Vernal Pool Fairy Shrimp

(Branchinecta lynchi)

Vernal Pool Tadpole Shrimp

(Lepidurus packardi)

Conservancy Fairy Shrimp

(Branchinecta conservatio)

5-Year Review:

Summary and Evaluation

Appendix
(Public Version)

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U.S. Fish and Wildlife Service

Sacramento Fish and Wildlife Office

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1. INTRODUCTION

The purpose of this Appendix is to provide additional information about the status of the vernal pool fairy shrimp, vernal pool tadpole shrimp, and Conservancy fairy shrimp and their habitat within each of the vernal pool regions and core areas where they are found. This information will include the number of occurrence records and their status, the amount of vernal pool grassland habitat if known, any trends in loss of habitat that are particular to the vernal pool region, the amount of protected habitat and number of protected occurrences if known, and a summary of all protected areas including federal lands, conservation banks, habitat conservation plans, and any other protected areas such as private preserves or state lands.

In order to streamline these sections, we will first introduce several concepts and summaries of data analyses that will be relevant to all vernal pool regions. This information is also discussed in the main body of the 5-year review.

1.1. Recovery Plan Concepts

The *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (Recovery Plan) (Service 2005a) defined vernal pool regions as discrete geographic regions identified largely on the basis of endemic species, with soils and geomorphology as secondary elements (**Figure 1.1**). The vernal pool fairy shrimp is currently known to occur in 13 of the vernal pool regions, the vernal pool tadpole shrimp is currently known to occur in 8 of the vernal pool regions, and the Conservancy fairy shrimp is currently known to occur in 6 of the vernal pool regions.

Within the vernal pool regions, the Recovery Plan identified 85 core areas. Core areas are the specific areas, or contain the specific sites, that are necessary to recover the endangered or threatened species, or the species of concern, addressed in the Recovery Plan. Core areas are not species-specific and may contain multiple listed species and species of concern. For most of the species covered in the Recovery Plan, core areas are ranked as zone 1, 2, or 3 in order of their overall priority for recovery. Recovery actions outside of Core Areas may contribute to recovering some species, though Core Areas are prioritized. The Recovery Plan allows the Service to modify core areas in the future based upon the results of status surveys and research. There are 41 core areas (15 designated zone 1 and 26 designated zone 2) identified for the vernal pool fairy shrimp in the Recovery Plan. There are 24 core areas (15 designated zone 1 and 9 designated zone 2) identified for the vernal pool tadpole shrimp in the Recovery Plan. There are eight core areas (seven designated zone 1 and one designated zone 2) identified for the Conservancy fairy shrimp in the Recovery Plan.

The Recovery Plan could not exactly define the amounts and locations of vernal pool habitat to protect due to lack of information on the current and historical distribution of species, basic biological needs and life histories of species, amount of upland habitat contributing to and necessary for the maintenance of vernal pool hydrological function, the distribution of vernal pools and vernal pool complexes across the landscape needed to provide for dispersal and genetic exchange, appropriate reserve size, and buffer sizes necessary to minimize threats of adjacent incompatible land uses (Service 2005a). The recovery criteria, strategies, and actions proposed in the Recovery Plan address these data gaps by recommending the protection of the

largest degree of diversity of vernal pool habitats possible and protection of habitat in blocks as large as possible, including the associated uplands, buffers, and contributing local watersheds. Appropriate sizes for effective management units should also be considered. Designation of vernal pool regions and focus on core areas within those vernal pool regions, as described above, is part of the Recovery Plan's strategy to ensure protection of diverse vernal pools and vernal pool species across the planning area.

Recovery criterion 1A of the Recovery Plan recommends protection of a certain proportion of the suitable vernal pool grassland habitat (vernal pools and upland matrix) present within each core area at the time of the Recovery Plan (*i.e.*, 2005). The total amount of suitable vernal pool grassland habitat within each core area was not listed, as this was outside of the scope of the Recovery Plan. For core areas within the Central Valley, the acreage of vernal pool grasslands mapped by Witham et al. (2013) provides an approximation of what existed in 2005, although in some cases this may be an underestimate. For example, in the biological opinion for the Stonegate Subdivision Project (Service 2020a) issued by the Service on January 23, 2020, we used vernal pool mapping from Witham et al. (2013; 2014) and the Butte County HCP to determine that 908 acres of vernal pool grassland existed within the Doe Mill Core Area in Butte County, whereas Witham et al. (2013) had only mapped 444 acres. Still, Witham et al.'s (2013) mapping provides a good baseline in the absence of more refined regional and local mapping efforts. Witham (2021) provides an estimate of how much vernal pool grassland still existed as of 2018, and Vollmar et al. (2017) provides a comprehensive assessment of protected lands within the Central Valley as of 2017. For core areas outside of the Central Valley there are usually not good estimates of historical (2005) or current acreages of vernal pool grassland or areas of protected vernal pool grassland habitat. This recovery criterion recommends protection of 85% of all vernal pool grassland habitat in applicable core areas that existed in 2005 in order to delist the vernal pool fairy shrimp; protection of 95% or 85% of all vernal pool grassland habitat that existed in 2005 in applicable zone 1 and 2 core areas, respectively, in order to downlist the vernal pool tadpole shrimp; and protection of 95% of all vernal pool grassland habitat in applicable core areas that existed in 2005 in order to downlist the Conservancy fairy shrimp.

Recovery criterion 1B of the Recovery Plan recommends protection of a certain proportion of the occurrences of each species known at the time the Recovery Plan was finalized in 2005. This criterion is intended to preserve occurrences that are representative of the full geographic, genetic, and ecological diversity of the three shrimp species. The Recovery Plan does not list the number of known occurrences as of 2005, although the Recovery Plan does generally use California Natural Diversity Database records as its definition of occurrences. Newly discovered or introduced occurrences may contribute to meeting this recovery criterion if the occurrences are within a protected area and monitoring has confirmed their viability. The Recovery Plan recommends protection of 80% of the number of vernal pool fairy shrimp occurrences known in 2005 in order to delist the species, protection of 80% of the number of vernal pool tadpole shrimp occurrences known in 2005 in order to downlist the species, and protection of 100% of the Conservancy fairy shrimp occurrences known in 2005 in order to downlist the species and 100% of newly discovered occurrences in order to delist the species. For the vernal pool tadpole shrimp and Conservancy fairy shrimp, Recovery criterion 1C also recommends protection of 100% of any reintroduced populations in addition to recovery criterion 1B in order to delist the species.

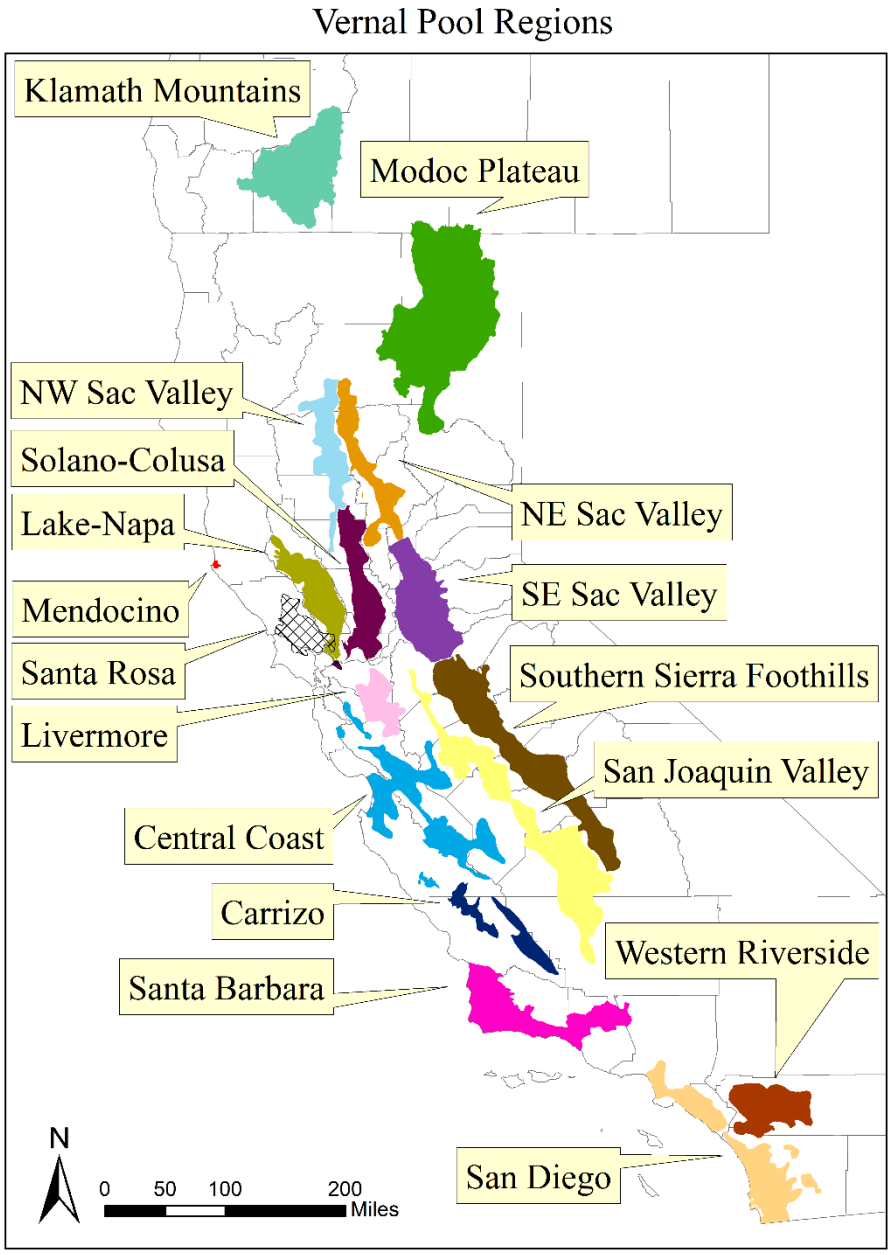


Figure 1.1. Map of the 16 vernal pool regions defined by the Recovery Plan. The Santa Rosa Vernal Pool Region, as defined by Keeler-Wolf et al. (1998), was not included in the Recovery Plan.

While the Recovery Plan identifies a specific strategy for obtaining recovery of the covered vernal pool plant and animal species, including the vernal pool fairy shrimp, it is not the only mechanism through which recovery may be obtained. Alternative conservation mechanisms, such as habitat conservation plans (HCPs) that cover the species and their vernal pool habitat, may be deemed equivalent to implementation of the Recovery Plan for the covered area if they contain the following elements (Service 2005a):

1. Permanently-protected vernal pool preserves within the area covered by the HCP in large contiguous blocks of suitable habitat;
2. Protection of the entire genetic range of each listed species within the area covered by the HCP;
3. Protection of all populations of species with 25 or fewer total occurrences addressed in the Recovery Plan within the area covered by the HCP;
4. Connectivity with other preserves within the area covered by the HCP;
5. Adaptive management of the preserves within the area covered by the HCP to support the species addressed in the Recovery Plan; and,
6. Sufficient funding for management, maintenance, and monitoring of the preserves in perpetuity.

1.2. Occurrences Records

Most occurrence records available for the three shrimp species come from the California Natural Diversity Database (Diversity Database or CNDDB), which is maintained by CDFW (Diversity Database 2022). A Diversity Database "occurrence" represents any documented collection, observation, or museum specimen of a species that is submitted to the CDFW by the public. Each collection or observation may be recorded and mapped separately, but if there are multiple observations or collections within ¼ mile of each other they may be combined into a single occurrence record. However, if the multiple individual observation records that are within ¼ mile of each other have different levels of resolution, or different purposes, there may be multiple records for the same parcel of land. Individual records may represent a single vernal pool, multiple pools, or a substantial portion of a vernal pool complex. Thus, some Diversity Database records may overlap and some may be quite large.

Determining which Diversity Database occurrences are no longer occupied is difficult due to limited survey data. Occurrences in the database include the Presence column which indicates if the occurrence is presumed extant, extirpated, or possibly extirpated. However, this field can only be updated if the site is re-surveyed and that information is submitted to CDFW. Many occurrences have not been re-surveyed in many years, so some of the presumed extant occurrences are likely extirpated. For occurrences that are within the Central Valley, an estimate of their current status is also possible by examining the most recent map of extant and extirpated vernal pool grassland habitat (Witham 2021). However, some occurrences fall outside of mapped vernal pool habitat; this could be because the vernal pool grasslands were lost prior to 2005, which was the starting point of Witham et al.'s (2013) habitat mapping efforts, or because the pools at these occurrence sites were not visible using aerial imagery. Also, some occurrences may be large enough to span both mapped and unmapped habitat, or extant mapped habitat and extirpated mapped habitat. In these cases, any overlap between any part of the occurrence and mapped, extant habitat resulted in a classification of extant.

The Recovery Plan specifies the percentage of occurrences known in 2005 that should be protected in order to downlist or delist the three shrimp species. Although the Recovery Plan does use Diversity Database records to estimate the number of occurrences, using a simple percentage of these occurrences to determine when this recovery criterion is met may be inappropriate due to the variability in size, shape, and accuracy of Diversity Database records. As an example, consider the Beale Core Area. There are five Diversity Database occurrences for the vernal pool fairy shrimp within this core area; however, one record represents the entire western portion of the vernal pool grasslands on Beale Air Force Base, while the other four represent small areas of surveyed vernal pools. If the one large occurrence was extirpated and the remaining four were protected this would result in the protection of 80% of known occurrences, but it would really represent the loss of the majority of the known occupied area within the core area. When assessing this recovery criterion in the main body of the 5-year review (section III.1B), we focused strictly on the number of occurrences. However, in this Appendix we will try to consider the size and geography of the occurrences in a bit more detail. This includes presenting maps for each core area that display the actual Diversity Database polygons so that their size and geographic distribution can be better understood. We hope that this is the first step in a more systematic assessment of the current progress towards protecting occurrences that represent the geographical, genetic, and ecological diversity of the three shrimp species.

In addition to the Diversity Database occurrences, the Service's Ventura Fish and Wildlife Office provided reports of several occurrences that have not yet been documented in the Diversity Database (M. Ogonowski, Service, *in litt*. 2023a). The Ventura Fish and Wildlife Office has also recently conducted several surveys themselves between February 2019 and May 2023 as part of recovery efforts to identify species occurrences and potentially work with landowners to preserve the vernal pool habitat on their properties (Ogonowski, *in litt*. 2023a). Because these efforts have relied on confidentiality to build trust with the landowners, we have taken efforts to present these data here while also keeping the exact locations confidential. The locations of species occurrences identified during these Service-led surveys have been randomly offset by up to 3 miles from their true location and are displayed on the maps in this document as circles with a 3-mile radius. Thus, the true location of each occurrence is somewhere within the circle, but the location cannot be narrowed down any farther than that based on the maps.

Finally, the vernal pool fairy shrimp also occurs outside of California within the Klamath Mountains Vernal Pool Region in Oregon. Occurrence data for this vernal pool region was provided by the Service's Roseburg Fish and Wildlife Office (S. Friedman, Service, *in litt.* 2021). Unlike the Diversity Database, this data contains points instead of polygons, generally representing individual vernal pools. Therefore, the number of Oregon occurrences and Diversity Database occurrences cannot be directly compared. However, because the Oregon occurrences are all equivalent to each other, the progress towards recovery criterion 1B can be more easily assessed using a simple percentage of protected occurrences. Still, additional consideration may be needed to determine if the protected occurrences represent the geographical, genetic, and ecological diversity of the vernal pool fairy shrimp.

In order to comply with CDFW's Diversity Database Data Use Guidelines, maps that depict Diversity Database occurrences at a scale larger than 1:350,000 will not be made publicly available. This guidance exists to balance the need to provide Diversity Database data to those whose intent is to conserve species with the possibility that some people will use the detailed

location information to do harm to a species or its habitat. All maps of individual core areas in this Appendix are more zoomed in than a 1:350,000 scale. Therefore, the publicly available version of this document has redacted all core area maps depicting Diversity Database occurrences; however, descriptions of the general location and protected status of the occurrences within each core area remain in the text. A separate internal version of this document for use by the Service and other entities that already have access to the full Diversity Database occurrence dataset will retain these maps, which were critical in the analyses presented in each core area section.

1.3. Vernal Pool Grassland Mapping

Within the Central Valley, Witham et al. (2013) used aerial imagery from 2005 to map the extent of vernal pool grasslands. This study provides the best data across the entire Central Valley of where vernal pool grasslands still existed on the landscape at the time the Recovery Plan was written. This mapping effort was subsequently updated using aerial imagery from 2012 (Witham et al. 2014) and 2018 (Witham 2021). These efforts identified losses of vernal pool habitat due to conversion and the cause of conversion, as well as vernal pool habitat that was either newly created, had recovered from prior disturbance, or had simply been missed in previous mapping efforts. Each polygon of vernal pool habitat was labeled as not converted/habitat extant, converted/habitat extirpated, modified/habitat altered, or new/habitat not previously mapped. These mapping efforts were large scale efforts, so they may have missed vernal pool habitat that was not readily apparent from the aerial imagery (see Doe Mill Core Area example above; Recovery Plan Concepts section).

These vernal pool mapping reports generally do not break down the acreages of habitat in all of the ways that were necessary for this 5-year review, so we used the geodatabases created by Witham et al. (2013; 2014) and Witham (2021) to directly calculate the acreage of extant, extirpated, new, and protected habitat in each vernal pool region and core area. We calculated extant habitat as all polygons that were labeled as not converted, modified, or new. The modified category captured areas that had been previously mapped, usually with a low density of vernal pools (1-5% of entire vernal pool complex), which had been converted to high density vernal pool habitat (10% of entire vernal pool complex), often highly disturbed mitigation banks or preserves, in subsequent remapping. The new category captured both areas in which mitigation banks or preserves had been built, many on former agricultural fields, and areas of habitat found on aerial imagery during remapping that were not apparent in earlier mapping imagery. Note that for the 2018 remapping (Witham 2021) these categories were based only on the comparison with the 2012 mapping data (Witham et al. 2014) and not the original 2005 data (Witham et al. 2013). Therefore, acreages could fluctuate between 2012 and 2018 based on differences in categorization as well as actual differences due to changes on the landscape. For example, a polygon labeled as “modified” or “new” by Witham et al. (2014) would subsequently be labeled as “not converted” by Witham (2021) if no change occurred to the land between 2012 and 2018. Also, whenever percentages are given, we specify if they are based on a percentage of the total acreage of vernal pool habitat from 2005 (the Recovery Plan baseline) or from the updated total acreage from 2012 or 2018. The total acreage (including extant and extirpated habitat) increases in each report as new polygons are added, either because they were previously missed or due to creation of new mitigation lands.

In order to calculate acreages within each vernal pool region, we used ArcMap 10.6.1 to identify the nearest vernal pool region to each polygon of vernal pool habitat. This was able to capture several polygons that were immediately outside of the vernal pool region boundaries defined in the Recovery Plan. In order to calculate acreages within each core area, we first had to clip the geodatabases to the core area boundaries, as several polygons were partially within and partially outside of a core area. We then had to recalculate the area of the polygons to account for the reduced acreage of these clipped polygons.

Vernal pool grasslands outside of the Central Valley have not received as much study. The only landscape-level mapping effort occurred along the Central Coast using aerial imagery from 1994 (Holland 2003). More regional- and local-scale mapping efforts have taken place, mostly for use in local conservation planning, such as County-wide habitat conservation plans. Many of these are also within the Central Valley; the two most relevant regional mapping efforts outside of the Central Valley were undertaken by the Oregon Natural Heritage Program (ONHP 1997; ONHP 1999) and the Western Riverside Habitat Conservation Plan (Dudek and Associates 2003a; Aerial Information Systems 2015). However, none of the mapping efforts besides Witham et al. (2013) were based on data from 2005, and thus specific baselines of extant vernal pool habitat relevant to the Recovery Plan are not available for vernal pool regions and core areas outside of the Central Valley.

1.4. Protected Lands

One of the central focuses of the Recovery Plan is the protection of vernal pool grasslands and known species occurrences. Habitat protection does not necessarily require land acquisitions or easements, only that land uses maintain or enhance species habitat values (Service 2005a). Protected lands may include federal- or state-owned lands that are managed for vernal pool habitat and species, lands owned by private non-profit land trusts or other conservation groups, or other private preserves that are governed by a conservation easement or deed restriction, including conservation/mitigation banks. Assessing the size and location of these protected lands is a vital part of assessing the progress towards recovery of the three shrimp species.

Vollmar et al. (2017) attempted to create a comprehensive map of all protected vernal pool grasslands within the Central Valley as of 2017. Data and shapefiles were obtained from several public conservation land databases as well as a broad range of public agencies, non-profit groups, and for-profit companies. Within the Central Valley, this report provides the most complete single source of information about protected lands, with the caveat that any lands protected since 2017 will not be included. However, this report did not break down the acreages of habitat in all of the ways that were necessary for this 5-year review, so the Service obtained a copy of the geodatabase of protected lands compiled by Vollmar et al. (2017) and compared it with Witham's (2021) geodatabase of vernal pool habitat as of 2018 and with Diversity Database records.

The Service calculated the acreage of protected vernal pool habitat within each vernal pool region and core area in ArcMap 10.6.1 by clipping Witham's (2021) layer of vernal pool habitat by Vollmar et al.'s (2017) layer of protected lands. We then had to recalculate the area of the polygons to account for the reduced acreage of any of the clipped polygons. In some cases, there was a slight skew between the parcel boundaries in the two databases which would slightly

reduce the estimated acreage of protected vernal pool habitat, but any error due to this skew was minimal. We also compared Vollmar et al.'s (2017) layer of protected lands to Diversity Database records for the three shrimp species to determine how many occurrences have been protected. We classified each Diversity Database record as either partially or entirely within protected lands. An occurrence may have been classified as partially protected either because the Diversity Database polygon represented a large area that was only partially protected, because the Diversity Database record's accuracy had a large margin of error and thus the polygon was a large circle that extended outside of protected land, or because there was a slight skew between the two layers which caused a small piece of the Diversity Database polygon to fall outside of the protected lands layer. Due to the latter two reasons, it is likely that some of the occurrences classified as partially protected are actually entirely within protected lands.

Outside of the Central Valley, there has not been an effort to systematically catalog all protected vernal pool grasslands. Therefore, our assessment of progress towards recovery for the three shrimp species in vernal pool regions and core areas outside of the Central Valley is necessarily more limited. Definitively identifying all protected lands within these areas is outside the scope of this 5-year review, but where possible we draw on any relevant sources to provide estimates of protected lands and species occurrences.

2. CARRIZO VERNAL POOL REGION

Only the vernal pool fairy shrimp is known to occur within the Carrizo Vernal Pool Region.

2.1. Vernal Pool Habitat

Holland (2003) mapped the vernal pool complexes of the Central Coast of California based on 1994 aerial imagery. The study area consisted of 9,574,099 acres and encompassed all of San Benito, Monterey, San Luis Obispo, Santa Barbara, and Ventura Counties; this encompasses all of the Carrizo Vernal Pool Region, as well as parts of the Central Coast and Santa Barbara Vernal Pool Regions. The Service does not have a copy of the geodatabase for this study, so we cannot break down the exact acreage of vernal pool complexes in each of the vernal pool regions. In total, 42,488 acres of vernal pool complexes were mapped throughout the study area (see **Figure 2.1**; Holland 2003), though comparison with high-resolution vernal pool mapping at Camp Roberts indicated that Holland's broad scale map is almost certainly an underestimate of both the number and size of vernal pool complexes in the Central Coast. A large amount of vernal pool habitat exists around the Carrizo Plain and Soda Lake, and significant, but smaller, clusters of vernal pool habitat exist around Camp Roberts and Paso Robles.

As in the Central Valley, many vernal pool complexes along the Central Coast, including the Carrizo Vernal Pool Region, are found in older alluvial soils with a claypan/duripan layer (Holland 2003). However, vernal pools are also found in two additional geomorphic settings not well represented in the Central Valley: sag ponds along faults and active Quaternary landslides on structurally incompetent mountain slopes. Holland (2003) also compared the 1994 imagery with satellite imagery from 2000 and found that 4,931 acres had been lost, a loss of 11.6% over the 6-year interval. Subsequent ground truthing in 2001 of 27 of the remaining polygons found that 15 had been converted to other uses, a loss of more than half of the polygons in the ground truthing area in just a year.

Because the Service does not know the exact acreage of vernal pool complexes in this region and because there has not been a comprehensive assessment of all protected lands within this region, we cannot provide a precise estimate of the amount or percentage of vernal pool habitat that has been protected. Lands with some level of protection include Camp Roberts, the Carrizo Plain National Monument, the Los Padres National Forest, and state and private preserves (**Figure 2.2**).

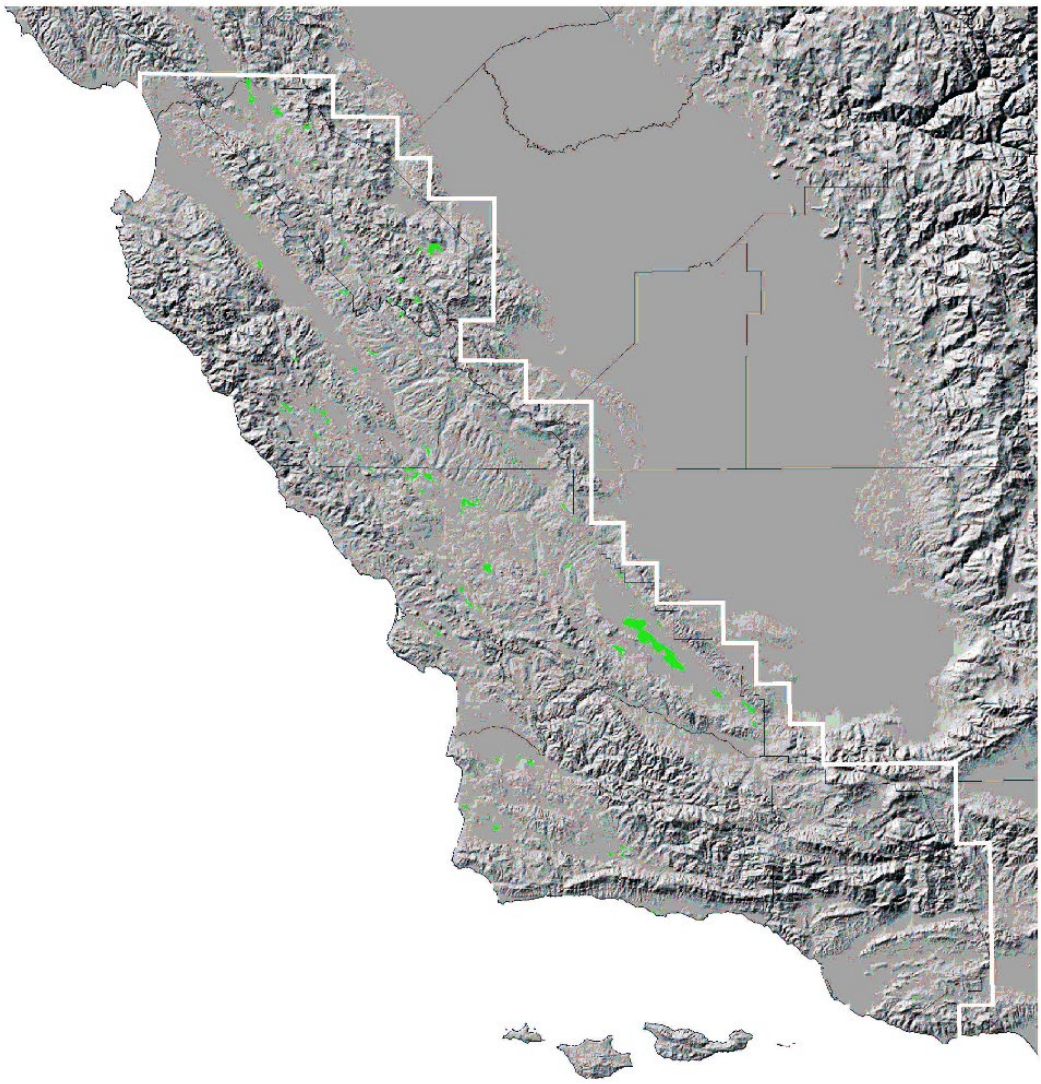


Figure 2.1. Map of vernal pool complexes in green along the Central Coast of California in 1994 mapped by Holland (2003). Taken from Figure 4 of Holland's report submitted to the Service.

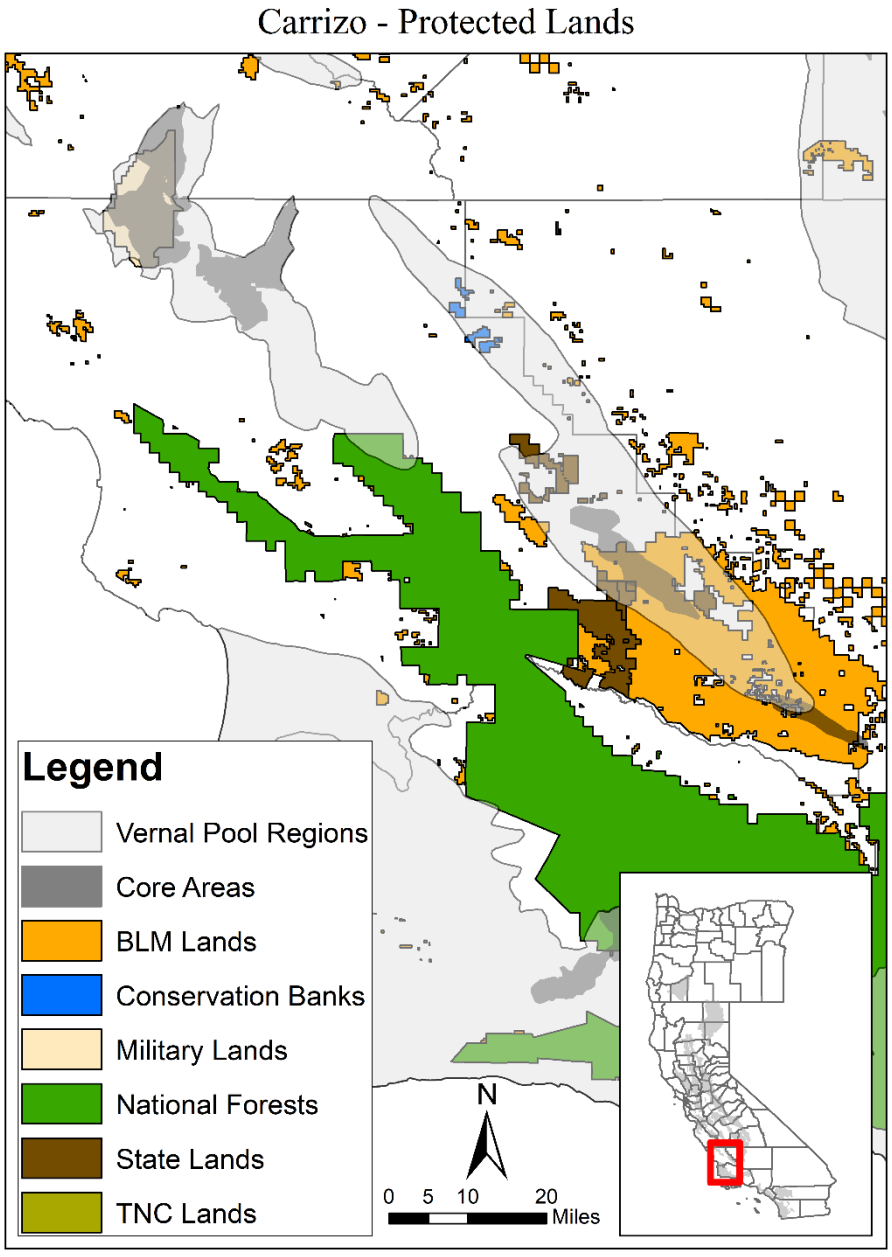


Figure 2.2. Map of protected areas that contain vernal pool grassland habitat and/or vernal pool fairy shrimp within the Carrizo Vernal Pool Region. BLM = Bureau of Land Management, TNC = The Nature Conservancy.

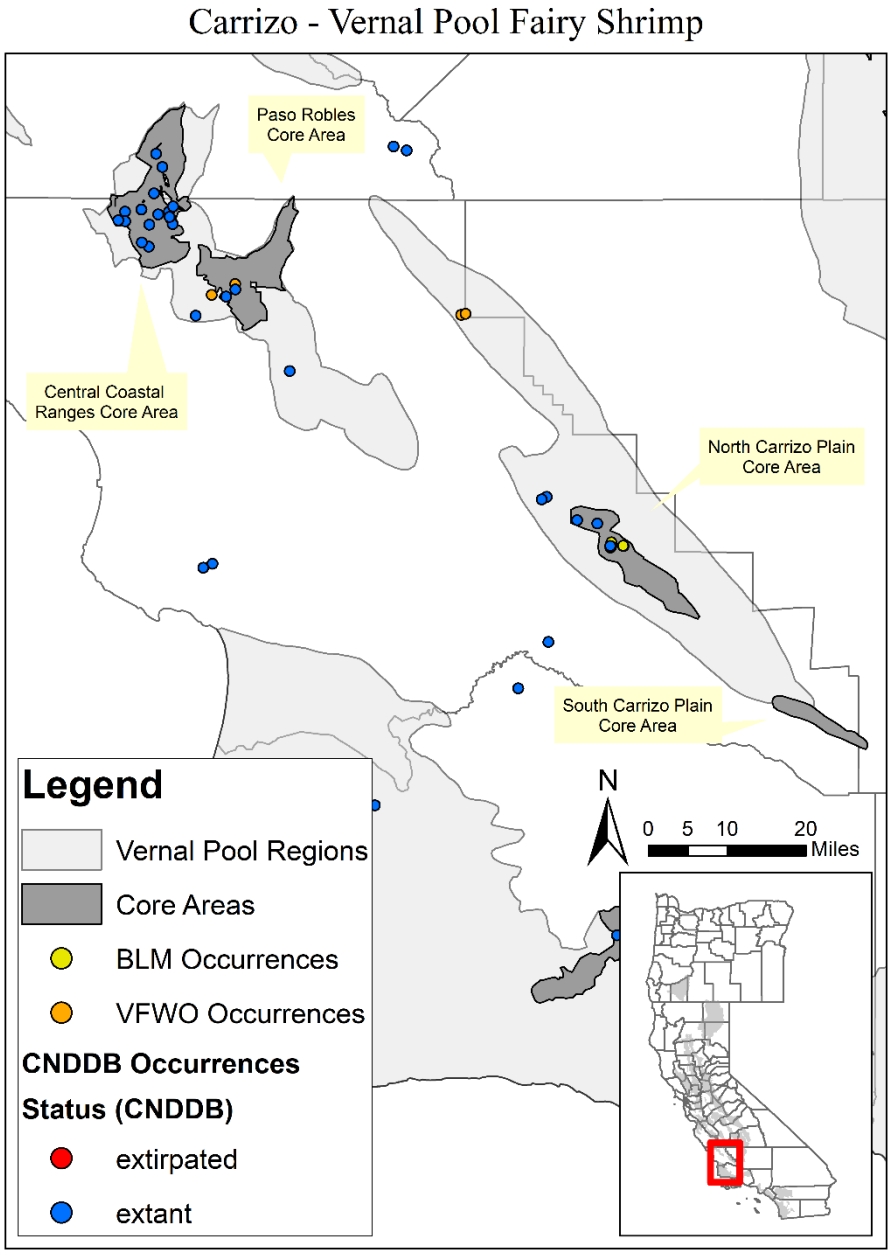


Figure 2.3. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022), provided by the Service's Ventura Fish and Wildlife Office (VFWO) (Ogonowski, *in litt*. 2023a), or documented during Bureau of Land Management (BLM) surveys in the Carrizo Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes.

2.2. Species Occurrences

2.2.1. Vernal Pool Fairy Shrimp

There are 28 occurrence records of the vernal pool fairy shrimp documented within, or immediately adjacent to, the Carrizo Vernal Pool Region in the Diversity Database (see **Figure 2.3**; Diversity Database 2022). Of these 28 occurrences, 16 are located on the Camp Roberts military installation, 1 is located on the Los Padres National Forest, and 11 are on private land (Diversity Database 2022). All are presumed extant by the Diversity Database, although it is possible that some of the 28 occurrences are no longer extant, but have not been surveyed recently. Several of the occurrence records on private land are described as being threatened by agricultural or solar development (Diversity Database 2022). In addition, surveys by the Bureau of Land Management (BLM) have identified the vernal pool fairy shrimp in two nearby clusters of pools within the region: one cluster of pools corresponds to Diversity Database record #259 and the other cluster does not correspond with any Diversity Database records and represent an additional occurrence record (**Figure 2.3**).

There are four additional occurrence records provided by the Ventura Fish and Wildlife Office that were not in the Diversity Database, all of which were first documented within the last 5 years (Ogonowski, *in litt*. 2023a). Two occurrences are located in Paso Robles and two are located within or adjacent to the Palo Prieto Conservation Bank.

Of the 28 Diversity Database occurrence records, 17 (61%) receive some level of protection by virtue of being located on federal land: 16 within Camp Roberts and 1 within Los Padres National Forest (**Figure 2.2**). Two additional occurrences not recorded in the Diversity Database are also protected: one within BLM's Carrizo Plain National Monument and one on the Palo Prieto Conservation Bank.

2.3. Federal Lands

2.3.1. National Wildlife Refuges

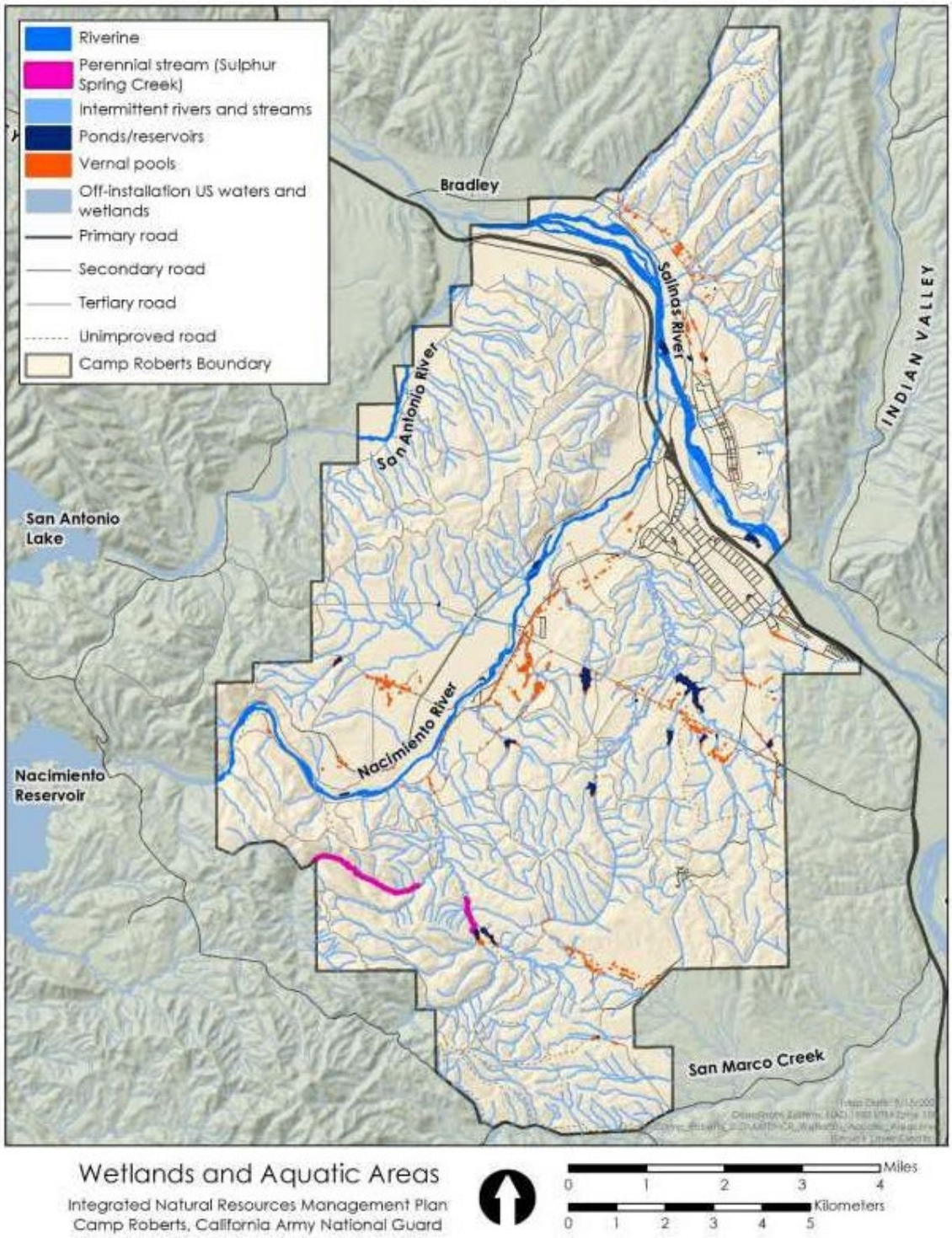
There are no National Wildlife Refuges with known occurrences of the vernal pool fairy shrimp in the Carrizo Vernal Pool Region.

2.3.2. Military Lands

Camp Roberts is a 42,784-acre military training site owned by the U.S. Army Corps of Engineers (Corps) and leased to the California Army National Guard (CA ARNG) located in the southern Salinas River Valley in Monterey and San Luis Obispo Counties. Most of Camp Roberts is within the Central Coastal Ranges Core Area. An Integrated Natural Resources Management Plan (INRMP) was finalized for Camp Roberts in August 2022 (CA ARNG 2022). There are 25,039 acres of annual or perennial grasslands throughout Camp Roberts, a portion of which include vernal pools. The vernal pools themselves cover 47 wetted acres and range in size from a few square feet to more than an acre in size (**Figure 2.4**). They occur in grasslands in gently sloping terrain such as river terraces, benches, valleys, or swales. There are natural and artificial vernal pools at Camp Roberts; natural pools occur on stream terraces, alluvial fans, and alluvial

terraces, while artificial pools consist of borrow pits, shell craters, and tire ruts (CA ARNG 2022).

The vernal pool fairy shrimp was first documented on Camp Roberts in 1995; it was definitively identified in 61 pools and immature fairy shrimp which could not be identified to the species level were identified in 119 additional pools (Jones and Stokes Associates 1997). Annual surveys ceased in 2008 due to funding shortfalls but resumed in 2017; the 2017 surveys identified the vernal pool fairy shrimp in 40 pools, some of which were ponds/reservoirs, with a total area of 38.3 acres (CA ARNG 2022). A programmatic biological opinion was written for training activities at Camp Roberts in 2009 that includes measures to avoid and minimize effects of activities on the vernal pool fairy shrimp (Service 2009a). As of 2021, approximately 22 acres of vernal pools had been protected to mitigate for impacts to vernal pool fairy shrimp (CA ARNG 2022). Management priorities identified in the INRMP include developing a vernal pool habitat management plan, conducting routine shrimp surveys to monitor population levels, controlling excessive vegetation using grazing and prescribed burning, and installing informational signage at vernal pool fairy shrimp mitigation areas (CA ARNG 2022).



Map 3-7. Camp Roberts wetlands and aquatic areas.

Figure 2.4. Map of vernal pools and other aquatic features at Camp Roberts. In addition to vernal pools, the vernal pool fairy shrimp has also been found in several of the ponds/reservoirs. Taken from Map 3-7 of the INRMP (CA ARNG 2022).

2.3.3. Bureau of Land Management

There is a large amount of land owned by the BLM throughout the Carrizo Vernal Pool Region, most of which is within the Carrizo Plain National Monument. A Resource Management Plan was approved for the Carrizo Plain National Monument in April 2010 (BLM 2010). The National Monument is 246,817 acres in total, including 206,635 acres of BLM land, 8,702 acres of CDFW land, 607 acres of other state-owned lands, 75 acres of land owned by The Nature Conservancy (TNC), and 30,798 acres of privately owned lands. The Resource Management Plan states that approximately 20 acres of small vernal pools occur within the National Monument, though the acreage of vernal pools and other aquatic features which provide habitat for vernal pool species is likely higher, particularly if more saline and alkaline features near Soda Lake are included. Vernal pools are found both on the valley floor (Carrizo Plain and Soda Lake) and in the foothills of the Caliente Range; many more vernal pools also occur just north of the National Monument's boundary. The Resource Management Plan contains various objectives and management actions related to protecting, restoring, monitoring, and studying vernal pool habitat, including actions related to livestock grazing, invasive plant management, native plant restoration, monitoring fairy shrimp populations, and ensuring BLM actions and authorization are designed to avoid impacts to vernal pools (BLM 2010).

The vernal pool fairy shrimp was not known to occur within the National Monument when the Resource Management Plan was published in 2010, but the species was included in the Resource Management Plan as a species that may be found in the future and would benefit from the protection and management of vernal pools within the National Monument. The vernal pool fairy shrimp does occur in several locations just north of the National Monument's boundary, and the species was identified within the National Monument for the first time in 2015 (BLM 2015). The endangered longhorn fairy shrimp (*Branchinecta longiantenna*) is known from pools throughout the National Monument as well.

The BLM surveyed vernal pools and similar features across the Carrizo Plain in and around the Carrizo Plain National Monument from 2015-2019 (BLM 2015; BLM 2016; BLM 2017a; BLM 2019a). Pools were surveyed once or twice each year for 1-4 years. The vernal pool fairy shrimp was observed at least once in seven pools, all located in North Carrizo Plain. One cluster of 14 pools, including four occupied by the vernal pool fairy shrimp, is located on the north side of Seven Mile Road on private land just outside of the BLM's Carrizo Plain National Monument; these pools are roughly synonymous with vernal pool fairy shrimp occurrence #259 in the Diversity Database. Another cluster of nine pools, including three occupied by the vernal pool fairy shrimp, is located along Borega Road on BLM land that is inside the northern boundary of the Carrizo Plain National Monument; these pools are not synonymous with any Diversity Database records and represent an additional occurrence record (**Figure 2.3**). Other areas that were surveyed but that had no pools occupied by the vernal pool fairy shrimp include Garcia Rocks in the north, Selby Rocks in the western Carrizo Plain National Monument, and the Jennifer Mata Spadefoot Pond and South Carrizo Plain sites in the southeastern portion of the Carrizo Plain National Monument.

2.3.4. Other Federal Lands

The Los Padres National Forest is owned and managed by the Forest Service. This National Forest is 1,781,364 acres in size and is spread across Kern, Los Angeles, Monterey, San Luis Obispo, Santa Barbara, and Ventura Counties (USDA 2005a). Most of the National Forest is within or adjacent to the Santa Barbara Vernal Pool Region, but the northernmost extent is located between the Carrizo and Santa Barbara Vernal Pool Regions. Within this northernmost extent there are two Diversity Database records of the vernal pool fairy shrimp, one in San Luis Obispo County which is closer to the Carrizo region and one in Santa Barbara County which is closer to the Santa Barbara region. The San Luis Obispo occurrence was found in 2005 approximately 0.5 mile north of Gifford Springs; the habitat consisted of a small swale on a south-facing slope, 700 meters below the ridgeline, that was surrounded by oak woodland and grassland (Diversity Database 2022). For more general information about the Los Padres National Forest, see Section 10 on the Santa Barbara Vernal Pool Region.

2.4. Conservation Banks

There are no conservation or mitigation banks that provide credits for the vernal pool fairy shrimp in the Carrizo Vernal Pool Region. The species was recently identified in one pool within the Palo Prieto Conservation Bank in the Buckley Parcel and in another pool immediately adjacent to the Buckley Parcel (Ogonowski, *in litt*. 2023a).

2.5. Habitat Conservation Plans

There is one regional Habitat Conservation Plan (HCP) within the Carrizo Vernal Pool Region that includes the three shrimp species as Covered Species. Although only the vernal pool fairy shrimp is found in the Carrizo Vernal Pool Region, this HCP spans multiple regions and therefore covers all three shrimp species.

2.5.1. PG&E Multiple Region Operations and Maintenance HCP

The Pacific Gas & Electric Company's (PG&E) Multiple Region Operations and Maintenance HCP covers PG&E activities within the Sacramento Valley, Sierra Nevada Foothills, North Coast, and Central Coast of California, spanning multiple vernal pool regions (ICF 2020). PG&E's Sacramento Valley and Foothills region includes the Northeastern and Northwestern Sacramento Valley Vernal Pool Regions, most of the Southeastern Sacramento Valley Vernal Pool Region, and parts of the Solano-Colusa and Southern Sierra Foothills Vernal Pool Regions. PG&E's Central Coast region includes most of the Central Coast and Carrizo Vernal Pool Regions, and part of the Santa Barbara Vernal Pool Region. This HCP was permitted in 2020 and has a 30-year permit term. The purpose of the HCP is to enable PG&E to continue to conduct current and future operations and maintenance activities within 34 California counties while avoiding, minimizing, and mitigating temporary and permanent impacts on threatened and endangered species habitat. The HCP's conservation strategy includes mitigation for permanent and temporary impacts to species habitat, which may be in the form of purchasing and/or placing easements on high quality habitat, purchase of conservation bank credits, contributions to existing conservation planning and recovery efforts, or habitat enhancement or restoration.

The HCP's Habitat Models estimated that 11,233 acres of vernal pool fairy shrimp and vernal pool tadpole shrimp habitat, as well as 2,260 acres of Conservancy fairy shrimp habitat, exist in PG&E's Sacramento Valley and Foothills region (ICF 2020). The HCP estimated permanent and temporary losses of vernal pool fairy shrimp and vernal pool tadpole shrimp habitat in the Sacramento Valley and Foothills region at 30.00 acres and 285.17 acres, respectively. The HCP estimated permanent and temporary losses of Conservancy fairy shrimp habitat in the Sacramento Valley and Foothills region at 7.50 acres and 57.92 acres, respectively. Permanent loss of habitat for the three shrimp species will be mitigated at a 3:1 ratio and temporary habitat loss at a 0.5:1 ratio. Therefore, a total of 232.6 acres of vernal pool fairy shrimp and vernal pool tadpole shrimp habitat, as well as 51.5 acres of Conservancy fairy shrimp habitat, will be preserved in perpetuity throughout PG&E's Sacramento Valley and Foothills region.

The HCP's Habitat Models estimated that 2,076 acres of vernal pool fairy shrimp and vernal pool tadpole shrimp habitat exists in PG&E's Central Coast region (ICF 2020). The HCP estimated permanent and temporary losses of vernal pool fairy shrimp and vernal pool tadpole shrimp habitat in the Central Coast region at 11.90 acres and 53.32 acres, respectively. Permanent loss of this habitat will be mitigated at a 3:1 ratio and temporary habitat loss at a 0.5:1 ratio. Therefore, a total of 62.4 acres of vernal pool fairy shrimp and vernal pool tadpole shrimp habitat will be preserved in perpetuity in PG&E's Central Coast region.

During HCP development, PG&E acquired several conservation lands to begin meeting the requirements of the conservation strategy; however, these properties had not yet been fully preserved in perpetuity as of the finalization of the HCP (ICF 2020). Lands acquired for the vernal pool fairy shrimp and vernal pool tadpole shrimp include the Sheridan property in Placer County (526 acres). The HCP says that the habitat may support the Conservancy fairy shrimp, but the species is not known to occur on this site.

2.6. Other Preserves

The Carrizo Plains Ecological Reserve is owned by CDFW and is located partly within and partly to the west of the Carrizo Plain National Monument. A Land Management Plan for the Ecological Reserve was written in 2019 (Jodi McGraw Consulting 2019). Vegetation mapping identified 16 acres of the California Mixed Annual/Perennial Freshwater Vernal Pool/Swale Bottomland Group habitat type within the Ecological Reserve. Of this, 11 acres were along an unnamed stream near Soda Lake in the American Unit, which is within the Carrizo Plain National Monument, and 5 acres were within the North and South Chimineas Units of the Ecological Reserve, west of the National Monument. The vernal pool fairy shrimp has never been identified within the Ecological Reserve, though it has been found within the Los Padres National Forest 0.5 miles north of CDFW's Gifford parcel, part of the South Chimineas Unit of the Ecological Reserve.

The North Carrizo Ecological Reserve is owned by CDFW and is located northwest of the North Carrizo Plain Core Area. CDFW acquired the Ecological Reserve in 2011 as mitigation for the Topaz Solar Farm project (Wildlands Conservation Science 2017). Vernal pools are found on the eastern portion of the 1,100-acre Parcel D, a.k.a. Cooper Unit, with 2.1 wetted acres present; vernal pool fairy shrimp were found throughout these pools (Althouse and Meade 2011). Management of the vernal pools includes cattle grazing, but excluding cattle from the pools with

fencing while water is present, avoiding use of pesticides, and invasive aquatic species eradication if necessary (Althouse and Meade 2011). The vernal pools did not fill from 2011-2016 due to drought. The vernal pool fairy shrimp was detected in 6 of 10 pools that filled within the Cooper Unit of the Ecological Reserve surveyed in 2017 and 2019 (Wildlands Conservation Science 2017; C. Fiehler, CDFW, *in litt*. 2022). These pools correspond to vernal pool fairy shrimp occurrence #863 in the Diversity Database.

The Nature Conservancy owns two parcels within the Carrizo Plain National Monument that total 75 acres. These two parcels are near Soda Lake, and the vernal pool fairy shrimp has not been documented within them.

There are no other private preserves or mitigation sites for vernal pool habitat or the vernal pool fairy shrimp that the Service is aware of in this vernal pool region.

2.7. Vernal Pool Core Areas

There are four Core Areas within the Carrizo Vernal Pool Region that are designated in the Recovery Plan for the vernal pool fairy shrimp: Central Coastal Ranges, North Carrizo Plain, Paso Robles, and South Carrizo Plain. Because the Service does not know how much vernal pool habitat existed in this region in 2005, how much still exists today, and how much has been protected, we do not know if any of the core areas have met the target of 85% of vernal pool habitat protected.

2.7.1. Central Coastal Ranges

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is located in southern Monterey County and northern San Luis Obispo County.

There is no estimate of how many acres of vernal pool complex existed in this core area in 2005 or today, and so the Service cannot assess what percentage of vernal pool habitat has been protected. Still, we can attempt to approximate the percentage of protected vernal pool habitat based on other available information. Approximately 68% of this core area is within Camp Roberts. Although we do not have access to Holland's (2003) geodatabase of vernal pool habitat mapped along the Central Coast from 1994, visual examination of his map (**Figure 2.1**) suggests that most or all of the vernal pool habitat within this core area is within Camp Roberts. However, comparison with high-resolution vernal pool mapping at Camp Roberts indicated that Holland's (2003) broad scale map is almost certainly an underestimate of both the number and size of vernal pool complexes in the Central Coast, meaning that there may be vernal pool complexes in this core area outside of Camp Roberts that were missed by Holland's mapping effort. It is therefore possible that 85% of vernal pool habitat in this core area has been protected within Camp Roberts, but further analysis is needed to confirm if this is correct. However, these areas are not protected in perpetuity under a conservation easement or deed restriction, and could conceivably be subject to changes in management if Federal priorities shift or if Camp Roberts is ever closed and the land is transferred to a different landowner.

2.7.1.1.Vernal Pool Fairy Shrimp Occurrences

There are 16 occurrence records from the Diversity Database for the vernal pool fairy shrimp within this core area, all of which are within the Camp Roberts military installation (see **Figure 2.5**; Diversity Database 2022). The vernal pool fairy shrimp was first detected at Camp Roberts in 1995 after the species was listed (Jones and Stokes Associates 1997), and 14 of the 16 occurrences were known prior to 2005 when the Recovery Plan was published (Diversity Database 2022). The two newer occurrences are near other known occurrences, and the vernal pool fairy shrimp was detected most recently at the base in 2017 (CA ARNG 2022). The vernal pool fairy shrimp has been found throughout Camp Roberts, and in 2017 they were found to occupy 38.3 acres (81.5%) of the 47 wetted acres of vernal pool complexes and similar features throughout the site (CA ARNG 2022).

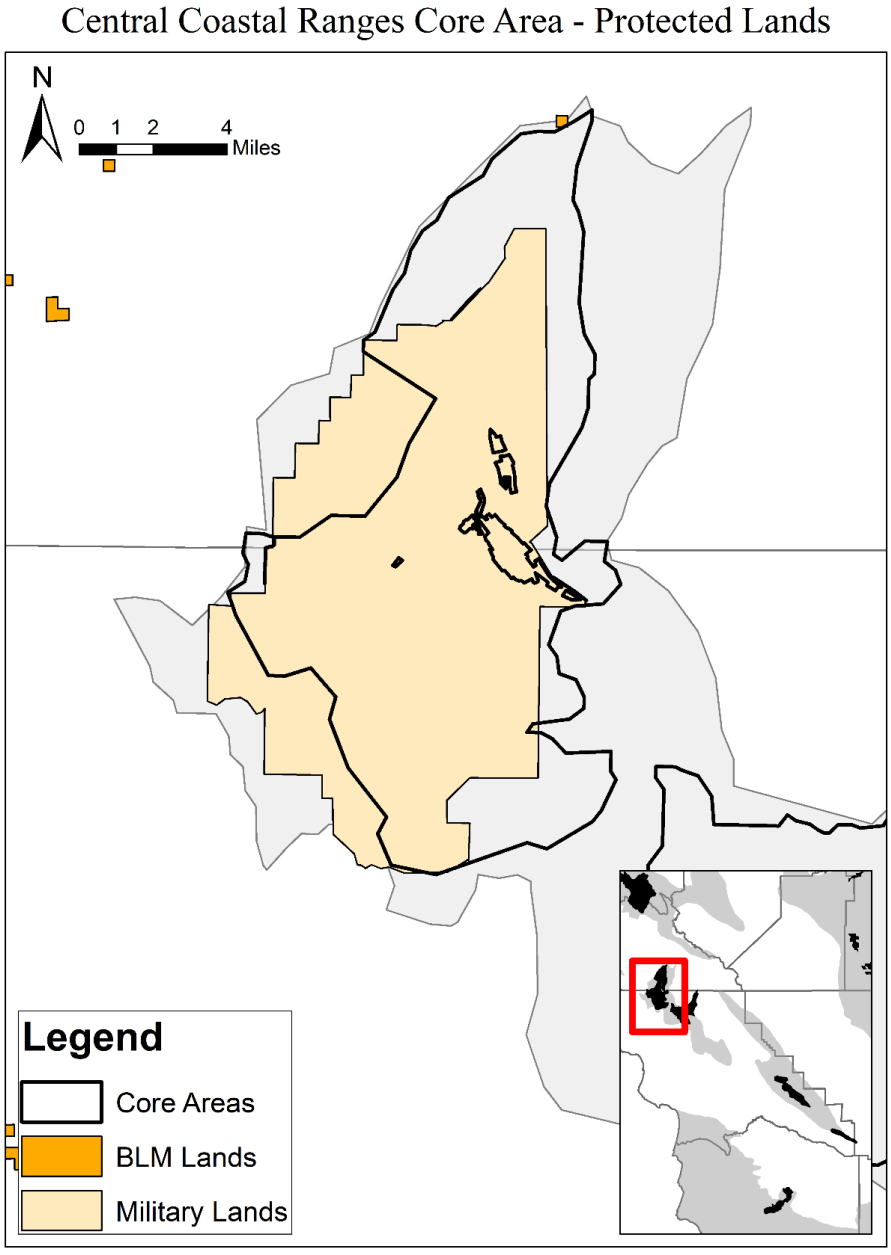


Figure 2.5. Map of all protected lands within the Central Coastal Ranges Core Area. Diversity Database (2022) records have been redacted from the map to comply with CDFW's Diversity Database Data Use Guidelines. BLM = Bureau of Land Management.

2.7.2. North Carrizo Plain

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is located in southeastern San Luis Obispo County.

There is no estimate of how many acres of vernal pool complex existed in this core area in 2005 or today, and so the Service cannot assess what percentage of vernal pool habitat has been protected. The 2010 Resource Management Plan states that there are approximately 20 wetted acres of vernal pools throughout the Carrizo Plain National Monument (BLM 2010). Although it does not say where within the National Monument the pools are located, the maps of vernal pool plants and the longhorn fairy shrimp in the plan suggest that they are mainly around Soda Lake (within this core area) or in the southeastern part of the Carrizo Plain (within the South Carrizo Plain Core Area). In addition, vegetation mapping within CDFW's Carrizo Plains Ecological Reserve showed 11 acres of the California Mixed Annual/Perennial Freshwater Vernal Pool/Swale Bottomland Group habitat type on an unnamed stream near Soda Lake, which is within this core area (Jodi McGraw Consulting 2019). All of these vernal pools are protected on federal or state land (**Figure 2.6**). There is no comprehensive assessment of how many acres of vernal pool complexes occur within this core area on the private lands north of the National Monument.

2.7.2.1. Vernal Pool Fairy Shrimp Occurrences

There are four occurrence records for the vernal pool fairy shrimp within this core area: three records from the Diversity Database and two occurrence records from BLM surveys in 2015-2019, one of which is synonymous with Diversity Database record #259 (see **Figure 2.7**; BLM 2015; BLM 2016; BLM 2017a; BLM 2019a; Diversity Database 2022). The vernal pool fairy shrimp was first observed in this core area in 1985 on private land at two locations just north of the Carrizo Plain National Monument (Diversity Database 2022). The third Diversity Database occurrence was recorded in 1995, and thus all three Diversity Database occurrences were known prior to 2005 when the Recovery Plan was published. Surveys conducted by BLM in 2015-2019 confirm that the vernal pool fairy shrimp still occurs in at least some of these pools on private land, and they also documented the species at one new location on BLM land within the Carrizo Plain National Monument for the first time (BLM 2015). Thus, just one (25%) of the four known occurrences of the vernal pool fairy shrimp within this core area is currently protected. For the two Diversity Database occurrences that do not overlap with BLM's surveys, one had vernal pool fairy shrimp during surveys in 2011 and 2017 and the other has not been surveyed since 1985 (Diversity Database 2022).

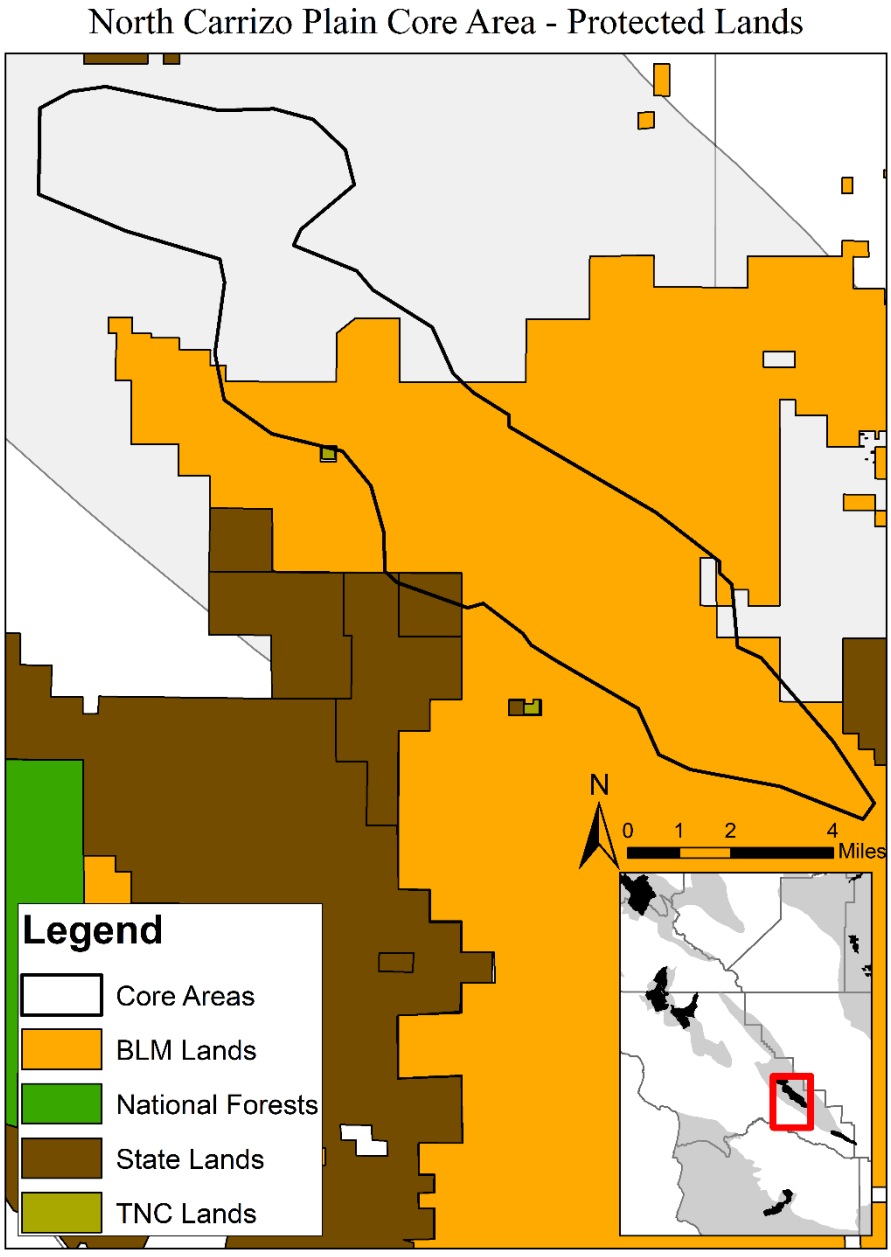


Figure 2.6. Map of protected areas within the North Carrizo Plain Core Area**.** BLM = Bureau of Land Management, TNC = The Nature Conservancy.

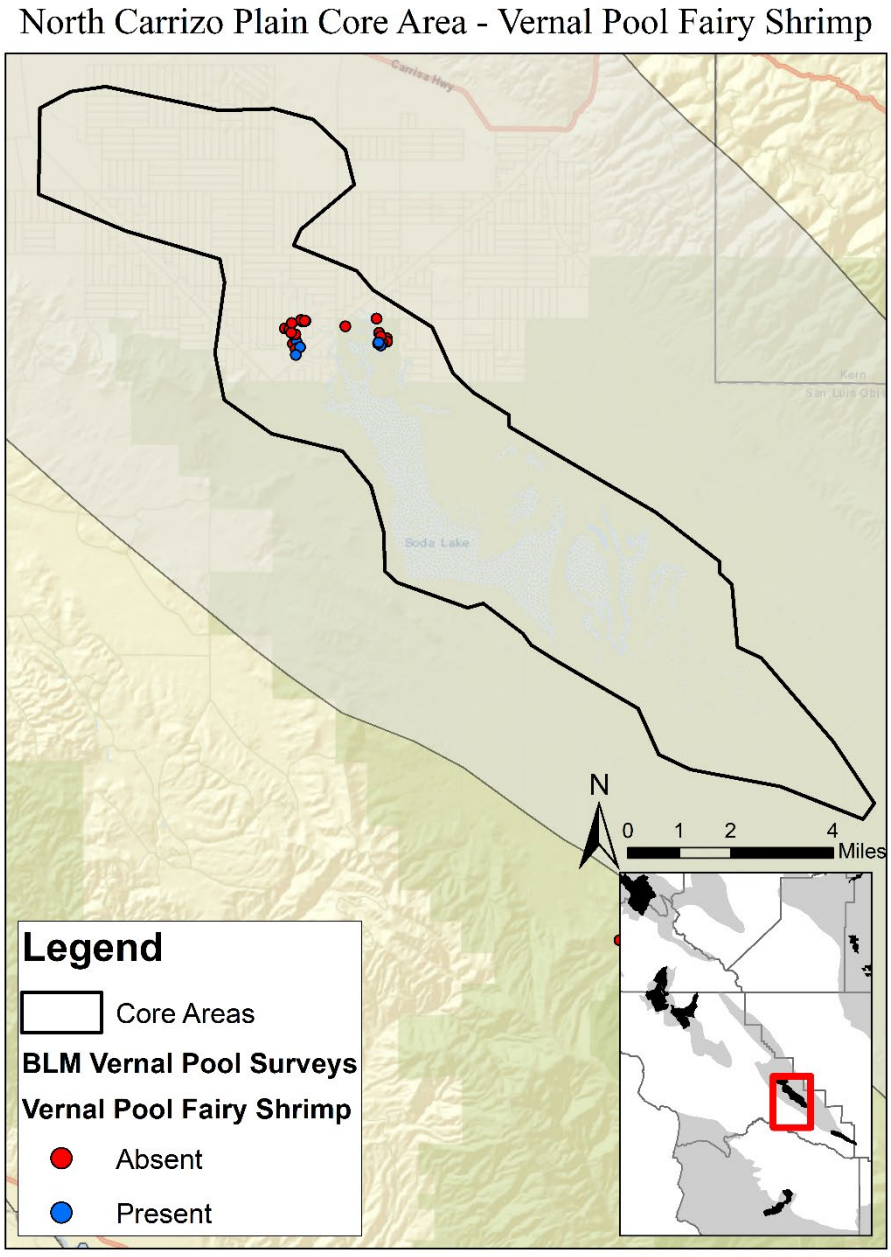


Figure 2.7. Map of known occurrences of vernal pool fairy shrimp recorded during Bureau of Land Management (BLM) surveys from 2015-2019 (BLM 2015; BLM 2016; BLM 2017a; BLM 2019a) within the North Carrizo Plain Core Area. BLM points represent individual vernal pools. Diversity Database (2022) records have been redacted from the map to comply with CDFW's Diversity Database Data Use Guidelines.

2.7.3. Paso Robles

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is located in northern San Luis Obispo County.

There is no estimate of how many acres of vernal pool complex existed in this core area in 2005 or today, and so the Service cannot assess what percentage of vernal pool habitat has been protected. However, the Service is not aware of any protected lands that exist within this core area, so it is possible that none of the existing vernal pool habitat has been protected.

2.7.3.1. Vernal Pool Fairy Shrimp Occurrences

There are two occurrence records from the Diversity Database for the vernal pool fairy shrimp within this core area, both on private land (see **Figure 2.8**; Diversity Database 2022). One is on the north side of Highway 46 and is described as two pools on "Blacks Hatchery and Turkey Farm." The other is on the south side of Highway 46 and is described as the "Agriglobe" vernal pools and as being threatened by agricultural development (Diversity Database 2022). Both were recorded in 2001, after the species was listed but prior to 2005 when the Recovery Plan was published, and no additional information has been provided since. Although the exact coordinates in the Diversity Database may not be precise, aerial imagery of the location of the second record suggests that it may have been converted to a vineyard (Google Maps 2023a).

There are two additional occurrence records provided by the Ventura Fish and Wildlife Office (Ogonowski, *in litt*. 2023a). One is within the core area along Dry Creek Road near the southeastern corner of the Paso Robles Municipal Airport. The naturally occurring pool along the road was recently disturbed during reconstruction of Dry Creek Road and an adjacent mitigation pool was created to compensate for this impact. In August 2022, the mitigation area was impacted by the installation of a new sewer line, so additional mitigation may occur to compensate for this additional impact. The vernal pool fairy shrimp was identified in the natural pool in 2021 prior to construction and in both the natural and created pools in 2023 after construction. The second occurrence is outside of the core area within a more urbanized area that has been proposed for the construction of a hotel. The vernal pool fairy shrimp was identified in two pools onsite in 2019.

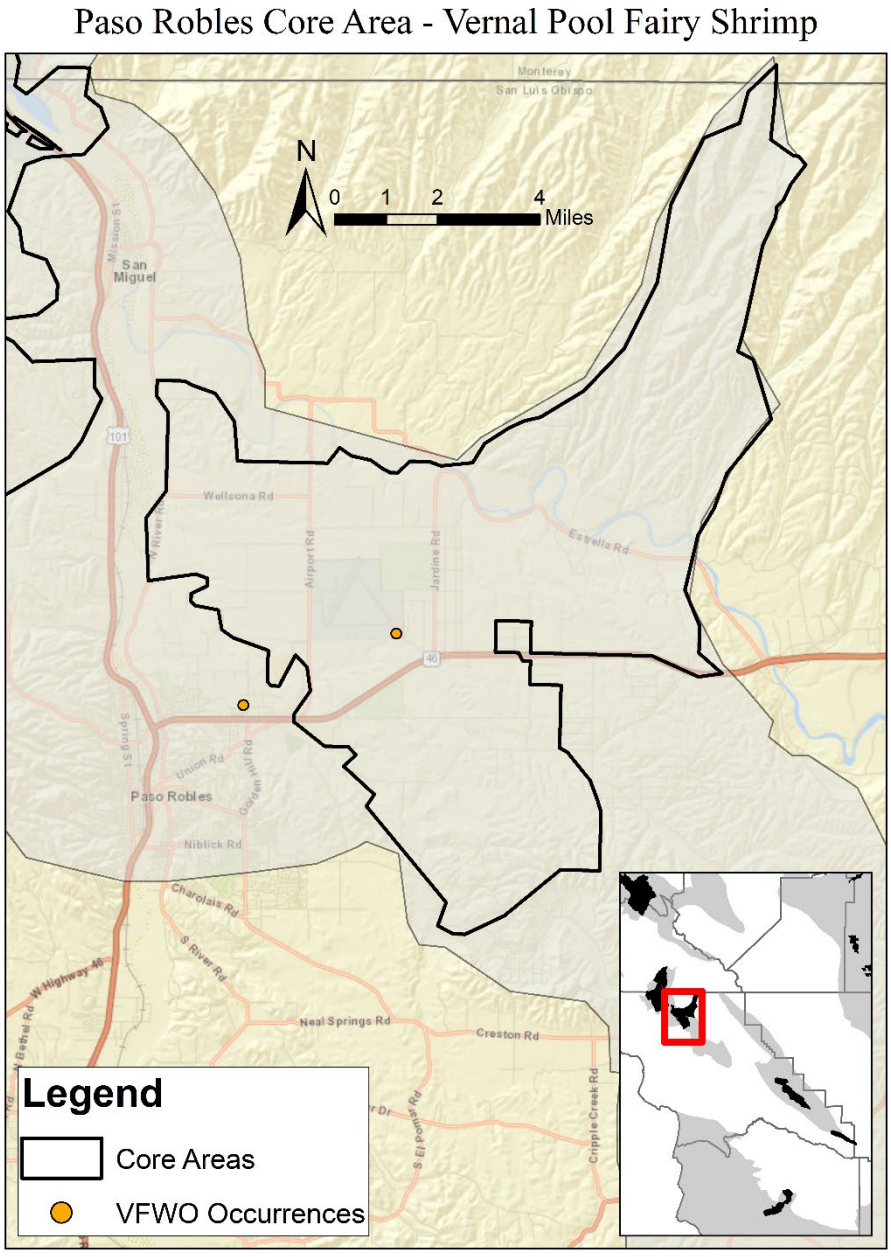


Figure 2.8. Map of known occurrences of vernal pool fairy shrimp provided by the Service's Ventura Fish and Wildlife Office (VFWO) (Ogonowski, *in litt*. 2023a) within the Paso Robles Core Area. Diversity Database (2022) records have been redacted from the map to comply with CDFW's Diversity Database Data Use Guidelines.

2.7.4. South Carrizo Plain

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is located in southeastern San Luis Obispo County and southwestern Kern County.

There is no estimate of how many acres of vernal pool complex existed in this core area in 2005 or today, and so the Service cannot assess what percentage of vernal pool habitat has been protected. The 2010 Resource Management Plan states that there are approximately 20 wetted acres of vernal pools throughout the Carrizo Plain National Monument (BLM 2010). Although it does not say where within the National Monument the pools are located, the maps of vernal pool plants and the longhorn fairy shrimp in the plan suggest that they are mainly around Soda Lake (within the North Carrizo Plain Core Area) or in the southeastern part of the Carrizo Plain (within this core area). The entirety of the core area is within the Carrizo Plain National Monument, though there are several parcels of private land within the core area (**Figure 2.9**), so we cannot say that 100% of the core area is protected within federal land.

2.7.4.1. Vernal Pool Fairy Shrimp Occurrences

There are no Diversity Database records of the vernal pool fairy shrimp in this core area, and the nearest known occurrence of the species is 28 miles away in the North Carrizo Plain Core Area. There are 10 vernal pools in this core area that were surveyed for 1-4 years by BLM from 2015 through 2019, and the vernal pool fairy shrimp was never found (see **Figure 2.10**; BLM 2015; BLM 2016; BLM 2017a; BLM 2019a). The longhorn fairy shrimp is known to occur in this core area, so the Recovery Plan likely included the vernal pool fairy shrimp due to uncertainty as to whether it occurred here as well.

