Interim Core Map Documentation for the San Francisco garter snake

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

Species Summary

The San Francisco garter snake (*Thamnophis sirtalis tetrataenia,* Entity ID 152) is an endangered reptile. The U.S. Fish and Wildlife Service (FWS) has not designated a critical habitat for the San Francisco garter snake. This species occurs across the San Francisco peninsula and requires both shallow freshwater habitat and contiguous uplands, meadows, or riparian habitat. Both habitats (aquatic and terrestrial) are necessary for the species, along with a corridor to travel between the habitats. It feeds primarily on California red-legged frogs (*Rana draytonii*) and Sierran treefrogs (*Pseudacris sierra*; also Sierran chorus frog).

Description of Core Map

The core map for the San Francisco garter snake is based on biological information.

Figure 1 depicts the resulting interim core map for the San Francisco garter snake. The size of this core map is approximately 122,647 acres. Landcover categories within the core map area are included in **Table 1**. Landcover is predominantly evergreen and mixed forests, shrub/scrub, grassland/herbaceous, and developed open space. Since this species occurs in forests, uplands, and meadows, many of these areas potentially represent habitat. The hexagonal units in the map reflect California's Department of Fish and Wildlife's (CDFW) Areas of Conservation Emphasis (ACE) database[1] and are used at a scale to protect California Natural Diversity Database (CNDDB) known locations.

The core map developed for the San Francisco garter snake is considered interim. This core map will be used to develop pesticide use limitation areas (PULAs) that include the San Francisco garter snake. This core map incorporates information developed by FWS and made available to the public; however, the core map has not been formally reviewed by FWS. This interim core map may be revised in the future to incorporate species expert feedback from FWS. This interim core map has an "average" (3) best professional judgment classification to describe major uncertainties/limitations. The map is based on known locations described by FWS, with known locations from CNDDB added via CDFW ACE hexagons. This core map does not replace or revise any range or designated critical habitat developed by FWS for this species.

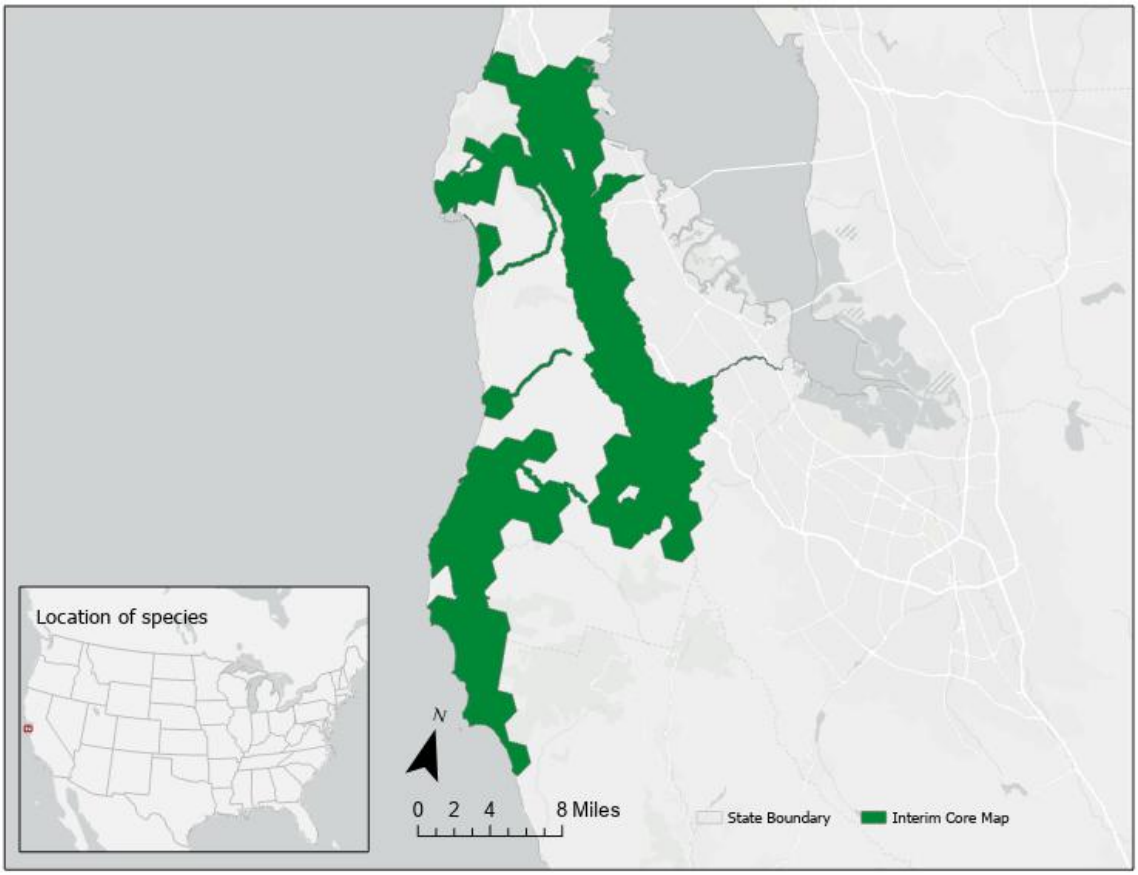

Figure 1. Interim core map for the San Francisco garter snake (122,647 acres).

Table 1. Percentage of Interim Core Map Represented by National Land Cover Database (NLCD) 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)	22%
Forestry	Mixed Forest (43)	28%
Agriculture	Pasture/Hay (81)	0%
Agriculture	Cultivated Crops (82)	1%
Mosquito adulticide, residential	Developed Open Space (21)	10%
Mosquito adulticide, residential	Developed Low Intensity (22)	5%
Mosquito adulticide, residential	Developed Medium Intensity (23)	4%
Mosquito adulticide, residential	Developed High Intensity (24)	2%
Invasive species control	Woody Wetlands (90)	1%
Invasive species control	Emergent Herbaceous Wetlands (95)	0%
Invasive species control	Open Water (11)	2%
Invasive species control	Grassland/Herbaceous (71)	10%
Invasive species control	Shrub/Scrub (52)	14%
Invasive species control	Barren Land (31)	0%
Total Acres	**Interim Core Map Acres**	**122,647 acres**

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 iNaturalist
- Occurrence locations included in Global Biodiversity Information Facility (GBIF)
- Occurrence locations included in NatureServe
- Occurrence locations included in California Natural Diversity Database

EPA evaluated these sets of data before selecting the type of and developing the core map. CNDBB appeared to have the finest resolution of the location information. Occurrences described by iNaturalist, GBIF, and NatureServe were consistent with those discussed in FWS documentation and seen in CNDDB. **Appendix 1** includes more information on the available known location.

- EPA queried iNaturalist, GBIF, NatureServe, and CNDDB. Collectively, the occurrence data are consistent with the FWS location data used to identify the core map.
- iNaturalist (available here) had 319 research grade observations available from 2002 to 2025 for this species. Location data for these observations are consistent with the core map given the positional accuracy of the information.
- GBIF (available here) included 72 additional occurrences and human observations. Location data for these observations are consistent with the core map given the positional accuracy of the information.

- NatureServe (available here) element occurrences were consistent with other databases.

Occurrences in iNaturalist, GBIF, and NatureServe did not support expanding the core map outside of the FWS range. **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[3]" (referred to as "the process"). This core map was developed by EPA using the four steps described in the process document:

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

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

- The FWS range extends farther north and south than documented populations of the species.
- The locations of the extant populations encompass a smaller footprint than the FWS species range.

For step 2, EPA used the compiled information to identify the core map type. EPA compared known location data to the range and found that these known locations are consistent with the species range but encompass a smaller footprint than the range. The entire range of the species was not used as the core map because the range contains areas where the species does not occur. Thus, EPA selected the locations of the described populations from FWS combined with locations from CNDDB in **Appendix 1** as the species core map. To protect the species, CNDDB known locations that were not encompassed by a description in FWS (i.e., Golden Gate National Park) were obscured using the California's Department of Fish and Wildlife's (CDFW) Areas of Conservation Emphasis (ACE) hexagons.

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, locations described in FWS documents, and CDFW's ACE hexagons 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.

