Interim Core Map Documentation for San Marcos Salamander

Version 1
Review Completed: April 2026
Core Map Developer: Center for Biological Diversity[1]

Species Summary

The San Marcos salamander (*Eurycea nana*; Entity ID 194) is a member of the family Plethodontidae (lungless salamanders). There is a narrow section of the species range designated as critical habitat. The San Marcos salamander is endemic to the San Marcos Spring near the city of San Marcos, Texas. This species inhabits the spring outflow areas with sand, gravel, with interspersed boulders substrate where it commonly hides in crevices and underneath boulders. Additional information is provided in **Appendix 1**.

Review Notes

This core map was developed using the U.S. Environmental Protection Agency's (EPA) process available at: https://www.epa.gov/endangered-species/process-epa-uses-develop-core-maps-pesticide-use-limitation-areas. EPA reviewed the draft interim map and documentation and evaluated if: (1) the map and documentation are consistent with EPA's process; (2) areas added to or excluded from the interim core map are consistent with the species biology and/or recovery needs; (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 based on the available information and was consistent with EPA's mapping process. EPA altered the developer's map by removing a 1,000 ft buffer because any buffering would occur as EPA develops Pesticide Use Limitations Areas for this species, which could include buffers of different sizes.

The core map developed in this document for the San Marcos salamander is considered interim. This core map incorporates information developed by the U.S. Fish and Wildlife Service (FWS) and made available to the public. EPA reviewed the core map; 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.

Description of Core Map

The core map for the San Marcos Salamander is based on the range. The available range layer is highly refined and represents areas important for this species' conservation. Based on information from the 2024 5-Year Review, a distinct population segment has not been established for the San Marcos

[1] CBD sent EPA the core map for this species before EPA released its mapping process document and example documentation. EPA modified the core map as described in this document and supplemented the documentation and supporting analysis for consistency with EPA's most recent documentation examples made available after CBD developed this core map.

salamander, but San Marcos salamanders only live near springs in the San Marcos River found in Hays County, Texas. There has been critical habitat designated for this species that falls within the species' delineated range. **Figure 1** depicts the interim core map for the San Marcos Salamander. The core map represents approximately 18 acres.

"San Marcos salamanders are found in mesohabitats that contain cobble, gravel, and boulder substrates, and may use or benefit from cover provided by Amblystegium moss or filamentous algae. Salamanders use interstitial spaces on or within the substrate and are less likely to be found in areas that have mud or silt substrates and rooted macrophytes, which embed the substrate that they use as cover features. The species displays a slight preference for water velocities of approximately 1 cubic centimeter per second (cm/s). Higher velocities can wash away potential habitat while lower velocities allow sediment to settle into the interstitial spaces that they use as habitat. It seems likely that the species reproduces underground based on the lack of eggs found at the surface and documentation of other closely related Eurycea salamanders that use surface and subterranean habitat during their lifetime." 2024 5-Year Review

Landcover categories within the core map area are included in **Table 1.** Landcover is developed land, which is generally consistent with where this species habitat is located.

The core map developed for the San Marcos Salamander is considered interim. This core map will be used to develop pesticide use limitation areas (PULAs) that include the San Marcos Salamander. 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 interim core map has a "none" best professional classification because it consists of the species' range without additions or subtractions. This core map does not replace or revise any range or designated critical habitat developed by FWS for this species.