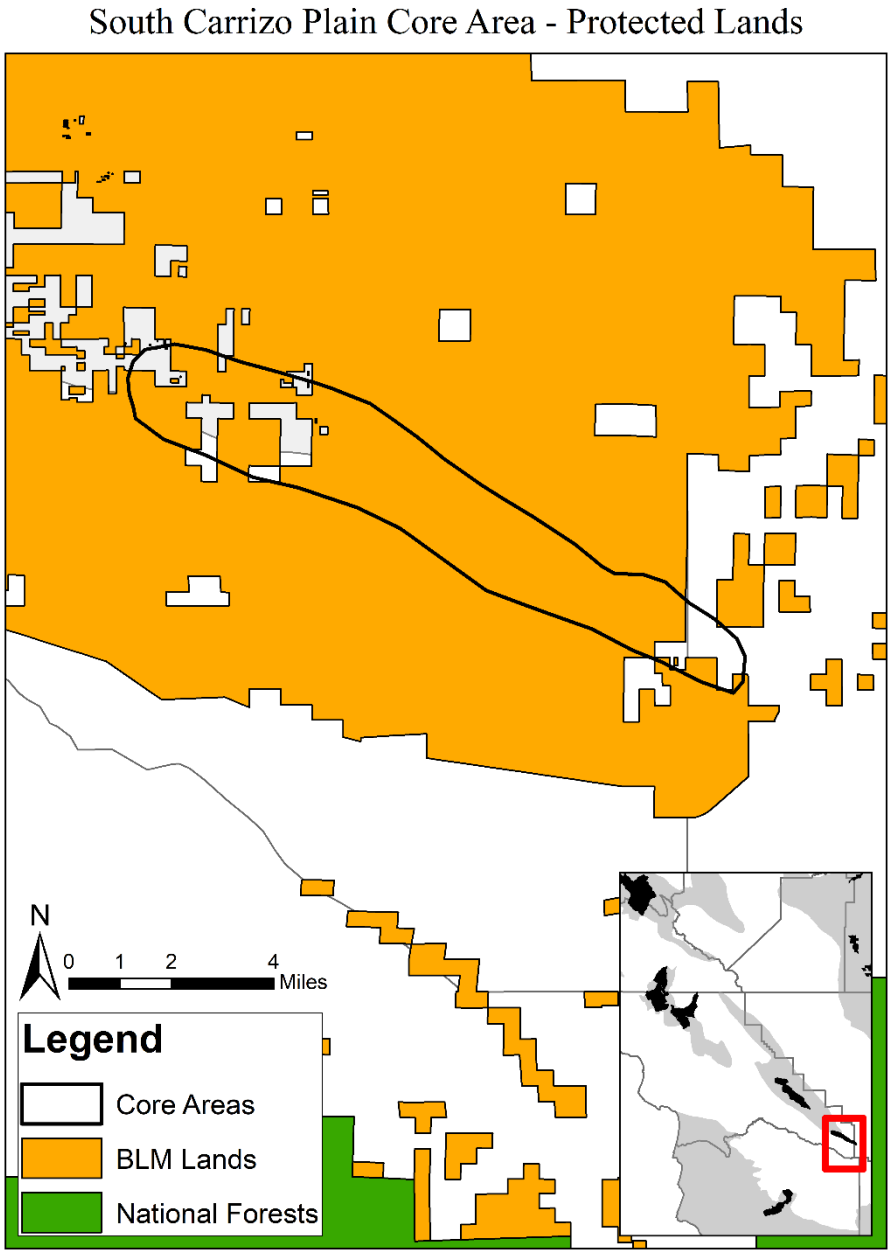


Figure 2.9. Map of protected areas within the South Carrizo Plain Core Area**.** BLM = Bureau of Land Management.

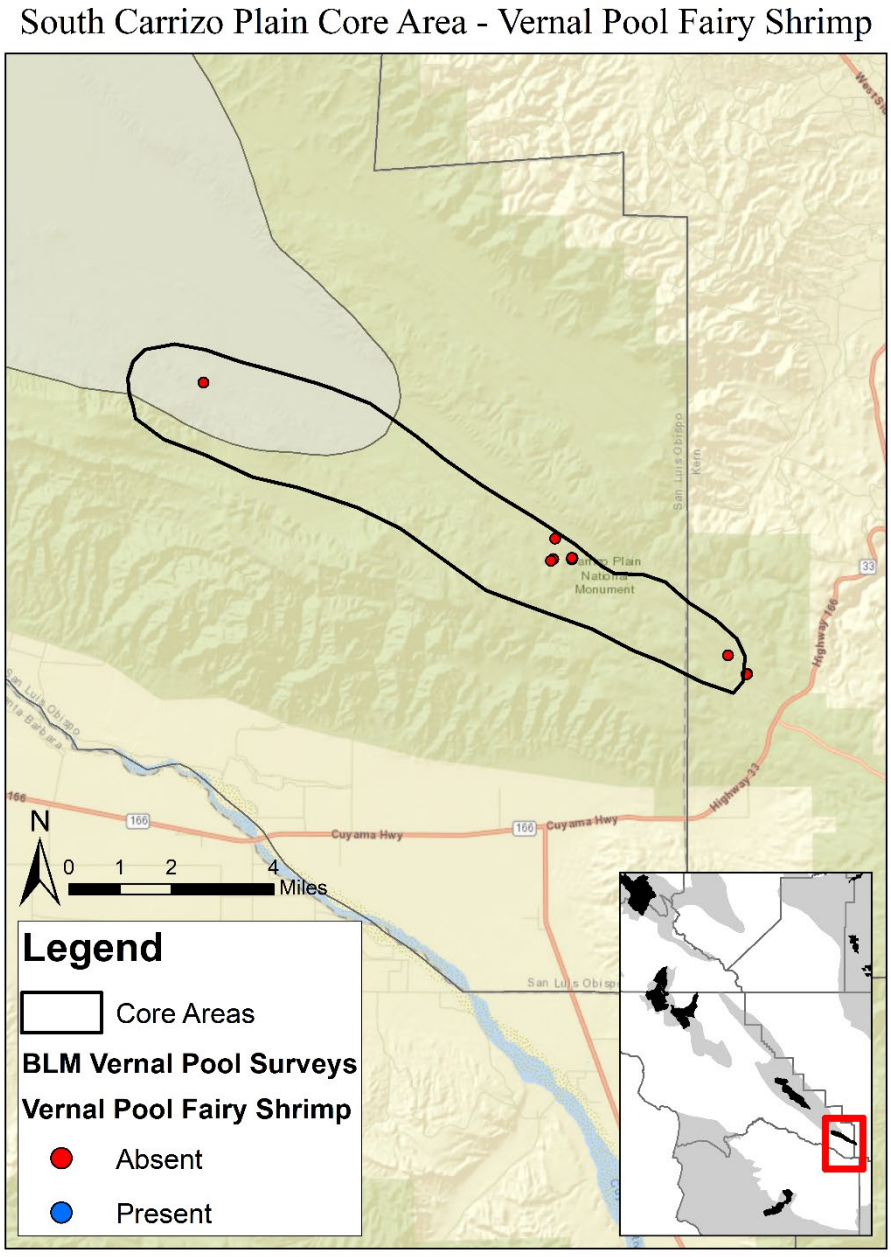


Figure 2.10. Map of vernal pools surveyed for vernal pool shrimp species during Bureau of Land Management (BLM) surveys from 2015-2019 (BLM 2015; BLM 2016; BLM 2017a; BLM 2019a) within the South Carrizo Plain Core Area. The vernal pool fairy shrimp has never been documented within the South Carrizo Plain Core Area.

3. CENTRAL COAST VERNAL POOL REGION

The vernal pool fairy shrimp and vernal pool tadpole shrimp are both known to occur within the Central Coast Vernal Pool Region. The Conservancy fairy shrimp is not known to occur within this region.

3.1. Vernal Pool Habitat

Holland (2003) mapped the vernal pool complexes of the Central Coast of California based on 1994 aerial imagery. The study area consisted of 9,574,099 acres and encompassed all of San Benito, Monterey, San Luis Obispo, Santa Barbara, and Ventura Counties; this encompasses most of the Central Coast Vernal Pool Region, as well as the Carrizo and parts of the Santa Barbara Vernal Pool Regions. The Service does not have a copy of the geodatabase for this study, so we cannot break down the exact acreage of vernal pool complexes in each of the vernal pool regions. In total, 42,488 acres of vernal pool complexes were mapped throughout the study area (see **Figure 3.1**; Holland 2003), though comparison with high-resolution vernal pool mapping at Camp Roberts indicated that Holland's broad scale map is almost certainly an underestimate of both the number and size of vernal pool complexes in the Central Coast. Most of the mapped habitat within the Central Coast Vernal Pool Region is within San Benito County or within southern Monterey County around Fort Hunter Liggett.

As in the Central Valley, many vernal pool complexes along the Central Coast, including the Central Coast Vernal Pool Region, are found in older alluvial soils with a claypan/duripan layer (Holland 2003). However, vernal pools are also found in two additional geomorphic settings not well represented in the Central Valley: sag ponds along faults and active Quaternary landslides on structurally incompetent mountain slopes. Holland (2003) also compared the 1994 imagery with satellite imagery from 2000 and found that 4,931 acres had been lost, a loss of 11.6% over the 6-year interval. Subsequent ground truthing in 2001 of 27 of the remaining polygons found that 15 had been converted to other uses, a loss of more than half of the polygons in the ground truthing area in just a year.

Because the Service does not know the exact acreage of vernal pool complexes in this region and because there has not been a comprehensive assessment of all protected lands within this region, we cannot estimate the amount or percentage of vernal pool habitat that has been protected. Lands with some level of protection include the Don Edwards San Francisco Bay National Wildlife Refuge, Fort Hunter Liggett, Bureau of Land Management land, Sans Topo Ranch, and Panoche Valley Preserve (**Figure 3.2**).

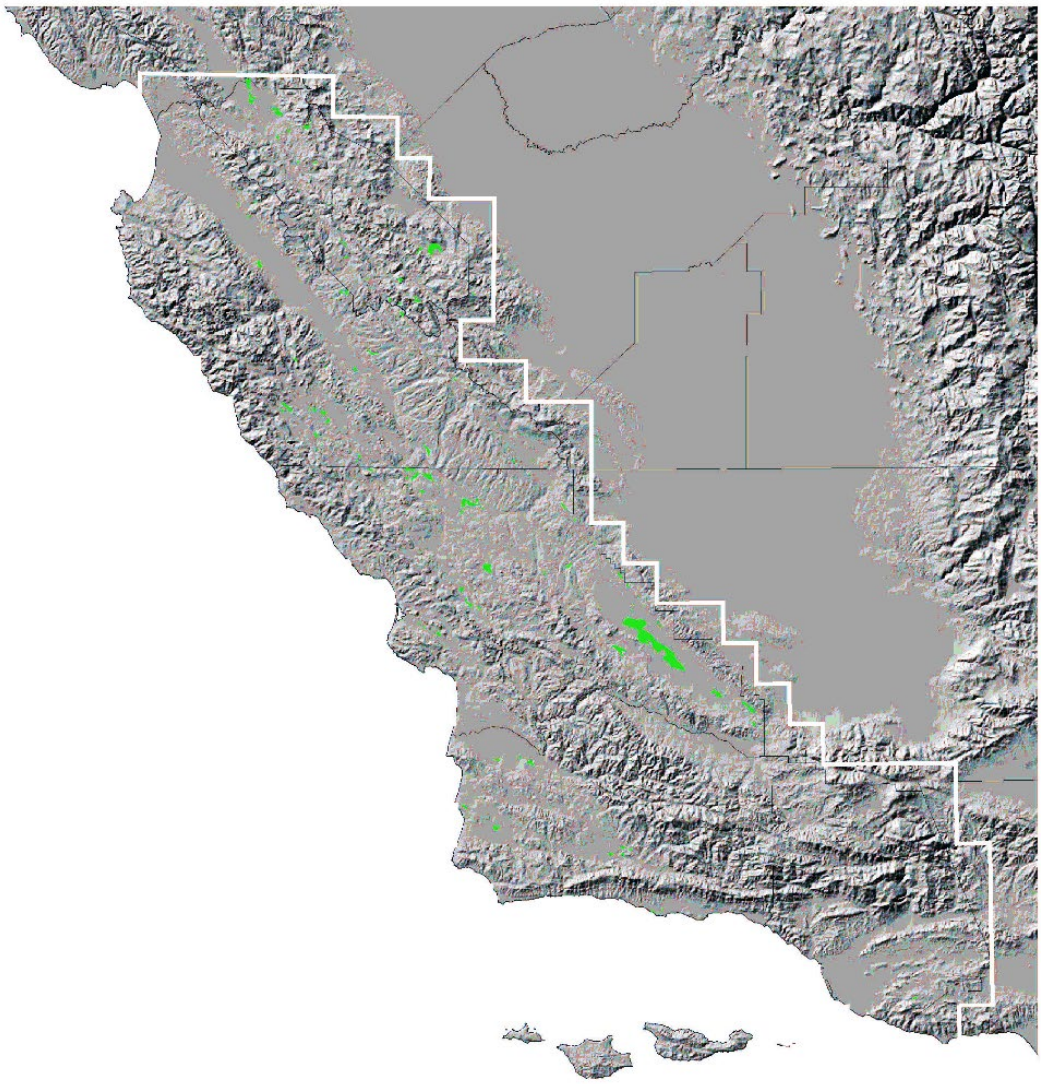


Figure 3.1. Map of vernal pool complexes in green along the Central Coast of California in 1994 mapped by Holland (2003). Taken from Figure 4 of Holland's report submitted to the Service.

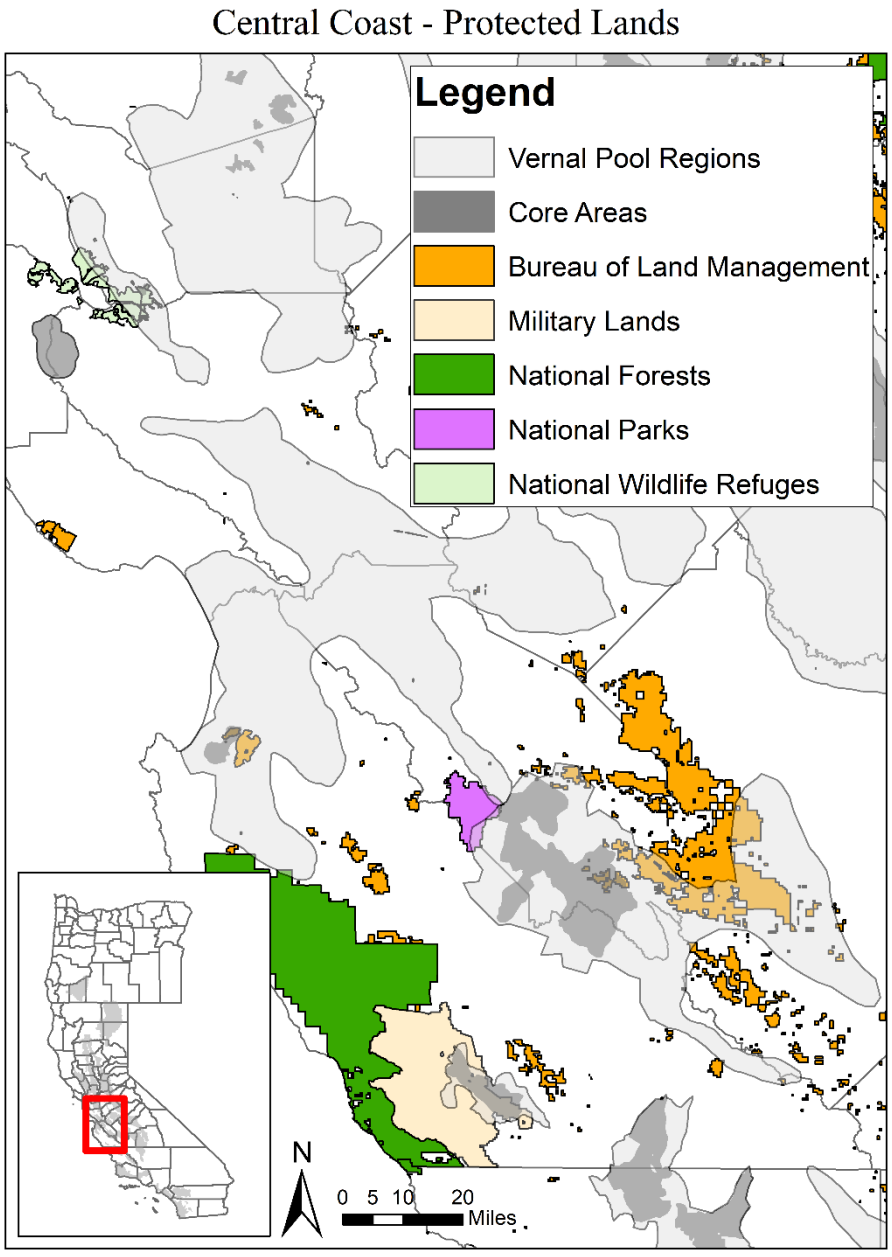


Figure 3.2. Map of protected areas that contain vernal pool grassland habitat and/or vernal pool fairy shrimp or vernal pool tadpole shrimp within the Central Coast Vernal Pool Region. Sans Topo Ranch is not depicted, but is located southeast of Pinnacles National Park. The Panoche Valley Preserve is not depicted, but is located in the Panoche Valley near the border of San Benito and Fresno Counties.

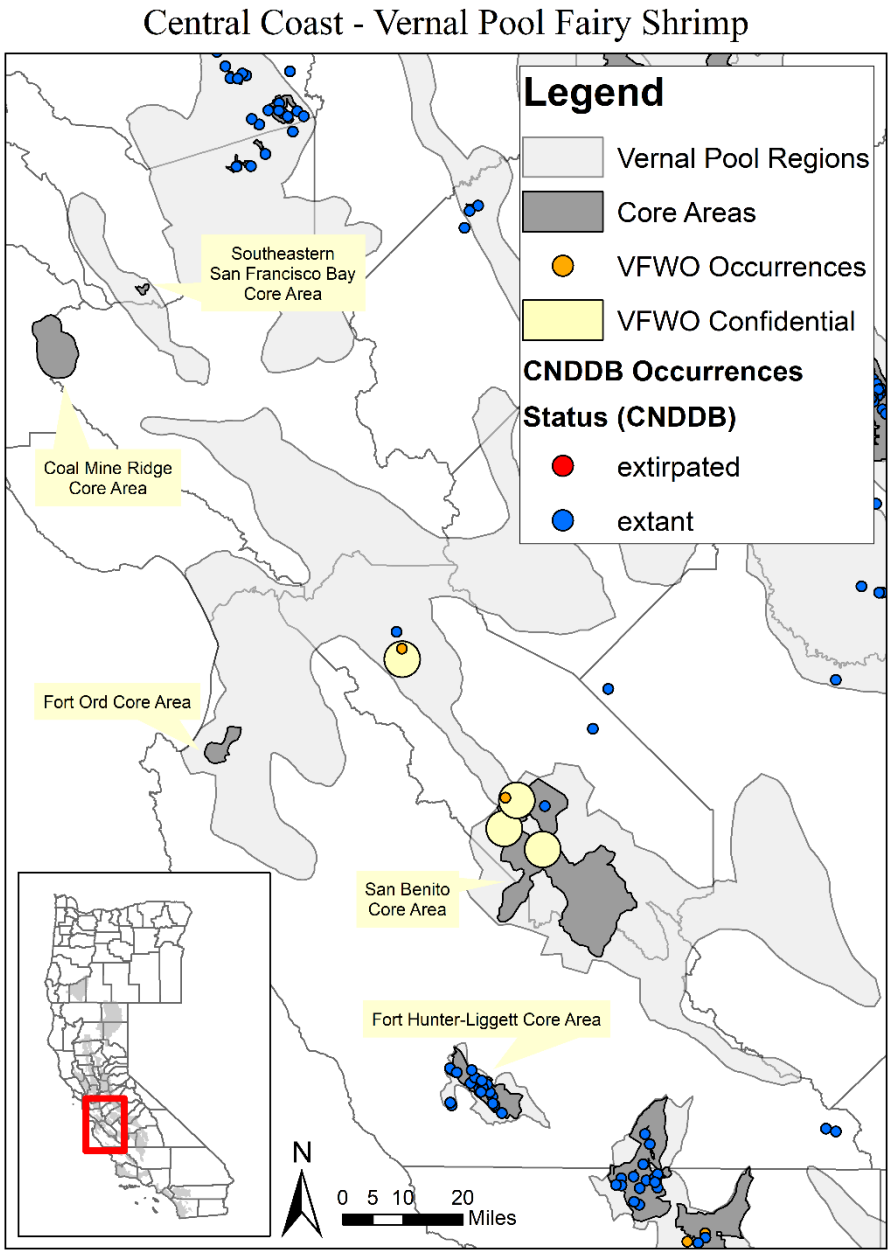


Figure 3.3. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) or provided by the Service's Ventura Fish and Wildlife Office (VFWO) (Ogonowski, *in litt*. 2023a) in the Central Coast Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. All five core areas in the region are displayed, though not all core areas are designated for the vernal pool fairy shrimp.

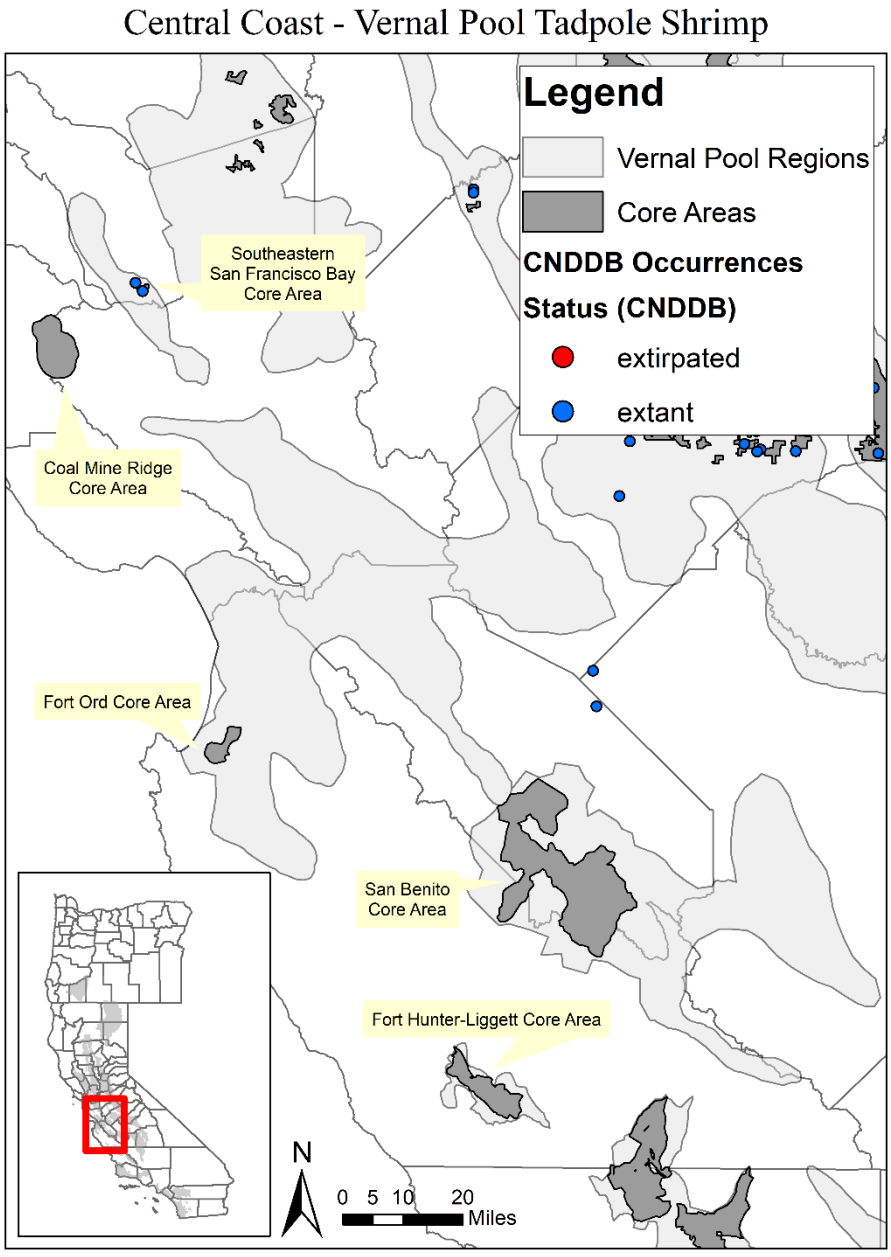


Figure 3.4. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) in the Central Coast Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. All five core areas in the region are displayed, though not all core areas are designated for the vernal pool tadpole shrimp.

3.2. Species Occurrences

3.2.1. Vernal Pool Fairy Shrimp

There are 21 occurrence records of the vernal pool fairy shrimp documented within, or immediately adjacent to, the Central Coast Vernal Pool Region in the Diversity Database (see **Figure 3.3**; Diversity Database 2022). Of these 21 occurrences, 17 are located on the Fort Hunter Liggett military installation and the other 4 are on private land (Diversity Database 2022). Two of these occurrences are outside of the vernal pool region; these were documented in 2010 in the Mercey Hot Springs/Little Panoche Valley area near the Merced-Fresno-San Benito County border. The southern of these occurrences is located in a solar development just outside of the Panoche Valley Preserve (Ogonowski, *in litt*. 2023a). All occurrences are presumed extant by the Diversity Database, although it is possible that some of the 21 occurrences are no longer extant, but have not been surveyed recently.

There are two additional occurrence records provided by the Ventura Fish and Wildlife Office that were not in the Diversity Database and four additional confidential locations that were surveyed by the Ventura Fish and Wildlife Office in the last 5 years (Ogonowski, *in litt*. 2023a). The two additional occurrences to the north are along Highway 25 south of the City of Hollister: one documented in 2018 in a proposed urban development and another in a confidential location documented by the Ventura Fish and Wildlife Office in 2023. The four additional occurrences to the south are along Highway 25 near Pinnacles National Park: one documented in 2022 and 2023 on APC Ranch just east of Pinnacles, two documented in 2023 by the Ventura Fish and Wildlife Office at confidential locations generally east of Pinnacles, and one documented in 2019 on the Sans Topo Ranch to the southeast of Pinnacles (exact location confidential, but a 4,500-acre portion of this ranch was protected with a conservation easement in 2023).

Of the 21 Diversity Database occurrence records, 17 (81%) receive some level of protection by virtue of being located on federal land on Fort Hunter Liggett (**Figure 3.2**). Of the additional occurrences, only one is protected on the Sans Topo Ranch.

3.2.2. Vernal Pool Tadpole Shrimp

There are four occurrence records of the vernal pool tadpole shrimp documented within, or adjacent to, the Central Coast Vernal Pool Region in the Diversity Database (see **Figure 3.4**; Diversity Database 2022). All occurrences are presumed extant by the Diversity Database. The two occurrences within the vernal pool region are located in the southern San Francisco Bay Area. One is within the Don Edwards San Francisco Bay National Wildlife Refuge and was first identified in 1993. The other occurrence, identified in 2016, is just outside of the Refuge on a PG&E substation less than 1 mile from the occurrence on the Refuge. There are also two occurrences from 2010 in the Mercey Hot Springs/Little Panoche Valley area near the Merced-Fresno-San Benito County border. The southern of these occurrences is located just outside of the Panoche Valley Preserve (Ogonowski, *in litt*. 2023a). The nearest vernal pool region is the Central Coast Vernal Pool Region (7–10 miles away), though the nearest occurrence of the vernal pool tadpole shrimp is 30 miles to the north along the San Luis Canal in the San Joaquin Vernal Pool Region (Diversity Database 2022). These two occurrences are approximately 100 miles away from the two Bay Area occurrences.

Of the four Diversity Database occurrence records, only the one (25%) on Don Edwards San Francisco Bay National Wildlife Refuge is protected (**Figure 3.2**).

3.3. Federal Lands

3.3.1. National Wildlife Refuges

Within the Central Coast Vernal Pool Region, the vernal pool tadpole shrimp is known to occur on the Don Edwards San Francisco Bay National Wildlife Refuge, part of the San Francisco Bay National Wildlife Refuge Complex. There are no National Wildlife Refuges with known occurrences of the vernal pool fairy shrimp in this region.

This Refuge was established with three major purposes: preserving the natural resources of the South Bay, including habitat of migratory birds, harbor seals, and endangered species, providing environmental education to Bay Area schools and residents, and protecting open space for the enjoyment of local residents and visitors. A Comprehensive Conservation Plan was prepared for the Refuge in 2012 that included the vernal pool tadpole shrimp (Service 2012a).

The Refuge is almost 30,000 acres in size and is located in a highly urbanized setting at the southern end of the San Francisco Bay and extends into Alameda, Santa Clara, and San Mateo Counties. Approximately 675 acres of vernal pool grassland has been mapped on the Mowry Unit, Warm Springs Seasonal Wetland sub-unit, in south Fremont (see **Figure 3.5**; Service 2012a). The initial 255 acres of the sub-unit was acquired in 1992 and contains natural vernal pools with a history of grazing and waterfowl hunting. In 2008, the Refuge added the Pacific Commons Preserve to the sub-unit, a 425-acre restored vernal pool grassland that had been highly disturbed but had been restored beginning in 1999 as mitigation for an adjacent development. There are approximately 250 individual vernal pools on the Warm Springs Seasonal Wetland sub-unit with a total wetted acreage of 145 acres (WRA Environmental Consultants 2012). Management of vernal pool grassland on the Refuge consists of grazing, monitoring of hydrology, invertebrates, and vegetation, and controlling invasive plant species (Service 2012a), with a specific monitoring plan designed for the Warm Springs Seasonal Wetland sub-unit (WRA Environmental Consultants 2012). Refuge staff and volunteers also lead vernal pool tours on the Refuge; the Warm Springs Seasonal Wetland sub-unit of the Refuge has been growing in popularity as one of the rare Bay Area locations to learn about and enjoy vernal pool grasslands (Service 2012a).

The vernal pool tadpole shrimp was identified in five vernal pools on the Warm Spring Seasonal Wetland sub-unit in 1993 and was consistently identified in surveys through 2004 (Diversity Database 2022) and during annual surveys from 2012 through 2023 (I. Loredo, Service, *in litt*. 2023). A total of 58 vernal pools are monitored each year, and the maximum number of pools where the species has been detected in one year is 52 pools in 2023 (Loredo, *in litt*. 2023).

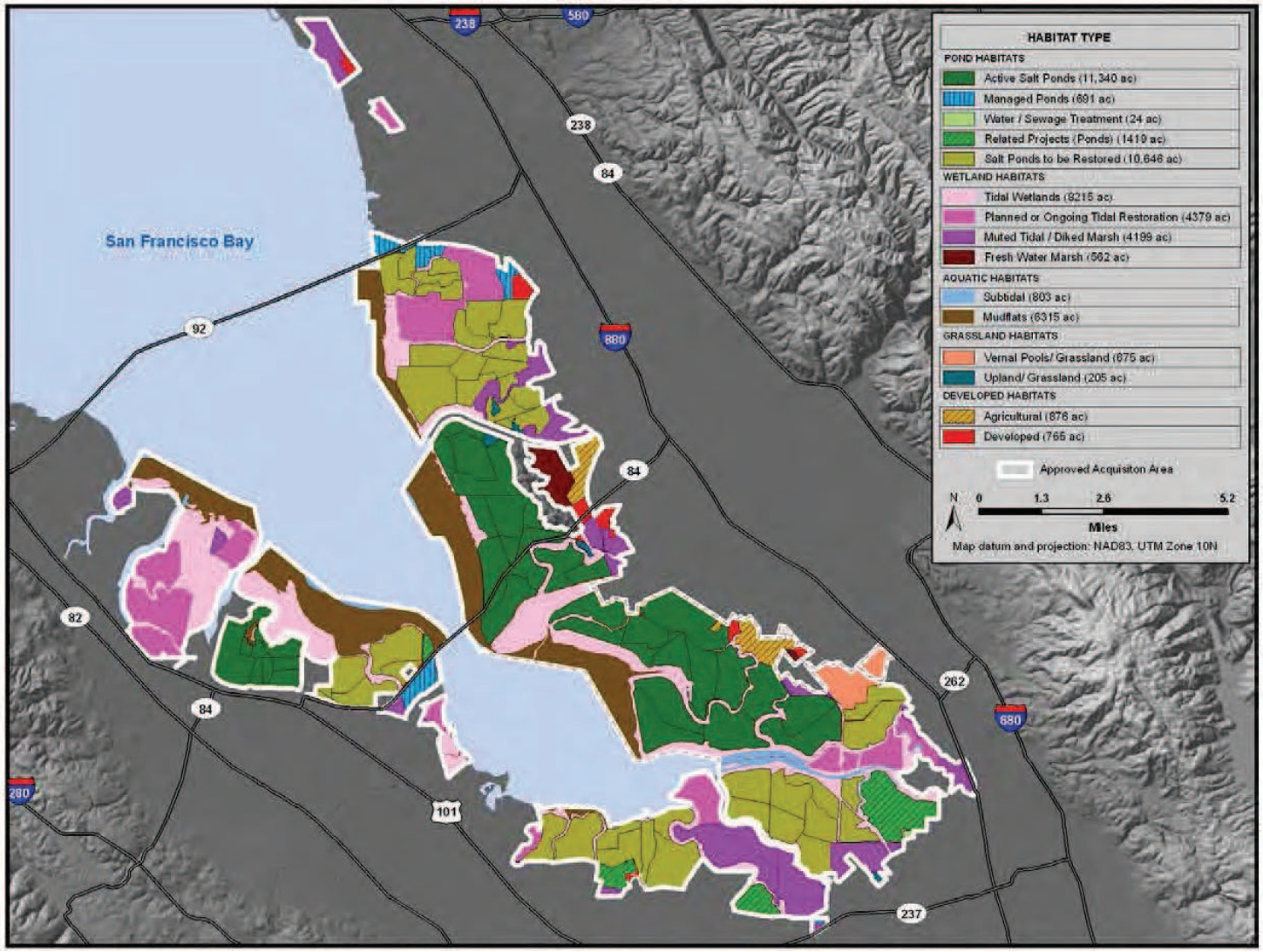


Figure 3.5. Map of habitat types mapped within the Don Edwards San Francisco Bay National Wildlife Refuge's approved acquisition boundary. Vernal pool grasslands are present in the southeast on the Mowry Unit, Warm Springs Seasonal Wetland sub-unit. Taken from Figure 16 of the 2012 Comprehensive Conservation Plan for the Refuge (Service 2012a).

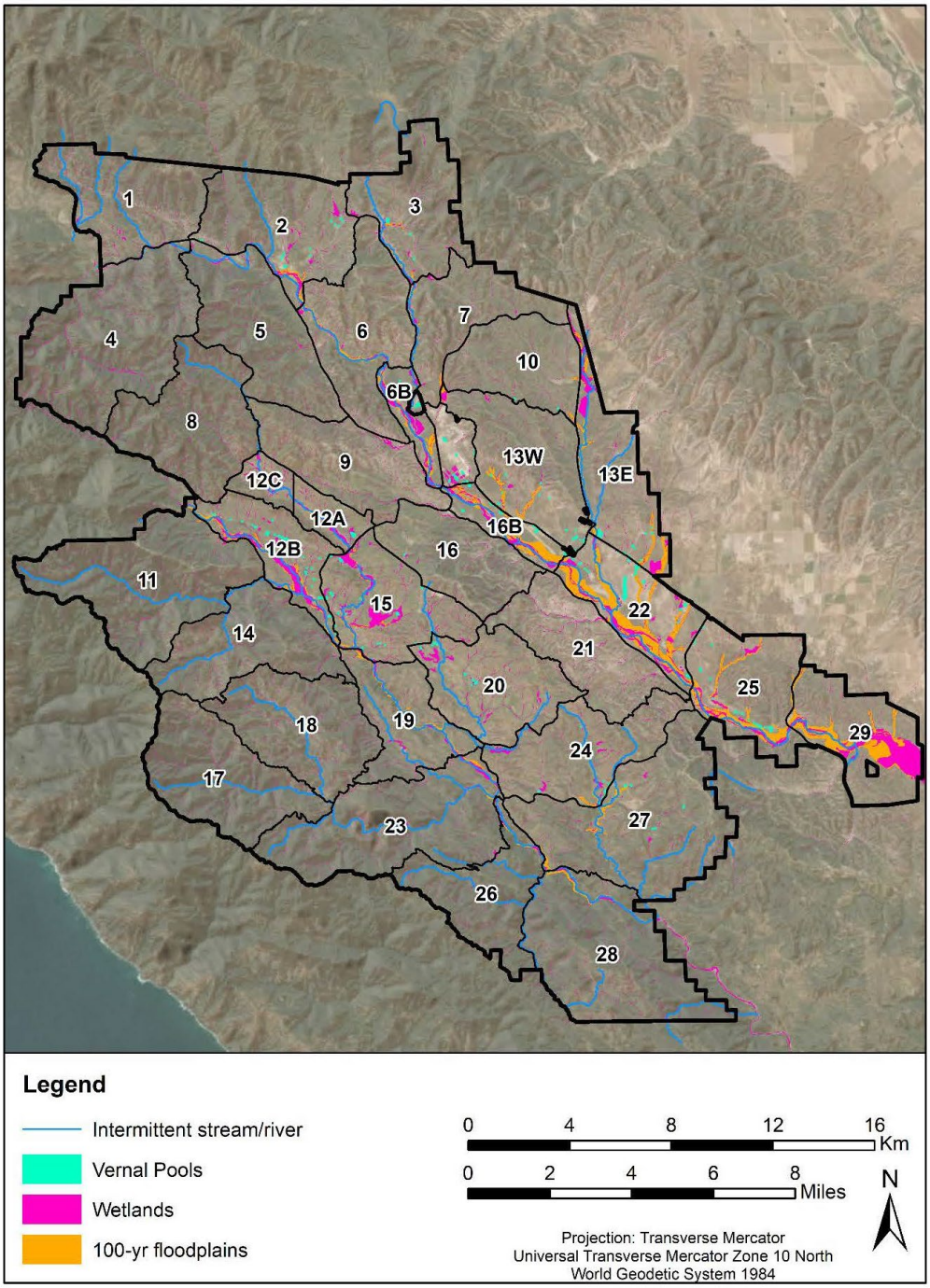


Figure 3.6. Map of the wetlands and various Training Areas within Fort Hunter Liggett. The cantonment is the unnumbered section near the center of the installation between Training Areas 13W, 16B, 6B, and 7. Taken from Figure 3 of the Integrated Natural Resource Management Plan for Fort Hunter Liggett (DOD 2023).

3.3.2. Military Lands

Within the Central Coast Vernal Pool Region, the vernal pool fairy shrimp is known to occur on the Fort Hunter Liggett military installation. There are no military lands with known occurrences of the vernal pool fairy shrimp in this region.

The approximately 167,000-acre Fort Hunter Liggett military installation is located in southwestern Monterey County and is owned by the Department of Defense (DOD). The most recent Integrated Natural Resource Management Plan for Fort Hunter Liggett was finalized in 2023 and includes the vernal pool fairy shrimp (DOD 2023). The Fort encompasses much of the headwaters of the Nacimiento and San Antonio River watersheds and there are a total of 8,620 acres of wetland features documented throughout the installation, though only a fraction of these wetlands are vernal pools (Figure 3.6; DOD 2023). A total of 306 vernal pools have been documented, though a majority of the vernal pools are somewhat artificial, being created by soil compaction in areas such as abandoned borrow sites and adjacent to roadways. There are 13 Diversity Database occurrences of the vernal pool fairy shrimp that were first documented in 1995 and 4 more first documented in 2000 (Diversity Database 2022). The vernal pool fairy shrimp was found in a total of 65 vernal pools during surveys in 2000, with 1 additional occupied pool discovered in 2008 (DOD 2023). Vernal pool fairy shrimp sites are concentrated in the San Antonio Valley in the cantonment area and Training Areas 13, 16B, 22, and 25, with two additional sites in the Nacimiento Valley in Training Area 20 (**Figure 3.6**). Approximately 1,800-acres of vernal pool fairy shrimp habitat have been designated as a Sensitive Resource Management Area in Training Areas 13E, 13W, and 22. Management of vernal pools on Fort Hunter Liggett includes annual monitoring for species presence, evidence of disturbance, adequacy of protection measures, exotic species encroachment, and evidence of succession (DOD 2023). In 2018, wet season disturbance monitoring found recent disturbance to twelve vernal pools, four of which were occupied by the vernal pool fairy shrimp. Some of the reported disturbance was caused by vehicles, but these appeared to be random incidents rather than a recurring problem (DOD 2023).

3.3.3. Bureau of Land Management

The Bureau of Land Management (BLM) owns a large block of land around the border of San Benito and Fresno Counties (**Figure 3.2**). This area includes many large grazing allotments as well as the San Benito Wilderness Study Area. There are also many small blocks of BLM land throughout and adjacent to the Central Coast Vernal Pool Region, particularly in the southern half of the region. However, the Service is unaware of any vernal pool habitat or occurrences of the vernal pool fairy shrimp or vernal pool tadpole shrimp within these areas.

3.3.4. Other Federal Lands

There are no other federal lands in this region with known occurrences of the vernal pool fairy shrimp or vernal pool tadpole shrimp. Both Pinnacles National Park and the northernmost part of Los Padres National Forest are immediately adjacent to the Central Coast Vernal Pool Region. On Pinnacles, two vernal pools, one drainage pool, and one artificial pond were surveyed in 2022–2023; neither vernal pool fairy shrimp or vernal pool tadpole shrimp were observed, though one vernal pool did contain the California fairy shrimp (*Linderiella occidentalis*) (M.

Ogonowski, Service, *in litt*. 2023b). The portions of Los Padres National Forest near the Central Coast Vernal Pool Region are not currently known to contain any vernal pool habitat.

3.4. Conservation Banks

There are no conservation or mitigation banks with known occurrences of the vernal pool fairy shrimp or vernal pool tadpole shrimp in the Central Coast Vernal Pool Region.

3.5. Habitat Conservation Plans

There are two regional Habitat Conservation Plans (HCPs) within the Central Coast Vernal Pool Region that include the three shrimp species as a Covered Species. Although the Conservancy fairy shrimp is not found in the Central Coast Vernal Pool Region, these HCPs spans multiple regions and therefore covers all three shrimp species.

3.5.1. PG&E Bay Area Operations and Maintenance HCP

The Pacific Gas & Electric Company's (PG&E) Bay Area Operations and Maintenance HCP covers PG&E activities within nine San Francisco Bay Area counties, spanning the Solano-Colusa, Lake-Napa, Livermore, and Central Coast Vernal Pool Regions (ICF 2017). This HCP was permitted in 2017 and has a 30-year permit term. The purpose of the HCP is to enable PG&E to continue to conduct current and future operations and maintenance activities within the nine Bay Area counties while avoiding, minimizing, and mitigating temporary and permanent impacts on threatened and endangered species habitat. The HCP's conservation strategy includes mitigation for permanent and temporary impacts to species habitat, which may be in the form of purchasing and/or placing easements on high quality habitat, purchase of conservation bank credits, contributions to existing conservation planning and recovery efforts, or habitat enhancement or restoration.

The HCP's Habitat Models estimated that 66,917 acres of vernal pool fairy shrimp habitat, 61,664 acres of vernal pool tadpole shrimp habitat, and 5,260 acres of Conservancy fairy shrimp habitat exists in the nine Bay Area counties (ICF 2017). Of this total habitat the HCP estimates that 4,963 acres, 4,382 acres, and 292 acres of habitat for each species, respectively, are within the HCP's Plan Area (PG&E lands, etc.) where Covered Activities will take place (ICF 2017). The HCP estimated permanent and temporary losses of vernal pool fairy shrimp habitat and vernal pool tadpole shrimp habitat to be 5 acres and 25 acres, respectively. The HCP estimated permanent and temporary losses of Conservancy fairy shrimp habitat to be 0.5 acres and 2 acres, respectively. Permanent loss of habitat will be mitigated at a 3:1 ratio and temporary habitat loss at a 1:1 ratio. Therefore, a total of 40 acres of vernal pool fairy shrimp habitat will be preserved in perpetuity; this mitigation is anticipated to occur in the Solano-Colusa and/or Livermore Vernal Pool Regions. Also, a total of 3.5 acres of Conservancy fairy shrimp habitat will be preserved in perpetuity; this mitigation is anticipated to occur in the Solano County. As of December 31, 2020, there have been no impacts to the three shrimp species from covered activities and no mitigation lands have been acquired for the three shrimp species (PG&E 2021).

3.5.2. PG&E Multiple Region Operations and Maintenance HCP

See section 2.5.1 for a description of this HCP.

3.6. Other Preserves

The Sans Topo Ranch is generally located southeast of Pinnacles National Park. The vernal pool fairy shrimp was documented by the Ventura Fish and Wildlife Office in two vernal pools during one day of surveys and may occur in additional pools (Ogonowski, *in litt*. 2023a). The ranch is approximately 5,000 acres and is almost entirely within the San Benito Core Area. In 2023, approximately 4,500 acres of the ranch were protected under a conservation easement with funding from a Section 6 Non-Traditional Recovery Lands Acquisition grant.

The Panoche Valley Preserve is a 26,419-acre preserve designated as compensatory mitigation for the Panoche Valley Solar Project in San Benito County near the border with Fresno County (Ogonowski, *in litt*. 2023a). It is outside of the defined boundary of the Central Coast Vernal Pool Region. Vernal pools mainly occur in the northwestern portion of the preserve, which is along Little Panoche Road and surrounds the solar development. California tiger salamanders (*Ambystoma californiense*) have been documented in several pools in the preserve, but the vernal pool fairy shrimp and vernal pool tadpole shrimp have only been documented in pools just outside of the preserve. The vernal pool fairy shrimp was documented in 2019–2021 in two pools in the center of the solar development, as well as in 2019 in one pool north of the preserve. The vernal pool tadpole shrimp was documented in 2019–2021 in one pool near the northwest corner of the preserve.

3.7. Vernal Pool Core Areas

There are two Core Areas within the Central Coast Vernal Pool Region that are designated in the Recovery Plan for the vernal pool fairy shrimp: Fort Hunter Liggett and San Benito. Because the Service does not know how much vernal pool habitat existed in this region in 2005, how much still exists today, and how much has been protected, we do not know if any of the core areas have met the target of 85% of vernal pool habitat protected.

There is one Core Area within the Central Coast Vernal Pool Region that is designated in the Recovery Plan for the vernal pool tadpole shrimp: Southeastern San Francisco Bay. The core area has met the target of 85% of vernal pool habitat protected.

3.7.1. Fort Hunter Liggett

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is located in southwestern Monterey County.

There is no estimate of how many acres of vernal pool complex existed in this core area in 2005 or today, and so the Service cannot assess what percentage of vernal pool habitat has been protected. Still, we can attempt to approximate the percentage of protected vernal pool habitat based on other available information. Approximately 81% of this core area is within Fort Hunter Liggett. There are a total of 8,620 acres of wetland features documented throughout the Fort, though only a fraction of these wetlands are vernal pools (DOD 2023). A majority of the vernal pools are somewhat artificial, being created soil compaction in areas such as abandoned borrow sites and adjacent to roadways. The majority of the Training Areas with vernal pool fairy shrimp sites are within the core area, which generally follows the San Antonio River. Vernal pool habitat has been protected within an 1,800-acre Sensitive Resource Management Area in

Training Areas 13E, 13W, and 22, which are in the northwestern half of the core area (**Figure 3.6**, **Figure 3.7**). Thus, a majority of vernal pool habitat is likely protected within this core area, though vernal pools in the southeastern portion of the core area, either within or outside of Fort Hunter Liggett, remain unprotected. However, these areas are not protected in perpetuity under a conservation easement or deed restriction, and could conceivably be subject to changes in management if Federal priorities shift or if the installation is ever closed and the land is transferred to a different landowner. In addition, vernal pool habitat within Fort Hunter Liggett is sometimes disturbed despite the protective measures in the Integrated Natural Resources Management Plan; in 2018, 12 vernal pools were found to be disturbed during routine monitoring efforts (DOD 2023).

3.7.1.1.Vernal Pool Fairy Shrimp Occurrences

There are 14 occurrence records from the Diversity Database for the vernal pool fairy shrimp within this core area and 3 other occurrences nearby, all of which are within the Fort Hunter Liggett military installation (see **Figure 3.7**; Diversity Database 2022). The vernal pool fairy shrimp was first detected at Fort Hunter Liggett in 1995 after the species was listed, and all 17 of the occurrences were known prior to 2005 when the Recovery Plan was published (Diversity Database 2022). All occurrences are presumed extant. The vernal pool fairy shrimp was found in a total of 65 vernal pools during surveys in 2000, with 1 additional occupied pool discovered in 2008 (DOD 2013). Vernal pool fairy shrimp sites are concentrated in the San Antonio Valley in the cantonment area and Training Areas 13, 16B, 22, and 25, with two additional sites in the Nacimiento Valley in Training Area 20 (**Figure 3.6**).

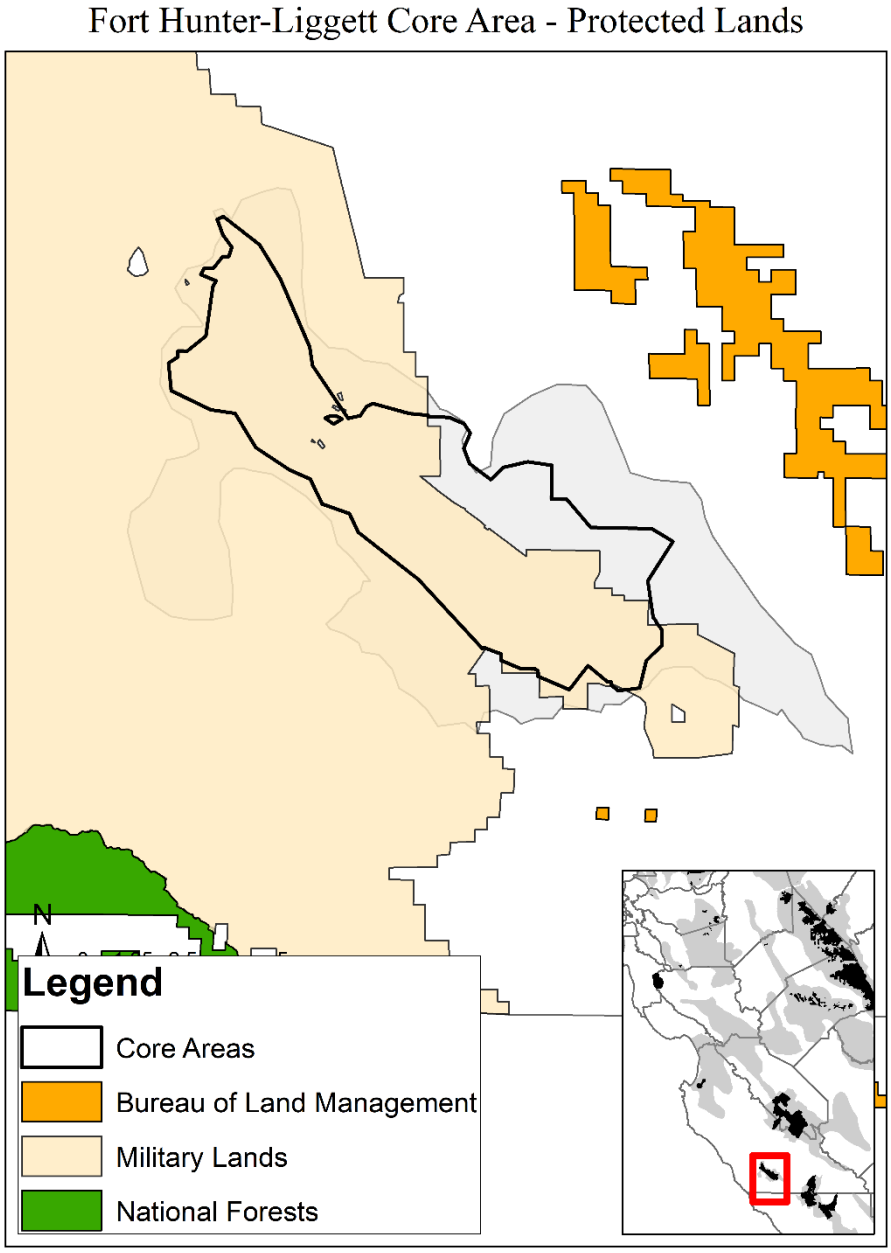


Figure 3.7. Map of all protected lands within the Fort Hunter Liggett Core Area. Diversity Database (2022) records have been redacted from the map to comply with CDFW's Diversity Database Data Use Guidelines.

3.7.2. San Benito

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is located in southwestern San Benito County, extending slightly into Monterey County.

There is no estimate of how many acres of vernal pool complex existed in this core area in 2005 or today. The Service's Ventura Fish and Wildlife Office is currently working with a number of landowners in San Benito County on a conservation easement effort through which the Service is identifying suitable/occupied vernal pool fairy shrimp habitat (M. Ogonowski, Service, *in litt*. 2021). As of 2023, one of these properties had been protected under a conservation easement: Sans Topo Ranch (Ogonowski, *in litt*. 2023a). Approximately 4,500 acres of Sans Topo Ranch has been protected within this core area, some of which contains vernal pool habitat that is known to support the vernal pool fairy shrimp. The APC Ranch has also been proposed as a conservation bank and may be protected in the future.

3.7.2.1. Vernal Pool Fairy Shrimp Occurrences

There is one occurrence record for the vernal pool fairy shrimp within this core area in the Diversity Database (see **Figure 3.8**; Diversity Database 2022). This record was recorded in 1987; the location data is very imprecise, being described only as "1.5 miles east of the junction of Smoker Canyon and the San Benito River." The occurrence is presumed extant, though it has not been surveyed since 1987 to the Service's knowledge. There are four additional occurrences within or immediately adjacent to the core area: Sans Topo Ranch southeast of Pinnacles National Park, and APC Ranch and two other ranches surveyed by the Ventura Fish and Wildlife Office east of Pinnacles National Park (Ogonowski, *in litt*. 2023a). These occurrences were all documented between 2019 and 2023.

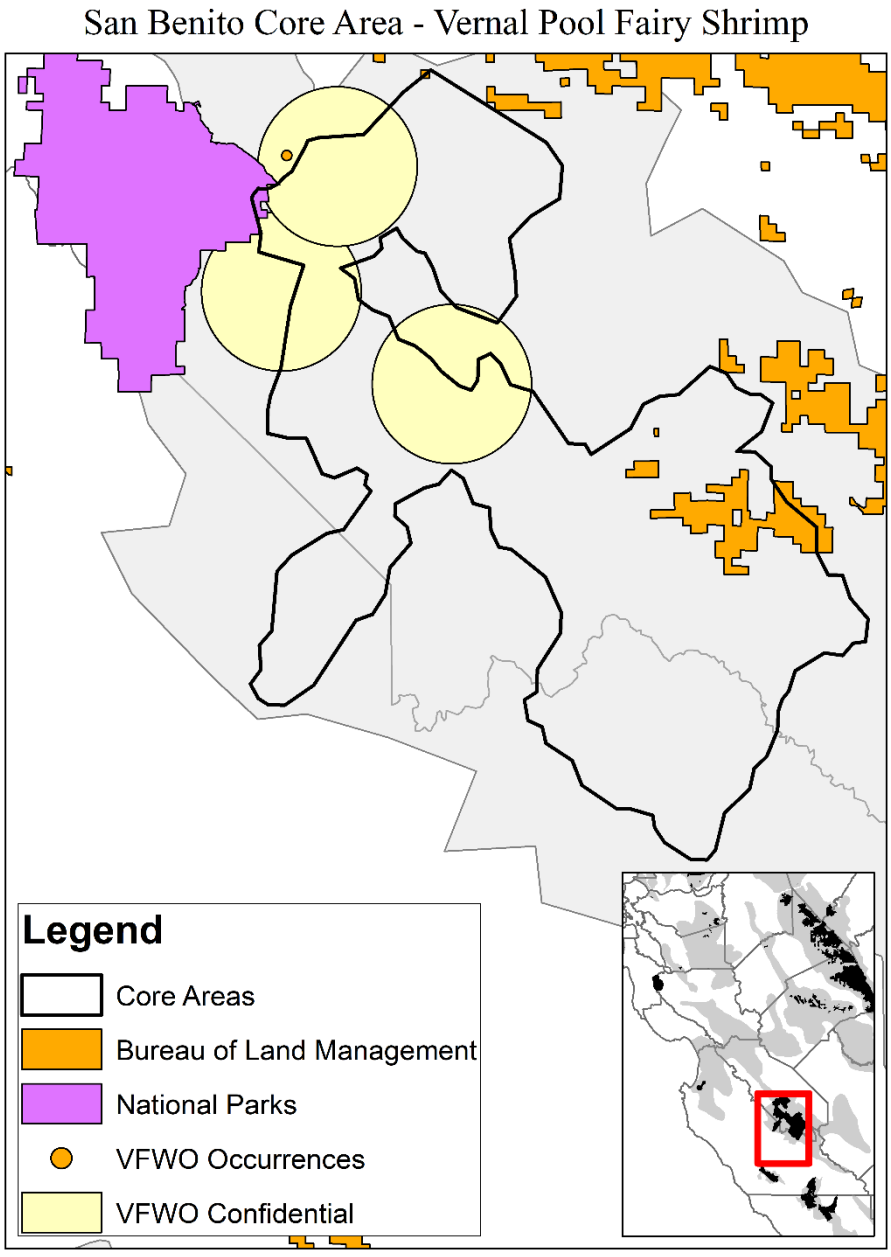


Figure 3.8. Map of known occurrences of vernal pool fairy shrimp provided by the Service's Ventura Fish and Wildlife Office (VFWO) (Ogonowski, *in litt*. 2023a) and all protected lands within the San Benito Core Area. Sans Topo Ranch is not explicitly depicted, but is generally located within the southeasternmost confidential occurrence record. Diversity Database (2022) records have been redacted from the map to comply with CDFW's Diversity Database Data Use Guidelines.

3.7.3. Southeastern San Francisco Bay

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool tadpole shrimp. The core area is located in the City of Fremont, Alameda County, in the Don Edwards San Francisco Bay National Wildlife Refuge, Mowry Unit, Warm Springs Seasonal Wetland sub-unit.

The boundaries of this core area generally align with the Warm Springs Seasonal Wetland sub-unit of the Refuge. Approximately 675 acres of vernal pool grasslands have been mapped within the sub-unit (**Figure 3.5**), including 425 acres of restored vernal pool grasslands (Service 2012a). There are approximately 250 individual vernal pools on the Warm Springs Seasonal Wetland sub-unit with a total wetted acreage of 145 acres (WRA Environmental Consultants 2012). All of the extant vernal pool grassland within the core area has been protected within the Refuge.

3.7.3.1. Vernal Pool Tadpole Shrimp Occurrences

There is one Diversity Database occurrence record for the vernal pool tadpole shrimp within this core area, which is protected within the Refuge (see **Figure 3.9**; Diversity Database 2022). The vernal pool tadpole shrimp was identified in five vernal pools on the Warm Spring Seasonal Wetland sub-unit in 1993 and was consistently identified in surveys through 2004 (Diversity Database 2022) and during annual surveys from 2012 through 2023 (I. Loredo, Service, *in litt*. 2023). A total of 58 vernal pools are monitored each year, and the maximum number of pools where the species has been detected in one year is 52 pools in 2023 (Loredo, *in litt*. 2023). There is also a nearby occurrence, identified in 2016, just outside of the Refuge on a PG&E substation; this occurrence is on semi-natural, grazed grassland, with disturbance from grazing and occasional maintenance of the overhead powerlines (Diversity Database 2022).

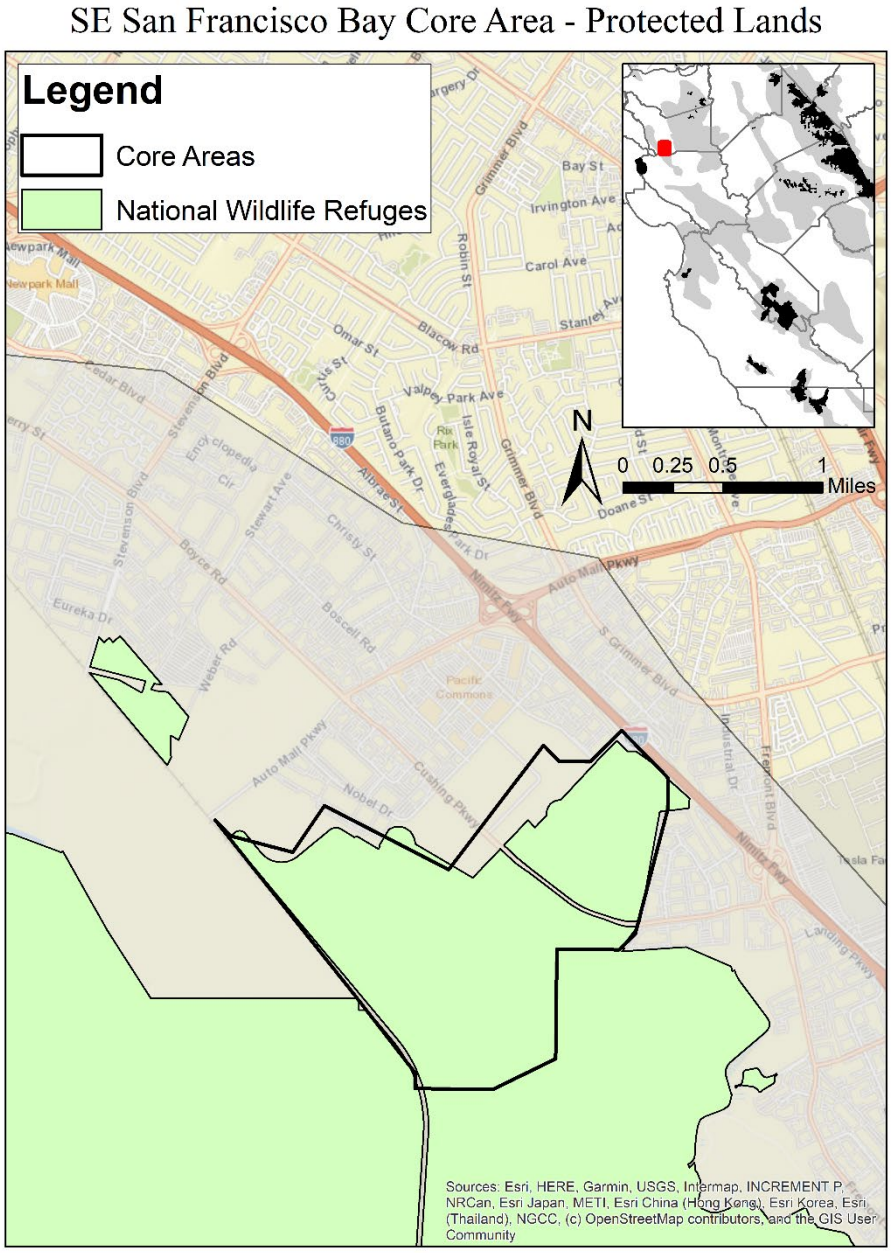


Figure 3.9. Map of all protected lands within the Southeastern San Francisco Bay Core Area. Diversity Database (2022) records have been redacted from the map to comply with CDFW's Diversity Database Data Use Guidelines.

4. KLAMATH MOUNTAINS VERNAL POOL REGION

Only the vernal pool fairy shrimp is known to occur within the Klamath Mountains Vernal Pool Region.

4.1. Vernal Pool Habitat

The Oregon Natural Heritage Program (ONHP; now the Oregon Biodiversity Information Center) mapped vernal pool habitat within 20,628 acres surrounding the Agate Desert in Jackson County, Oregon using 1996 aerial imagery (ONHP 1997). Almost 12,000 acres had already been leveled or developed by that point, and ONHP further refined the mapping on the 8,801 acres of remaining vernal pool habitat using improved 1998 aerial imagery and videography (ONHP 1999). The refined imagery classified an additional 2,855 acres as developed, leveled, or otherwise having no vernal pools, leaving only 5,946 acres of vernal pool habitat in 1998 (**Figure 4.1**; ONHP 1999). This remaining vernal pool habitat varied in condition. No fully intact vernal pool habitat remained, but the highest quality habitat type (hydrology/topography intact, but vegetation altered) was present on 3,621 acres, or 17.6% of the historical distribution (ONHP 1999; Service 2012b). The *Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems* (Rogue and Illinois Valley Recovery Plan), published in 2012, mentions that there are approximately 5,000 acres of vernal pool habitat in the Rogue Valley (Service 2012b). The Service is currently funding a new vernal pool mapping assessment in Oregon, so more current data on the distribution of vernal pools in the Klamath Mountains Vernal Pool Region is expected by 2023 (S. Friedman, Service, *in litt*. 2022a).

As of 2012, the Rogue and Illinois Valley Recovery Plan identified approximately 2,293 acres of vernal pool habitat that had been protected for the vernal pool fairy shrimp (Service 2012b; Table II-6 incorrectly sums the total to 2,333 acres). The formal section 7 consultation on the Agate Bay Solar Project, issued by the Service on October 24, 2018, identifies 2,593 acres of protected lands in the Status of the Species section of the biological opinion (Service 2018a). Additional information collected for this 5-year review has refined this number and clarified differences between the total acres of land protected within each core area and the acreage of vernal pool habitat protected within each core area. In total, 2,758.74 acres of total land has been preserved within the core areas, as well as one 352-acre preserve that is outside of the core areas; 2,504.31 acres of vernal pool habitat has been preserved (**Figure 4.2**, **Table 4.1**).This means that somewhere between 42% (using the total acreage of 5,946 acres; ONHP 1999) and 50% (using the total acreage of 5,000 acres; Service 2012b) of the remaining vernal pool habitat in this region has been protected.

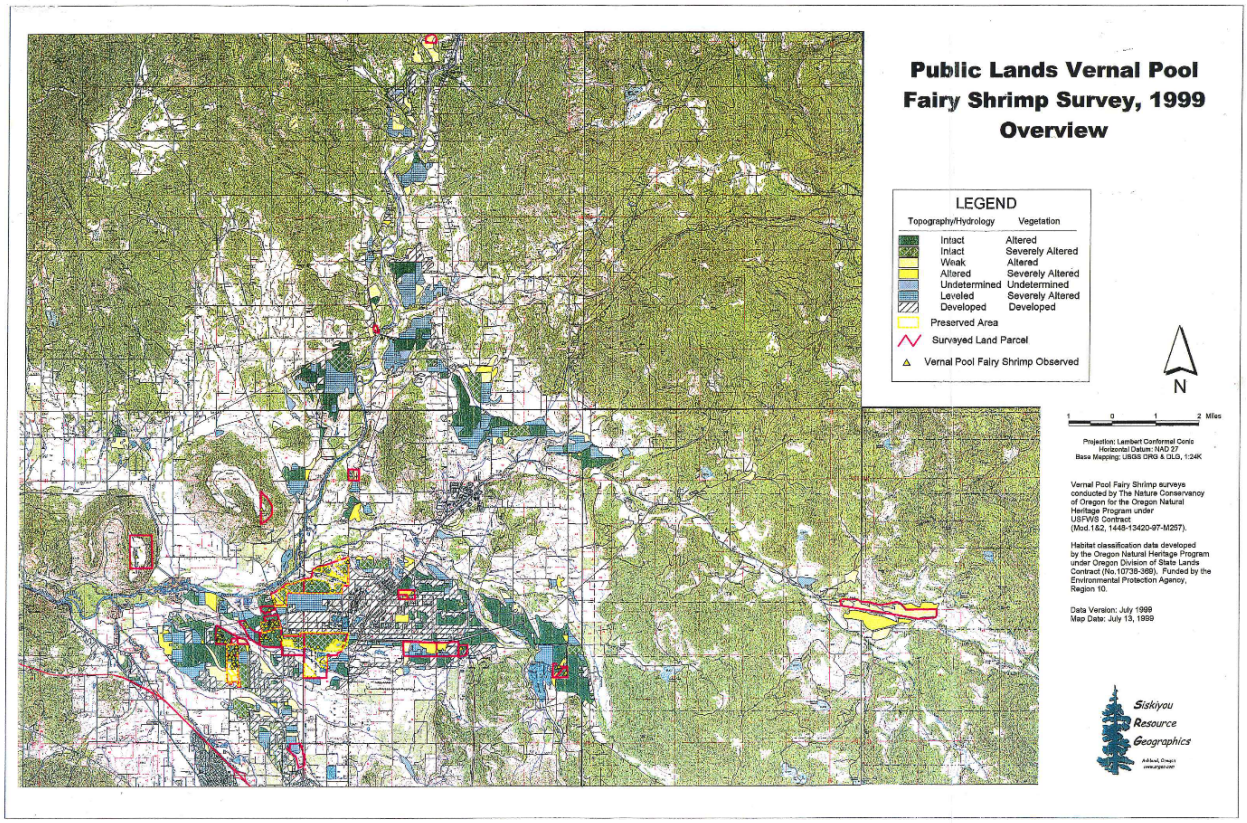


Figure 4.1. Map of vernal pool habitat in Jackson County, Oregon, in 1998. Taken from the *Revised Assessment and Map of Vernal Pool Systems on the Agate Desert, Jackson County, Oregon* submitted to the Service (ONHP 1999).

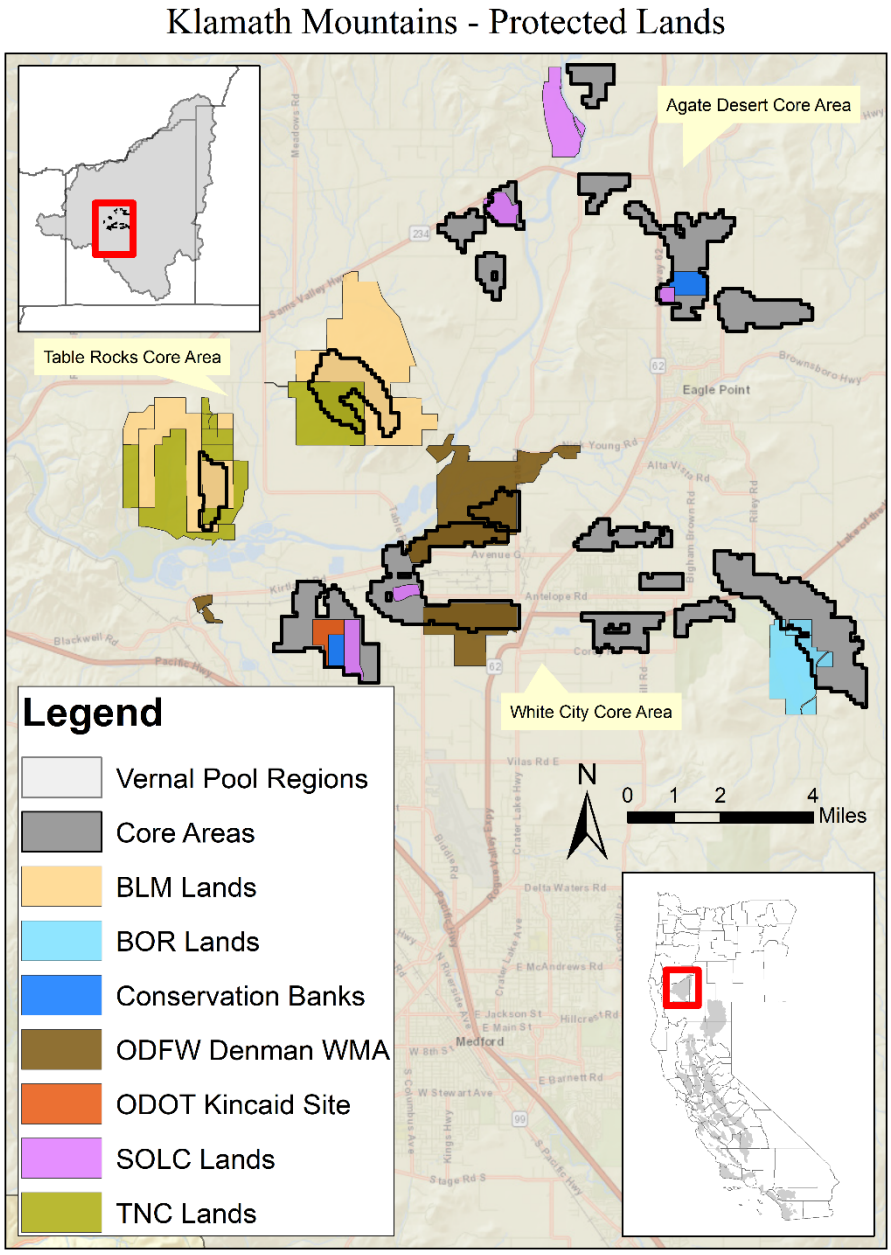


Figure 4.2. Map of protected areas that contain vernal pool grassland habitat and/or vernal pool fairy shrimp within the Klamath Mountains Vernal Pool Region. Seven small parcels throughout White City that have been protected as compensatory mitigation associated with section 7 consultations, described in the Other Preserves section below, are not displayed here as shapefiles were not obtained. BLM = Bureau of Land Management, BOR = Bureau of Reclamation, ODFW Denman WMA = Oregon Department of Fish and Wildlife Denman Wildlife Management Area, ODOT = Oregon Department of Transportation, SOLC = Southern Oregon Land Conservancy, TNC = The Nature Conservancy

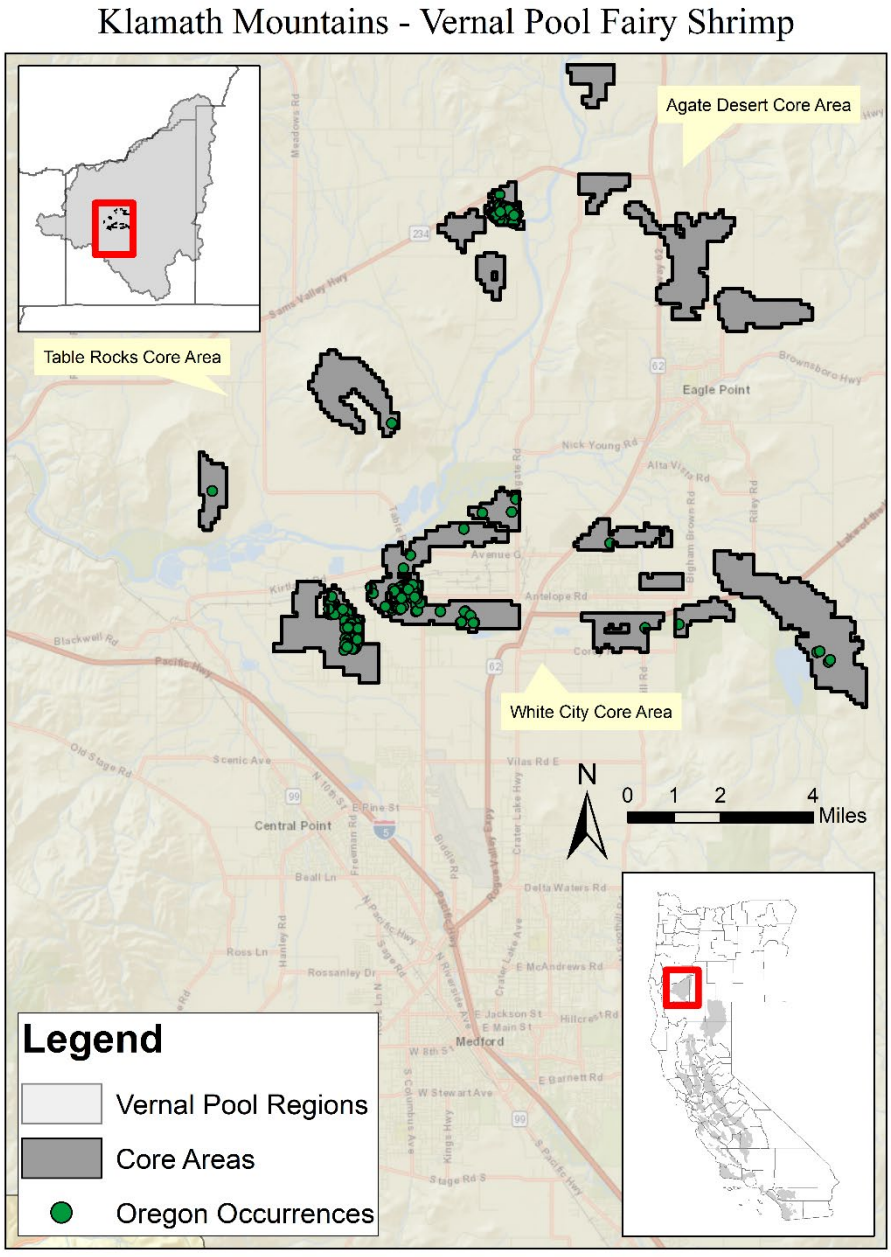


Figure 4.3. Map of known occurrences of vernal pool fairy shrimp in the Klamath Mountains Vernal Pool Region provided by the Roseburg Fish and Wildlife Office (Friedman, *in litt*. 2021). Points represent individual vernal pools. The entire extent of the vernal pool region is displayed at the top left.