Appendix 1. Information Compiled for Species

1. **Recent FWS Documents**

2020 Species Status Assessment
2020 5-year review
2006 5-year review
1985 Recovery plan

2. **Background information on Species**

- **Status:** Federally listed as endangered in 1967
- **Taxonomy**: Reptile
- **Resiliency**
  - "Population complex resiliency varied somewhat across three potential future scenarios. For several, there were reductions in habitat condition based on projected impacts from saltwater inundation, which has the potential to affect at least four population complexes. There were also potential extirpations in two population complexes in all scenarios. In the most optimistic scenario there were increases or maintenance of resiliency in some population complexes because of anticipated headstarting and population augmentation." (Species Status Assessment 2020, p. 70)
  - "The presence of red-legged frogs (the preferred food for females of this size) is important for population resiliency. Treefrogs are important prey sources for neonates and juveniles, thus are important for recruitment into the population. Although freshwater habitat used by San Francisco garter snakes can include a variety of waterbodies including sag ponds, creeks, marshes, canals, and other water sources, resilient populations require impounded freshwater with appropriate aquatic vegetation." (Species Status Assessment 2020, p. 22)
- **Redundancy**
  - "The continued presence of population complexes at both the northern and southern edge of the species' range with either high or moderate habitat and demographic conditions, in combination with the distribution of these populations, suggest that the species has the potential to retain redundancy… It is unlikely that a catastrophic event would extirpate the species under any of the scenarios." (Species Status Assessment 2020, p. 71)
- **Representation**
  - "The San Francisco garter snake will likely maintain its current level of genetic diversity into the future since the species is projected to continue to have population complexes distributed across both the northern and southern genetic clusters under all three scenarios, although some of these population complexes may have reduced resiliency. The species is likely to maintain its genetic diversity but may have reduced ecological diversity in the future." (Species Status Assessment 2020, p. 71)
- **Habitat Description**
  - San Francisco garter snakes are often found in or adjacent to aquatic habitats in association with a terrestrial niche, requiring both shallow freshwater habitat and contiguous uplands, meadows, or riparian habitat and have been found in meadowlands up to 2 km (6,562 feet) from marshland. Habitat diversity has been positively correlated with occupancy across multiple years at trap arrays, particularly for those located near water. (Species Status Assessment 2020, p. 15)
  - Aquatic habitat, including sag ponds, creeks, marshes, canals, and other water sources, is used for foraging and basking, with requirements related to water depth, inundation period, salinity, and associated vegetation. Water was the primary factor correlated with San

Francisco garter snake presence at a site, with optimal aquatic habitat having a shallow inshore zone and maintaining an average depth of 0.5 m (1.5 feet) throughout the year. The species tends to avoid aquatic habitat with steeply sloped banks. Even artificial aquatic habitats (e.g., reservoirs) can attract San Francisco garter snakes within a year of development of the habitat and they are also thought to use less ideal waterbodies, such as irrigation ditches, for foraging. Freshwater is important, as salinity can limit presence of the snake's amphibian prey and can influence the growth and/or composition of aquatic vegetation. (Species Status Assessment 2020, p. 15)

- Vegetative cover, including emergent vegetation and floating aquatic vegetation, is important for feeding and basking. Dense cover around or within the freshwater site is also essential for snakes to retreat to when disturbed. Aquatic vegetation often consists of a wide band around a pond edge or dense reed-shrub cover throughout a marsh, but the species will also use aquatic habitat with sparser emergent vegetation if sufficient cover occurs adjacent to the water. Along streams, riparian vegetation often overhangs the edge of habitat including extending upland away from the stream edge, with snakes selecting areas with no clearance between the water and overhanging vegetation. Movements between aquatic habitats sometimes involve a shift between ephemeral and permanent water sources, with San Francisco garter snakes shifting resource use to ephemeral marshes during the spring. (Species Status Assessment 2020, p. 15)
- "Only one population in a genetic analysis occurred at high elevation (~550 m), and this site is genetically differentiated from other populations in the southern cluster. Other than this site, there is limited information about the species' potential distribution at higher elevations." (Species Status Assessment 2020, p. 24)
- "Hibernacula sites are typically open meadowlands with rodent burrows within 1.2 km (3,937 feet) of aquatic foraging habitat." (Species Status Assessment 2020, p. 16)

- **Relevant Life History Information**
  - "San Francisco garter snakes are ovoviviparous (fertilized eggs develop within the female and the embryo gains no nutritional substances from the female)." (Species Status Assessment 2020, p. 13)
  - "The minimum size at sexual maturity for females is 368 mm and most observed gravid females are at least 2 years old. Although there is little information on reproductive frequency of the San Francisco garter snake, data on other common garter snake subspecies suggest that most females probably reproduce each year." (Species Status Assessment 2020, p. 14)
  - "The mating season for the San Francisco garter snake extends from February into May, and resumes briefly in the fall. Females give birth in the summer after a gestation period of 2 to 3 months". (Species Status Assessment 2020, p. 14)
- **Ecology**
  - "The San Francisco garter snake uses terrestrial habitat that is contiguous to aquatic habitat to regulate its body temperature (thermoregulate), estivate, find cover, forage, mate, and hibernate. San Francisco garter snakes bask in grasslands, at rodent burrow entrances, on trails, in and under vegetation, in or adjacent to water, and on pond banks. Grasslands with scattered shrubs provide the best terrestrial habitat, and habitat complexity or heterogeneity is associated with San Francisco garter snake habitat use." (Species Status Assessment 2020, p. 16)
  - "San Francisco garter snakes use both visual and chemical cues to forage, feeding primarily on California red-legged frogs (*Rana draytonii*) and Sierran treefrogs (*Pseudacris sierra*; also Sierran chorus frog). Other prey taken to a lesser degree include western/California toad

(*Anaxyrus boreas halophilus*), slender salamander (*Batrachoseps attenuatus*), small fish, newts, annelids, and even rodents" (Species Status Assessment 2020, p. 17)
    - There is currently no data on connectivity or dispersal between population sites. However, the maximum distance moved between captures by 95 percent of individuals at five sites was less than 200 m. (Species Status Assessment 2020, p. 18)
    - "Individual San Francisco garter snakes must be able to move freely between aquatic habitat and upland habitat. In areas with both permanent and ephemeral water sources, movement corridors between these habitat patches are essential for the snake…At one site, most recaptures occurred within 167 m (550 feet) of the original capture, although one female moved up to 671 m (2,200 feet) and a male moved 632 m (2,075 feet)" (Species Status Assessment 2020, p. 21)
- **Taxonomy**
    - It is a subspecies of the common garter snake (*Thamnophis sirtalis*) and is taxonomically defined as *Thamnophis sirtalis tetrataenia*. (Species Status Assessment 2020, p. 3)
- **Relevant Pesticide Use Sites**
    - None are mentioned
- **Threats**
    - "Current or potential future threats to the San Francisco garter snake include: fragmentation and urbanization; changes to aquatic habitat, including saltwater intrusion, drought, and water management activities; seral succession; illegal collection; predation by non-native invasive bullfrogs and fish; disease, specifically the emerging threat of Snake Fungal Disease; small population size; and climate change." (5-year review 2020, p. 2)
- **Relevant Recovery Criteria and Actions (Source: 1985 Recovery Plan)**
    - Downlisting criteria include:
        - Protect and maintain a minimum of 10 populations, each containing 200 adult snakes (50:50 sex ratio) for at least 5 consecutive years for 6 of the 10 populations.
    - De-listing criteria include:
        - Population levels at all 10 locations maintained for 15 consecutive years.
    - Recovery actions include:
        - Use legal authorities to protect the snake and its habitat.
        - Protect the six known colonies through appropriate management.
        - Protect/establish at least four additional populations.
        - Assess population trends and make modifications in management plans if necessary.
        - Identify additional recovery needs for the species and modify prime objective/management plans accordingly.
        - Educate the public about the threats and status of the San Francisco garter snake.

3. Description of Species Range

- The current geographic range encompasses 618,317 acres.
- **Figure A1-1** depicts the current FWS species range map (last updated 03/21/2018).

Figure A1-1. Map of the FWS San Francisco garter snake range (618,317 acres).

4. Critical Habitat

There is no critical habitat for this species.

5. Known Locations

- **Occurrences Described in FWS Documents**
  - "The San Francisco garter snake is endemic to the San Francisco peninsula. The historical range extended from approximately the San Francisco-San Mateo County line south along the base of the Santa Cruz Mountains into northern Santa Cruz County." (Species Status Assessment 2020, p. 7)
  - Populations as identified by Barry (1978), the Recovery Plan (Service 1985), and McGinnis (1987) are presented in **Figure A1-2**. Because illegal collection is a historical and current threat to the species, FWS denoted population occurrences on the map using general waypoints but did not provide exact locations. (Species Status Assessment 2020, p. 7)
  - "Current San Francisco garter snake populations are found on the San Francisco peninsula from San Mateo County to northwestern Santa Cruz County (Service 2006, pp. 43-44). The California Natural Diversity Database (CNDDB) includes 63 element occurrences that are presumed extant and four element occurrences that are extirpated (CNDDB 2018)." (Species Status Assessment 2020, p. 9)
  - "Less than one third of the CNDDB occurrences have updated information in the database since the last status review for the species. In addition to the historical records and known CNDDB occurrences, coastal property on the west side of the Santa Cruz Mountains may be inhabited by San Francisco garter snakes (Service

2006, p. 5). However, because much of this property is privately owned, surveys are not available. Although the species is still distributed across most of its historical range (Barry 1978, pp. 1, 5-9; CNDDB 2018), much of the range has been fragmented or degraded by urbanization." (Species Status Assessment 2020, p. 10)

- There are 13 populations described in the 2020 Species Status Assessment (p. 26-33) and they are detailed in **Table A1-1**.

