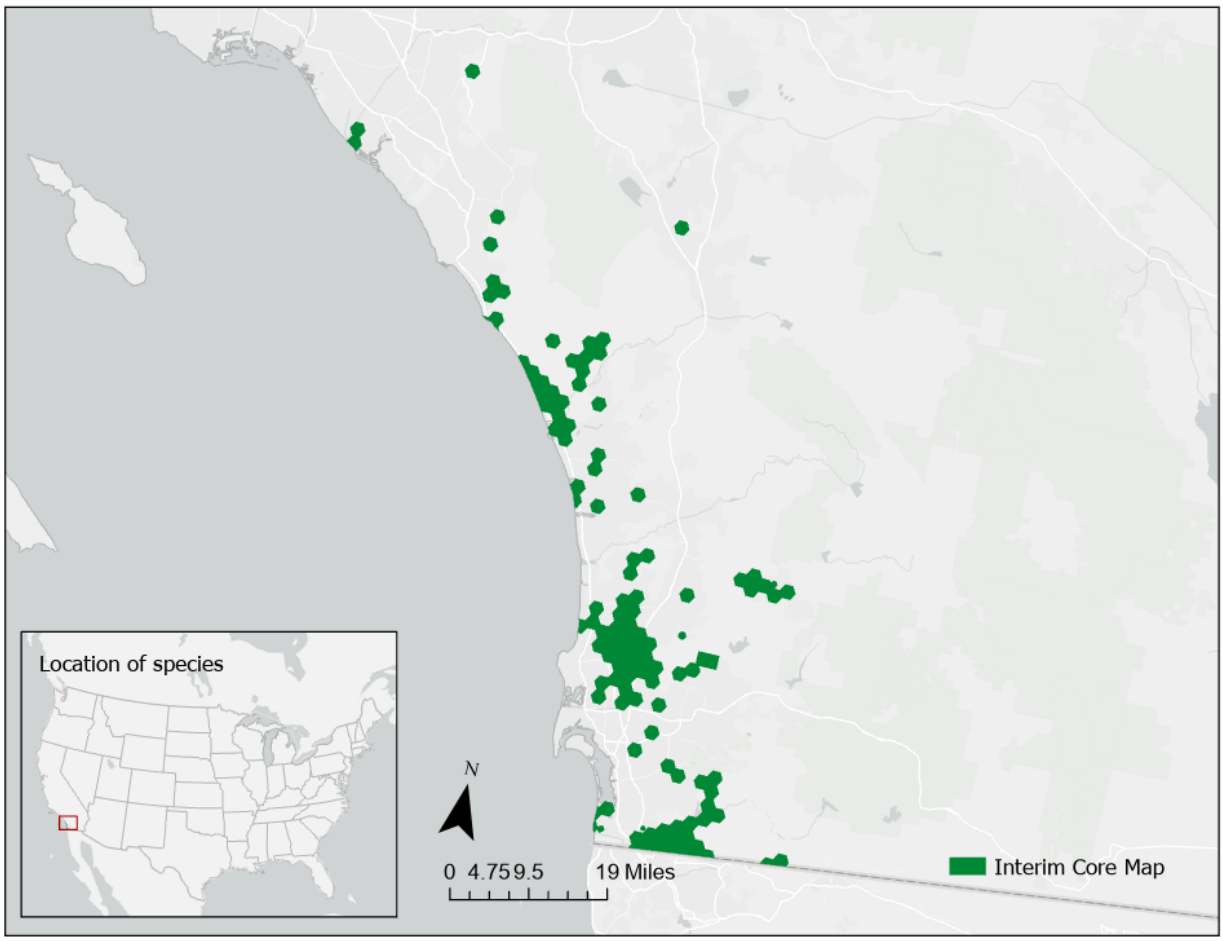


Figure 1. Interim core map for the San Diego fairy shrimp.

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 Class/Value	% Area	Total area for landcover type
Forestry	Deciduous Forest (41)	0	0
Forestry	Evergreen Forest (42)	0	0
Forestry	Mixed Forest (43)	0	0
Agriculture	Pasture/Hay (81)	0	0
Agriculture	Cultivated Crops (82)	0	0
Mosquito adulticide, residential	Open space, developed (21)	8	43
Mosquito adulticide, residential	Developed, Low intensity (22)	9	43
Mosquito adulticide, residential	Developed, Medium intensity (23)	18	43
Mosquito adulticide, residential	Developed, High intensity (24)	8	43
Invasive species control	Woody Wetlands (90)	2	74
Invasive species control	Emergent Herbaceous Wetlands (95)	18	74
Invasive species control	Open water (11)	2	74
Invasive species control	Grassland/herbaceous (71)	18	74
Invasive species control	Scrub/shrub (52)	34	74
Invasive species control	Barren land (rock/sand/clay; 31)	0	74
Total Acres	**Interim Core Map Acres**	**~169,000**	

Evaluation of Known Location Information

There are five datasets with known location information:

- Descriptions of locations provided by FWS documents;
- Occurrence locations from FWS Ecological Services Program (Carlsbad Fish and Wildlife Office);
- Occurrence locations in iNaturalist;
- Occurrence locations in NatureServe; and
- Occurrence locations in GBIF.

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

EPA evaluated these five sets of data before selecting the type of and developing the core map. The Carlsbad Fish and Wildlife Office is part of the FWS Ecological Services Program. This dataset had the largest number of San Diego fairy shrimp observations. However, this dataset did not include all known locations found in Figure 1 of the 2021 5-Year Review. The FWS Ecological Service Program, iNaturalist, and GBIF datasets were robust and used to create the core map. NatureServe data was evaluated but not included in the core map because locations were already accounted from other sources. **Appendix 1** includes more information on the available known location information.

Approach Used to Create Core Map

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

For step 1, EPA compiled available information for the San Diego fairy shrimp from FWS, as well as observation information available from various publicly available sources (including FWS, iNaturalist, NatureServe and GBIF). The information compiled for San Diego fairy shrimp is included in **Appendix 1**. Influential information that impacted the development of the core map included:

- This species is restricted to vernal pools and other ephemeral basins in coastal Orange and San Diego Counties in southern California and in northwestern Baja California, Mexico.
- Known location data for this species is robust.

For step 2, EPA used the compiled information to identify the core map type, including the species range, critical habitat, and known location information. The species range seems to follow an unknown and unspecified geopolitical boundary (i.e., county). Given this, the range is not limited to the areas containing required habitat of the species (vernal pools). The range is also much larger than the areas where species occurrences have been documented. The species critical habitat was designated in 2007 and may not account for more recent known locations of the species. Datasets from FWS, iNaturalist, and GBIF are robust and contain current known locations of the species, found outside both the current range and current critical habitat. Based on this information, the core map is a biological information core map since the species is restricted to vernal pools and known location data are robust.

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 the CA FWS Areas of Conservation Emphasis (ACE) habitats dataset to identify (1) vernal pools within the FWS-defined range or intersect with known locations (if the habitat is outside of the range), and 2) clusters of FWS observations of this species (for 5 areas that were outside of the CA FWS-identified vernal pool areas). **Appendix 2** provides more details on the GIS analysis and data used to generate the core map.