Table 4.1. Total acreage of preserve lands and preserved vernal pool habitat for all protected lands within the Klamath Mountains Vernal Pool Region. Preserve acreage within core areas does not include portions of the protected lands that extend outside of the designated core areas, except for the one preserve that occurs entirely outside of a core area. BLM = Bureau of Land Management, BOR = Bureau of Reclamation, JCURA = Jackson County Urban Renewal Agency, ODFW Denman WMA = Oregon Department of Fish and Wildlife Denman Wildlife Management Area, ODOT = Oregon Department of Transportation, TNC = The Nature Conservancy

Core Area	Preserve Name	Preserve Acreage within Core Area	Vernal Pool Habitat Acreage
Agate Desert	Rogue Plains Preserve	346	252
Agate Desert	Wood House	38	38
Agate Desert	Rogue Valley Mitigation/Conservation Bank	131.43	115
Table Rocks	BLM and TNC lands	892	708
White City	Whetstone Savanna Preserve	140	140
White City	ODOT Vernal Pool Mitigation/Conservation Bank	80.23	80.23
White City	ODOT Kincaid Property Mitigation Site	116	116
White City	Agate Desert Preserve	53	53
White City	Agate Lake BOR land	154	154
White City	ODFW Denman WMA	720	720
White City	JCURA/ODOT Dutton Road Mitigation Site	3.3	3.3
White City	Eagle Point School District Mitigation Site	25	25
White City	JCURA/Jackson County Parks Mitigation Site	10.93	10.93
White City	Hornaker Mitigation Site	5	5
White City	Bear Valley Sanitary District Mitigation Site	4.85	4.85
White City	City of Medford Mitigation Site	3	3
White City	Medford Water Commission Mitigation Site	36	36
N/A	Rogue River Preserve	352[1]	40
Klamath Vernal Pool Region Total		**2,758.74[2]**	**2,504.31**

[1] This is the complete size of the preserve, but this preserve is not within any of the core areas.
[2] This total does not include the 352 acres on the Rogue River Preserve that are not within a core area. With this preserve, the total would come to 3,110.74 acres.

4.2. Species Occurrences

4.2.1. Vernal Pool Fairy Shrimp

There are 243 occurrence records of the vernal pool fairy shrimp documented within the Klamath Mountains Vernal Pool Region that have been collected by the Service's Roseburg Fish and Wildlife Office (**Figure 4.3**; Friedman, *in litt*. 2021). Unlike the Diversity Database, this data contains points instead of polygons, generally representing individual vernal pools. The vernal pool fairy shrimp was first observed at these 243 locations between 1998 and 2004, and the species has only been found within the core areas identified in the Recovery Plan. In addition to these locations, the vernal pool fairy shrimp is also known to occur on the Rogue Valley Mitigation/Conservation Bank and the Wood House property (**Figure 4.2**). The ONHP had documented 11 occurrences of the vernal pool fairy shrimp (larger areas of occurrence, not individual pools) as of 2012 (Service 2012b). The previous 5-year review for the species from 2007 mentions occurrences from Upper and Lower Table Rock, three preserves owned by The Nature Conservancy (TNC) (now owned by Southern Oregon Lands Conservancy), Bureau of Reclamation land around Agate Lake, and Oregon Department of Fish and Wildlife's Denman Wildlife Management Area (Service 2007a), all of which are included in the data provided by the Roseburg Fish and Wildlife Office.

Of the 243 vernal pool fairy shrimp occurrences collected by the Roseburg Fish and Wildlife Office, 192 (79%) are within mapped protected lands (**Figure 4.2**), and the vernal pool fairy shrimp has also been found on the Rogue Valley Mitigation/Conservation Bank and the Wood House property. Shapefiles of seven small parcels throughout White City that have been protected as compensatory mitigation associated with section 7 consultations, described in the Other Preserves section below, were not obtained, so several of the remaining 51 occurrences may be within these unmapped protected lands. However, it is very likely that the vernal pool fairy shrimp may occur on other areas of protected vernal pool, but no surveys have been conducted on most unprotected private lands. In addition, projects that have provided mitigation for the loss of vernal pool fairy shrimp habitat, either in the form of mitigation lands or purchasing conservation credits from a bank, typically assume presence without surveying for the species; therefore, it is reasonable to expect that some occurrences of the vernal pool fairy shrimp have been lost even though survey data is not available. Still, based on all the information collected here, it does seem that conservation within the Klamath Mountains Vernal Pool Region has been successful or nearly successful in meeting the Recovery Plan's goal of protecting at least 80% of vernal pool fairy shrimp occurrences (that were known as of 2005) across the species range, including extreme edges, in order to preserve the geographic, genetic, and ecological diversity of the species.

4.3. Federal Lands

4.3.1. National Wildlife Refuges

There are no National Wildlife Refuges with known occurrences of the vernal pool fairy shrimp in the Klamath Mountains Vernal Pool Region.

4.3.2. Military Lands

There are no military lands with known occurrences of the vernal pool fairy shrimp in the Klamath Mountains Vernal Pool Region.

4.3.3. Bureau of Land Management

The vernal pool fairy shrimp is known to occur on both Upper Table Rock and Lower Table Rock, which are within the U.S. Bureau of Land Management's (BLM) Table Rocks Management Area. Different parts of the Table Rocks are either owned and administered by BLM, owned by TNC, or have conservation easements held by TNC, totaling 4,864 acres (see **Figure 4.2**; BLM 2013; M. Morison, TNC, *in litt*. 2022). However, the vernal pool fairy shrimp is only known to occur in areas owned and administered by BLM. Vernal pool-mounded prairie complexes occur on the flat tops of the Table Rocks, 246 acres on Lower Table Rock and 462 acres on Upper Table Rock (BLM 2013). Baseline surveys from 2004 to 2006 documented the vernal pool fairy shrimp in 8 of 38 pools sampled across Table Rocks (ESA Associates 2006a). No additional surveys have been conducted since 2006 (D. Roelofs, BLM, *in litt*. 2022). A management plan for the Table Rocks was created in 2013; management recommendations related to the vernal pool fairy shrimp included maintaining native plant communities in the vernal pool-mounded prairie complex, monitoring vernal pool species, and restricting foot traffic and educating the public to stay on trails where the trails are adjacent to vernal pools (BLM 2013). Since 2013, some of the TNC-owned lands have been transferred to BLM, and other TNC-owned lands are proposed for transfer to BLM in the future (Morison, *in litt*. 2022). In 2016, TNC conducted an assessment of restoration opportunities across Table Rocks, which included mapping the extent of vernal pools using both LiDAR and aerial imagery (TNC 2016). This mapping allows for planning of protection or restoration management activities, such as identifying historical disturbance to hydrologic patterns, prioritizing target areas for invasive plant control, and planning the location of trails that will avoid disturbance to vernal pools (TNC 2016).

4.3.4. Other Federal Lands

The Agate Lake Reservoir is located southeast of White City and south of Highway 140 and is managed by the U.S. Bureau of Reclamation (BOR) in conjunction with the Jackson County Roads and Parks Services (see **Figure 4.2**; BOR 2000). Approximately 154 acres of vernal pool grasslands occur on the northeast side of Agate Lake, within the White City Core Area (BOR 2000; Service 2018a). The vernal pool fairy shrimp was first observed within the Agate Lake Reservoir in four vernal pools during the 1998-1999 wet season by ONHP (BOR 2000). At the Service's recommendation, the BOR's Agate Lake Resource Management Plan (BOR 2000) did not include plans for trails or interpretive sites in vernal pool habitat. This plan also recommended that a specific vernal pool management plan be developed for the Agate Lake Reservoir (BOR 2000), but the Service is unaware if such an effort has been completed.

4.4. Conservation Banks

There are two conservation or mitigation banks within the Klamath Mountains Vernal Pool Region that provide credits for preserved vernal pools that support the vernal pool fairy shrimp

(see **Figure 4.2**; RIBITS 2021). The Rogue Valley Mitigation/Conservation Bank is located north of the City of Eagle Point in the Agate Desert Core Area. The bank is 131.43 acres and protects 115 acres of vernal pool and swale complex, including 38.3 acres of preserved vernal pools for the vernal pool fairy shrimp (Resource Environmental Solutions 2019; RIBITS 2021). During surveys in 2016, the vernal pool fairy shrimp was identified in 19 of 50 sampled pools (Running W Land & Cattle 2016). The Oregon Department of Transportation (ODOT) Vernal Pool Mitigation/Conservation Bank is located west of The Nature Conservancy's Whetstone Savanna Preserve in the western part of the White City Core Area. The bank is 80.23 acres and protects prairie and woodland habitat which support 20.95 acres of vernal pools (ODOT 2009). This bank is owned by TNC and managed by ODOT, and it is a single-client bank which only provides credits for ODOT projects that affect vernal pools. Successful restoration of vernal pools within the bank and on adjacent preserved lands occurred between 2011 and 2019 and is described in the Other Preserves section below (Perchemlides et al. 2020). Together, these two banks have sold a total of 27.82 acres of vernal pool preservation credits for the vernal pool fairy shrimp (RIBITS 2021).

4.5. Habitat Conservation Plans

There are no Habitat Conservation Plans (HCPs) within the Klamath Mountains Vernal Pool Region that includes the vernal pool fairy shrimp as a Covered Species.

4.6. Other Preserves

There are several vernal pool preserves outside of federal lands and banks that have been established in this vernal pool region. The 336-acre Whetstone Savanna Conservation Area consists of three properties: the 140-acre Whetstone Savanna Preserve (originally acquired and owned by TNC, transferred to the Southern Oregon Land Conservancy [SOLC] in February 2022), the 80-acre ODOT Mitigation/Conservation Bank described above, and the 116-acre Kincaid Property Mitigation Site owned and managed by ODOT (ODOT 2009; ODOT 2021; Perchemlides et al. 2020; TNC 2021a). Some vernal pool habitat within the Whetstone Savanna Conservation Area had been degraded by historic activities, and a large restoration effort occurred between 2011 and 2019. Compared to a four-year baseline prior to restoration, vernal pool habitat within the Whetstone Savanna Conservation Area has now doubled in area and occupancy by vernal pool fairy shrimp increased to four-times the baseline level (Perchemlides et al. 2020). The vernal pool fairy shrimp has been documented in pools throughout all three properties in surveys from 2020-2022 (see **Figure 4.4**, **Figure 4.5**; ODOT 2021; R. Bergkoetter, SOLC, *in litt*. 2022; P. Benton, ODOT, *in litt*. 2022). The two ODOT properties have management plans which address vernal pools (ODOT 2009; ODOT 2021); the Whetstone Savanna Preserve has only a very brief general management plan (TNC 2021a), but SOLC is in the process of preparing a more comprehensive management plan (Bergkoetter, *in litt*. 2022).

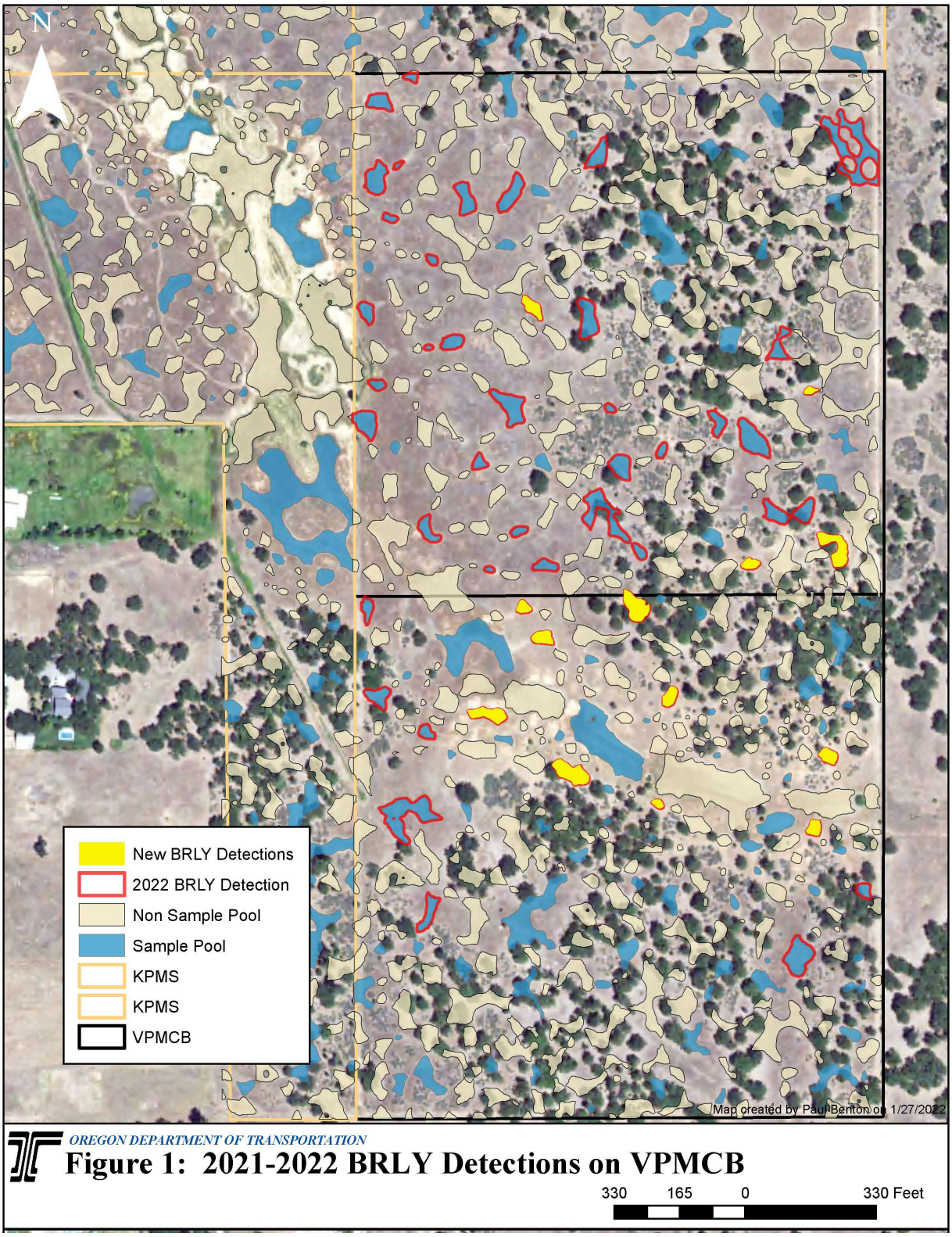


Figure 4.4. Map of vernal pool fairy shrimp occurrences from ODOT's Vernal Pool Mitigation/Conservation Bank from 2022 surveys. Provided by Paul Benton from ODOT (Benton, *in litt*. 2022).

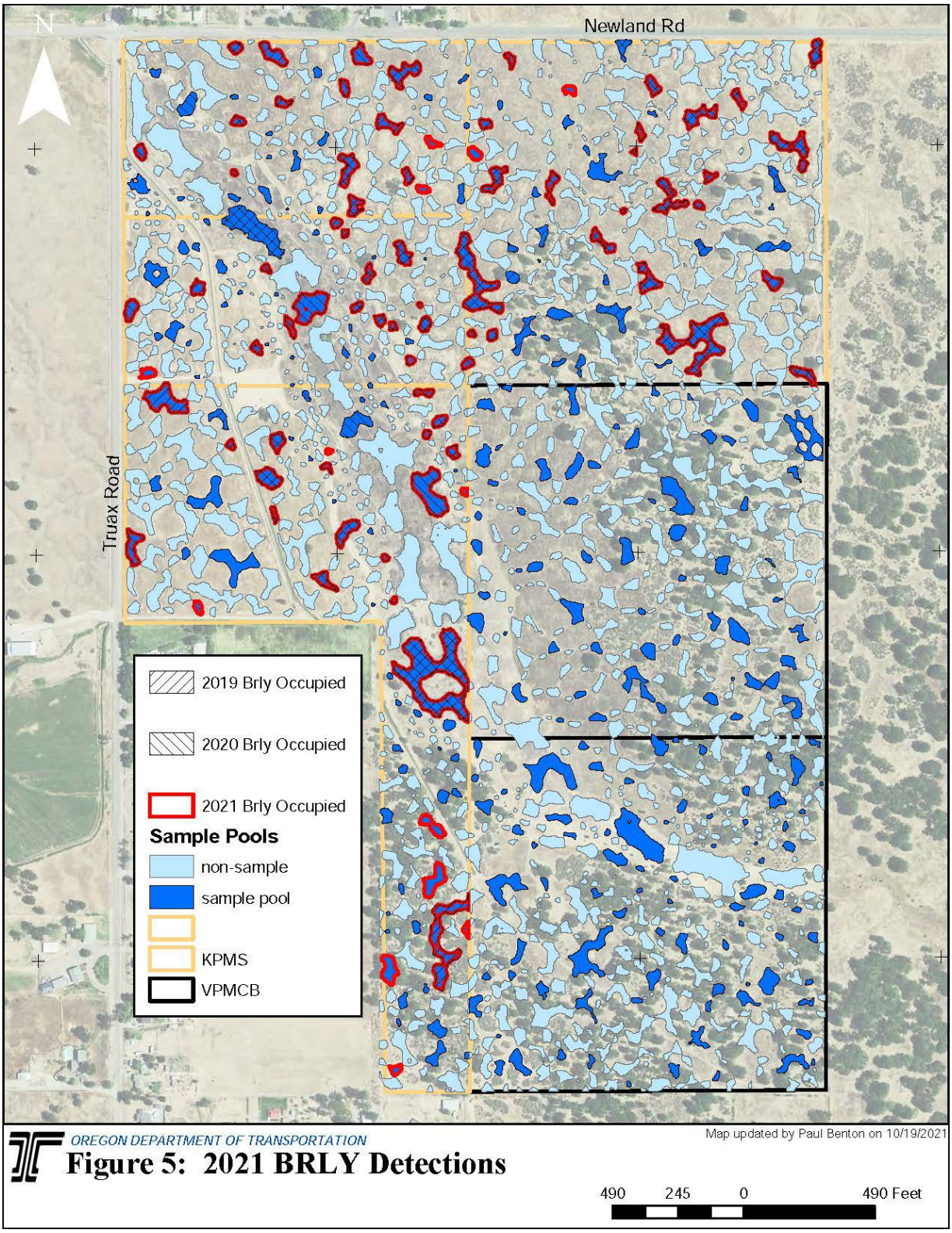


Figure 4.5. Map of vernal pool fairy shrimp occurrences from ODOT's Kincaid Property Mitigation Site from 2019-2021 surveys. Taken from Figure 5 of the 2021 monitoring report (ODOT 2021).

Besides the Whetstone Savanna Preserve, the SOLC also has two other preserves that were transferred from TNC in February 2022: Agate Desert Preserve and Rogue Plains Preserve. The 53-acre Agate Desert Preserve is located in western White City, is owned by SOLC in fee title, and has a very brief general management plan inherited from TNC (TNC 2021b). Management activities for 2022-2023 include vegetation and listed species monitoring, conducting a prescribed burn, surveying and controlling invasive plant species, and general preserve maintenance (TNC 2021b). The vernal pool fairy shrimp has been identified in various vernal pools throughout the preserve during surveys conducted between 1998 and 2022 (Bergkoetter, *in litt*. 2022). The Rogue Plains Preserve (a.k.a., Rogue River Plains Preserve) is located north of Eagle Point, has a conservation easement held by SOLC, and does not currently have a management plan, though SOLC is in the process of developing one since receiving the property from TNC in February 2022 (Bergkoetter, *in litt*. 2022). This preserve is 346 acres in total, of which 252 acres are vernal pool habitat (Service 2012b). The vernal pool fairy shrimp has been identified in various vernal pools throughout the preserve during surveys conducted in 2002, 2003, 2019, and 2020 (Bergkoetter, *in litt*. 2022).

The SOLC also has two other preserves: Rogue River Preserve and Wood House. The Rogue River Preserve is a 352-acre preserve owned by SOLC along the western bank of the Rogue River north of Highway 234, of which 40 acres support vernal pool mounded prairie complex (SOLC 2021). This preserve is not within any of the core areas designated by the Recovery Plan. The vernal pool fairy shrimp has not been detected at this site despite multiple survey attempts in 2015-2017 and 2017-2018 (SOLC 2021). The Wood House property is a historic property north of Eagle Point with an approximately 38-acre conservation easement held by SOLC. The Service identified the vernal pool fairy shrimp onsite in 2008 (C. Tuss, Service, *in litt*. 2008) and the species was named in the conservation easement. The only current management plan for Wood House is a grazing management plan (NRCS 2009).

The Oregon Department of Fish and Wildlife's (ODFW) Denman Wildlife Management Area (WMA) is 1,858 acres in size and located at the confluence of Little Butte Creek and the Rogue River in White City (ODFW 2017). There are 720 acres of vernal pool complex within the Denman WMA (**Figure 4.6**), all of which is within the White City Core Area. Past management practices involved attempts to improve the soil for agriculture by deep ripping the hardpan and filling pools with bark mulch; these practices were stopped in the 1980's when the value of the vernal pools was realized (ODFW 2017). Since 1995, TNC and the Service have surveyed for the vernal pool fairy shrimp on Denman WMA; as of 2017, the surveys showed no population decline, good recruitment, and good physical condition (ODFW 2017). Management practices for the vernal pools include controlled burns and seeding of native species. The 2017 management plan for Denman WMA includes the objective to protect and restore the 720 acres of vernal pool complex by continuing to monitor vernal pool species and by coordinating with TNC and the Service to implement habitat improvement projects (ODFW 2017).

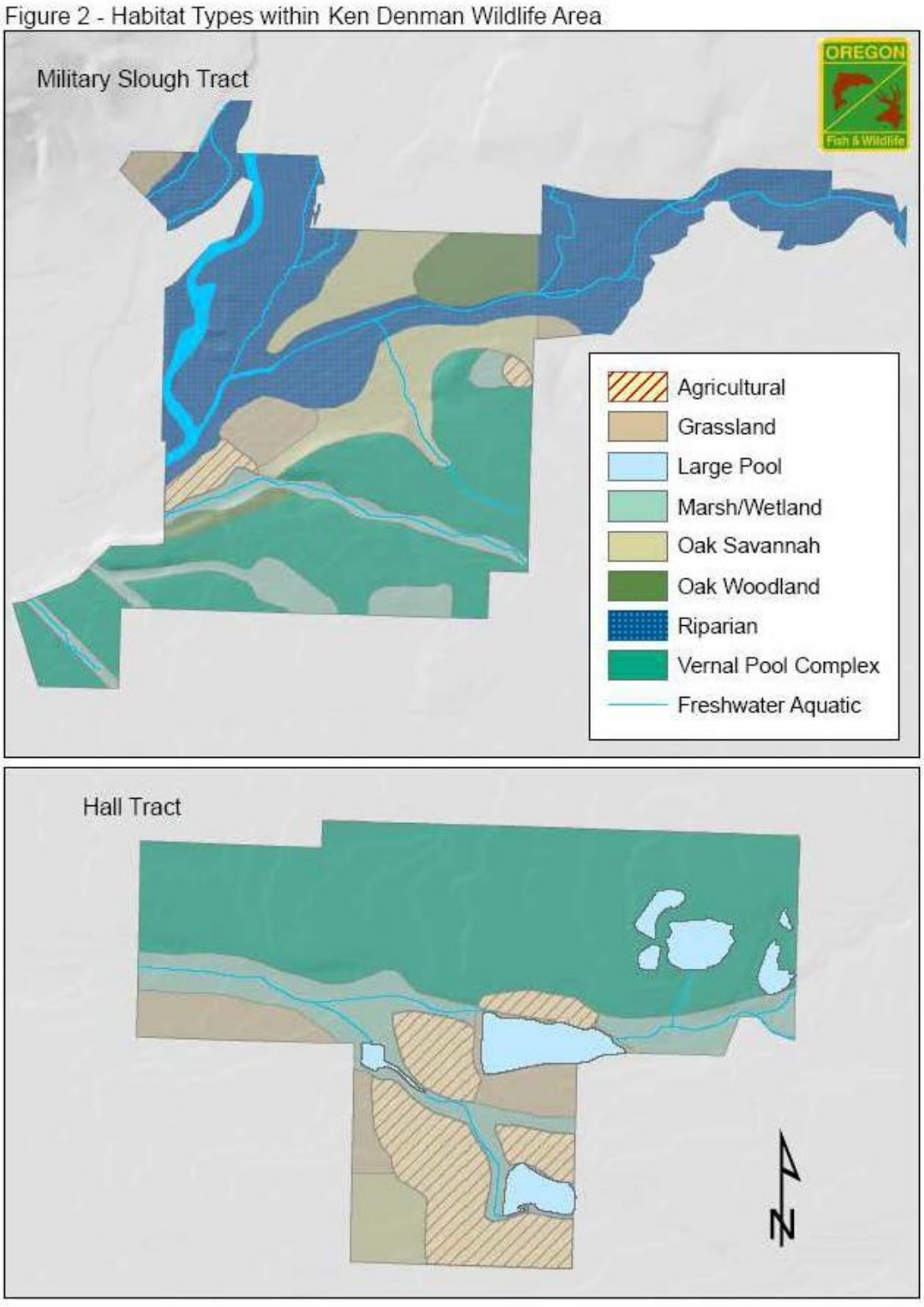


Figure 4.6. Map of vernal pool habitat within Oregon Department of Fish and Wildlife's Denman Wildlife Management Area. Taken from Figure 2 of the management plan (ODFW 2017).

Seven other small parcels throughout White City have been protected as compensatory mitigation associated with section 7 consultations (S. Friedman, Service, *in litt*. 2022b). These seven parcels total 88.08 acres, four parcels totaling 44.23 acres in east White City and three parcels totaling 43.85 acres in west White City. The Eagle Point School District owns 25 acres of restored and protected vernal pools which are managed using rotation grazing (Friedman, *in litt*. 2022b). The Jackson County Urban Renewal Agency (JCURA) and ODOT own a mitigation property at the intersection of Highway 62 and Dutton Road which includes 1.048 wetted acres of vernal pools within an approximately 3-acre area in the western corner of the property (Terra Science 2010; Friedman, *in litt*. 2022b). All mitigation performance standards were met in 2010 after five years of monitoring. Survey efforts have not yet identified the vernal pool fairy shrimp onsite (Terra Science 2010). The JCURA also has a 10.93-acre vernal pool restoration site on a property owned and managed by Jackson County Parks; management activities focus on invasive plant control (Friedman, *in litt*. 2022b). The Hornaker restoration and mitigation site contains 5 acres of vernal pool habitat protected under a deed restriction (Friedman, *in litt*. 2022b). There are three restoration sites on property owned by the City of Medford: a 4.85-acre site for the Bear Valley Sanitary District, a 3-acre City of Medford site, and a 36-acre site for the Medford Water Commission. The Medford Water Commission site has a long-term management plan, has been managed with prescribed burning, and federally-listed vernal pool plant species have been planted onsite; management of the other sites consists of periodic grazing or mowing (Friedman, *in litt*. 2022b).

4.7. Vernal Pool Core Areas

There are three Core Areas within the Klamath Mountains Vernal Pool Region that are designated in the Recovery Plan for the vernal pool fairy shrimp: Agate Desert, Table Rocks, and White City. One of the three core areas have met the target of 85% of vernal pool habitat protected (**Table 4.2**).

The 2012 *Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems* (Rogue and Illinois Valley Recovery Plan) also designated core areas for two endangered vernal pool plant species (Service 2012b). These core areas were based on species occurrences and the presence of vernal pool habitat as determined by aerial imagery, topography, and soil types. These core areas generally correspond to core areas identified in the Recovery Plan, but differ slightly due to more accurate delineation of habitat areas and differing habitat needs of the two endangered plant species (see **Figure 4.7**; Service 2012b). All currently known occurrences of the vernal pool fairy shrimp fall within the core area boundaries delineated by both recovery plans. This 5-year review uses the original core areas from the Recovery Plan, but we recommend that these be officially updated to reflect the more accurate delineations from the Rogue and Illinois Valley Recovery Plan.

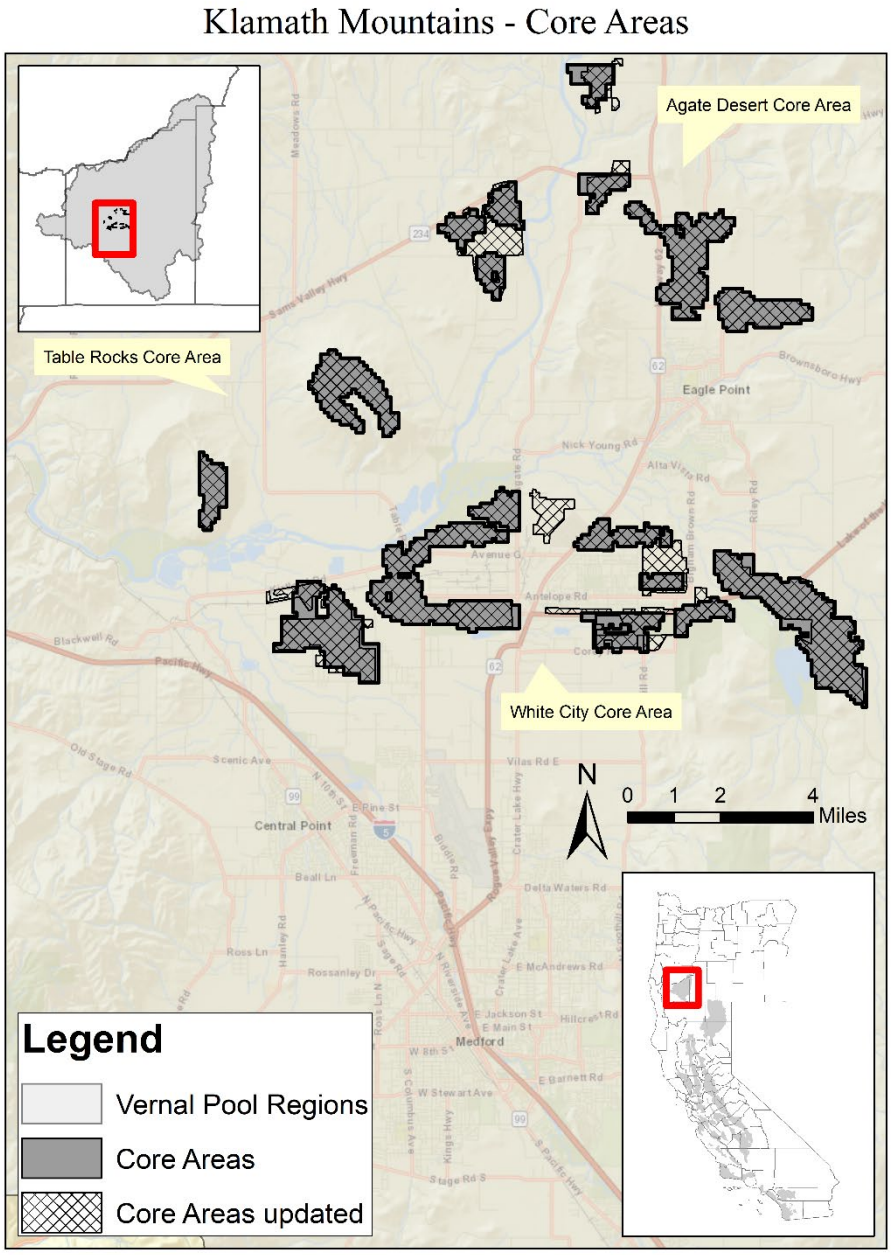


Figure 4.7. Comparison of the core areas delineated by the Recovery Plan in 2005 and the updated core areas for vernal pool fairy shrimp in the 2012 Rogue and Illinois Valley Recovery Plan.

Table 4.2. Total acreage and acreage of vernal pool habitat protected within each core area of the Klamath Mountains Vernal Pool Region. Core area total acreage is based on the updated core areas from the Rogue and Illinois Valley Recovery Plan. Core area vernal pool acreage estimate is taken from the estimates provided in the Rogue and Illinois Valley Recovery Plan. Total acreage protected and vernal pool acreage protected are based on the information in **Table 4.1**.

Core Area	Core Area Total Acreage	Core Area Vernal Pool Acreage Estimate	Total Acreage Protected (% of Core Area Total)	Vernal Pool Acreage Protected (% of Core Area Vernal Pool Estimate)
Agate Desert	2,211	2,130	515 (23.3%)	405 (19.1%)
Table Rocks	892	892	892 (100%)	708 (100%[1])
White City	4,762	4,552	1,351 (28.4%)	1,351 (29.7%)

4.7.1. Agate Desert

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is composed of seven polygons which are located north of the City of Eagle Point on both sides of the Rogue River. This core area corresponds to the Rogue Plains, Hammel Road, and North Eagle Point Core Areas from the Rogue and Illinois Valley Recovery Plan (Service 2012b). The biggest difference in the boundaries is the inclusion of the area in between the three polygons west of the Rogue River (**Figure 4.7**).

Based on the core area boundaries from the Rogue and Illinois Valley Recovery Plan, this core area is 2,211 acres in size, of which 2,130 acres was estimated to be vernal pool habitat (Service 2012b). The Rogue Plains Preserve, Rogue Valley Mitigation/Conservation Bank, and Wood House property protect approximately 517 acres of land within this core area, of which 407 acres are vernal pool habitat. Thus, an estimated 19.1% of vernal pool habitat has been protected within this core area (**Figure 4.8**, **Table 4.2**). The Rogue River Preserve is outside of, but very close to, this core area and contains 40 acres of vernal pool habitat.

4.7.1.1.Vernal Pool Fairy Shrimp Occurrences

All known occurrences of the vernal pool fairy shrimp in this core area are within protected lands (**Figure 4.8**). Although occurrences records collected by the Service's Roseburg Fish and Wildlife Office only include 56 points within the Rogue Plains Preserve (Friedman, *in litt*. 2021), the vernal pool fairy shrimp is also known from the Rogue Valley Mitigation/Conservation Bank (Running W Land & Cattle 2016) and the Wood House property (Tuss, *in litt*. 2008), which is protected under a conservation easement held by SOLC. Practically all of the land in this core area is privately owned (99%; Service 2012b), so it is very likely that the vernal pool fairy

[1] This was determined to be all of the vernal pool habitat in this core area based on mapping of landcover types (BLM, 2013). Differences in acreage between estimates may reflect refined data or may simply be due to different methods of acreage calculations.

shrimp may occur on other areas of vernal pool habitat outside of these three protected properties, but no surveys have been conducted on these unprotected private lands.

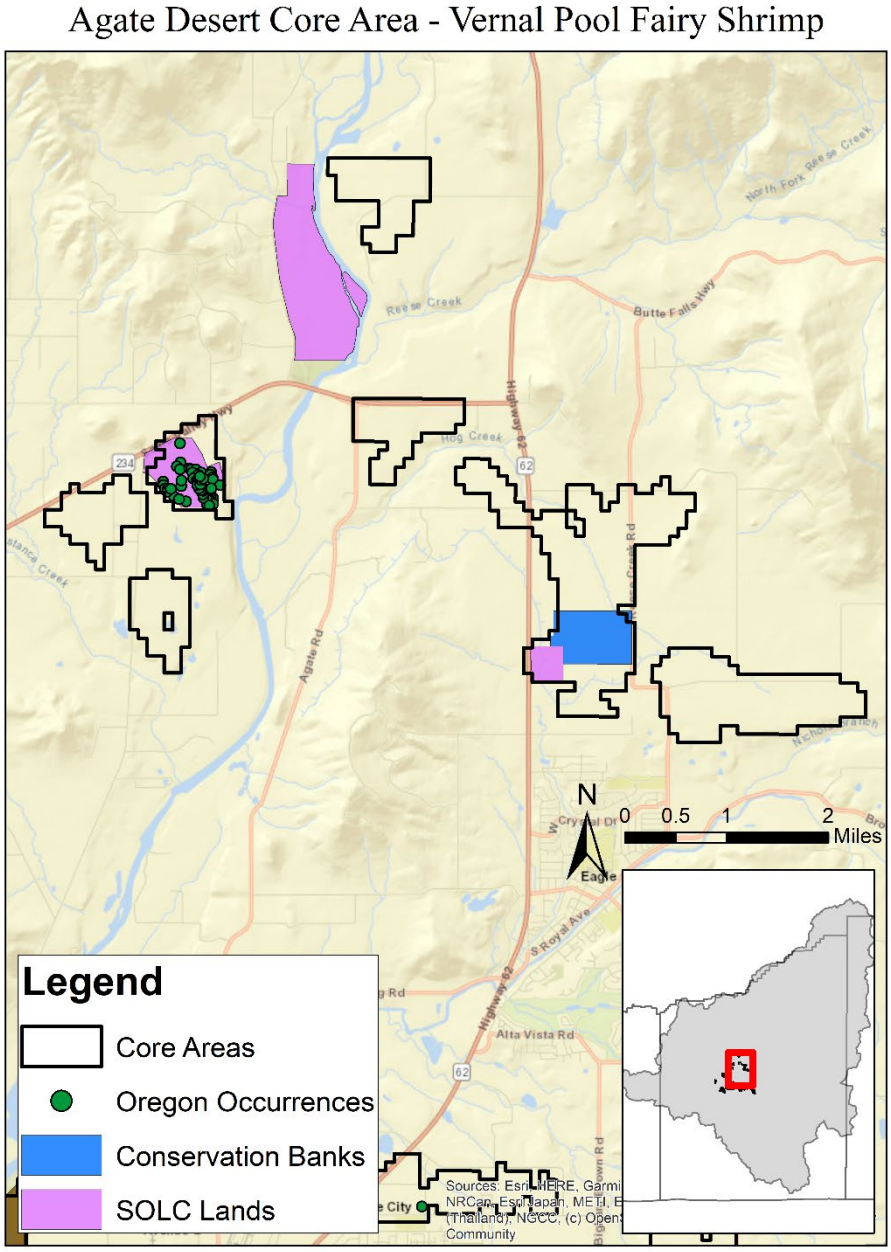


Figure 4.8. Map of known occurrences of vernal pool fairy shrimp provided by the Roseburg Fish and Wildlife Office (Friedman, *in litt*. 2021) and of all protected lands within the Agate Desert Core Area. The vernal pool fairy shrimp is also known to occur on the Rogue Valley Mitigation/Conservation Bank and the Wood House property. SOLC = Southern Oregon Land Conservancy

4.7.2. Table Rocks

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is composed of two polygons which encompass the tops of Lower Table Rock and Upper Table Rock, northeast of White City and the Rogue River. This core area corresponds to the Upper Table Rock and Lower Table Rock Core Areas from the Rogue and Illinois Valley Recovery Plan, which have identical boundaries (see **Figure 4.7**; Service 2012b).

This core area is 892 acres in size, all of which was estimated to be vernal pool habitat based on the Rogue and Illinois Valley Recovery Plan (Service 2012b). More refined habitat estimates show a total of 708 acres of vernal pool habitat in this core area (246 acres on Lower Table Rock and 462 acres on Upper Table Rock), all of which is protected on BLM or TNC lands (see **Table 4.2**; BLM 2013). A management plan for the Table Rocks was created by BLM and TNC in 2013; management recommendations related to the vernal pool fairy shrimp included maintaining native plant communities in the vernal pool-mounded prairie complex, monitoring vernal pool species, and restricting foot traffic and educating the public to stay on trails where the trails are adjacent to vernal pools (BLM 2013). Vernal pools have been precisely mapped on Table Rocks using a combination of aerial imagery and LiDAR (TNC 2016).

4.7.2.1. Vernal Pool Fairy Shrimp Occurrences

All vernal pool fairy shrimp occurrences and vernal pool habitat within this core area have been protected. The core area is entirely within lands in BLM's Table Rocks Management Area that are owned and administered by BLM, owned by TNC, or have a conservation easement held by TNC (**Figure 4.9**). Although occurrences records collected by the Service's Roseburg Fish and Wildlife Office only include two occurrence points within this core area (Friedman, *in litt*. 2021), BLM surveys from 2004 to 2006 documented the vernal pool fairy shrimp in 8 of 38 pools sampled across Table Rocks (ESA Associates 2006a). These occupied pools are found across both Upper and Lower Table Rocks (**Figure 4.10**) and are all protected within BLM lands.

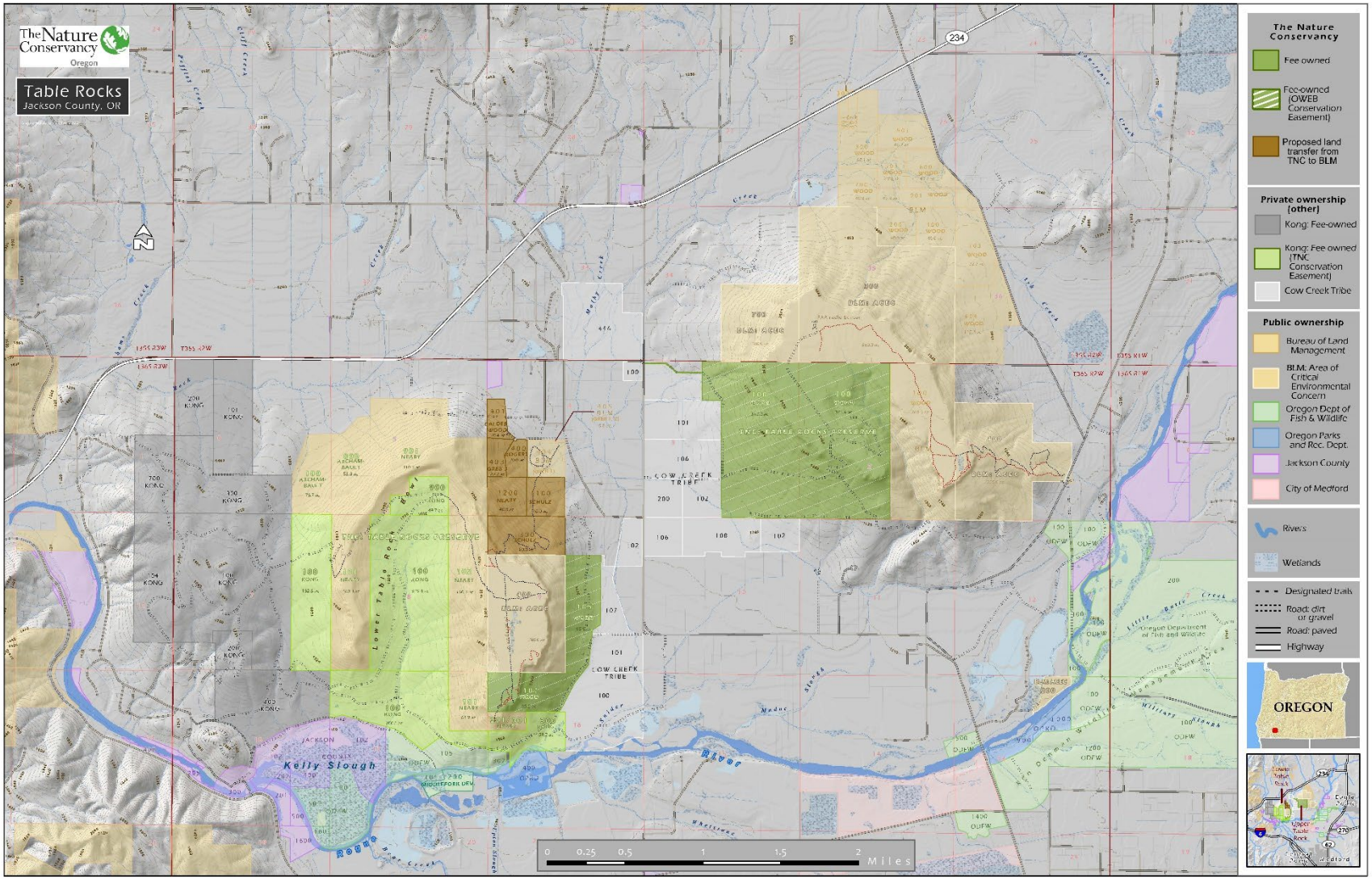


Figure 4.9. Map of protected lands in and around the Table Rocks Core Area. Figure provided by The Nature Conservancy (Morison, *in litt*. 2022).

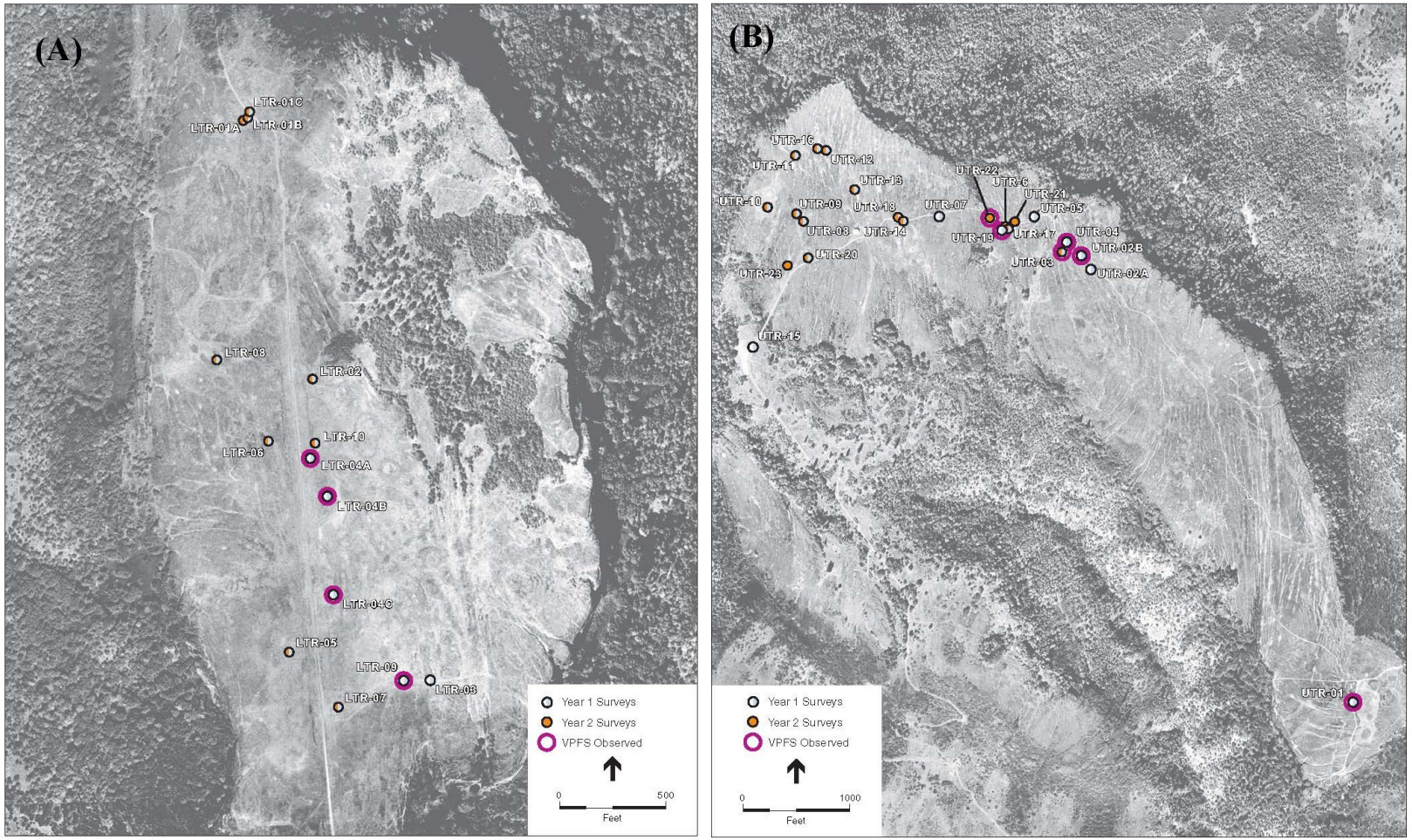


Figure 4.10. Map of vernal pools occupied by the vernal pool fairy shrimp within the Table Rocks Core Area during 2004-2006 surveys. (A) Lower Table Rock, taken from Figure 3 of ESA Associates (2006a). (B) Upper Table Rock, taken from Figure 5 of ESA Associates (2006a).

4.7.3. White City

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is composed of eight polygons which are located throughout White City. This core area corresponds to the Whetstone Creek, Agate Desert, and Agate Lake Core Areas from the Rogue and Illinois Valley Recovery Plan (Service 2012b). The biggest differences in the boundaries are the addition of a polygon in the north-central portion of White City and the inclusion of the area between the two polygons on the east side of White City (**Figure 4.7**).

Based on the core area boundaries from the Rogue and Illinois Valley Recovery Plan, this core area is 4,762 acres in size (2,358 acres White City East, 2,368 acres White City West), of which 4,552 acres was estimated to be vernal pool habitat (2,251 acres White City East, 2,301 acres White City West) (Service 2012b). There are 13 different preserved areas for vernal pools in this core area (**Table 4.1**). These preserved areas protect approximately 1,351 acres of land within this core area, all of which is vernal pool habitat. Thus, an estimated 29.7% of vernal pool habitat has been protected within this core area (**Figure 4.11**, **Figure 4.12**, **Table 4.2**).

4.7.3.1. Vernal Pool Fairy Shrimp Occurrences

Of the 186 occurrence records within this core area provided by the Roseburg Fish and Wildlife Office (Friedman, *in litt*. 2021), 135 (73%) are within mapped protected lands and 51 (27%) are outside of mapped protected lands (**Figure 4.11**, **Figure 4.12**). Shapefiles of seven small parcels throughout White City that have been protected as compensatory mitigation associated with section 7 consultations were not obtained, so several of the remaining 51 occurrences may be within these unmapped protected lands. And though the occurrence records only show the vernal pool fairy shrimp within the Whetstone Savanna Preserve, it is also known to occur in pools throughout the adjacent ODOT Vernal Pool Mitigation/Conservation Bank and ODOT Kincaid Site Mitigation Property as well.

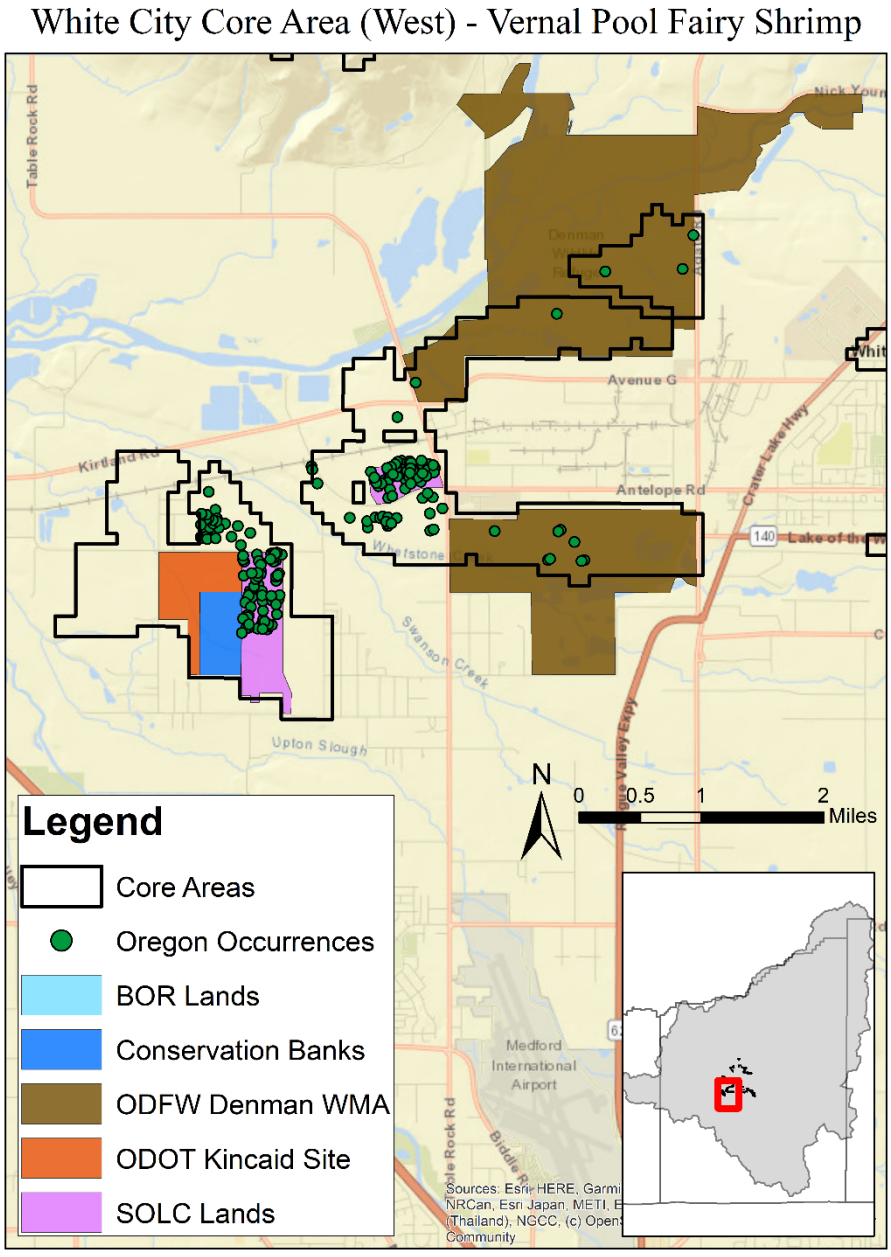


Figure 4.11. Map of known occurrences of vernal pool fairy shrimp provided by the Roseburg Fish and Wildlife Office (Friedman, *in litt*. 2021) and of protected lands within the western part of the White City Core Area. The vernal pool fairy shrimp is also known to occur on the ODOT Vernal Pool Mitigation/Conservation Bank and the ODOT Kincaid Property Mitigation Site. Shapefiles for three small mitigation parcels in western White City were not obtained. BOR = Bureau of Reclamation, ODFW Denman WMA = Oregon Department of Fish and Wildlife Denman Wildlife Management Area, ODOT = Oregon Department of Transportation, SOLC = Southern Oregon Land Conservancy

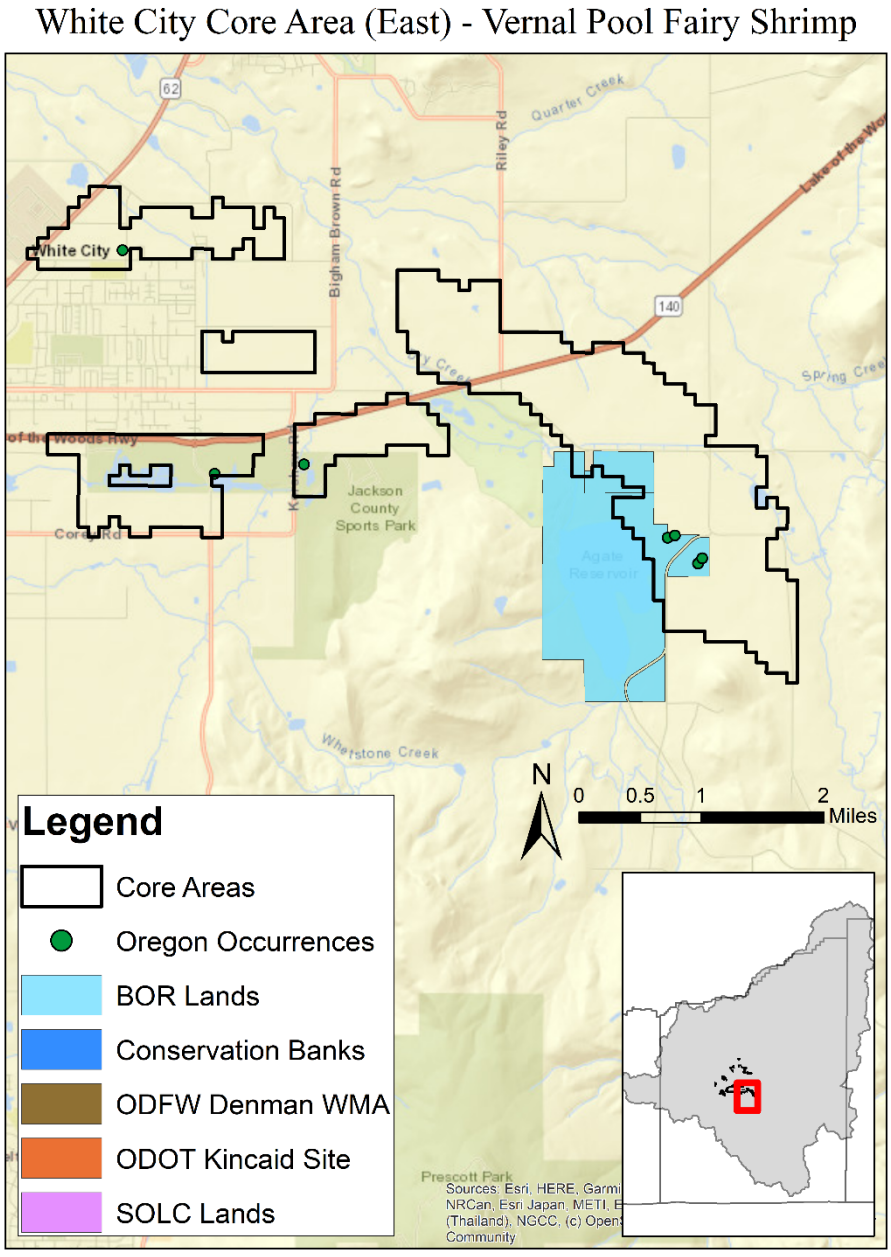


Figure 4.12. Map of known occurrences of vernal pool fairy shrimp provided by the Roseburg Fish and Wildlife Office (Friedman, *in litt*. 2021) and of protected lands within the eastern part of the White City Core Area. Shapefiles for four small mitigation parcels in eastern White City were not obtained. BOR = Bureau of Reclamation, ODFW Denman WMA = Oregon Department of Fish and Wildlife Denman Wildlife Management Area, ODOT = Oregon Department of Transportation, SOLC = Southern Oregon Land Conservancy

5. LAKE-NAPA VERNAL POOL REGION

Only the vernal pool fairy shrimp is known to occur within the Lake-Napa Vernal Pool Region.

5.1. Species Occurrences

5.1.1. Vernal Pool Fairy Shrimp

There is one occurrence record of the vernal pool fairy shrimp documented within the Lake-Napa Vernal Pool Region on the southern edge of the Napa County Airport (**Figure 5.1**). The vernal pool fairy shrimp was documented in one vernal pool during the 2002-2003 wet season, and other surrounding pools were sampled and had no detections (Diversity Database 2022). The vernal pool fairy shrimp was not detected during subsequent wet-season surveys in 2004 and 2005 (J. Wallace, pers. comm. 2007 as cited in Service 2007a). To our knowledge, the species has not been found anywhere else in the region.

5.2. Vernal Pool Core Areas

There is one Core Area within the Lake-Napa Vernal Pool Region that is designated in the Recovery Plan for the vernal pool fairy shrimp: Napa River.

5.2.1. Napa River

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is located near the end of the Napa River where the grassland begins transitioning into marshland.

This core area contains the Napa County Airport, the Fagan Marsh (a.k.a., Fagan Slough) Ecological Reserve (including Bull Island), and Ponds 9 and 10 of the Napa-Sonoma Marshes Wildlife Area. The latter two sites are owned by CDFW and mainly composed of tidal marsh habitat, so the vernal pool fairy shrimp is not expected to be found throughout the majority of these properties. Because there is currently no precise mapping of how much vernal pool habitat existed within the core area in 2005, how much still exists today, and how much has been preserved, the exact amount of progress towards meeting the 85% protection goal is not known.

5.2.1.1. Vernal Pool Fairy Shrimp Occurrences

The one known vernal pool fairy shrimp occurrence is located at the southern end of the Napa County Airport property (see **Figure 5.1**; Diversity Database 2022). Although the vernal pool fairy shrimp is only known from one pool within the Napa Airport, the entire airport property is designated as critical habitat for the vernal pool fairy shrimp, so airport projects that may affect vernal pool habitat anywhere onsite go through section 7 consultation. As a result of one such consultation, the airport agreed to set aside 18 acres of vernal pool grassland at the southern end of the property and manage it for long-term preservation of vernal pool habitat and species (Service 2006a), although this preservation has not occurred as of 2022 (K. Bales, Napa County, *in litt*. 2022).

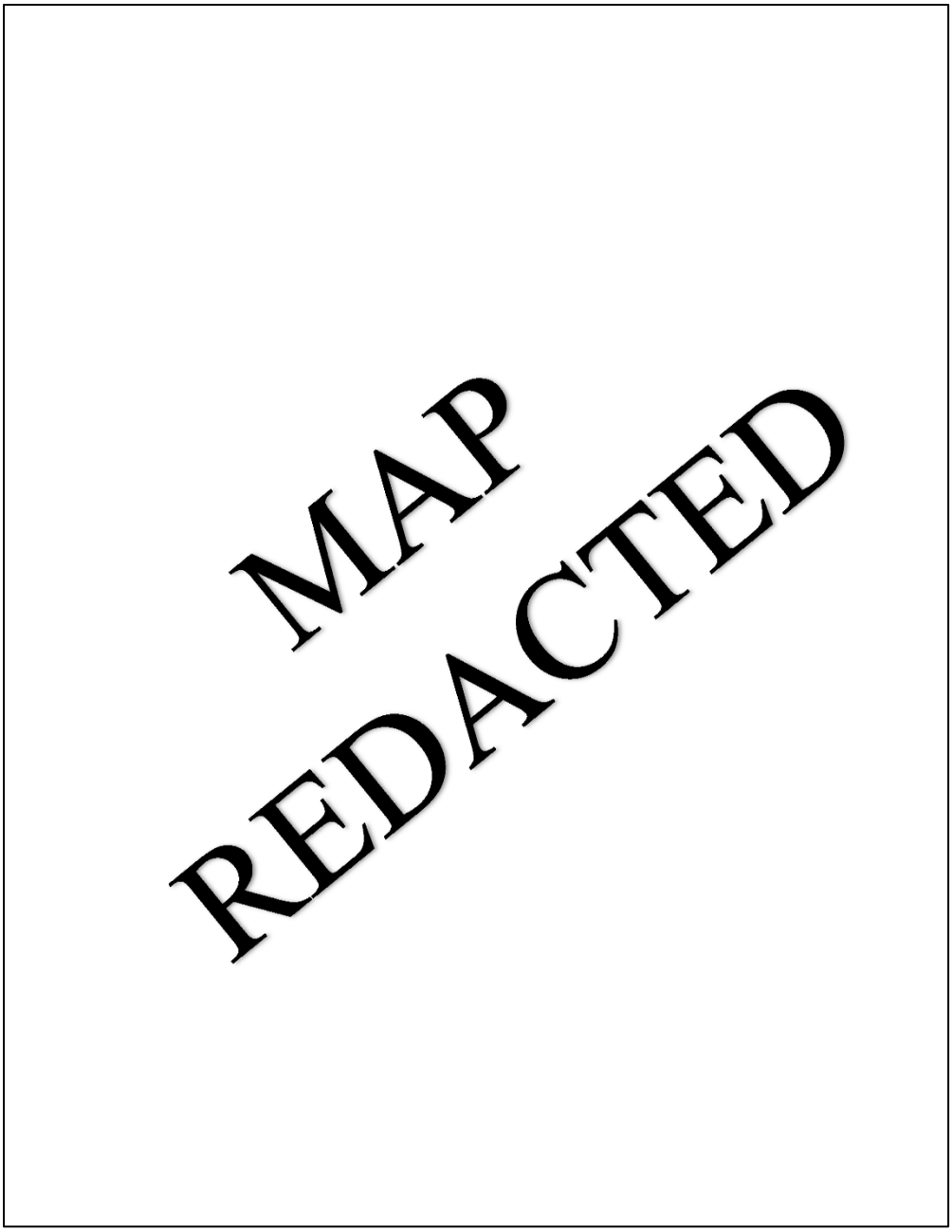


Figure 5.1. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Napa River Core Area.

6. LIVERMORE VERNAL POOL REGION

The vernal pool fairy shrimp and vernal pool tadpole shrimp are both known to occur within the Livermore Vernal Pool Region. The Conservancy fairy shrimp is not known to occur within this region.

6.1. Vernal Pool Habitat

The majority of the Livermore Vernal Pool Region and the entirety of the Altamont Hills Core Area were within the study areas of vernal pool and protected lands mapping efforts for the Central Valley (Vollmar et al. 2017; Witham et al. 2013; Witham et al. 2014; Witham 2021). Acreages reported throughout this section are based on those studies. However, it is possible that there are additional vernal pool grasslands in the southern and southwestern portions of this vernal pool region as well that have not been documented here. Unlike most of the Central Valley, the vernal pool habitat in this vernal pool region is mainly found in hilly areas and occasionally in rock outcrops, not flat grasslands, so the mapping efforts based on aerial imagery may have underestimated the amount of vernal pool habitat. This is evident based on the number of occurrences for vernal pool species in the Diversity Database that are outside of mapped vernal pool habitat.

Approximately 5,473 acres of vernal pool grassland existed within, or immediately adjacent to, this region when the Recovery Plan was published in 2005 (see **Figure 6.1**, **Table 6.1**; Witham et al. 2013). Approximately 5,429 acres remained as of 2012, with 59.8 acres (1.1% of 2005 total) lost between 2005 and 2012 (Witham et al. 2014). However, 16.4 acres of new vernal pool grassland were created over that same period on vernal pool mitigation banks and other managed wetlands. All of the habitat losses were due to agricultural conversion (73.1% to bare plowed agricultural land, 18.8% to rice or row crops, and 8.1% to alfalfa or irrigated pasture) (Witham et al. 2014).

By 2018, approximately 5,424 acres of vernal pool grassland remained, with a total of 65 acres (1.2% of 2005 total) lost between 2005 and 2018 (see **Table 6.1**; Witham 2021). No new areas of vernal pool grassland were identified in the 2018 aerial imagery that were either not present or not visible on the 2005 and 2012 aerial imagery. All of the habitat losses since 2005 were due to agricultural conversion (78.5% to bare plowed agricultural land, 19.9% to rice or row crops, and 1.6% to agricultural residences) (see **Table 6.2**; Witham 2021). Assuming that there were no losses of vernal pool habitat outside of Witham's (2021) study area, this vernal pool region has exhibited the lowest amount and percentage of vernal pool habitat losses (Witham 2021).

As of 2018, roughly 1,984 acres of vernal pool grassland was estimated to be protected in this region (see **Figure 6.1**, **Figure 6.2**, **Table 6.1**; Witham 2021; Vollmar et al. 2017). This represents approximately 36.1% of the currently remaining vernal pool grassland in the region and 36.2% of the vernal pool grassland that existed in the region in 2005, the Recovery Plan's baseline. Additional vernal pool habitat has been protected since 2018 within the East Contra Costa County Habitat Conservation Plan's Preserve System (ECCCHC 2022). In addition, neither Vollmar et al. (2017) nor **Figure 6.2** include the Marsh Creek Habitat Management Unit or the entire northern portion of Brushy Peak Region Preserve, which are discussed further in the Other Preserves section below.

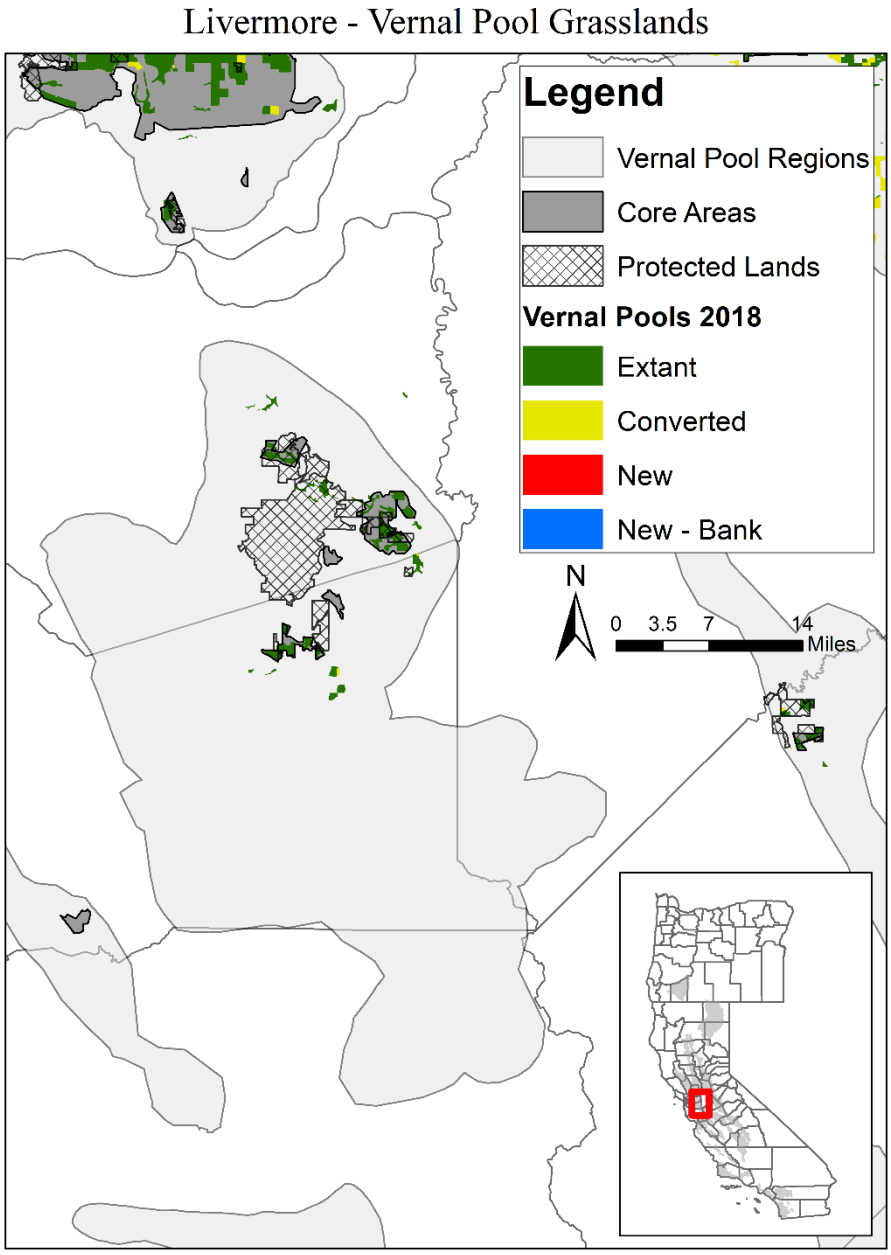


Figure 6.1. Map of vernal pool habitat within the Livermore Vernal Pool Region mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

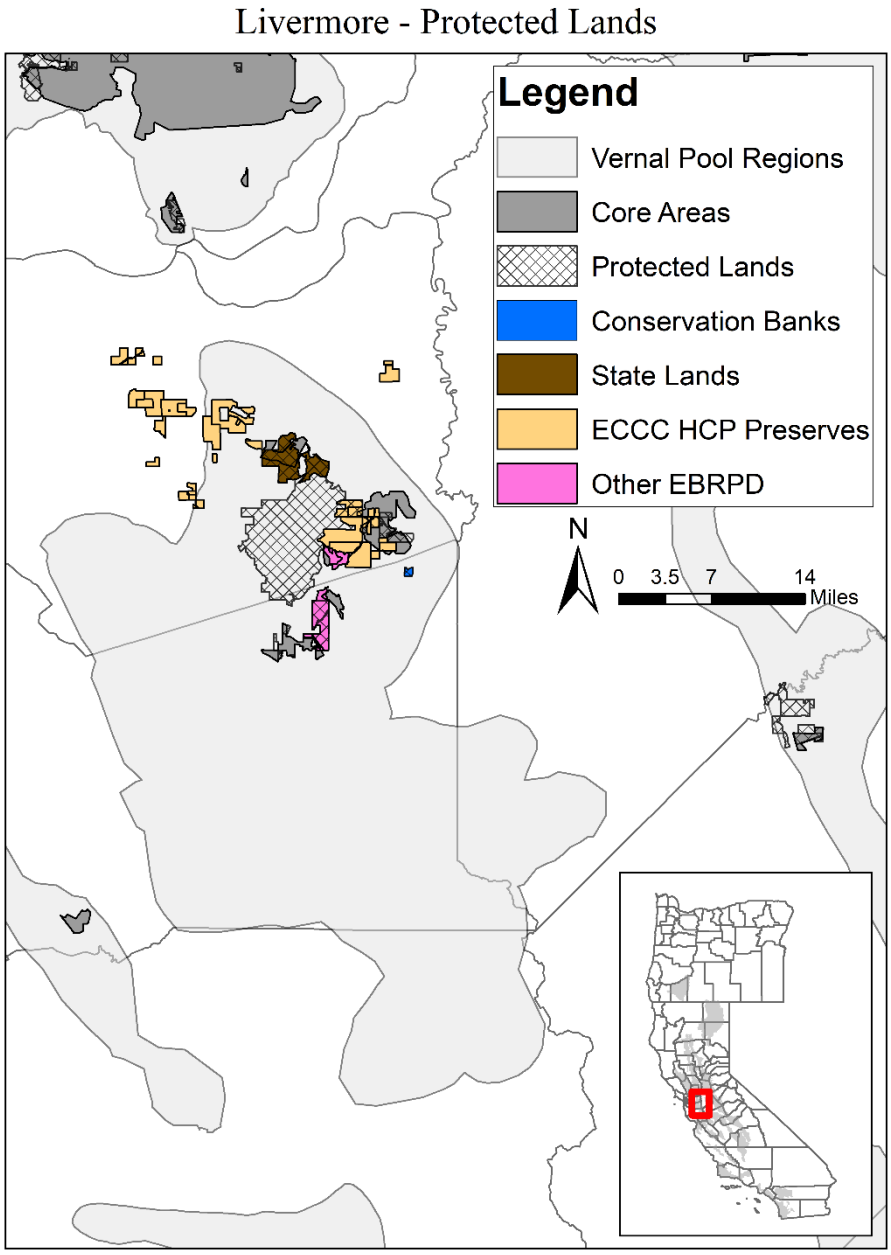


Figure 6.2. Map of protected areas that contain vernal pool grassland habitat and/or vernal pool fairy shrimp within the Livermore Vernal Pool Region**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. Zoom in for finer resolution. ECCC HCP = East Contra Costa County Habitat Conservation Plan, EBRPD = East Bay Regional Park District.

Table 6.1. Acreage of vernal pool habitat and habitat converted within the Livermore Vernal Pool Region mapped by Witham (2021). All habitat labeled as not converted, altered, or new was considered extant. Protected acreage is based on Vollmar et al. (2017).

Core Area	2005 Acres	2018 Acres Total	2018 Acres Extant (% of Total)	2018 Acres Converted – Agriculture (% of Total)	2018 Acres Converted – Urban Development (% of Total)	2018 Acres Protected (% of Total)
Altamont Hills	3,524.5	3,524.5	3,522.3 (99.9%)	2.1 (0.1%)	0.0 (0.0%)	1,321.6 (37.5%)
Livermore Vernal Pool Region Total	**5,472.7**	**5,489.0**	**5,424.1 (98.8%)**	**65.0 (1.2%)**	**0.0 (0.0%)**	**1,983.8 (36.1%)**

Table 6.2. Acreage of vernal pool habitat losses within the Livermore Vernal Pool Region between 2005 and 2018 mapped by Witham (2021), broken down by what the land use was converted to. All categories besides urban development and managed wetlands are considered agricultural conversions.

Core Area	Urban, Commercial, & Industrial	Orchards, Vineyards, Eucalyptus	Alfalfa and Irrigated Pasture	Bare Plowed Agricultural Lands	Other Ag (Rice, Row Crops, Dairy,	Agricultural Residential	Managed Wetlands	Total Losses	% Losses Urban Development	% Losses Agricultural Conversions
Altamont Hills	0.0	0.0	0.0	2.1	0.0	0.0	0.0	2.1	0.0%	100%
Livermore Vernal Pool Region Total	**0.0**	**0.0**	**0.0**	**51.0**	**12.9**	**1.0**	**0.0**	**65.0**	**0.0%**	**100%**

6.2. Species Occurrences

6.2.1. Vernal Pool Fairy Shrimp

There are 23 occurrence records of the vernal pool fairy shrimp documented within, or immediately adjacent to, the Livermore Vernal Pool Region in the Diversity Database (see **Figure 6.3**; Diversity Database 2022). These occurrences are found on land owned by a variety of private or public entities. Of these 23 occurrences, all are listed as presumed extant by the Diversity Database; 9 occurrences are within extant vernal pool habitat based on Witham's (2021) mapping efforts and 14 are outside of mapped vernal pool habitat. It is possible that some of the 23 occurrences are no longer extant, but have not been surveyed recently.