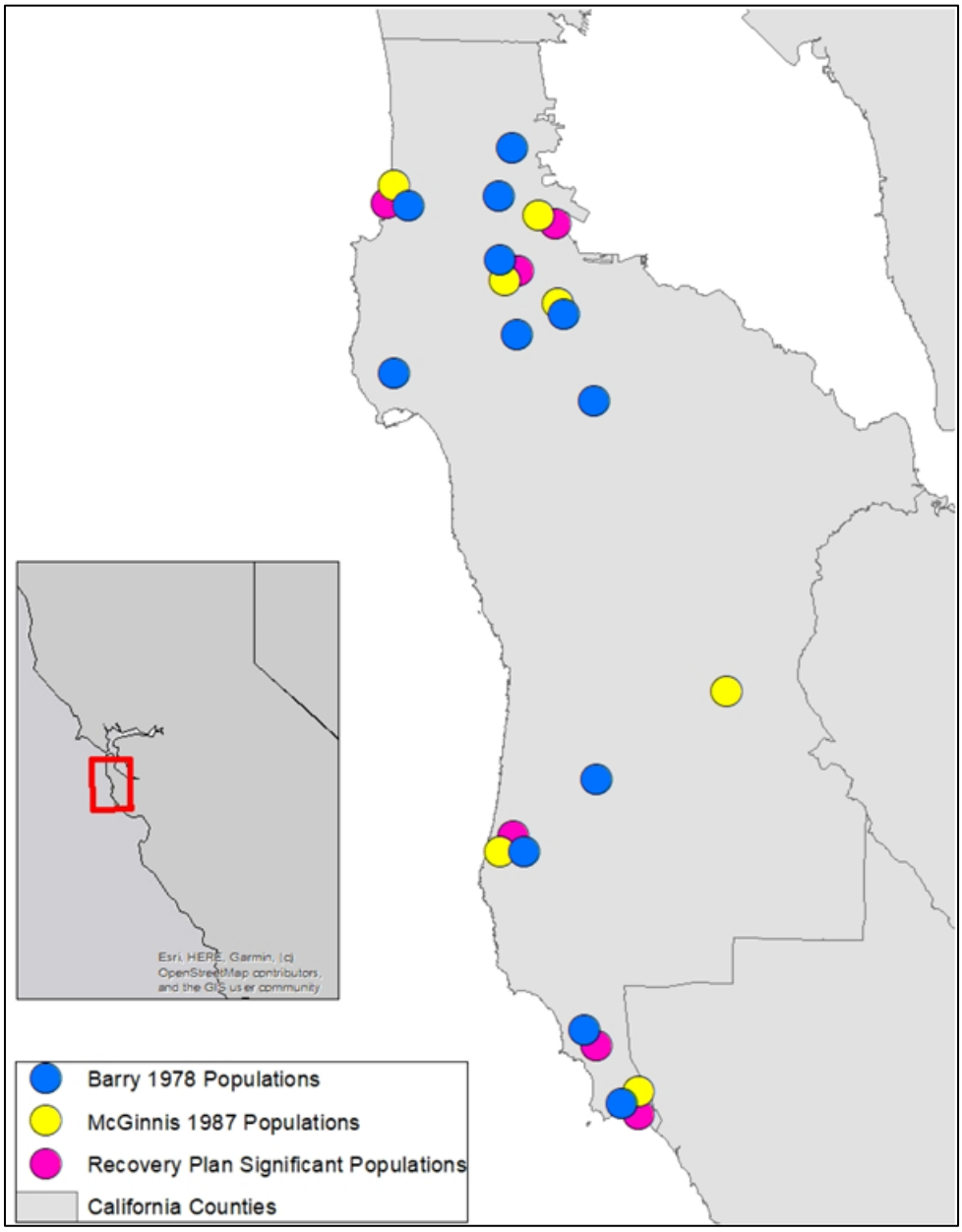

Figure A1-2. Populations of San Francisco garter snakes according to surveys by Barry (1978) and McGinnis (1987), as well as the six significant populations from the Recovery Plan. Locations are approximate. (Species Status Assessment 2020, p. 9)

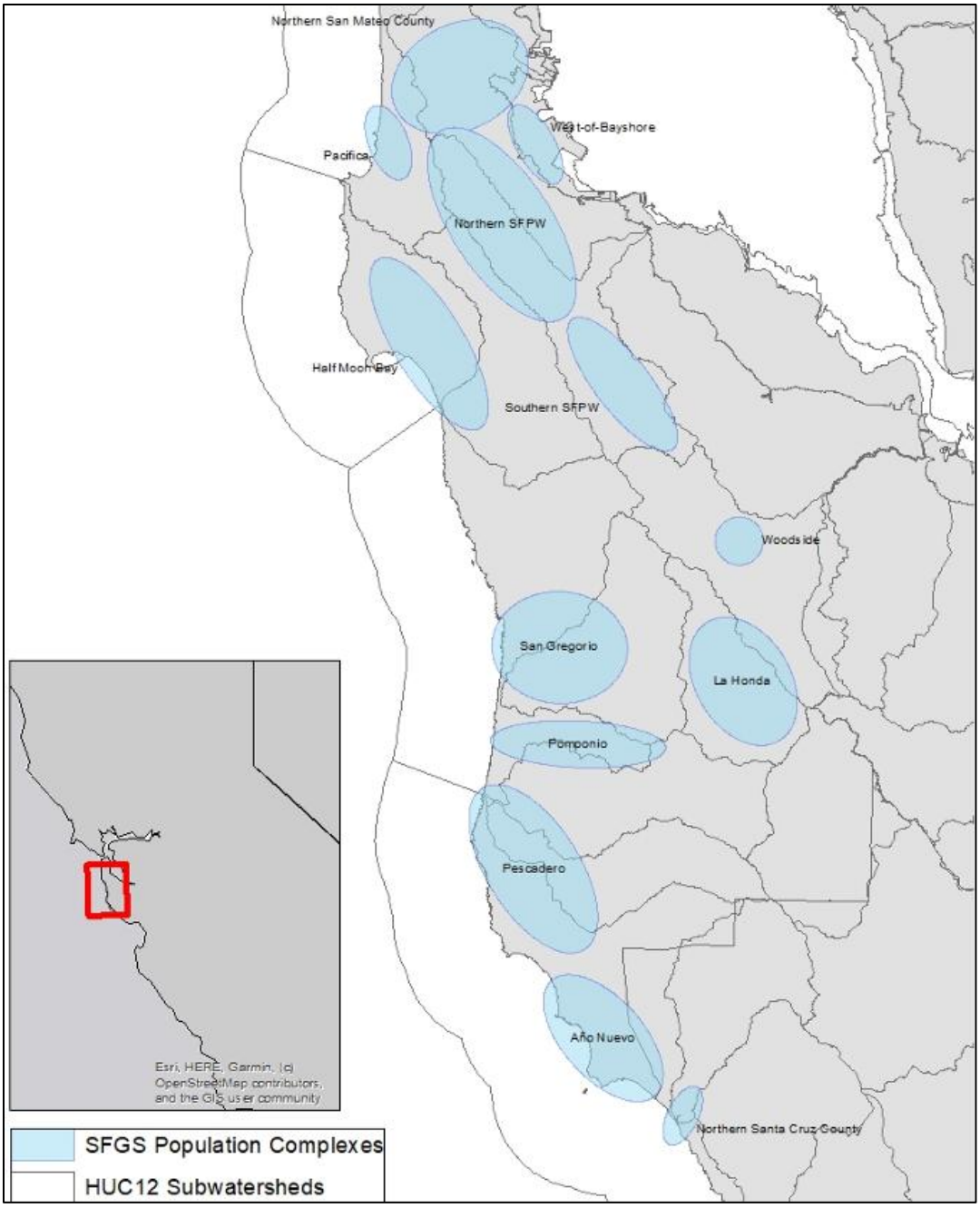

Figure A1-3. Population complexes used to assess population condition in San Francisco garter snake resiliency analysis. (Species Status Assessment 2020, p. 11)

Table A1-1. Population complexes and details on location, survey dates, and population status for the San Francisco garter snake from north to south (compiled from Species Status Assessment 2020).

Population	Location	Landowner	Year Last Surveyed	Population Status	Additional Details
Northern San Mateo County	Sag ponds along Skyline Blvd	--	1978	Extirpated	--
Pacifica	Laguna Salada	City of San Francisco	1987	Extant	Managed waterbody within the Sharp Park Golf Course (within Golden Gate National Recreation Area)
Pacifica	Mori Point	NPS	2018	Extant	Golden Gate National Recreation Area
Pacifica	Calera Creek ponds	--	--	Unknown	Lack of management has led to extremely dense vegetation in the creek and loss of the ponds
West-of-Bayshore	West of the main SFO terminal complex across U.S. Highway 101.	City of San Francisco	2017	Extant	73 hectares (180 acres); near the San Francisco International Airport (SFO)
Northern San Francisco Peninsula Watershed (SFPW)	Skyline Wetlands and Fifield-Cahill Ridge Trail are mentioned but the species is across the SFPW. Population is north of Highway 92	San Francisco Public Utilities Commission; managed by California Department of Fish and Wildlife (CDFW)	2016	Extant	Known by San Francisco State Fish and Game Refuge in older FWS documents; see p. 19 of report for location of the SFPW
Southern SFPW	Population is south of Highway 92	San Francisco Public Utilities Commission; managed by California Department of Fish and Wildlife (CDFW)	2018	Extant	Known by San Francisco State Fish and Game Refuge in older FWS documents; see p. 19 of report for location of the SFPW
Half Moon Bay	Denniston Creek and Denniston Reservoir, as well as the mouth of Pilarcitos Creek to the south and Rancho Corral de Tierra	Denniston Reservoir: regulated by CDFW; Rancho Corral de Tierra: owned by NPS	2006	Extant	No observations in 2006 but lack of detections doesn't necessarily indicate absence at the site
Woodside	--	Private property	--	Extant	No survey dates provided; part of Stanford University, no details provided on location other than **Figure A1-3**.
San Gregorio	Habitat along Tunitas and San Gregorio Creeks	--	1980s	Uknown	--