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

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

Alternative approaches and data not discussed in this documentation were not considered in the development of this interim core map.

Appendix 1. Information compiled for the San Diego fairy shrimp during Step 1

1. **Recent FWS documents/links and other data sources**
    - Final Rule on Designation of Critical Habitat (2007) (https://www.govinfo.gov/content/pkg/FR-2007-12-12/pdf/07-5972.pdf#page=1)
    - Recovery Plan (1998) (https://ecos.fws.gov/docs/recovery_plan/980903a.pdf)
    - 5-Year Review (2008) (https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/1299.pdf)
    - 5-Year Review (2021) (https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/3503.pdf)
    - Range and Critical Habitat https://ecos.fws.gov/ecp/species/6945
    - FWS Ecological Services Program (Carlsbad Fish and Wildlife Office): (https://www.fws.gov/office/carlsbad-fish-and-wildlife/library; https://www.fws.gov/media/gis-species-occurrence-data-updated-august-2024
    - iNaturalist (https://services9.arcgis.com/RHVPKKiFTONKtxq3/arcgis/rest/services/iNat_PreUC_View/FeatureServer; https://epa.maps.arcgis.com/home/item.html?id=99e3e9ccfaec422db6d4266569aa19d7)
    - Global Biodiversity Information Facility (GBIF) (https://www.gbif.org/species/2235356)
    - NatureServe
    - California Department of Fish and Wildlife's Areas of Conservation Emphasis (ACE) (https://gis.data.ca.gov/datasets/CDFW::vernal-pools-ace-ds2732-1/about)
    - Vernal Pools, Areas of Conservation Emphasis (ACE), version 3.0, last updated on 7/29/2024.

2. **Background information**
    - **Status:** Federally listed as endangered in 1997
    - **Resiliency, redundancy, and representation** (the 3Rs)
        - While there is no Species Status Assessment (SSA) available, the overall distribution of vernal pool complexes known to be occupied by the San Diego fairy shrimp has increased since listing from an estimated 25 occupied complexes to approximately 137 known today. The additional occurrences increase the potential for conservation and recovery of San Diego fairy shrimp as these additional occurrences contribute to the resilience of this species via population redundancy; i.e., more populations are known to be available to contribute to sustaining the species in the event some populations are extirpated (5-Year Review, 2008)
    - **Habitat**
        - Generally restricted to vernal pools and other ephemeral (lasting a short time) basins in coastal Orange and San Diego Counties in southern California and in northwestern Baja California, Mexico (Habitat Designation).
        - The San Diego fairy shrimp occur in groups of vernal pools referred to as vernal pool complexes. Vernal pools generally include between 5 and 50 vernal pools, although some can have as little as 2 pools and others can have several hundred pools (Habitat Designation).

    - The San Diego fairy shrimp is a habitat specialist found in shallower pools that range in depth from 2 to 12 inches (Habitat Designation).
    - San Diego fairy shrimp are restricted to dilute vernal pools, having relatively low sodium concentrations (below 60 millimoles per liter), low alkalinity (below 1000 milligrams per liter), and neutral pH (near 7) (5-Year Review 2008).
- **Diet:** San Diego fairy shrimp feed on algae, diatoms, and particulate organic matter (5-Year Review, 2008)

- **Taxonomy**
    - Aquatic Invertebrate
    - FWS Category: Crustacean

- **Relevant Pesticide Use Sites**
    - Pesticide use was identified in the listing rule as a threat to San Diego fairy shrimp in the Fairview complex in Orange County (insecticide use) and generally (herbicide use) (5-Year Review 2008).
    - Herbicides are commonly used to control weeds outside of vernal pools (e.g., along roads, farms, and residential landscaping) and within vernal pools themselves (e.g., for enhancement/restoration projects) (5-Year Review, 2008)
    - Pesticide applications for mosquito larvae control have become increasingly common to combat West Nile Virus (5-Year Review, 2008)

- **Recovery Criteria/Objectives**
    - The Recovery Plan for the San Diego fairy shrimp proposes a two-fold strategy to recover multiple vernal pool species: 1) stabilization of the populations through procurement and management of habitat; and 2) reclassification of the species through restoration and enhancement, including recolonization and expansion of existing populations (5-Year Review, 2008).
    - Recovery Criteria/Objectives
        - Existing vernal pools and their associated watersheds contained within the complexes must be secured from further loss and degradation in a configuration that maintains habitat function and species viability to maintain genetic diversity and population stability of the listed species.
        - Existing vernal pools and their associated watersheds contained within the complexes must be secured in a configuration that maintains habitat function and species viability before reclassification the species to threatened status may be considered.
        - Secured vernal pools must be enhanced or restored such that population levels of existing species are stabilized or increased.
        - Population trends must be shown to be stable or increasing for a minimum of 10 consecutive years prior to consideration for reclassification.
- **Recovery**
    - Work with internal and external partners to address the threat of hybridization and competition with *Branchinecta lindahli* based on current research.
    - Support the continued work by researchers to designate local management units for SDFS based on population genetics, especially for conservation activities featuring the movement of soil and restoration of vernal pools

- Complete a thorough review of all remaining occupied habitat, including status (e.g., conserved, restored, managed, monitored, impacted, illegally impacted) and management needs (e.g., conservation, restoration, management, monitoring) categories for all SDFS habitat complexes, including locations in Baja California.
- Develop protocols for quantitative estimates of adult and cyst abundance, as feasible, and define ranges within which 1) cyst banks would be considered adequately populated and 2) adult numbers reflect a healthy population.
- Work with partners to explore the feasibility of using eDNA for wet season sampling instead of dip-netting and update the Survey Guidelines for the Listed Large Branchiopods as appropriate.

3. **Description of Species Range**
    - Updated March 27, 2018
    - Generally limited to vernal pools in Orange County, San Diego County, and in northwestern Baja California, Mexico
    - A total of 877 occupied locations were identified prior to 2008. It is difficult to characterize the status of each location because most have not been revisited before and after the last review. After 2008, only 397 locations were surveyed, many of which were included in the original 877 locations (5-Year Review, 2021).
        - However, it's believed that majority of the locations are extant or presumed extant and that the number of locations where the San Diego fairy shrimp is known to occur within the historical range of the species has increased since the last review (5-Year Review 2021).
    - In 2017, this species was also detected at the Clayton Ranch mitigation site in Riverside County (5-Year Review 2021).
    - **Figure A1-1** depicts the current FWS species range (last updated 2021). The species range is 629,268 acres.