Protected areas contain, at least partially, 11 of the 23 Diversity Database records (48%) for the vernal pool fairy shrimp in this region. However, this does not mean that 48% of all occurrences of the vernal pool fairy shrimp in this region have been protected, as the Diversity Database is not an appropriate source for determining all known occurrences (individual Diversity Database records are not necessarily equivalent to occurrences, and some known occurrences may not be documented in the Diversity Database). Only 5 of the 23 Diversity Database polygons (22%) are entirely within the protected areas.

6.2.2. Vernal Pool Tadpole Shrimp

There is only one occurrence record of the vernal pool tadpole shrimp documented within the Livermore Vernal Pool Region in the Diversity Database (see **Figure 6.4**; Diversity Database 2022). This occurrence is found on private, unprotected land and is described as a small 8-inch by 12-inch claypan vernal pool in a swale; it was documented in 2003 and has not been surveyed since (Diversity Database 2022). The occurrence is presumed extant by the Diversity Database, but it is outside of mapped vernal pool grassland (Witham 2021). This is likely because it is a single isolated pool, but it may be because the habitat has been disturbed or destroyed and no longer appears on aerial imagery. To our knowledge, the species has not been found anywhere else in the region.

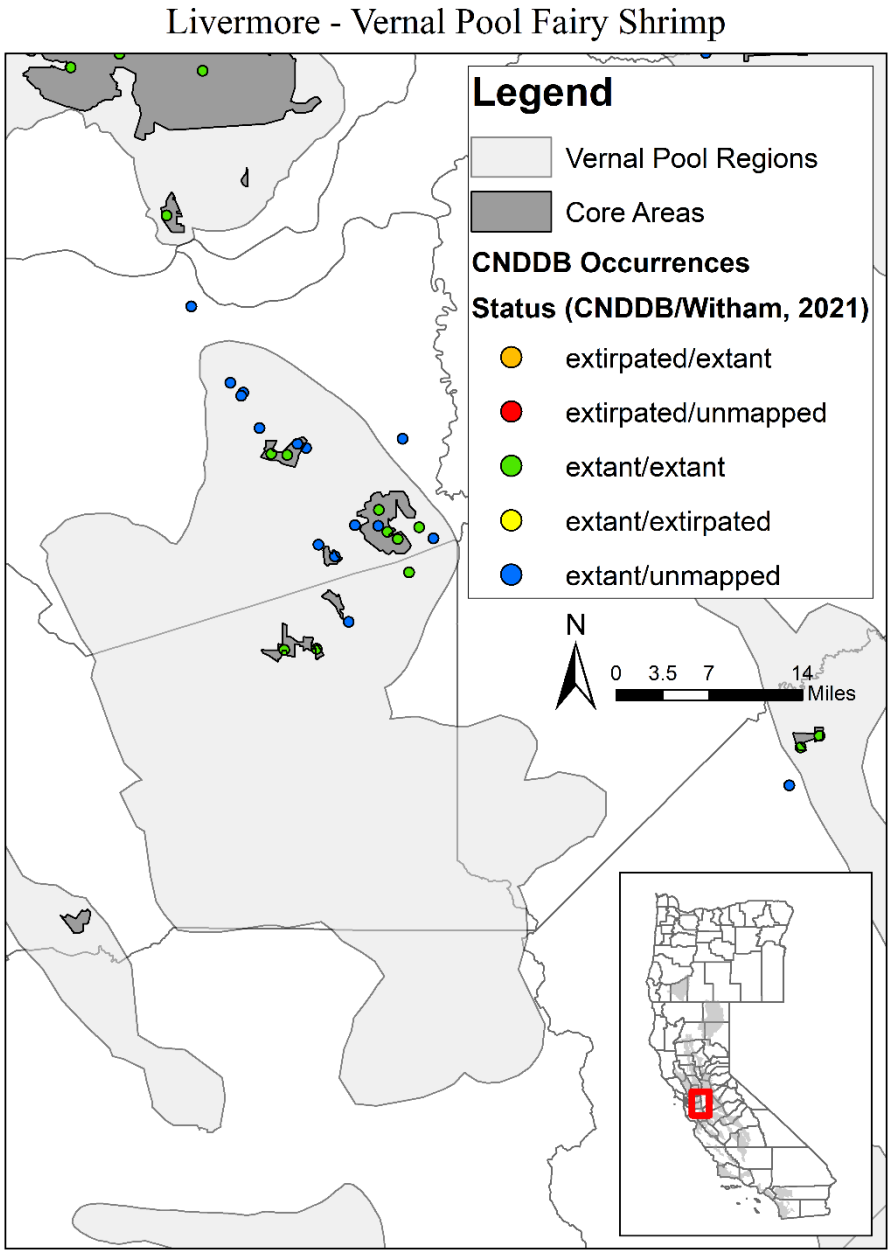


Figure 6.3. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) in the Livermore Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both Diversity Database occurrence records and Witham's (2021) map of vernal pool habitat.

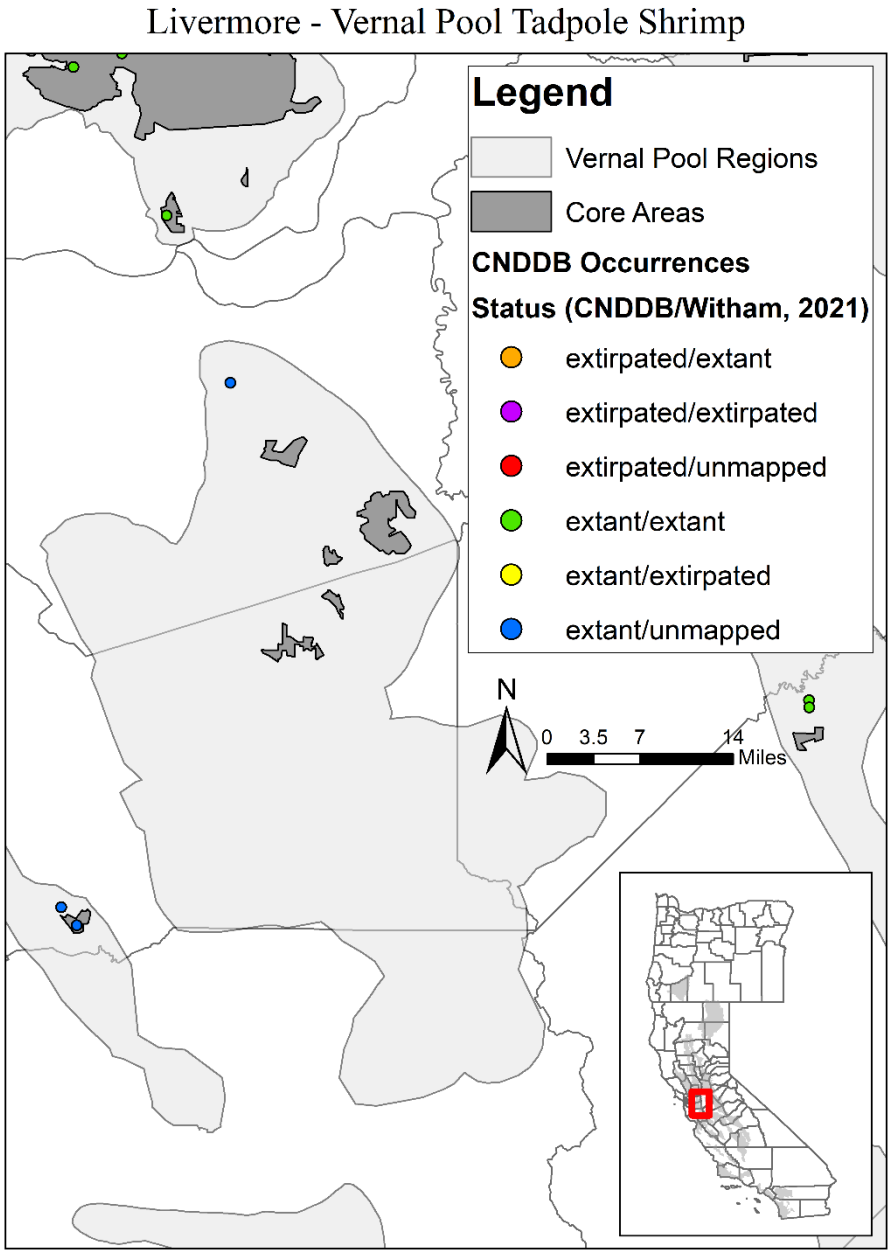


Figure 6.4. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) in the Livermore Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both Diversity Database occurrence records and Witham's (2021) map of vernal pool habitat.

6.3. Federal Lands

6.3.1. National Wildlife Refuges

There are no National Wildlife Refuges with known occurrences of the vernal pool fairy shrimp or vernal pool tadpole shrimp in the Livermore Vernal Pool Region.

6.3.2. Military Lands

There are no military lands with known occurrences of the vernal pool fairy shrimp or vernal pool tadpole shrimp in the Livermore Vernal Pool Region.

6.3.3. Bureau of Land Management

There are no Bureau of Land Management lands with known occurrences of the vernal pool fairy shrimp or vernal pool tadpole shrimp in the Livermore Vernal Pool Region.

6.3.4. Other Federal Lands

The vernal pool fairy shrimp in known to occur in the vicinity of the Los Vaqueros Reservoir Watershed. The Bureau of Reclamation funded a reservoir expansion project there in 2012, but this area is owned and operated by the Contra Costa Water District and is discussed in the **Other Preserves** section below.

6.4. Conservation Banks

There is one conservation bank within the Livermore Vernal Pool Region that provides credits for preserved vernal pools that support the vernal pool fairy shrimp: Mountain House Conservation Bank (see **Figure 6.2**; RIBITS 2021). This 145-acre bank is located in Alameda County north of Bethany Reservoir between Kelso Road, Bruns Road, and Christensen Road. It protects habitat for a variety of federally listed species and includes a small amount of vernal pool habitat, 0.46 acre, which provides preservation credits for the vernal pool fairy shrimp (Fletcher Conservation Lands 2018). The bank is sold-out of credits and is now operating under its long-term management plan.

Wildlands' Byron Conservation Bank (a.k.a., Byron Ranch Conservation Bank) is named in the description of one Diversity Database occurrence and thus was mentioned in the previous 5-year review (Service 2007a). This occurrence spans the Byron Airport Habitat Management Lands and the adjacent area to the south. However, this property is no longer listed on Wildlands' website, and the area south of Byron Airport has been acquired as part of the East Contra Costa County Habitat Conservation Plan's Preserve System, so the Service assumes that this bank no longer exists and is now a preserve instead.

There are no conservation banks that provide credits for the vernal pool tadpole shrimp within the Livermore Vernal Pool Region.

6.5. Habitat Conservation Plans

There are two regional Habitat Conservation Plans (HCPs) within the Livermore Vernal Pool Region that include all three shrimp species as Covered Species and one regional HCP that includes only the vernal pool fairy shrimp and vernal pool tadpole shrimp as Covered Species (**Figure 6.5**).

6.5.1. East Contra Costa County HCP

The East Contra Costa County HCP covers the eastern portion of Contra Costa County, and is mostly within the vernal pool region (Jones and Stokes Associates 2006a). This HCP was permitted in 2007 and has a 30-year permit term, and the permittees are Contra Costa County, the Contra Costa County Flood Control and Water Conservation District, the East Bay Regional Park District (EBRPD) and the Cities of Brentwood, Clayton, Oakley, and Pittsburg. The goal of the HCP is to provide an effective framework to protect natural resources in eastern Contra Costa County while improving and streamlining the environmental permitting process for impacts on endangered species. The HCP's Conservation Strategy will result in an interconnected Preserve System totaling between 23,800 acres and 30,300 acres of land preserved in perpetuity.

The HCP mapped landcover types within the inventory area, and 121 acres of seasonal wetland complexes and 483 acres of undetermined wetlands were identified that may be suitable for the vernal pool fairy shrimp and vernal pool tadpole shrimp; this does not include the surrounding annual grassland or rock outcrops. Because these habitat features are difficult to identify from aerial photos and because access to private lands for field verification was restricted, habitat models for covered shrimp species were not developed. Effects on the vernal pool fairy shrimp and vernal pool tadpole shrimp from Covered Activities include loss of up to 131 acres (22%) of the seasonal wetland complexes and undetermined wetlands. The HCP has a variety of biological goals, measurable objectives, and conservation actions related to protecting covered shrimp species, including: preserving seasonal wetlands and alkali wetlands to offset losses from covered activities at a ratio of 3:1, restoring seasonal wetlands and alkali wetlands to offset losses from covered activities at a ratio of 2:1, and collecting topsoil from vernal pools to be converted by Covered Activities for later use as inoculum for the created pools (Jones and Stokes Associates 2006a).

As of December 31, 2021, Covered Activities have directly impacted 1.62 acres of seasonal wetlands and 0.15 acre of alkali wetlands and indirectly impacted 4.03 acres of seasonal wetlands and 1.00 acre of alkali wetlands (ECCCHC 2022). The East Contra Costa County Habitat Conservancy (ECCCHC) has acquired 42 properties for the Preserve System, totaling over 14,500 acres. All but one of the acquisitions were completed in partnership with the EBRPD which owns the lands and manages them together with the ECCCHC (ECCCHC 2022). In total, 13.4 acres of seasonal wetlands and 34.8 acres of alkali wetlands have been preserved. Preserve System lands known to support the vernal pool fairy shrimp include the Coehlo, Souza I, Souza II, Vaquero Farms South, Casey, and Campos Preserves. In addition, 11 restoration or creation projects have occurred, 9 of which have restored or created seasonal or alkali wetlands: Lentzner Spring, Vasco Caves Souza I Pond, Souza II Wetland, Upper Hess Watershed, Souza II Corral Seasonal Wetland, Vaquero Farms Seasonal Wetland Creation (Pools 1 and 2), Hess Creek Channel, Vaquero Farms Seasonal Wetland Creation (Pool 3), and Horse Valley Creek

and Wetland Restoration Projects. In total, these projects have restored 2.47 acres of seasonal wetlands and 0.87 acre of alkali wetlands and have created 4.58 acres of seasonal wetlands and 1.25 acres of alkali wetlands (ECCCHC 2022). The vernal pool tadpole shrimp has not been observed at any of these preserves.

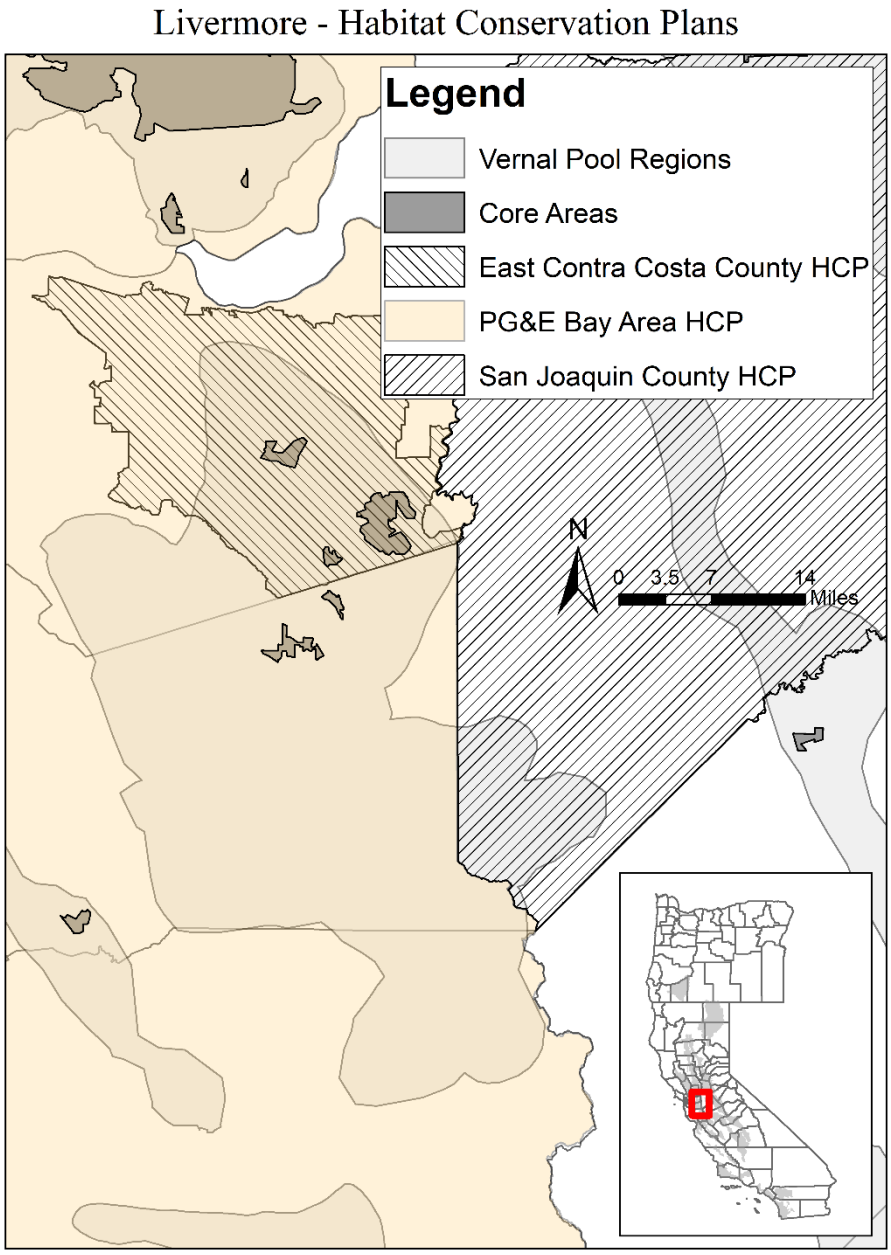


Figure 6.5. Map of the habitat conservation plans (HCPs) within the Livermore Vernal Pool Region that include any of the three shrimp species as Covered Species.

6.5.2. PG&E Bay Area Operations and Maintenance HCP

See section 3.5.1 for a description of this HCP.

6.5.3. San Joaquin County HCP

The San Joaquin County HCP covers the entirety of San Joaquin County and spans the southern end of the Southeastern Sacramento Valley Vernal Pool Region and the northern end of the Southern Sierra Foothills Vernal Pool Region (SJCHCP 2000). It also includes the northern end of the San Joaquin Valley Vernal Pool Region and the southeastern end of the Livermore Vernal Pool Region, though no vernal pool grasslands have been present in these parts of San Joaquin County since at least 2005 (Witham et al. 2013; Witham et al. 2014; Witham 2021). This HCP was permitted in 2001 and has a 50-year permit term, and the permittees include San Joaquin County and all of its incorporated cities, Caltrans, and the San Joaquin Council of Governments. The key purpose of the HCP is to provide a strategy for balancing the need to conserve Open Space and to convert Open Space while protecting the region's agricultural economy, preserving landowner property rights, providing for the long term management of plant, fish, and wildlife species, providing and maintaining multiple-use Open Spaces which contribute to the quality of life of county residents, and accommodating a growing population while minimizing costs to Project Proponents and society at large. An anticipated 109,302 acres of Open Space will be converted, and 100,841 acres of land will be preserved in perpetuity to compensate for impacts to Covered Species.

The HCP area includes a total of 77,806 acres of potential habitat for the vernal pool fairy shrimp, including an estimated 73,614 acres of natural vernal pool grassland as well as other natural and agricultural land cover types that may provide habitat for the species. Over the 50-year permit term, Covered Activities will affect 6,793 acres of vernal pool fairy shrimp habitat and 5,378 acres of vernal pool tadpole shrimp habitat. The HCP's Preserve System will compensate for habitat loss via preservation of habitat at a 3:1 ratio for natural lands and a 1:1 ratio for agricultural lands. For the vernal pools themselves, the 3:1 ratio will be achieved by preserving 2 acres of natural vernal pools per every 1 acre lost and creating 1 acre of vernal pools per 1 acre lost. Topsoil from vernal pools to be converted by Covered Activities will be collected and stored for later use as inoculum for the created vernal pools. Approximately 18,000 acres of vernal pool grassland is expected to be preserved by the HCP; these will likely be spread across the full extent of the vernal pool grasslands in the County, but there is no provision in the HCP requiring specific amounts of preservation to occur in specific vernal pool regions.

The HCP fulfilled its "jumpstart" requirement for vernal pools in 2005 with the purchase of 10.34 vernal pool preservation credits at Fitzgerald Ranch Conservation Bank, equaling 6 wetted acres and 18.585 acres of surrounding upland (SJCOG 2020). As of 2020, the vernal pool jumpstart purchase remains unused, as no vernal pool impacts have occurred requiring their use for mitigation (SJCOG 2020). The HCP has also preserved 71.76 acres of vernal pool grassland in the San Joaquin County Liberty and Dustin Road Preserve Dedication (SJCOG 2020). Both of these protected properties are in the Southeastern Sacramento Valley Vernal Pool Region.

Although the Conservancy fairy shrimp was not and still is not known to occur in San Joaquin County, it was included in this HCP at the request of the Service due to the identification of

scattered vernal pools south of I-580 (Livermore Vernal Pool Region) with the potential to support the species in 1998 (SJCHCP 2000). Pre-construction surveys are required in potential habitat, and full avoidance if the species is found. The nearest known occurrence of the Conservancy fairy shrimp is from Mapes Ranch in Stanislaus County.

6.6. Other Preserves

Besides land within the East Contra Costa County HCP Preserve System, East Bay Regional Park District also has two other preserved lands in Contra Costa and Alameda Counties with vernal pool habitat (**Figure 6.2**). The 1,979-acre Brushy Peak Regional Preserve is located just northeast of the City of Livermore. The original 507-acre portion of the preserve is owned and managed by the Livermore Area Regional Park District, and EBRPD owns and manages the more recently acquired 1,472 acres. Note that **Figure 6.2** does not depict a small section of land that is part of the preserve in the northeastern part of the preserve, inside the Altamont Hills Core Area. The 763-acre Vasco Caves Regional Preserve is located in southern Contra Costa County and is surrounded by the ECCHCP Preserve System to the north and east and the Los Vaqueros Watershed to the west. It is jointly owned and managed by EBRPD and Contra Costa Water District. Both of these preserves are characterized by rock outcrops with indentations that seasonally pool water and act as vernal pools. The vernal pool fairy shrimp is known to occur on both of these Regional Preserves, as well as the endangered longhorn fairy shrimp (*Branchinecta longiantenna*) (Diversity Database 2022).

The Byron Airport Habitat Management Lands consist of 814 acres of land on the southwest side of the Byron Airport which were preserved to offset impacts of the airport's expansion in 1994 (The Wildlife Project 2013). The land is owned by Contra Costa County and has a conservation easement held by CDFW. Most of the land is annual grassland with vernal pools, and several acres of vernal pools and seasonal wetlands have been created onsite (0.06 acre of vernal pools in Pasture 5, 1.33 acres of pools for California tiger salamanders [*Ambystoma californiense*] in Pasture 5, and 7.02 acres of seasonal wetlands and alkali wetlands in Areas A and B) (The Wildlife Project 2013). The vernal pool fairy shrimp has been found on or near this preserve consistently since 1997 (Diversity Database 2022). Management tasks include grazing at appropriate levels, monitoring wetlands every five years, and preventing activities inconsistent with the conservation easement, and funding has been provided for maintenance, management, monitoring, and consulting services (The Wildlife Project 2013).

Marsh Creek State Park (a.k.a., Cowell Ranch/John Marsh Home) is owned by the California Department of Parks and Recreation (CDPR) and is located in the southwestern portion of the City of Brentwood. The park has 3,600 acres of various habitat types. The vernal pool fairy shrimp is known to occur in 16 vernal pools in the Briones Valley, which is located on the western half of the park and is within one polygon of the Altamont Hill Core Area (CDPR 2012). Management includes grazing and siting trails to avoid impacts to vernal pools while also allowing the public to appreciate the pools (CDPR 2012).

The Los Vaqueros Reservoir is a 1,900-acre off-stream storage reservoir located within the 18,535-acre Los Vaqueros Watershed in southeastern Contra Costa County. The reservoir and watershed are owned and managed by the Contra Costa Water District, and the Bureau of Reclamation (BOR) provided funding in 2012 to expand the reservoir's capacity (Service

2020b). As mitigation for habitat loss caused by the expansion project, Contra Costa Water District purchased 5,079 acres of conservation lands in the surrounding areas. Vernal pool habitat and vernal pool fairy shrimp are known from the northeastern portion of the watershed (H.T. Harvey and Associates 2019a) and the Marsh Creek Habitat Management Unit – Deer Valley West Subunit of the conservation lands (ICF 2015); Witham (2021) also mapped vernal pool habitat within the northern portion of the watershed and in the Marsh Creek Habitat Management Unit – Deer Valley East Subunit. Note that the Marsh Creek Habitat Management Unit was not captured in Vollmar et al. (2017) or included in **Figure 6.2**. In 2018-2019, the vernal pool fairy shrimp was found in the Kellogg and Temblor vernal pool complexes (H.T. Harvey and Associates 2019a). Management of these lands, such as grazing, weed management, and avoidance of vernal pools, is prescribed by a resource management plan for the watershed (ICF 2016) and a habitat management plan for the conservation lands (ICF 2015). A section 7 consultation which covered routine operations and maintenance activities across these lands was written in 2012 and updated in 2020 (Service 2020b).

Other preserved lands include 5 private mitigation lands with conservation easements (2 held by CDFW, 2 held by Wildlife Heritage Foundation, 1 unknown), a 45-acre parcel owned by Contra Costa Water District surrounded by EBRPD land near Byron Airport, and a 119-acre parcel owned by the University of California north of Livermore (Vollmar et al. 2017).

6.7. Vernal Pool Core Areas

There is one Core Area within the Livermore Vernal Pool Region that is designated in the Recovery Plan for the vernal pool fairy shrimp: Altamont Hills. This core area has not met the target of 85% of vernal pool habitat protected, but as of 2018 it had lost less than 0.01% of the baseline level of habitat that was present in 2005 (see **Table 6.1**; Vollmar et al. 2017; Witham 2021).

There are no Core Areas within the Livermore Vernal Pool Region that are designated in the Recovery Plan for the vernal pool tadpole shrimp.

6.7.1. Altamont Hills

This is a zone 1 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is located in southeastern Contra Costa County and northeastern Alameda County.

There were approximately 3,524 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 3,522 acres of vernal pool grassland remaining, with only 2.1 acres lost due to agricultural conversion (see **Figure 6.6**, **Table 6.1**; Witham 2021). The total acreage of vernal pool habitat in this region is likely higher, given that many areas of vernal pool habitat occur in hilly terrain or rock outcrops which are not as clearly identifiable on aerial imagery as the flat vernal pool grasslands of the Central Valley. Within the bounds of the Altamont Hills Core Area, vernal pools that were not mapped by Witham (2021) are known to occur north of the Marsh Creek State Park, within the Vasco Caves area, and on the northern part of the Brushy Peak Regional Preserve based on presumed extant occurrences of the vernal pool fairy shrimp and the longhorn fairy shrimp in the

Diversity Database. Roughly 1,322 acres of mapped vernal pool grasslands (Witham 2021) were protected within this core area as of 2017 based on Vollmar et al.'s database (Vollmar et al. 2017), representing 37.5% of the 2005 baseline. In addition, areas of mapped (Witham 2021) and unmapped vernal pool habitat have been preserved within protected lands that were not captured by Vollmar et al.'s (2017) database, including Marsh Creek Habitat Management Unit, Vasco Caves Regional Preserve, Brushy Peak Regional Preserve, and several ECCC HCP preserves that were acquired after 2017 (**Figure 6.7**).

This core area is partially within the boundary of the East Contra Costa County HCP (Jones and Stokes Associates 2006a). To date, the ECCCHC has preserved six properties known to support the vernal pool fairy shrimp, four of which are within the Altamont Hills Core Area (**Figure 6.7**), and conducted nine restoration projects involving seasonal wetlands or alkali wetlands, two of which are within the core area (ECCCHC 2022). Other preserves that are within this core area include: Marsh Creek State Park, Marsh Creek Habitat Management Unit (not included in **Figure 6.7**), the Byron Airport Habitat Management Lands, Vasco Caves Regional Preserve, the northeastern (not included in **Figure 6.7**) and southern portions of Brushy Peak Regional Preserve, a 45-acre parcel owned by Contra Costa Water District near Byron Airport, and four small private mitigation lands with conservation easements.

6.7.1.1.Vernal Pool Fairy Shrimp Occurrences

There are 10 occurrence records from the Diversity Database for the vernal pool fairy shrimp within this core area (see **Figure 6.8**; Diversity Database 2022). As of 2018, seven of these occurrences were partially or entirely within protected areas mapped by Vollmar et al. (2017) and one additional occurrence was protected within the Vasco Caves Regional Preserve. Of the 10 records, 4 were known at the time of listing in 1994 and 7 were known at the time the Recovery Plan was published in 2005; these 7 occurrences are located throughout the core area. The three newer records are all located near the Byron Airport within the Byron Airport Habitat Management Lands or the East Contra Costa County HCP Preserve System.

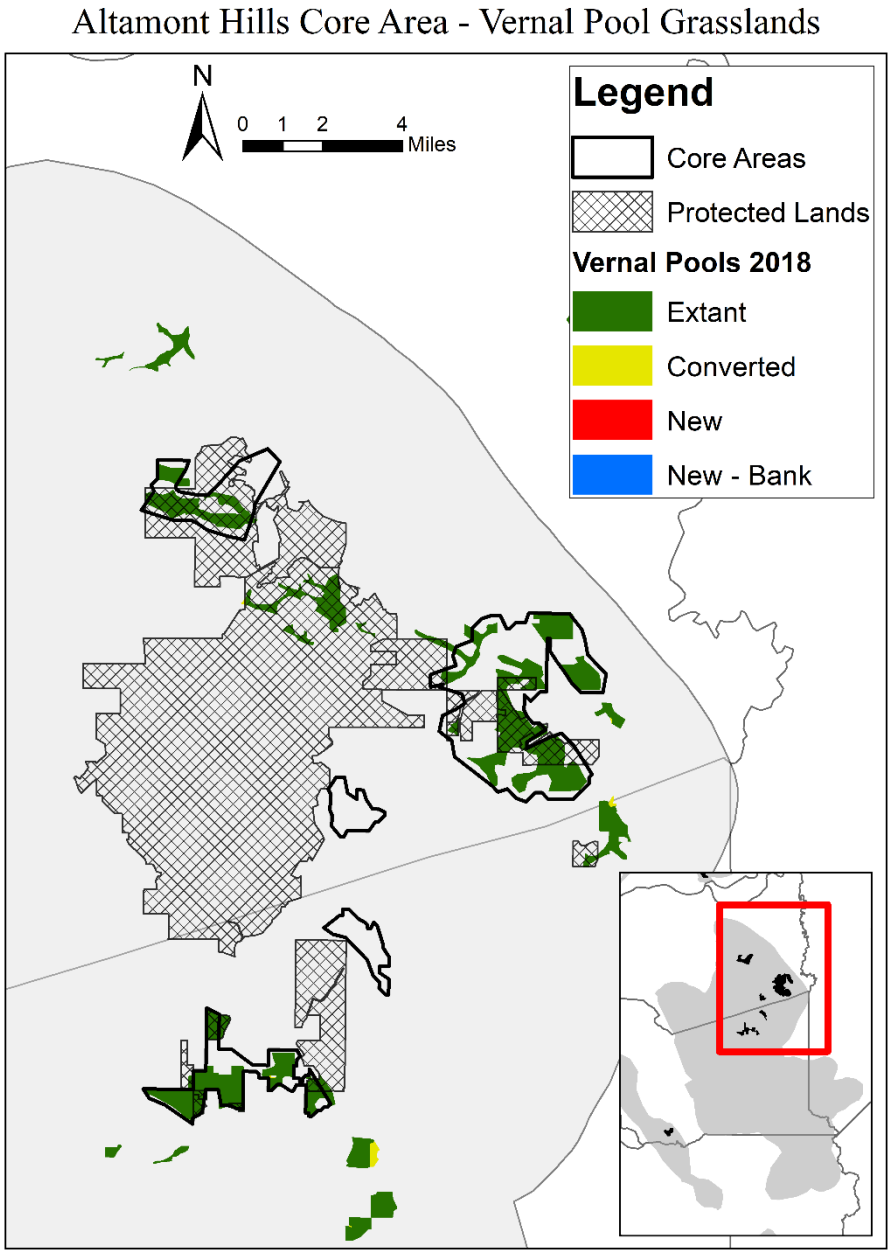


Figure 6.6. Map of vernal pool grassland habitat within the Altamont Hills Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

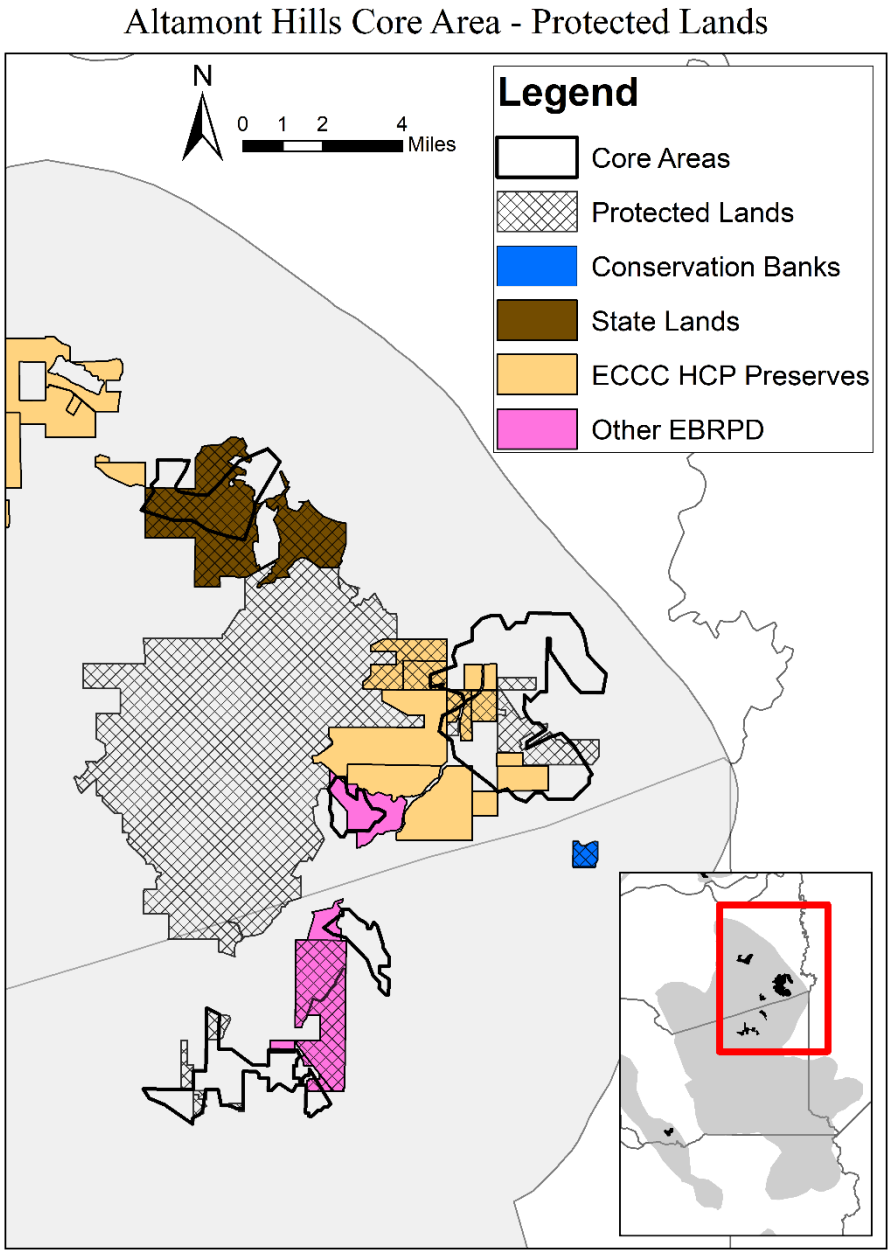


Figure 6.7. Map of protected areas within the Altamont Hills Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. ECCC HCP = East Contra Costa County Habitat Conservation Plan, EBRPD = East Bay Regional Park District.

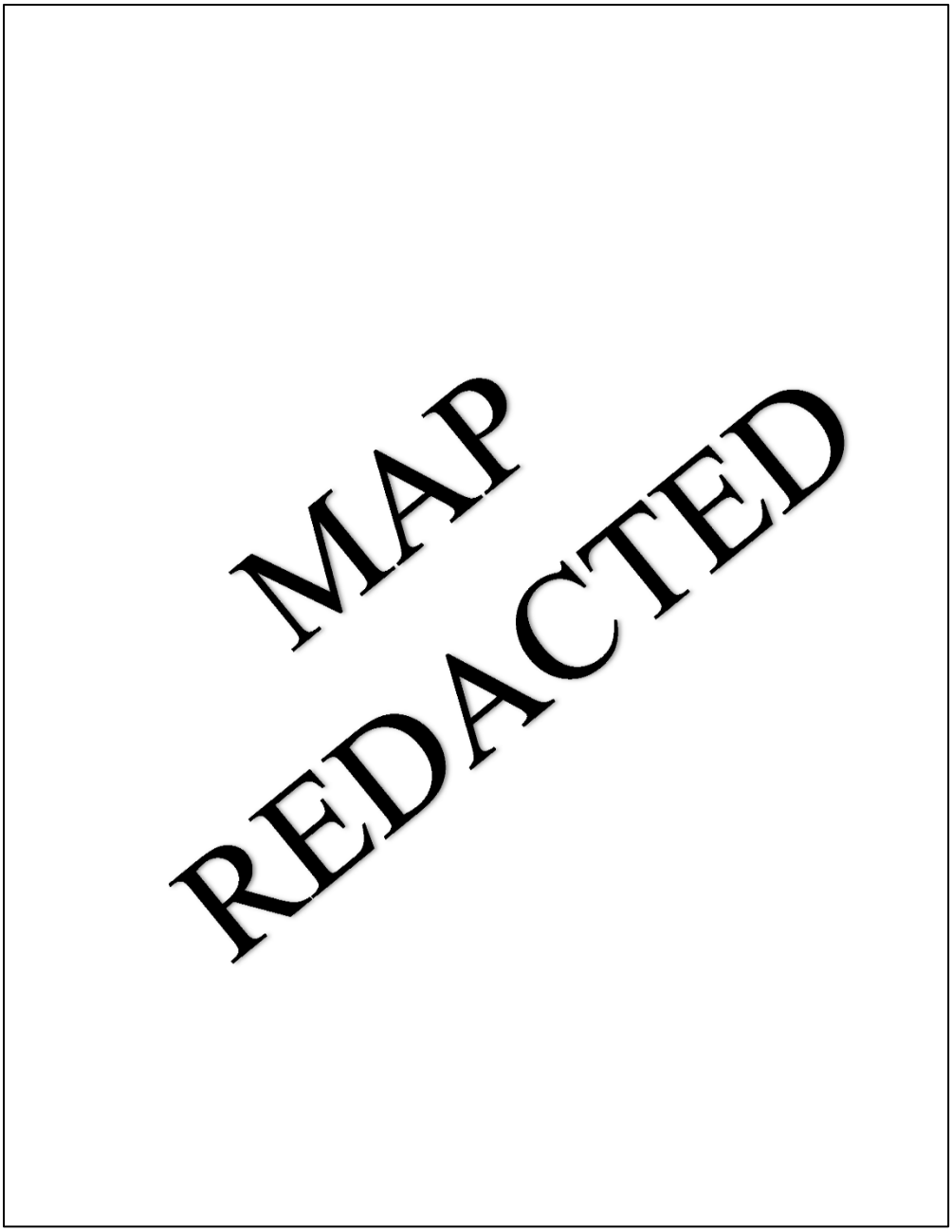


Figure 6.8. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Altamont Hills Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

7. NORTHEASTERN SACRAMENTO VALLEY VERNAL POOL REGION

All three shrimp species occur within the Northeastern Sacramento Valley Vernal Pool Region.

7.1. Vernal Pool Habitat

Approximately 134,478 acres of vernal pool grassland existed within, or immediately adjacent to, this region when the Recovery Plan was published in 2005 (see **Figure 7.1**, **Table 7.1**; Witham et al. 2013). Approximately 133,478 acres remained as of 2012, with 1,107 acres (0.8% of 2005 total) lost between 2005 and 2012 (Witham et al. 2014). However, 107 acres of new vernal pool grassland were created over that same period on vernal pool mitigation banks and other managed wetlands. Of the habitat lost, 62 acres (5.6%) were to urbanization and 1,045 acres (94.4%) were to agricultural conversion (54.4% to bare plowed agricultural land, 30.2% to rice or row crops, 6.9% to orchards, and 2.8% to other agricultural conversions) (Witham et al. 2014).

By 2018, approximately 131,461 acres of vernal pool grassland remained, with a total of 3,126 acres (2.3% of 2005 total) lost between 2005 and 2018 (see **Table 7.1**; Witham 2021). Just 0.6 acres of new vernal pool grassland were identified in the 2018 aerial imagery that were either not present or not visible on both the 2005 and 2012 aerial imagery. Of the habitat lost since 2005, 280 acres (9.0%) were to urbanization and 2,803 acres (89.7%) were to agricultural conversion (36.0% to bare plowed agricultural land, 20.3% to rice or row crops, 27.6% to orchards, and 5.9% to other agricultural conversions) (see **Table 7.2**; Witham 2021). There were also conversions of 43 acres of vernal pool grasslands to managed wetlands with hydrology that no longer supported vernal pool species. Note that some patches of vernal pool grassland that had been converted to bare plowed land in 2012 had been fully converted to agricultural use for either orchards, rice, or row crops by 2018, although some were never developed and actually returned to being vernal pool grassland.

This vernal pool region has exhibited the least amount of total vernal pool losses of all the vernal pool regions that are entirely within the Central Valley (Witham, 2021). It has the least amount of loss due to urban development within the Central Valley (i.e., not including the portions of the Central Coast and Livermore Vernal Pool Regions within Witham's [2021] study area) and the second lowest amount of losses to agricultural conversions within the Central Valley after the Solano-Colusa Vernal Pool Region. The vast majority of vernal pool losses within this region have been to agricultural conversions (89.7%), which is unsurprising given that the region is composed primarily of agricultural lands and very few cities or towns. Many of these losses are likely due to land conversions to orchards and rice or row crops that should be regulated by the Clean Water Act but that are proceeding illegally without the necessary 404 permit from the Corps (Witham et al. 2014; Witham 2021). The largest urban center is the City of Chico, and unlike the rest of the region, the Chico and Doe Mill Core Areas have experienced significant losses of vernal pool habitat to urban development (**Table 7.2**).

As of 2018, roughly 43,718 acres of vernal pool grassland was estimated to be protected in this region, or immediately adjacent to it, typically under a conservation easement (see **Figure 7.1**, **Figure 7.2**, **Table 7.1**; Witham 2021; Vollmar et al. 2017). This represents approximately 33.2% of the currently remaining vernal pool grassland in the region and 32.5% of the vernal pool

grassland that existed in the region in 2005, the Recovery Plan's baseline. However, Vollmar et al.'s (2017) did not include the 4,273-acre easement on the Lowe property that protects an additional 2,836 acres of vernal pool grassland. Thus, a total of 46,554 acres of vernal pool grassland is protected, representing 35.4% of the currently remaining vernal pool grassland and 34.6% of the 2005 baseline.

7.2. Species Occurrences

7.2.1. Vernal Pool Fairy Shrimp

There are 59 occurrence records of the vernal pool fairy shrimp documented within, or immediately adjacent to, the Northeastern Sacramento Valley Vernal Pool Region in the Diversity Database (see **Figure 7.3**; Diversity Database 2022). These occurrences are found on land owned by a variety of private or public entities. Of these 59 occurrences, 1 is listed by the Diversity Database as extirpated; all other occurrences are listed as presumed extant and either occur within extant vernal pool habitat based on Witham's (2021) mapping efforts (52 occurrences) or outside of mapped vernal pool habitat (6 occurrences). It is likely that some of these occurrences are no longer extant, but have not been surveyed recently.

The protected areas contain, at least partially, 29 of the 59 Diversity Database records (49%) for the vernal pool fairy shrimp in this region. However, this does not mean that 49% of all occurrences of the vernal pool fairy shrimp, as the Diversity Database is not an appropriate source for determining all known occurrences (individual Diversity Database records are not necessarily equivalent to occurrences, and some known occurrences may not be documented in the Diversity Database). Only 12 of the 59 Diversity Database polygons (20%) are entirely within the protected areas, although the true number is likely closer to 25. The difference between the number of records partially and entirely within the mapped protected areas is likely a reflection of the irregular size and shape of polygons in the Diversity Database, as well as slight discrepancies in the overlap between the two databases.

7.2.2. Vernal Pool Tadpole Shrimp

There are 61 occurrence records of the vernal pool tadpole shrimp documented within, or immediately adjacent to, the Northeastern Sacramento Valley Vernal Pool Region in the Diversity Database (see **Figure 7.4**; Diversity Database 2022). These occurrences are found on land owned by a variety of private or public entities. All occurrences are presumed extant by the Diversity Database; 51 occur within extant vernal pool grassland, 1 within extirpated vernal pool grassland, and 9 outside of mapped vernal pool grassland (Witham 2021). It is likely that some of these occurrences are no longer extant, but have not been surveyed recently.

The protected areas contain, at least partially, 38 of the 61 Diversity Database records (62%) for the vernal pool tadpole shrimp in this region. Only 16 of the 61 Diversity Database polygons (26%) are entirely within the protected areas; the difference between the number of records partially and entirely within the mapped protected areas is likely a reflection of the irregular size and shape of polygons in the Diversity Database, as well as slight discrepancies in the overlap between the two databases.

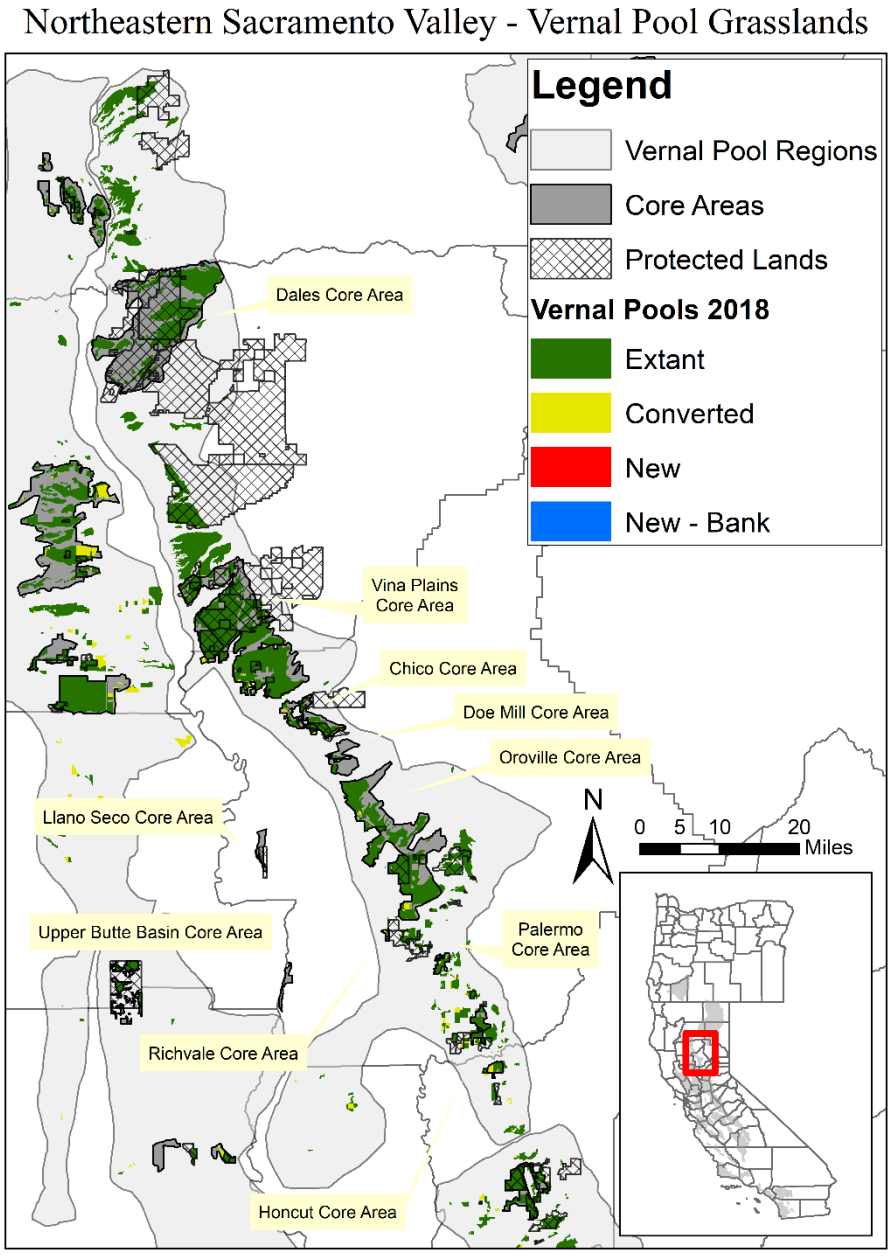


Figure 7.1. Map of vernal pool habitat within the Northeastern Sacramento Valley Vernal Pool Region mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

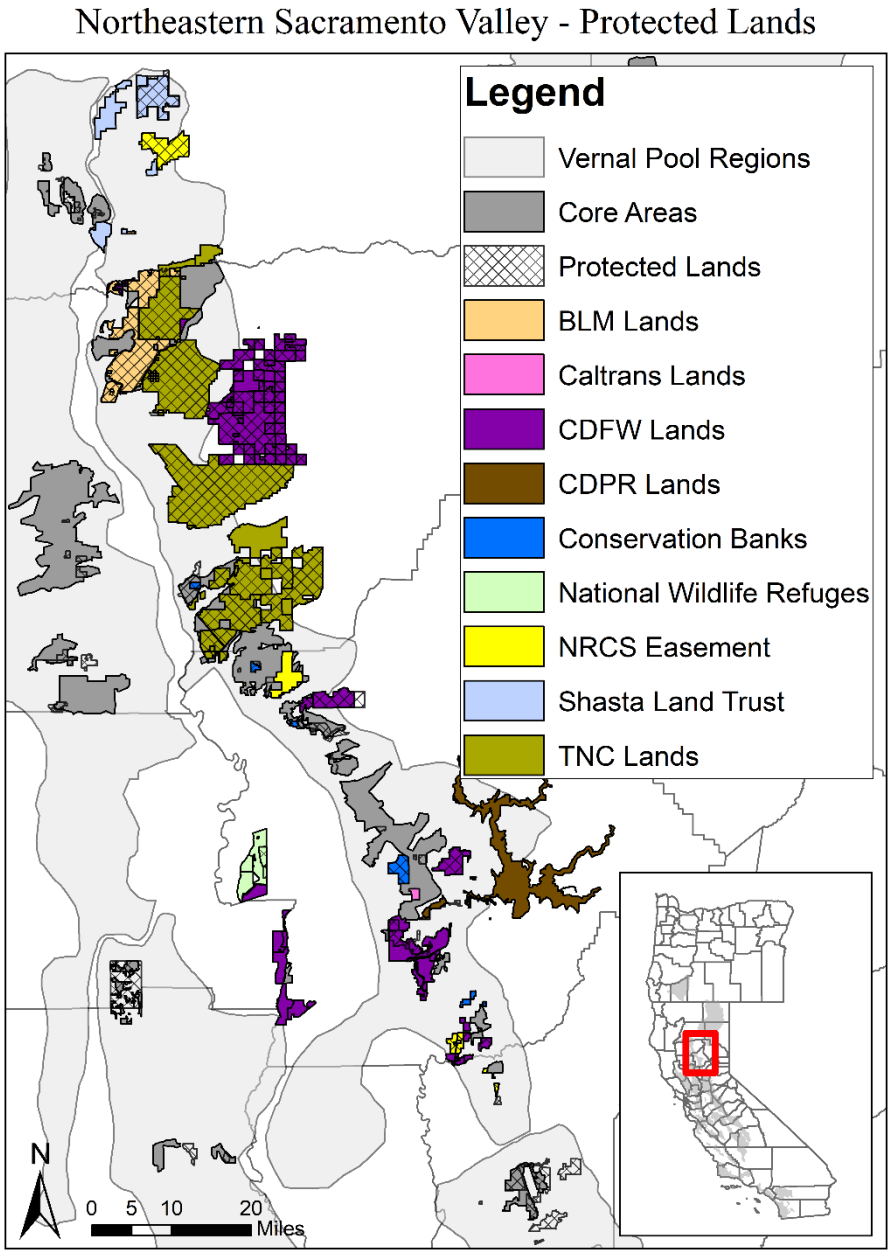


Figure 7.2. Map of protected areas that contain vernal pool grassland habitat and/or the three shrimp species within the Northeastern Sacramento Valley Vernal Pool Region**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. The suspended Shauna Downs Mitigation Bank is not pictured. Zoom in for finer resolution. BLM = Bureau of Land Management, CDFW = California Department of Fish and Wildlife, CDPR = California Department of Parks and Recreation, NRCS = Natural Resources Conservation Service, TNC = The Nature Conservancy.

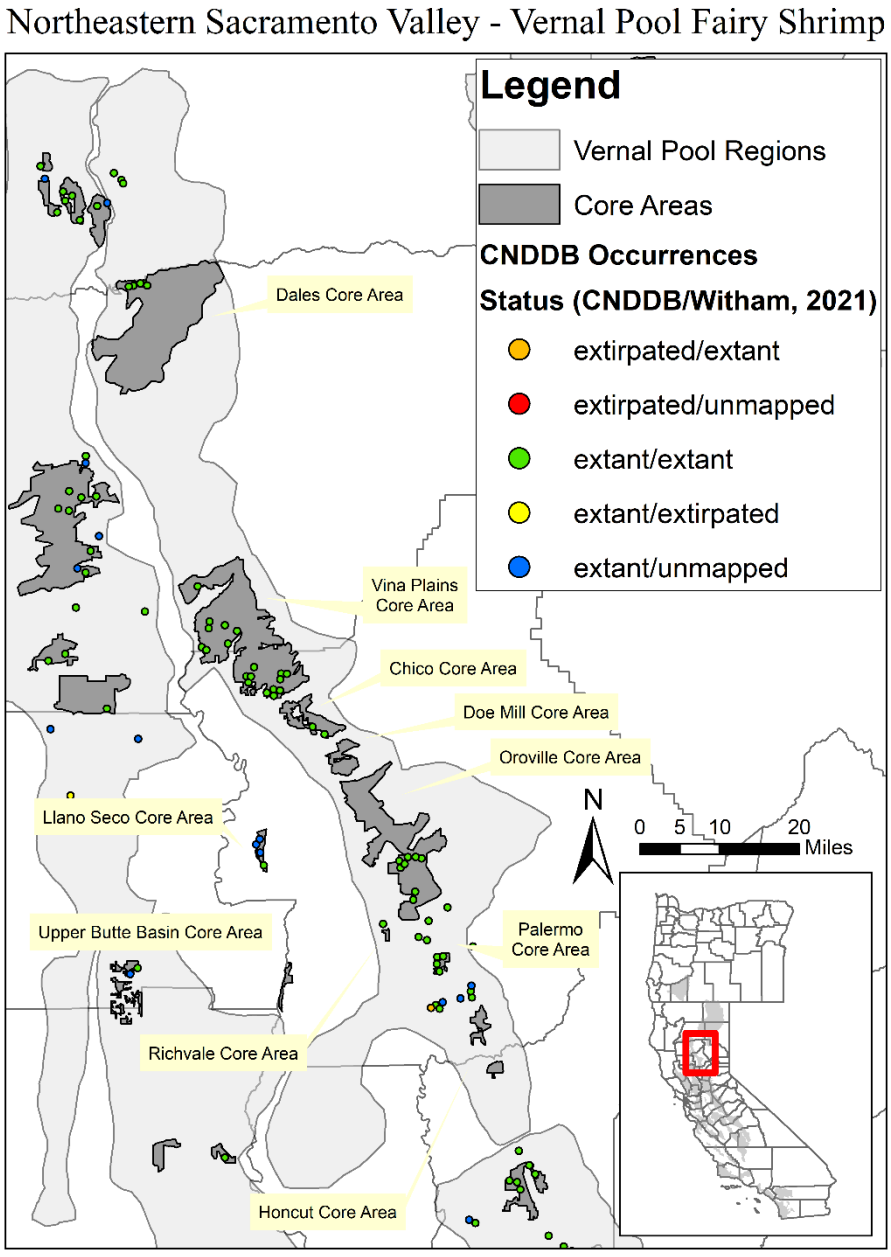


Figure 7.3. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) in the Northeastern Sacramento Valley Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both Diversity Database occurrence records and Witham's (2021) map of vernal pool habitat. All 10 core areas in the region are displayed, though not all core areas are designated for the vernal pool fairy shrimp.

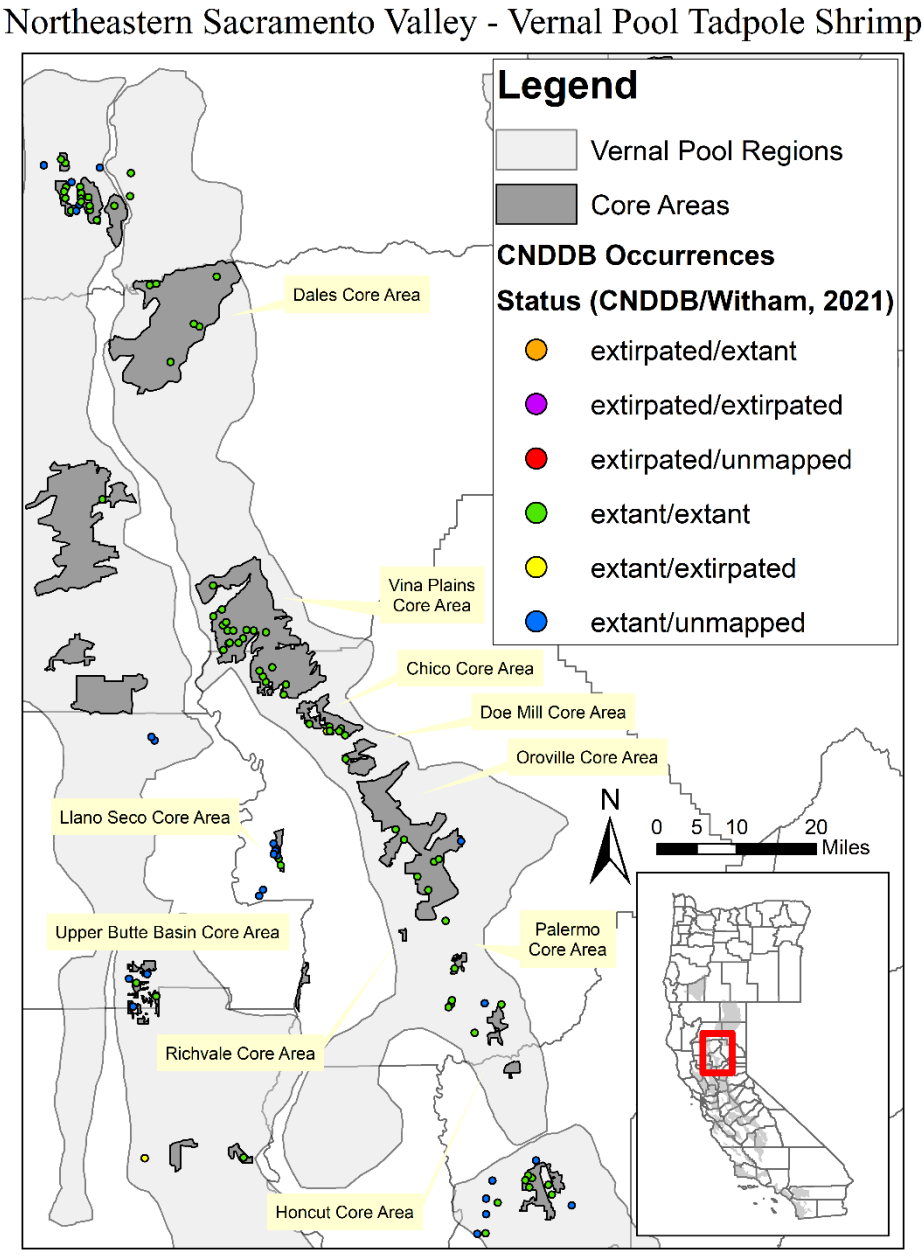


Figure 7.4. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) in the Northeastern Sacramento Valley Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both Diversity Database occurrence records and Witham's (2021) map of vernal pool habitat. All 10 core areas in the region are displayed, though not all core areas are designated for the vernal pool tadpole shrimp.

Table 7.1. Acreage of vernal pool habitat and habitat converted within the Northeastern Sacramento Valley Vernal Pool Region mapped by Witham (2021). All habitat labeled as not converted, altered, or new was considered extant. Protected acreage is based on Vollmar et al. (2017).

Core Area	2005 Acres	2018 Acres Total	2018 Acres Extant (% of Total)	2018 Acres Converted – Agriculture (% of Total)	2018 Acres Converted – Urban Development (% of Total)	2018 Acres Protected (% of Total)
Chico	3,153.8	3,153.8	2,933.3 (93.0%)	47.7 (1.5%)	172.9 (5.5%)	1,498.5 (47.5%)
Dales	19,161.2	19,161.2	19,161.2 (100.0%)	0.0 (0.0%)	0.0 (0.0%)	10,718.0 (55.9%)
Doe Mill	444.6	444.6	444.6 (100.0%)	0.0 (0.0%)	0.0 (0.0%)	35.5 (8.0%)
Llano Seco	0.0	107.2	107.2 (100.0%)	0.0 (0.0%)	0.0 (0.0%)	107.2 (100.0%)
Oroville	19,576.0	19,576.0	19,209.8 (98.1%)	334.7 (1.7%)	31.5 (0.2%)	2,799.3 (14.3%)
Palermo	841.1	841.1	648.6 (77.1%)	192.5 (22.9%)	0.0 (0.0%)	0.0 (0.0%)
Richvale	151.2	151.2	113.9 (75.4%)	37.3 (24.6%)	0.0 (0.0%)	18.5 (12.2%)
Vina Plains	34,594.1	34,594.1	34,134.9 (98.7%)	451.1 (1.3%)	8.0 (<0.1%)	16,196.5 (46.8%)
Northeastern Sacramento Valley Vernal Pool Region Total	**134,478.2**	**134,586.1**	**131,460.5 (97.7%)**	**2,802.9 (2.1%)**	**280.0 (0.2%)**	**43,717.5 (32.5%)**

Table 7.2. Acreage of vernal pool habitat losses within the Northeastern Sacramento Valley Vernal Pool Region between 2005 and 2018 mapped by Witham (2021), broken down by what the land use was converted to. All categories besides urban development and managed wetlands are considered agricultural conversions.

Core Area	Urban, Commercial, & Industrial	Orchards, Vineyards, Eucalyptus	Alfalfa and Irrigated Pasture	Bare Plowed Agricultural Lands	Other Ag (Rice, Row Crops, Dairy,	Agricultural Residential	Managed Wetlands	Total Losses	% Losses Urban Development	% Losses Agricultural Conversions
Chico	172.9	47.7	0.0	0.0	0.0	0.0	0.0	220.5	78.4%	21.6%
Dales	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Doe Mill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Llano Seco	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Oroville	31.5	194.1	0.0	0.0	121.0	19.7	0.0	366.2	8.6%	91.4%
Palermo	0.0	164.4	0.0	4.7	12.6	10.8	0.0	192.5	0.0%	100.0%
Richvale	0.0	0.0	0.0	37.3	0.0	0.0	0.0	37.3	0.0%	100.0%
Vina Plains	8.0	196.8	2.9	201.3	0.0	50.2	0.0	459.1	1.7%	98.3%
Northeastern Sacramento Valley Vernal Pool Region Total	**280.0**	**861.3**	**3.3**	**1124.3**	**634.0**	**180.0**	**42.6**	**3,125.6**	**9.0%**	**89.7%**

7.2.3. Conservancy Fairy Shrimp

There are 13 occurrence records of the Conservancy fairy shrimp documented within the Northeastern Sacramento Valley Vernal Pool Region in the Diversity Database (Diversity Database 2022). These occurrences are all considered part of the Vina Plains population and are within the Vina Plains Core Area. All are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). See the Vina Plains Core Area section for more details.

7.3. Federal Lands

7.3.1. National Wildlife Refuges

Within the Northeastern Sacramento Valley Vernal Pool Region, the vernal pool fairy shrimp and vernal pool tadpole shrimp are known to occur on the North Central Valley Wildlife Management Area, which is part of the Sacramento National Wildlife Refuge Complex (**Figure 7.2**). There are no National Wildlife Refuges with known occurrences of the Conservancy fairy shrimp within this region.

The primary purpose of the Refuge Complex is to maintain managed wetlands that support habitat for birds on the Pacific Flyway, but there are also many other habitats such as vernal pool grasslands throughout the complex given that they are some of the last large areas of undeveloped lands in an otherwise agricultural landscape. A Comprehensive Conservation Plan was prepared for the North Central Valley Wildlife Management Area, and two other wildlife management areas, in 2019 that included the vernal pool fairy shrimp and vernal pool tadpole shrimp (Service 2020c).

There are approximately 404 acres of vernal pool grassland, including 13 acres of vernal pools, on the Service-owned Llano Seco Unit of the Wildlife Management Area (not to be confused with the surrounding CDFW-owned “Llano Seco Unit” of the Upper Butte Basin Wildlife Area or the privately-owned “Llano Seco Ranch” which has a Service-held conservation easement on it) (Service 2020c). The vernal pools occur primarily within Sanctuary II (the eastern unit of the Llano Seco Unit); the western half of Sanctuary II has grasslands with vernal pools, while the eastern half contains seasonal wetlands that are managed for migratory birds. The Comprehensive Conservation Plan includes a variety of goals and management strategies related to enhancing and managing the vernal pool grasslands, including vegetation management, population monitoring, and research (Service 2020c). Information about the vernal pools from past survey efforts, in conjunction with basic soil inventory data, was used to restore vernal pool topography and hydrology at Llano Seco Unit, Sanctuary II, Tract 17 (Service 2020c). Vernal pools also occur on the Llano Seco Ranch conservation easement. Sanctuary II of the Llano Seco Unit is mostly within the Llano Seco Core Area, and the adjacent Llano Seco Ranch conservation easement is also partly within the Llano Seco Core Area.

Based on 11 years of survey data collected between 1993 and 2017, the vernal pool fairy shrimp was observed once in 1 of the 15 vernal pools within Sanctuary II of the Llano Seco Unit in 1994 and once in a restored vernal pool within Tract 17 in 2017 (Helm Biological Consulting 2017; M. D’Errico, Service, *in litt*. 2022). Based on that same survey data, the vernal pool tadpole

shrimp was observed once in 1 of the 15 vernal pools within Sanctuary II of the Llano Seco Unit in 1994, once in a restored vernal pool within Tract 17 in 2015, and three times in a different restored vernal pool within Tract 17 in 2013, 2015, and 2017 (Helm Biological Consulting 2017; M. D'Errico, Service, *in litt*. 2022). There are also two vernal pool fairy shrimp Diversity Database records on the adjacent North Slough Pasture of the Llano Seco Ranch conservation easement area, one from 1994 and one from 2004 .There are also four vernal pool tadpole shrimp Diversity Database records on the adjacent North Slough Pasture of the Llano Seco Ranch conservation easement area and two records on the southwestern portion of the Llano Seco Rancho conservation easement area that have all been observed multiple times between 1993 and 2010 (Diversity Database 2022). The Llano Seco Ranch conservation easement has not been surveyed for the three shrimp species since 2004 (D'Errico, *in litt*. 2022).

7.3.2. Military Lands

There are no military lands with known occurrences of the three shrimp species within the Northeastern Sacramento Valley Vernal Pool Region.

7.3.3. Bureau of Land Management

The Bureau of Land Management's (BLM) Sacramento River Bend area is located on the east side of the Sacramento River north of the City of Red Bluff within the Dales Core Area (**Figure 7.2**). BLM recently completed a multi-year effort to survey and map all vernal pools within the Sacramento River Bend area. There were 149 pools throughout the Sacramento River Bend area, 9 of which were occupied by the vernal pool fairy shrimp (BLM 2017b; BLM 2018; BLM 2019b). All nine of these pools were near the Spring Branch Road target shooting area adjacent to Battle Creek, and seven of the nine pools were classified as artificially created stock ponds and not natural vernal pools. Within the same 149 pools, 8 were occupied by the vernal pool tadpole shrimp (BLM 2017b; BLM 2018; BLM 2019b). Six of the eight pools were near the Spring Branch Road target shooting area adjacent to Battle Creek and were classified as artificially created stock ponds and not natural vernal pools. The other two were in the Hog Lake and Nordic Quarry areas to the southeast and were classified as modified ponds/vernal pools. There is no vernal pool management plan for the Sacramento River Bend area, though the BLM's Redding Field Office, which covers Butte, Tehama, Shasta, Trinity, and Siskiyou Counties, is currently revising its Resource Management Plan, which mentions vernal pools as an important resource that needs protection (S. Laymon, BLM, *in litt*. 2022).

There are several other small parcels of BLM land, likely grazing allotments, throughout this Vernal Pool Region that have vernal pool grasslands mapped within them (Witham 2021), but there are no known occurrences of the vernal pool fairy shrimp or the vernal pool tadpole shrimp within them (Diversity Database 2022).

There are no BLM lands with known occurrences of the Conservancy fairy shrimp within the Northeastern Sacramento Valley Vernal Pool Region.

7.3.4. Other Federal Lands

There are no other federal lands with known occurrences of the three shrimp species within the Northeastern Sacramento Valley Vernal Pool Region.

7.4. Conservation Banks

There are five conservation or mitigation banks within the Northeastern Sacramento Valley Vernal Pool Region that provide credits for preserved and/or created vernal pools that support the vernal pool fairy shrimp and vernal pool tadpole shrimp: Daley Ranch Vernal Pool Conservation Bank, Dove Ridge, Hamilton Ranch, Meridian Ranch, and Shauna Downs (see **Figure 7.2**; RIBITS 2021), though Shauna Downs has been suspended. These banks protect a total of 4,204 acres of land, including 434.9 acres and 424.9 acres of preserved vernal pools for the vernal pool fairy shrimp and vernal pool tadpole shrimp, respectively, and 31.3 acres of created vernal pools for both shrimp species (Table 6 shows 639.2 and 329.2 preservation credits for the vernal pool fairy shrimp and vernal pool tadpole shrimp, respectively, because Dove Ridge Conservation Bank received 2 credits for every 1 acre of preserved habitat). This region has the third largest number of preservation credits and total acreage of banks, and it is one of only three regions that has creation credits for the vernal pool fairy shrimp and vernal pool tadpole shrimp, though other regions may have artificial vernal pools created outside of banks. The five banks have sold a total of 209.39 preservation credits (33% and 49%, respectively), representing 130.18 acres, and 23.96 acres (76% and 76%, respectively) of creation credits for the vernal pool fairy shrimp and vernal pool tadpole shrimp (RIBITS 2021). None of the 31.03 preservation credits for the vernal pool fairy shrimp or the 20.98 preservation credits for the vernal pool tadpole shrimp were sold at the suspended Shauna Downs Mitigation Bank. There is also one proposed bank within this region, the Sycamore Creek Conservation Bank, which may be approved within the next year (**Figure 7.2**).

One of these conservation banks also provides credits for preserved vernal pools that support the Conservancy fairy shrimp: Hamilton Ranch (RIBITS 2021). This bank protects a total of 394 acres of land, including 20.37 acres of preserved vernal pools for the Conservancy fairy shrimp. The Conservancy fairy shrimp was observed on the site in three large vernal pools, known as the Laniger Lakes, in 2003 (Diversity Database 2022) and was most recently observed during regular bank monitoring in 2020 within 2 of the 22 pools that ponded water (Gallaway Enterprises 2020).

The Meridian Ranch Mitigation Bank also supports the Conservancy fairy shrimp, though it does not sell any preservation or creation credits for the species. This bank is 530 acres and contains 55.51 acres of preserved vernal pools and 31.34 acres of created/restored vernal pools for the vernal pool fairy shrimp and vernal pool tadpole shrimp (RIBITS 2021). The Conservancy fairy shrimp has been found in three restored pools on the bank and was observed during surveys in 2012, 2015, and 2016, but not in 2018 (Westervelt Ecological Services 2019a). It was also observed on the adjacent Meridian Preserve mitigation site (a.k.a., Palermo Vernal Pool Restoration Project) in 2009, 2011, 2013, and 2016, but not in 2018 (Westervelt Ecological Services 2019a).

7.5. Habitat Conservation Plans

There is one regional Habitat Conservation Plan (HCP) within the Northeastern Sacramento Valley Vernal Pool Region that includes all three shrimp species as Covered Species.

7.5.1. PG&E Multiple Region Operations and Maintenance HCP

See section 2.5.1 for a description of this HCP.

7.6. Other Preserves

The California Department of Water Resources (DWR) operates the Oroville and Thermalito Dams along the Feather River and owns much of the surrounding lands. The Service issued a biological opinion on the proposed issuance of a Federal Energy Regulatory Commission (FERC) license to DWR for the Oroville facilities on April 9, 2007 (Service 2007b). This biological opinion documented the environmental baseline within the FERC boundary as 72.3 wetted acres of vernal pools and swales, and it stated that take would not exceed 9.5 acres of vernal pools prior to the end of the 50-year FERC license term. CDFW manages the Oroville Wildlife Area, which consists of the Thermalito Afterbay and adjacent portions of the Feather River, and the Thermalito Forebay is within the Lake Oroville State Recreation Area managed by California Department of Parks and Recreation (CDPR). The Oroville Wildlife Area is immediately adjacent to the Oroville, Richvale, and Palermo Core Areas. Most of the vernal pools within the FERC boundary are within Oroville Wildlife Area, but there are some vernal pools outside of the Wildlife Area around Thermalito Forebay as well (R. Carter-Ervin, DWR, *in litt*. 2022). DWR monitors all vernal pools within the FERC boundary to ensure compliance with the biological opinion, but they do not survey for shrimp species; however, pools are occasionally inspected visually, and DWR staff recall seeing vernal pool tadpole shrimp in some pools within the past 10 years (R. Carter-Ervin and K. Moncrief, DWR, pers. comm. 2022). There are nine Diversity Database occurrences of the vernal pool fairy shrimp and two Diversity Database occurrences of the vernal pool tadpole shrimp immediately outside of the FERC boundary. Recent management activities included controlled burns for invasive grasses, but no grazing or other weed management is currently being implemented (Carter-Ervin and Moncrief, pers. comm. 2022).

In addition to the Lake Oroville State Recreation Area, the vernal pool fairy shrimp is also known to occur on CDPR land within the Clay Pit State Vehicular Recreation Area. CDPR is currently preparing a Wildlife Habitat Protection Plan for this area, which includes monitoring for vernal pool fairy shrimp (CDPR 2022a). There are approximately 26 acres of vernal pools within Clay Pit, and despite the disturbance to the pools from off-road vehicles the vernal pool fairy shrimp has consistently been documented within the pools (CDPR 2022a). Potential habitat for the vernal pool tadpole shrimp is also known to occur within the Clay Pit State Vehicular Recreation Area, with the nearest known occurrence of the vernal pool tadpole shrimp is 1.5 miles north.

In addition to the Oroville Wildlife Area, CDFW owns five other preserved areas within this Vernal Pool Region with vernal pool habitat: Dales Lake Ecological Reserve, North Table Mountain Ecological Reserve, Stone Ridge Ecological Reserve, Battle Creek Wildlife Area, Tehama Wildlife Area, and Upper Butte Basin Wildlife Area. CDFW also holds conservation easements on properties around Musty Buck Ridge, Honcut Creek, and Wyandott Creek. The vernal pool fairy shrimp is not known to occur on any of these properties, though it has a high potential to occur on the Dales Lake Ecological Reserve and the Upper Butte Basin Wildlife

Area. The vernal pool tadpole shrimp is only known to occur on the Dales Lake Ecological Reserve, though it has a high potential to occur on the Upper Butte Basin Wildlife Area as well.