Population	Location	Landowner	Year Last Surveyed	Population Status	Additional Details
La Honda	2 ranches – one is part of the Russian Ridge Open Space Preserve	Private property; Midpeninsula Regional Open Space District	2017	Extant	--
Pomponio	Habitat along Pomponio Creek and Pomponio Reservoir	--	1980s	Uknown	--
Pescadero	Private ranch and Pescadero Marsh Natural Preserve	Preserve: owned and managed by California State Parks; Private ranch: managed/owned by Peninsula Open Space Trust	2018	Extant	Pescadero Marsh Natural Preserve and private property
Año Nuevo	Año Nuevo State Park and Reserve and Cascade Ranch	Reserve & Park: managed by California State Parks. Cascade Ranch: private property	2018	Extant	No details provided on Cascade Ranch population abundance
Northern Santa Cruz County	Ponds near the coast in the northern part of the county	--	--	Unknown	Cite CNDDB 2018 data

- **Occurrences in iNaturalist**
    - Searched on 7/14/2025
    - Search Results
    - There are 319 research grade observations available from 2002 to 2025 and one observation from 1985.
    - Coordinates were downloaded from iNaturalist and imported into ArcGIS with the coordinate system GCS_North_American_1983. All observations are obscured by 28.5 km. When accounting for obscuring, it appears no observations are in the portion of the range to the east of the San Francisco Bay. Observations are also not in the southern portion of the range, which is consistent with the southern-most population listed in the 2020 Species Status Assessment as "Northern Santa Cruz County".

- **Occurrences in GBIF**
    - Searched on 7/14/2025
    - Search Results
    - There were 447 observations available for this species, 316 of which had coordinates, and 72 which were not included in iNaturalist and are "preserved specimens" from 1909 to 2019. Of these, 14 observations are from 1992 to 2019.
    - These observations are consistent with the West-of-Bayshore, Pescadero, and Año Nuevo populations.

- **Occurrences in NatureServe**
    - NatureServe was searched on 7/14/2025
    - Search Results
    - NatureServe did not have any additional locations and showed a range consistent with that of the current FWS range.

- **Occurrences in California Natural Diversity Database (CNDDB)**
    - Searched on 7/14/2025
    - Unmasked location data from the CNDDB was downloaded and included in the core map after obscuring the data with CDFW's ACE hexagons.

Collectively, the occurrence data are consistent with reducing the core map to biological information, which would be the locations of the population complexes. The current FWS species range extends south to the Pajaro River, but the southern-most extant population is in northern Santa Cruz county, approximately 20 miles north of where the FWS range ends. Similarly, the FWS range extends north to San Francisco, but the northern-most extant population is approximately nine miles south of where the FWS range extends. Additionally, the FWS range encompasses areas outside of the documented locations of the populations described in **Table A1-1**.

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

EPA developed the interim core map by refining the species range based on where the described locations of the population complexes are in combination with the known locations. This core map was created based on biological information, including occupied locations. GBIF, iNaturalist, and NatureServe data were considered and visually compared to the range and named locations but were not used to refine the interim core map since they were consistent with the range and named locations. CNDDB data were used to refine the core map as they were more specific locations than those provided in FWS (FWS obscured locations to prevent illegal collection). To protect the species, EPA obscured the CNDDB locations using CDFW's ACE hexagons. The core map file is "*SanFranciscoGarterSnake_CoreMap_Final*".

1. **Dataset References and Software**

   Datasets used:

   1.1. FWS Species Range (last updated 03/21/2018)

   1.2. Occurrences from California Natural Diversity Database, information downloaded 7/2025

   1.2.1. Woodside population, La Honda population, Northern Santa Cruz County population

   1.3. NPS - Land Resources Division Boundary and Tract Data Service (NPS data)

   1.3.1. Pacifica population (Golden Gate National Recreation Area, GGNRA); Half Moon Bay population (GGNRA includes Rancho Corral de Tierra)

   1.4. Regrid Nationwide Parcel Data

   1.4.1. West-of-Bayshore population (Owner name: CITY & CO OF SAN FRANCISCO; Second owner name: INTERNATIONAL AIRPORT), Pescadero population (Owner name: MIDPENINSULA REGIONAL OPEN SPACE DISTRIV, Second owner name: PENINSULA OPEN SPACE TRUST)

   1.5. National Hydrography Dataset Plus High Resolution HUC12 Watersheds (NHDPlus HUC12)

   1.5.1. Northern and Southern San Francisco Peninsula Watershed populations

   1.6. USA Parks

   1.6.1. Half Moon Bay population (Half Moon Bay State Beach), Woodside population (Jasper Ridge Biological Preserve), Pescadero population (Pescadero Marsh Natural Preserve), Año Nuevo population (Año Nuevo State Park and State Reserve Año Nuevo)

   1.7. National Hydrography Database Plus - High Resolution (NHDPlus – High Res)

   1.7.1. Half Moon Bay population (Denniston Creek and Reservoir and mouth of Pilarcitos Creek), San Gregorio population (Tunitas and San Gregorio Creeks); Pomponio population (Pomponio Creek and Reservoir)

   1.8. Open Data Midpen

   1.8.1. La Honda population (Russian Ridge Open Space Preserve)

   1.9. California Department of Fish and Wildlife (CDFW) Areas of Conservation Emphasis (ACE) Terrestrial Significant Habitats

   1.10. USEPA Modified Cultivated Layer

Table A2-1. Datasets used to create the core map encompassing all 12 population of the San Franciso garter snake.

Population	Datasets Used	Specifics
Pacifica	-NPS data: Golden Gate National Recreation Area	
West-of-Bayshore	-Regrid Nationwide Parcel Data: Owner name: CITY & CO OF SAN FRANCISCO; Second owner name: INTERNATIONAL AIRPORT	Approx. 180 acres total

Population	Datasets Used	Specifics
Northern San Francisco Peninsula Watershed (SFPW)	-NHDPlus HUC12: Name: San Francisquito Creek	
Southern SFPW	-NHDPlus HUC12: Name: San Mateo Creek-Frontal San Francisco Bay Estuaries	
Half Moon Bay	-NPS data: Golden Gate National Recreation Area -USA Parks: Half Moon Bay State Beach -NHDPlus-High Res: Denniston Creek and Reservoir and mouth of Pilarcitos Creek	Includes Rancho Corral de Tierra
Woodside	-USA Parks: Jasper Ridge Biological Preserve -CNDDB data buffered using ACE hexagons	
San Gregorio	-NHDPlus-High Res: Tunitas Creek and San Gregorio Creek	
La Honda	-Open Data Midpen: Russian Ridge Open Space Preserve -CNDDB data buffered using ACE hexagons	
Pomponio	-NHDPlus-High Res: Pomponio Creek and Reservoir	
Pescadero	-Regrid Nationwide Parcel Data: Owner name: MIDPENINSULA REGIONAL OPEN SPACE DISTRIV, Second owner name: PENINSULA OPEN SPACE TRUST -USA Parks: Pescadero Marsh Natural Preserve	
Año Nuevo	-USA Parks: Año Nuevo State Park and State Reserve Año Nuevo	
Northern Santa Cruz County	-CNDDB data buffered using ACE hexagons	

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, readily downloadable from Environmental Conservation Online System (ECOS), was used as the outer extent of the core map. As discussed in Appendix 1, FWS have not designated a critical habitat for this species. The core map was created by gathering the information in **Table A1-1** and combining it with known locations from the CNDDB dataset (buffered, see Step 3.7 below). **Table A2-1** builds on information presented in Appendix 1 and provides more detail on which datasets were used to capture each population described in FWS documents.

3. GIS Process Used

3.1. Refining NPS data

Portions of the Pacifica and Half Moon Bay populations are encompassed within the Golden Gate National Recreation Area, GGNRA; **Table A1-1**). Added the NPS dataset to the map and selected the park needed using the "select by attributes" tool.