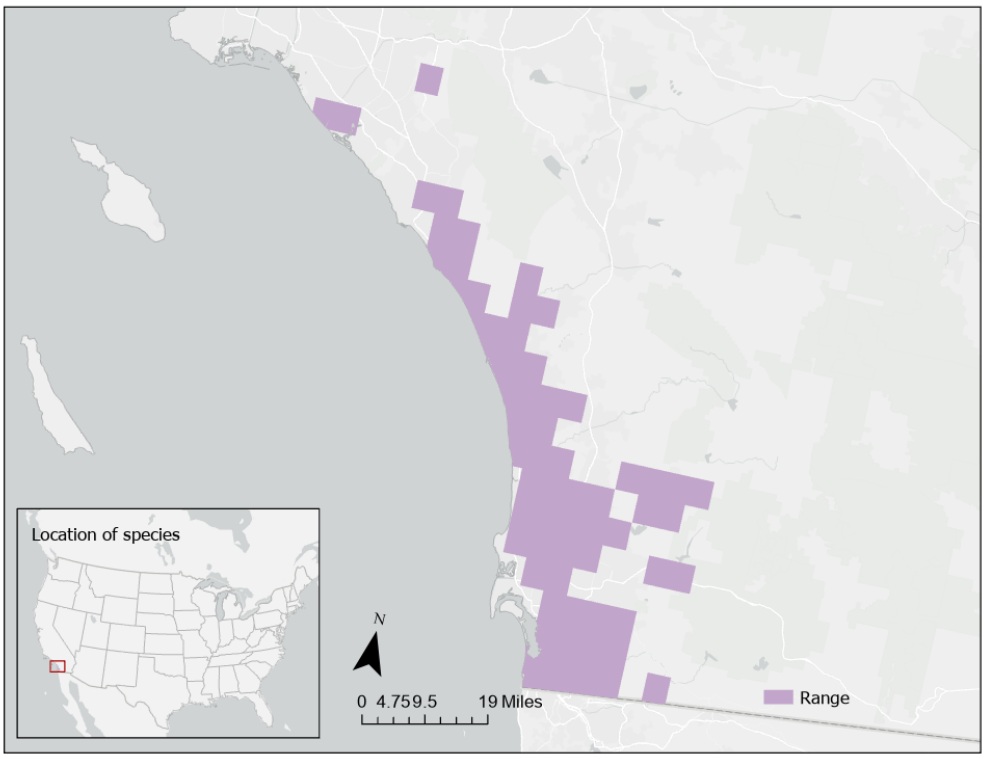


Figure A1-1. FWS range for San Diego fairy shrimp. Total acreage of range is around 629,628 acres.

4. **Critical Habitat**
    - Approximately 3,000 acres (1,250 hectares) of habitat in Orange and San Diego counties, California are being designated as critical habitat for the San Diego fairy shrimp
    - Physical or biological features (Habitat Designation)
        - Primary constituent elements (PCE) determined for the San Diego fairy shrimp:
            - Vernal pools with shallow to moderate depths (2 in (5 cm) to 12 in (30 cm)) that hold water for sufficient lengths of time (7 to 60 days) necessary for incubation, maturation, and reproduction of the San Diego fairy shrimp, in all but the driest years.
            - Topographic features characterized by mounds and swales and depressions within a matrix of surrounding uplands that result in complexes of continuously, or intermittently, flowing surface water in the swales connecting the pools described in the above PCE, providing for dispersal and promoting hydroperiods of adequate length in the pools (i.e., the vernal pool watershed).
            - Flat to gently sloping topography, and any soil type with a clay component and/or an impermeable surface or subsurface layer known to support vernal pool habitat (including Carlsbad, Chesterton, Diablo, Huerhuero, Linne, Olivenhain, Placentia, Redding, and Stockpen soils
    - **Figure A1-2** depicts the current critical habitat.

Figure A1-2. FWS critical habitat of San Diego fairy shrimp. Range also included for reference.

5. **Known Locations**
    - **Known Locations Described in FWS 5-Year Review Documents**
        - Occurrences identified at listing in 1997 and since listing (5-Year Review, 2008)
            - Orange County, California
            - San Diego County, California
            - Marine Corps Base (MCB) Camp Pendleton
            - San Marcos
            - Carlsbad
            - Ramona
            - Santa Fe Valley
            - Del Mar Mesa, Lopez Ridge, and Mira Mesa
            - Santee
            - Mission Trails Regional Park
            - Kearny Mesa
            - Chollas Heights
            - Sweetwater Reservoir
            - Marron Valley
            - Otay Mesa
            - Tijuana Slough National Wildlife Refuge
            - Imperial Beach
            - Baja California, Mexico
        - In 2017, this species was also detected at the Clayton Ranch mitigation site in Riverside County. This was the first detection of San Diego fairy shrimp east of the coastal range in southern California. It was confirmed again in 2020 (5-Year Review 2021).

- In the 2021 5-Year Review, the following are listed as known locations for the San Diego fairy shrimp:
    - Riverside County
    - Los Angeles Basin-Orange
    - San Diego North Coastal Mesas
    - San Diego Central Coastal Mesas
    - San Diego Inland Valleys
    - San Diego Southern Coastal Mesas
- **Figure A1-3** depicts the distribution of San Diego fairy shrimp throughout the range of the species (5-Year Review, 2021).