The Dales Lake Ecological Reserve is 367 acres located east of BLM's Sacramento River Bend Area and the Inks Creek Ranch. The Ecological Reserve consists of the 17-acre Dales Lake, three sets of constructed vernal pools, and an artificial "pool" which is an old borrow pit (R. Lis, CDFW, *in litt*. 2023). The entire Reserve was mapped as vernal pool grassland habitat by Witham's (2021) mapping efforts. The vernal pool fairy shrimp has never been documented within the Ecological Reserve; however, the vernal pool tadpole shrimp has been observed in all five of these aquatic features in the past, as well as the California fairy shrimp (*Linderiella occidentalis*) (Diversity Database 2022; Lis, *in litt*. 2023). More recently, Dales Lake and the borrow pit consistently fill with water for long enough to support the vernal pool tadpole shrimp's lifecycle, but only a few of the created pools do. However, vernal pool tadpole shrimp carapaces were observed along the edge of one created pool in 2021 and 2022, so some of the created pools may still support the species (Lis, *in litt*. 2023). The nearest known occurrence of the vernal pool fairy shrimp is 6 miles to the northwest in BLM's Sacramento River Bend area (Diversity Database 2022). There is no management plan for the Ecological Reserve (Lis, *in litt*. 2023).

The Upper Butte Basin Wildlife Area totals 9,597 acres along Upper Butte Creek east of the Sacramento River in Butte and Glenn Counties and is divided into three management units: Llano Seco, Howard Slough, and Little Dry Creek (ESA Associates 2013). Vernal pools only occur in field 312 of the Llano Seco Unit (ESA Associates 2013), which is immediately south of the Service's Llano Seco Unit of the North Central Valley Wildlife Management Area, though this habitat was not captured by Witham's (2021) mapping efforts. Surveys for the vernal pool fairy shrimp and vernal pool tadpole shrimp have not been conducted, but both species are known from the adjacent pools on the Service's Llano Seco Unit. The management plan for Upper Butte Basin Wildlife Area includes maintaining, enhancing, and/or restoring vernal pools, using appropriate management techniques for vernal pools such as grazing or controlled burns, and surveying for vernal pool shrimp species (ESA Associates 2013). The Little Dry Creek Unit is the only unit that is actually within the boundaries of the Northeastern Sacramento Valley Vernal Pool Region delineated by the Recovery Plan, as well as the Upper Butte Basin Core Area, but neither the management plan nor Witham's (2021) mapping efforts identified any vernal pool habitat within the Little Dry Creek Unit.

The North Table Mountain Ecological Reserve is 3,315 acres located north of the city of Oroville and has a management plan with the primary purpose of preserving the Northern Basalt Flow Vernal Pool habitat type and sensitive species (ESA Associates 2007). Witham (2021) mapped 2,188 acres of vernal pool grasslands within the Ecological Reserve, though the management plan states that vernal pools are restricted to the Cherotable-Kramn soil complex that covers 407 acres on the top of North Table Mountain (ESA 2007).

The Stone Ridge Ecological Reserve is 754 acres located east of the Chico Airport. About half of the Ecological Reserve is mapped as vernal pool grassland by Witham (2021) and a total of 6.6 acres of vernal pools and swales occur on the property (M. Stanfield, CDFW, *in litt*. 2022), though some do occur on the eastern half of the property that Witham (2021) did not map vernal pool grassland. A draft management plan states that there is potential for the vernal pool fairy

shrimp and the vernal pool tadpole shrimp to occur on the Ecological Reserve (Stanfield, *in litt*. 2022). However, surveys in January 2023 did not find the vernal pool fairy shrimp or the vernal pool tadpole shrimp; despite a large amount of rain, there were only five features onsite that had ponded, leading the CDFW biologist to speculate that the Ecological Reserve may be too steeply sloped to support appropriate hydrology for the vernal pool fairy shrimp or the vernal pool tadpole shrimp (M. Stanfield, CDFW, *in litt*. 2023). The Ecological Reserve is adjacent to the 3,885-acre Musty Buck Ridge property which has a conservation easement held by CDFW (Stanfield, *in litt*. 2022), though only a very small amount of the western edge of this property is estimated to contain vernal pool habitat (Witham 2021).

The Battle Creek Wildlife Area is 582 acres located adjacent to the north side of BLM's Sacramento River Bend Area. Only a small amount of vernal pool habitat is estimated to occur there (Witham 2021), but it is adjacent to the vernal pools occupied by the vernal pool fairy shrimp and the vernal pool tadpole shrimp in the Sacramento River Bend Area. The vernal pools occur on the bluff overlooking Battle Creek, but these pools are quite shallow, barely support vernal pool flora, and have not contained the vernal pool fairy shrimp or vernal pool tadpole shrimp when surveyed by CDFW in the past (Lis, *in litt*. 2023).

The Tehama Wildlife Area is 44,500 acres located between the Sacramento River Bend Area and Lassen National Forest. Again, only a small area is estimated to contain vernal pool habitat (Witham 2021). The Honcut Creek and Wyandott Creek conservation easements are both made up of multiple parcels, with one parcel each that contains vernal pool grassland based on Witham's (2021) mapping efforts. The Honcut Creek easement protects 275 acres of extant vernal pool grassland, about half of which is within the Honcut Core Area, and the Wyandott Creek easement protects 80 acres of extant vernal pool grassland (Witham 2021).

The Nature Conservancy (TNC) owns the Vina Plains Preserve, manages the Dye Creek Preserve, and holds easements on Inks Creek Ranch, Battle Creek, Deer Creek, Mill Creek, and Vina Plains. The Vina Plains Preserve is 4,591 acres located on either side of Highway 99 at the Butte-Tehama County border within the Vina Plains Core Area. Almost the entirety of the preserve is mapped as vernal pool grassland by Witham (2021). There are two Diversity Database occurrences of the vernal pool fairy shrimp within the Preserve and four more which are on the border of the Preserve and may or may not extend into the Preserve (Diversity Database 2022). There are nine Diversity Database occurrences of the vernal pool tadpole shrimp partially or entirely within the Preserve (Diversity Database 2022). There are four Diversity Database occurrences of the Conservancy fairy shrimp within the Preserve and one more which is on the border of the Preserve and may or may not extend into the Preserve (Diversity Database 2022). The management plan for the site identifies grazing as the main management tool, and vernal pool shrimp surveys are planned to occur every five years (TNC 2020).

Northeast of the Vina Plains Preserve are two large conservation easements held by TNC: the 21,015-acre Vina Plains easement and the 25,629 Deer Creek easement. About half of the Vina Plains easement is vernal pool grassland and only a small part of the Deer Creek easement contains vernal pool grasslands (Witham 2021). There is one Diversity Database occurrence of the vernal pool fairy shrimp within the Vina Plains easement and two that border it, Six Diversity Database occurrences of the vernal pool tadpole shrimp partially or entirely within the Vina Plains easement, and one Diversity Database occurrence of the Conservancy fairy shrimp along

the border of the Vina Plains easement and the Vina Plains Preserve (Diversity Database 2022). There are no occurrences of the three shrimp species within the Deer Creek easement (Diversity Database 2022).

The Dye Creek Preserve is 37,540 acres located east of Highway 99 and south of CDFW's Tehama Wildlife Area. It is owned in trust by Exchange Bank, managed by TNC, and TNC reports to the State Controllers Office (A. Craig, TNC, pers. comm. 2022). Witham (2021) mapped an extensive area of presumed vernal pool grassland on the western side of the Preserve. The Preserve's management plan estimated only 10 wetted acres of vernal pools and swales, with much of the other mapped areas being only annual grassland (H.T. Harvey and Associates 2019b), but a focused survey effort in 2020-2021 found vernal pools throughout the entirety of the western side of the preserve (Kramer Botanical 2021), as predicted by Witham (2021). A total of 134 vernal pools were identified, 39 of which were natural and 95 of which were altered, primarily associated with canal levees and road berms (Kramer Botanical 2021). The vernal pool fairy shrimp is known to occur in the southern plains near Mill Creek and is presumed to occur in the vernal pool habitat throughout the western plains (H.T. Harvey and Associates 2019b; S. Wingo, Service, *in litt*. 2022). The vernal pool tadpole shrimp is not known to occur on the preserve, though it is possible as suitable habitat is present (H.T. Harvey and Associates 2019b). Grazing is used to manage the vernal pool grasslands, as well as occasional prescribed fires, and there is the potential for vernal pool restoration to occur on the southern plains (H.T. Harvey and Associates 2019b). The Mill Creek conservation easement borders the Dye Creek Preserve to the south, which is adjacent to the known vernal pool fairy shrimp occurrences on Dye Creek Preserve.

The 36,085-acre Inks Creek Ranch conservation easement is located east of BLM's Sacramento River Bend Area. Witham's (2021) mapping efforts estimated 6,951 acres of vernal pool grassland within the Inks Creek Ranch easement area. There are no known occurrences of the vernal pool fairy shrimp within this area, but the vernal pool tadpole shrimp is known from one pool near the border with the Dales Lake Ecological Reserve, and another occurrence is located just east of Hog Lake on BLM land, though it is unclear if this occurrence is on BLM land or on Inks Creek Ranch (Diversity Database 2022).

A 3,002-acre portion of the Battle Creek conservation easement is located northeast of the Sacramento River Bend Area (other portions are located further west, outside of the Vernal Pool Region). Witham's (2021) mapping efforts estimated 149 acres of vernal pool grassland within the Battle Creek easement area. There are no known occurrences of the three shrimp species within this area (Diversity Database 2022).

The California Department of Transportation (Caltrans) acquired and preserved the Cottonwood Creek Conservation Area north of the City of Oroville in 2008 as advanced mitigation to mitigate for future Caltrans projects with adverse effects to vernal pool species. The Butte County Resource Conservation District holds the conservation easement on the preserve. The preserve is 574 acres of vernal pool grassland complex, with 91.08 acres authorized as vernal pool preservation credits for the vernal pool fairy shrimp and vernal pool tadpole shrimp; to date, 34.86 acres of the preservation credits have been used by local Caltrans projects (Butte County Resource Conservation District 2020). The vernal pool fairy shrimp is known to occur

throughout the preserve and the vernal pool tadpole shrimp is known to occur in the northwest corner of the preserve (Diversity Database 2022).

The Shasta Land Trust holds conservation easements over five properties in this region that have vernal pool grasslands mapped by Witham (2021): Fenwood Ranch, Bear Creek Nature Preserve (a.k.a., Blue Oak Ranch), Rickert Brothers Ranch, Triple B Ranch, and Hathaway Ranch. The former three properties are verified by Shasta Land Trust to have vernal pool habitat onsite, while the latter two properties have wetland features, but not distinctively vernal pool habitat (T. Blevins, Shasta Land Trust, *in litt*. 2022). There are no specific management plans for these properties, and species monitoring is not typically conducted (Blevins, *in litt*. 2022). However, surveys were conducted at the Bear Creek Nature Preserve in 2018; the California fairy shrimp (*Linderiella occidentalis*) was identified within the four vernal pools onsite, but the vernal pool fairy shrimp and vernal pool tadpole shrimp were not (Blevins, *in litt*. 2022). These five properties total 14,637 acres in size, though most of the Fenwood Ranch property is within the Northwestern Sacramento Valley Vernal Pool Region. Only the Hathaway Ranch was included in Vollmar et al.'s (2017) database of protected lands; thus, an additional 1,864 acres of vernal pool habitat mapped by Witham (2021) is estimated to be protected in the Northeastern Sacramento Valley Vernal Pool Region within the other four properties.

In addition to the many protected areas described here, Vollmar et al. (2017) identified 16 other protected properties within the Northeastern Sacramento Valley Vernal Pool Region. The majority of these sites are private preserves that were protected as mitigation by landowners, likely as part of proposed conservation measures during Section 7 interagency consultations. There are also six properties that have a conservation easement held by the Natural Resources Conservation Service (NRCS) including the 4,273-acre Lowe property, one property owned by the California State University system, and one additional area that Vollmar et al. (2017) identify as having a TNC-held conservation easement despite not being included in TNC's GIS layer. All 16 of these protected properties may contain suitable habitat for the vernal pool fairy shrimp and vernal pool tadpole shrimp. Seven of these protected properties are within the Vina Plains Core Area and therefore may also contain suitable habitat for the Conservancy fairy shrimp.

7.7. Vernal Pool Core Areas

There are five Core Areas within the Northeastern Sacramento Valley Vernal Pool Region that are designated in the Recovery Plan for the vernal pool fairy shrimp: Chico, Doe Mill, Llano Seco, Oroville, Vina Plains. There are also three additional Core Areas that were not designated for the vernal pool fairy shrimp in the Recovery Plan, but that have known occurrences of the species in the Diversity Database: Dales, Palermo, and Richvale (Diversity Database 2022). For the Palermo Core Area, the vernal pool fairy shrimp was not identified until 2007, which is why this core area was not designated for the vernal pool fairy shrimp in the Recovery Plan. For the Dales and Richvale Core Areas, there was one Diversity Database occurrence per core area that was known prior to 2005, so the two core areas likely should have been designated for the vernal pool fairy shrimp in the Recovery Plan. One of the eight core areas has met the target of 85% of vernal pool habitat protected and two have lost more than 15% of the amount of vernal pool habitat that remained in 2005, making the 85% target unattainable without habitat creation or restoration (see **Table 7.1**; Vollmar et al. 2017; Witham 2021).

There are six Core Areas within the Northeastern Sacramento Valley Vernal Pool Region that are designated in the Recovery Plan for the vernal pool tadpole shrimp: Chico, Dales, Doe Mill, Llano Seco, Oroville, and Vina Plains. There is also one additional Core Area that was not designated for the vernal pool tadpole shrimp in the Recovery Plan, but that has known occurrences of the species in the Diversity Database: Palermo (Diversity Database 2022). For the Palermo Core Area, the vernal pool tadpole shrimp was not identified until 2008, which is why this core area was not designated for the vernal pool tadpole shrimp in the Recovery Plan. One of the eight core areas has met the target of vernal pool habitat protected (95% for zone 1) and one has lost more than 15% of the amount of vernal pool habitat that remained in 2005, making the target (85% for zone 2) unattainable without habitat creation or restoration (see **Table 7.1**; Vollmar et al. 2017; Witham 2021).

There is one Core Area within the Northeastern Sacramento Valley Vernal Pool Region that is designated in the Recovery Plan for the Conservancy fairy shrimp: Vina Plains. This core area has not yet met the target of 95% of vernal pool habitat protected, but as of 2018 it had only lost 1.3% of the baseline level of habitat that was present in 2005 (see **Table 7.1**; Vollmar et al. 2017; Witham 2021).

7.7.1. Chico

This is a zone 1 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and 95% of vernal pool habitat for the vernal pool tadpole shrimp. The core area is located around the northeastern edge of the City of Chico in Butte County.

There were approximately 3,154 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 2,933 acres of vernal pool grassland remaining, with 221 acres lost since 2005 (see **Figure 7.5**, **Table 7.1**; Witham 2021). Unlike most other habitat losses, the majority of habitat losses within this core area were due to urban development (172.9 acres, 78.4%), which makes sense given the urban setting of the core area (see **Table 7.2**; Witham 2021). All agricultural habitat losses (47.7 acres, 21.6%) were caused by conversion to orchards. Roughly 1,499 acres of vernal pool grassland were protected within this core area as of 2017 (Vollmar et al. 2017), representing 47.5% of the 2005 baseline.

The human population of Chico was 101,475 in 2020, growing 17.7% from 2010 to 2020 after having already grown by over 40% per decade for the three decades prior (U.S. Census Bureau 2022). Due to the Camp Fire wildfire from the nearby town of Paradise in 2018, Chico's population increased by 18,040 people (19.5%) from 2018 to 2019 alone (City of Chico 2022). Residential housing continues to be a need in Chico (City of Chico 2022), and therefore urbanization will likely continue to be a significant cause of habitat loss within this core area.

Protected areas within this core area include CDFW's Stone Ridge Ecological Reserve and several areas owned by the City of Chico, including the Sycamore Glen Wetland Preserve, which was preserved as mitigation for a section 7 consultation (**Figure 7.6**). The proposed Sycamore Creek Conservation Bank is also within this core area.

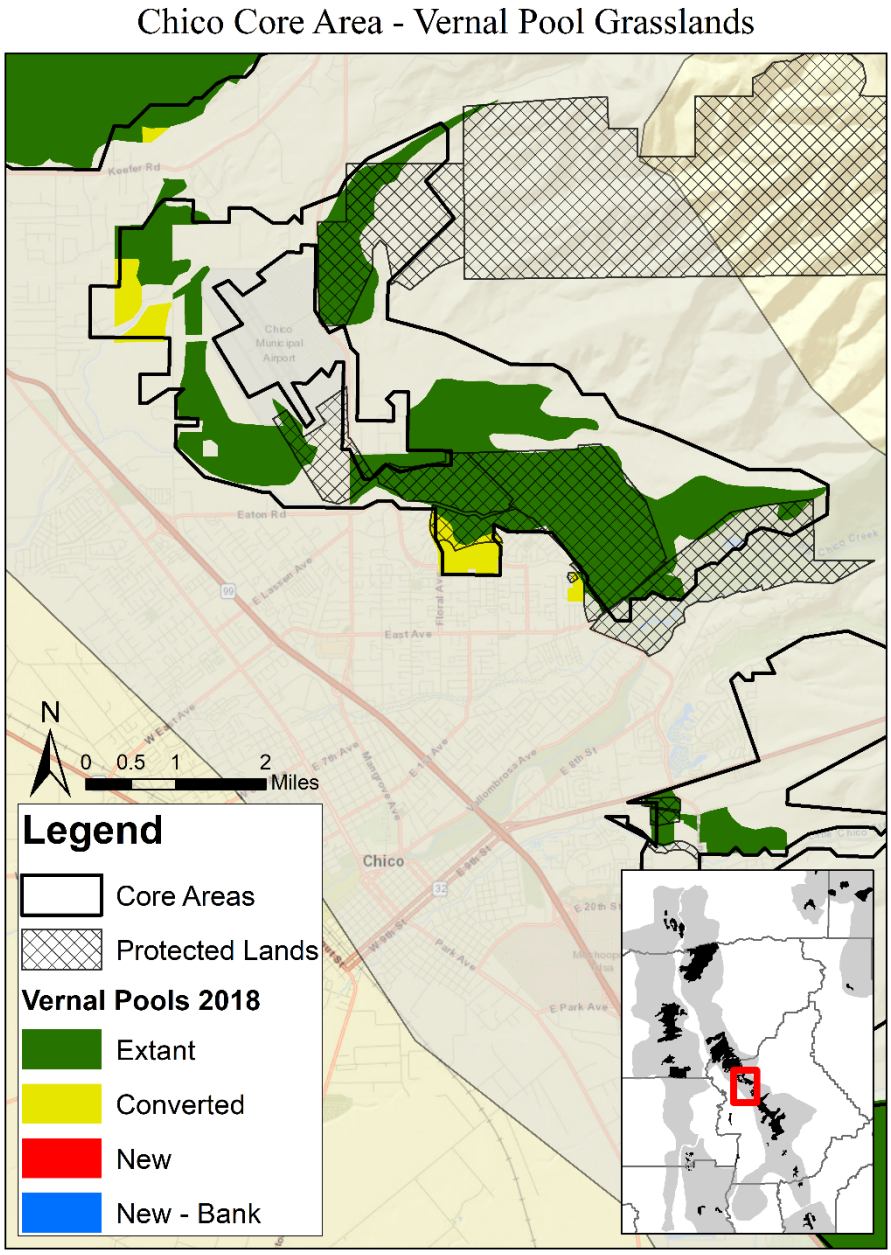


Figure 7.5. Map of vernal pool grassland habitat within the Chico Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

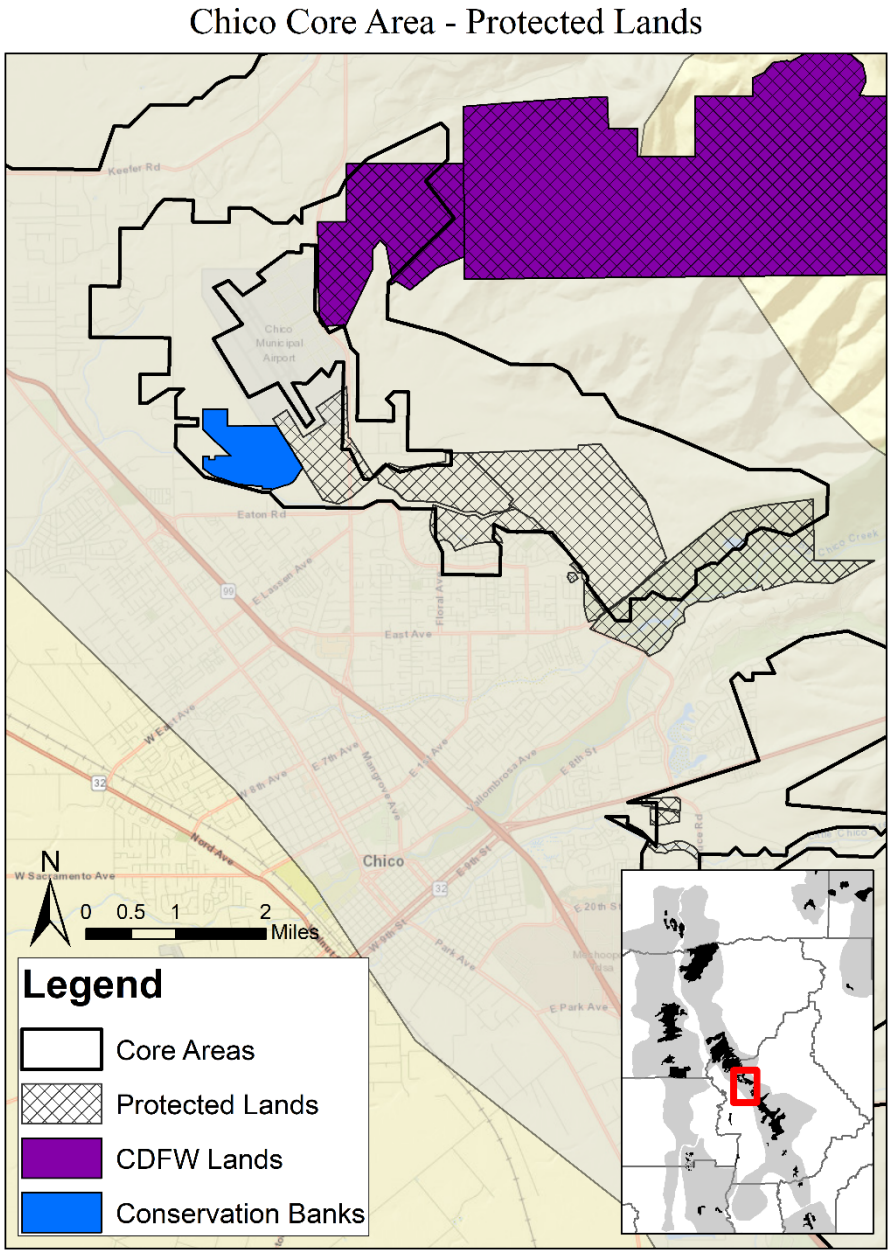


Figure 7.6. Map of protected areas within the Chico Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. The conservation bank depicted is the proposed Sycamore Creek Conservation Bank, which has not yet been approved by the Service. CDFW = California Department of Fish and Wildlife.

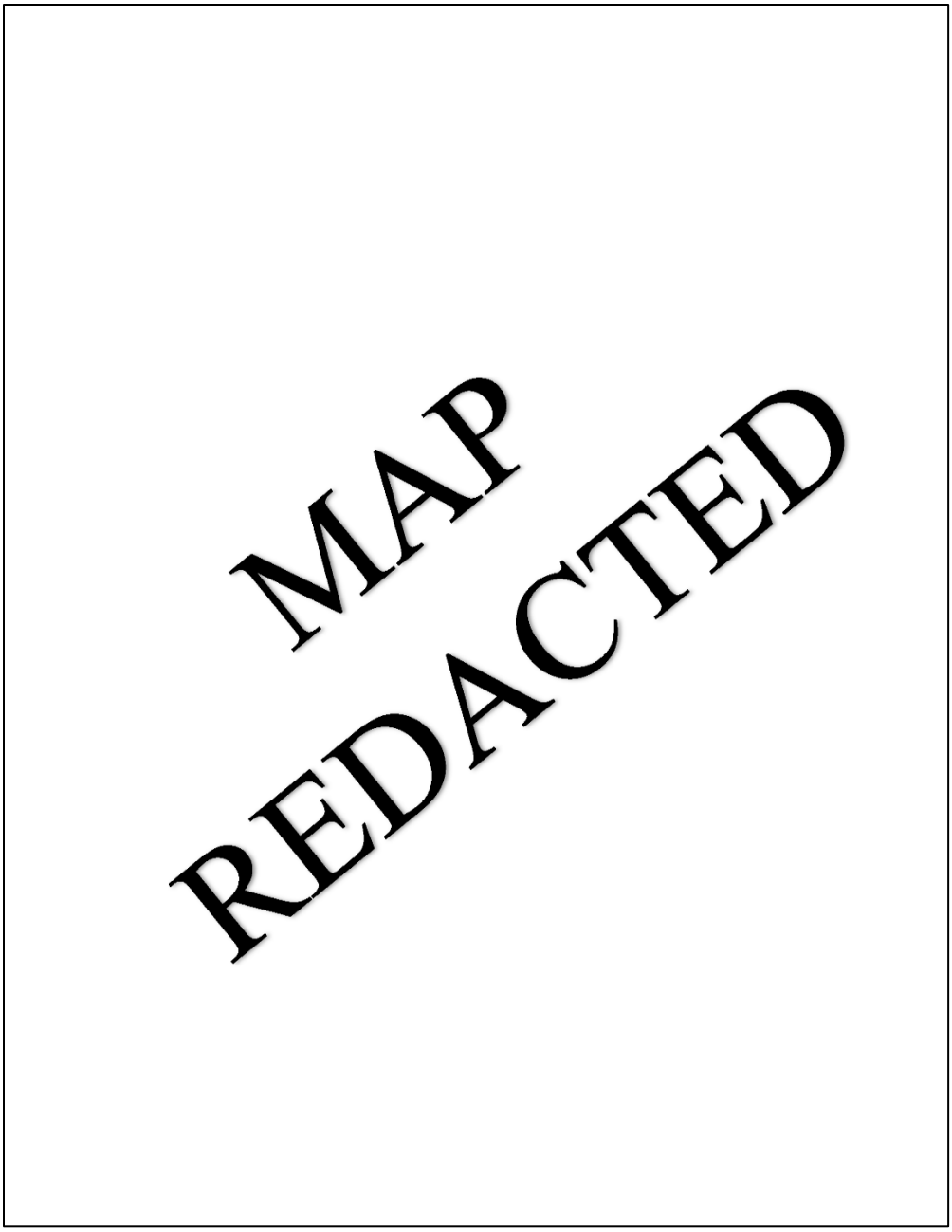


Figure 7.7. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Chico Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

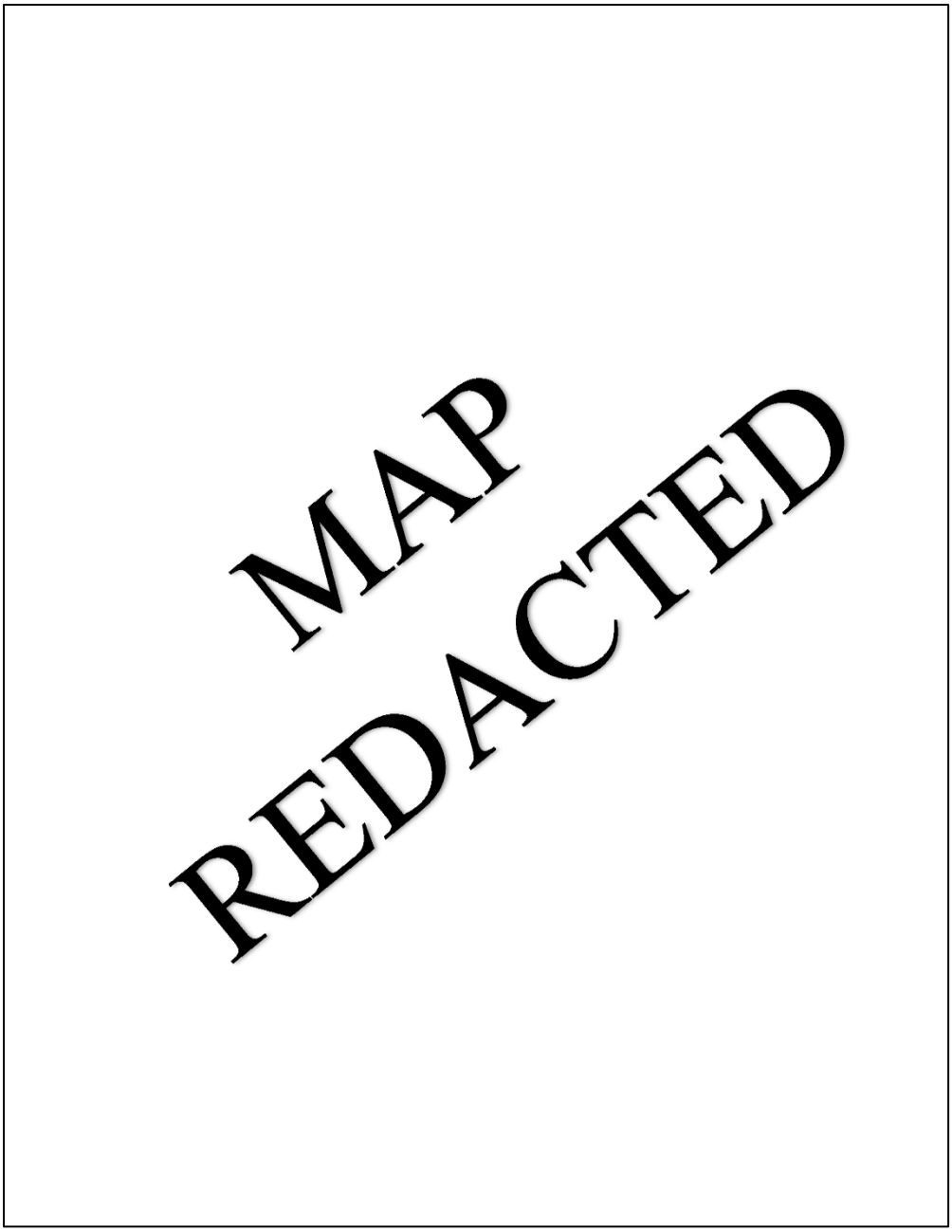


Figure 7.8. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Chico Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

7.7.1.1.Vernal Pool Fairy Shrimp Occurrences

There are two Diversity Database occurrence records for the vernal pool fairy shrimp within this core area (see **Figure 7.7**; Diversity Database 2022). As of 2018, both occurrences were entirely within protected areas (Vollmar et al. 2017); the Service's analysis classified the occurrences as partially protected, but a visual inspection shows that this is simply due to slight discrepancies between the boundaries used by the Diversity Database and Vollmar et al.'s database. Both occurrences are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). The western record was known at the time of listing in 1994 and other record was not recorded until 2009, after the Recovery Plan was published.

7.7.1.2.Vernal Pool Tadpole Shrimp Occurrences

There are seven Diversity Database occurrence records for the vernal pool tadpole shrimp within this core area (see **Figure 7.8**; Diversity Database 2022). As of 2018, six of these occurrences were at least partially within protected areas, and the seventh is within a proposed conservation bank (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database; six are within extant vernal pool grasslands and one is within extirpated vernal pool grassland (Witham 2021). None of the occurrences were known at the time of listing in 1994, six were recorded before 2005 when the Recovery Plan was published, and one, which is adjacent to another occurrence, was not recorded until 2009.

7.7.2. Dales

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool tadpole shrimp. This core area was not designated for the vernal pool fairy shrimp in the Recovery Plan, but the species is known to occur there. The core area is located in Tehama County northeast of the City of Red Bluff.

There were approximately 19,161 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were still 19,161 acres of vernal pool grassland remaining, with no habitat losses occurring since 2005 (see **Figure 7.9**, **Table 7.1**; Witham 2021). Roughly 10,718 acres of vernal pool grassland were protected within this core area as of 2017 (Vollmar et al. 2017), representing 56% of the 2005 baseline.

Protected areas within this core area include BLM's Sacramento River Bend Area, CDFW's Dales Lake Ecological Reserve and Battle Creek Wildlife Area, and parts of TNC's Inks Creek Ranch and Battle Creek conservation easements (**Figure 7.10**).

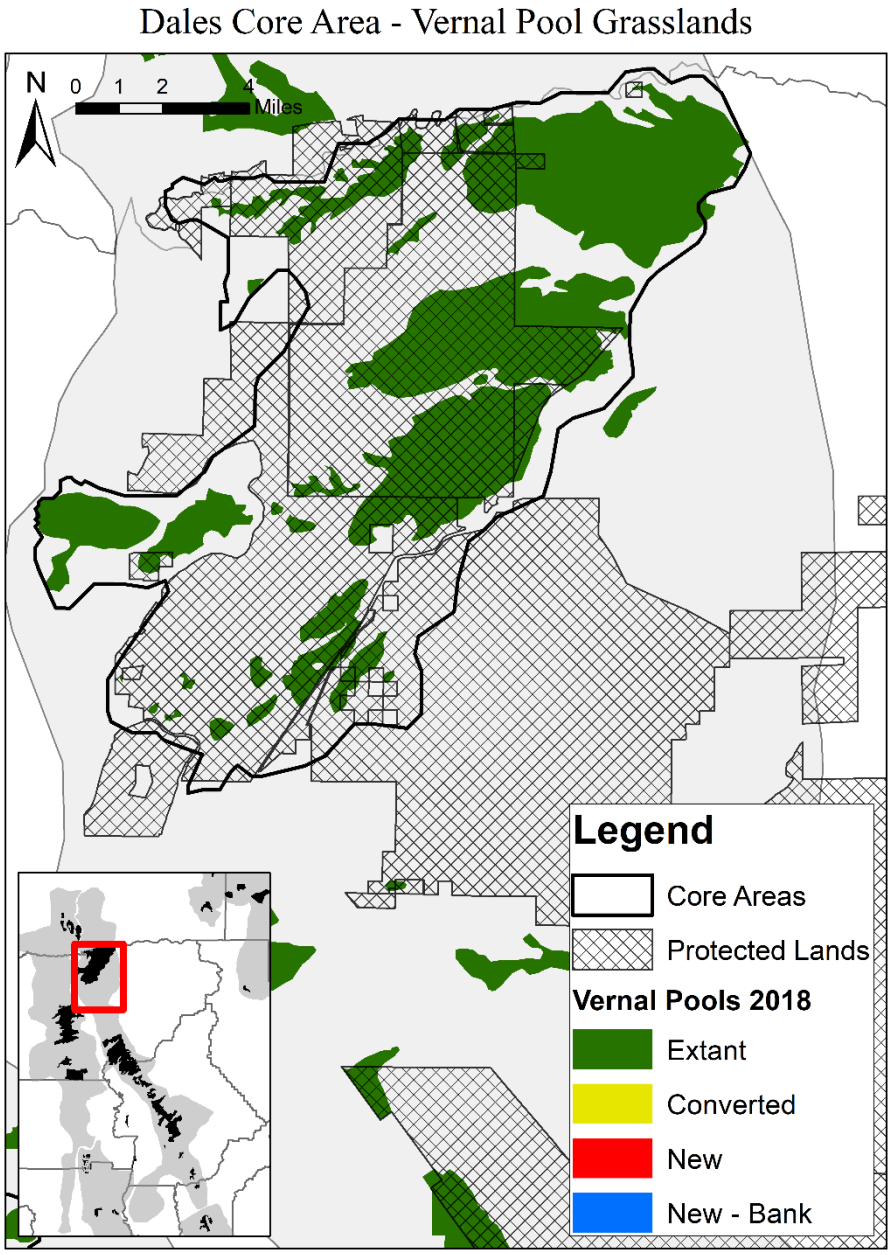


Figure 7.9. Map of vernal pool grassland habitat within the Dales Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

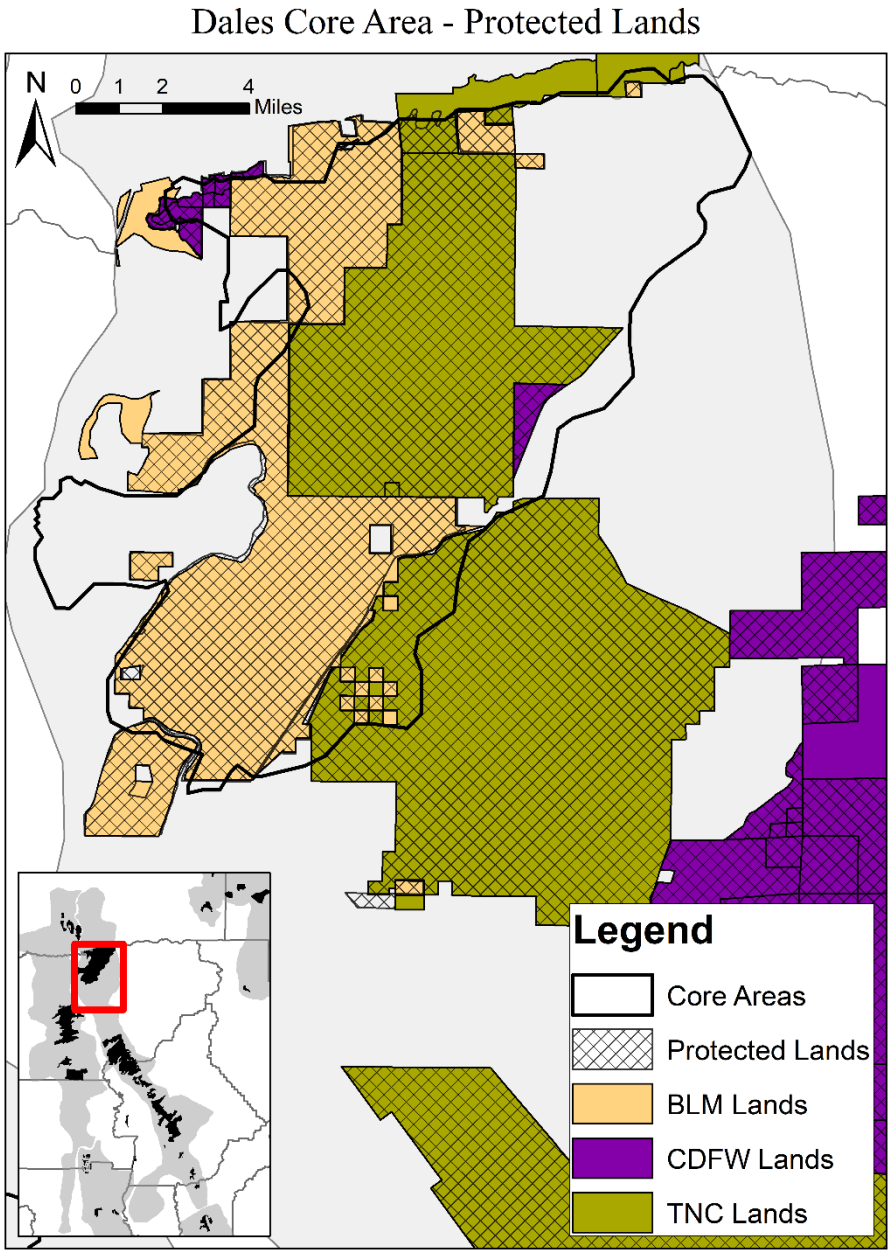


Figure 7.10. Map of protected areas within the Dales Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. BLM = Bureau of Land Management, CDFW = California Department of Fish and Wildlife, TNC = The Nature Conservancy.

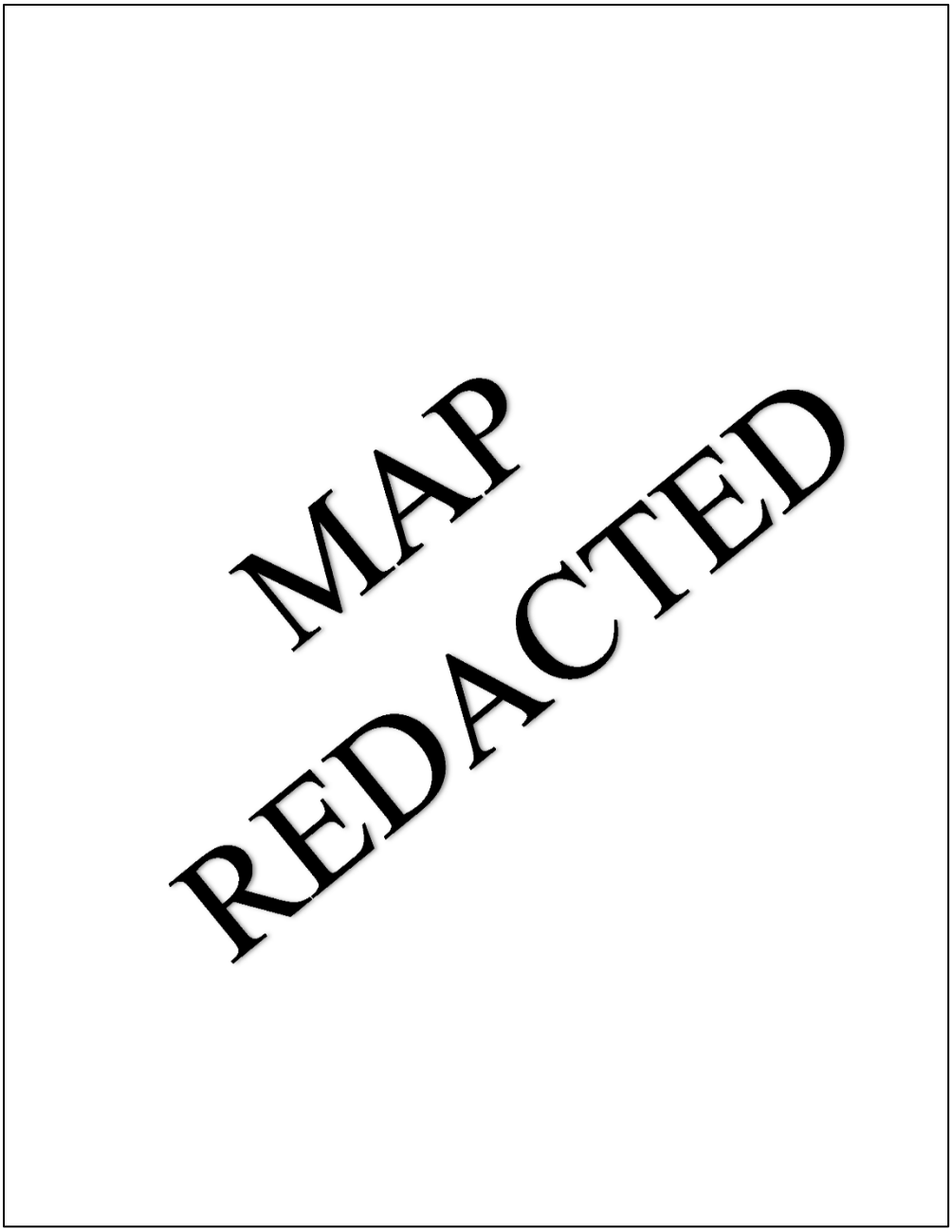


Figure 7.11. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Dales Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

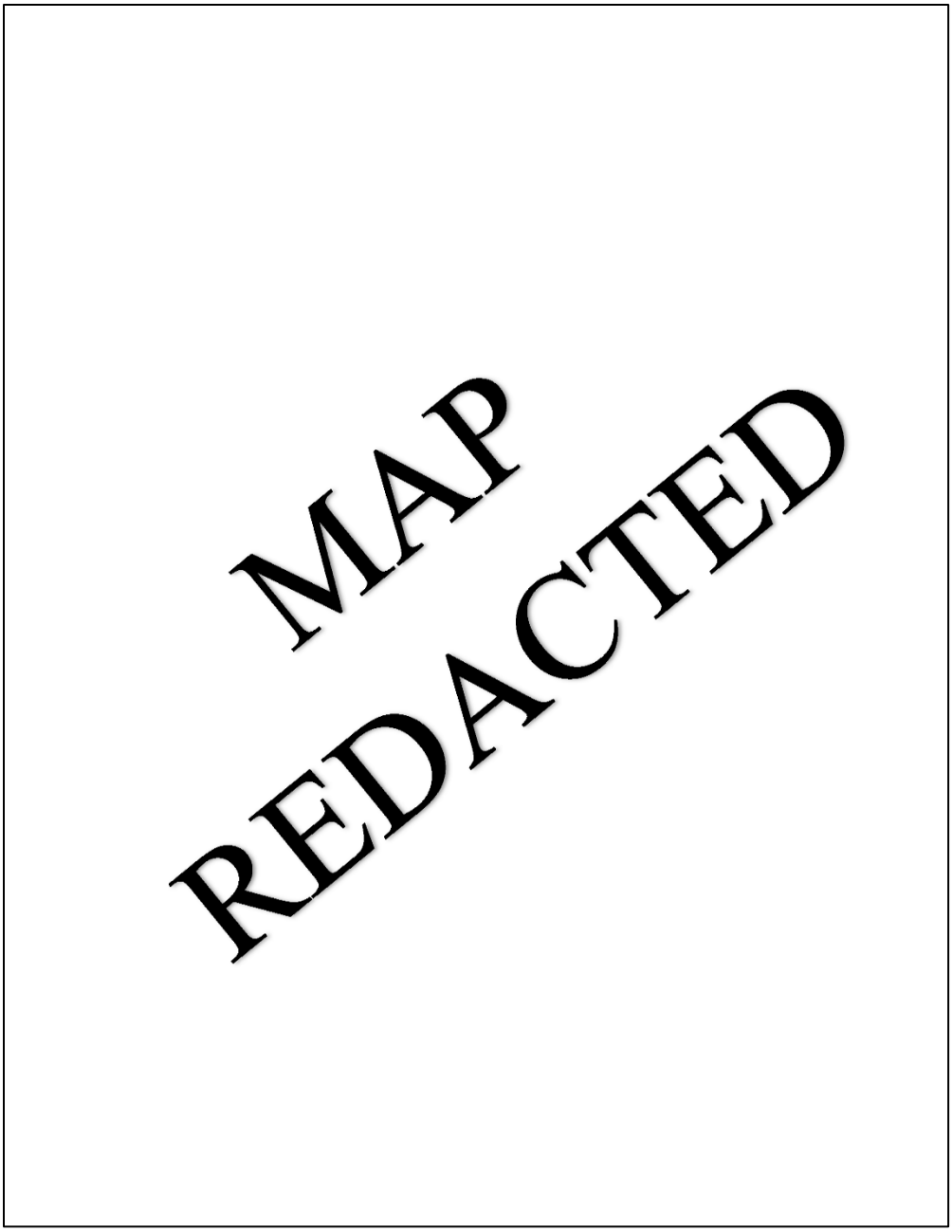


Figure 7.12. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) and during Bureau of Land Management (BLM) surveys (BLM 2017b; BLM 2018; BLM 2019b) within the Dales Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

7.7.2.1.Vernal Pool Fairy Shrimp Occurrences

There are five Diversity Database occurrence records for the vernal pool fairy shrimp within this core area, all in the northwestern corner of the core area along Spring Branch Road near Battle Creek (see **Figure 7.11**; Diversity Database 2022). As of 2018, all of these occurrences were entirely within protected areas (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). Vernal pool fairy shrimp were found most recently in all five locations in 2019 during BLM surveys (BLM 2019b). One of these occurrences, comprised of two pools, mentions collection of vernal pool fairy shrimp occurring in 1993 and 1994. Thus, the Recovery Plan likely should have designated this core area for the vernal pool fairy shrimp. Surveys for vernal pool shrimp species were conducted by BLM in 2017-2019 throughout the Sacramento River Bend Area within the core area and the vernal pool fairy shrimp was never identified in any other part of the core area (BLM 2017b; BLM 2018; BLM 2019b). This indicates that the species is likely restricted to the vernal pool habitat along Spring Branch Road despite the large amount of vernal pool grassland habitat available in the core area and the presence of other vernal pool shrimp species in other parts of the core area.

7.7.2.2.Vernal Pool Tadpole Shrimp Occurrences

There are six Diversity Database occurrence records for the vernal pool tadpole shrimp within this core area (see **Figure 7.12**; Diversity Database 2022). There are also eight occurrence records from recent BLM surveys (BLM 2017b; BLM 2018; BLM 2019b); most of these are within or adjacent to the Diversity Database records, though the is one in the Nordic Quarry area about halfway between the Hog Lake occurrence in the south and the Dales Lake occurrences in the east. As of 2018, five of the Diversity Database occurrences and all of the BLM occurrences were entirely within protected areas (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). Four of the Diversity Database occurrences were known at the time of listing in 1994 and all six were known in 2005 when the Recovery Plan was published.

7.7.3. Doe Mill

This is a zone 1 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is located in the southeastern portion of the City of Chico and adjacent areas of unincorporated Butte County.

Witham et al.'s (2013) mapping effort estimated that there were 445 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005, and as of 2018 no habitat losses were estimated to have occurred (see **Figure 7.13**, **Table 7.1**; Witham 2021). However, in the biological opinion for the Stonegate Subdivision Project (Service 2020a), the Service estimated that there were approximately 908 acres of extant vernal pool grassland within the Doe Mill Core Area based on habitat mapping conducted for the Butte County Habitat Conservation Plan conducted in 2008, NAIP aerial imagery from 2016, and Witham et al.'s updated 2012 habitat map (see **Figure 7.14**; Witham et al. 2014; C. Hickam, Service, *in litt*. 2019). Thus, an appropriate 2005 baseline for this core area is at least 908 acres of vernal pool grassland. The biological opinion also identified 8 other projects within the Doe Mill Core Area

that had been authorized since 2005 that would result in the loss of 76 acres of vernal pool grassland, but it was not known if any of those losses had occurred yet or if the projects had not yet begun construction (Service 2020a). If the Stonegate Subdivision Project proceeds with construction, it will result in the loss of an additional 170 acres of vernal pool grassland; this is a loss of more than 15% of the amount of vernal pool habitat that remained in 2005, making the 85% target unattainable without habitat creation or restoration. All of these losses are attributable to urbanization.

The human population of Chico was 101,475 in 2020, growing 17.7% from 2010 to 2020 after having already grown by over 40% per decade for the three decades prior (U.S. Census Bureau 2022). Due to the Camp Fire wildfire from the nearby town of Paradise in 2018, Chico's population increased by 18,040 people (19.5%) from 2018 to 2019 alone (City of Chico 2022). Residential housing continues to be a need in Chico (City of Chico 2022), and therefore urbanization will likely continue to be a significant cause of habitat loss for the vernal pool fairy shrimp and vernal pool tadpole shrimp within this core area.

Vollmar et al. (2017) estimated that 35.5 acres of vernal pool grassland were protected within this core area as of 2017; based on Witham et al.'s (2013) estimate of a baseline of 445 acres this is 8% of habitat protected, but based on the Service's estimate of a baseline of 908 acres this is only 4% of habitat protected. The 35.5 acres includes the Meriam Park Preserve and a protected section of Little Chico Creek south of the Preserve (note that the Meriam Park Preserve management plan actually states that the preserve is 42.5 acres; Gallaway Consulting 2009). It does not include the 14.76-acre Doe Mill Schmidbauer Meadowfoam Preserve, which is owned by the City of Chico but has no source of funding (Service 2020a). Part of the Stonegate Subdivision Project includes establishing a 132-acre preserve, which would include the Doe Mill Schmidbauer Meadowfoam Preserve, protected by a conservation easement and with a long-term management plan and endowment fund (Service 2020a). This would result in a total of approximately 168 acres of habitat protected within the core area (18.5% of the Service's 908-acre baseline).

7.7.3.1. Vernal Pool Fairy Shrimp Occurrences

There are no Diversity Database occurrence records for the vernal pool fairy shrimp within this core area; the nearest occurrence is approximately 2 miles northwest within the Chico Core Area (Diversity Database 2022). However, the vernal pool fairy shrimp is presumed to be present within the Doe Mill Core Area due to the presence of suitable habitat and the proximity to nearby occurrences. Biological opinions for section 7 consultations within the core area presume presence and analyze effects to the species, such as the Stonegate Subdivision Project (Service 2020a), and preserves within the core do as well, such as the Meriam Park Preserve (Gallaway Consulting 2009).

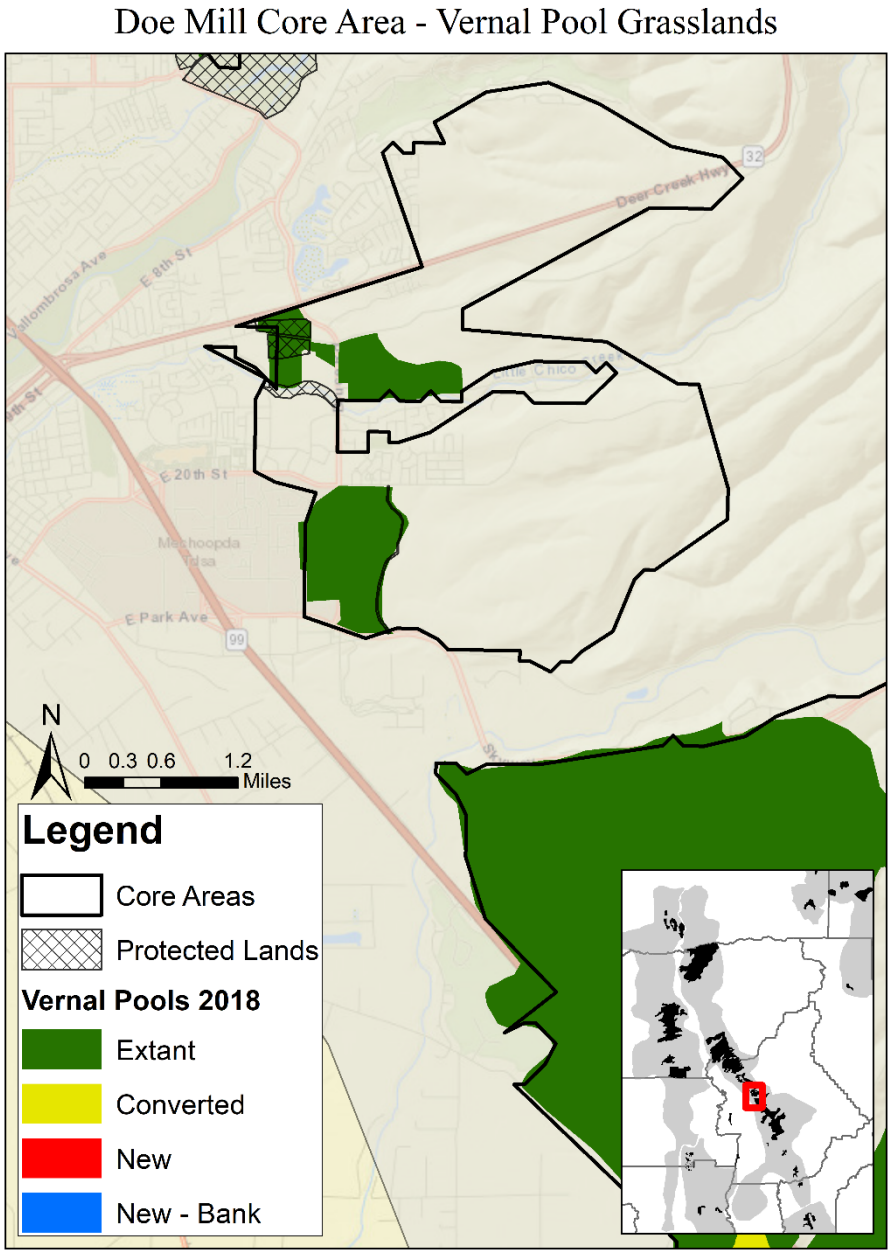


Figure 7.13. Map of vernal pool grassland habitat within the Doe Mill Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

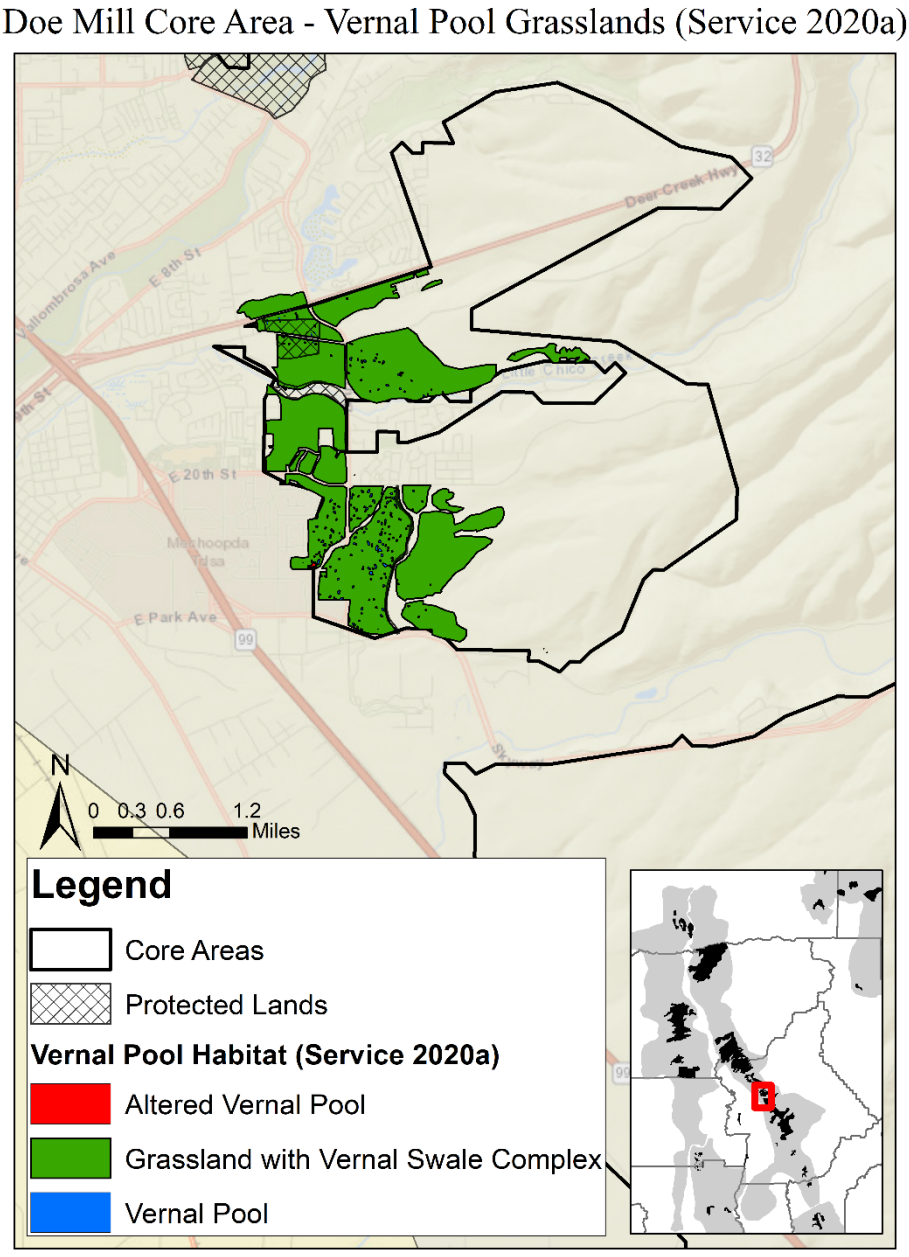


Figure 7.14. Map of vernal pool grassland habitat within the Doe Mill Core Area created by the Service for the section 7 consultation on the Stonegate Subdivision Project. Data sources included habitat mapping conducted for the Butte County Habitat Conservation Plan in 2008, NAIP aerial imagery from 2016, and Witham et al.'s updated 2012 habitat map (Witham et al. 2014; Hickam, *in litt*. 2019).

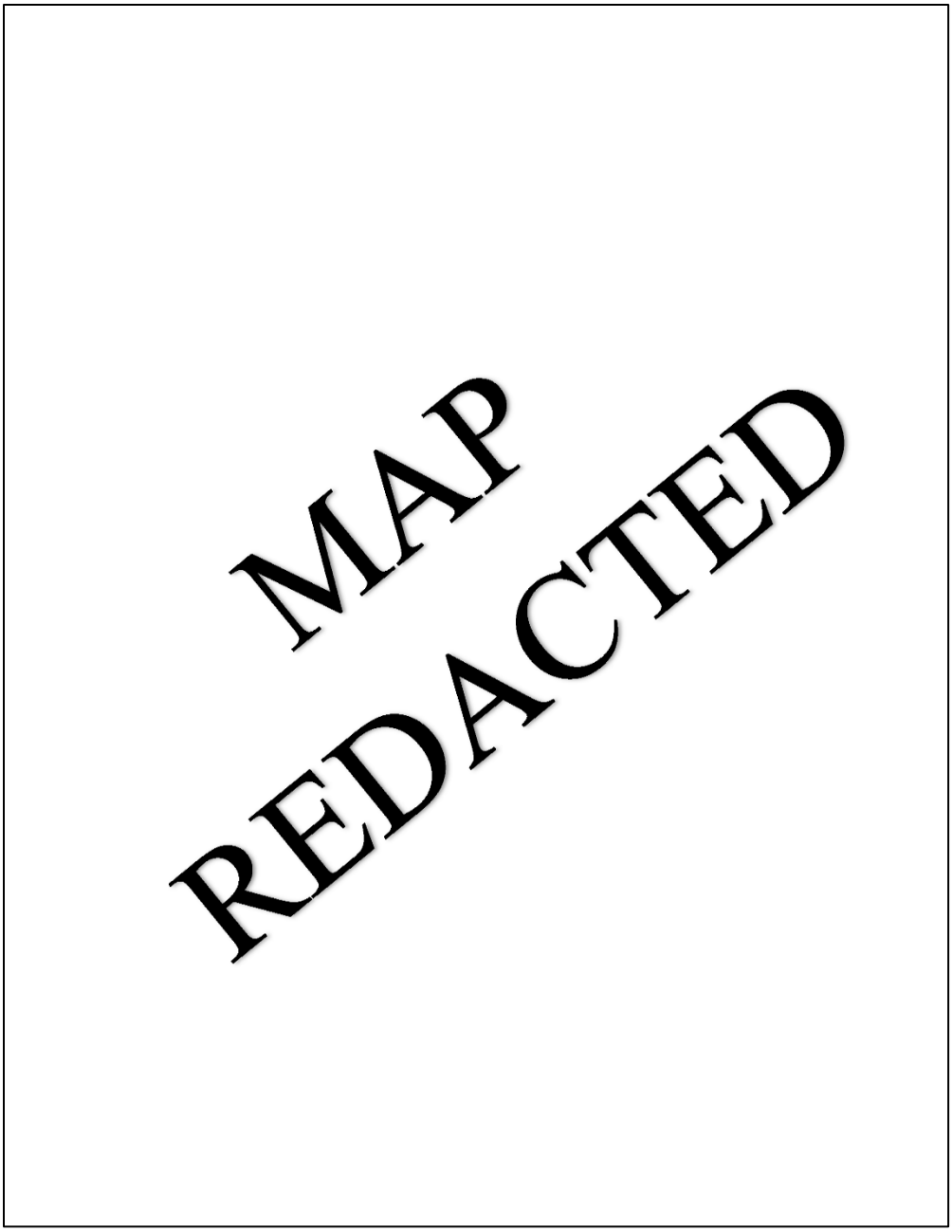


Figure 7.15. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Doe Mill Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

7.7.3.1.Vernal Pool Tadpole Shrimp Occurrences

There is one Diversity Database occurrence record for the vernal pool tadpole shrimp within this core area (see **Figure 7.15**; Diversity Database 2022). Although this occurrence was only ever recorded in 1993 and the spatial precision is low, the location is described as east of Highway 99 and south of Highway 32, which does describe the location of the core area. Biological opinions for section 7 consultations within the core area presume presence and analyze effects to the species, such as the Stonegate Subdivision Project (Service 2020a), and preserves within the core do as well, such as the Meriam Park Preserve (Gallaway Consulting 2009), even when the species has not been confirmed to be present.

7.7.4. Llano Seco

This is a zone 1 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and 95% of vernal pool habitat for the vernal pool tadpole shrimp. The core area is geographically disjunct from the rest of the Northeastern Sacramento Valley Vernal Pool Region, located within the North Central Valley Wildlife Management Area of the Sacramento National Wildlife Refuge Complex in Butte County.

Witham (2021) identified 107 acres of vernal pool grassland within this core area, though it was not visible on 2005 aerial imagery (**Figure 7.16**); this habitat is within the Sanctuary II subunit (eastern subunit) of the Service-owned Llano Seco Unit (**Figure 7.17**). The Comprehensive Conservation Plan for the North Central Valley Wildlife Management Area identified 404 acres of vernal pool grassland within the Llano Seco Unit, mostly within the Sanctuary II subunit (Service 2020c). Some amount of these 404 acres is outside of the core area in the Sanctuary I subunit, but there is likely also more vernal pool grassland within the surrounding Service-held conservation easements, which are not considered part of the Llano Seco Unit, given the Diversity Database records of the vernal pool fairy shrimp and vernal pool tadpole shrimp present. The Service-held easements are part of the North Central Valley Wildlife Management Area and include the northern half of the Llano Seco Core Area as well as surrounding lands. Vernal pool grasslands are also present in Field 312 of the nearby CDFW Llano Seco Unit of the Upper Butte Basin Wildlife Area, though the acreage is not quantified in the land management plan (ESA Associates 2013). Although only parts of the areas described here are within the boundaries of the core area, it is likely appropriate to consider this block of federal- and state-owned land a connected vernal pool ecosystem. Regardless of which estimate or boundaries are used, all of the vernal pool grassland complex within and around this core area are protected within the National Wildlife Refuge and CDFW Wildlife Area.

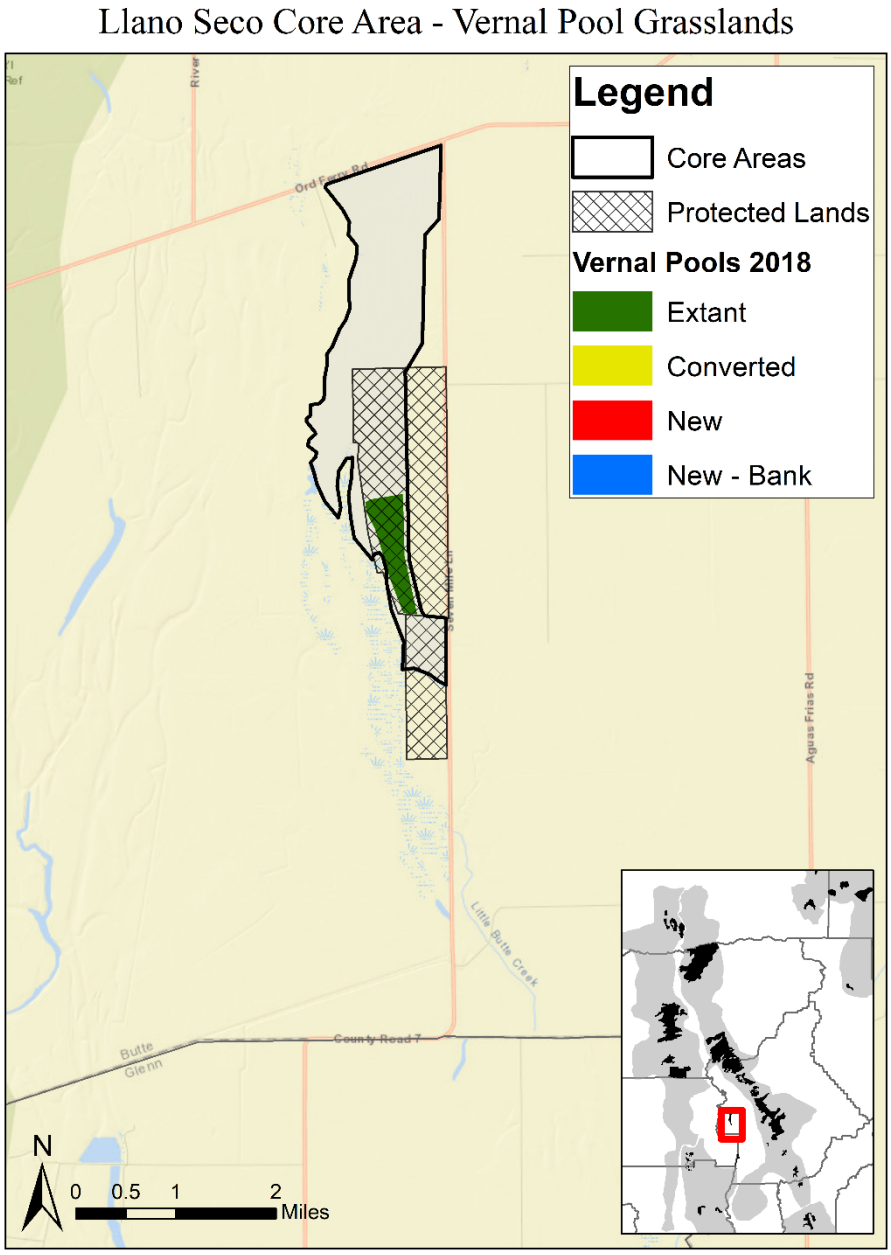


Figure 7.16. Map of vernal pool grassland habitat within the Llano Seco Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

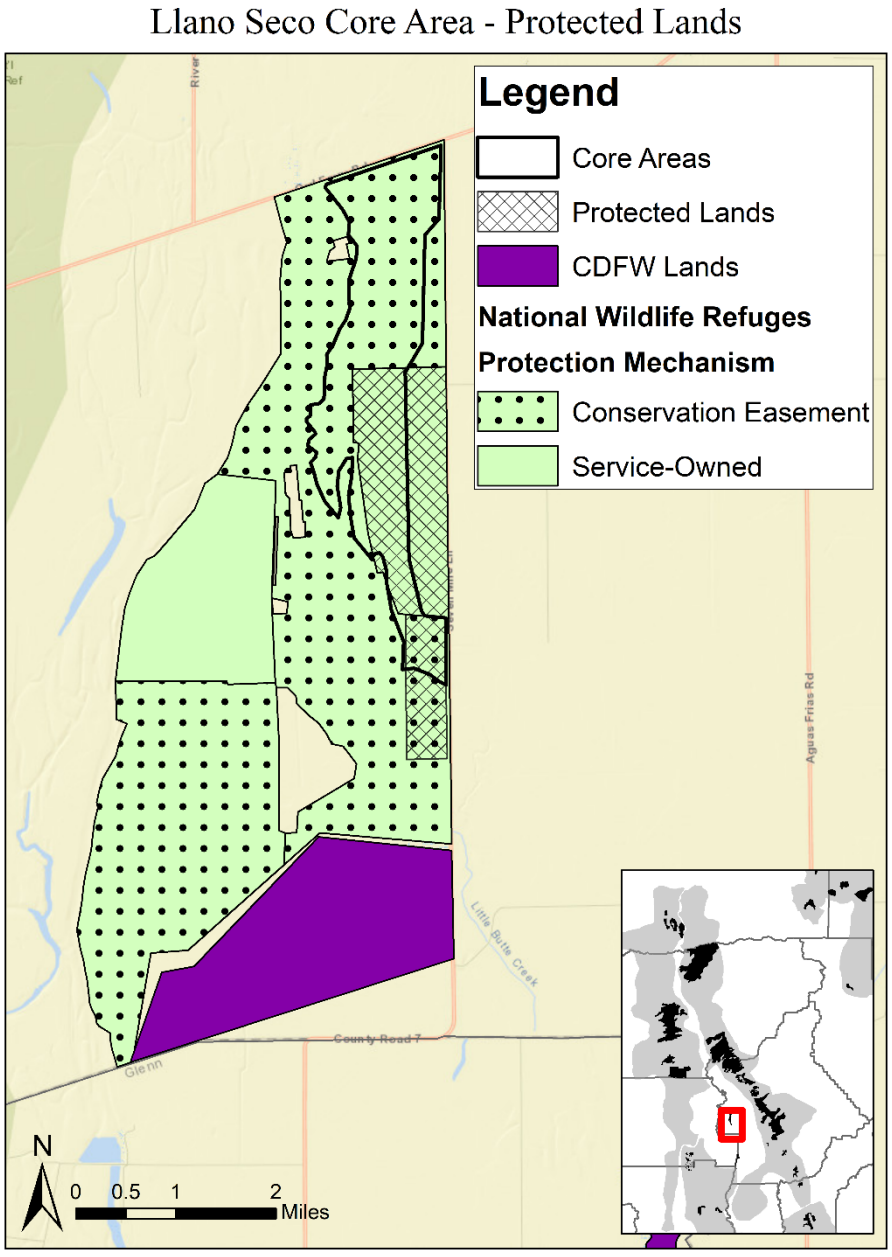


Figure 7.17. Map of protected areas within the Llano Seco Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. CDFW = California Department of Fish and Wildlife.