Select by Attributes (tool):

- Input rows: *NPS_Data/nps_boundary*
- Selection type: New Selection
- Expression structured as follows: Where PARKNAME is equal to Golden Gate
- Output: Saved by right clicking on the input layer, selecting "Data" from the dropdown menu, then "Export Features": *NPS_GGNRA*

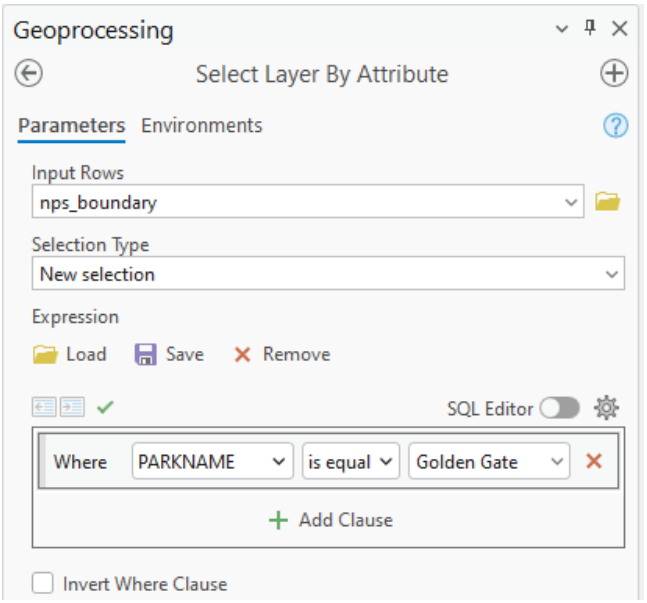

Figure A2-1. Screenshot of the setup for the Select by Attribute tool.

GGNRA is a large park encompassing many smaller sections. The Pacifica population is found in the Sharp Park Golf Course, Mori Point, and in ponds along Calara Creek, all which are to the west of Interstate Highway 1 and north of Fassler Avenue. “Create Features” within “Editing” was used to trace the segment of the larger polygon that was consistent with the portion of the GGNRA west of Interstate Highway 1.

Editing -> Create Features:

- Input rows: *NPS_GGNRA*
- Method: Trace
- Traced as shown in Figure A2-2 below
- Output: Added as a new row in *NPS_GGNRA* shapefile

Figure A2-2. Screenshot of the portion of the GGNRA that was traced and made into a new row within the *NPS_GGNRA* layer (Pacifica population).

The Half Moon Bay population is within the Rancho Corral de Tierra portion of the GGNRA. The same approach was used as with the Pacifica population. To confirm where this portion of the GGNRA is, Google Maps was used to compare the outline of the GGNRA polygon with the location of Rancho Corral de Tierra.

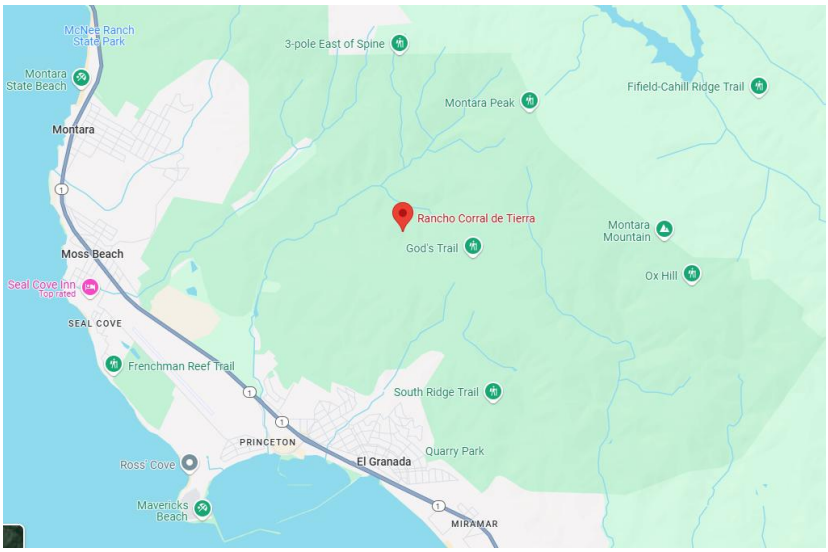

Figure A2-3. Screenshot of Google maps showing Rancho Corral de Tierra within the GGNRA.

Editing -> Create Features:

- Input rows: *NPS_GGNRA*
- Method: Trace
- Traced outline of polygon as shown in Figure A2-4 below

Editing->Modify->Continue Feature:

- Input rows: NPS_GGNRA
- Method: Trace
- Traced inner hole in polygon as shown in Figure A2-4 below
- Output: Added as a new row in *NPS_GGNRA* shapefile

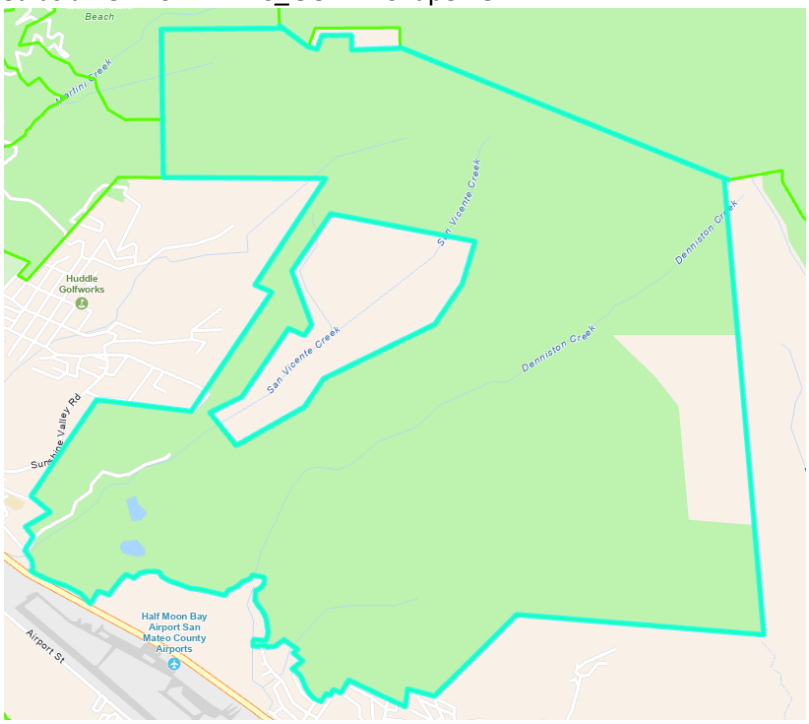

Figure A2-4. Screenshot of the portion of the GGNRA (Rancho Corral de Tierra) that was traced and made into a new row within the *NPS_GGNRA* layer, including the hole in the middle of the park that is not part of GGNRA (Half Moon Bay population).

Calculate area of created polygon to see if it approximates the size of Rancho Corral de Tierra (~ 4,000 acres).

Calculate Geometry (tool):

Input Features: *NPS_GGNRA*

Attributes New Field: Area_acres

Property/Unit: Area (geodesic); US Survey Acres

Coordinate System: WGS_1984_Web_Mercator_Auxiliary_Sphere

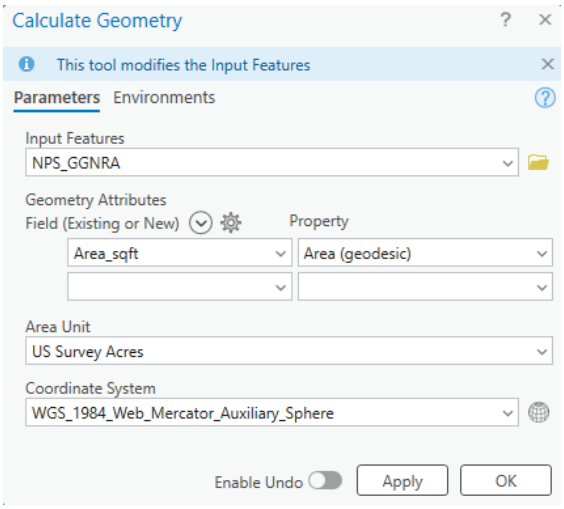

Figure A2-5. Screenshot of the setup for the Calculate Geometry tool used to calculate the area of the polygon created to represent Rancho Corral de Tierra.

Select for portions of GGNRA that we are keeping and save as a new layer.
Select by Attributes (tool):

- Input rows: *NPA_GGNRA*
- Selection type: New Selection
- Expression structured as follows: Where Creator is equal to R. Prather
- Output: Saved by right clicking on the input layer, selecting “Data” from the dropdown menu, then “Export Features”: *NPS_CoreMap2*

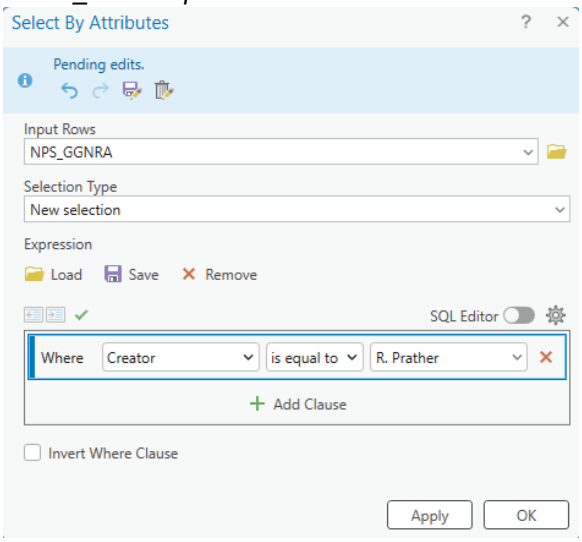

Figure A2-6. Screenshot of the setup for the Select by Attribute tool.

