

Interim Core Map Documentation for Buena Vista Lake Ornate Shrew

December 17th, 2024

Developed by US Environmental Protection Agency, Office of Pesticide Programs

Species Summary

Buena Vista Lake Ornate Shrew (*Sorex ornatus relictus*; Entity ID #58) is an endangered mammal. This species is commonly found near open water in areas with a dense vegetative understory or a deep layer of leaf litter near the southern portion of the San Joaquin Valley, California (the Tulare Basin). There is a designated critical habitat for this species. Additional information is provided in **Appendix 1**. This species is currently included in the Vulnerable Species Action Plan.

Description of Core Map

The core map for Buena Vista Lake Ornate Shrew is based on biological information, specifically the species' known locations. All of the current known locations with extant members of the species have been identified by the U.S. Fish and Wildlife Service (FWS) in the 2020 Species Status Assessment. These known locations are mappable, and EPA considers them to be the best available information on which to base a core map for this species. **Figure 1** depicts the interim core map for Buena Vista Lake Ornate Shrew. The core map represents 23,000 acres.

Landcover categories within the core map area are included in **Table 1**. Landcover is predominantly herbaceous wetlands and cultivated lands. However, upon visual inspection, the cultivated land overlap may be erroneous, and related to data resolution. Based on aerial imagery, known location patches seem to be adjacent to agricultural land but do not represent agricultural land (see **Appendix 3** for maps of each location).

The core map developed for the Buena Vista Lake Ornate Shrew is considered interim. This core map will be used to develop pesticide use limitation areas (PULAs) that include the Buena Vista Lake Ornate Shrew. However, this interim core map may be revised in the future to incorporate species expert feedback from FWS. This interim core map has a "limited" best professional classification because it consists of known location information taken directly from FWS documents and left unaltered. Little professional judgment was needed to interpret the species location information. The developer has confidence in the core map because it contains all of the species' known occurrences, designated critical habitat, and FWS noted that these locations represent all of the known extant populations for the species. This core map does not replace or revise any range or designated critical habitat developed by FWS for this species.

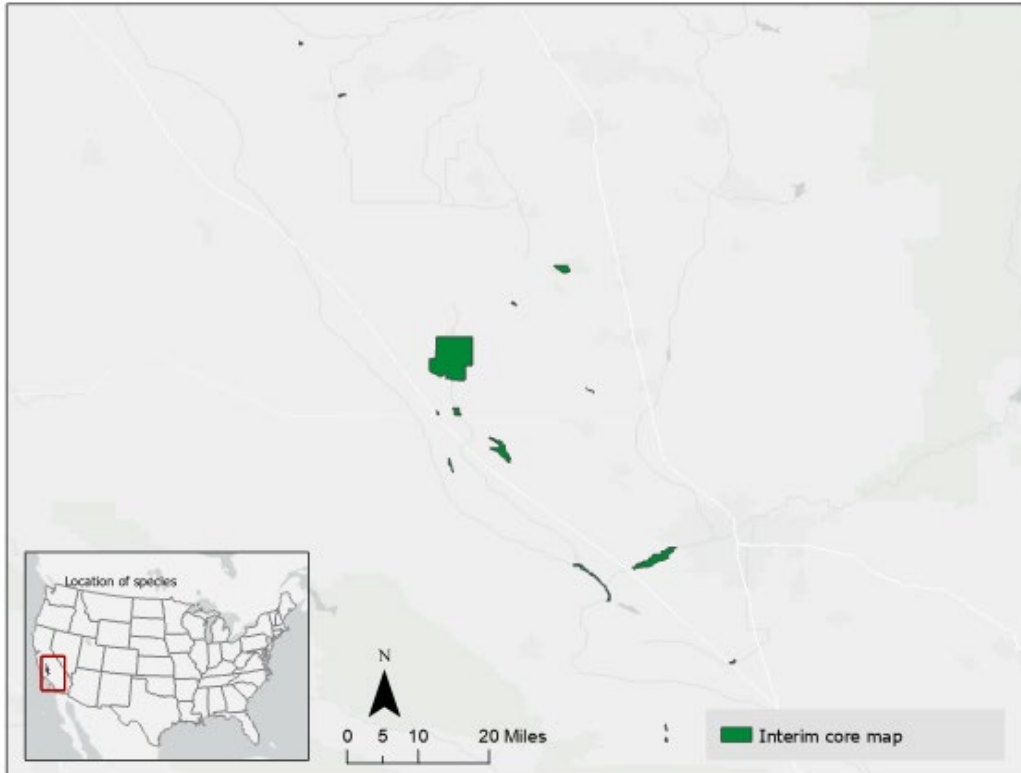


Figure 1. Interim core map for Buena Vista Lake Ornate Shrew.

Table 1. Percentage of Interim Core Map Represented by NLCD¹ Land Covers and Associated Example Pesticide Use Sites/Types.

Example pesticide use sites/types	NLCD Land Cover (Value)	% of core map represented by landcover	% of core map represented by example pesticide use
Forestry	Deciduous Forest (41)	0	0
	Evergreen Forest (42)	0	
	Mixed Forest (43)	0	
Agriculture	Pasture/Hay (81)	0	28
	Cultivated Crops (82)	28	
Mosquito adulticide, residential	Open space, developed (21)	1	2
	Developed, Low intensity (22)	1	
	Developed, Medium intensity (23)	0	
	Developed, High intensity (24)	0	
Invasive species control	Woody Wetlands (90)	6	70
	Emergent Herbaceous Wetlands (95)	43	

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

	Open water (11)	1	
	Grassland/herbaceous (71)	19	
	Scrub/shrub (52)	1	
	Barren land (rock/sand/clay; 31)	0	
Total Acres	Interim Core Map Acres	~ 23,000	

Evaluation of Known Location Information

There are three datasets with known location information:

- Descriptions of locations provided by FWS;
- Occurrence locations in iNaturalist; and
- Occurrence locations in GBIF.

EPA evaluated these three sets of data before selecting the type of core map and developing the core map. iNaturalist had no observations for this species. GBIF had 26 occurrences, all of which were from the year 2000 or earlier. EPA did not use these occurrences to alter the core map given the age and resolution of these occurrences because FWS' more recent 2020 Species Status Assessment detailed the known locations of this species. There are 15 occurrences identified by FWS with extant members of this species. Location data included in the Species Status Assessment is visualized in **Appendix 2**. **Appendix 1** includes additional details 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”). This core map was developed by EPA using the 4 steps described in the process document:

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

For step 1, EPA compiled available information for Buena Vista Lake Ornate Shrew from FWS, as well as observation information available from various publicly available sources (**Appendix 1**). Influential information that impacted the development of the core map included:

- FWS indicated in the 2020 Species Status Assessment that there are 15 locations where the species is known to still occur (be extant);
- FWS provided satellite images and detailed maps of these 15 known locations;
- These 15 known locations are highly refined and include the species' critical habitat.