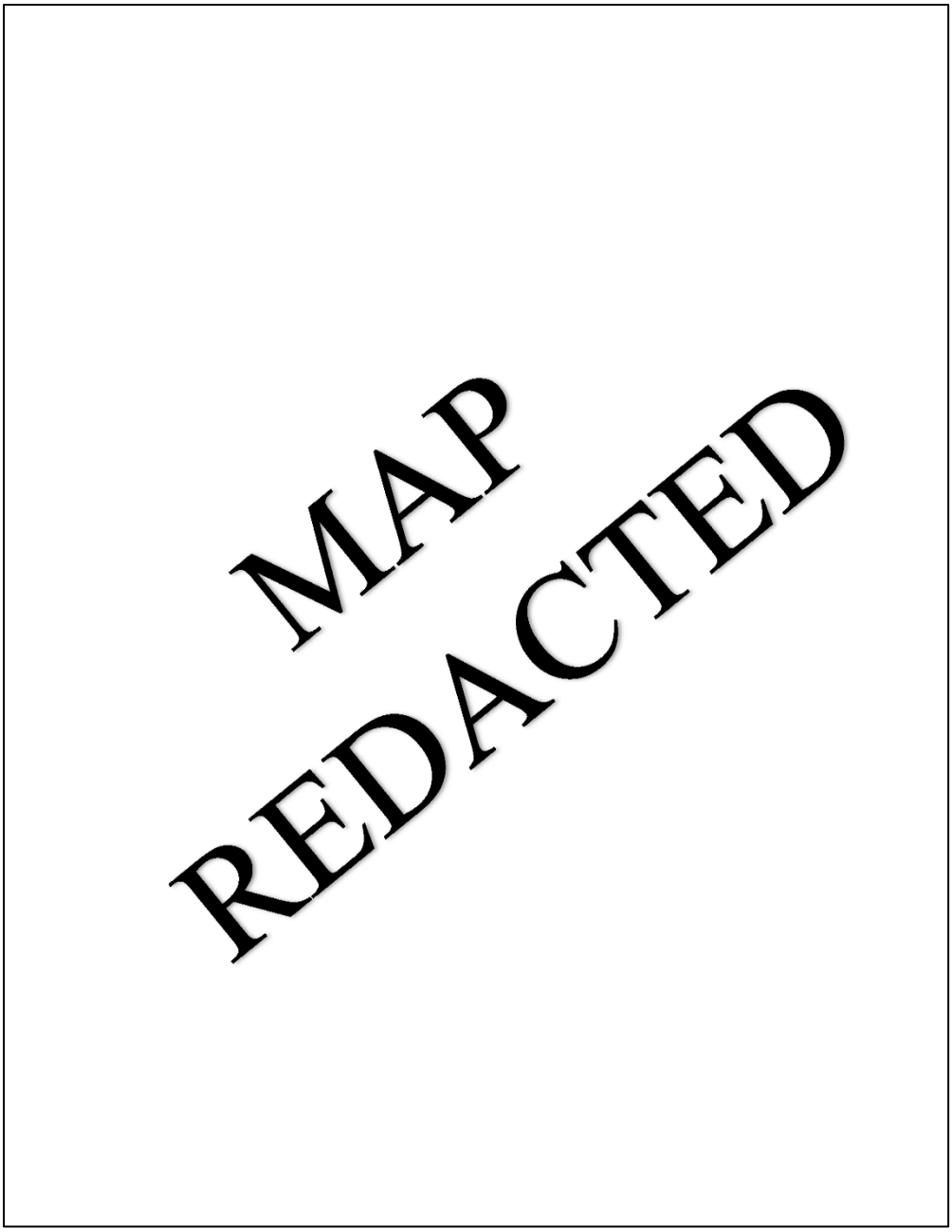


Figure 7.18. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Llano Seco Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

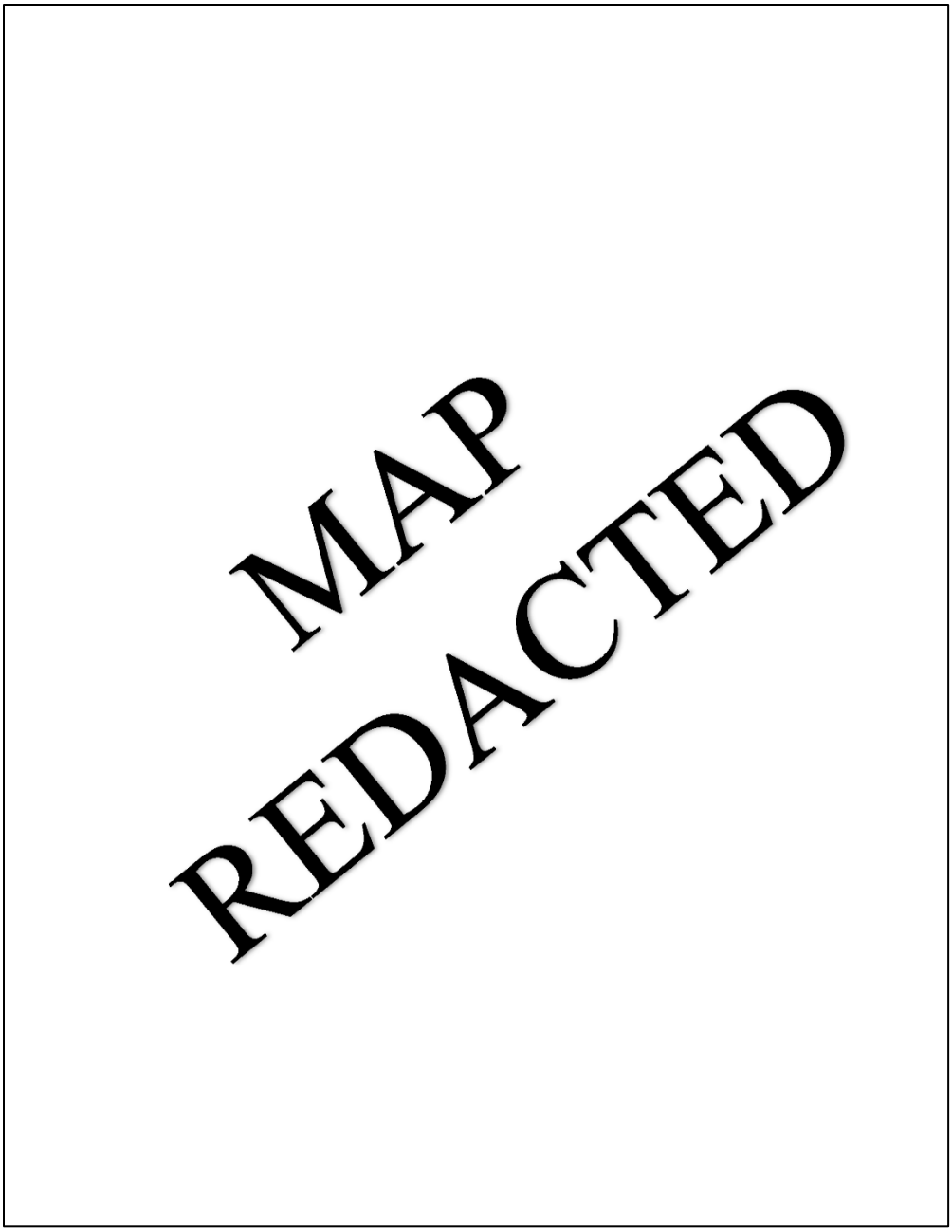


Figure 7.19. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Llano Seco Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

7.7.4.1.Vernal Pool Fairy Shrimp Occurrences

There are three Diversity Database occurrence records for the vernal pool fairy shrimp within this core area and one immediately outside the core area (see **Figure 7.18**; Diversity Database 2022). All of these occurrences are presumed extant by the Diversity Database and are entirely protected within the Sacramento National Wildlife Refuge Complex. Of the four records, two were known at the time of listing in 1994 and three were known at the time the Recovery Plan was published in 2005. The one newer record was from 2017 on the southern border of the Service's Llano Seco Unit, Sanctuary II subunit. The nearby Llano Seco Unit of CDFW's Upper Butte Basin Wildlife Area also contains suitable vernal pool habitat, but it has not been surveyed for the vernal pool fairy shrimp (ESA Associates 2013).

7.7.4.1.Vernal Pool Tadpole Shrimp Occurrences

There are six Diversity Database occurrence records for the vernal pool tadpole shrimp within this core area, one immediately outside the core area, and two 4 miles to the southwest (see **Figure 7.19**; Diversity Database 2022). All of these occurrences are presumed extant by the Diversity Database and are entirely protected within the Sacramento National Wildlife Refuge Complex. Of these nine records, three were known at the time of listing in 1994 and seven were known at the time the Recovery Plan was published in 2005. The two newer records were from 2013 and 2015 on the borders of the Service's Llano Seco Unit, Sanctuary II subunit. The nearby Llano Seco Unit of CDFW's Upper Butte Basin Wildlife Area also contains suitable vernal pool habitat, but it has not been surveyed for the vernal pool tadpole shrimp (ESA Associates 2013).

7.7.5. Oroville

This is a zone 1 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and 95% of vernal pool habitat for the vernal pool tadpole shrimp. The core area is located along Highways 99 and 149 between the cities of Oroville and Chico in Butte County.

There were approximately 19,576 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 19,210 acres of vernal pool grassland remaining, with 366 acres lost since 2005 (see **Figure 7.20**, **Table 7.1**; Witham 2021). The majority of losses were due to agricultural conversion to either orchards (194 acres, 53%) or rice, row crops, dairies, or nurseries (121 acres, 33%), with the remaining losses due to urbanization or agricultural residences (see **Table 7.2**; Witham 2021). Roughly 2,799 acres of vernal pool grassland were protected within this core area as of 2017 (Vollmar et al. 2017), representing 14.3% of the 2005 baseline. However, this number includes the now suspended 212-acre Shauna Downs Mitigation Bank, but also misses the 574-acre Caltrans Cottonwood Creek Conservation Area. Thus, a net total of 3,161 acres of vernal pool grassland are protected, representing 16.1% of the 2005 baseline.

Protected areas within this core area include the Dove Ridge Conservation Bank, Caltrans Cottonwood Creek Conservation Area, and two other mitigation sites identified by Vollmar et al. (2017) (**Figure 7.21**). The Oroville Wildlife Area and CDPR lands around the Thermalito Forebay are also adjacent to the core area to the south.

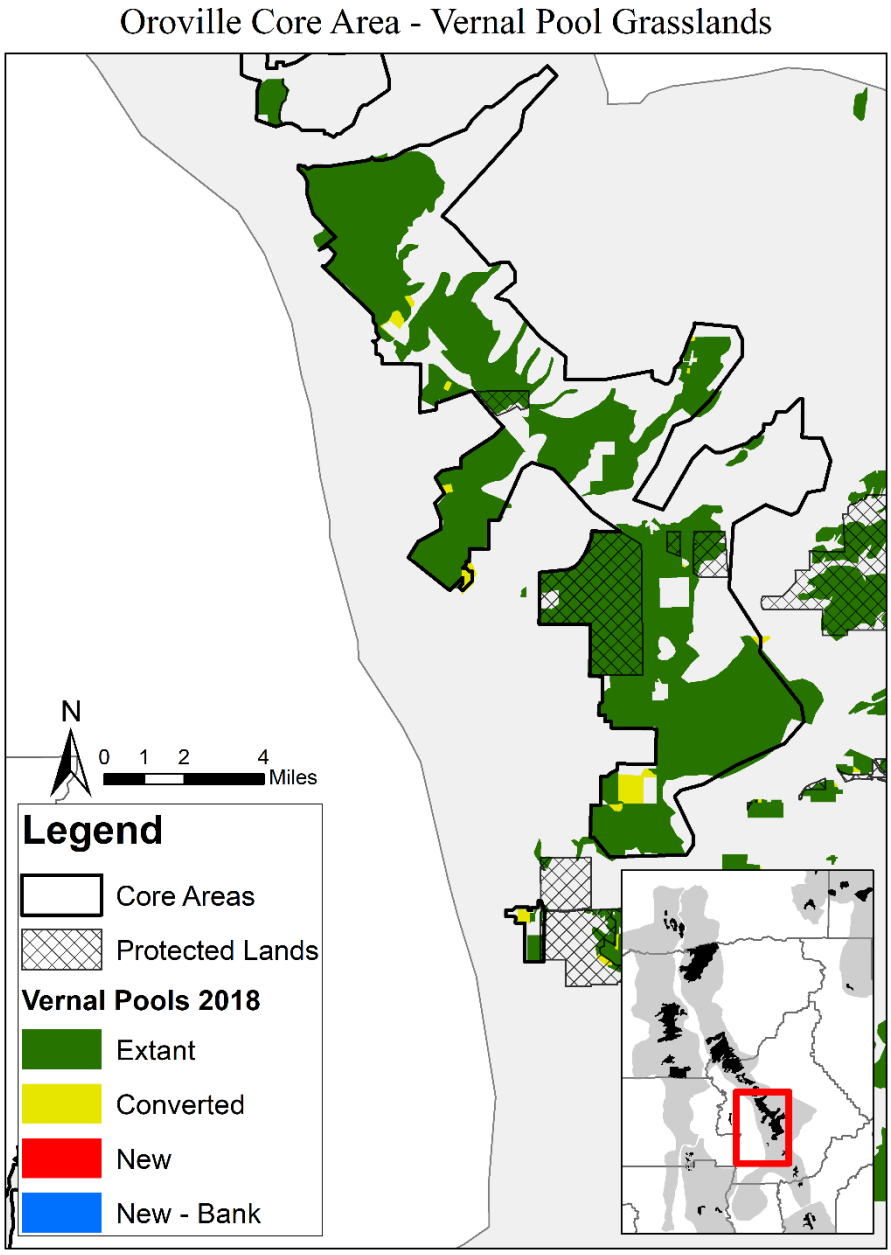


Figure 7.20. Map of vernal pool grassland habitat within the Oroville Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

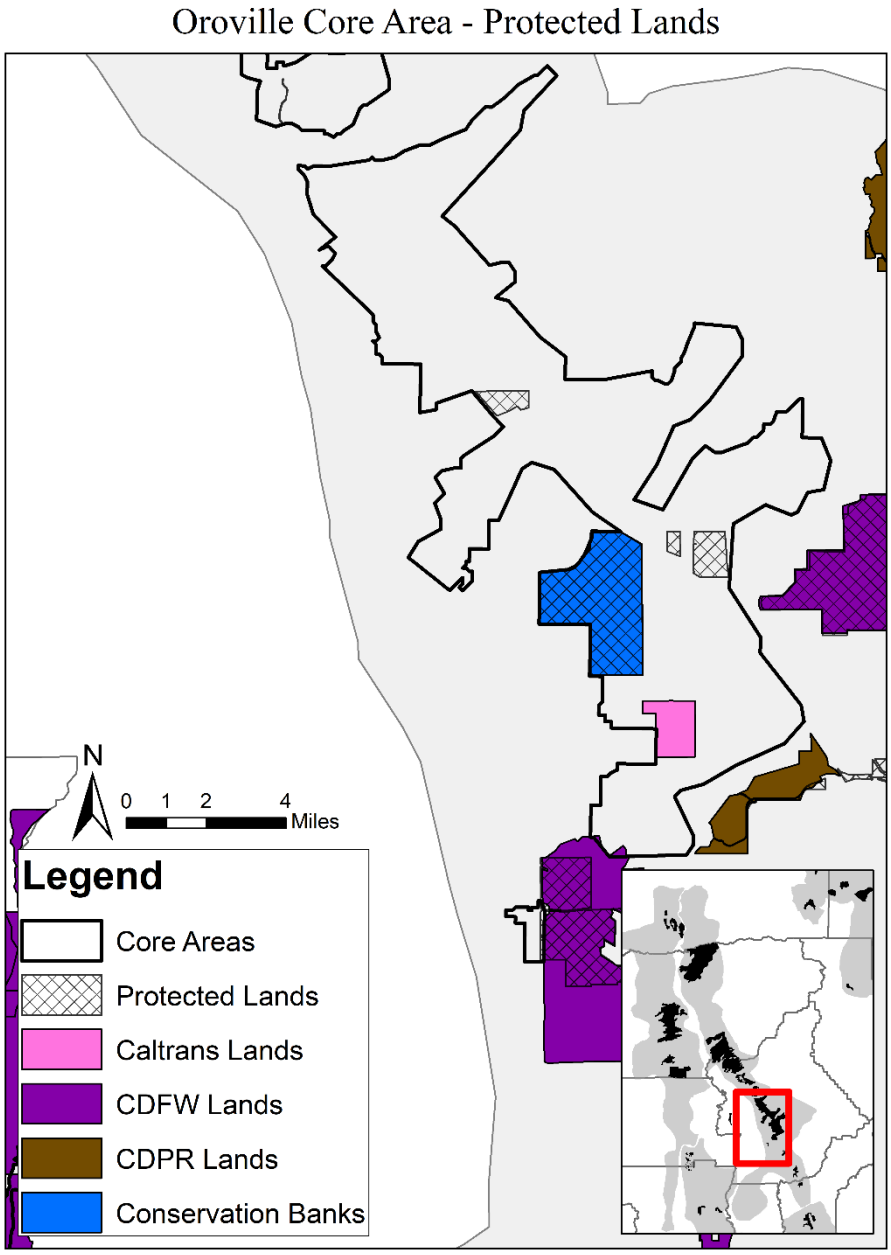


Figure 7.21. Map of protected areas within the Oroville Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. The northernmost protected area depicted within the core area is the Shauna Downs Mitigation Bank, which is currently suspended and no longer considered protected. CDFW = California Department of Fish and Wildlife, CDPR = California Department of Parks and Recreation.

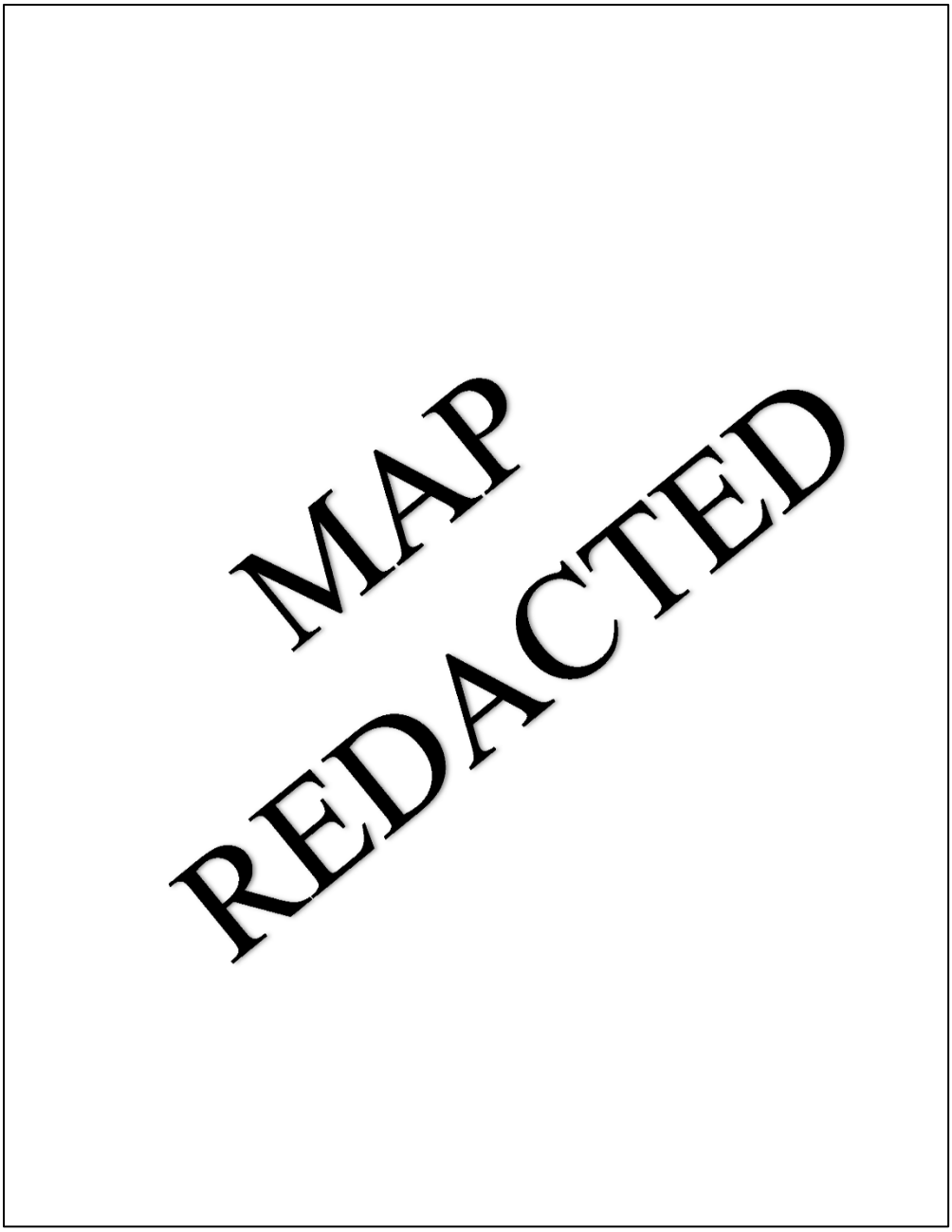


Figure 7.22. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Oroville Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

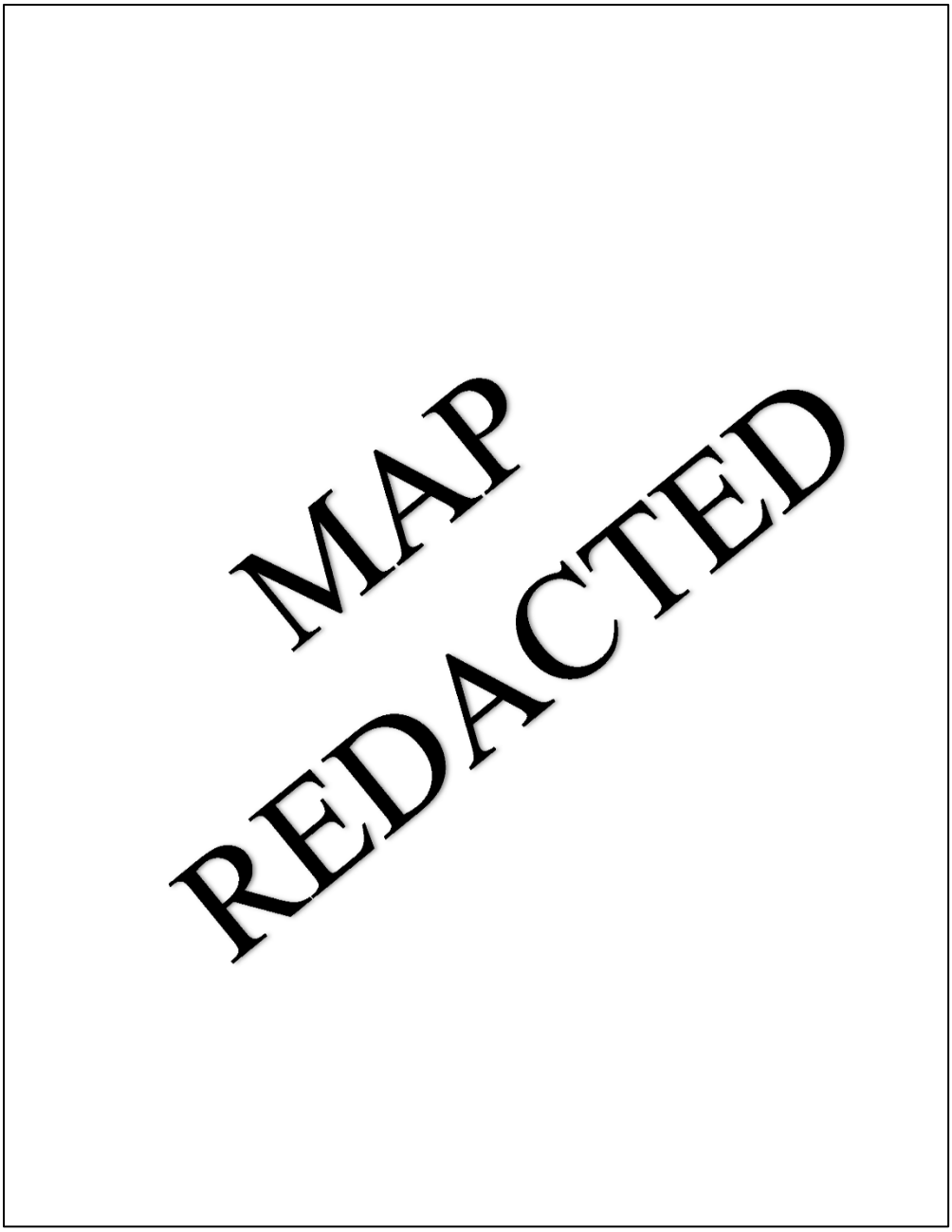


Figure 7.23. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Oroville Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

7.7.5.1.Vernal Pool Fairy Shrimp Occurrences

There are eight Diversity Database occurrence records for the vernal pool fairy shrimp within this core area (see **Figure 7.22**; Diversity Database 2022). As of 2018, all of these occurrences were at least partially within protected areas (Vollmar et al. 2017); seven occurrences are entirely within protected areas and one occurrence is almost entirely within the Caltrans Cottonwood Creek Conservation Area except for one vernal pool (Diversity Database 2022). All occurrences are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). Of the eight records, none were known at the time of listing in 1994 and four were known at the time the Recovery Plan was published in 2005; these records are all within the Dove Ridge Conservation Bank. The four newer records are located within the Caltrans Cottonwood Creek Conservation Area and two other mitigation properties, expanding the distribution of the vernal pool fairy shrimp within this core area from what was known at the time the Recovery Plan was published.

7.7.5.1.Vernal Pool Tadpole Shrimp Occurrences

There are seven Diversity Database occurrence records for the vernal pool tadpole shrimp within this core area (see **Figure 7.23**; Diversity Database 2022). As of 2018, four of these occurrences were at least partially within protected areas (Vollmar et al. 2017) (Diversity Database 2022). All occurrences are presumed extant by the Diversity Database; six are within extant vernal pool grasslands and one is outside of mapped vernal pool grasslands (Witham 2021). Of the seven records, four were known at the time of listing in 1994 and five were known at the time the Recovery Plan was published in 2005; these records are spread across the central and eastern portions of the core area. The two newer records are clusters of vernal pools, one within the Caltrans Cottonwood Creek Conservation Area to the south and the other within a protected mitigation site to the east.

7.7.6. Palermo

This is a zone 2 core area, but it was not designated for the vernal pool fairy shrimp or vernal pool tadpole shrimp in the Recovery Plan. It was designated for slender Orcutt grass (*Orcuttia tenuis*), with a goal of protecting 85% of vernal pool habitat. The core area is located east of the Oroville Wildlife Area and south of the City of Oroville in Butte County.

There were approximately 841 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 649 acres of vernal pool grassland remaining, with 192 acres lost since 2005 (see **Figure 7.24**, **Table 7.1**; Witham 2021). This represents a loss of more than 15% of the amount of vernal pool habitat that remained in 2005, making the 85% target unattainable without habitat creation or restoration. The majority of losses were due to conversion to orchards (164 acres, 85%), with the remaining losses due to other types of agricultural conversions (see **Table 7.2**; Witham 2021). The Service is not aware of any protected vernal pool habitat within this core area (see **Figure 7.25**; Vollmar et al. 2017). CDFW's Oroville Wildlife Area is immediately west of this core area.

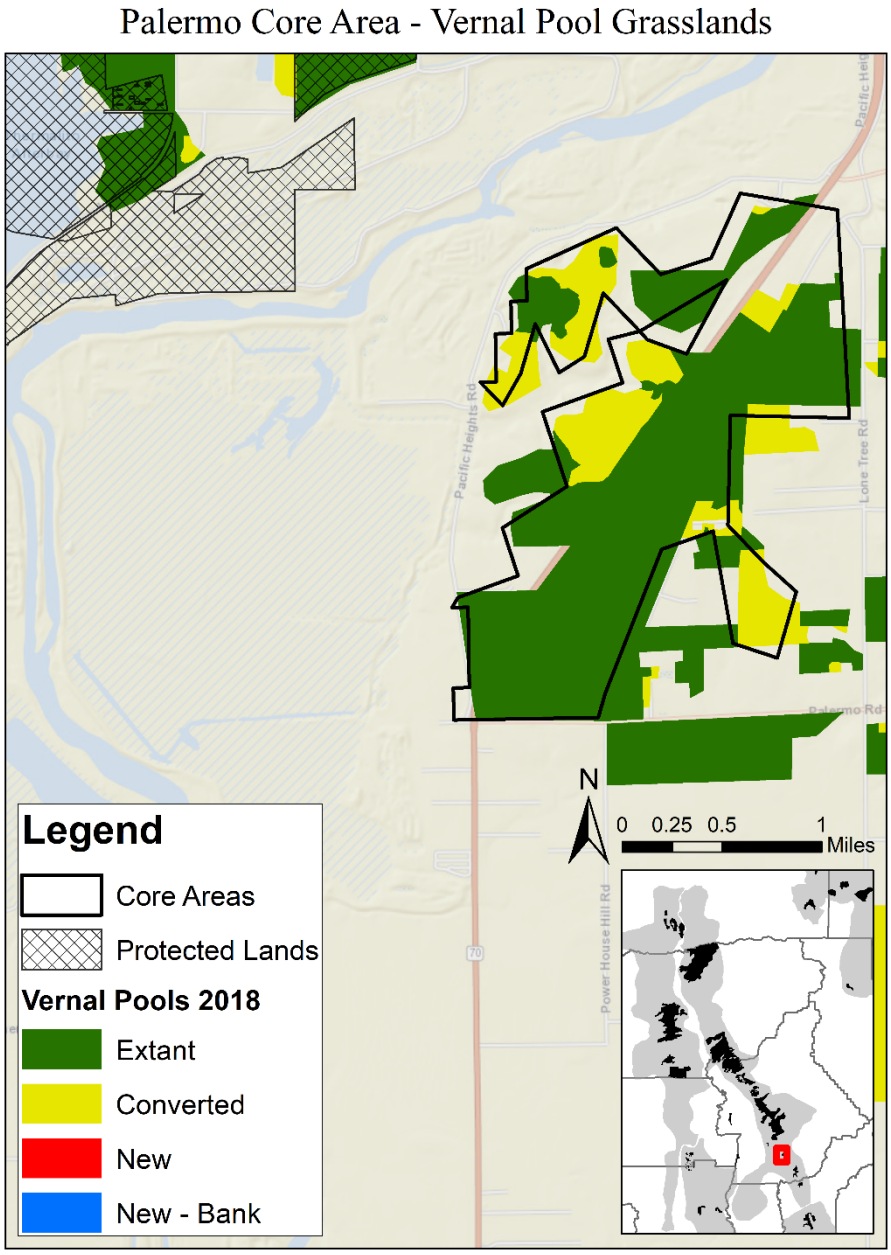


Figure 7.24. Map of vernal pool grassland habitat within the Palermo Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

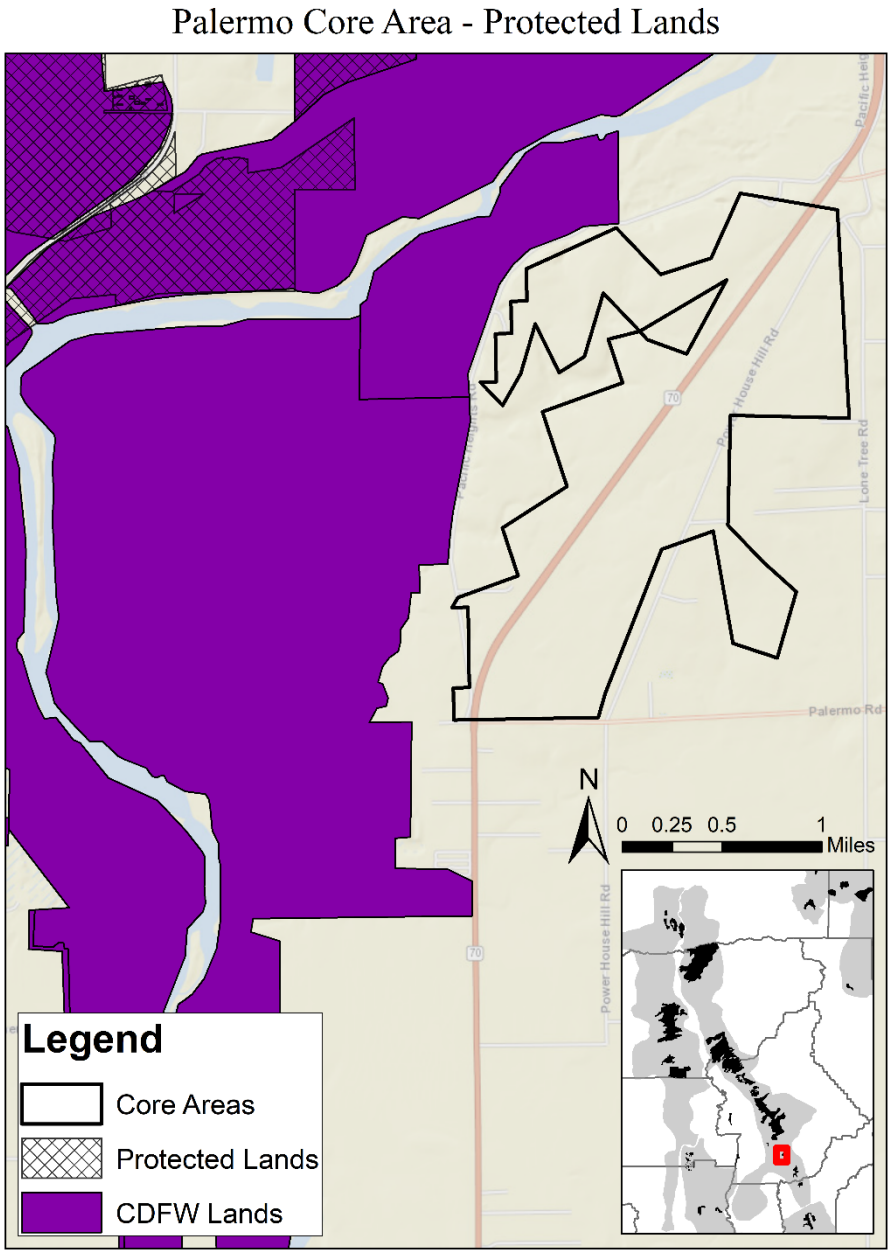


Figure 7.25. Map of protected areas within the Palermo Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. CDFW = California Department of Fish and Wildlife.

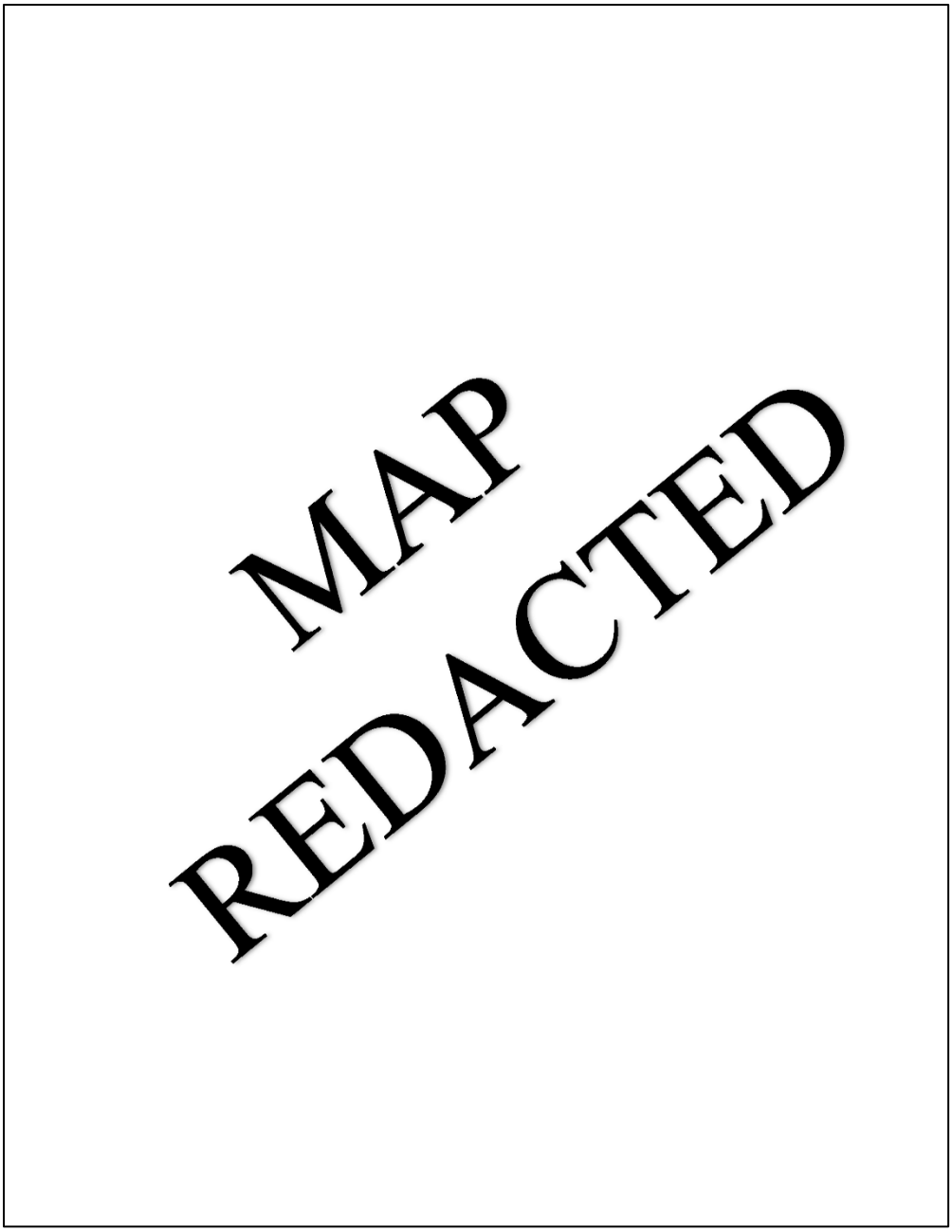


Figure 7.26. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Palermo Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

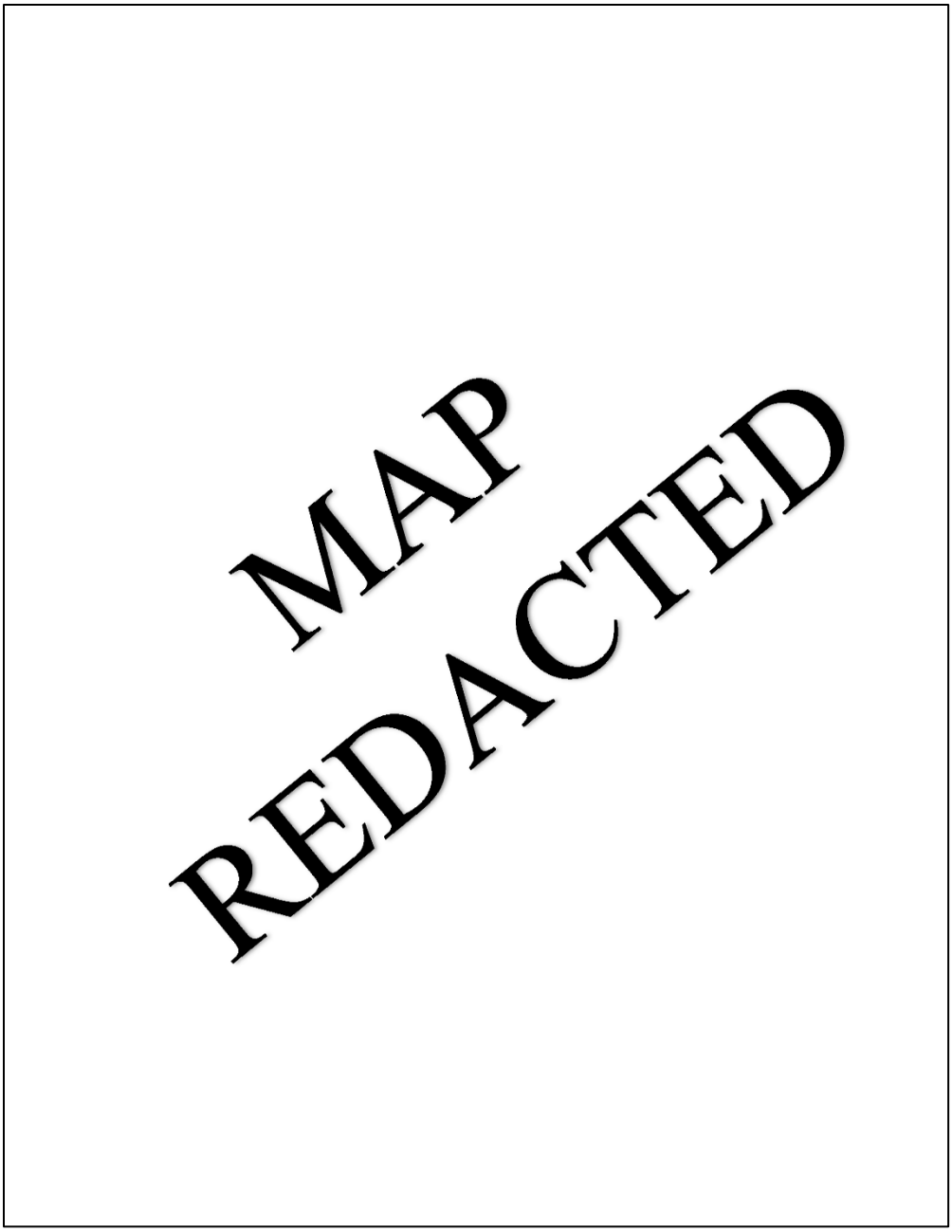


Figure 7.27. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Palermo Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

7.7.6.1.Vernal Pool Fairy Shrimp Occurrences

There are four Diversity Database occurrence records for the vernal pool fairy shrimp within this core area, one of which extends outside of the core area to the west (see **Figure 7.26**; Diversity Database 2022). As of 2018, none of these occurrences were protected (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). None of these occurrences were known at the time of listing or when the Recovery Plan was published. All four occurrences were recorded during the 2007-2008 and 2008-2009 wet seasons on the Rio D'Oro property (Diversity Database 2022).

7.7.6.1.Vernal Pool Tadpole Shrimp Occurrences

There is one Diversity Database occurrence record for the vernal pool tadpole shrimp within this core area (see **Figure 7.27**; Diversity Database 2022). As of 2018, this occurrence was not protected (Vollmar et al. 2017). The occurrence is presumed extant by the Diversity Database and within extant vernal pool grasslands (Witham 2021). The occurrence was not known at the time of listing or when the Recovery Plan was published; it was first detected in 2008 on the Rio D'Oro property (Diversity Database 2022).

7.7.7. Richvale

This is a zone 2 core area, but it was not designated for the vernal pool fairy shrimp in the Recovery Plan. It was designated for Greene's tuctoria (*Tuctoria greenei*), with a goal of protecting 85% of vernal pool habitat. The core area is located west of the Thermalito Afterbay near the City of Oroville in Butte County.

There were approximately 151 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 114 acres of vernal pool grassland remaining, with 37 acres lost since 2005 (see **Figure 7.28**, **Table 7.1**; Witham 2021). All losses were due to conversion to bare plowed agricultural land (see **Table 7.2**; Witham 2021). This represents a loss of more than 15% of the amount of vernal poolhabitat that remained in 2005, making the 85% target unattainable without habitat creation or restoration.

There is a slight disagreement in the GIS layers regarding whether CDFW's Oroville Wildlife Area extends into the Richvale Core Area or not. Both Vollmar et al.'s (2017) database and DWR's vernal pool survey data (Carter-Ervin, *in litt*. 2022) suggest that the Oroville Wildlife Area does extend into the core area (**Figure 7.29**); if this is correct, then roughly 18.5 acres of vernal pool grassland were protected within this core area as of 2017 (Vollmar et al. 2017), representing 12.2% of the 2005 baseline. However, given the exact border between the core area and the GIS layers obtained from CDFW, it may have been the intent of the Recovery Plan to not include the Oroville Wildlife Area within the Richvale Core Area.

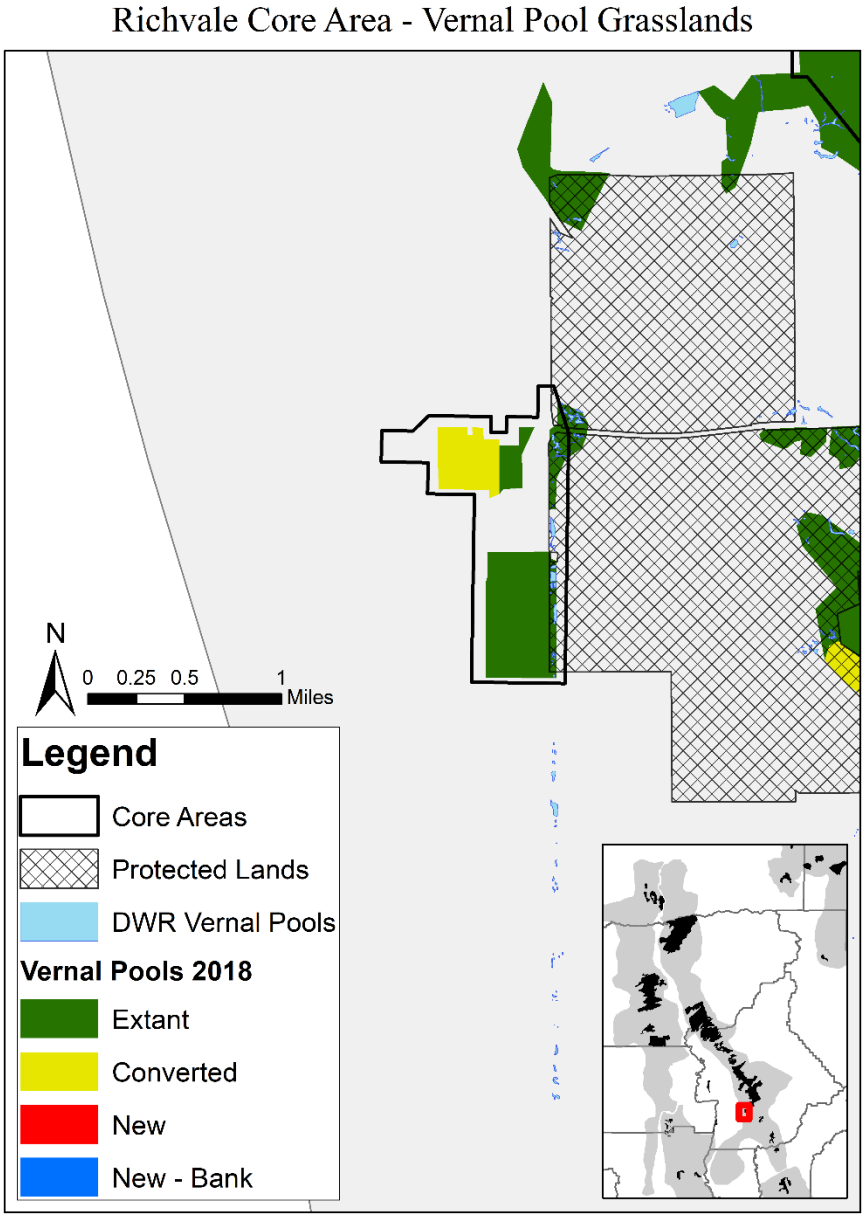


Figure 7.28. Map of vernal pool grassland habitat within the Richvale Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Vernal pools were mapped by the California Department of Water Resources (DWR) (Carter-Ervin, *in litt*. 2022). Zoom in for finer resolution.

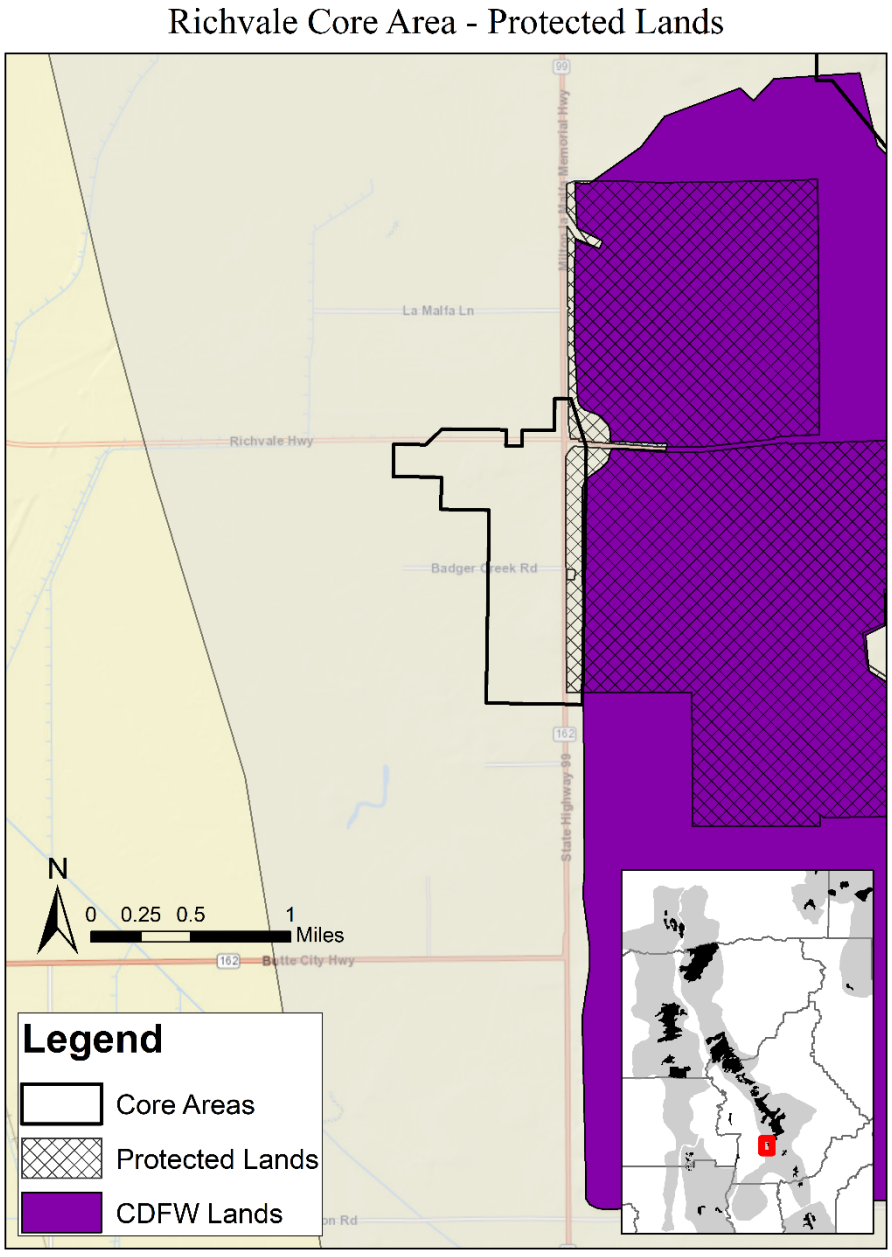


Figure 7.29. Map of protected areas within the Richvale Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. CDFW = California Department of Fish and Wildlife.

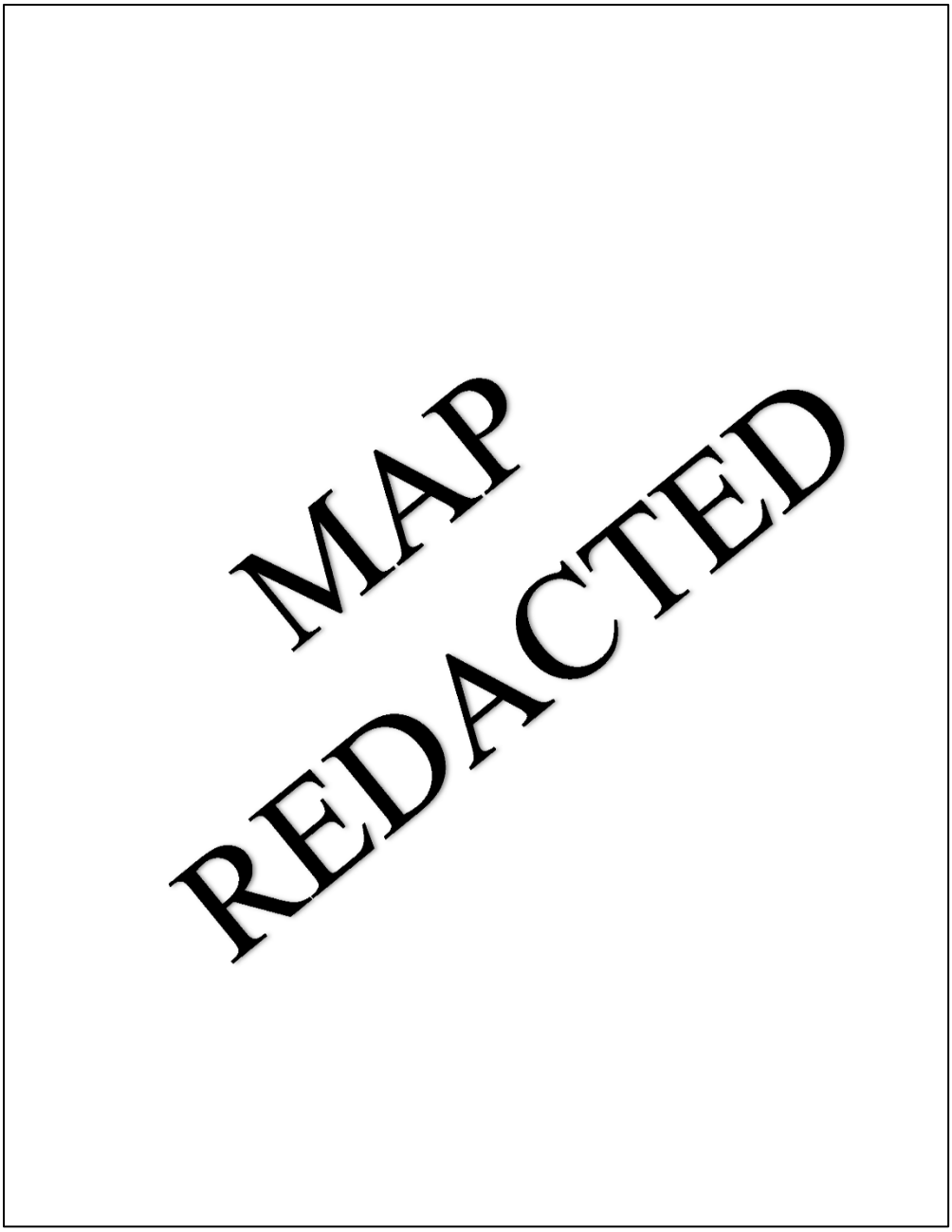


Figure 7.30. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Richvale Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

7.7.7.1.Vernal Pool Fairy Shrimp Occurrences

There is one Diversity Database occurrence record for the vernal pool fairy shrimp that partially overlaps this core area (see **Figure 7.30**; Diversity Database 2022). This occurrence was observed in 1993 and was described as northwest of the intersection of Highway 99 and Richvale East Road, likely putting the true location just outside of the core area. As of 2018, this occurrence was not protected (Vollmar et al. 2017), but it is presumed extant by the Diversity Database. This occurrence was classified as partly within extant vernal pool grasslands given the overlap of the polygon with grassland mapped to the northeast (Witham 2021), but the likely true location of the occurrence is outside of vernal pool grasslands mapped by Witham (2021).

7.7.8. Vina Plains

This is a zone 1 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and 95% of vernal pool habitat for the vernal pool tadpole shrimp and Conservancy fairy shrimp. The core area is located in northern Butte County and southern Tehama County.

There were approximately 34,594 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 34,135 acres of vernal pool grassland remaining, with 459 acres lost since 2005 (see **Figure 7.31**, **Table 7.1**; Witham 2021). Almost all losses were due to agricultural conversion (451 acres, 98.3%), mainly to orchards (197 acres, 42.9%) or bare plowed agricultural land (201 acres, 43.8%), and a small amount were due to urbanization (8 acres, 1.7%) (see **Table 7.2**; Witham 2021). Vollmar et al. (2017) estimated that roughly 16,197 acres of vernal pool grassland were protected within this core area as of 2017, representing 46.8% of the 2005 baseline. However, this does not include a 160-acre parcel that is part of TNC's Vina Plains Preserve (**Figure 7.32**) or the 4,273-acre easement on the Lowe property that protects an additional 2,836 acres of vernal pool grassland, so there is actually a total of 19,193 acres of vernal pool grassland protected, representing 55.5% of the 2005 baseline.

Protected areas within this core area include TNC's Vina Plains Preserve, most of the Vina Plains conservation easement, and a small part of the Deer Creek conservation easement; the Hamilton Ranch Conservation Bank, the Meridian Ranch Mitigation Bank and adjacent Meridian Preserve, the Wurlitzer Ranch/Tuscan Preserve (which may or may not still exist; see Service 2020a), and one other mitigation site identified by Vollmar et al. (2017); three ranches with conservation easements, one of which is held by the Natural Resources Conservation Service (NRCS) and another that Vollmar et al. (2017) says is held by TNC; the Lowe property with a conservation easement held by NRCS; and a property owned by Chico State Enterprises (formerly the CSU Chico Research Foundation) (**Figure 7.32**).

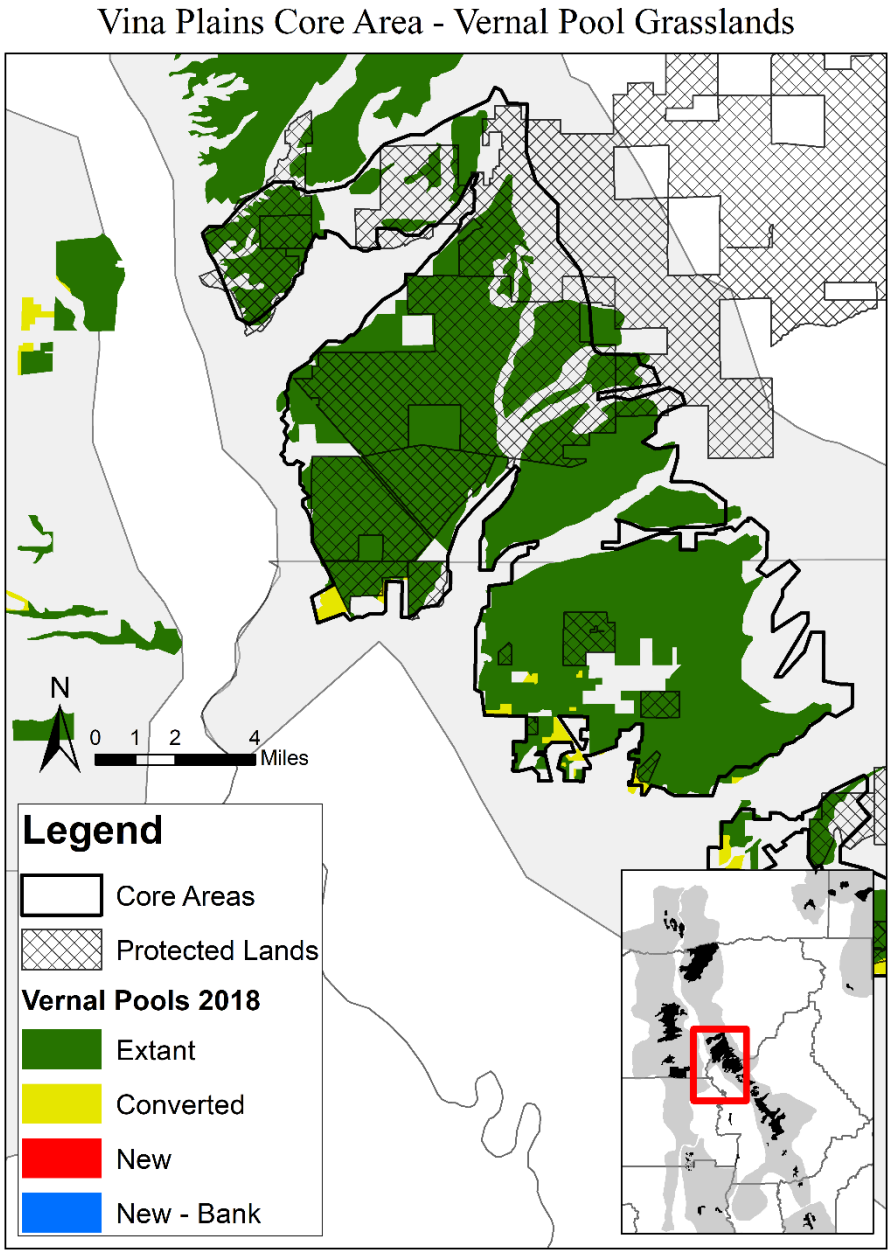


Figure 7.31. Map of vernal pool grassland habitat within the Vina Plains Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

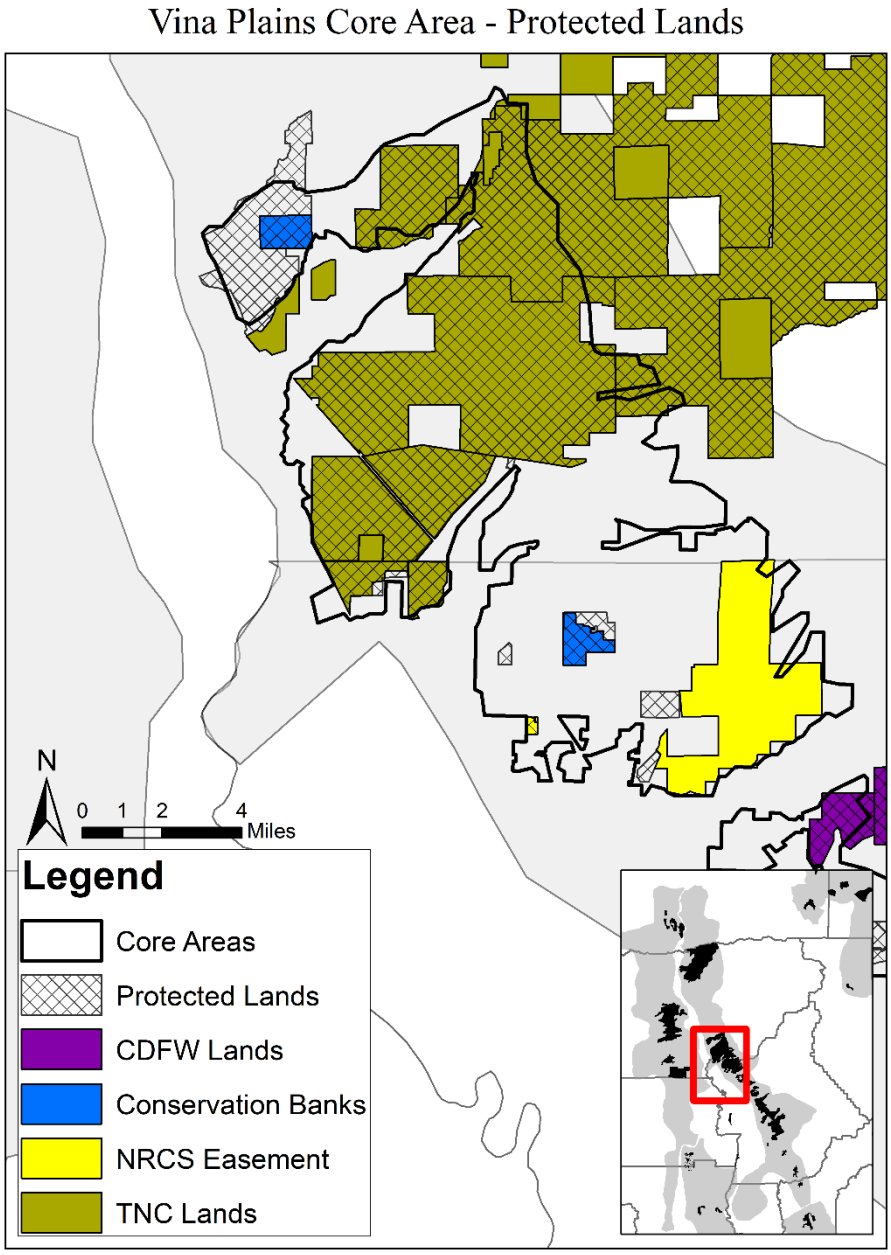


Figure 7.32. Map of protected areas within the Vina Plains Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. NRCS = Natural Resources Conservation Service, TNC = The Nature Conservancy.

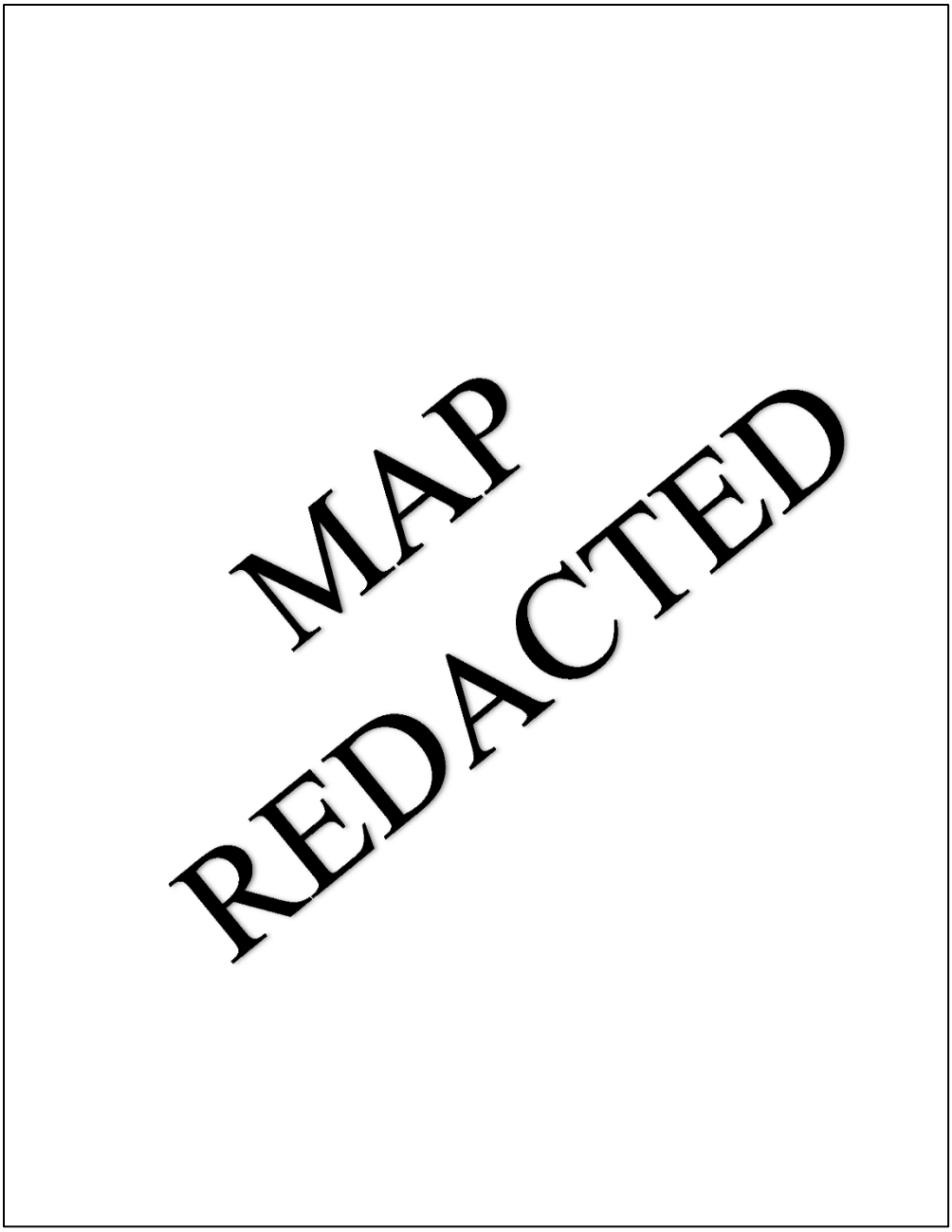


Figure 7.33. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Vina Plains Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

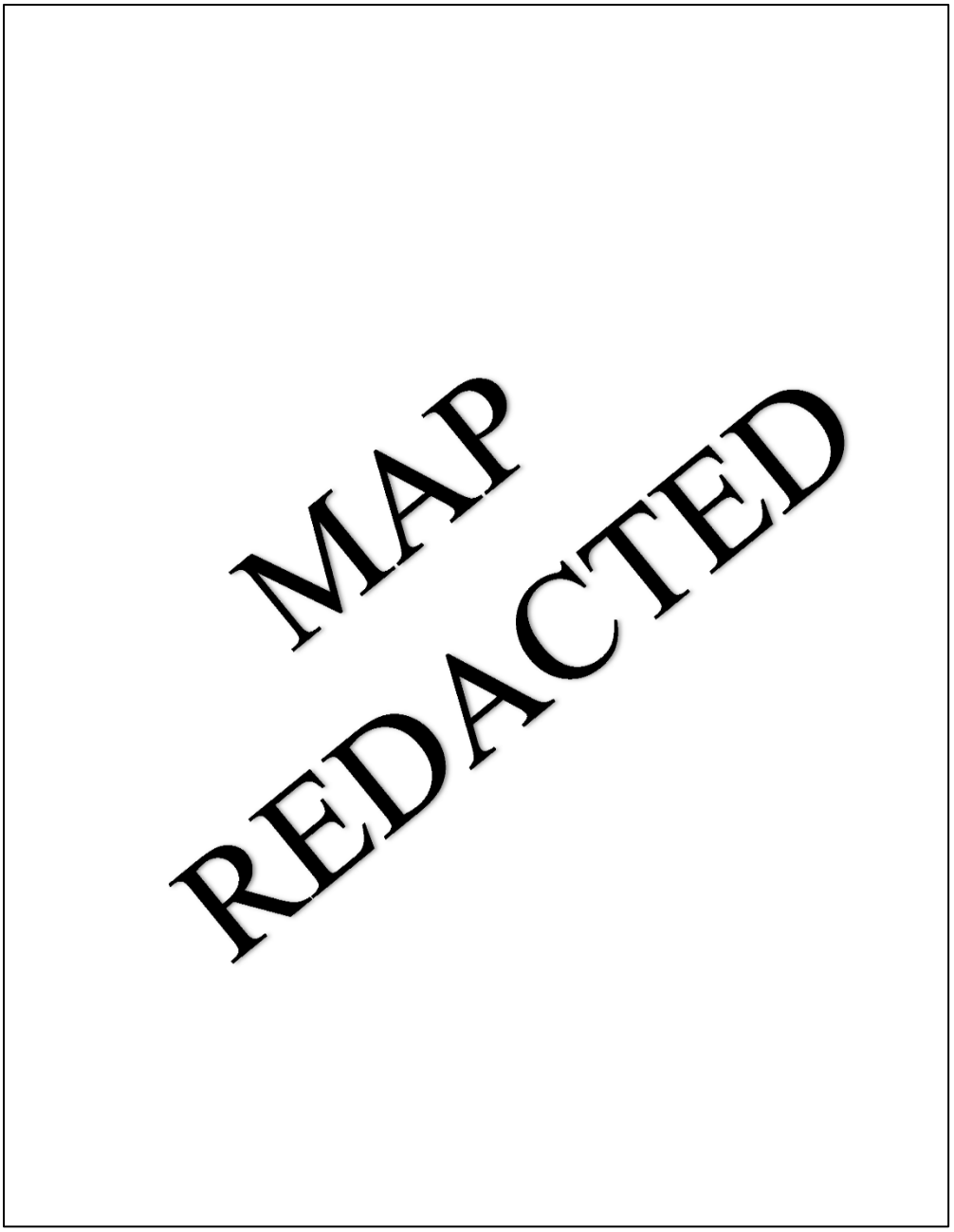


Figure 7.34. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Vina Plains Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

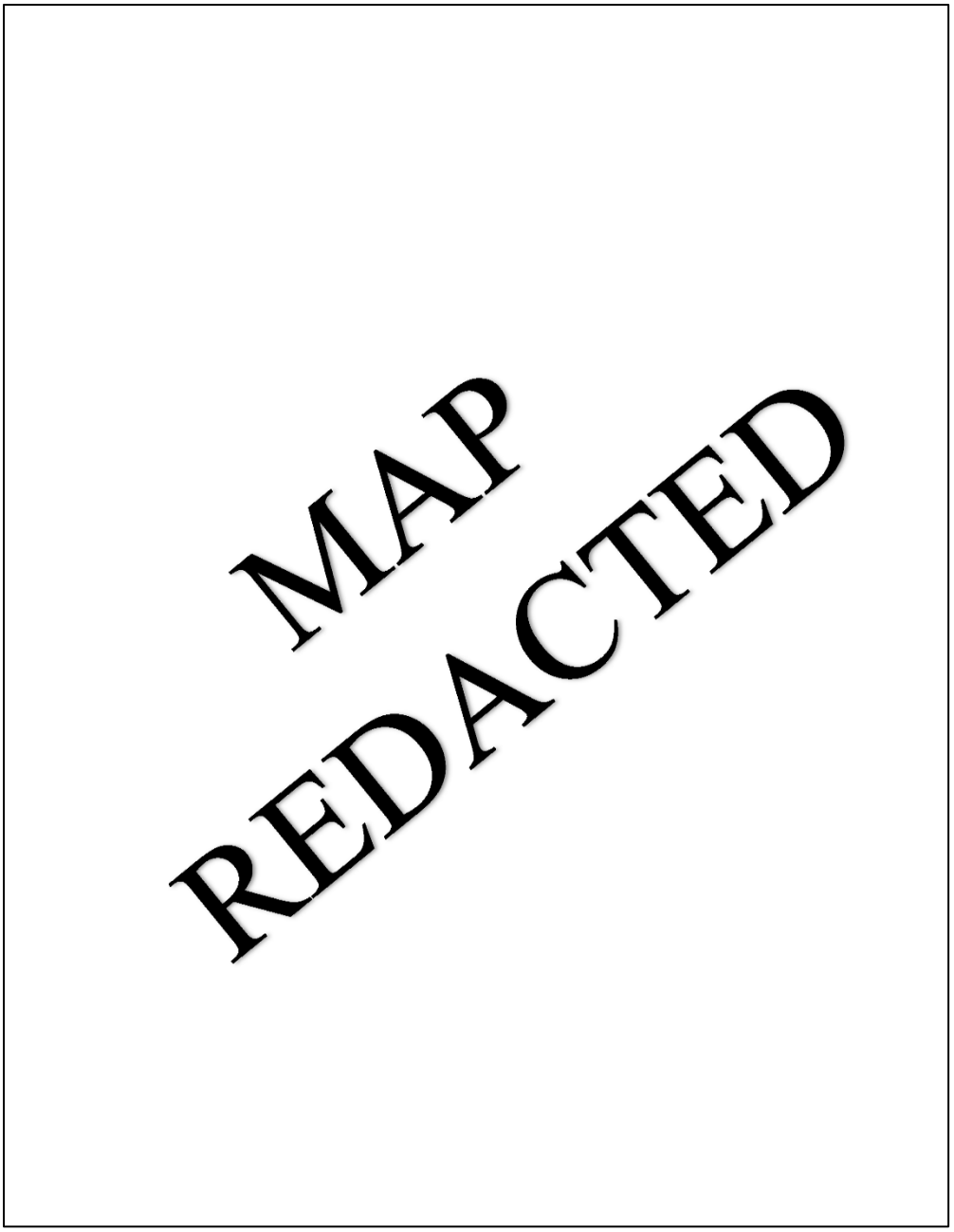


Figure 7.35. Map of known occurrences of Conservancy fairy shrimp recorded in the Diversity Database (2022) within the Vina Plains Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

7.7.8.1.Vernal Pool Fairy Shrimp Occurrences

There are 19 Diversity Database occurrence records for the vernal pool fairy shrimp within this core area (see **Figure 7.33**; Diversity Database 2022). As of 2018, 10 of these occurrences were at least partially within protected areas (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). Of the 19 records, 5 were known at the time of listing in 1994 and 15 were known at the time the Recovery Plan was published in 2005; these records are located throughout the core area, confirming that the majority of vernal pool grasslands in this core area are occupied by the vernal pool fairy shrimp. The four newer records are located very close to the older records.

7.7.8.1.Vernal Pool Tadpole Shrimp Occurrences

There are 21 Diversity Database occurrence records for the vernal pool tadpole shrimp within this core area (see **Figure 7.34**; Diversity Database 2022). As of 2018, 17 of these occurrences were at least partially within protected areas (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). Of the 21 records, 11 were known at the time of listing in 1994 and 18 were known at the time the Recovery Plan was published in 2005; these records are located throughout the core area. The three newer records are located in the southern portion of the core area, one within the Meridian Ranch Mitigation Bank and adjacent Meridian Preserve, one within another mitigation site to the south, and one just south of the Chico State University research site.

7.7.8.1.Conservancy Fairy Shrimp Occurrences

There are 13 Diversity Database occurrence records for the Conservancy fairy shrimp within this core area (see **Figure 7.35**; Diversity Database 2022). As of 2018, 10 of these occurrences were at least partially within protected areas (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). Of the 13 records, 5 were known at the time of listing in 1994 and 11 were known at the time the Recovery Plan was published in 2005; these records are located throughout the core area. The two newer records are both located on Meridian Ranch in the southern portion of the core area. One occurrence was first observed in 2008 on the northern portion of the property (the Meridian Preserve mitigation site) and the other occurrence was first observed in 2012 on the southern portion of the property (the Meridian Ranch Mitigation Bank). Only 6 of the 13 Diversity Database occurrences include observations from more than one year (Diversity Database 2022), though the two occurrences on Hamilton Ranch Conservation Bank have been observed during more recent regular monitoring (Gallaway Enterprises 2020). Seven of the occurrences have been observed somewhat recently (*i.e.*, 2008 or later) and the other six have not been observed since 2003, either because the species was not present during survey efforts or because the sites have not been surveyed recently.

8. NORTHWESTERN SACRAMENTO VALLEY VERNAL POOL REGION

The vernal pool fairy shrimp and vernal pool tadpole shrimp are both known to occur within the Northwestern Sacramento Valley Vernal Pool Region. The Conservancy fairy shrimp is not known to occur within this region.

8.1. Vernal Pool Habitat

Approximately 50,314 acres of vernal pool grassland existed within, or immediately adjacent to, this region when the Recovery Plan was published in 2005 (see **Figure 8.1**, **Table 8.1**; Witham et al. 2013). Approximately 46,016 acres remained as of 2012, with 4,335 acres (8.6% of 2005 total) lost between 2005 and 2012 (Witham et al. 2014). However, 27 acres of new vernal pool grassland were created over that same period on vernal pool mitigation banks and other managed wetlands, and 10 additional acres were identified that were either not present or not visible on the 2005 aerial imagery. Of the habitat lost, 585 acres (13.5%) were to urbanization and 3,750 acres (86.5%) were to agricultural conversion (58.5% to orchards, 27.5% to bare plowed agricultural land, and 0.5% to other agricultural conversions) (Witham et al. 2014).

By 2018, approximately 42,521 acres of vernal pool grassland remained, with a total of 7,830 acres (15.6% of 2005 total) lost between 2005 and 2018 (see **Table 8.1**; Witham 2021). No areas of new vernal pool grassland were identified in the 2018 aerial imagery that were either not present or not visible on both the 2005 and 2012 aerial imagery. Of the habitat lost since 2005, 592 acres (7.6%) were to urbanization and 7,238 acres (92.4%) were to agricultural conversion (82.5% to orchards, 9.0% to bare plowed agricultural land, and 0.9% to other agricultural conversions) (see **Table 8.2**; Witham 2021). Note that most patches of vernal pool grassland that had been converted to bare plowed land in 2012 had been fully converted to agricultural use for orchards by 2018.