3.2. Refining Regrid Nationwide Parcel data

The West-of-Bayshore population and part of the Pescadero population were found using the Regrid Nationwide Parcel dataset. The West-of-Bayshore population is located west of the main San Francisco International Airport terminal complex across U.S. Highway 101 on approximately 180 acres owned by the city of San Francisco (**Table A1-1**). The Pescadero population is managed by the Peninsula Open Space Trust (**Table A1-1**). Added the Regrid dataset to the map and selected the parcels needed using the “select by attributes” tool.

Select by Attributes (tool):

- Input rows: *Regrid Nationwide Parcel Data*
- Selection type: New Selection
- Expression structured as follows: Where Owner Name is equal to CO OF SAN FRANCISCO And Second Owner Name is equal to INTERNATIONAL AIRPORT Or Owner Name is equal to MIDPENINSULA REGIONAL OPEN SPACE DISTRIV And Second Owner Name is equal to PENINSULA OPEN SPACE TRUST
- Output: Saved by right clicking on the input layer, selecting "Data" from the dropdown menu, then "Export Features": *Regrid_Data*

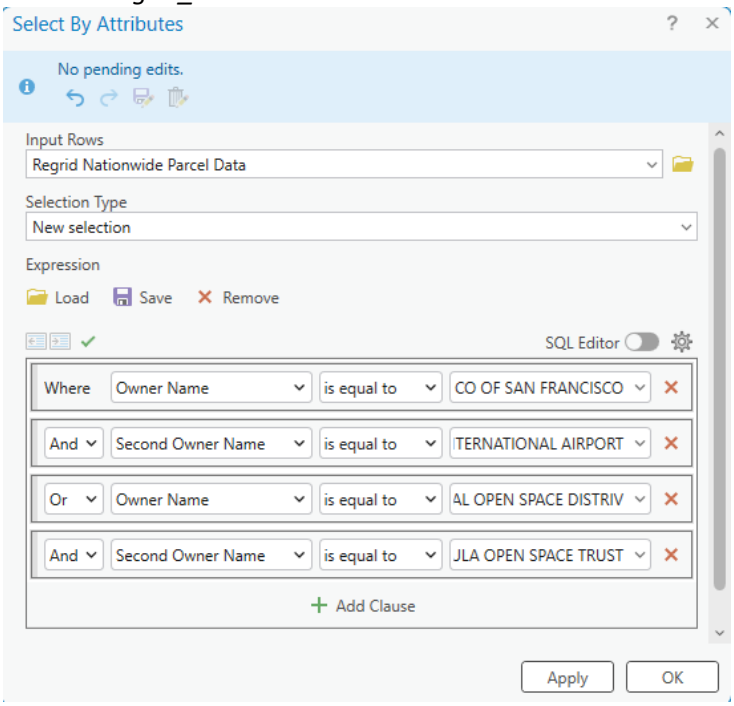

Figure A2-7. Screenshot of the setup for the Select by Attribute tool.

There are several parcels in the land around SFO to the west of the highway that overlap the highway, so a polygon was created using the same steps as in 3.1 using the Edit->Create and the lines of the polygons to the west of the highway were traced (no figure shown due to the high precision of the locations).

The created SFO polygon and the parcels owned by Peninsula Open Space Trust were selected using the "Select by Attribute" tool as described above in Section 3.2 and exported as a new layer: *Regrid_CoreMap*. Excess columns with identifying information were removed per the data use agreement for this dataset.

3.3. Refining NHDPlus HUC12 data

The Northern and Southern San Francisco Peninsula Watershed populations are described as being within specific watersheds **(Table A1-1).** The NHDPlus HUC12 dataset was used and refined to select the two relevant watersheds. The process described in Section 3.1 was repeated with the NHDPlus HUC12 data layer, with the "Select by Attributes" tool used to select the two relevant watersheds (Name is equal to San Mateo Creek-Frontal San Francisco Bay Estuaries Or Name is equal to San Francisquito Creek). This output was saved as a separate layer: *HUC12_CoreMap*

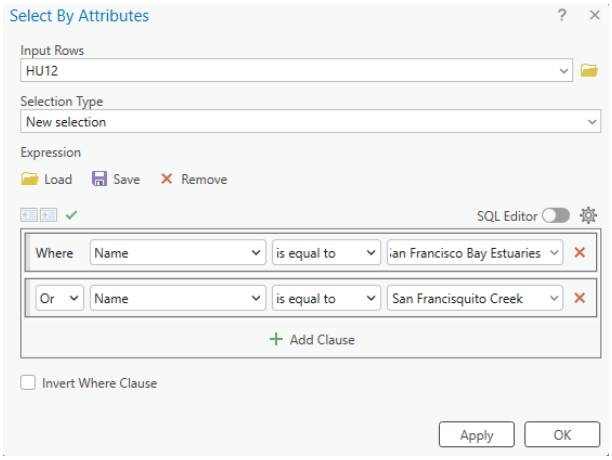

Figure A2-9. Screenshot of the setup for the Select by Attribute tool (Northern and Southern San Francisco Peninsula Watershed populations)

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3.4. Refining USA Parks data

Portions of the Half Moon Bay, Woodside, Pescadero, and Año Nuevo populations are located within parks, so the USA Parks dataset was used. The process described in Section 3.1 was repeated and parks were selected using the "Select by Attribute" tool and the information provided in **Table A1-1** (Name is equal to Half Moon Bay State Beach Or Name is equal to Jasper Ridge Biological Preserve Or Name is equal to Pescadero Marsh Natural Preserve Or Name is equal to Ano Nuevo State Park Or Name is equal to State Reserve Año Nuevo. This output was saved as a separate layer: *Parks_CoreMap*

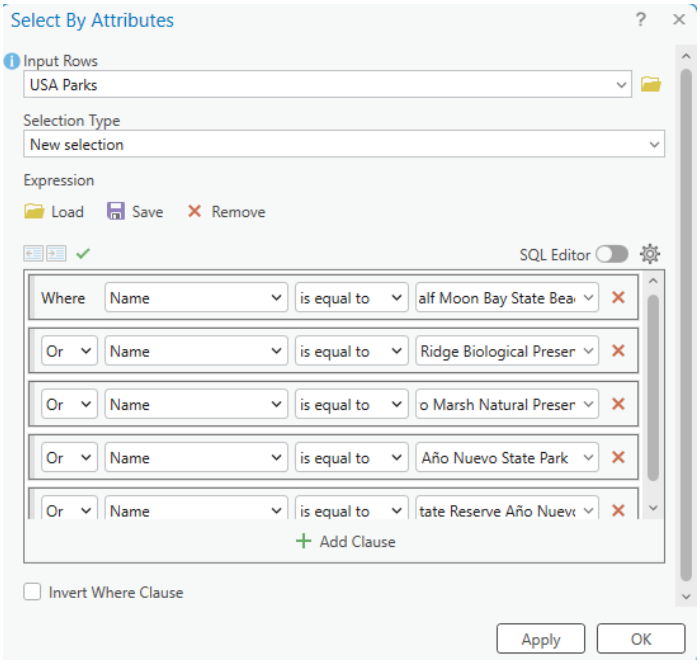

Figure A2-10. Screenshot of the setup for the Select by Attribute tool (portion of Half Moon Bay, Woodside, Pescadero, and Año Nuevo populations)

3.5. Refining NHDPlus – High Res data

Added the NHDPlus dataset to the map and clipped to the extent of the species range for efficient data processing:

Clip (tool):

- Input Dataset: *NHDPlus/Flowlines*
- Output extent: *USFWS San Francisco garter snake range*
- Output: *Flowlines_Clip*

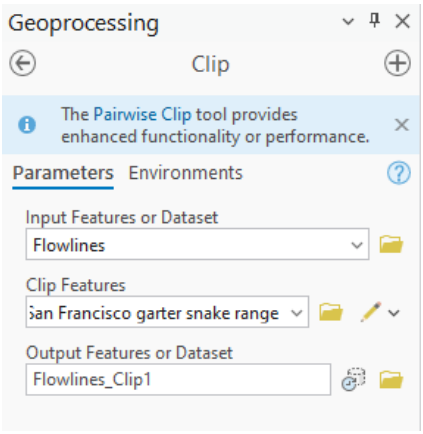

Figure A2-11. Screenshot of the setup for the Clip tool.