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

For step 2, EPA used the compiled information to identify the core map type, including species range, critical habitat, and known location information. EPA found that the 15 known locations identified by FWS as the only places where the species is known to be extant also include the species' critical habitat. Based on this information, EPA selected the biological information core map type, which consists of these known locations identified by FWS. Critical habitat was considered as the core map type but was not selected because it does not contain all of the known locations with extant populations of this species identified by FWS. The range of the species was not selected as the core map because it contains areas where the species does not live (based on landcover information that represents areas that are not likely habitat).

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 known locations for Buena Vista Lake Ornate Shrew as identified by FWS in the 2020 Species Status Assessment. For each known location, the precise location was determined and the geojson.io tool was used to draw a polygon to match the figure from FWS. **Appendix 2** provides more details on the GIS analysis and data used to generate the core map.

This core map has not been formally reviewed by FWS, but may be reviewed by FWS species experts in the future. This core map may be revised after FWS species expert review.

Appendix 1. Information Compiled During Step 1 for the Buena Vista Lake Ornate Shrew

1. Recent FWS documents/links

- Environmental Conservation Online System (ECOS). 2024. Available at: <https://ecos.fws.gov/ecp/species/1610>
- Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Buena Vista Lake Shrew A Rule by the [Fish and Wildlife Service](#). 2013. Available at <https://www.federalregister.gov/documents/2013/07/02/2013-15586/endangered-and-threatened-wildlife-and-plants-designation-of-critical-habitat-for-buena-vista-lake>
Docket link: <https://www.regulations.gov/document/FWS-R8-ES-2009-0062-0054>
- 5-Year Review. 2020. Buena Vista Lake Ornate Shrew (*Sorex ornatus relictus*). Available at: https://ecos.fws.gov/docs/five_year_review/doc6576.pdf
- Buena Vista Lake Ornate Shrew Species Status Assessment, Version 1.0. 2020. Available at <https://www.fws.gov/node/70324>
- Sacramento Fish and Wildlife Office. Biological Opinion with California Department of Transportation. 08ESMF00-2021-E-05071. 2021. Available at: <https://www.fws.gov/node/258739>
- Recovery Plan for Upland Species of the San Joaquin Valley, California. 1998. Available at: <https://www.fws.gov/node/68609>

2. Background information

- Status: Federally listed as endangered in 2002
- Resiliency, redundancy, and representation (the 3Rs). All data from Buena Vista Lake Ornate Shrew Species Status Assessment, Version 1.0. Aug 31, 2020
 - “BVLOS currently shows greater redundancy and representation than what was known at the time of listing. In the future, resiliency is likely to decrease generally due to changing climate, insufficient water, selenium, pesticides, and inbreeding depression. Redundancy also appears likely to decrease due to population losses from changing climate, insufficient water, and additional development. If the populations lost include those supporting important diversity within the subspecies, then representation will decrease in the future as well.”
 - Resiliency of the species is summarized in **Table A1-1**.

Table A1-1. Information on Buena Vista Lake Ornate Shrew Resiliency

Location	Habitat Quality (1–3)	Protection & Mgt (1–3)	Water Stability (1–3)	Selenium Safety (0.5–1.5)	Pesticide Safety (0.5–1.5)	Current Resiliency
NAS Lemoore	Low (1)	High (3)	Moderate (2)	Moderate (1)	Low (0.5)	Moderate (7.5)
Lemoore Wetland Reserve	Low (1)	High (3)	High (3)	Moderate (1)	Low (0.5)	Moderate (8.5)
Pixley NWR	High (3)	High (3)	High (3)	High (1.5)	Moderate (1)	High (11.5)
Atwell Island	Moderate (2)	High (3)	High (3)	Moderate (1)	High (1.5)	High (10.5)
Kern NWR	High (3)	High (3)	High (3)	Low (0.5)	High (1.5)	High (11)
Poso Creek	Low (1)	Low (1)	Low (1)	High (1.5)	Low (0.5)	Low (5)
Semitropic Ecological Reserve	Low (1)	Moderate (2)	Low (1)	Moderate (1)	Moderate (1)	Low (6)
Kern River Overflow Canal at Fwy 5 & Hwy 46	Low (1)	Low (1)	Low (1)	High (1.5)	Moderate (1)	Low (5.5)
Goose Lake	Moderate (2)	Moderate (2)	Low (1)	Moderate (1)	Low (0.5)	Moderate (6.5)
Kern River Overflow Canal at Semitropic Canal Crossing	Low (1)	Low (1)	Low (1)	Moderate (1)	Low (0.5)	Low (4.5)
Kern Fan	Low (1)	Moderate (2)	Low (1)	High (1.5)	Moderate (1)	Moderate (6.5)
Coles Levee	Low (1)	Moderate (2)	High (3)	High (1.5)	Moderate (1)	Moderate (8.5)
Kern Lake	Low (1)	Low (1)	High (3)	Moderate (1)	Low (0.5)	Moderate (6.5)
Wind Wolves – Twin Fawns	Low (1)	Moderate (2)	High (3)	High (1.5)	High (1.5)	Moderate (9)
Wind Wolves – The Willows	Moderate (2)	Moderate (2)	High (3)	High (1.5)	High (1.5)	High (10)

- Redundancy: significantly improved from time of listing.
 - 15 occupied population locations that are assumed still occupied despite failure to find BVLOS during the most recent survey in 2017 (last Five-Year Review, in 2011, only eight occupied locations were known).
- Representation: recent discovery of three population clusters with moderate genetic variation across them:
 - Lemoore Wetland Reserve, the two Wind Wolves sites, and Goose Lake, has high resiliency at one location and moderate resiliency at the other three sites, leaving 74 it relatively well-positioned for preservation.
 - Atwell Island, Kern NWR, The Semitropic Ecological Reserve, Coles Levee, and the Kern Fan Recharge, includes two sites with high current resiliencies, and so is also relatively well-positioned for preservation of representative sites.
 - Kern Lake on private land with low protection and management. The likelihood of preserving representatives of this genetic cluster is thus lower than for the other

clusters, and overall representation would increase if protection or management at the site could somehow be improved.

- **Habitat:** Data taken from Buena Vista Lake Ornate Shrew Species Status Assessment, Version 1.0. Aug 31, 2020
 - most commonly been found near open water, in areas with a dense vegetative understory or a deep layer of leaf litter.
 - moist soil and dense cover from riparian or emergent marsh vegetation.
 - dense vegetation provides protection from predators and supports prey items such as insects and other invertebrate species.
 - downed logs and branches may also be important.
 - (sub-optimal habitat) occasionally been found in drier areas with fairly dense vegetation consisting of grassland, alkali desert scrub, alkali sink scrub, or (less frequently) disturbed habitats.
 - areas typically have a seasonal or artificial water source within several hundred feet, or a high water table, that maintains fairly moist soils at or just below surface level.
 - large areas with somewhat dense vegetative cover and soils moist enough to support a marginal prey base, may be important for movement and dispersal.
 - may also use more narrow corridors of optimal or suboptimal habitat for this dispersal habitat.