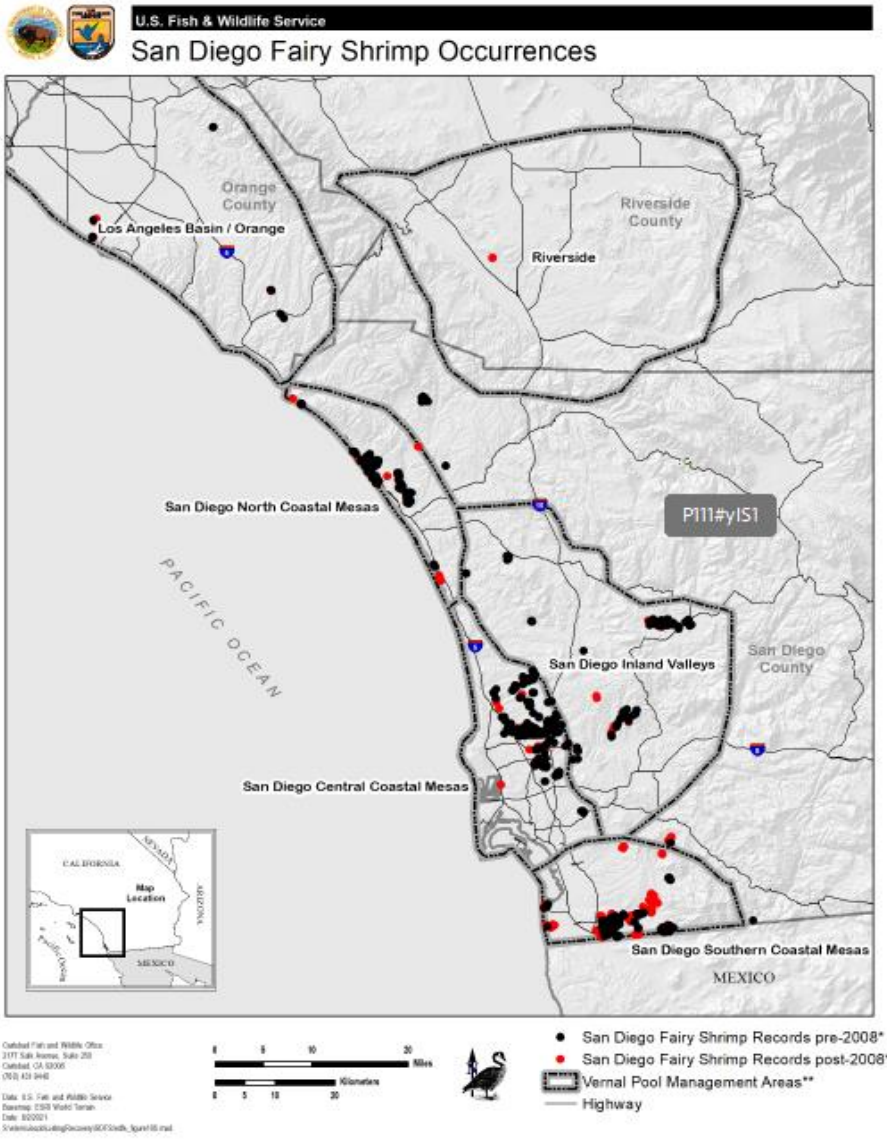


Figure 1. Distribution of San Diego fairy shrimp throughout the range of the species

Figure A1-3. Distribution of San Diego fairy shrimp throughout the range of the species. Reproduced from the FWS 5-Year Review (2021).

- **Occurrences Included in Public Databases**
    - EPA queried FWS Ecological Services Program, iNaturalist, GBIF, and NatureServe Across the three datasets, 62 observations fell outside of the species required habitat or species range. More weight was given to FWS observations since the data is more robust and FWS is considered the species experts.
    - FWS Ecological Services Program (Carlsbad Fish and Wildlife Office) (linked here) included 1,273 observations for this species. Observations outside of the species required habitat or range were included in the final core map. This dataset was last update in December of 2024.
    - iNaturalist (available here) included 16 research grade observations for this species. Observations outside of the species required habitat or range were not included in the final core map, this is likely due to the precision of the data point.
    - GBIF (available here) included 13 geo-references observations all of which were duplicates from iNaturalist. Occurrences from NatureServe were also noted but did not include coordinates. Additional geo-references observations classified as a preserved specimen or material sample were not included because these occurrences may not represent the location where the sample was collected.
    - NatureServe (linked here) occurrences were consistent with other occurrence data sources no additions were made to the core map based on this sources.

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

This core map was created based on biological information, including species habitat and species known locations.

1. **Dataset References and Software**

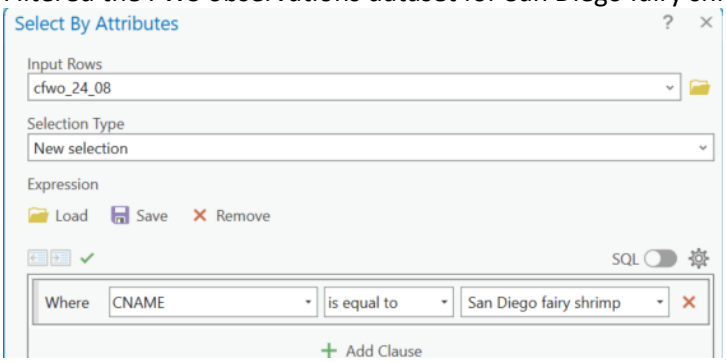
   - California Department of Fish and Wildlife's ACE
     - Vernal Pools, Areas of Conservation Emphasis (ACE), version 3.0, last updated on July 29, 2024.
   - FWS Ecological Services Program (Carlsbad Fish and Wildlife Office)
     - Available for download here, last updated in December 2024
   - iNaturalist
   - GBIF
   - FWS Species Range – last updated on March 27, 2018
   - Software used: ArcGIS Pro 3.2

2. **Datasets Used in Core Map Development**
   - All datasets used in core map development are described in EPA's process document, including the California ACE dataset.

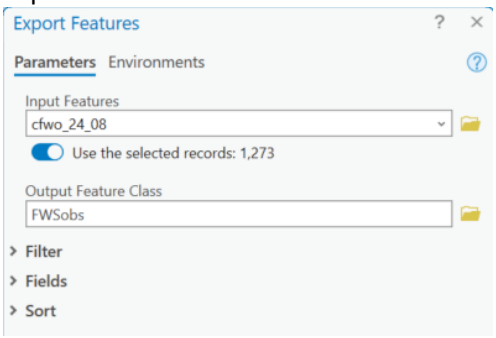
3. **Core Map Development**

   The core map for the San Diego Fairy Shrimp is based on 1) vernal pools (habitat type) that are within the FWS-defined range or intersect with known locations from FWS (if the habitat is outside of the range), and 2) clusters of FWS observations of this species (for 5 areas that were outside of the CA FWS-identified vernal pool areas).

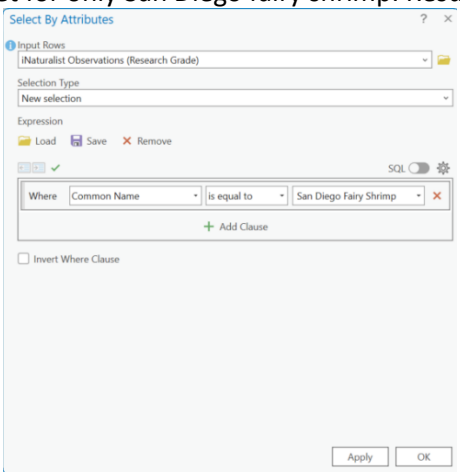
1. Add the range, critical habitat, vernal pool habitats, iNaturalist observations, and FWS observations to the map.
2. Filtered the FWS observations dataset for San Diego fairy shrimp only. Resulted in 1,273 records.



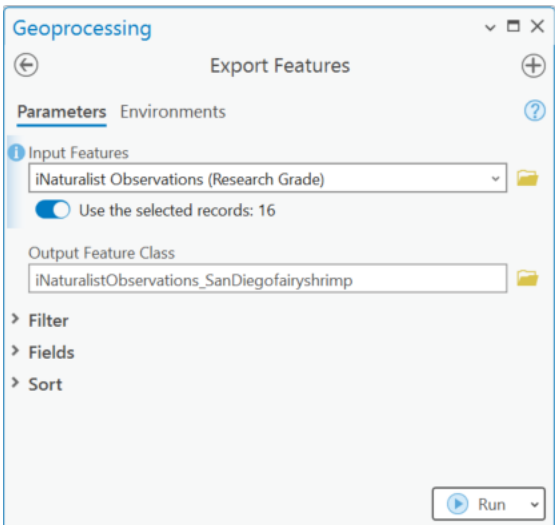
   - Exported these observations to create a new layer called “FWSobs”.