As described in **Table A1-1**, populations are found along Denniston Creek and Reservoir and mouth of Pilarcitos Creek, Tunitas Creek, San Gregorio Creek, Pomponio Creek, and Pomponio Reservoir. The process described in Section 3.1 was repeated and creeks were selected using the "Select by Attribute" tool from the *Flowlines_Clip* layer and the information provided in **Table A1-1** (Name from Geographic Names Information System is equal to Denniston Creek Or Pilarcitos Creek Or Tunitas Creek Or San Gregorio Creek Or Pomponio Creek. This output was saved as a separate layer: *Flowlines_Selection*

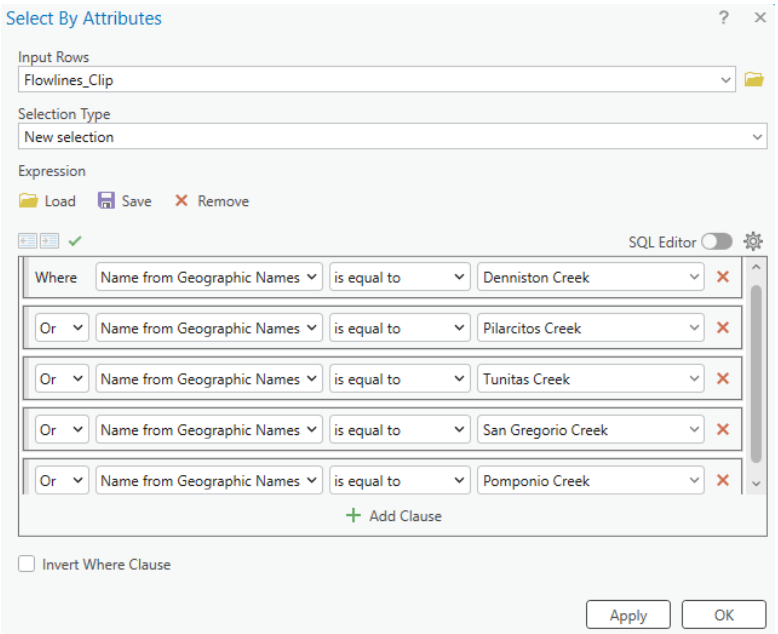

Figure A2-12. Screenshot of the setup for the Select by Attribute tool (portion of Half Moon Bay, San Gregorio, and Pomponio populations).

FWS documents were reviewed to decide on the buffer that should be added to selected waterbodies to protect habitat needed for the San Francisco garter snake. A 200-meter (m) buffer was chosen based on the following information provided in the 2020 Species Status Assessment. Specifically, because 95% of captures at several sites was less than 200 m, this was thought to be a sufficiently protective distance for the snake.

- "There is currently no data on connectivity or dispersal between population sites. However, the maximum distance moved between captures by 95 percent of individuals at five sites was less than 200 m." (p. 18)
- "Individual San Francisco garter snakes must be able to move freely between aquatic habitat and upland habitat. In areas with both permanent and ephemeral water sources, movement corridors between these habitat patches are essential for the snake…At one site, most recaptures occurred within 167 m (550 feet) of the original capture, although one female moved up to 671 m (2,200 feet) and a male moved 632 m (2,075 feet)" (p. 21)
- "San Francisco garter snakes are often found in or adjacent to aquatic habitats in association with a terrestrial niche, requiring both shallow freshwater habitat and contiguous uplands, meadows, or riparian habitat and have been found in meadowlands up to 2 km (6,562 feet) from marshland." (p. 15)

Creeks were buffered 200 m using the "Buffer tool"
Buffer (tool):

- Input Features: *Flowlines_Selection*
- Distance: 200 meters
- Side Type: Full
- End Type: Round
- Dissolve Type: Dissolve features using the listed fields' unique values
    - Dissolve Field(s): Name from Geographic Names Information System
- Output: *Flowlines_Selection_Buffer*

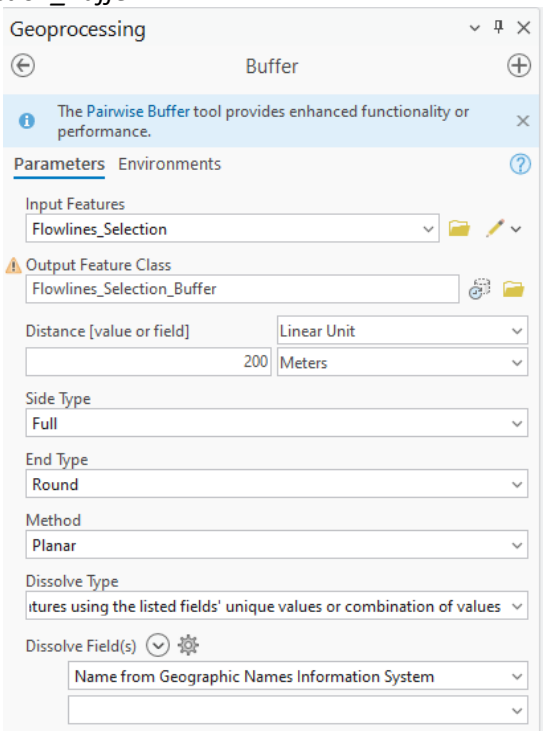

Figure A2-13. Screenshot of the setup for the Buffer tool.

3.6. Refining Open Data Midpen

Portions of the La Honda population is managed by the Midpeninsula Regional Open Space District **(Table A1-1)**, so a dataset of their land was downloaded and used. The process described in Section 3.1 was repeated and parks were selected using the "Select by Attribute" tool and the information provided in **Table A1-1** (PRESERVE is equal to Russian Ridge). This output was saved as a separate layer: *MidPen_CoreMap*

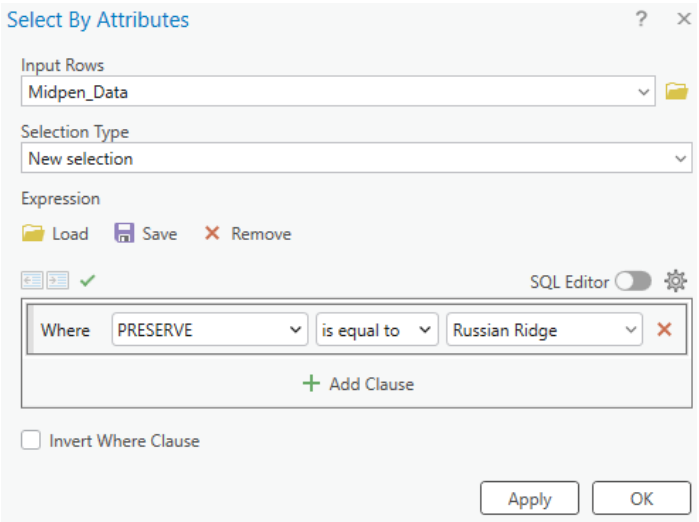

Figure A2-14. Screenshot of the setup for the Select by Attribute tool (portion of La Honda population).

3.7. Merging datasets together

Datasets were merged before adding CNDDB data using the "Merge" tool.

Merge (tool):

- Input Datasets: *Flowlines_Selection_Buffer*, *NPS_CoreMap2, Regrid_CoreMap, HUC12_CoreMap, Parks_CoreMap, Midpen_CoreMap*
- Output: *Merge_CoreMap*

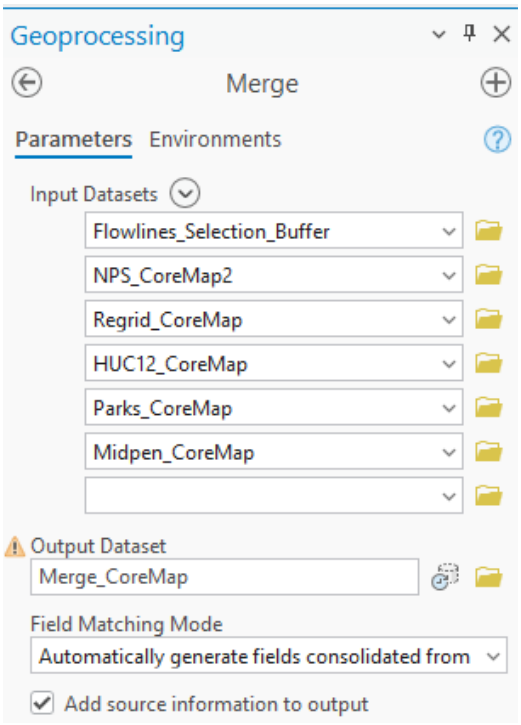

Figure A2-17. Screenshot of the setup for the Merge tool.

3.8. 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, San Francisco garter snake observations were selected using the "Select by Attribute" tool (SNAME is equal to *Thamnophis sirtalis tetrataenia*). This output was saved as a separate layer: *cnddb_occurrences*

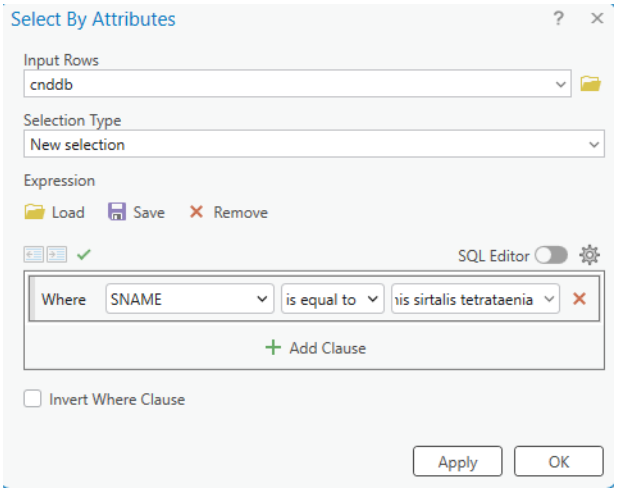

Figure A2-15. Screenshot of the setup for the Select by Attribute tool.