- **Relevant Pesticide Use Sites**
 - “Because BVLOS are distributed among small patches of habitat in a landscape otherwise dominated by agriculture, they could be exposed to lethal or unhealthy concentrations of pesticides sprayed on nearby crops, or of herbicides sprayed on roadsides and canal banks (FWS 2011, p. 15). Pesticides could also affect BVLOS indirectly by lowering their prey base (Ma and Talmage 2001, p. 11).” (Buena Vista Lake Ornate Shrew Species Status Assessment, Version 1.0. Aug 31, 2020)
 - “6(9) Effects of Pesticides Pesticide application data for 2016 (the most recent year available) shows heavy to moderate use of neonicotinoids in the vicinity of six of the eleven locations occupied by BVLOS, and heavy to moderate use of cholinesterase inhibitors (such as malathion) at seven locations (FWS in litt. 2019, pp. 1–2)” (Buena Vista Lake Ornate Shrew Species Status Assessment, Version 1.0. Aug 31, 2020).

In **Table A1-2**, below, pesticide condition levels have been characterized in the area surrounding each occupied BVLOS site using overall scores of 0 to 6. Overall scores reflect the combination of scores from 0 to 3 for each of the two common pesticide types applied. Higher scores indicate better conditions for BVLOS, so areas with no application of a given pesticide were assigned a value of 3, those with light pesticide application were assigned a 2, and moderate and heavy application levels were assigned 1 and 0, respectively. (Buena Vista Lake Ornate Shrew Species Status Table 2. Pesticide Condition Levels (Assessment, Version 1.0. Aug 31, 2020).

Table A1-2. Pesticide condition in the area surrounding each occupied BVLOS site.

Location	Cholinesterase Inhibitors	Neonicotinoids	Numerical Score	Descriptive Category
NAS Lemoore	0	0	0	Low
Lemoore Wetland Reserve	0.5 (0 & 1)	0	0.5	Low
Pixley NWR	1	2	3	Moderate
Atwell Island	2	3	5	High
Kern NWR	2	3	5	High
Poso Creek	1.5 (2 & 1)	0.5 (1 & 0)	2	Low
Semitropic Ecological Reserve	2 (3 & 1)	1.5 (3 & 0)	3.5	Moderate
Kern River Overflow Canal at Fwy 5 & Hwy 46	2 (3 & 1)	1.5 (3 & 0)	3.5	Moderate
Goose Lake	1	1	2	Low
Kern River Overflow Canal at Semitropic Canal Crossing	1	0	1	Low
Kern Fan	1.5 (2 & 1)	2 (3 & 1)	3.5	Moderate
Coles Levee	1 (2, 1, & 0)	1.3 (3, 1, & 0)	2.3	Moderate
Kern Lake	0	0	0	Low
Wind Wolves –	3	3	6	High

66

Twin Fawns				
Wind Wolves – The Willows	3	3	6	High

- Relevant Recovery Criteria and Actions
 - 2020 5-Year Review: There are currently no recovery criteria for the BVLOS
 - Recovery Plan for Upland Species of the San Joaquin Valley, California. Sep 30, 1998
 - Recovery criteria for the BVLOS were not included in the Recovery Plan for Upland Species of the San Joaquin Valley, California (1998), because the recovery plan was written and finalized when the BVLOS was a candidate for listing but was not yet listed under the Act. However, the recovery plan did provide three criteria for long-term conservation of the BVLOS (Service 1998, p. 192).
 - Habitat protection for three or more disjunct occupied sites with (collectively) at least 2,000 hectares (ha) (4,940 acres (ac)) of occupied habitat;
 - An approved and implemented management plan for all protected areas, that includes BVLOS survival as an objective;
 - Continuing BVLOS presence at known occupied sites, as shown by population monitoring.

- Recovery Criteria/Objectives from 1998 Plan
 - “The Kern Lake site should be preserved in perpetuity for the Buena Vista Lake shrew.”
 - Greater efforts to locate and protect other extant populations of Buena Vista Lake shrews within the Tulare Basin are needed
 - Critical to conservation is the establishment of habitat that can support expansion and introduction efforts.
 - Expansion of habitat, introduction efforts, and the protection of the Buena Vista Lake shrew should be an objective of any future National Wildlife Refuge and Ecological Reserve development and management plans.
 - The status of the Buena Vista Lake shrew should be reevaluated within 3 years of recovery plan approval.
- Recovery Actions
 - Establishment of the Kern Lake Preserve.

3. Description of Species Range (Figure A1-1)

- <https://www.fws.gov/species/buena-vista-lake-ornate-shrew-sorex-ornatus-relictus>

Historical range is thought to be within the moist habitat surrounding the wetlands of the Kern, Buena Vista, Goose and Tulare lakes on the San Joaquin Valley floor, below elevations of 350 feet. Much of the shrew’s original wetland habitat has been drained and converted to agricultural land or is no longer suitable habitat due to changes in vegetation, and the spread of non-native plant species.

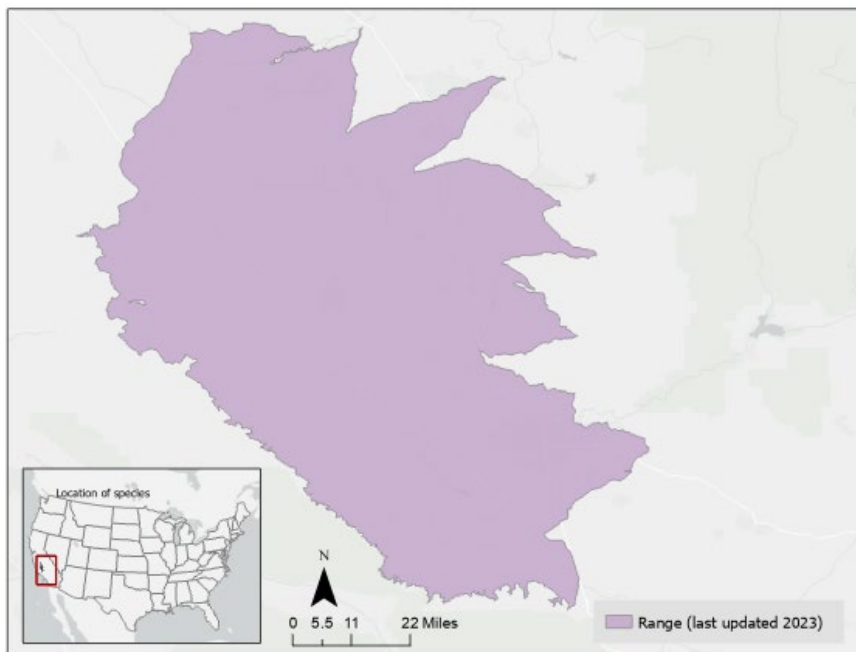


Figure A1-1. ECOS Range for BVLOS (<https://ecos.fws.gov/ecp/species/1610>) Total acreage of range is approximately 3,300,000 acres. <https://ecos.fws.gov/ecp/species/1610>).