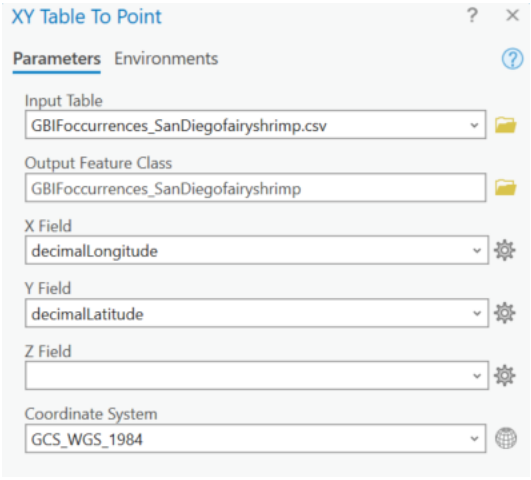
3. Filtered the iNaturalist dataset for only San Diego fairy shrimp. Resulted in 16 records.



   - Exported these observations to create a new layer called “iNaturalistObservations_SanDiegofairyshrimp”.

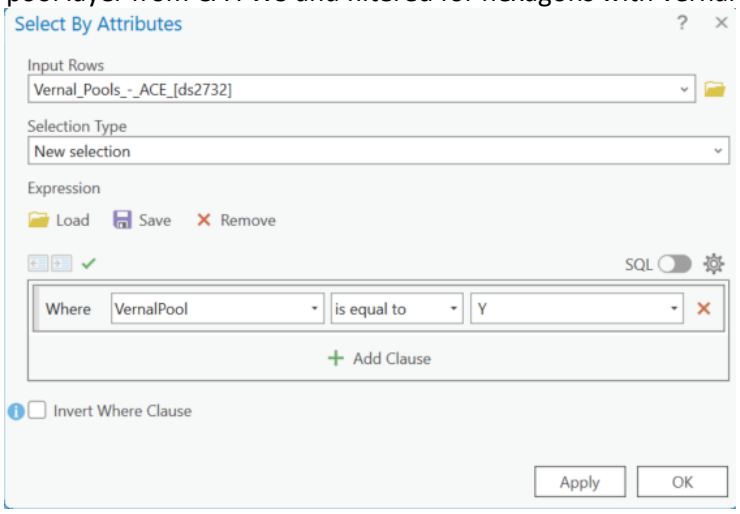


4. Added the GBIF observations as a table to the map and created point data from this observation information.

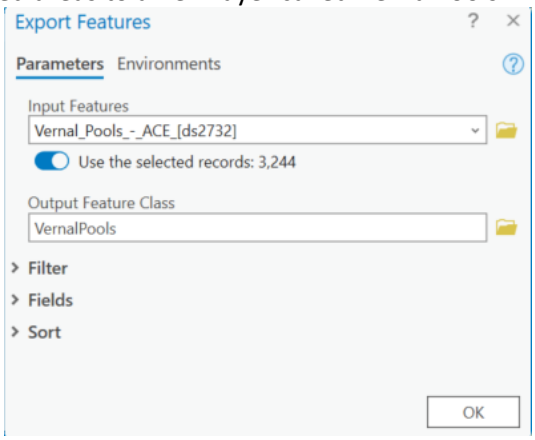


   - Overall result for the GBIF data with 293 points, but most are for preserved specimens or material samples. Of the 293 occurrences 193, did not have coordinates and did not result in points on the map. The points from iNaturalist were also found in the GBIF dataset.

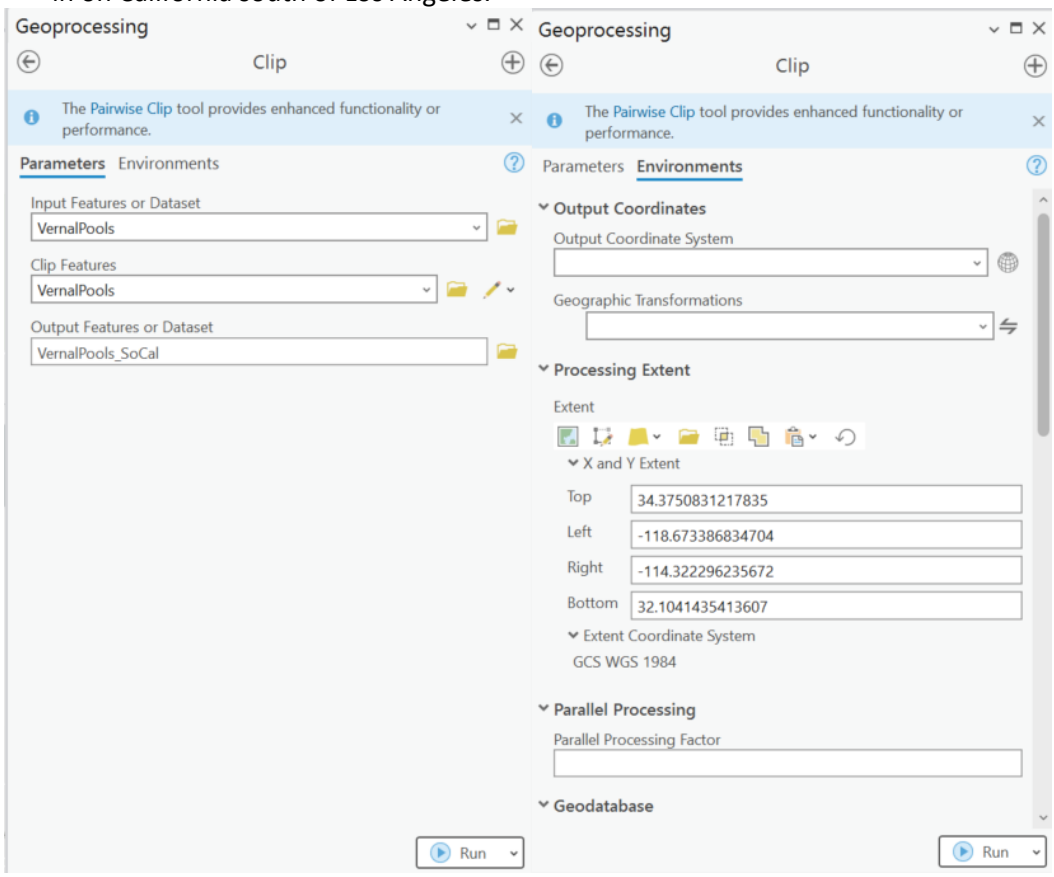
5. Added the vernal pool layer from CA FWS and filtered for hexagons with vernal pools