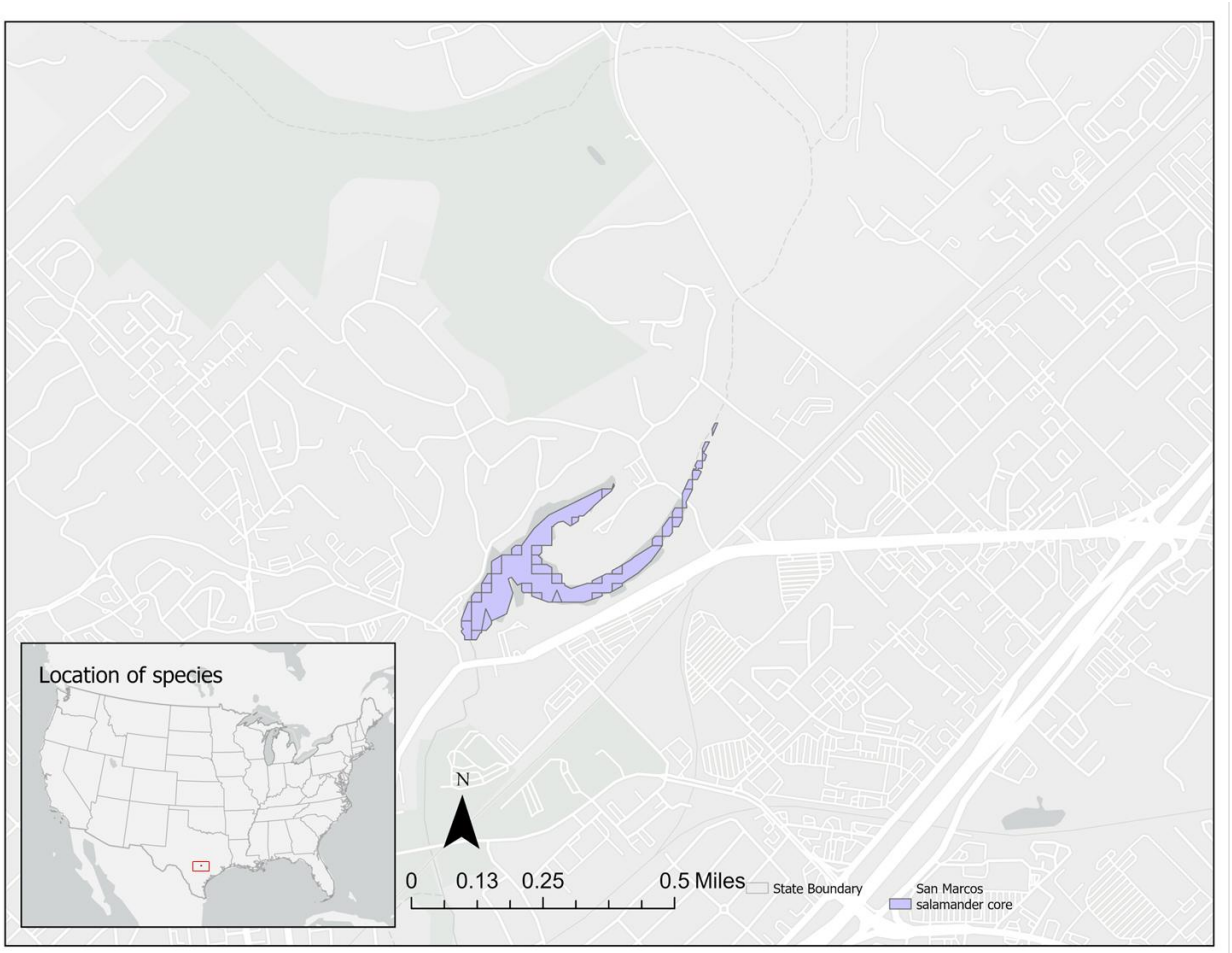

Figure 1. Interim core map for the San Marcos salamander. The total acreage of the interim core map is approximately 18 acres.

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

Example pesticide use sites/types	NLCD Landcover (Value)	% of core map represented by landcover
Forestry	Deciduous Forest (41)	0
Forestry	Evergreen Forest (42)	17
Forestry	Mixed Forest (43)	0
Agriculture	Pasture/Hay (81)	0
Agriculture	Cultivated Crops (82)	0
Mosquito adulticide, residential	Open space, developed (21)	6
Mosquito adulticide, residential	Developed, Low intensity (22)	0
Mosquito adulticide, residential	Developed, Medium intensity (23)	0
Mosquito adulticide, residential	Developed, High intensity (24)	0
Invasive species control	Woody Wetlands (90)	0
Invasive species control	Emergent Herbaceous Wetlands (95)	0

Example pesticide use sites/types	NLCD Landcover (Value)	% of core map represented by landcover
Invasive species control	Open water (11)	72
Invasive species control	Grassland/herbaceous (71)	0
Invasive species control	Scrub/shrub (52)	5
Invasive species control	Barren land (rock/sand/clay; 31)	0
Total Acres	**Interim Core Map Acres**	**~18**

Evaluation of Known Location Information

Four datasets with known location information for this species were evaluated:

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

EPA evaluated these four sets of data to inform or support the core map. FWS provided the most refined descriptions of the occurrence information and confirmed that all known locations of extant populations are located within the range. iNaturalist had 38 research grade observations, which are consistent with the species range. GBIF's occurrence data predominately consisted of occurrences that had also been accounted for in iNaturalist. NatureServe included documented areas which were consistent with the location of the species range. **Appendix 1** includes more information on the available known location information.

Approach Used to Create Core Map

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

- The species range is highly refined.
- Designated critical habitat is within the species' range.
- Occurrence data from other sources are generally consistent with the species range location.

The developer used the compiled information to identify the core map type. Based on the narrow range that includes all occurrence data identified by FWS, the developer selected the range to use as the species core map.