4. Description of Critical Habitat (Figure A1-2)

- First designated final critical habitat in 2005.

- Updated in 2013: new designation effective August 1, 2013.
- <https://ecos.fws.gov/ecp/report/table/critical-habitat.html>
- <https://www.federalregister.gov/documents/2013/07/02/2013-15586/angered-and-threatened-wildlife-and-plants-designation-of-critical-habitat-for-buena-vista-lake>
- <https://www.regulations.gov/document/FWS-R8-ES-2009-0062-0054>
- 2013 Final Rule: Approximately 2,485 acres (1,006 hectares) in Kings and Kern Counties, California, fall within the boundaries of the critical habitat designation. From the 2012 proposed rule: “In 2009, we proposed to revise our critical habitat designation to consist of 4,649 acres (1,881 hectares) of land in five units in Kern County. That acreage has been recalculated, with use of current Geographic Information Systems technology, as 4,657 acres (1,885 hectares). In this revised proposal, we propose to add 525 acres (212 hectares) as critical habitat in the general areas of Kings and Kern Counties, California, including new units near Lemoore, Kings County, and near Semitropic, Kern County, California. In total, we are now proposing to designate approximately 5,182 acres (2,098 hectares) as critical habitat for the Buena Vista Lake shrew.”
- Primary Constituent Elements for this species: “Permanent and intermittent riparian or wetland communities that contain:
 - A complex vegetative structure with a thick cover of leaf litter or dense mats of low-lying vegetation. Associated plant species can include, but are not limited to, Fremont cottonwoods, willows, glasswort, wild-rye grass, and rush grass. Although moist soil in areas with an overstory of willows or cottonwoods appears to be favored, such overstory may not be essential.
 - Suitable moisture supplied by a shallow water table, irrigation, or proximity to permanent or semipermanent water; and
 - A consistent and diverse supply of prey. Although the specific prey species used by the Buena Vista Lake shrew have not been identified, ornate shrews are known to eat a variety of terrestrial and aquatic invertebrates, including amphipods, slugs, and insects.”

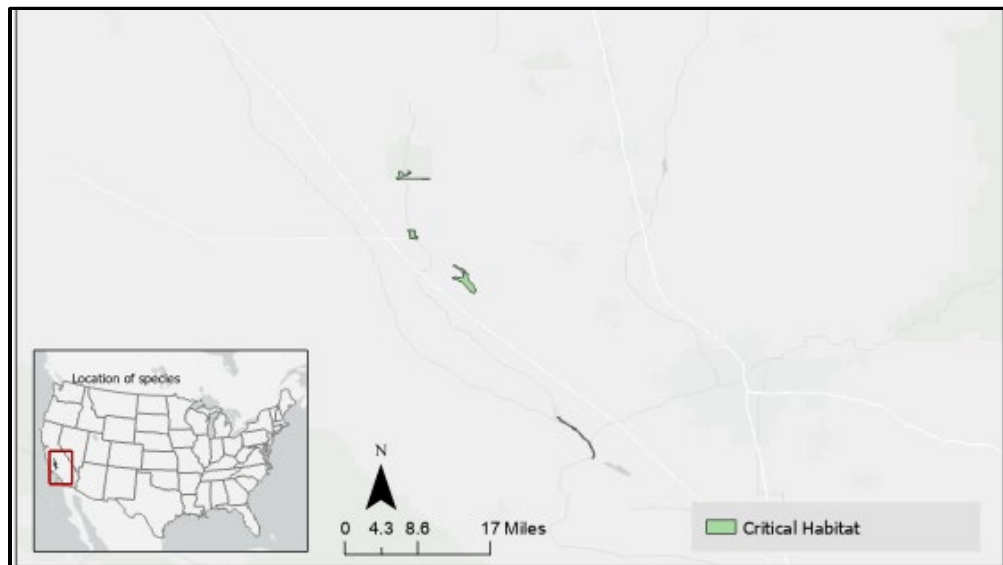


Figure A1-2. ECOS Critical Habitat for BVLOS. Total acreage of Critical Habitat is approximately 2,500 acres.

5. Known Locations/Occurrence Data

• Occurrences Described in FWS Documents

15 known occupied locations according to FWS’ 2020 Species Status Assessment. The species is “Known from 11 sites in the southern portion of the San Joaquin Valley, California (the Tulare Basin).” (Buena Vista Lake Ornate Shrew Species Status Assessment, Version 1.0. 2020).

• Additional information on known locations in FWS Species Status Assessment is in **Table A1-3 and Figure A1-3.**

• Additional sources

- Source 1: iNaturalist <https://www.inaturalist.org/observations>: No observations
- Source 2: GBIF <https://www.gbif.org/>: 26 observations

Table A1-3. Known Sites with Buena Vista Lake Ornate Shrew from the Species Status Assessment

Location (Listed N to S)	Considered Present at Time of Listing in 2002? (4 areas) ¹	Considered Present When Critical Habitat Designated in 2013? (8 areas) ²	Considered Present in 2020? (15 areas) ³
NAS Lemoore	No – not surveyed	No – not surveyed	Yes
Lemoore Wetland Reserve	No – not surveyed	Yes (Critical Habitat Unit 7)	Yes, but no recent surveys*
Pixley NWR	No – not surveyed	No ⁴	Yes
Atwell Island	No – not surveyed	Yes (but habitat suboptimal - not critical habitat)	Yes, (newly created optimal habitat)
Lake Woollomes	No – not surveyed	No ⁴	No
Kern NWR	Yes	Yes (Critical Habitat Unit 1)	Yes
Poso Creek	No – not surveyed	No – not surveyed	Yes
Semitropic Ecological Reserve	No – not surveyed	Yes (“Main drain canal”) (Critical Habitat Unit 6)	Yes
Kern River Overflow Canal at Fwy 5 & Hwy 46	No – not surveyed	No – not surveyed	Yes
Semitropic Water District Overflow	No – not surveyed	No – not surveyed	No
Tumblin Lake	No – not surveyed	No – not surveyed	No
Goose Lake	No – not surveyed	Yes (Critical Habitat Unit 2)	Yes, but no recent surveys*
Kern River Overflow Canal at Semitropic Canal Crossing	No – not surveyed	No – not surveyed	Yes
Hart Park	No – not surveyed	No – not surveyed	No
Panorama Vista Preserve	No – not surveyed	No – not surveyed	No
Tule Elk Reserve	No – not surveyed	No ⁴	No
Kern Fan Water Recharge Area	Yes	Yes (Critical Habitat Unit 3)	Yes
Coles Levee Ecological Preserve	Yes	Yes (Critical Habitat Unit 4)	Yes, but not found by recent survey** (Additional surveys needed).
Buena Vista Recreation Area	No – not surveyed	No ⁴	No
Tejon Ranch	No – not surveyed	No – not surveyed	No
Kern Lake	Yes	Yes (Critical Habitat Unit 5)	Yes, no recent surveys*



Figure A1-3. Map of Locations Surveyed, with BVLOS Presence or Absence Noted (sources below).