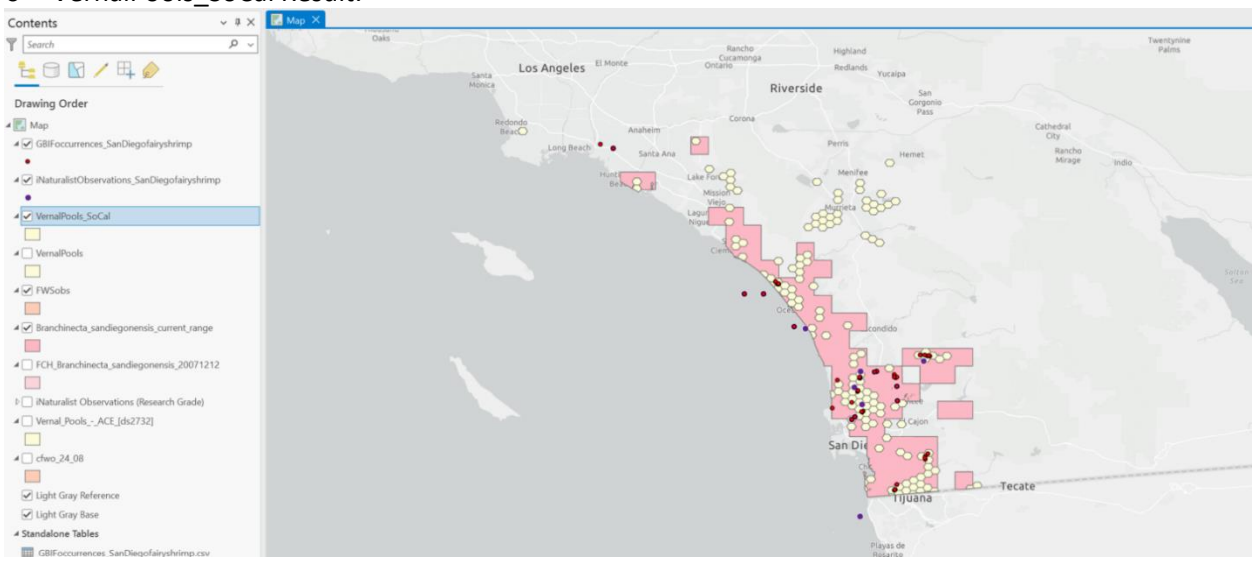
   - Exported these selected areas to a new layer called VernalPools



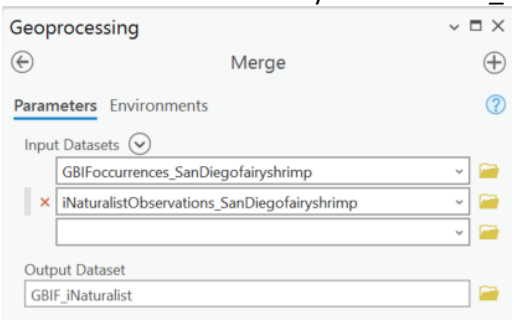
- Clipped the VernalPools layer to focus on Southern CA (i.e., south of Los Angeles) where this species exists. Set the processing extent to the current display, which was zoomed in on California south of Los Angeles.



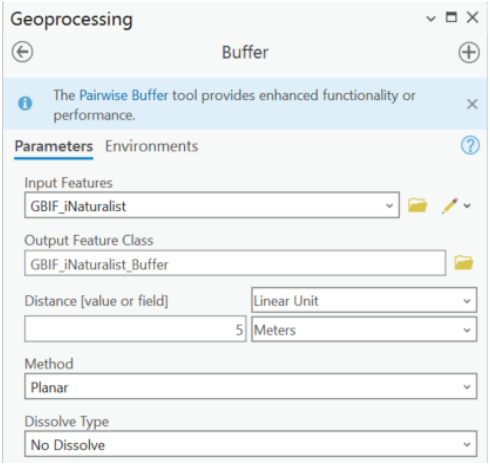
- VernalPools_SoCal Result:



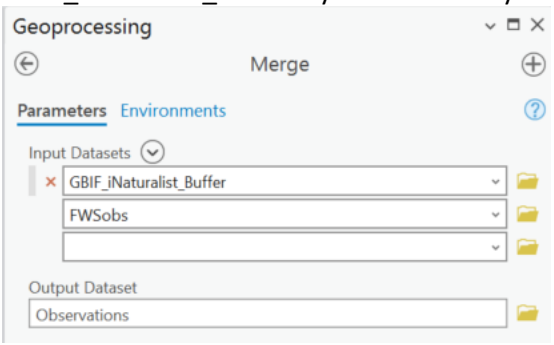
6. Merged GBIF and iNaturalist observations into one layer called GBIF_iNaturalist



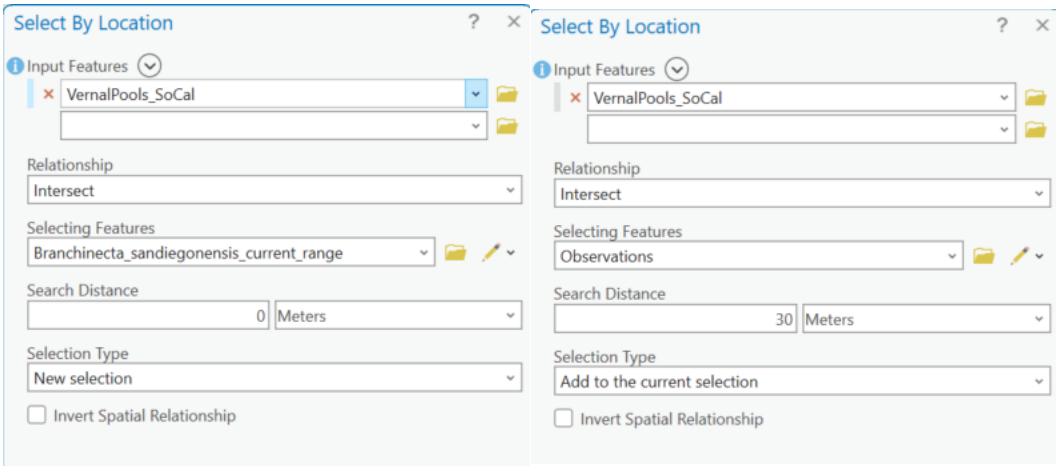
   - Added a minimal buffer to the merged observation data in GBIF_iNaturalist in order to facilitate merging these point data with the FWSObs polygons