Appendix 1. Information Compiled for Species

1. **Recent FWS Documents**

- San Marcos Salamander 2024 5-year Status Review
- Species Biological Report for Southern Edwards Aquifer Springs and Associated Aquatic Ecosystems 2024

2. **Background information on Species**

- **Status:** Federally listed as endangered in 1980
- **Taxonomy**. The San Marcos salamander (Eurycea nana) is a member of the family Plethodontidae (lungless salamanders).
- **Resiliency** - Low
- **Redundancy** - Low
- **Representation** - Low

The 5-Year Review does not discuss in explicit detail the three Rs (resiliency, redundancy, and representation). A distinct population segment has not been established for the San Marcos salamander, but this species is highly geographically restricted.

"Previous population estimates for the San Marcos salamander have ranged from 17,000 to 21,000 individuals in the floating algal mats at the uppermost portion of Spring Lake (Tupa and Davis 1976, pp. 92-93), to as many as 53,200 salamanders from Spring Lake 8 and the rocky substrates within about 46 meters (m) (150 feet (ft)) downstream of the Spring Lake Dam (Nelson 1993, pp. 19-20)." (5-Year Review, 2024 p. 7)

- **Habitat Description**

"San Marcos salamanders only live near springs in the San Marcos River, which has stable habitat conditions consistent with the San Marcos Springs in the City of San Marcos, Hays County, Texas." "San Marcos salamanders are found in mesohabitats that contain cobble, gravel, and boulder substrates, and may use or benefit from cover provided by Amblystegium moss or filamentous algae (Diaz et al. 2015, pp. 307, 316).. Salamanders use interstitial spaces on or within the substrate and are less likely to be found in areas that have mud or silt substrates and rooted macrophytes, which embed the substrate that they use as cover features (Diaz et al. 2015, p. 316). The species displays a slight preference for water velocities of approximately 1 cubic centimeter per second (cm/s) (Fries 2002, pp. 113, 115). Higher velocities can wash away potential habitat while lower velocities allow sediment to settle into the interstitial spaces that they use as habitat. It seems likely that the species reproduces underground based on the lack of eggs found at the surface and documentation of other closely related Eurycea salamanders that use surface and subterranean habitat during their lifetime (e.g., Barton Springs salamander, McDermid et al. 2015, p. 556, Bendik et al. 2021, entire)." (5-Year Review, 2024 p. 5-6).

- **Relevant Life History Information:**

"Males are sexually mature at a snout-vent length of 1.9 centimeters (cm) (0.7 inches (in)) (Tupa and Davis 1976, p. 186), but both sexes continue to grow after sexual maturity. Courtship and eggs have not been observed in the wild. Because gravid females and juveniles are found throughout the year, reproduction likely occurs throughout the year (Tupa and Davis 1976, p. 190). In captivity, eggs were found on aquatic moss and on marbles (Najvar et al. 2007, p. 146). Clutch size ranged from 2-73 eggs, with a mean of 34.7 eggs (Najvar et al. 2007, p. 146). Eggs hatched 16-24 days after oviposition (Najvar et al. 2007, p. 146). It is possible that the conditions in captivity, such as abundant food resources and lack of potential predation, allow captive salamanders to allocate more resources to egg production than is possible in the wild (Najvar et al. 2007, p. 146). San Marcos salamanders are generalist predators and prey on a variety of macroinvertebrates (Diaz 2010, p. 18). In a study of gut contents, they consumed the most common available taxa, including amphipods, ostracods, chironomids, caddisflies, and snails (Diaz 2010, pp. 14-15). "

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- **Ecology**

"San Marcos Springs is the second largest spring system in Texas and is the headwaters of the San Marcos River. San Marcos Springs is located in the artesian zone of the aquifer and receives water from the regional flowpath northeast from Comal Springs parallel to the Balcones Fault Zone (DeCook 1963, pp. 48, 53; Puente 1976, pp. 25–26; Guyton and Associates 1979, p. 71). Groundwater traveling northeast from Comal Springs becomes increasingly diluted with recharge upon reaching San Marcos Springs along the regional flowpath, cooling one degree to approximately 22° C (72° F) once it reaches San Marcos Springs (Ogden et al. 1986, p. 121; Johnson and Schindel 2008, pp. 45–47). The water discharging from San Marcos Springs represents the lowest altitude spring of the southern segment of the Edwards Aquifer, which is more 9 narrow and closer to the surface (Guyton and Associates 1979, pp. 57, 61, 79; Longley 1981, p. 125; Lindgren et al. 2004, p. 40).