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

1. Dataset References and Software

- **Software used:** geojson.io and R-4.4.2 for Windows
- Known locations from FWS Species Status Assessment³

2. Datasets Used in Core Map Development

All datasets used in core map development are described in EPA's process document.

³ <https://ecos.fws.gov/ServCat/DownloadFile/178536>

3. Core Map Development

This section describes the process used to develop a core map based on known locations identified in FWS' species status assessment³. **Figure A2-1** summarizes the R code used to create the core map. R-4.4.2 for Windows was used to run the code.

```
library(dplyr)
library(geojsonsf)
library(ggmap)
library(ggpattern)
library(ggplot2)
library(ggthemes)
library(sf)
library(units)

register_google("AIzaSyC6sQ_6vcSvg0LSunfTT4H5jiM-rcEdYXU")
```

Figure A2-1. The above code was used to add necessary libraries for the creation of this core map and has been included for reproducibility. Below is list of functionalities provided by each line.

- dplyr: used to data manipulation
- geojsonsf: used for working with and reading in geojson files
- ggmap: used for creating the basemap layers
- ggpattern: used for plotting sf objects with pattern fill
- ggplot2: needed for general plotting of maps
- ggthemes: provides clean themes for map display
- sf: needed to manipulate simple features (think spatial) objects
- units: needed to convert units from sq. ft. to acres
- The last line simply registers an API access key to use Google generated base map layer. Please create and register your own Google key when reproducing this code.

4. Mapping Known Locations Description and General Methodology

This document aims to reproduce the detailed known location maps for the Buena Vista Lake Ornate Shrew. The maps of known locations (15 sites) are taken from the FWS Species Status Assessment which can be found [here](#)⁴. The maps start on page 21 of the FWS document. FWS did not provide shapefiles for these maps; therefore, the developer translated the figures from FWS into shapefiles. The shapefiles were manually drawn using [geojson.io](#) to match the figures provided by FWS.

- 1) To locate the sites provided by FWS, there is oftentimes enough information on the map provided by FWS to pin the location exactly. Other times, there is not.
 - a) When there was not enough information, the developer searched the site name from FWS (e.g., NAS Lemoore) using on Google Maps. FWS listed the locations in order from north to south so that the search can be confined to areas south of the previous location.
 - b) For reproducibility later on, the exact latitude/longitude coordinates for each site are listed below within the code chunks.
- 2) Once the location was found on Google Maps, the developer turned over to the [geojson.io](#) tool to draw the polygon to match the figure from FWS.
 - a) Sometimes, the satellite images between the FWS document and [geojson.io](#) were similar enough so that the exact shape from FWS can be drawn.
 - b) Other times, matching the FWS map exactly is not feasible due to either insurmountable disparity between the satellite images or due to the polygon being too irregularly shaped.

⁴ <https://ecos.fws.gov/ServCat/DownloadFile/178536>

- c) As such, the manually drawn polygons of known locations will not perfectly match the FWS’s document but is drawn so that it is erred on the side of being “too large”. This simplification of the polygons is done to minimize tedious manual work or to minimize (false negative) errors.

Appendix 3 include a map for each location and highlights any challenges when identifying the specific location. Alongside each mapped polygon is the original image from the FWS document (linked above) for comparison. Details related to reproducibility that are location specific will be mentioned within each location’s subsection below. **Appendix 4** includes the code used for generating each of the maps.

Appendix 3. Maps of Each Known Location for the Buena Vista Orate Shrew

Location #1: Naval Air Station (NAS) Lemoore

The main challenges to matching the FWS figure concerns the northwest and eastern parts of the map. There appears to be a visible contour on the northwest part, but a slight buffer was added to ensure all relevant areas were captured. For the eastern part, EPA used the small pond to the southeast border as a reference guide. For the parts of the polygon that run close to the south/west/southwest road, EPA simply took added buffers up to the road (**Figure A3-1**).



(a) Manually Drawn



(b) FWS

Figure A3-1: Lemoore Naval Air Station (NAS), a comparison of manually drawn (a) and the figure provided in the FWS documentation (b).

Location #2: Lemoore Wetland Reserve

Figure A3-2 compares maps for the Lemoore Wetland Reserve. The maps match.

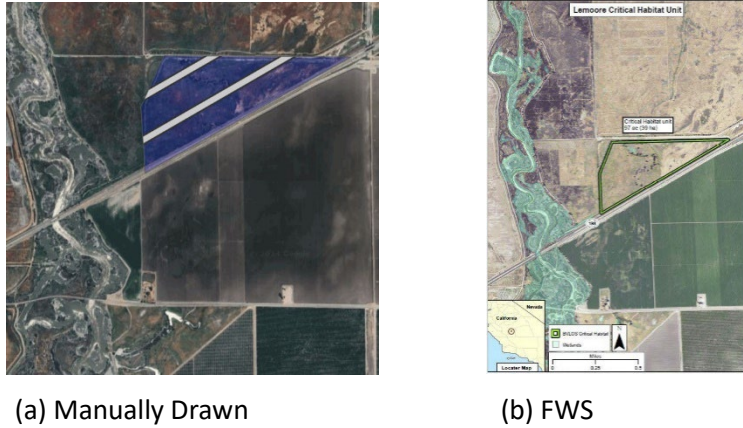


Figure A3-2: Lemoore Wetland Reserve, a comparison of manually drawn (a) and the figure provided in the FWS documentation (b).

Location #3: Pixley National Wildlife Refuge

Figure A3-3 compares maps for Pixley National Wildlife Refuge (NWR). The maps are basically an exact match, and the shape of FWS map is easily visible.