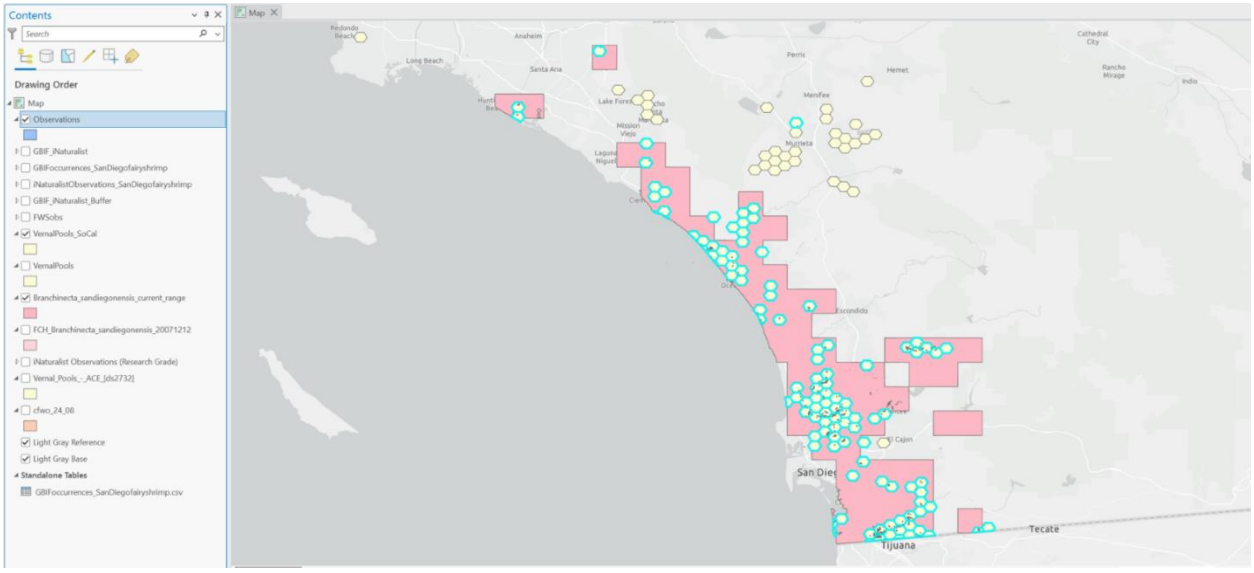
7. Merged the FWSObs and GBIF_iNaturalist_Buffer layers into one layer called Observations



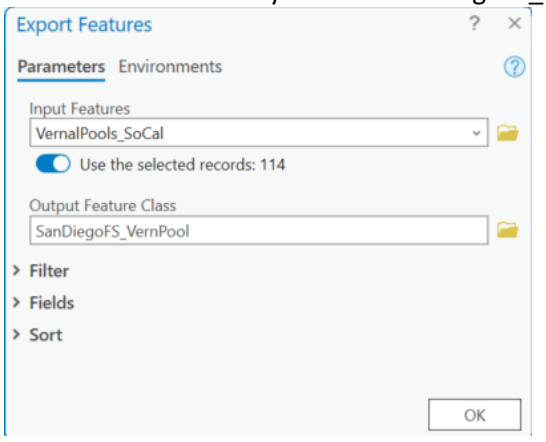
8. Selected all vernal pools (in VernalPools_SoCal layer) within the range of the species and then additionally selected all vernal pools within 100 m of an observation (in Observations layer). The purpose of this was to identify vernal pool habitat areas that are within the range or near where the species has been observed.



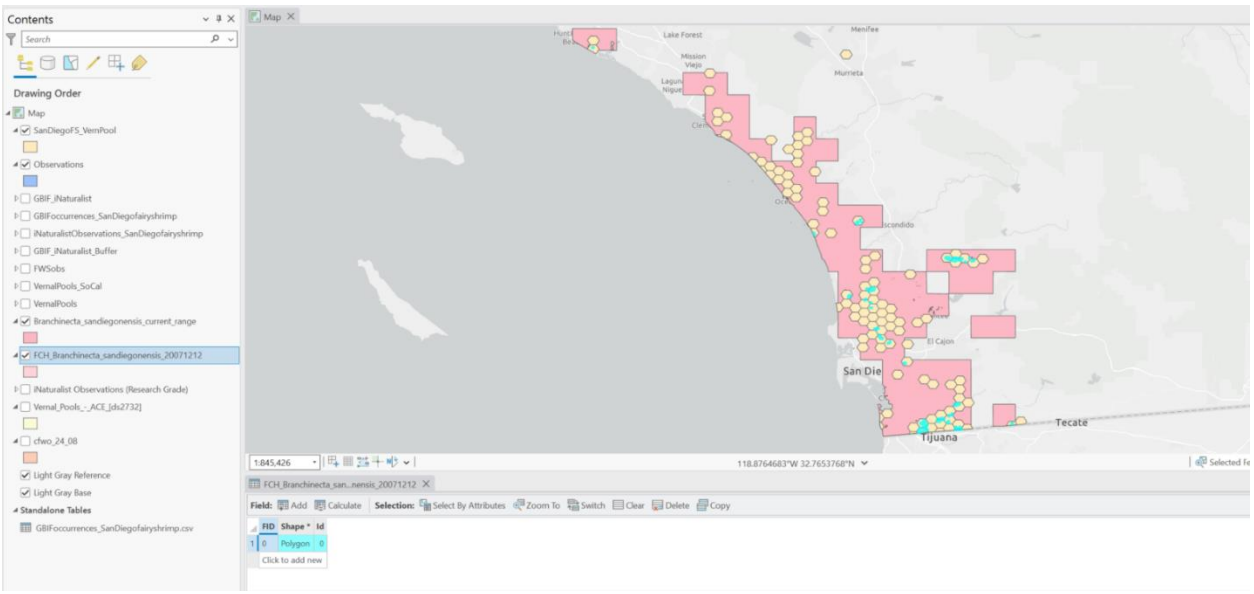
- Result:



- Exported the selected features to create a layer called SanDiegoFS_VernPool:

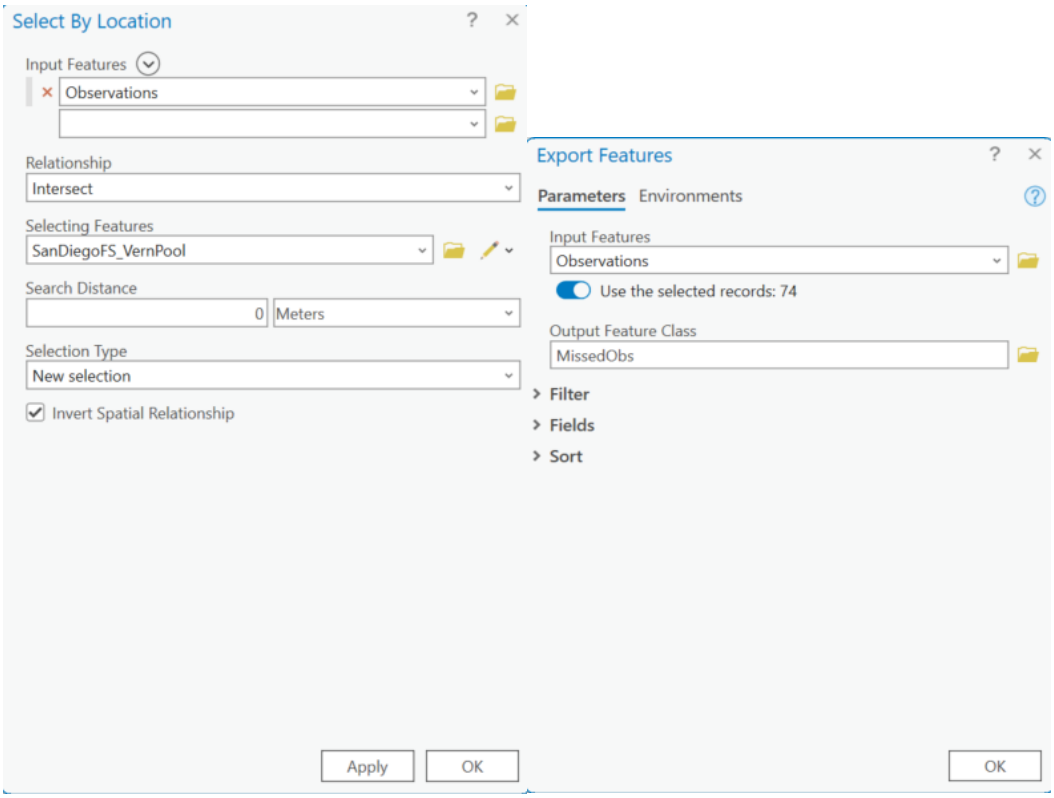


9. Verified that the entire designated critical habitat (highlighted polygons) is within SanDiegoFS_VernPool:

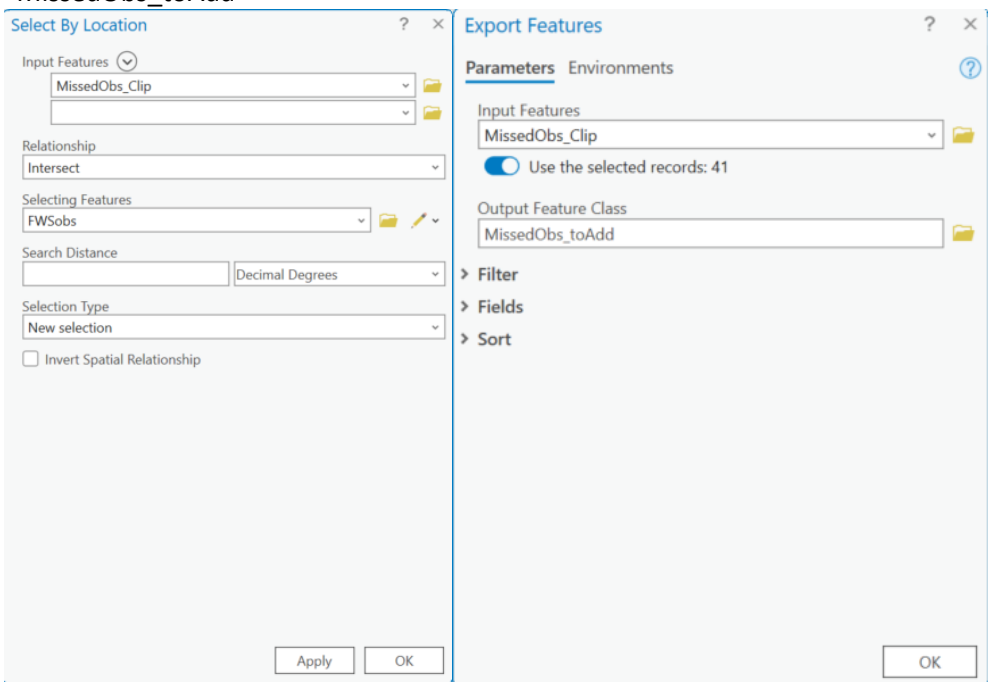


- Therefore, the areas within the designated critical habitat are already covered and do not need to be added to the SanDiegoFS_VernPool layer.

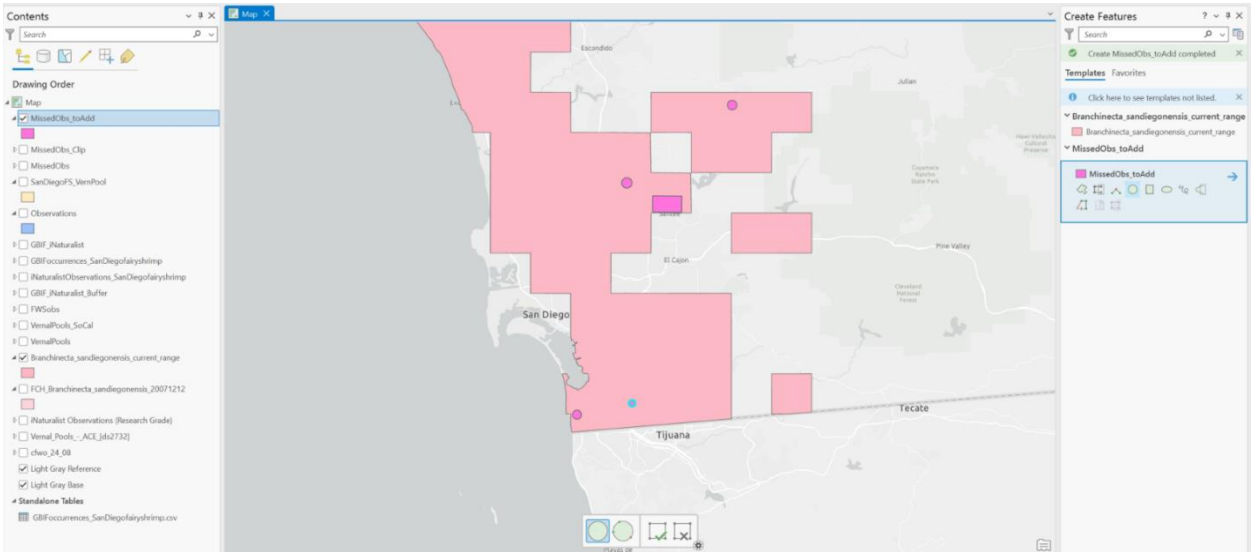
10. Lastly, identified any observation data not within the SanDiegoFS_VernPool layer's polygons using Select by Location and then exported these areas to a layer called "MissedObs". These areas are not identified as vernal pools in the ACE dataset.



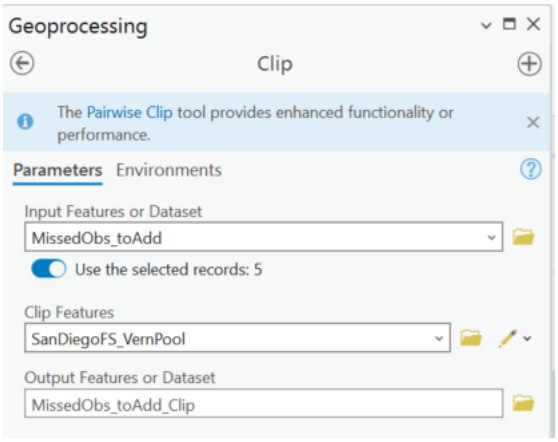
- Of these missed observations 41 were from FWS and therefore were added to SanDiegoFS_VernPool layer using the following steps.
- Therefore, these observations (n=41) were selected and exported to a layer called "MissedObs_toAdd"



11. Zoomed to these small clusters of observations and drew new polygons to cover these areas



12. Selected the five newly drawn polygons and removed areas and removed areas that overlap with the SanDiegoFS_VernPool layer using clip and erase.



- Result:

13. Finally, merged these 5 new polygons in MissedObs_toAdd_Clip_Erase with SanDiegoFS_VernPool to create a new layer San Diego Fairy Shrimp core map. Core map name: SanDiegoFS_CoreMap