Local recharge is primarily sourced from the Blanco River and supplemented by ephemeral streams, as well as other potential contributions from groundwater, either originating from the Trinity Aquifer or the saline water zone (Guyton and Associates 1979, p. 71; Musgrove and Crow 2012, pp. 80, 88). Flow at San Marcos Springs has been monitored intermittently since 1894, with more reliable measurements beginning in 1956 (USGS gage 08170000) (Puente 1976, p. 27; U.S. Geological Survey 2022, unpaginated).

Relevant Pesticide Use Sites

Specific pesticide use sites were not discussed. FWS documents note that "Although water quality in the Edwards Aquifer is generally good, several studies have detected contaminants in groundwater from the southern segment including nitrates, herbicides, pesticides, and polycyclic aromatic hydrocarbons, among many others (Fahlquist and Ardis, 2004 pp. 7-8, 10; Johnson et al. 2009, pp. 10-13, 23-26, 31-35; Musgrove et al. 2014, pp. 67, 69-71; Opsahl et al. 2018, p. 58; Opsahl et al. 2020, pp. 17-30).

Threats

"A primary threat to the habitat of the San Marcos salamander is the potential loss of springflows and reduced water quantity underground brought on by groundwater withdrawals from the San Antonio segment of the Edwards Aquifer." (5-Year Review, 2024, p. 14).

"Water quality at the San Marcos springs ecosystems is influenced by groundwater and surface water. The spring ecosystem depends on groundwater flow from the San Antonio segment of the Edwards Aquifer. This segment of the aquifer is fed by many stream systems that enter the aquifer through

recharge features. The Edwards Aquifer is vulnerable to contamination because the limestone and carbonate rocks are highly permeable and exposed at the surface in the recharge zone (Clark 2000, pp. 1-2, 8-9; Burri et al. 2019, p. 150). Contaminants, commonly linked to urban and suburban activities such as residential and commercial development, industrial operations, transportation infrastructure, and waste disposal, tend to accumulate in higher concentrations within the shallow areas of recharge zones, especially in regions characterized by urban land uses" (5-Year Review, 2024, p. 15).

- **Reclassification Criteria**

No information available in 5-Year Review, 2024.

- **Delisting Criteria**

No information available in 5-Year Review, 2024.

- **Recovery Actions**

"Continue to plan and implement regular surveys that monitor San Marcos salamander occurrence, habitat condition, groundwater and surface water quality, as well as any potential threat to San Marcos salamander from disease and parasitism. · Incorporate habitat-centered biological goals and objectives during the EARIP HCP renewal process to promote protection of suitable habitat quality and quantity and species resiliency. · Ensure continuation of the captive propagation research · Continue to conduct ongoing research to enhance captive propagation techniques. · Develop the capacity to produce offspring on-demand, anticipating potential catastrophic events or extirpation in the wild. · Continue to examine genetic variability among sub-populations of San Marcos salamander in order to evaluate gene flow, population structure, and estimate population sizes. These data can inform captive husbandry practices to preserve genetic diversity in the refugia population and future recovery plan implementation." (5-Year Review, 2024 p. 24)

3. **Description of Species Range**

This species range is highly refined, including a 16 acre area in or near the San Marcos River. The range was last updated in 2020.

Figure 2. Range of the San Marcos Salamander

4. **Critical Habitat**

There is designated critical habitat for this species depicted below. Critical habitat is a subset of the 16-acre range.

Figure 3. Designated Critical Habitat of the San Marcos Salamander

5. **Known Locations**

- Occurrences Described in FWS Documents

"The San Marcos salamander is only found in Spring Lake and downstream in the San Marcos River to approximately 152 m (500 ft) below Spring Lake Dam. The species was also collected in 2015 at the Texas State University Artesian well, indicating the species may utilize subsurface habitats.

Extant populations:

- "Efforts to estimate San Marcos salamander populations is intensive and somewhat limited because juveniles are small, and salamanders can move undetected into interstitial spaces in the substrate. Mark-recapture methods would most likely focus on salamanders at the surface. Population genetics could provide a total population estimate but would likely not distinguish between the surface and subsurface individuals. Previous population estimates for the San Marcos salamander have ranged from 17,000 to 21,000 individuals in the floating algal mats at the uppermost portion of Spring Lake, to as many as 53,200 salamanders from Spring Lake and the rocky substrates within about 46 meters (m) (150 feet (ft)) downstream of the Spring Lake Dam." (5-Year Review, 2024 p. 7)

Occurrences Described in public databases:

Developers searched for occurrences in iNaturalist, GBIF, and Natureserve. Collectively, the occurrence data from these databases were consistent with the species range given their precision and scale.

- iNaturalist (https://www.inaturalist.org/observations?quality_grade=research&subview=map&taxon_id=27091)
- GBIF: https://www.gbif.org/
- NatureServe: https://explorer.natureserve.org/pro/Welcome