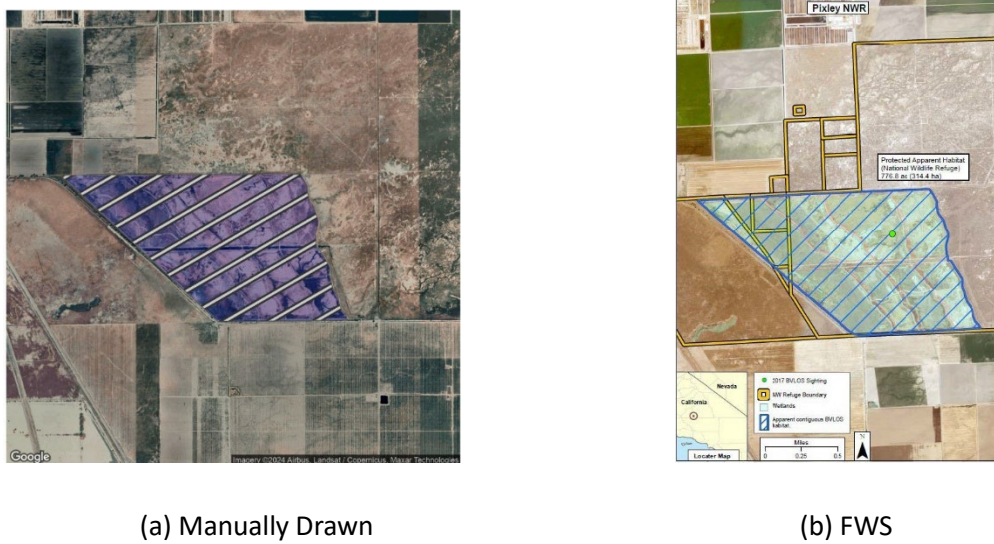
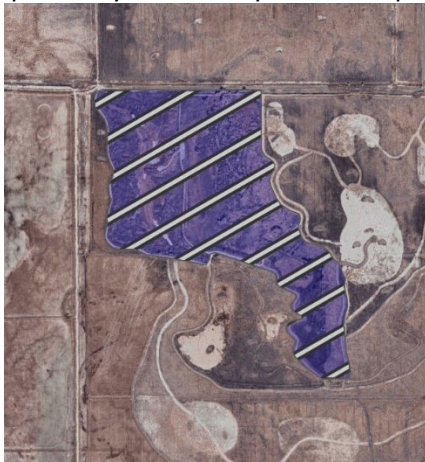


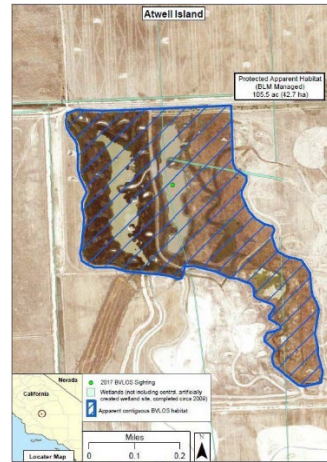
Figure A3-3: Pixley National Wildlife Refuge (NWR), a comparison of manually drawn (a) and the figure provided in the FWS documentation (b).

Location #4: Atwell Island

Figure A3-4 compares maps for Atwell Island. The maps are basically an exact match, and the shape of FWS map is easily visible despite the shape being irregular.



(a) Manually Drawn



(b) FWS

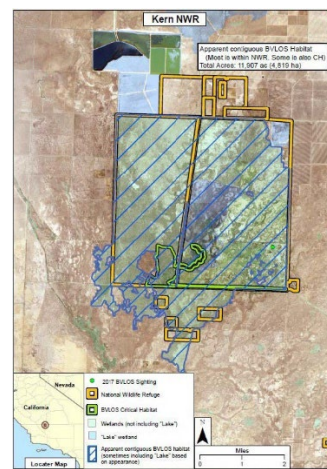
Figure A3-4: Atwell Island, a comparison of manually drawn (a) and the figure provided in the FWS documentation (b).

Location #5: Kern National Wildlife Refuge

Figure A3-5 compares maps for Kern National Wildlife Refuge (NWR). Most of the FWS map is exactly matched except for the southwestern part and some small parts in the northeastern part. For the northeastern part, EPA used what appears to be parcel borders to draw along. The southwestern part was drawn to include a large area using the visible green patches and visible roads as reference points for where the maximum southern and western reaches of the FWS polygon are located.



(a) Manually Drawn



(b) FWS

Figure A3-5: Kern National Wildlife Refuge (NWR), a comparison of manually drawn (a) and the figure provided in the FWS documentation (b).

Location #6: Poso Creek

Figure A3-6 compares maps for Poso Creek. The maps are basically an exact match, and the shape of FWS map is easily visible.



(a) Manually Drawn

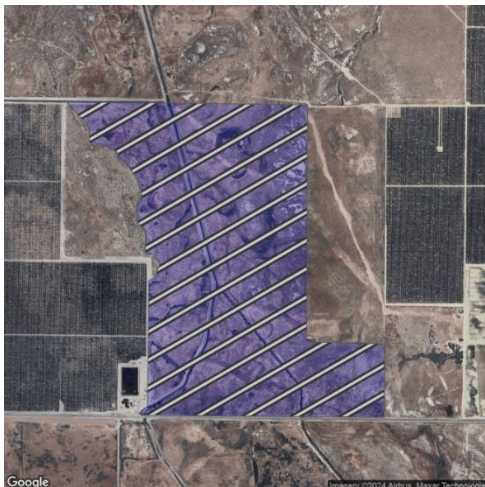


(b) FWS

Figure A3-6: Poso Creek (Blankenship Ave & CA-43, a comparison of manually drawn (a) and the figure provided in the FWS documentation (b).

Location #7: Semitropic Ecological Reserve

Figure A3-7 compares maps for Semitropic Ecological Reserve. The maps are basically an exact match, and the shape of FWS map is easily visible.



(a) Manually Drawn



(b) FWS

Figure A3-7: Semitropic Ecological Reserve (CA Hwy 46 and Main Drain Rd), a comparison of manually drawn (a) and the figure provided in the FWS documentation (b).

Location #8: Kern River Overflow Canal

Figure A3-8 compares maps for the Kern River Overflow Canal. FWS polygon is both irregularly shaped and hard to match features with newer satellite imagery. EPA primarily used roads and edges of greenery to capture the extreme reaches of the FWS polygon.



(a) Manually Drawn



(b) FWS

Figure A3-8: Kern River Overflow Canal (CA Hwy 46 and Fwy 5), a comparison of manually drawn (a) and the figure provided in the FWS documentation (b).

Location #9: Goose Lake Critical Habitat

Figure A3-9 maps for Goose Lake Critical Habitat. Another irregular FWS polygon with hard to match features. EPA used visible parcel boundaries to approximate FWS polygon.



(a) Manually Drawn



(b) FWS

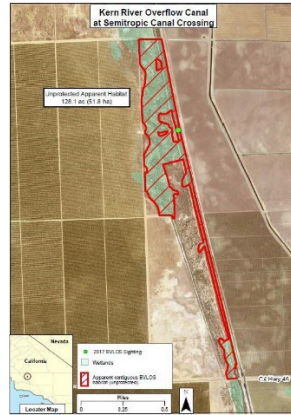
Figure A3-9: Goose Lake Critical Habitat (Between CA Fwy 5 & Hwy 46), a comparison of manually drawn (a) and the figure provided in the FWS documentation (b).

Location #10: Kern River Overflow Canal at Semitropic Canal Crossing

Figure A3-10 compares maps for Kern River Overflow Canal at Semitropic Canal Crossing. Another irregular polygon but most of the features are easily matched. Furthermore, FWS incorrectly labelled the bordering southern highway as CA Hwy 46 when in reality it is W Lerdo Hwy. EPA simplified many of the irregular shapes and made conservative buffers for the southern tip.