This vernal pool region has exhibited the largest percentage of total vernal pool losses and the largest percentage of losses to agricultural conversion within the Central Valley, although other regions do have a greater amount of loss (Witham 2021). The vast majority of vernal pool losses within this region have been to agricultural conversions (92.4%), which is unsurprising given that the region is composed primarily of agricultural lands and very few cities or towns. Many of these losses are likely due to land conversions to orchards that should be regulated by the Clean Water Act but that are proceeding illegally without the necessary 404 permit from the Corps (Witham et al. 2014; Witham 2021). This region also had the second highest amount and percentage of vernal pool grassland lost to urban development, after the Southeastern Sacramento Valley Vernal Pool Region. Almost all of these losses (579 of 592 acres) in this region are associated with the development of a golf course at the Rolling Hills Casino and Resort (Witham 2021).

As of 2018, roughly 4,018 acres of vernal pool grassland was estimated to be protected in this region, or immediately adjacent to it, typically under a conservation easement (see **Figure 8.1**, **Figure 8.2**, **Table 8.1**; Witham 2021; Vollmar et al. 2017). This represents only 8.0% of both the currently remaining vernal pool grassland in the region and the vernal pool grassland that existed in the region in 2005, the Recovery Plan's baseline. This region has both the lowest amount and

lowest percentage of protected vernal pool grasslands of all the vernal pool regions that are entirely within the Central Valley.

8.2. Species Occurrences

8.2.1. Vernal Pool Fairy Shrimp

There are 29 occurrence records of the vernal pool fairy shrimp documented within, or immediately adjacent to, the Northwestern Sacramento Valley Vernal Pool Region in the Diversity Database (see **Figure 8.3**; Diversity Database 2022). The majority of these occurrences are on privately owned land and are therefore vulnerable to extirpation. Of these 29 occurrences, all are listed by the Diversity Database as presumed extant, though 1 occurrence is within extirpated vernal pool habitat based on Witham's (2021) mapping efforts. There are also six occurrences that are outside of vernal pool habitat mapped by Witham (2021). It is likely that some of the occurrences that are presumed extant are no longer extant, but have not been surveyed recently, particularly given the amount of habitat loss in the region.

The protected areas contain, at least partially, 8 of the 29 Diversity Database records (28%) for the vernal pool fairy shrimp in this region. However, this does not mean that 28% of all occurrences of the vernal pool fairy shrimp in this region have been protected, as the Diversity Database is not an appropriate source for determining all known occurrences (individual Diversity Database records are not necessarily equivalent to occurrences, and some known occurrences may not be documented in the Diversity Database). Only 3 of the 29 Diversity Database polygons (10%) are entirely within the protected areas.

8.2.2. Vernal Pool Tadpole Shrimp

There are 24 occurrence records of the vernal pool tadpole shrimp documented within the Northwestern Sacramento Valley Vernal Pool Region in the Diversity Database (see **Figure 8.4**; Diversity Database 2022). The majority of these occurrences are on privately owned land and are therefore vulnerable to extirpation. Of these 24 occurrences, all are listed by the Diversity Database as presumed extant; 17 are within extant vernal pool grasslands and 7 are outside of vernal pool grasslands mapped by Witham (2021). It is likely that some of the occurrences that are presumed extant are no longer extant, but have not been surveyed recently, particularly given the amount of habitat loss in the region.

The protected areas contain, at least partially, 10 of the 24 Diversity Database records (42%) for the vernal pool tadpole shrimp in this region. Only 2 of the 24 Diversity Database polygons (8%) are entirely within the protected areas.

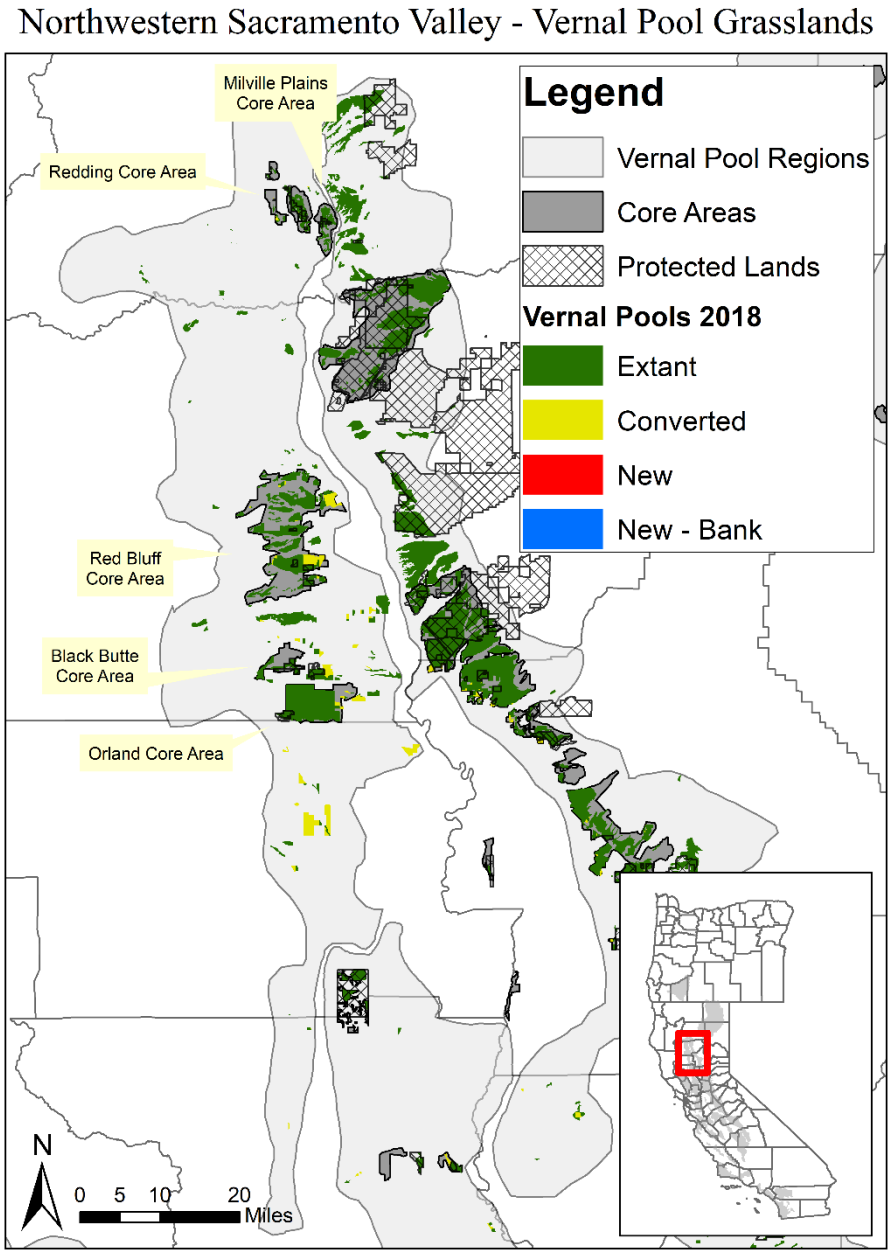


Figure 8.1. Map of vernal pool habitat within the Northwestern Sacramento Valley Vernal Pool Region mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

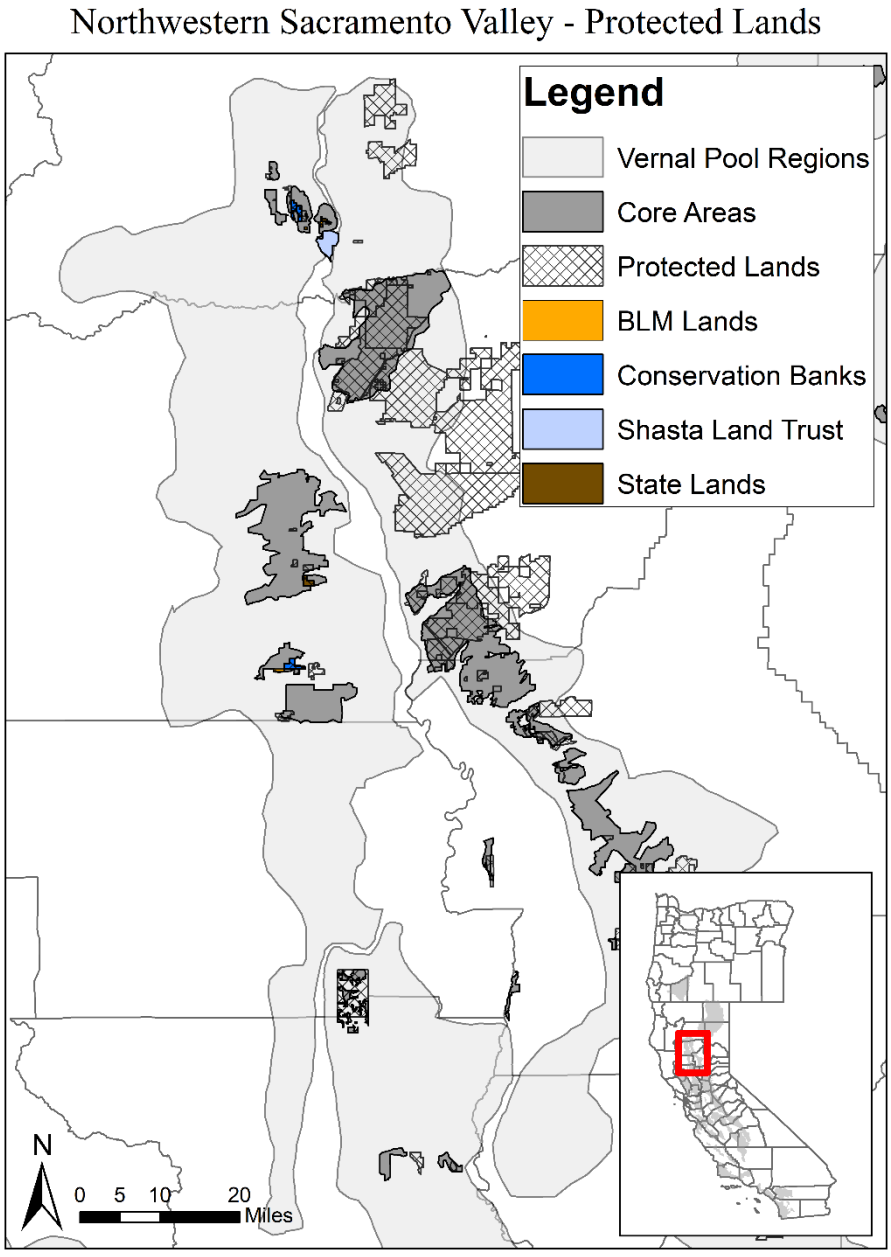


Figure 8.2. Map of protected areas that contain vernal pool grassland habitat and/or vernal pool fairy shrimp or vernal pool tadpole within the Northwestern Sacramento Valley Vernal Pool Region**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. Zoom in for finer resolution. BLM = Bureau of Land Management.

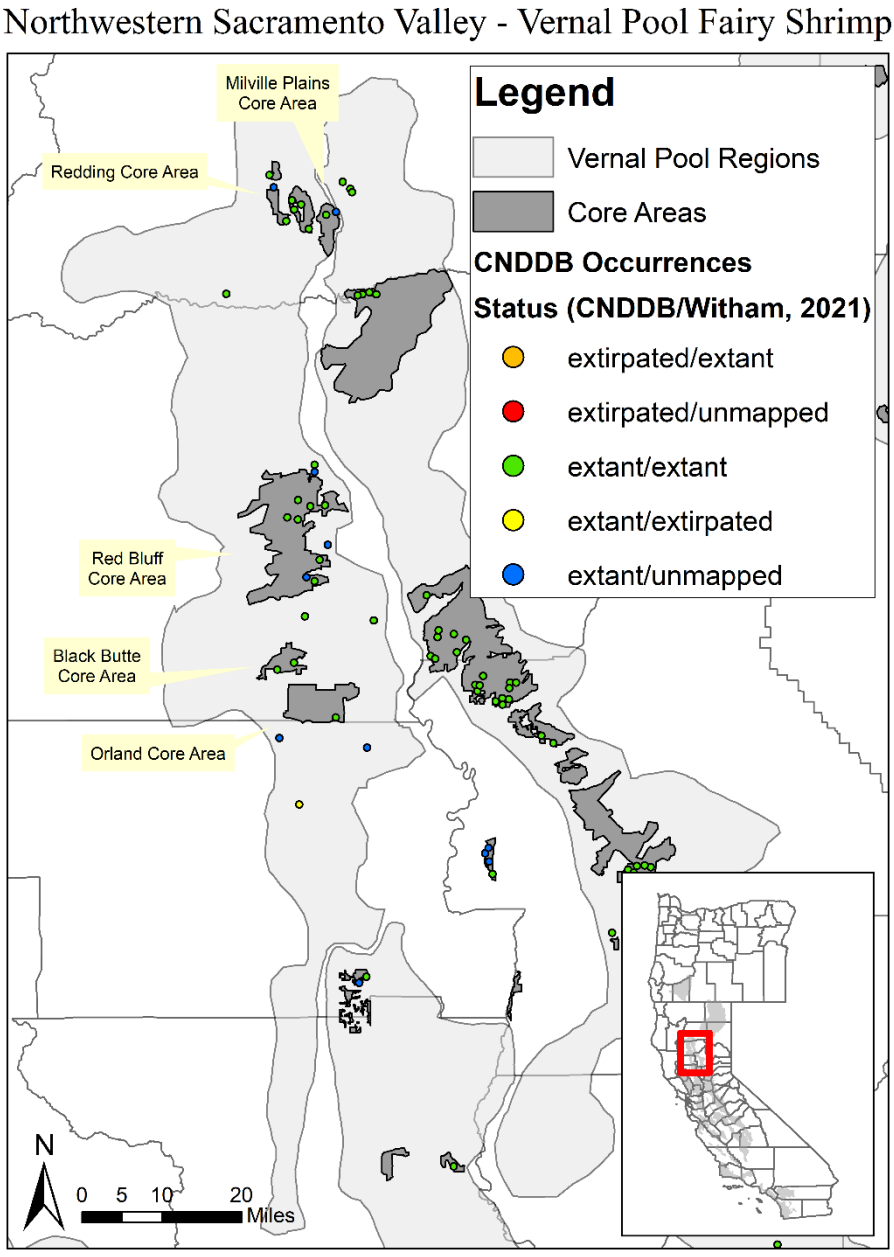


Figure 8.3. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) in the Northwestern Sacramento Valley Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both Diversity Database occurrence records and Witham's (2021) map of vernal pool habitat.

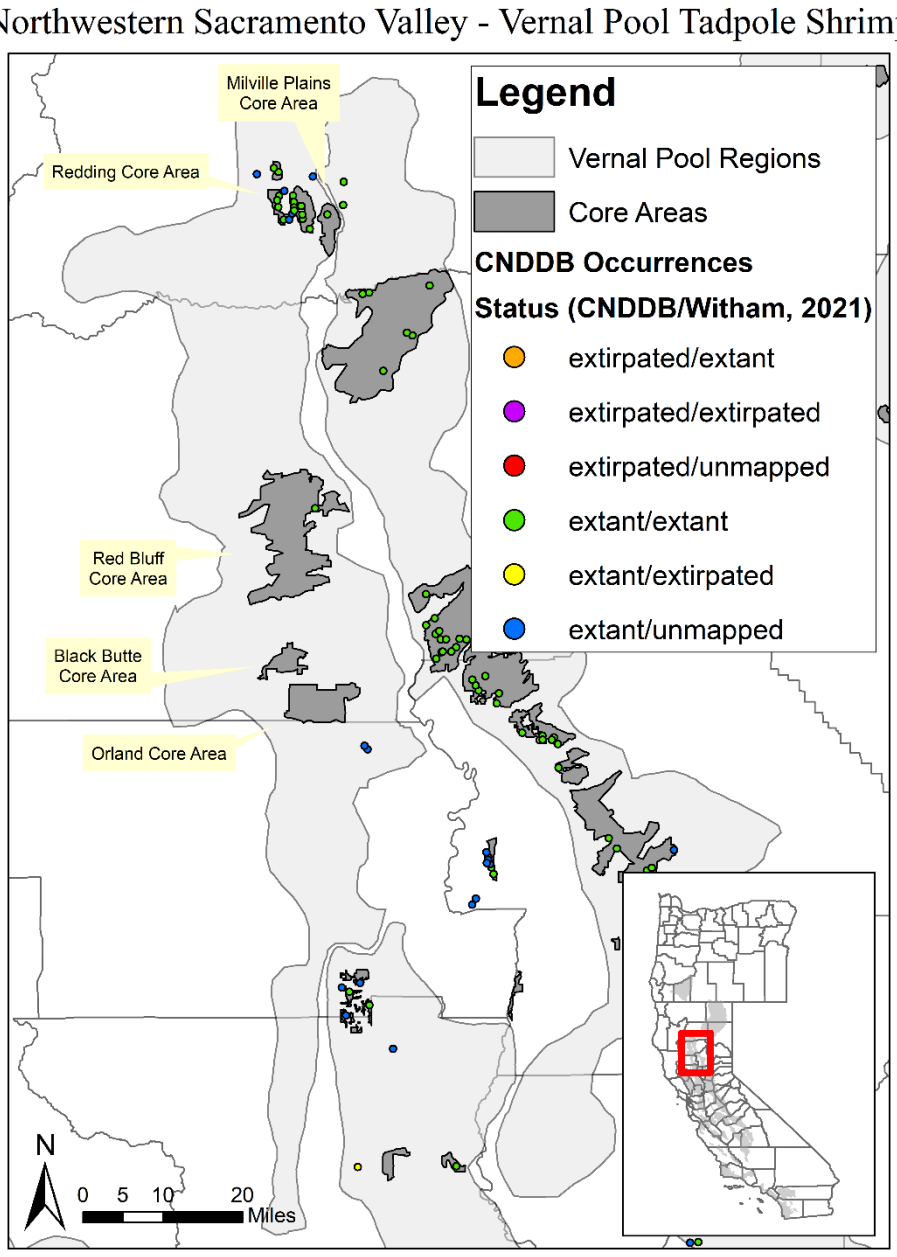


Figure 8.4. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) in the Northwestern Sacramento Valley Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both Diversity Database occurrence records and Witham's (2021) map of vernal pool habitat. All 5 core areas in the region are displayed, though not all core areas are designated for the vernal pool tadpole shrimp.

Table 8.1. Acreage of vernal pool habitat and habitat converted within the Northwestern Sacramento Valley Vernal Pool Region mapped by Witham (2021). All habitat labeled as not converted, altered, or new was considered extant. Protected acreage is based on Vollmar et al. (2017).

Core Area	2005 Acres	2018 Acres Total	2018 Acres Extant (% of Total)	2018 Acres Converted – Agriculture (% of Total)	2018 Acres Converted – Urban Development (% of Total)	2018 Acres Protected (% of Total)
Black Butte	1,360.5	1,360.5	1,360.5 (100.0%)	0.0 (0.0%)	0.0 (0.0%)	625.4 (46.0%)
Millville Plains	1,751.8	1,751.8	1,751.8 (100.0%)	0.0 (0.0%)	0.0 (0.0%)	268.8 (15.3%)
Orland	10,173.2	10,173.2	9,913.2 (97.4%)	260.0 (2.6%)	0.0 (0.0%)	389.8 (3.8%)
Red Bluff	17,078.8	17,078.8	14,965.1 (87.6%)	2,111.8 (12.4%)	1.8 (<0.1%)	903.1 (5.3%)
Redding	1,812.3	1,812.8	1,766.8 (97.5%)	44.8 (2.5%)	1.2 (0.1%)	425.3 (23.5%)
Northwestern Sacramento Valley Vernal Pool Region Total	**50,313.9**	**50,350.6**	**42,521.1 (84.5%)**	**7,237.9 (14.4%)**	**591.7 (1.2%)**	**4,017.8 (8.0%)**

Table 8.2. Acreage of vernal pool habitat losses within the Northwestern Sacramento Valley Vernal Pool Region between 2005 and 2018 mapped by Witham (2021), broken down by what the land use was converted to. All categories besides urban development and managed wetlands are considered agricultural conversions.

Core Area	Urban, Commercial, & Industrial	Orchards, Vineyards, Eucalyptus	Alfalfa and Irrigated Pasture	Bare Plowed Agricultural Lands	Other Ag (Rice, Row Crops, Dairy,	Agricultural Residential	Managed Wetlands	Total Losses	% Losses Urban Development	% Losses Agricultural Conversions
Black Butte	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Millville Plains	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Orland	0.0	230.4	0.0	29.6	0.0	0.0	0.0	260.0	0.0%	100.0%
Red Bluff	1.8	1,905.9	17.6	180.9	0.0	7.4	0.0	2,113.6	0.1%	99.9%
Redding	1.2	0.0	0.0	44.8	0.0	0.0	0.0	45.9	2.6%	97.4%
Northwestern Sacramento Valley Vernal Pool Region Total	**591.7**	**6,458.8**	**24.7**	**708.5**	**31.5**	**14.3**	**0.0**	**7,829.5**	**7.6%**	**92.4%**

8.3. Federal Lands

8.3.1. National Wildlife Refuges

There are no National Wildlife Refuges with known occurrences of the vernal pool fairy shrimp or vernal pool tadpole shrimp in the Northwestern Sacramento Valley Vernal Pool Region.

8.3.2. Military Lands

There are no military lands with known occurrences of the vernal pool fairy shrimp or vernal pool tadpole shrimp in the Northwestern Sacramento Valley Vernal Pool Region.

8.3.3. Bureau of Land Management

There are three small parcels of land owned by the Bureau of Land Management (BLM) within this vernal pool region that contain vernal pool grasslands (**Figure 8.2**). Two small parcels, approximately 42 acres each, are located in southern Shasta County, one in the Redding Core Area and one in the Millville Core Area. The parcel within the Redding Core Area has been designated as the Hawes Corner Area of Critical Environmental Concern and contains a vernal pool fairy shrimp occurrence from 1988 and a vernal pool tadpole shrimp occurrence that was documented in 1938 and again in 1988 (Diversity Database 2022). Two vernal pools have been mapped by BLM within the Hawes Corner parcel, but they were not surveyed during BLM surveys in 2017-2019 (BLM 2017b; BLM 2018; BLM 2019b). The third parcel is located in southern Tehama County within the Black Butte Core Area, is approximately 163 acres in size, and is called the Corning Parcel. The vernal pool fairy shrimp was documented here for the first time within 24 pools in 2019 during BLM surveys (BLM 2019b). The vernal pool tadpole shrimp has not been documented on the Corning Parcel (BLM 2019b). The BLM's Redding Field Office, which covers Butte, Tehama, Shasta, Trinity, and Siskiyou Counties, is currently revising its Resource Management Plan and will be proposing the Corning Parcel for designation as an Area of Critical Environmental Concern due to the high concentration of vernal pools with vernal pool fairy shrimp (Laymon, *in litt*. 2022).

8.3.4. Other Federal Lands

There are no other federal lands with known occurrences of the vernal pool fairy shrimp or vernal pool tadpole shrimp in the Northwestern Sacramento Valley Vernal Pool Region.

8.4. Conservation Banks

There are two conservation banks within the Northwestern Sacramento Valley Vernal Pool Region that provides credits for preserved or created vernal pools that support the vernal pool fairy shrimp: Blackburn Vernal Pool Conservation Bank and Stillwater Plains Mitigation Bank (see **Figure 8.2**; RIBITS 2021). The Stillwater Plains Mitigation Bank also provides credits for preserved and created vernal pools that support the vernal pool tadpole shrimp.

Blackburn is a 631-acre bank located in southern Tehama County, west of Interstate 5. The bank was established in 2006 and is currently operating under its long-term management plan; monitoring for the vernal pool fairy shrimp was last conducted in 2016 and will occur every 10

years (Wildlands 2016). Surveys in 2016 found the vernal pool fairy shrimp in 45 vernal pools (60%) of the 75 pools sampled throughout the bank, which is a higher occupancy rate than the 33% occupancy observed during baseline monitoring. Overall management of the bank consists of livestock grazing in addition to the long-term monitoring, and vernal pool hydrology and floristics demonstrate continuing successful ecosystem function (Wildlands 2016). The bank has sold 2.226 of its 36.24 total vernal pool fairy shrimp preservation credits (RIBITS 2021).

Stillwater Plains Mitigation Bank is an 834-acre multi-phase bank located in southern Shasta County south of Redding. The first phase of the bank was established in 2000 and the second and third phases were established in 2006. Parts of the bank are dedicated to vernal pool complexes and other parts to elderberry shrubs for the valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*). Unlike other banks, the credits are not designated as species credits for the vernal pool shrimp species, but the vernal pool complexes are known to support the vernal pool fairy shrimp and vernal pool tadpole shrimp (Diversity Database 2022). The long-term management goal for various types of wetlands within the bank, including vernal pools and swales, is to maintain the biological integrity and diversity of the wetland systems in terms of plant species composition and cover, hydrology, and the absence of invasive species (May Consulting Services 2000). Grazing is the primary management tool, with the option for using prescribed fire or herbicides in limited instances. Monitoring for vernal pool shrimp species will occur every three years. The bank has sold 29.1 of its 70.4 vernal pool or swale preservation credits and 40.8 of its 47.9 vernal pool or swale creation credits (RIBITS 2021).

8.5. Habitat Conservation Plans

There is one regional Habitat Conservation Plan (HCP) within the Northwestern Sacramento Valley Vernal Pool Region that includes the three shrimp species as Covered Species.

8.5.1. PG&E Multiple Region Operations and Maintenance HCP

See section 2.5.1 for a description of this HCP.

8.6. Other Preserves

The California Department of Fish and Wildlife (CDFW) owns the 443-acre Thomes Creek Ecological Reserve in Tehama County located on the south side of Gyle Road just west of the intersection with I-5. The entire property consists of small vernal pools less than 0.1-acre in size on either side of Thomes Creek (Lis, *in litt*. 2023), though Witham's (2021) mapping only identified 346 acres as vernal pool grassland. The vernal pool fairy shrimp was identified within this area during multiple years throughout the 1990's, and the most recent detection was in 2012; the vernal pool tadpole shrimp has not been identified within this Ecological Reserve (Diversity Database 2022). Due to the small size of the pools, the pools did not fill with water during the 2018-2022 drought years (Lis, *in litt*. 2023). There is no management plan for the Ecological Reserve, and regular monitoring has been difficult due to difficulty accessing the site and the short time period that these small vernal pools hold water (Lis, *in litt*. 2023). CDFW also holds conservation easements on three properties in Shasta County southeast of the City of Redding and northeast of the City of Anderson: Shaw, Honker Way, and Millville Plains. These easements are 9 acres, 83 acres, and 116 acres in size, respectively, and are all mapped entirely

as vernal pool grasslands (Witham 2021). The vernal pool fairy shrimp and vernal pool tadpole shrimp have not been documented within these easements (Diversity Database 2022) and CDFW staff have not visited these sites since 2008 or 2009 and are not aware of when the vernal pools were most recently sampled (Lis, *in litt*. 2023). Technically, one Diversity Database occurrence for the vernal pool tadpole shrimp does overlap the eastern edge of the Millville Plains conservation easement; however, this was an occurrence that was reported as along Millville Plains Road, and, because there was no more detail, the occurrence was mapped to include all 7 miles of Millville Plains Road. There is one other occurrence immediately north of the easements as well as several occurrences of the vernal pool fairy shrimp nearby (Diversity Database 2022), so it is possible that the vernal pool fairy shrimp and vernal pool tadpole shrimp are present within these easements.

The Shasta Land Trust holds conservation easements over one property in this region that has vernal pool grasslands mapped by Witham (2021): Fenwood Ranch. The 2,242-acre Fenwood Ranch is mostly within this vernal pool region, although it does extend slightly into the Northeastern Sacramento Valley Vernal Pool Region as well. This property is verified by Shasta Land Trust to have vernal pool habitat onsite, while the other properties in the area have wetland features, but not distinctively vernal pool habitat (Blevins, *in litt*. 2022). There is no specific management plan for this property, and species monitoring is not typically conducted (Blevins, *in litt*. 2022). Fenwood Ranch was not included in Vollmar et al.'s (2017) database of protected lands; thus, an additional 444 acres of vernal pool habitat mapped by Witham (2021) is estimated to be protected in the Northwestern Sacramento Valley Vernal Pool Region within Fenwood Ranch.

Vollmar et al. (2017) identified 12 other protected properties within the Northwestern Sacramento Valley Vernal Pool Region, all of which are protected by a conservation easement. There are four mitigation properties that have been protected, likely as part of proposed conservation measures during Section 7 interagency consultations; three of the conservation easements are held by Wildlife Heritage Foundation and one is held by the City of Redding. There are also seven properties that have a conservation easement held by the Natural Resources Conservation Service (NRCS) and one that has a conservation easement held by the U.S. Bureau of Reclamation (BOR). Vollmar et al. (2017) also depict the entire 791-acre Blackburn property as protected, although the Service is only aware of the 631-acre Blackburn Vernal Pool Conservation Bank being protected, and not the additional 160 acres.

8.7. Vernal Pool Core Areas

There are three Core Areas within the Northwestern Sacramento Valley Vernal Pool Region that are designated in the Recovery Plan for the vernal pool fairy shrimp: Orland, Red Bluff, and Redding. There are also two additional Core Areas that were not designated for the vernal pool fairy shrimp in the Recovery Plan, but that have known occurrences of the species in the Diversity Database: Black Butte and Millville Plains (Diversity Database 2022). For both of these two core areas, at least one of the Diversity Database occurrences includes information about surveys that occurred before 2005, so the two core areas likely should have been designated for the vernal pool fairy shrimp in the Recovery Plan; however, it is possible that these occurrence records were not uploaded to the Diversity Database until after 2005. None of the five core areas have met the target of 85% of vernal pool habitat protected, but as of 2018

none had lost more than 13% of the baseline level of habitat that was present in 2005 (see **Table 8.1**; Vollmar et al. 2017; Witham 2021).

There are two Core Areas within the Northwestern Sacramento Valley Vernal Pool Region that are designated in the Recovery Plan for the vernal pool tadpole shrimp: Red Bluff and Redding. There is also one additional Core Area that was not designated for the vernal pool tadpole shrimp in the Recovery Plan, but that has known occurrences of the species in the Diversity Database: Millville Plains (Diversity Database 2022). The vernal pool tadpole shrimp was not definitively identified in the Millville Plains Core Area until 2012, which is why this core area was not designated for the vernal pool tadpole shrimp in the Recovery Plan. None of the three core areas have met the target of 85% of vernal pool habitat protected, but as of 2018 none had lost more than 13% of the baseline level of habitat that was present in 2005 (see **Table 8.1**; Vollmar et al. 2017; Witham 2021).

8.7.1. Black Butte

This is a zone 2 core area, but it was not designated for the vernal pool fairy shrimp in the Recovery Plan. It was designated for Boggs Lake hedge-hyssop (*Gratiola heterosepala*) and legenere (*Legenere limosa*), with a goal of protecting 85% of vernal pool habitat. The core area is located in southern Tehama County west of Interstate 5 between the cities of Orland and Corning.

There were approximately 1,361 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were still 1,361 acres of vernal pool grassland remaining, with no habitat losses occurring since 2005 (see **Figure 8.5**, **Table 8.1**; Witham 2021). Roughly 625 acres of vernal pool grassland were protected within this core area as of 2017 (Vollmar et al. 2017), representing 46% of the 2005 baseline.

Protected areas within this core area include the Blackburn Vernal Pool Conservation Bank and BLM's Corning Parcel (**Figure 8.6**). Vollmar et al.'s (2017) database depicts the entire 791-acre Blackburn property as protected, although the Conservation Bank is only composed of a 631-acre portion of the property. The Service is unaware if the remaining parcel is in fact protected as depicted by Vollmar et al. (2017) or if this was simply a mistake.

8.7.1.1.Vernal Pool Fairy Shrimp Occurrences

There are two Diversity Database occurrence records for the vernal pool fairy shrimp within this core area (see **Figure 8.7**; Diversity Database 2022). As of 2018, both of these occurrences were at least partially within protected areas (Vollmar et al. 2017). Both occurrences are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). The western occurrence is almost entirely within the Blackburn Vernal Pool Conservation Bank and the vernal pool fairy shrimp was most recently found here in 2016 (Wildlands 2016). This occurrence was first documented in 1992 (Diversity Database 2022), and thus the Recovery Plan likely should have designated this core area for the vernal pool fairy shrimp. The eastern occurrence is within the Corning Parcel owned by BLM, and the vernal pool fairy shrimp was first documented here during BLM surveys in 2019 (BLM 2019b).

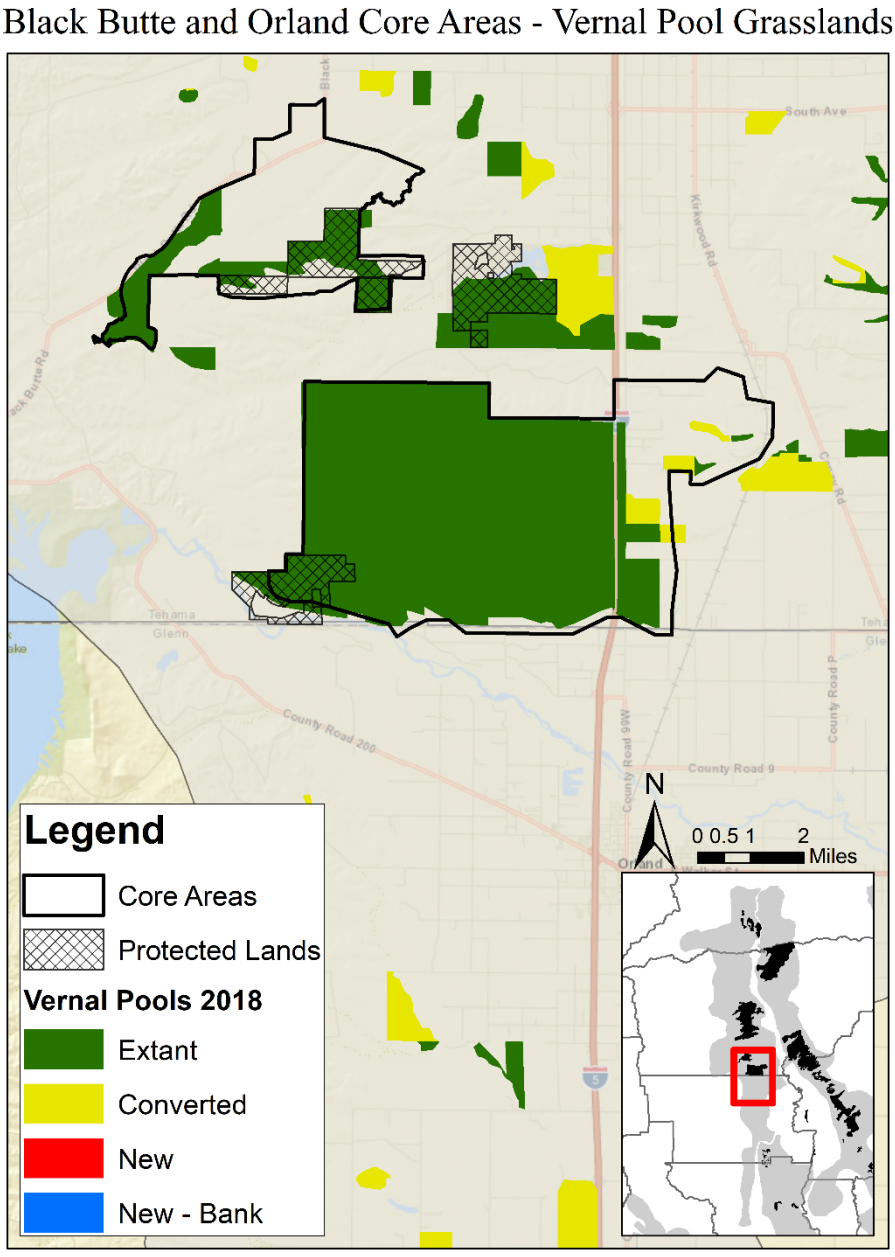


Figure 8.5. Map of vernal pool grassland habitat within the Black Butte (north) and Orland (south) Core Areas mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

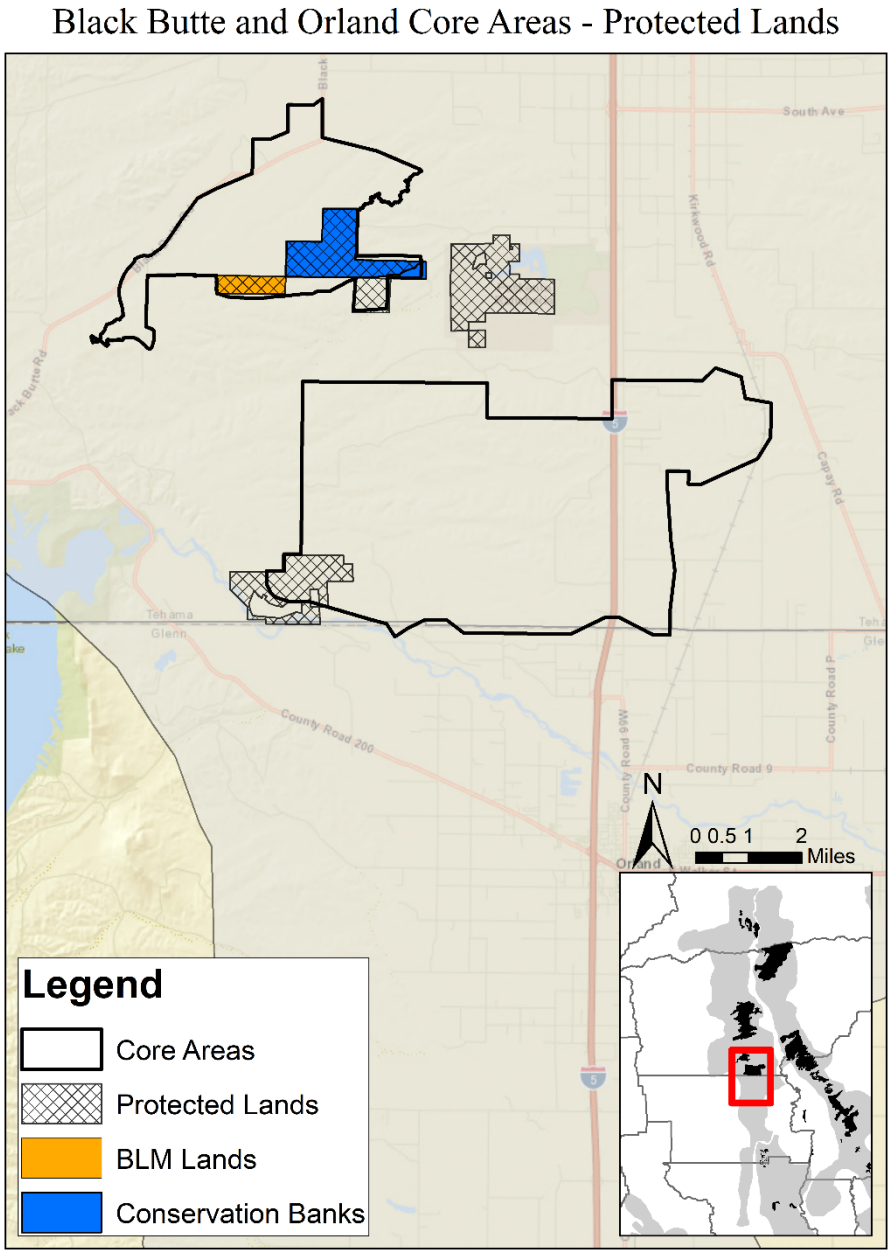


Figure 8.6. Map of protected areas within the Black Butte (north) and Orland (south) Core Areas**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. BLM = Bureau of Land Management.

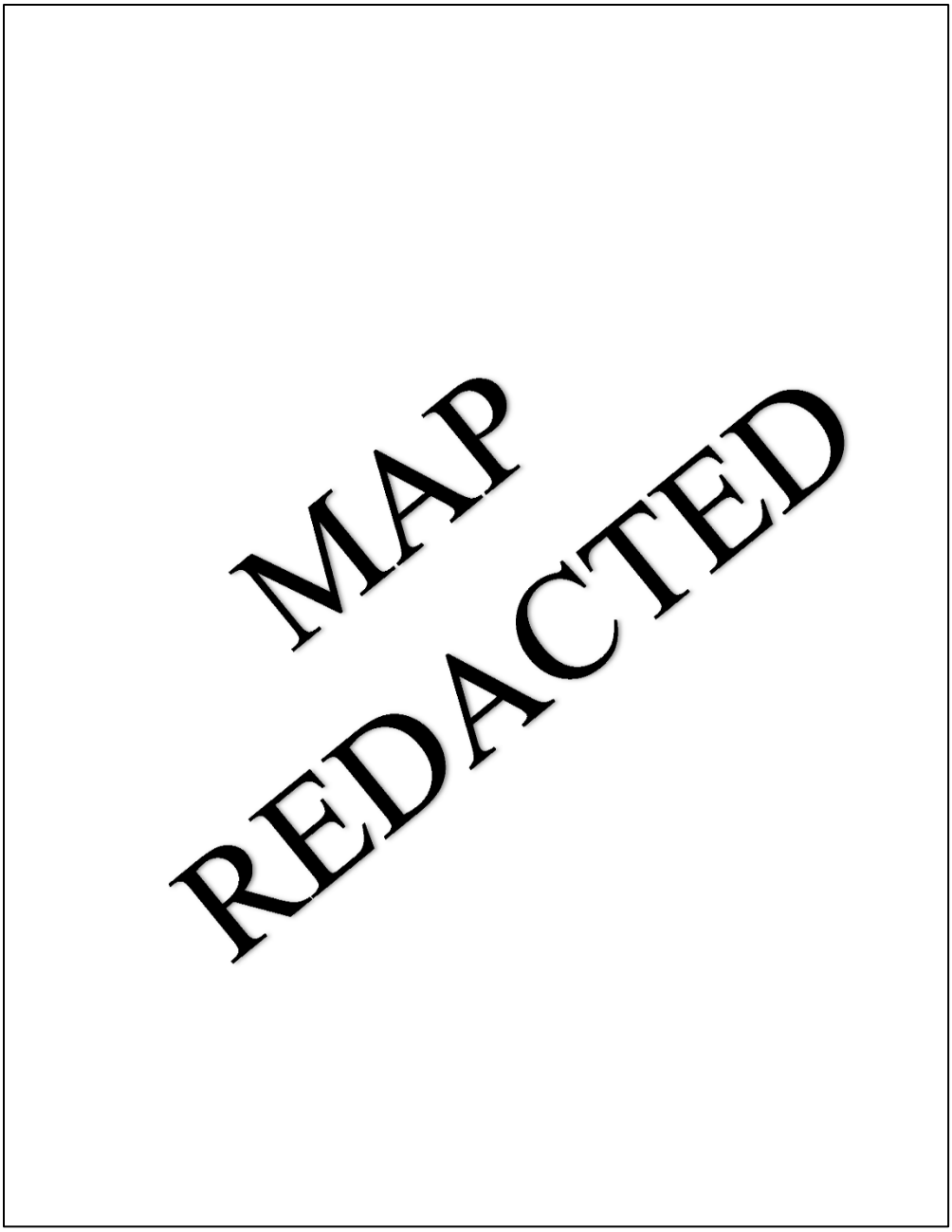


Figure 8.7. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Black Butte (north) and Orland (south) Core Areas. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

8.7.2. Millville Plains

This is a zone 2 core area, but it was not designated for the vernal pool fairy shrimp or vernal pool tadpole shrimp in the Recovery Plan. It was designated for slender Orcutt grass (*Orcuttia tenuis*), with a goal of protecting 85% of vernal pool habitat. The core area is located in Shasta County southeast of the City of Redding.

There were approximately 1,752 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were still 1,752 acres of vernal pool grassland remaining, with no habitat losses occurring since 2005 (see **Figure 8.8**, **Table 8.1**; Witham 2021). Vollmar et al. (2017) estimated that there were roughly 269 acres of vernal pool grassland were protected within this core area as of 2017 (Vollmar et al. 2017), representing 15.3% of the 2005 baseline. An additional 444 acres of vernal pool grassland mapped by Witham (2021) is protected within the Fenwood Ranch conservation easement held by Shasta Land Trust, for a total of 713 acres protected, representing 40.7% of the 2005 baseline.

Protected areas within this core area include the Fenwood Ranch conservation easement held by Shasta Land Trust, the 42-acre BLM parcel, and the Millville Plains and Honker Way conservation easements held by CDFW (**Figure 8.9**).

8.7.2.1. Vernal Pool Fairy Shrimp Occurrences

There are two Diversity Database occurrence records for the vernal pool fairy shrimp within this core area (see **Figure 8.10**; Diversity Database 2022). As of 2018, neither of these occurrences were within protected areas (Vollmar et al. 2017). Both occurrences are presumed extant by the Diversity Database; one is within extant mapped vernal pool grasslands and one is outside of mapped vernal pool grasslands (Witham 2021). The vernal pool fairy shrimp was documented within the eastern occurrence in 1993 and 1994 (Diversity Database 2022), and thus the Recovery Plan likely should have designated this core area for the vernal pool fairy shrimp. This occurrence has not been surveyed since 1994. The western occurrence was first documented in 2012 (Diversity Database 2022) and has not been surveyed since, to the Service's knowledge.

8.7.2.2. Vernal Pool Tadpole Shrimp Occurrences

There are two Diversity Database occurrence records for the vernal pool tadpole shrimp within this core area (see **Figure 8.11**; Diversity Database 2022). As of 2018, neither of these occurrences were within protected areas (Vollmar et al. 2017). Both occurrences are presumed extant by the Diversity Database; one is within extant mapped vernal pool grasslands and one is outside of mapped vernal pool grasslands (Witham 2021). One occurrence spans the entire length of Millville Plains Road across the Northwestern and Northeastern Sacramento Valley Vernal Pool Regions; the description of the location was only "along Millville Plains Road", so the Diversity Database mapped the occurrence to the entirety of the road (Diversity Database 2022). This occurrence was documented in 1994 (Diversity Database 2022), but the Recovery Plan likely did not designate this core area for the vernal pool tadpole shrimp at the time due to the vagueness of the occurrence's location. The other occurrence was first documented in 2012 just north of CDFW's Honker Way and Millville Plains conservation easements; at the time of the survey the property was proposed as a mitigation bank (Diversity Database 2022).

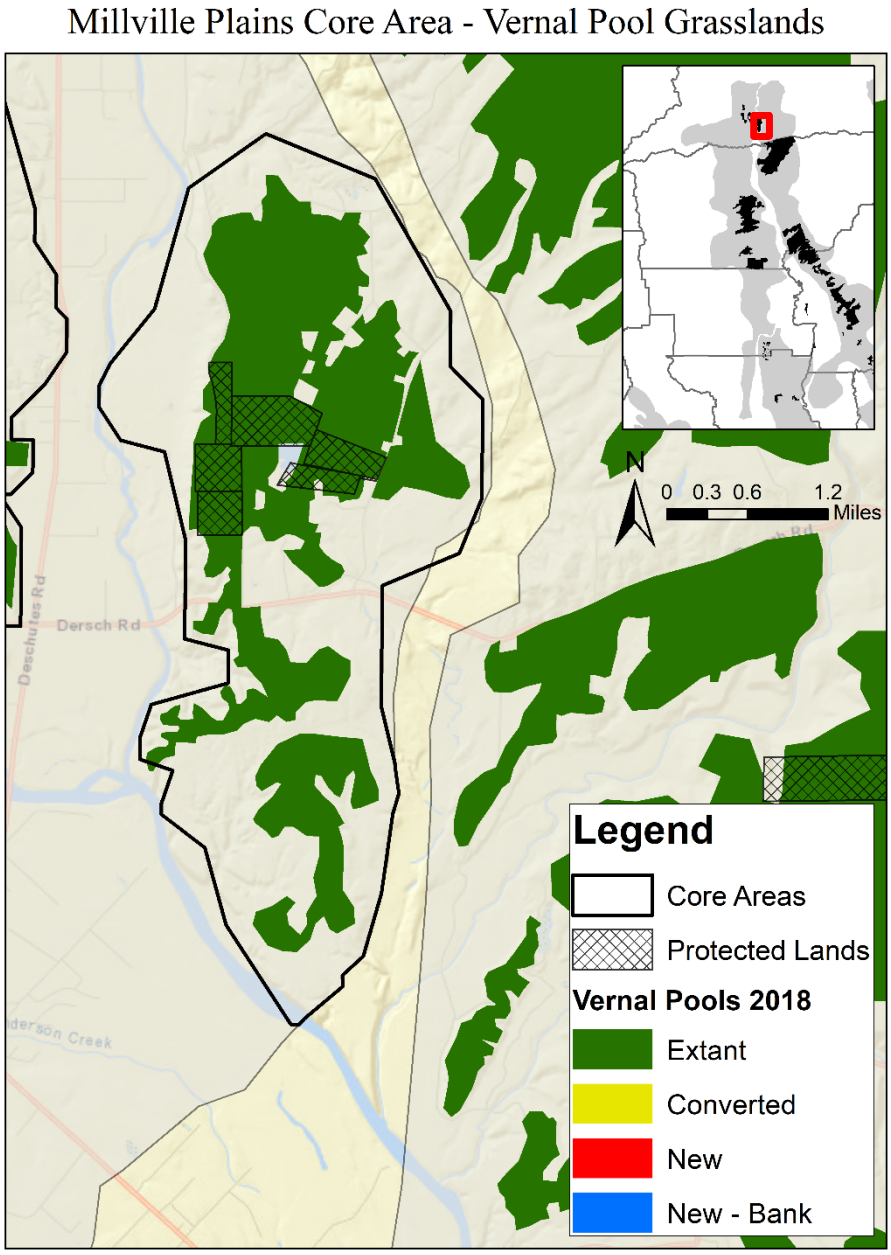


Figure 8.8. Map of vernal pool grassland habitat within the Millville Plains Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

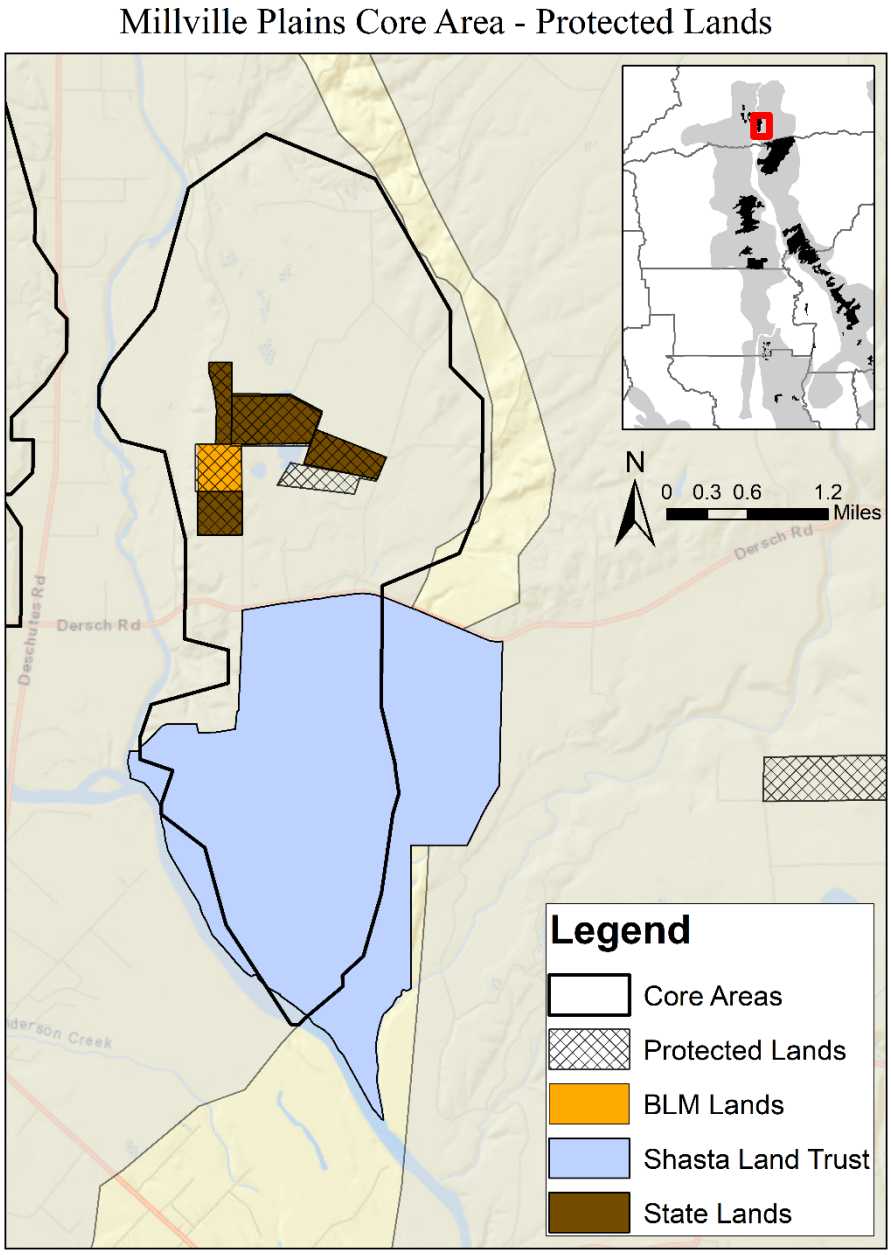


Figure 8.9. Map of protected areas within the Millville Plains Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. BLM = Bureau Land Management.

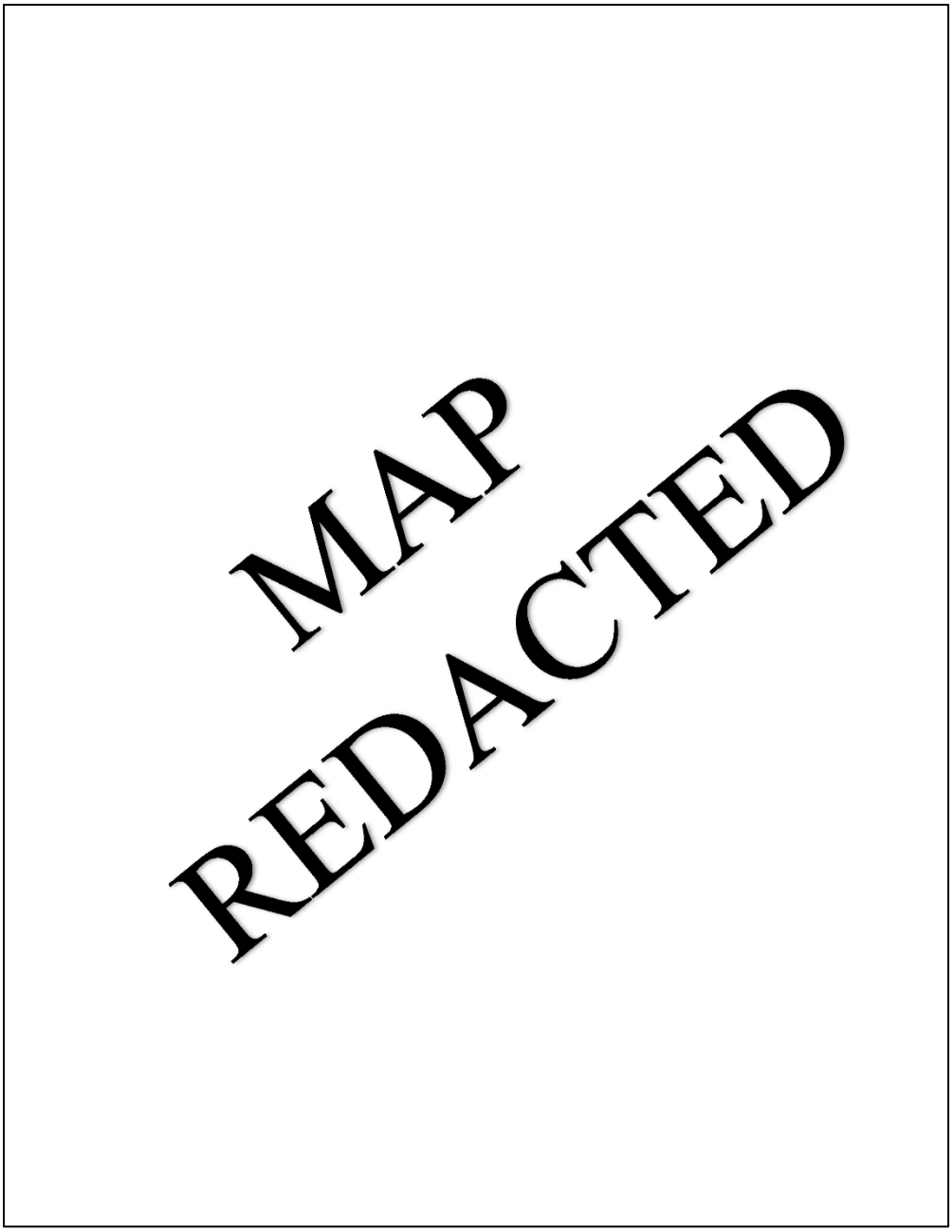


Figure 8.10. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Millville Plains Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

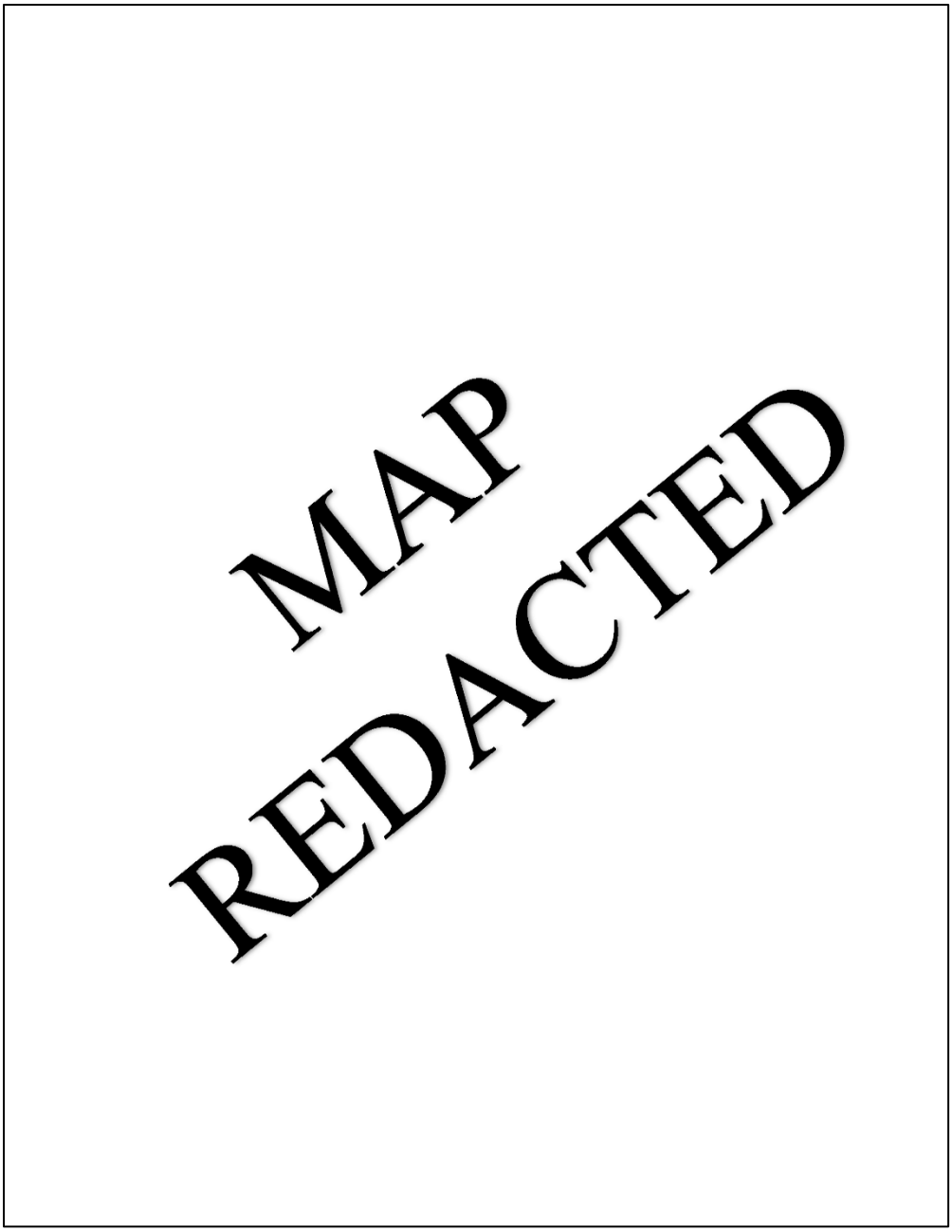


Figure 8.11. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Millville Plains Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

8.7.3. Orland

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is located in southern Tehama County between the cities of Orland and Corning.

There were approximately 10,173 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 9,913 acres of vernal pool grassland remaining, with 260 acres lost since 2005 (see **Figure 8.5**, **Table 8.1**; Witham 2021). All losses were due to agricultural conversion, with the majority being converted to orchards (230 acres, 89%) and the remainder converted to bare plowed agricultural land (30 acres, 11%) (see **Table 8.2**; Witham 2021). Roughly 390 acres of vernal pool grassland were protected within this core area as of 2017 (Vollmar et al. 2017), representing 3.8% of the 2005 baseline.

The only known protected area within this core area is a conservation easement held by the Natural Resources Conservation Service (NRCS) on private ranch land (**Figure 8.6**; Vollmar et al. 2017).

8.7.3.1. Vernal Pool Fairy Shrimp Occurrences

There is one Diversity Database occurrence record for the vernal pool fairy shrimp within this core area (see **Figure 8.7**; Diversity Database 2022). As of 2018, this occurrence was not protected (Vollmar et al. 2017). It is presumed extant by the Diversity Database and is within extant vernal pool grasslands (Witham 2021). This occurrence was first documented in 1980 (Diversity Database 2022), and the Service is not aware of any surveys of this occurrence that have occurred since 1980.

8.7.4. Red Bluff

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and vernal pool tadpole shrimp. The core area is located in Tehama County between the cities of Corning and Red Bluff.

There were approximately 17,079 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 14,965 acres of vernal pool grassland remaining, with 2,114 acres lost since 2005 (see **Figure 8.12**, **Table 8.1**; Witham 2021). The majority of losses were due to agricultural conversion to orchards (1,906 acres, 90.2%), with other losses due to conversion to bare plowed agricultural land (181 acres, 8.6%), alfalfa or irrigated pasture (18 acres, <0.01%), agricultural residences (7 acres, <0.01%), and urban development (2 acres, <0.01%) (see **Table 8.2**; Witham 2021). Roughly 903 acres of vernal pool grassland were protected within this core area as of 2017 (Vollmar et al. 2017), representing 5.3% of the 2005 baseline.

Protected areas within this core area include CDFW's Thomes Creek Ecological Reserve and three properties that have conservation easements held by NRCS (**Figure 8.13**).

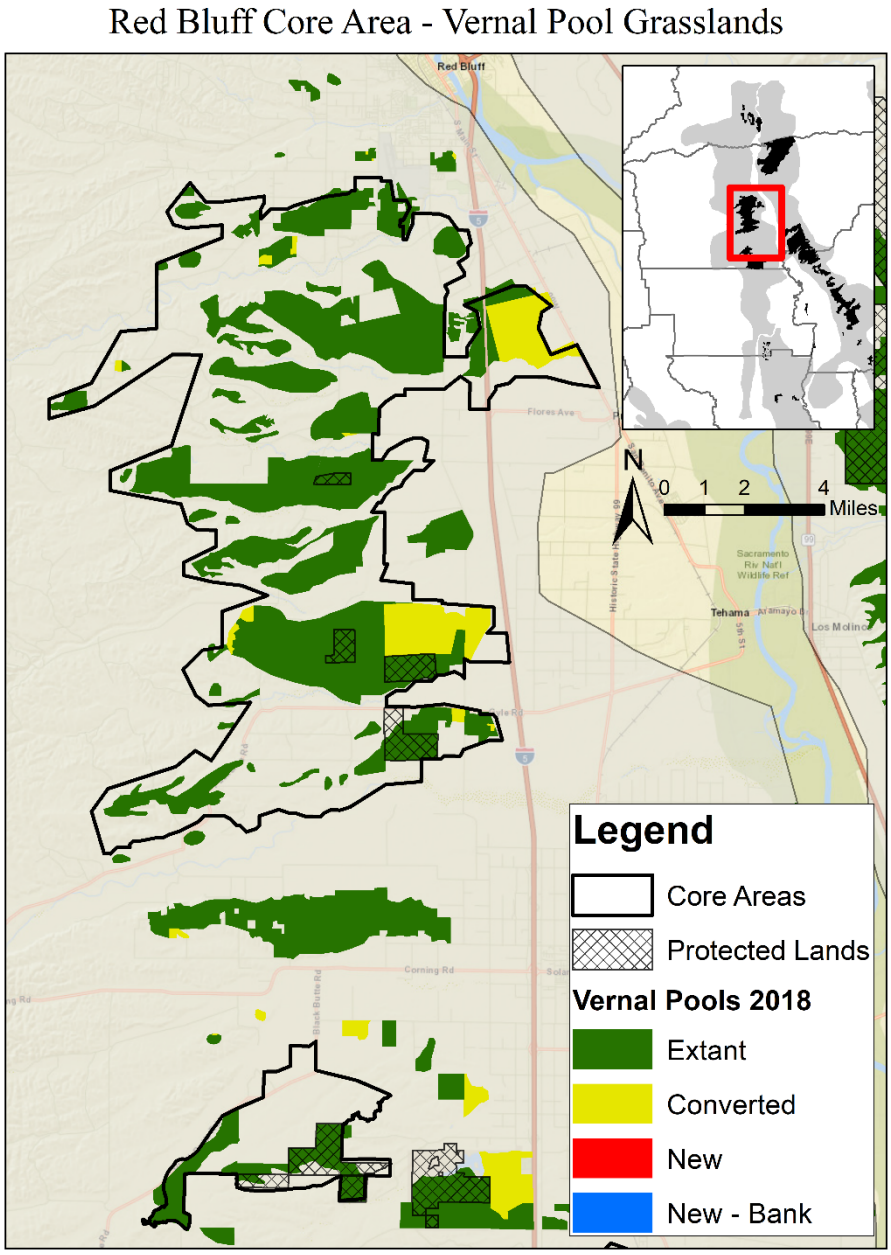


Figure 8.12. Map of vernal pool grassland habitat within the Red Bluff Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

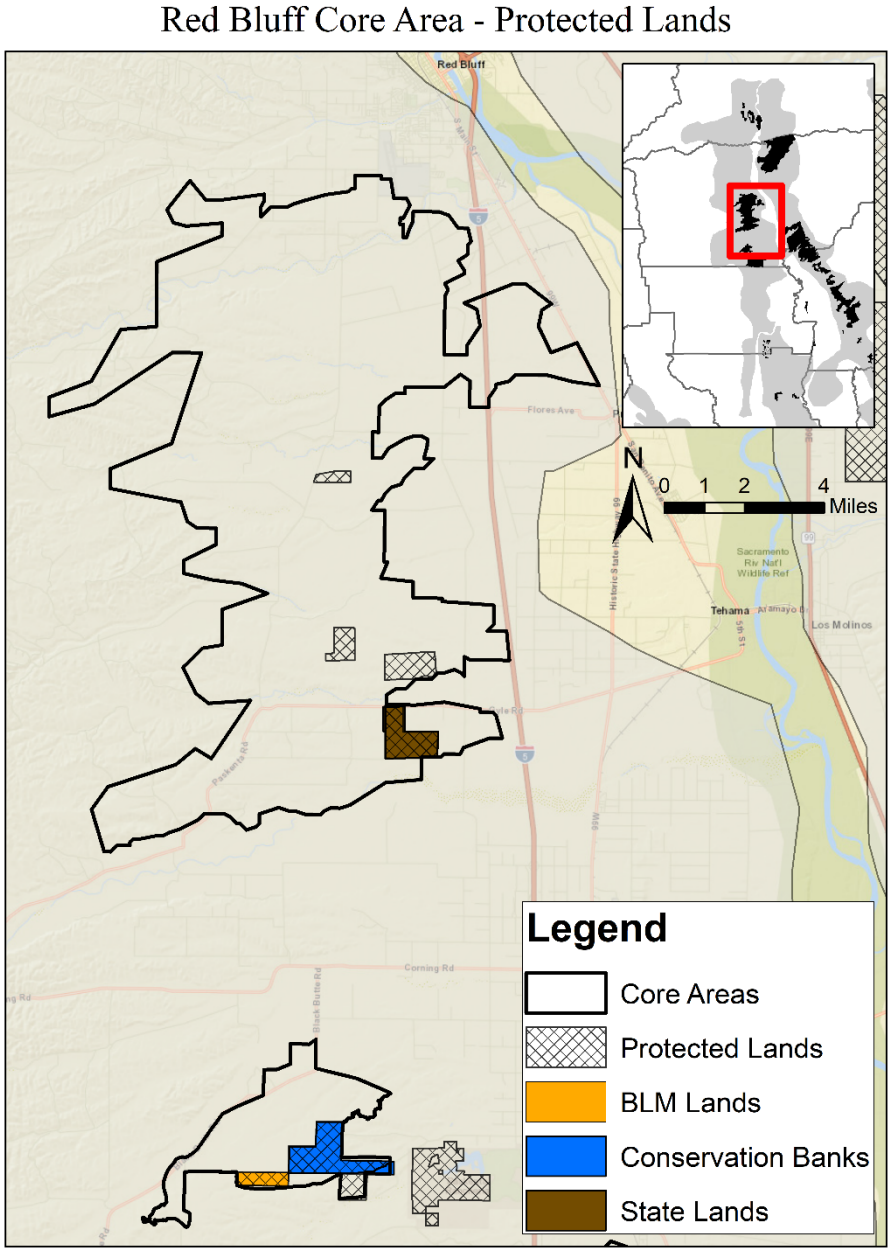


Figure 8.13. Map of protected areas within the Red Bluff Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. BLM = Bureau Land Management.

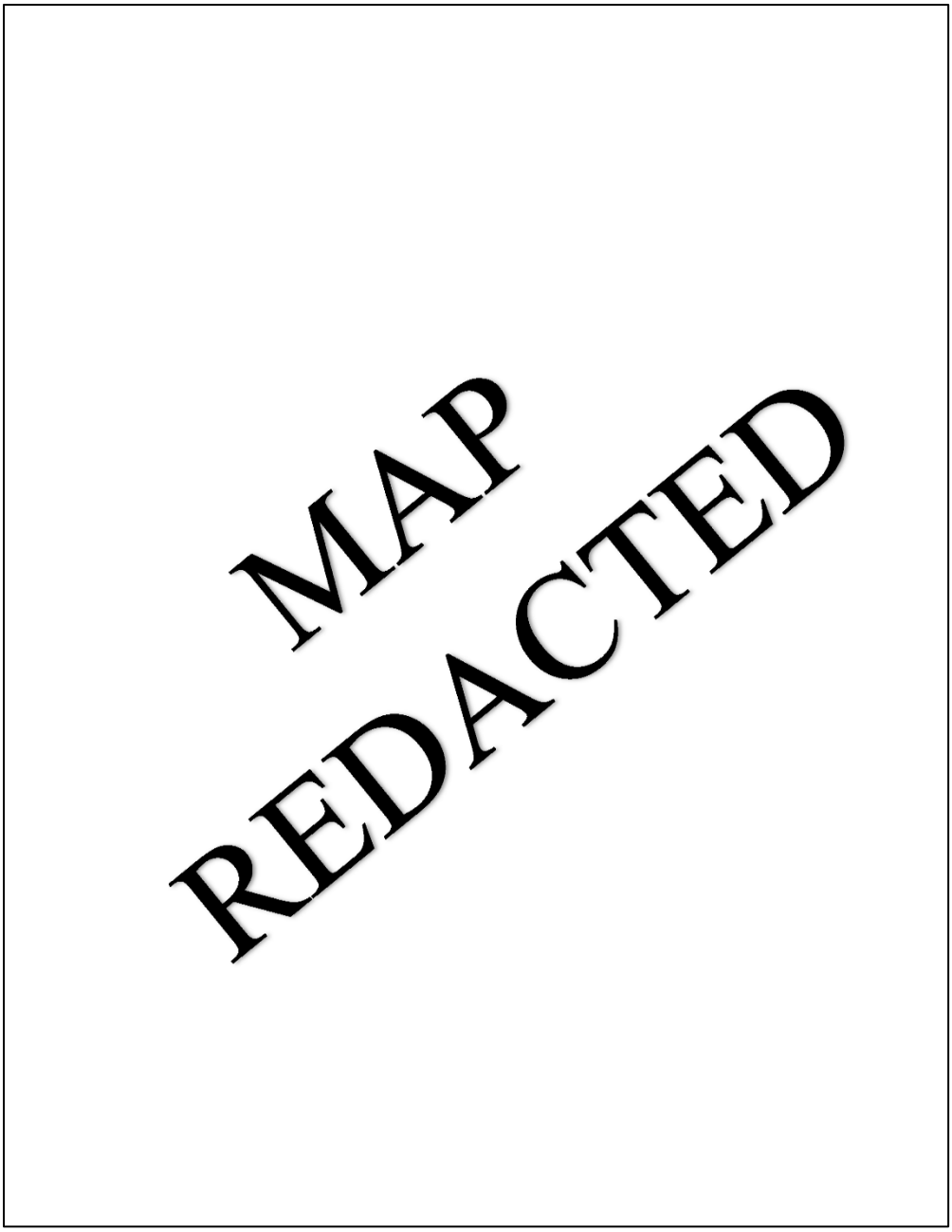


Figure 8.14. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Red Bluff Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

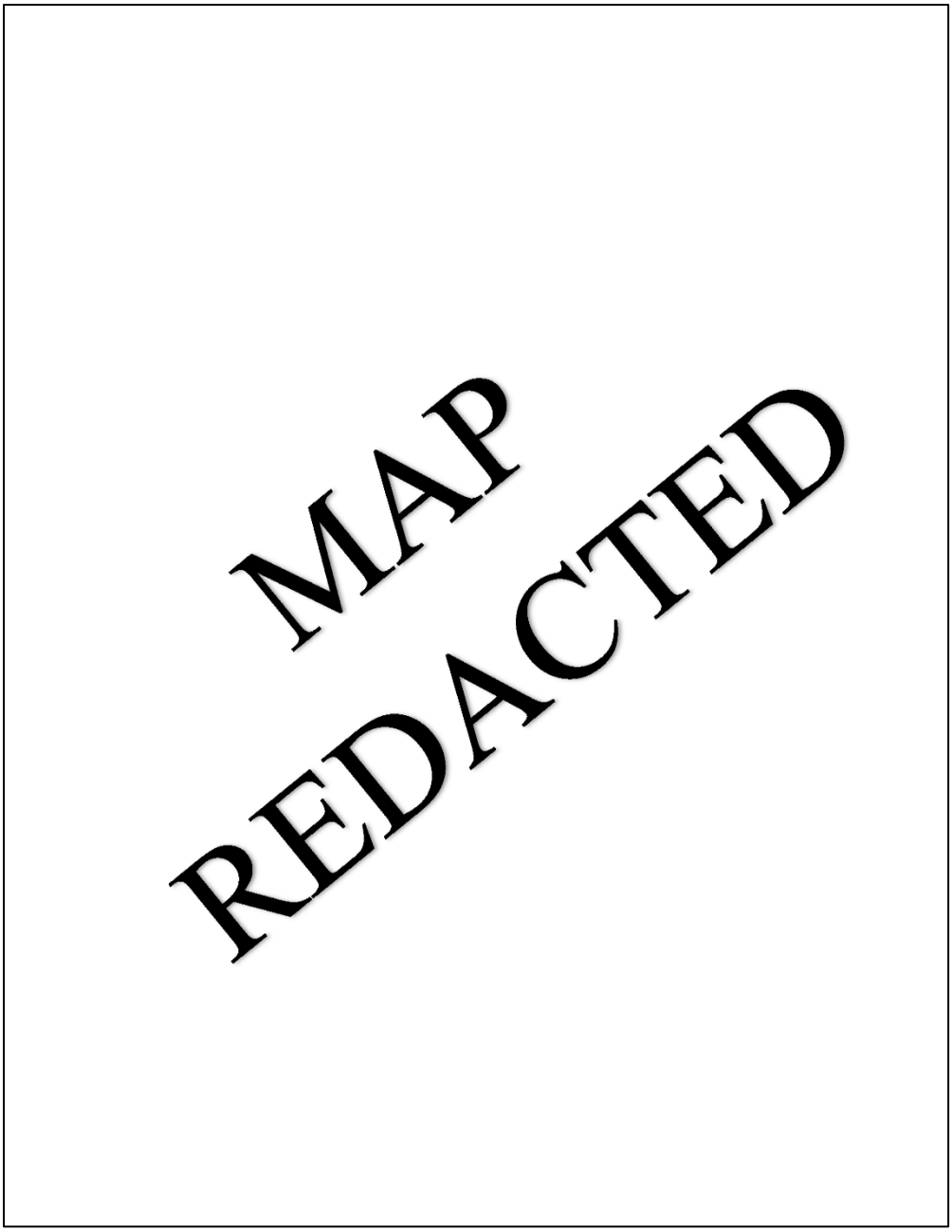


Figure 8.15. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Red Bluff Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

8.7.4.1.Vernal Pool Fairy Shrimp Occurrences

There are eight Diversity Database occurrence records for the vernal pool fairy shrimp within this core area (see **Figure 8.14**; Diversity Database 2022). As of 2018, two of the eight occurrences were at least partially within protected areas (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database; seven are within extant mapped vernal pool grasslands and one is outside of mapped vernal pool grasslands (Witham 2021). Of the eight records, two were known at the time of listing in 1994 and seven were known at the time the Recovery Plan was published in 2005. The one newer occurrence was first documented in 2012 within the Thomes Creek Ecological Reserve. A majority of these occurrences were documented in more than one year, but only two occurrences have been documented more recently than 2001: the newer occurrence within Thomes Creek Ecological Reserve in 2012 and the northeastern occurrence on either side of Interstate 5 in 2014, partly within the proposed Coyote Creek Mitigation Bank (Diversity Database 2022).