Only "presumed extant" occurrences were used so extirpated occurrences were filtered out using the process described in Section 3.1 and the "Select by Attribute" tool (PRESENCE is equal to Presumed Extant). This output was saved as a separate layer: *cnddb _extant*

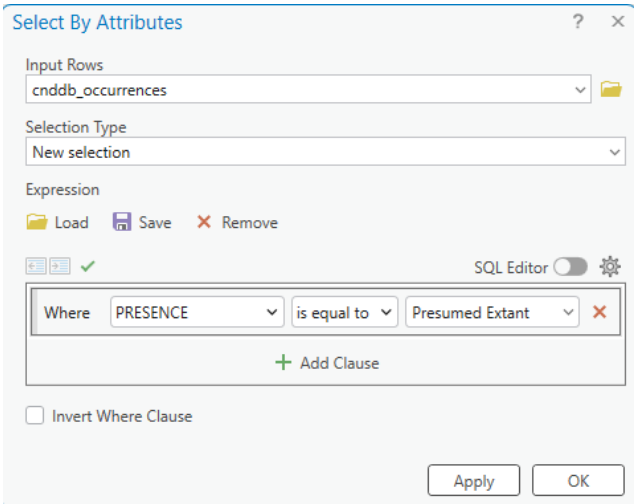

Figure A2-16. Screenshot of the setup for the Select by Attribute tool.

EPA then compared CNDDB known locations with areas of the core map already created to see which CNDDB known locations were not completely encompassed. This was done using the "Select Layer by Location" tool with "invert spatial relationship" selected.

Select Layer by Location (tool):

- Input features: *cnddb_extant*
- Relationship: Completely within
- Selecting features: *Merge_CoreMap*
- Search distance: 0 meters
- Selection type: New selection
- Invert spatial relationship: selected
- Output, saved by right clicking on the input layer, selecting "Data" from the dropdown menu, then "Export Features": *unmasked_cnddb*

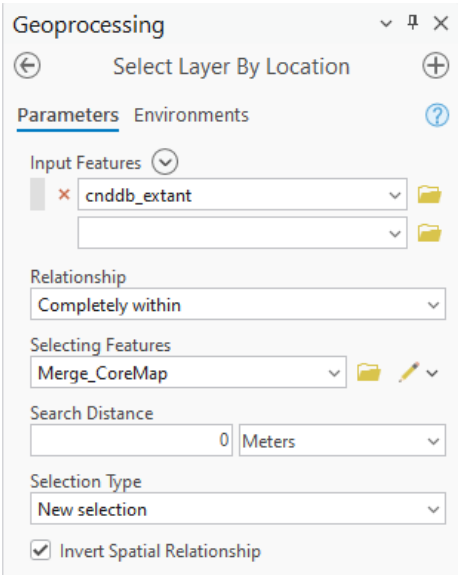

Figure A2-17. Screenshot of the setup for the Select by Layer tool.

There were 49 CNDDB locations that were not completely encompassed within the core map areas created using FWS information. These were intersected with CDFW's ACE hexagons using the "Select Layer by Location" tool as with above with *ds2721* (ACE hexagons).

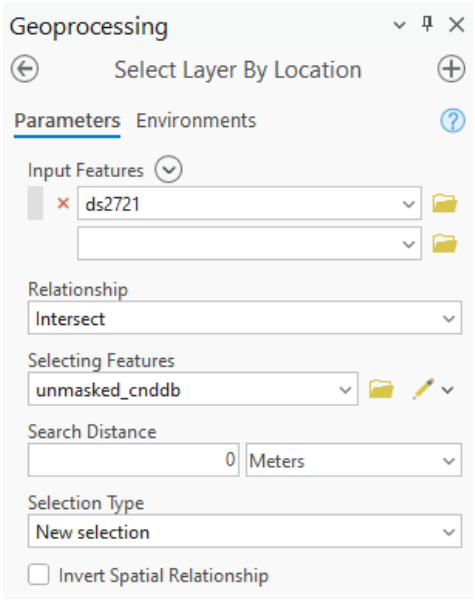

Figure A2-18. Screenshot of the setup for the Select by Layer tool.

3.9. Refining based on EPA Cultivated Lands data

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). For the San Francisco garter snake, the extent of the map was **not** refined by this layer because the species can traverse agriculture. In addition, once the modified cultivated layer and accurate known location occurrences were added to the map, the known locations coincided with portions of the modified cultivated layer. Removing this area from the core map would result in damage to either the species or its habitat so was not removed from the core map.

3.10. Merging datasets together

Datasets were merged using the "Merge" tool.

Merge (tool):

- Input Datasets: *ds2721_cnddb_unmasked and Merge_CoreMap*
- Output: *SanFranciscoGarterSnake_CoreMap*

3.11. Remove small, disconnected patches less than 2 acres

Buffer "*SanFranciscoGarterSnake_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: *SanFranciscoGarterSnake_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

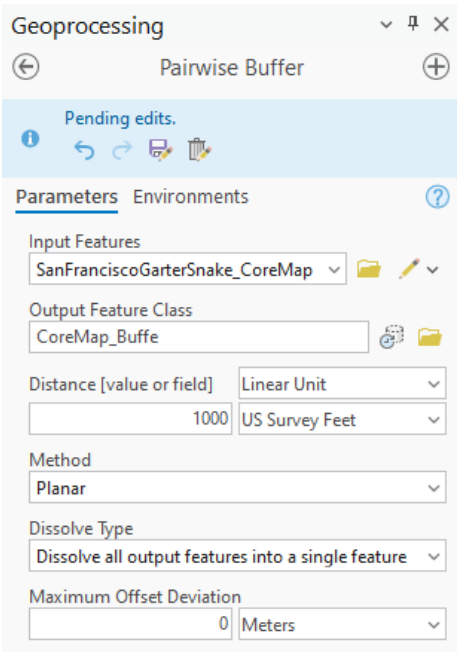

Figure A2-19. Screenshot of Pairwise Buffer tool.

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_Buffe*
- Output feature class: *CoreMap_Buffer_Extent*
- Condition: Area
- Area: 400,000 square meters

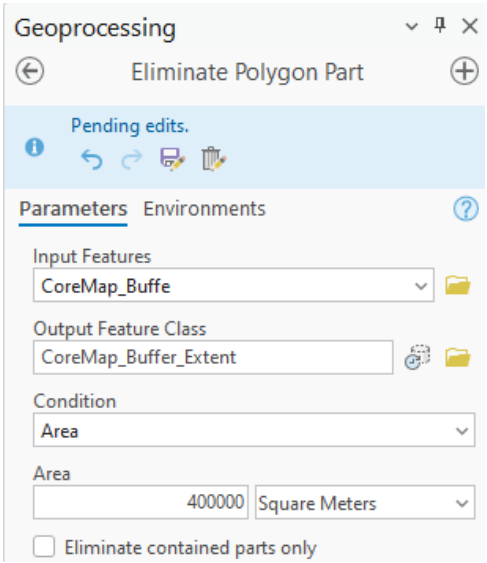

Figure A2-20. Screenshot of Eliminate Polygon Parts tool.

After checking *CoreMap_Buffer_Extent*, there are no areas to eliminate.

3.12. “Smooth” the Core Map by filling in gaps or holes

Use the “Dissolve” tool to merge polygons into one polygon.

Dissolve (tool)

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

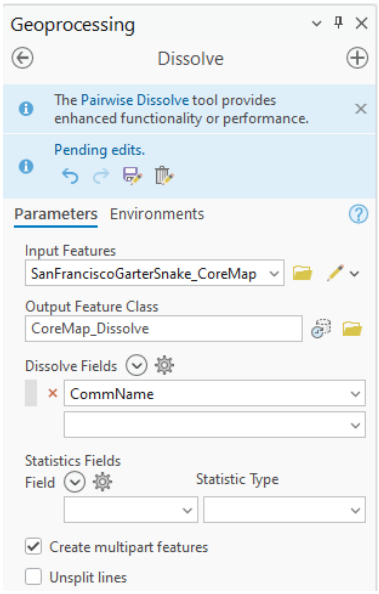

Figure A2-21. Screenshot of Dissolve tool.

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

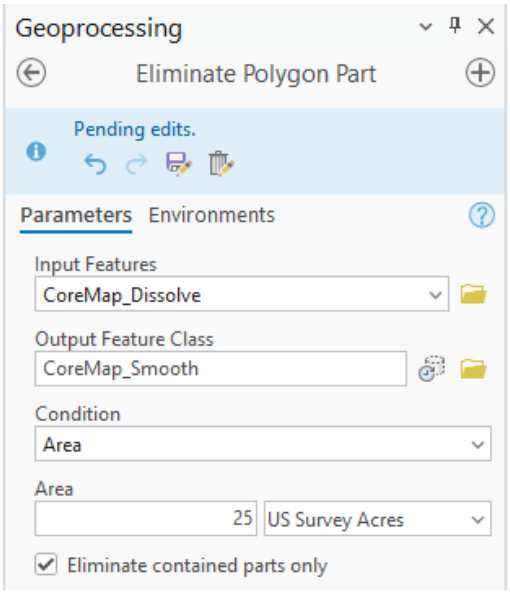

Figure A2-22. Screenshot of Eliminate Polygon Parts tool.

3.13. Update attributes and "calculate geometry"

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

SciName: *Thamnophis sirtalis tetrataenia*
EntityID: 152
ECOS_WebPg: https://ecos.fws.gov/ecp/species/5956
Area_Acres: Use Calculate Geometry tool with US Survey Acres and GCS_WGS_1984 coordinate system to calculate the area of the core map.