(a) Manually Drawn

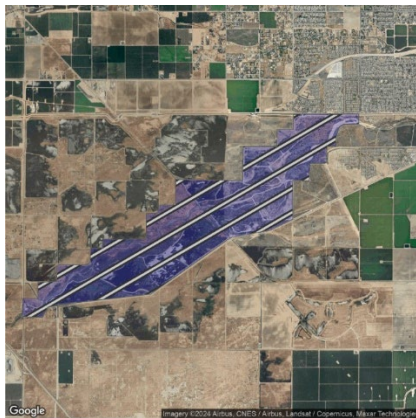


(b) FWS

Figure A3-10: Kern River Overflow Canal at Semitropic Canal Crossing, a comparison of manually drawn (a) and the figure provided in the FWS documentation (b).

Location #11: Kern Fan Water Recharge Area

Figure A3-11 compares maps for Kern Fan Water Recharge Area. The maps are basically an exact match, and the shape of FWS map is easily visible despite the shape being irregular.



(a) Manually Drawn



(b) FWS

Figure A3-11: Kern Fan Water Recharge Area, a comparison of manually drawn (a) and the figure provided in the FWS documentation (b).

Location #12: Coles Levee Critical Habitat

Figure A3-12 compares maps for Coles Levee Critical Habitat. This also encapsulates Figure 17 of the FWS (SSA) document, i.e., the Coles Levee Pond. Much of the FWS polygon can be easily matched using the canal that borders the polygon to the west. Buffers were added when features are hard to identify and match.



(a) Manually Drawn



(b) FWS

Figure A3-12: Coles Levee Critical Habitat Unit, a comparison of manually drawn (a) and the figure provided in the FWS documentation (b).

Location #13: Kern Lake Critical Habitat Unit

Figure A3-13 compares maps for Kern Lake Critical Habitat Unit. The maps are basically an exact match, and the shape of FWS map is easily visible.



(a) Manually Drawn

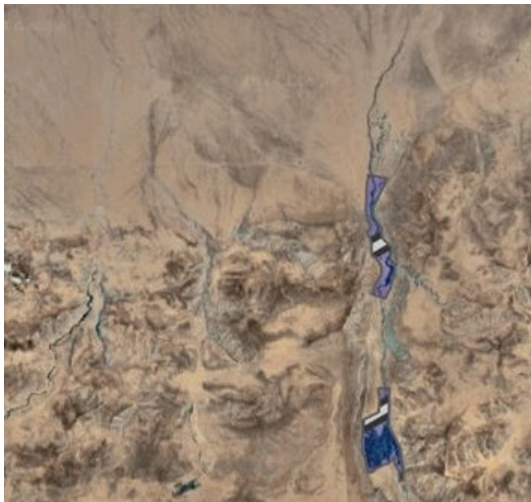


(b) FWS

Figure A3-13: Kern Lake Critical Habitat Unit, a comparison of manually drawn (a) and the figure provided in the FWS documentation (b).

Location #14 and 15: Wind Wolves Preserve (Twin Fawns & The Willows)

Figure A3-14 compares maps for Wind Wolves Preserve. This location combines the last two locations from the FWS document: the Twin Fawns Site and The Willows Site. Features are conforming enough to capture the FWS entirely but not exactly, i.e., the manually drawn map is drawn too large.



(a) Manually Drawn



(b) FWS

Figure A3-14: Wind Wolves Preserve, a comparison of manually drawn (a) and the figure provided in the FWS documentation (b).

All Locations

All locations are mapped together over top of a roadmap base layer in **Figure A3-15**.

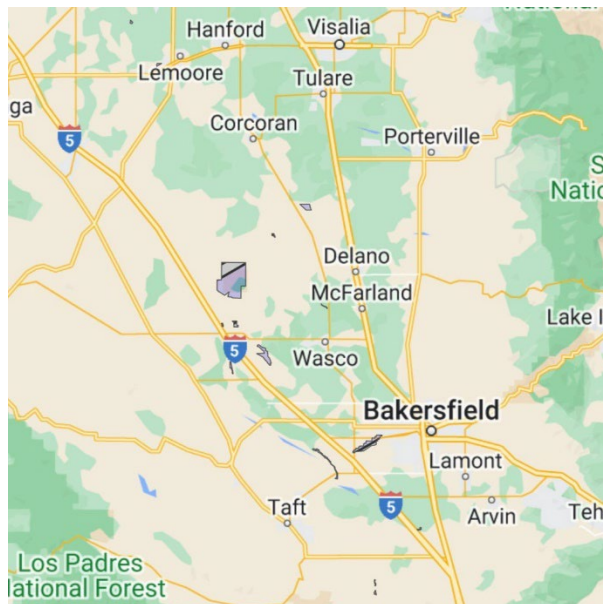


Figure A3-15. Interim Core Map plotted in R, containing all 15 Known Locations

Appendix 4. R Code Used to Generate Each Maps

Location #1: Naval Air Station (NAS) Lemoore

The code below (**Figure A4-1**) simply reads in the geojson object (or data) after it was hand drawn and saved locally. Then the code plots the map.

```
r1 = geojson_sf("r1_nas_lemoore.geojson")

p1 = ggmap(
  get_map(
    c(long = -119.930168, lat = 36.372655),
    zoom = 15,
    maptype = "satellite"
  )
) +

geom_sf_pattern(data = r1,
  inherit.aes = F,
  fill = alpha("blue",.2)) +
theme_map() +
theme(plot.margin = unit(c(0, -3, -.1, -3), 'lines')) # t, r, b, l

# ggsave("plot_r1_lemoore_nas.jpg", p1, scale = 3)
```

Figure A4-1. R code for plotting the map.

Location #2: Lemoore Wetland Reserve

The code below (**Figure A4-2**) simply reads in the geojson object (or data) after it was hand drawn and saved locally. Then the code plots the map.

```
r2 = geojson_sf("r2_lemoore_wetland_reserve_critical_habitat.geojson")

p2 = ggmap(
  get_map(
    c(long = -119.845714, lat = 36.267708),
    zoom = 14,
    maptype = "satellite"
  )
) +

geom_sf_pattern(data = r2,
  inherit.aes = F,
  fill = alpha("blue",.2)) +
theme_map()
```

Figure A4-2. R code for plotting the map.

Location #3: Pixley National Wildlife Refuge

The code below (**Figure A4-3**) simply reads in the geojson object (or data) after it was hand drawn and saved locally. Then the code plots the map.

```
r3 = geojson_sf("r3_pixley_nwr.geojson")

p3 = ggmap(
  get_map(
    c(long = -119.393179, lat = 35.914272),
    zoom = 14,
    maptype = "satellite"
  )
) +

geom_sf_pattern(data = r3,
  inherit.aes = F,
  fill = alpha("blue",.2)) +
theme_map()
```

Figure A4-3. R code for plotting the map.

Location #4: Atwell Island

The code below (**Figure A4-4**) simply reads in the geojson object (or data) after it was hand drawn and saved locally. Then the code plots the map.

```
r4 = geojson_sf("r4_atwell_island.geojson")

p4 = ggmap(
  get_map(
    c(long = -119.494431, lat = 35.844466),
    zoom = 15,
    maptype = "satellite"
  )
) +

geom_sf_pattern(data = r4,
  inherit.aes = F,
  fill = alpha("blue",.2)) +
theme_map()
```

Figure A4-4. R code for plotting the map.

Location #5: Kern National Wildlife Refuge

The code below (**Figure A4-5**) simply reads in the geojson object (or data) after it was hand drawn and saved locally. Then the code plots the map.

```
r5 = geojson_sf("r5_kern_nwr.geojson")

p5 = ggmap(
  get_map(
    c(long = -119.613641, lat = 35.730253),
    zoom = 12,
    maptype = "satellite"
  )
) +

geom_sf_pattern(data = r5,
  inherit.aes = F,
  fill = alpha("blue",.2)) +

# ggsave("plot_r5_kern_nwr.jpg", p5)
```

Figure A4-5. R code for plotting the map.

Location #6: Poso Creek

The code below (**Figure A4-6**) simply reads in the geojson object (or data) after it was hand drawn and saved locally. Then the code plots the map.

```
r6 = geojson_sf("r6_poso_creek.geojson")

p6 = ggmap(

  get_map(
    c(long = -119.339742, lat = 35.667154),
    zoom = 15,
    maptype = "satellite"
  )
) +

geom_sf_pattern(data = r6,
  inherit.aes = F,
  fill = alpha("blue",.2)) +
theme_map()
```

Figure A4-6. R code for plotting the map.

Location #7: Semitropic Ecological Reserve

The code below (**Figure A4-7**) simply reads in the geojson object (or data) after it was hand drawn and saved locally. Then the code plots the map.

```
r7 = geojson_sf("r7_semitropic_ecological_reserve.geojson")

p7 = ggmap(
  get_map(
    c(long = -119.610129, lat = 35.623763),
    zoom = 15,
    maptype = "satellite"
  )
) +

geom_sf_pattern(data = r7,
  inherit.aes = F,
  fill = alpha("blue",.2)) +
theme_map()
```

Figure A4-7. R code for plotting the map.

Location #8: Kern River Overflow Canal

The code below (**Figure A4-8**) simply reads in the geojson object (or data) after it was hand drawn and saved locally. Then the code plots the map.

```
r8 = geojson_sf("r8_kern_river_overflow_canal_fw5_hwy46.geojson")

p8 = ggmap(
  get_map(
    c(long = -119.650080, lat = 35.620941),
    zoom = 15,
    maptype = "satellite"
  )
) +

geom_sf_pattern(data = r8,
  inherit.aes = F,
  fill = alpha("blue",.2)) +
theme_map()
```

Figure A4-8. R code for plotting the map.

Location #9: Goose Lake Critical Habitat

The code below (**Figure A4-9**) simply reads in the geojson object (or data) after it was hand drawn and saved locally. Then the code plots the map.

```
r9 = geojson_sf("r9_goose_lake_critical_habitat.geojson")

p9 = ggmap(
  get_map(
    c(long = -119.518183, lat = 35.548155),
    zoom = 13,
    maptype = "satellite"
  )
) +
  geom_sf_pattern(data = r9,
    inherit.aes = F,
```

```
theme_map()
```

```
# ggsave("plot_r9_gooselake_ch.jpg", p9)
```

Figure A4-9. R code for plotting the map.

Location #10: Kern River Overflow Canal at Semitropic Canal Crossing

The below code (**Figure A4-10**) simply reads in the geojson object (or data) after it was hand drawn and saved locally. Then the code plots the map.

```
r10 = geojson_sf("r10_kern_river_overflow.geojson")

p10 = ggmap(
  get_map(
    c(long = -119.622683, lat = 35.511742),
    zoom = 14,
    maptype = "satellite"
  )
) +
  geom_sf_pattern(data = r10,
    inherit.aes = F,
    fill = alpha("blue",.2)) +
  theme_map()
```

Figure A4-10. R code for plotting the map.

Location #11: Kern Fan Water Recharge Area

The below code (**Figure A4-11**) simply reads in the geojson object (or data) after it was hand drawn and saved locally. Then the code plots the map.

```
r11 = geojson_sf("r11_kern_fan_water_recharge_area.geojson")

p11 = ggmap(
  get_map(
    c(long = -119.202322, lat = 35.326214),
    zoom = 13,
    maptype = "satellite"
  )
) +
  geom_sf_pattern(data = r11,
    inherit.aes = F,
    fill = alpha("blue",.2)) +
  theme_map()
```

Figure A4-11. R code for plotting the map.

Location #12: Coles Levee Critical Habitat

The below code (**Figure A4-12**) simply reads in the geojson object (or data) after it was hand drawn and saved locally. Then the code plots the map.

```
r12 = geojson_sf("r12_coles_levee_ch.geojson")

p12 = ggmap(
  get_map(
    c(long = -119.329141, lat = 35.278853),
    zoom = 13,
    maptype = "satellite"
  )
) +
  geom_sf_pattern(data = r12,
    inherit.aes = F,
    fill = alpha("blue",.2)) +
  theme_map()
```

Figure A4-12. R code for plotting the map.

Location #13: Kern Lake Critical Habitat Unit

The below code (**Figure A4-13**) simply reads in the geojson object (or data) after it was hand drawn and saved locally. Then the code plots the map.

```
r13 = geojson_sf("r13_kern_lake_ch.geojson")

p13= ggmap(
  get_map(
    c(long = -119.049614, lat = 35.114619),
    zoom = 15,
    maptype = "satellite"
  )
) +

  geom_sf_pattern(data = r13,
    inherit.aes = F,

theme_map()

# ggsave("plot_r13_kern_lake_ch.jpg", p13)
```

Figure A4-13. R code for plotting the map.

Location #14 and 15: Wind Wolves Preserve (Twin Fawns & The Willows)

The below code (**Figure A4-14**) simply reads in the geojson object (or data) after it was hand drawn and saved locally. Then the code plots the map.

```
r14 = geojson_sf("r14_wind_wolves.geojson")

p14= ggmap(
  get_map(
    c(long = -119.184442, lat = 34.979692),
    zoom = 12,
    maptype = "satellite"
  )
) +

  geom_sf_pattern(data = r14,
    inherit.aes = F,
    fill = alpha("blue",.2)) +
  theme_map()
```

Figure A4-14. R code for plotting the map.

All Locations

The code below (**Figure A4-15**) combines the 15 locations into one core map and then produces the map.

```
list_all_r = dplyr::bind_rows(
  list(r1,r2,r3,r4,r5,r6,r7,r8,r9,r10,r11,r12,r13,r14)
)

full_r = st_union(list_all_r)

full_p = ggmap(
  get_map(
    c(long = -119.518465, lat = 35.669648),
    zoom = 8,
    maptype = "roadmap"
  )
) +

  geom_sf_pattern(
    data = full_r,
    inherit.aes = F,
    fill = alpha("blue", .2)
  ) +

  theme_map()
```

Figure A4-15. R code for plotting the map.