8.7.4.1.Vernal Pool Tadpole Shrimp Occurrences

There is one Diversity Database occurrence record for the vernal pool tadpole shrimp within this core area (see **Figure 8.15**; Diversity Database 2022). As of 2018, was not protected (Vollmar et al. 2017). The occurrence is presumed extant by the Diversity Database and within extant mapped vernal pool grasslands (Witham 2021). It was observed in 2001 and the Service is not aware of any surveys since; the vernal pool fairy shrimp occurrence that overlaps this occurrence also has not been updated since 2001 (Diversity Database 2022).

8.7.5. Redding

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and vernal pool tadpole shrimp. The core area is located in Shasta County on the southeastern edge of the City of Redding.

There were approximately 1,813 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 1,767 acres of vernal pool grassland remaining, with 45 acres lost since 2005 (see **Figure 8.16**, **Table 8.1**; Witham 2021). The majority of losses were due to conversion to bare plowed agricultural land (44.8 acres, 97.4%), with a small amount of loss due to urban development (1.2 acres, 2.6%) (see **Table 8.2**; Witham 2021). Roughly 425 acres of vernal pool grassland were protected within this core area as of 2017 (Vollmar et al. 2017), representing 23.5% of the 2005 baseline.

Protected areas within this core area include part of the Stillwater Plains Mitigation Bank (although most of the bank is cut out of the core area), BLM's Hawes Corner parcel, CDFW's Shaw conservation easement, four mitigation properties with conservation easements (one held by the City of Redding, two held by Wildlife Heritage Foundation, and one with the easement holder unknown), and one property with a conservation easement held by NRCS (**Figure 8.17**).

8.7.5.1.Vernal Pool Fairy Shrimp Occurrences

There are four Diversity Database occurrence records for the vernal pool fairy shrimp within this core area, as well as two Diversity Database records immediately adjacent to the core area (see

Figure 8.18; Diversity Database 2022). As of 2018, two of the four occurrences were at least partially within protected areas (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). Of the four records, two were known at the time of listing in 1994 and three were known at the time the Recovery Plan was published in 2005. The one newer occurrence was first documented in 2009 in the Stillwater Plains northeast of the Redding Municipal Airport and northwest of the Stillwater Plains Mitigation Bank. The two occurrences in the Stillwater Plains were most recently detected in 2011 and 2016 (Diversity Database 2022). The two more southern occurrences have not been surveyed, to the Service's knowledge, since they were originally documented in 1988 and 1993 (Diversity Database 2022).

8.7.5.2.Vernal Pool Tadpole Shrimp Occurrences

There are 14 Diversity Database occurrence records for the vernal pool tadpole shrimp within this core area, as well as 5 Diversity Database records immediately adjacent to the core area (see **Figure 8.19**; Diversity Database 2022). As of 2018, 9 of the 14 occurrences within the core area and one of the adjacent occurrences were at least partially within protected areas (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database; 14 are within extant vernal pool grasslands and 5 are outside of mapped vernal pool grasslands (Witham 2021). Of the 19 total records, 5 were known at the time of listing in 1994 and 18 were known at the time the Recovery Plan was published in 2005. The one newer occurrence was first documented in 2006 in the Stillwater Plains northeast of the Redding Municipal Airport and northwest of the Stillwater Plains Mitigation Bank. The majority of occurrences have not been observed since they were first documented (Diversity Database 2022).

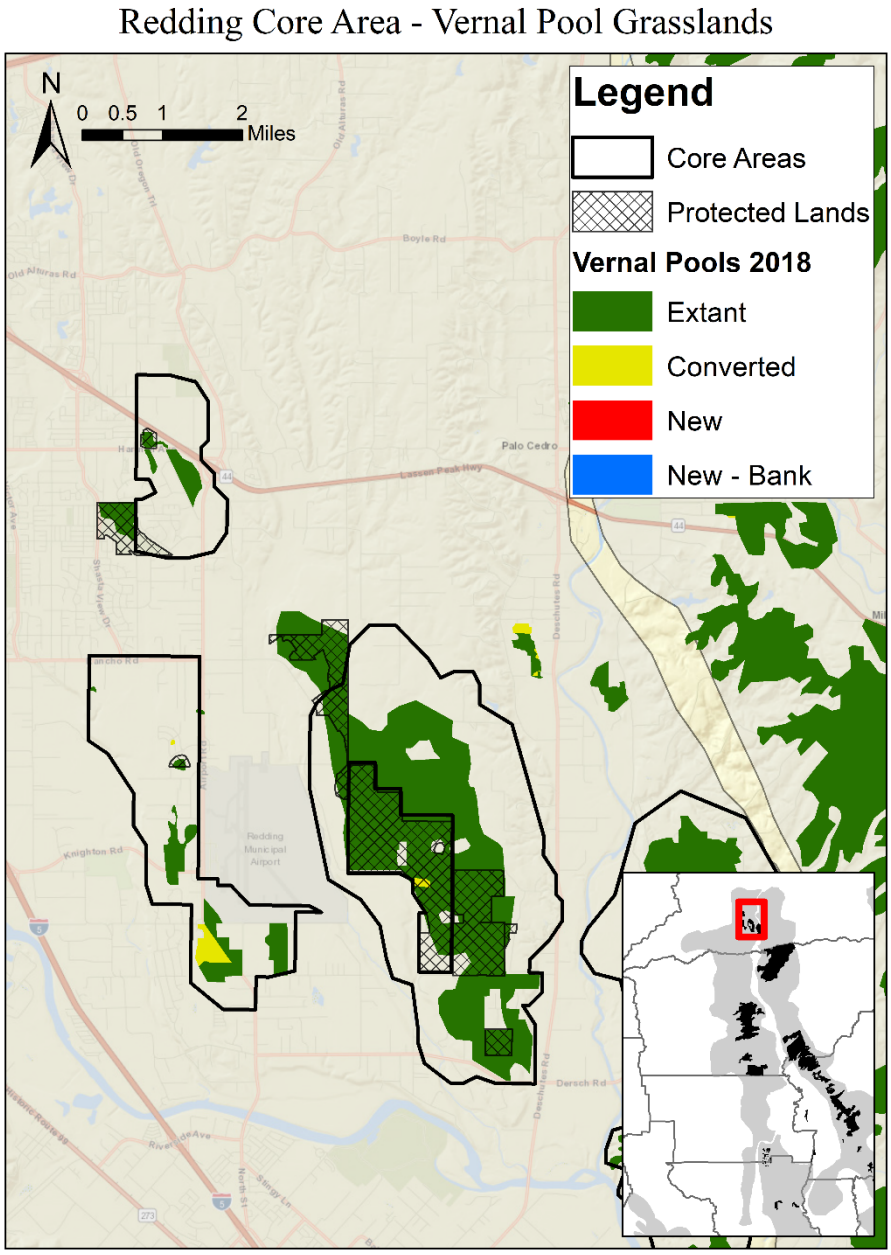


Figure 8.16. Map of vernal pool grassland habitat within the Redding Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

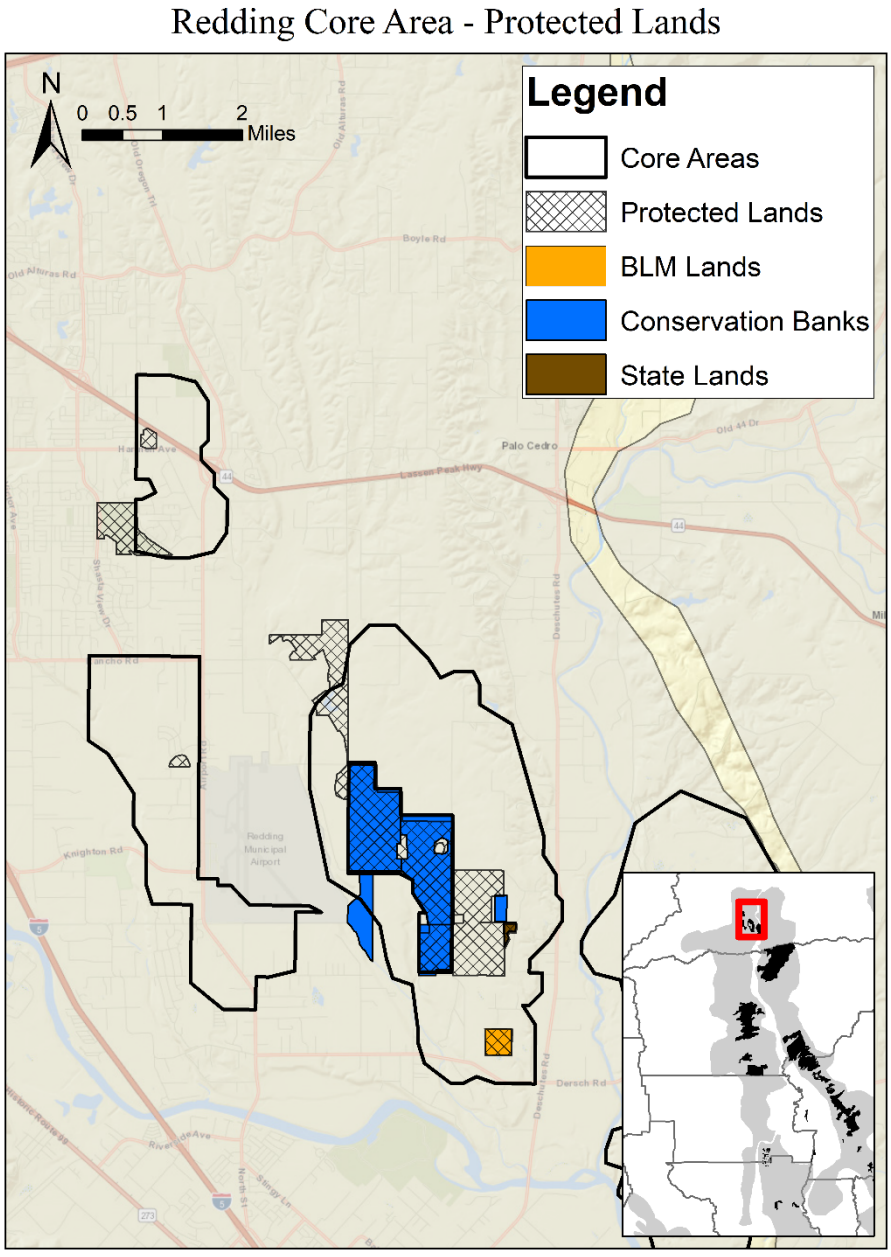


Figure 8.17. Map of protected areas within the Redding Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. BLM = Bureau Land Management.

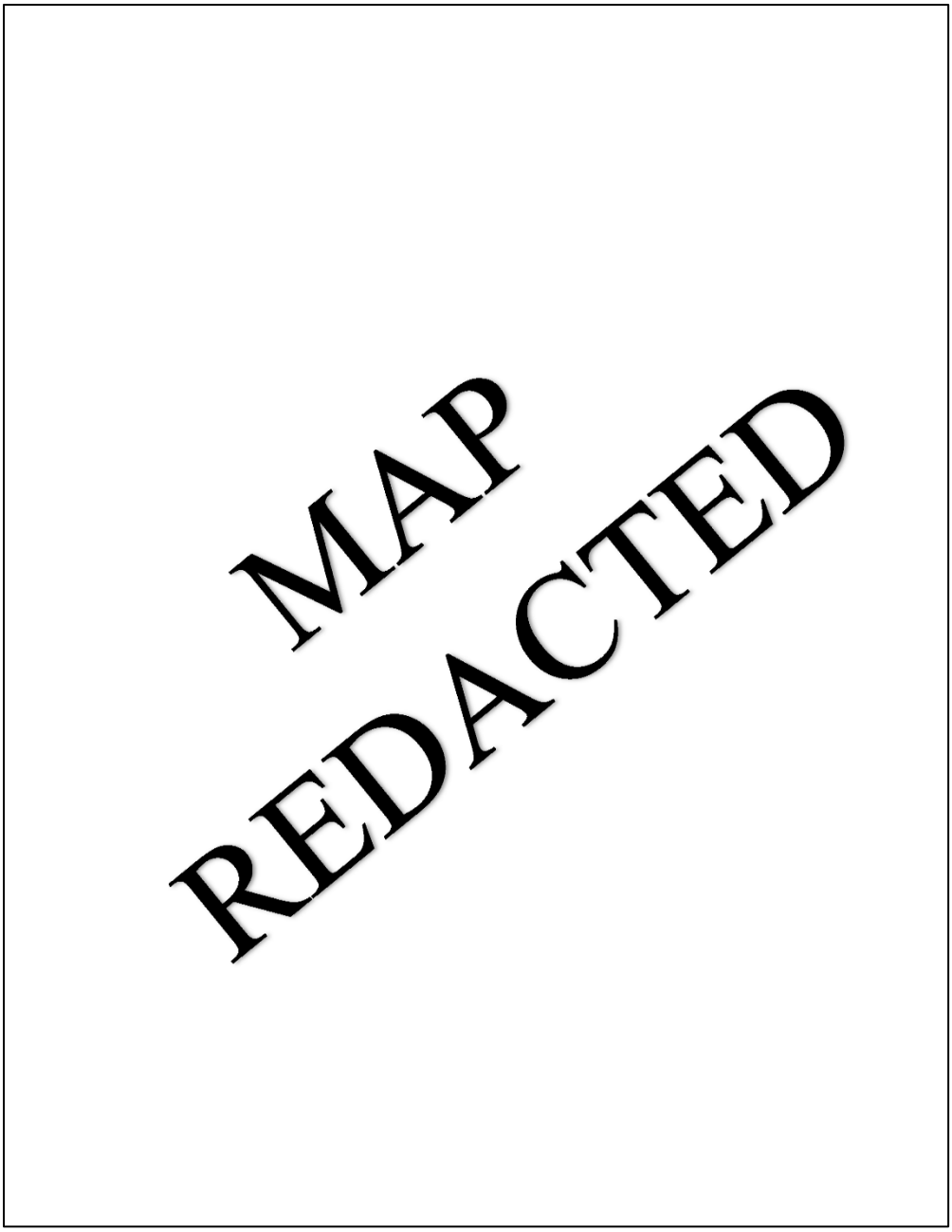


Figure 8.18. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Redding Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

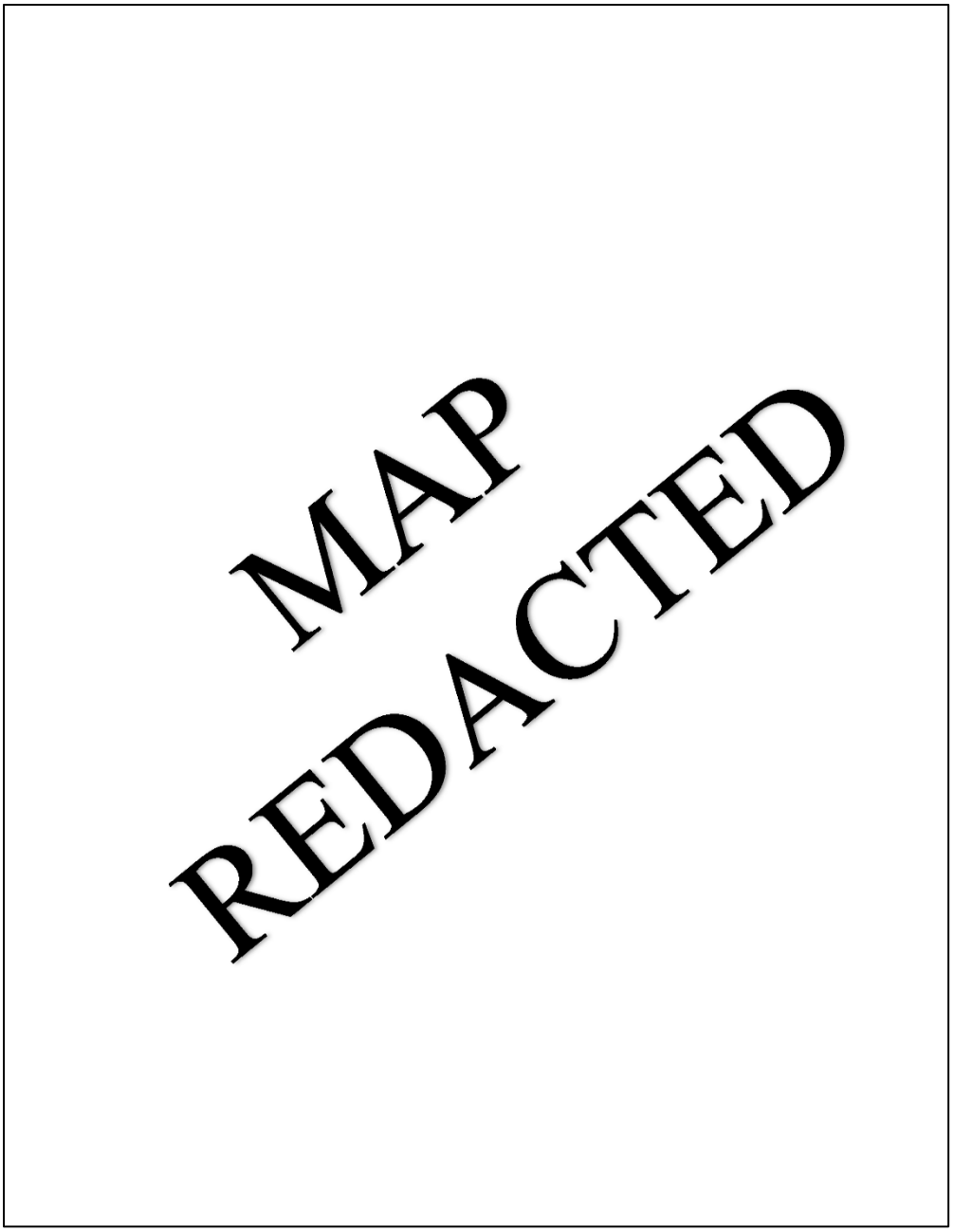


Figure 8.19. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Redding Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

9. SAN JOAQUIN VALLEY VERNAL POOL REGION

All three shrimp species occur within the San Joaquin Valley Vernal Pool Region.

9.1. Vernal Pool Habitat

Approximately 225,745 acres of vernal pool grassland existed within, or immediately adjacent to, this region when the Recovery Plan was published in 2005 (see **Figure 9.1**, **Figure 9.2**, **Table 9.1**; Witham et al. 2013). Approximately 212,860 acres remained as of 2012, with 14,911 acres (6.6% of 2005 total) lost between 2005 and 2012 (Witham et al. 2014). However, 2,025 additional acres were identified that were either not present or not visible on the 2005 aerial imagery. Of the habitat lost, 180 acres (1.2%) were to urbanization and 14,731 acres (98.8%) were to agricultural conversion (56.6% to bare plowed agricultural land, 36.3% to alfalfa or irrigated pasture, 5.8% to orchards, and 0.1% to agricultural residences) (Witham et al. 2014).

By 2018, approximately 206,960 acres of vernal pool grassland remained, with a total of 20,914 acres (9.3% of 2005 total) lost between 2005 and 2018 (see **Table 9.1**; Witham 2021). However, 103 acres were identified that were either not present or not visible on the 2005 or 2012 aerial imagery. Of the habitat lost since 2005, 561 acres (2.7%) were to urbanization and 20,319 acres (97.2%) were to agricultural conversions (45.4% to orchards, 28.6% to alfalfa or irrigated pasture, 17.4% to bare plowed agricultural land, and 5.7% to other agricultural uses) (see **Table 9.2**; Witham 2021). Note that many patches of vernal pool grassland that had been converted to bare plowed land in 2012 had been fully converted to agricultural use, mainly orchards, by 2018. There were also conversions of 34 acres of vernal pool grasslands to managed wetlands with hydrology that no longer supported vernal pool species.

This vernal pool region had the greatest amount of extant vernal pool habitat in 2005 of all the vernal pool regions, and this is still true today (Witham 2021). This region also exhibited the second highest amount of vernal pool losses in the Central Valley, after the Southern Sierra Foothills Vernal Pool Region, although proportional to total habitat there were three other regions with a greater percentage of losses (Witham 2021). The vast majority of vernal pool losses within this region have been to agricultural conversions (97.2%), which is unsurprising given that the region is composed primarily of agricultural lands and very few cities or towns. Many of these losses are likely due to land conversions to orchards or other agricultural uses that should be regulated by the Clean Water Act but that are proceeding illegally without the necessary 404 permit from the Corps (Witham et al. 2014; Witham 2021). This region also had the third highest amount vernal pool losses to urbanization, but due to the large amount of habitat in the region this only represented 0.2% of all losses.

As of 2018, roughly 125,561 acres of vernal pool grassland was estimated to be protected in this region, or immediately adjacent to it (see **Figure 9.3**, **Figure 9.4**, **Table 9.1**; Witham 2021; Vollmar et al. 2017). This represents 61% of the currently remaining vernal pool grassland in the region and 56% of the vernal pool grassland that existed in 2005, the Recovery Plan's baseline. This vernal pool region has the greatest amount and largest percentage of protected vernal pool habitat of all regions in the Central Valley, mainly due to the Service's large National Wildlife Refuges which protect nearly all of the remaining vernal pool habitat in western Merced County (Witham 2021).

9.2. Species Occurrences

9.2.1. Vernal Pool Fairy Shrimp

There are 42 occurrence records of the vernal pool fairy shrimp documented within, or immediately adjacent to, the San Joaquin Valley Vernal Pool Region in the Diversity Database (see **Figure 9.5**, **Figure 9.6**; Diversity Database 2022). Approximately half of these occurrences are listed as on land owned by a government agency or land management organization, and half are listed as on private land not owned by a land management organization (Diversity Database 2022). All 42 occurrences are presumed extant by the Diversity Database; 32 occur within extant vernal pool grassland based on Witham's (2021) mapping efforts, 1 occurs within extirpated vernal pool grassland, and 9 are outside of mapped vernal pool grassland.

The protected areas contain, at least partially, 20 of the 42 Diversity Database records (48%) for the vernal pool fairy shrimp in this region. However, this does not mean that 48% of all occurrences of the vernal pool fairy shrimp in this region have been protected, as the Diversity Database is not an appropriate source for determining all known occurrences (individual Diversity Database records are not necessarily equivalent to occurrences, and some known occurrences may not be documented in the Diversity Database). Only 7 of the 42 Diversity Database polygons (17%) are entirely within the protected areas; the difference between the number of records partially and entirely within the mapped protected areas is likely a reflection of the irregular size and shape of polygons in the Diversity Database, as well as slight discrepancies in the overlap between the two databases.

9.2.2. Vernal Pool Tadpole Shrimp

There are 30 occurrence records of the vernal pool tadpole shrimp documented within, or immediately adjacent to, the San Joaquin Valley Vernal Pool Region in the Diversity Database (see **Figure 9.7**, **Figure 9.8**; Diversity Database 2022). Approximately half of these occurrences are listed as on land owned by a government agency or land management organization, and half are listed as on private land not owned by a land management organization (Diversity Database 2022). All 30 occurrences are presumed extant by the Diversity Database; 28 occur within extant vernal pool grassland based on Witham's (2021) mapping efforts, 1 occurs within extirpated vernal pool grassland, and 1 is outside of mapped vernal pool grassland.

The protected areas contain 20 of the 30 Diversity Database records (67%) for the vernal pool tadpole shrimp in this region. Some of these occurrences were categorized as only partially protected, but visual inspection shows that this was entirely due to slight discrepancies in the overlap between the two databases.

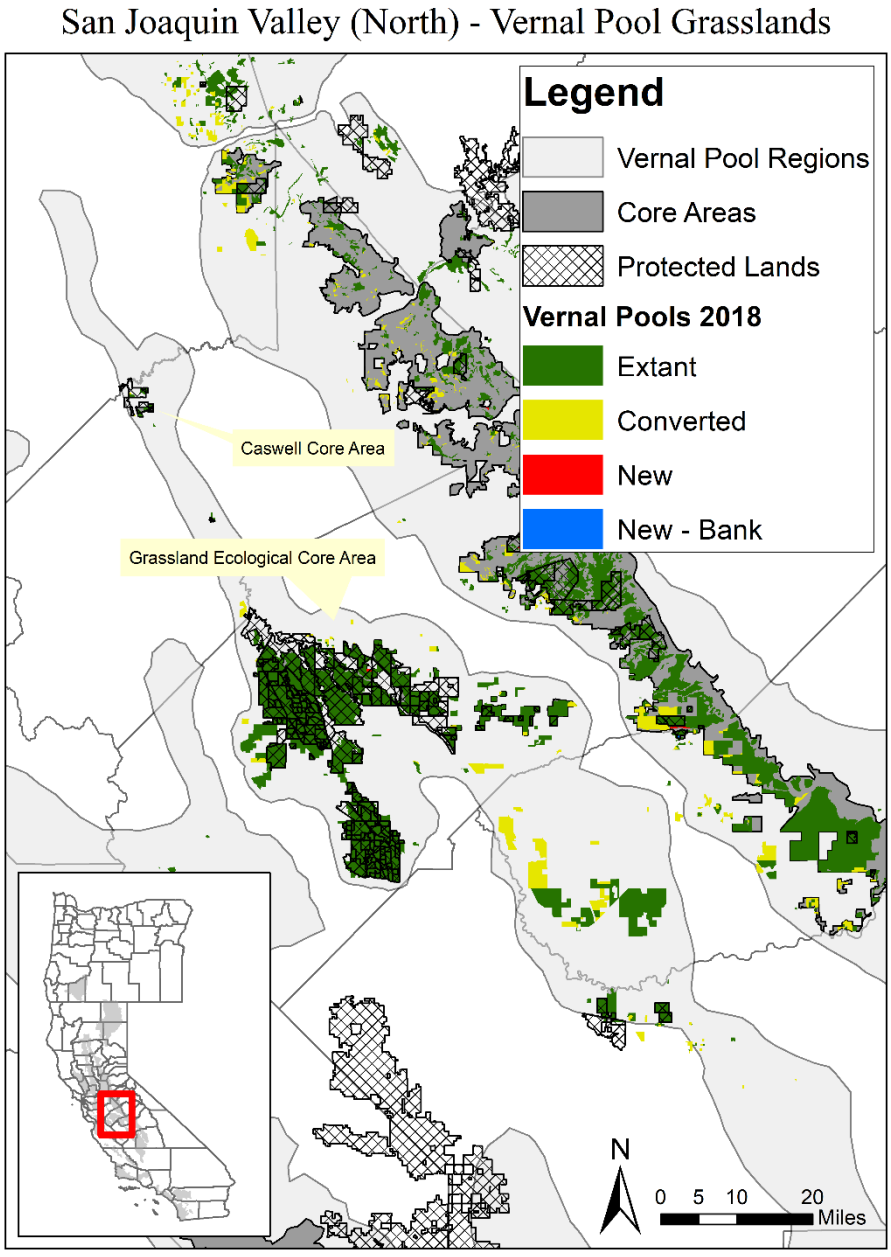


Figure 9.1. Map of vernal pool habitat within the northern San Joaquin Valley Vernal Pool Region mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

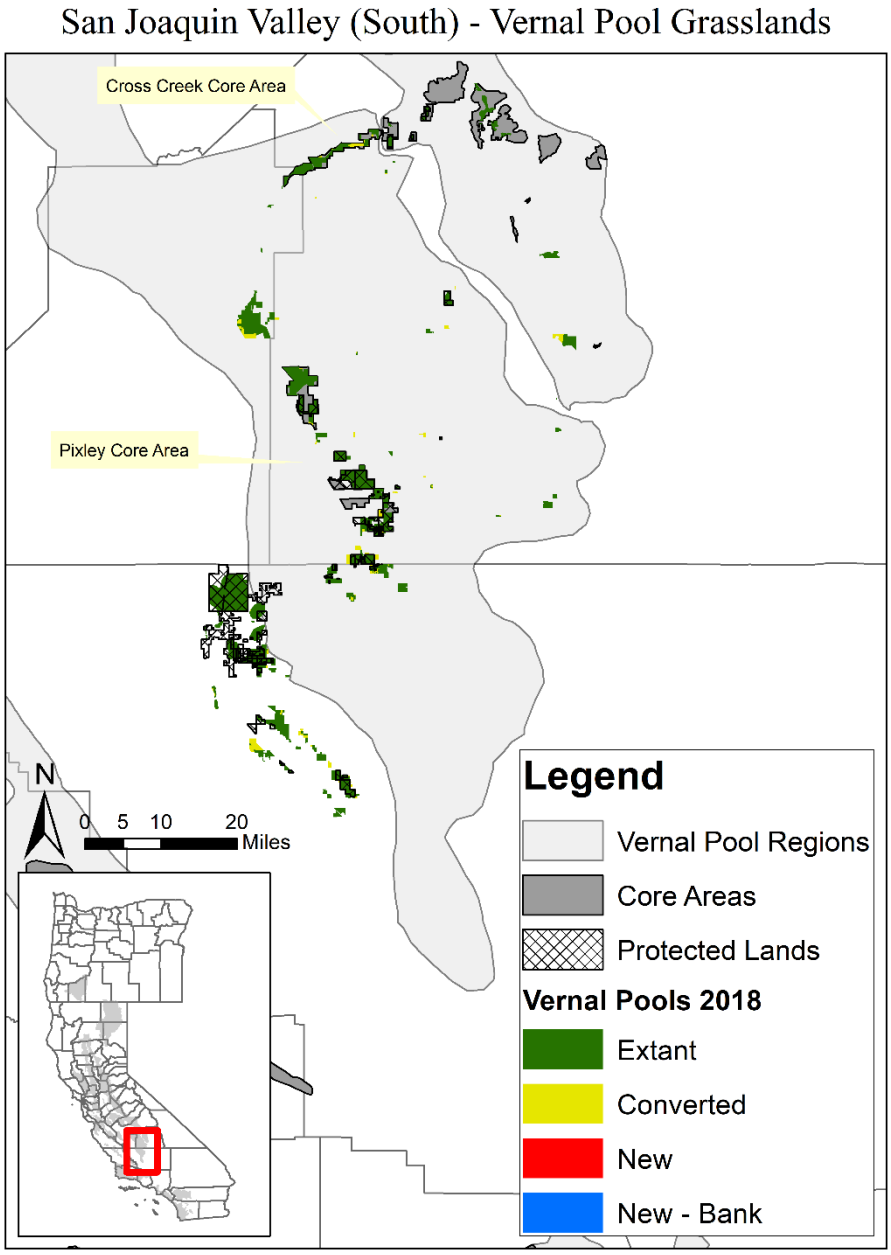


Figure 9.2. Map of vernal pool habitat within the southern San Joaquin Valley Vernal Pool Region mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

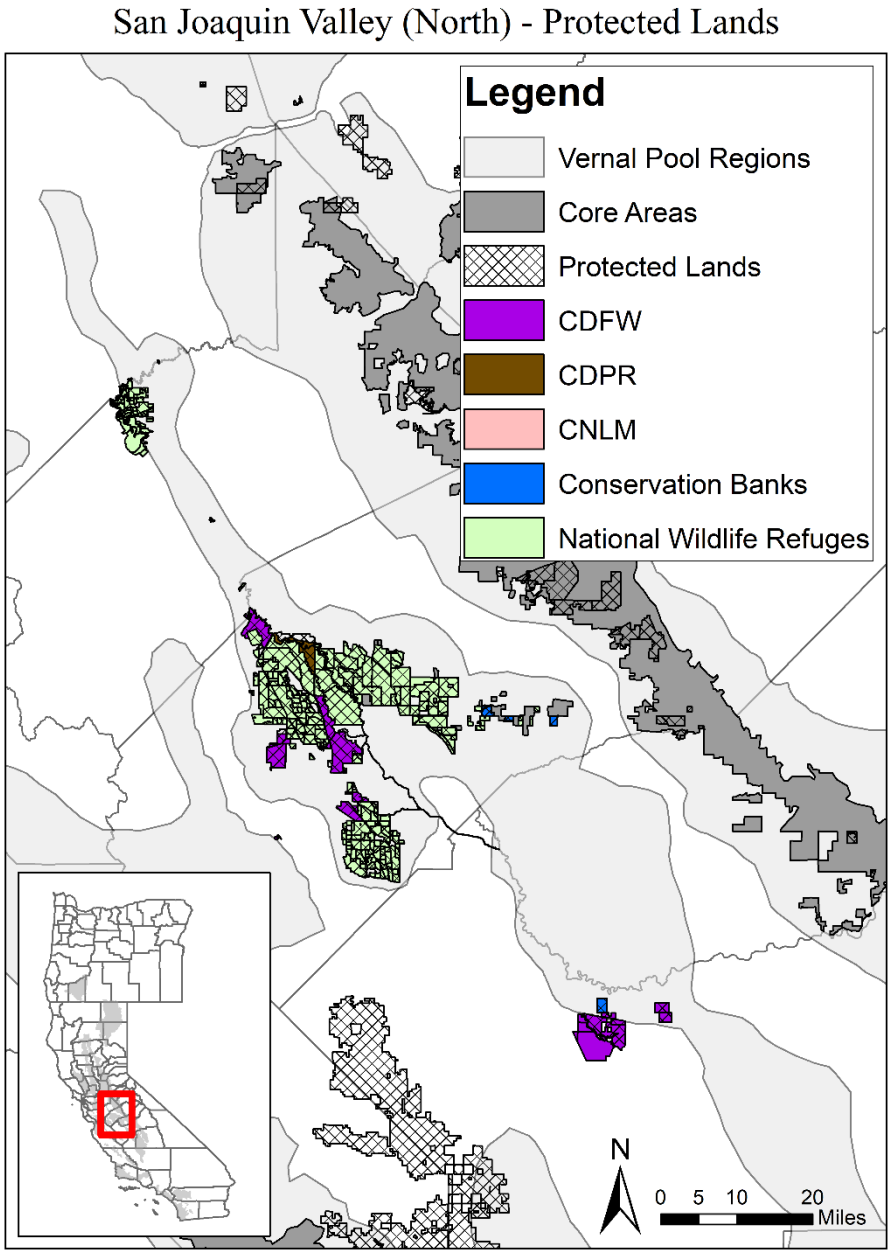


Figure 9.3. Map of protected areas that contain vernal pool grassland habitat and/or the three shrimp species within the northern San Joaquin Valley Vernal Pool Region**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. Zoom in for finer resolution. CDFW = California Department of Fish and Wildlife, CDPR = California Department of Parks and Recreation, CNLM = Center for Natural Lands Management.

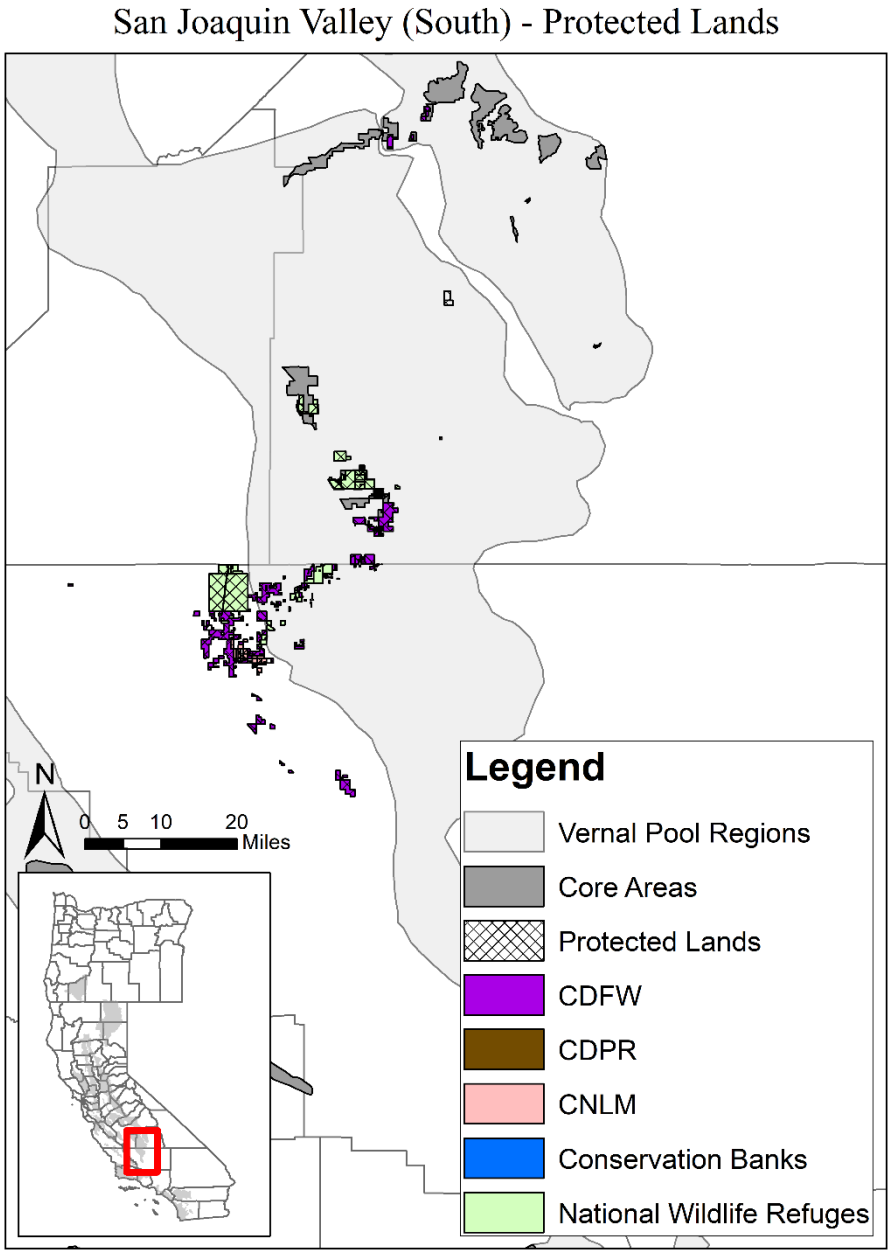


Figure 9.4. Map of protected areas that contain vernal pool grassland habitat and/or the three shrimp species within the southern San Joaquin Valley Vernal Pool Region**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. Zoom in for finer resolution. CDFW = California Department of Fish and Wildlife, CDPR = California Department of Parks and Recreation, CNLM = Center for Natural Lands Management.

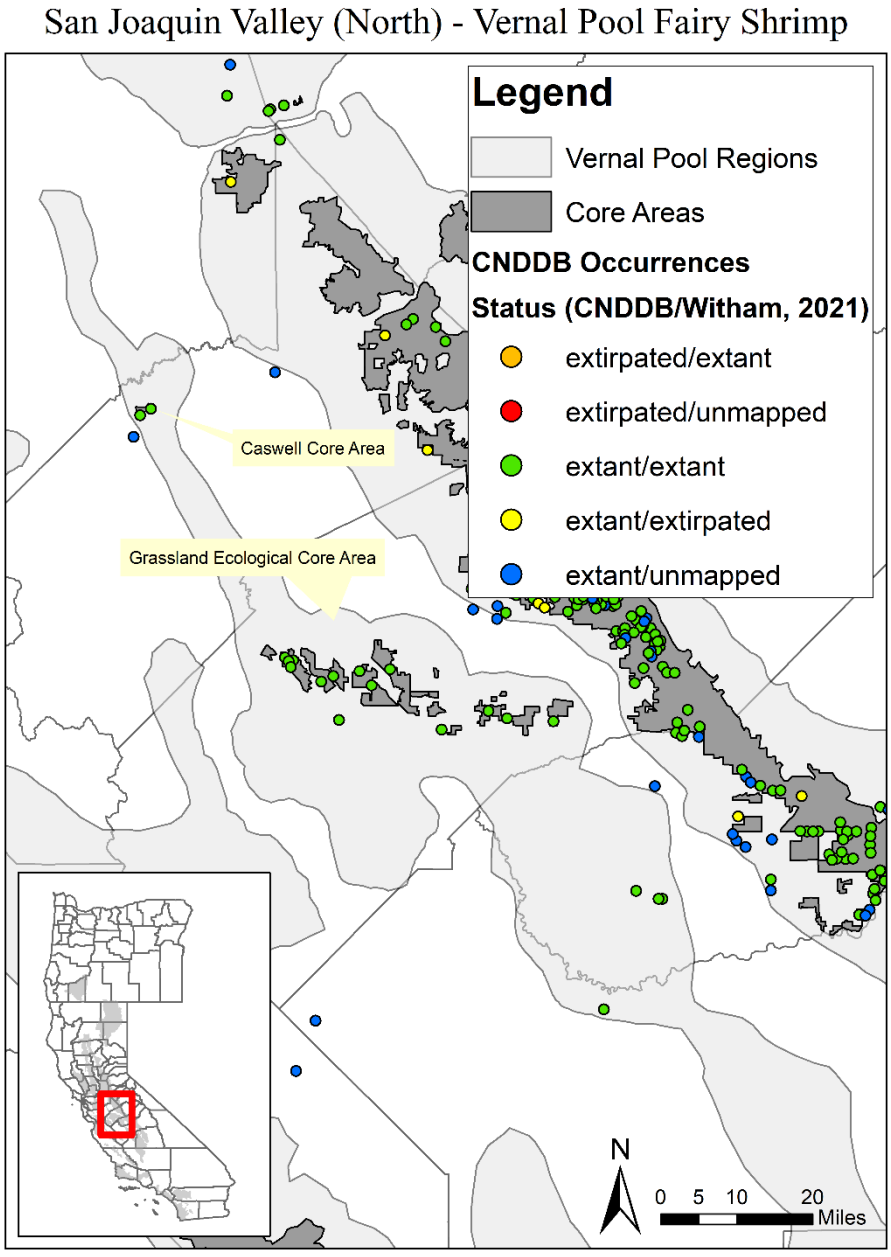


Figure 9.5. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) in the northern San Joaquin Valley Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both Diversity Database occurrence records and Witham's (2021) map of vernal pool habitat.

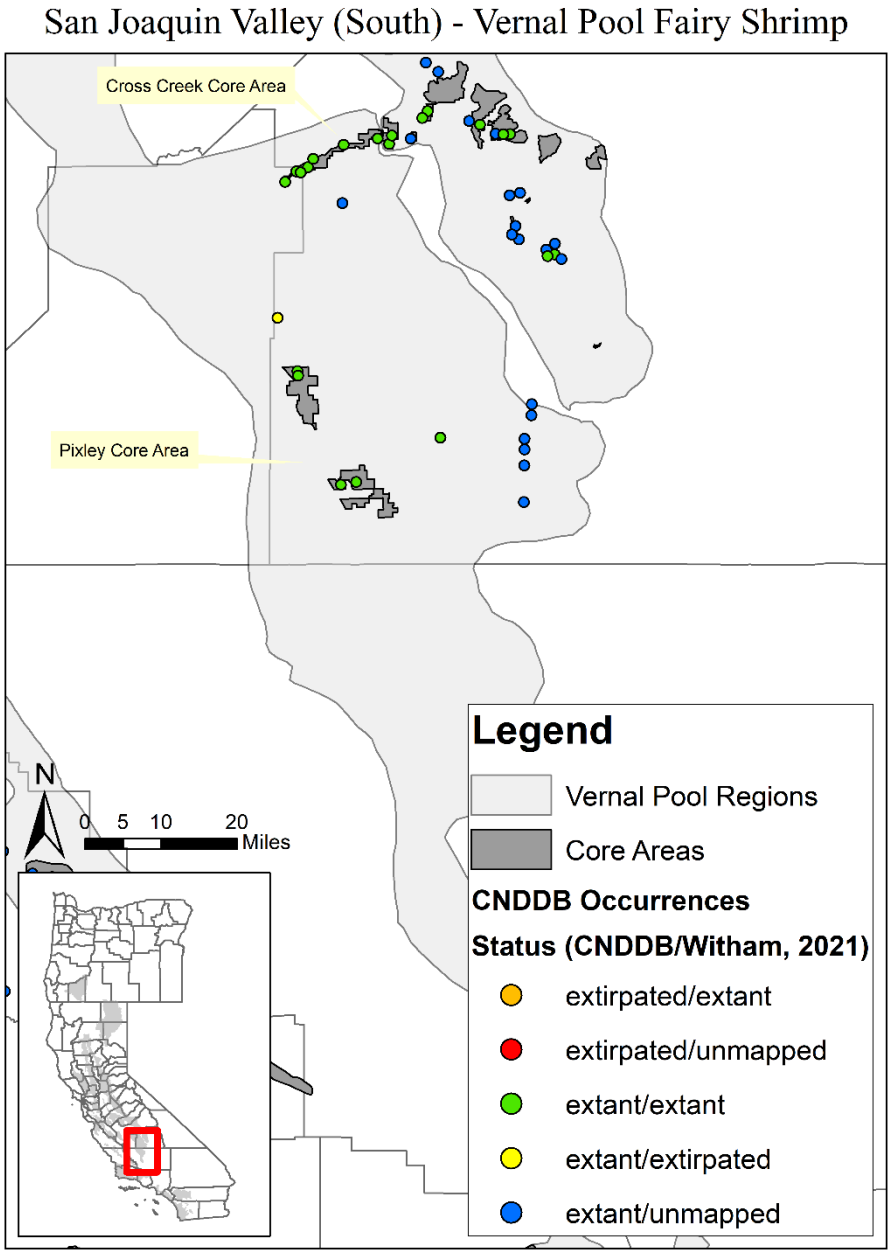


Figure 9.6. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) in the southern San Joaquin Valley Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both Diversity Database occurrence records and Witham's (2021) map of vernal pool habitat.

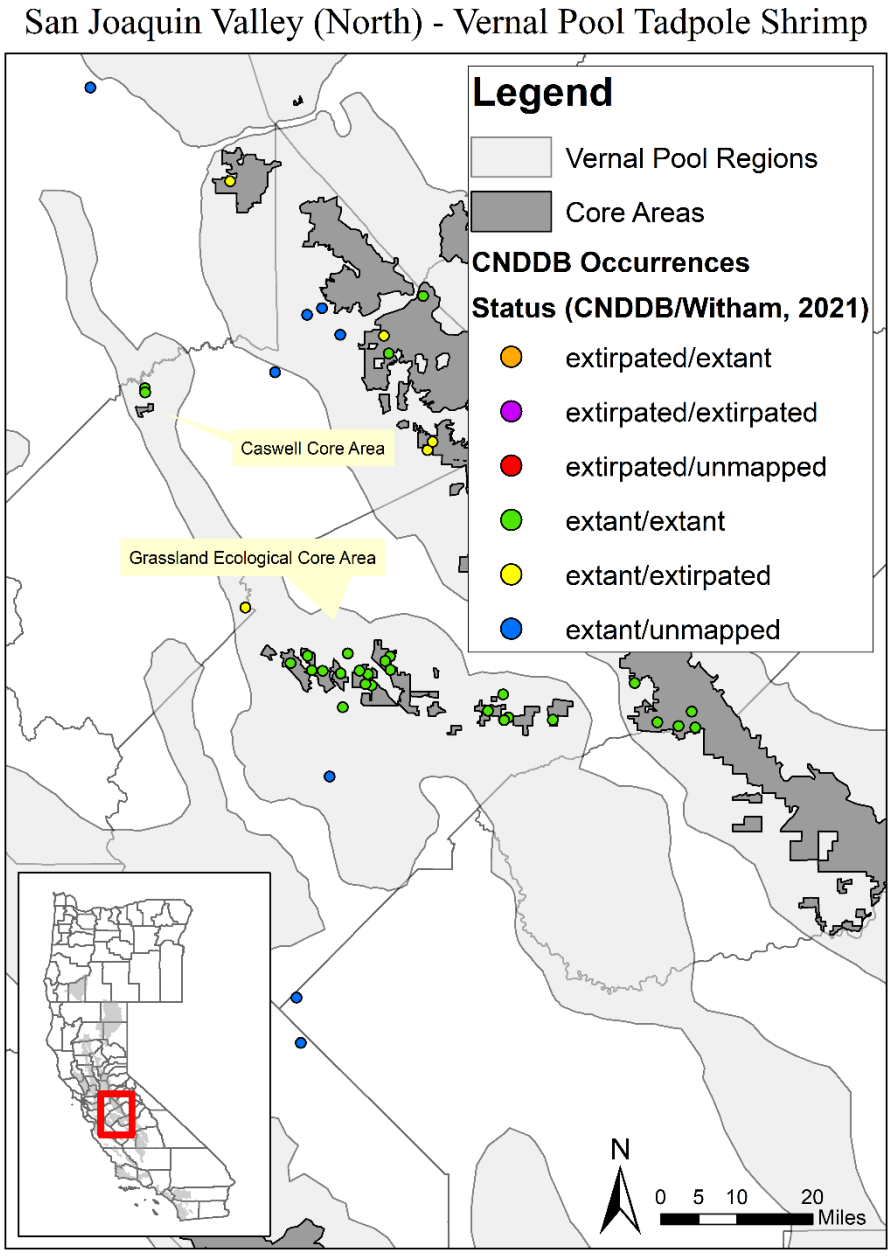


Figure 9.7. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) in the northern San Joaquin Valley Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both Diversity Database occurrence records and Witham's (2021) map of vernal pool habitat. The two core areas in the northern portion of the region are displayed, though not all core areas are designated for the vernal pool tadpole shrimp.

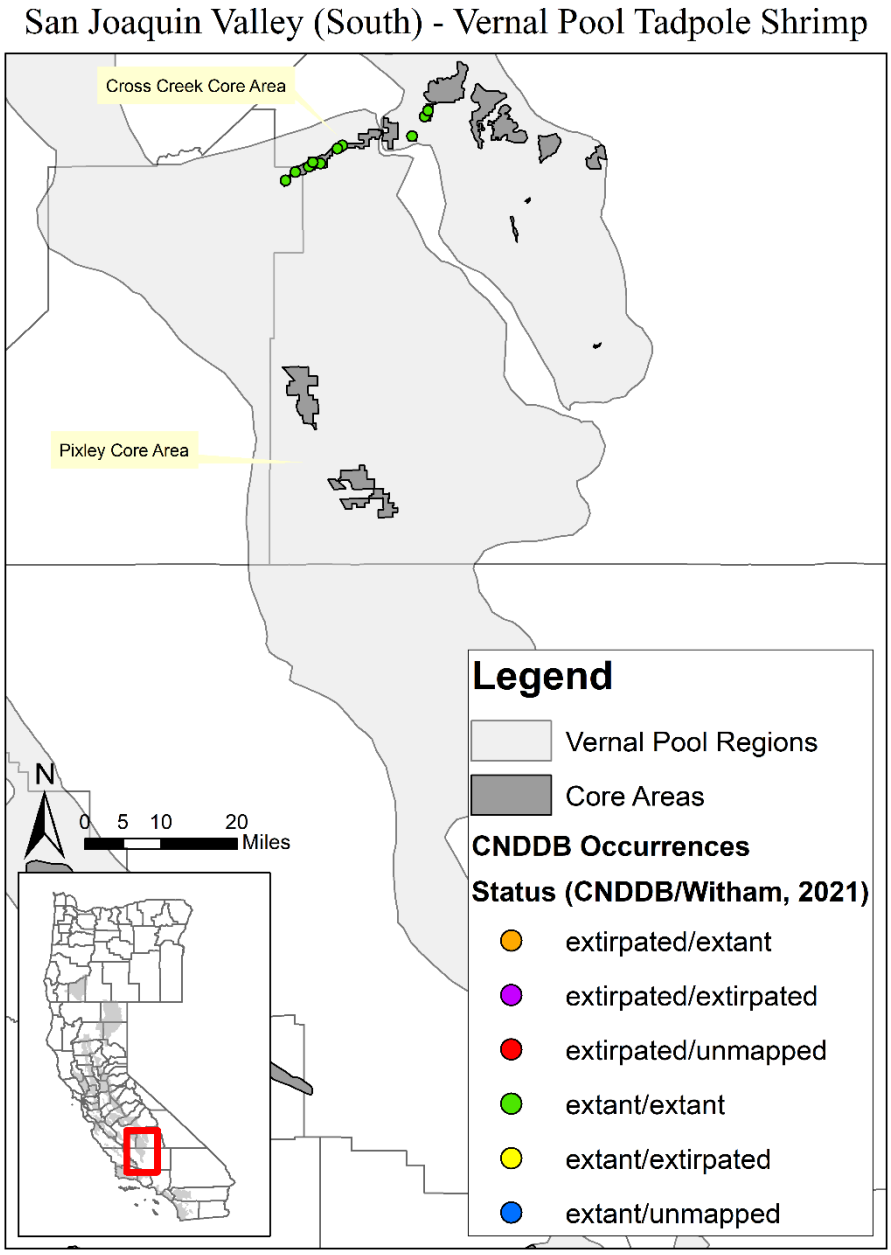


Figure 9.8. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) in the southern San Joaquin Valley Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both Diversity Database occurrence records and Witham's (2021) map of vernal pool habitat. The two core areas in the southern portion of the region are displayed, though not all core areas are designated for the vernal pool tadpole shrimp.

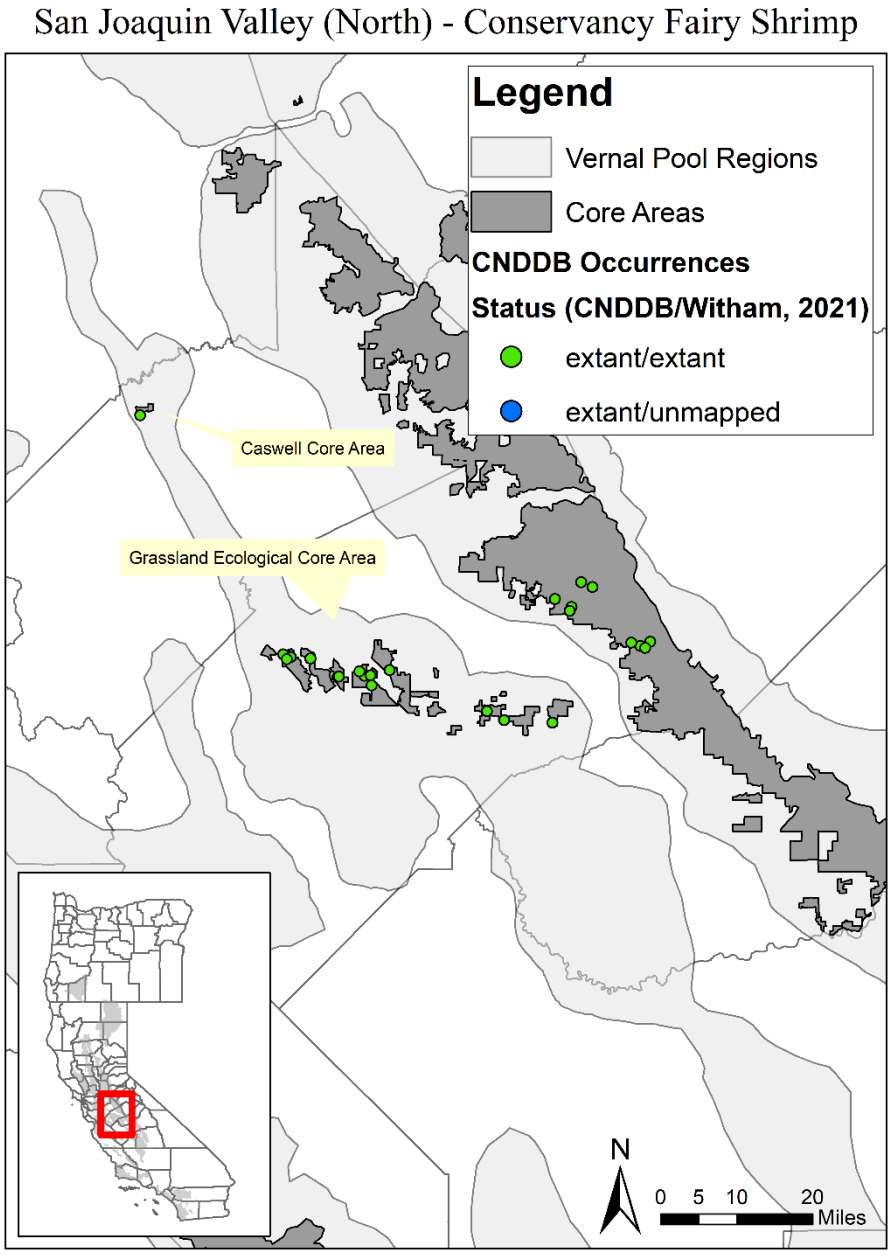


Figure 9.9. Map of known occurrences of Conservancy fairy shrimp recorded in the Diversity Database (2022) in the northern San Joaquin Valley Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both Diversity Database occurrence records and Witham's (2021) map of vernal pool habitat.

Table 9.1. Acreage of vernal pool habitat and habitat converted within the San Joaquin Valley Vernal Pool Region mapped by Witham (2021). All habitat labeled as not converted, altered, or new was considered extant. Protected acreage is based on Vollmar et al. (2017).

Core Area	2005 Acres	2018 Acres Total	2018 Acres Extant (% of Total)	2018 Acres Converted – Agriculture (% of Total)	2018 Acres Converted – Urban Development (% of Total)	2018 Acres Protected (% of Total)
Caswell	395.3	395.3	395.3 (100.0%)	0.0 (0.0%)	0.0 (0.0%)	311.1 (78.7%)
Cross Creek	3,799.5	3,799.5	3,392.8 (89.3%)	406.7 (10.7%)	0.0 (0.0%)	0.0 (0.0%)
Grassland Ecological Area	30,830.3	30,855.9	30,525.0 (98.9%)	330.9 (1.1%)	0.0 (0.0%)	23,221.0 (75.3%)
Pixley	10,745.3	10,745.3	10,475.8 (97.5%)	269.5 (2.5%)	0.0 (0.0%)	5,173.2 (48.1%)
San Joaquin Valley Vernal Pool Region Total	**225,745.4**	**227,873.4**	**206,959.6 (90.8%)**	**20,318.8 (8.9%)**	**560.9 (0.2%)**	**125,561.1 (55.1%)**

Table 9.2. Acreage of vernal pool habitat losses within the San Joaquin Valley Vernal Pool Region between 2005 and 2018 mapped by Witham (2021), broken down by what the land use was converted to. All categories besides urban development and managed wetlands are considered agricultural conversions.

Core Area	Urban, Commercial, & Industrial	Orchards, Vineyards, Eucalyptus	Alfalfa and Irrigated Pasture	Bare Plowed Agricultural Lands	Other Ag (Rice, Row Crops, Dairy, Nurseries)	Agricultural Residential	Managed Wetlands	Total Losses	% Losses Urban Development	% Losses Agricultural Conversions
Caswell	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Cross Creek	0.0	39.4	126.5	5.8	235.0	0.0	0.0	406.7	0.0%	100%
Grassland Ecological Area	0.0	0.0	175.8	155.1	0.0	0.0	0.0	330.9	0.0%	100%
Pixley	0.0	4.0	0.0	195.4	70.1	0.0	0.0	269.5	0.0%	100%
San Joaquin Valley Vernal Pool Region Total	**560.9**	**9,486.8**	**5,979.3**	**3,641.2**	**1,013.5**	**198.0**	**34.0**	**20,913.8**	**2.7%**	**97.2%**

9.2.3. Conservancy Fairy Shrimp

There are 14 occurrence records of the Conservancy fairy shrimp documented within the San Joaquin Valley Vernal Pool Region in the Diversity Database, all in the northern half of the region (see **Figure 9.9**; Diversity Database 2022). These occurrences include the Mapes Ranch, Highway 165/Grasslands Ecological Area, and Sandy Mush Road populations. There are 11 occurrences on federal or state land and 3 on conservation banks (Diversity Database 2022). All 14 occurrences are presumed extant by the Diversity Database and are within extant vernal pool habitat based on Witham's (2021) mapping efforts.

The protected areas contain all 14 Diversity Database records (100%) for the Conservancy fairy shrimp in this region: 10 in the San Luis National Wildlife Refuge Complex, 1 in the Great Valley Grasslands State Park, and 3 in conservations banks.

9.3. Federal Lands

9.3.1. National Wildlife Refuges

Within the San Joaquin Valley Vernal Pool Region, all three shrimp species are known to occur within all four refuge units of the San Luis National Wildlife Refuge Complex (Grasslands Wildlife Management Area, Merced National Wildlife Refuge, San Luis National Wildlife Refuge, and San Joaquin River National Wildlife Refuge). A Comprehensive Conservation Plan was prepared for the San Joaquin River National Wildlife Refuge in 2006 (Service 2006) and the rest of the San Luis Complex in 2015 (Service 2015). The vernal pool fairy shrimp is also known to occur within the Pixley National Wildlife Refuge of the Kern National Wildlife Refuge Complex. The other two units of the Kern National Wildlife Refuge Complex, Kern National Wildlife Refuge and Tulare Basin Wildlife Management Area, do have vernal pool habitat but do not have known occurrences of the vernal pool fairy shrimp. A Comprehensive Conservation Plan was prepared for the Kern and Pixley National Wildlife Refuges in 2005 (Service 2005b), and a stepped down Natural Resource Management Plan was prepared for the Kern National Wildlife Refuge Complex in 2021 (Service 2021a).

The San Joaquin River National Wildlife Refuge consists of 12,887 acres located in northern Stanislaus County (Service 2006b). The Refuge was established in 1987 with the primary goal of protecting and managing wintering habitat for Aleutian Canada geese (*Branta canadensis leucopareia*); since then, the Refuge's focus has expanded to include other threatened and endangered species, including the vernal pool fairy shrimp. The Refuge has mapped 372 acres of native grassland; only 4 acres of features characterized as vernal pools are mapped, but seasonal and semi-permanent wetlands are also mapped throughout, some of which may provide suitable habitat for the vernal pool fairy shrimp (Service 2006b). These areas generally correspond to the 826 acres of extant vernal pool habitat mapped by Witham (2021) (the large difference in acreage may be due to differences in the method of calculation). Approximately 43 acres of vernal pool habitat that was present on the Refuge in 2005 was lost between 2012 and 2018 (Witham 2021). Management objectives on the Refuge include protecting populations of the three shrimp species by mapping vernal pools, avoiding earthmoving or alteration of topography to vernal pools and associated uplands, and using appropriate grazing regimes (Service 2006b).

The vernal pool fairy shrimp was observed on Mapes Ranch within the San Joaquin River National Wildlife Refuge in 1991 and 1998, and *Branchinecta* cysts were identified in the soil in 2011; the species was also observed in other locations on the Refuge in 1998 (Diversity Database 2022). During more recent annual surveys of vernal pools on the San Luis National Wildlife Refuge Complex, the San Joaquin River National Wildlife Refuge was only surveyed in 2017, and the survey occurred too late in the season to detect the vernal pool fairy shrimp (Service 2018b). The vernal pool tadpole shrimp was observed in the northeastern corner of the Refuge south of Beckwith Road in 1998 and 2000 (Diversity Database 2022) and most recently in 2018 (Service 2018b). The Conservancy fairy shrimp was observed on Mapes Ranch within the Refuge in 1991 in two vernal pools (Diversity Database 2022). The Service is not aware of any surveys of this occurrence since 1991; the San Joaquin River National Wildlife Refuge was surveyed in 2017, but not the portion of the Refuge with the Conservancy fairy shrimp (Service 2018b). Mapping of the vernal pools on the Refuge for all three shrimp species has been consistently identified as a priority in recent years, but has not yet occurred (Service 2018b; F. Takahashi, Service, *in litt*. 2021). Based on the information available to the Service at the time, the previous 5-year review for the Conservancy fairy shrimp (Service 2012b) stated that the Mapes Ranch occurrence was still privately owned and that the hydrology on the site may have been altered, possibly extirpating the Conservancy fairy shrimp. However, this portion of Mapes Ranch did have a Refuge conservation easement placed on it in 2010, so the property should be being managed according to the Refuge's Comprehensive Conservation Plan (Service 2006). Surveys of Mapes Ranch are needed to determine if the Conservancy fairy shrimp remains extant.

The other three units of the San Luis National Wildlife Refuge Complex are located in Merced County within the largest continuous block of freshwater wetlands remaining in California (Service 2015). The Merced National Wildlife Refuge is 10,262 acres, the San Luis National Wildlife Refuge is 26,878 acres, and the Grasslands Wildlife Management Area consists of 75,225 acres of conservation easements on private land. The vast majority of these areas are extant potential vernal pool grasslands and they comprise approximately half of all extant vernal pool grasslands mapped in the San Joaquin Valley Vernal Pool Region (Witham 2021). However, some of these areas are currently managed for waterfowl with hydrology that does not support vernal pool species. As of 2015, the Service has identified 389 vernal pools on parts of the San Luis and Merced Refuges (Service 2015), and more vernal pools have been mapped in more recent surveys as well (Service 2019; Service 2020d; Service 2021b). The largest concentrations of vernal pools are found on the Kesterson and West Bear Creek units of the San Luis Refuge and the Snobird and Arena Plains units of the Merced Refuge (**Figure 9.10**). Vernal pools have also been identified on easement lands within the Grasslands Wildlife Management Area, but they have not been comprehensively mapped (Service 2015).

The vernal pool fairy shrimp was identified in several locations throughout the Refuge Complex in 1993 and 1994, with five additional Diversity Database occurrences recorded since 2008 (Diversity Database 2022). The vernal pool tadpole shrimp was identified in several locations throughout the Refuge Complex in 1993, 1994, and 2000, with four additional Diversity Database occurrences recorded in 2015 (Diversity Database 2022). The vernal pool fairy shrimp and vernal pool tadpole shrimp have been consistently documented during recent annual surveys between 2018 and 2021, with occurrences on the Merced Refuge's Arena Plains and Snobird subunits and San Luis Refuge's Kesterson, West Bear Creek, and East Bear Creek subunits

(Service 2018b; Service 2019; Service 2020d; Service 2021b). The Conservancy fairy shrimp has been identified on the Merced Refuge's Arena Plains and Snobird units and the San Luis Refuge's Kesterson and East Bear Creek units. On the Arena Plains unit, there is one Diversity Database occurrence that was observed in 1994 and 2015 (Diversity Database 2022); however, the species was not observed during surveys in 2018, 2019, and 2020 (Service 2018b; Service 2019; Service 2020d). On the Snobird unit, there are three Diversity Database occurrences that were observed in 2015, and the species was observed during surveys in 2019, 2020, and 2021 (Service 2019; Service 2020d; Service 2021b; Diversity Database 2022). On the Kesterson unit, one occurrence was recorded in 1994, and this occurrence plus two more were observed in 2016 (Diversity Database 2022); however, the species was not observed during surveys in 2018, 2019, and 2020 (Service 2018b; Service 2019; Service 2020d). On the East Bear Creek unit, there are two Diversity Database occurrences: one on the west side near the San Joaquin River recorded in 1994 and one on the east side near the Snobird unit in 2015 (Diversity Database 2022). The Conservancy fairy shrimp was not identified on the east side of the unit when surveyed in 2019, but it was observed in two pools on the west side of the unit when surveyed in 2020 (Service 2019; Service 2020d).

The Kern National Wildlife Refuge Complex is made up of three units with the primary purpose of protecting and managing wetland habitat for migratory birds (**Figure 9.4**). Pixley National Wildlife Refuge consists of approximately 6,939 acres located in southwestern Tulare County, Kern National Wildlife Refuge consists of 11,249 acres located in northern Kern County, and Tulare Basin Wildlife Management Area consists of 4,439 acres located in northern Kern County. Witham (2021) mapped almost the entirety of Pixley and Kern as vernal pool grassland habitat based on aerial imagery, but vernal pools have only been documented on four subunits within Pixley and two subunits within Kern (Service 2021a). Currently, the ecological health of the vernal pools on these two refuges is not well understood due to the lack of biological surveys or inventories (Service 2021a). A small amount of vernal pool grassland occurs within the Tulare Basin Wildlife Management Area as well (Witham 2021), but this area is either not known to contain vernal pools or hasn't been surveyed. The vernal pool fairy shrimp was first identified in 1988 at two locations on the Pixley Refuge (Diversity Database 2022). The species was most recently identified by refuge staff in 2022 in five of six pools sampled on the Pixley Refuge (K. Jimenez, Service, *in litt*. 2023). No occurrences have been recorded on the Kern Refuge or Tulare Basin Wildlife Management Area (Diversity Database 2022). However, during the 2022 surveys, one vernal pool on Kern had both versatile fairy shrimp (*Branchinecta lindahli*) and individuals which were not identified conclusively but may have been vernal pool fairy shrimp or versatile fairy shrimp (Jimenez, *in litt*. 2023).

Figure 1-5. Units of the Grasslands WMA

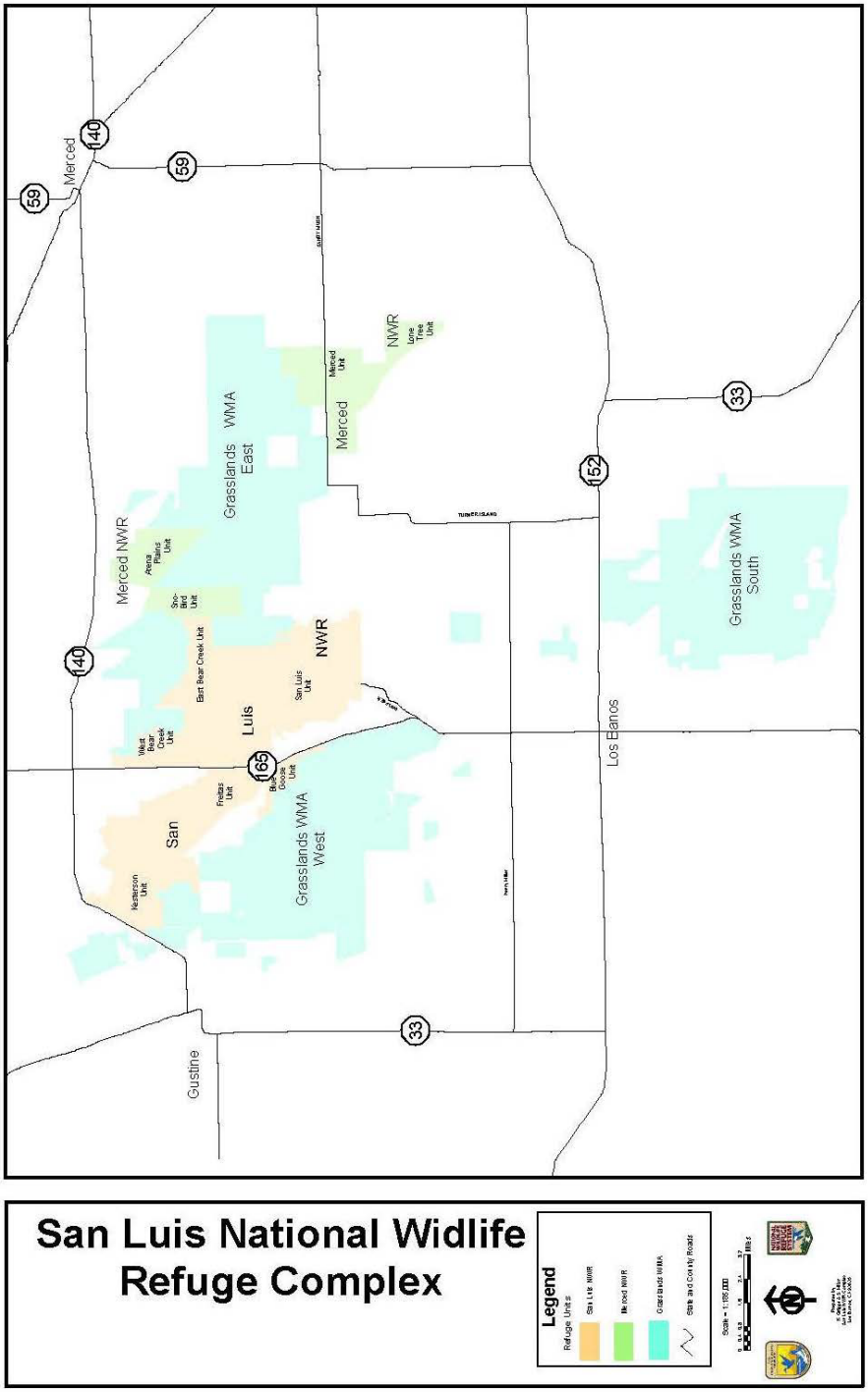


Figure 9.10. Map of the units within the Merced National Wildlife Refuge, San Luis National Wildlife Refuge, and Grasslands Wildlife Management Area. Taken from Figure 1-5 of the 2015 draft Comprehensive Conservation Plan for these refuge lands (Service 2015).

9.3.2. Military Lands

There are no military lands with known occurrences of the three shrimp species in the San Joaquin Valley Vernal Pool Region.

9.3.3. Bureau of Land Management

There are no Bureau of Land Management lands with known occurrences of the three shrimp species in the San Joaquin Valley Vernal Pool Region.

9.3.4. Other Federal Lands

There are no other federal lands with known occurrences of the three shrimp species in the San Joaquin Valley Vernal Pool Region.

9.4. Conservation Banks

There are four conservation or mitigation banks within the San Joaquin Valley Vernal Pool Region that provide credits for preserved vernal pools that support the vernal pool fairy shrimp: Alkali Sink, Deadman Creek, Dutchman Creek, and Vieira-Sandy Mush Road (see **Figure 9.3**; RIBITS 2021). These banks protect a total of 2,494 acres of land, including 114.316 acres of preserved vernal pools for the vernal pool fairy shrimp (Table 6). The four banks have sold a total of 56.741 acres of preservation credits (50%) for the vernal pool fairy shrimp (RIBITS 2021). Alkali Sink Conservation Bank is sold out of credits for the vernal pool fairy shrimp, though this bank only had 0.4 acres of vernal pool preservation credits. This region has much less land protected within conservation banks than other regions in the Central Valley, particularly considering that this region has the largest amount of vernal pool grassland of any vernal pool region. However, this region does have the greatest amount and largest percentage of protected vernal pool habitat of all regions in the Central Valley, indicating that conservation banking has contributed less to the overall protection of vernal pool habitat in this region than it has in most other regions.

There are three conservation or mitigation banks within the San Joaquin Valley Vernal Pool Region that provide credits for preserved vernal pools that support the vernal pool tadpole shrimp: Deadman Creek, Dutchman Creek, and Vieira-Sandy Mush Road (see **Figure 9.3**; RIBITS 2021). These banks protect a total of 1,548 acres of land, including 113.916 acres of preserved vernal pools for the vernal pool tadpole shrimp (Table 6). Many of these preserved pools also provide habitat for the vernal pool fairy shrimp. The three banks have sold a total of 56.341 acres of preservation credits (50%) for the vernal pool tadpole shrimp (RIBITS 2021).

There are three conservation banks within the San Joaquin Valley Vernal Pool Region that are known to support the Conservancy fairy shrimp: Deadman Creek, Dutchman Creek, and Vieira-Sandy Mush Road (see **Figure 9.3**; Diversity Database 2022). However, only the Dutchman Creek Conservation Bank provides credits for preserved vernal pools that support the Conservancy fairy shrimp (RIBITIS 2021). Dutchman Creek specifically provides preservation credits for 8.32 acres of vernal pools that provide habitat for the Conservancy fairy shrimp, 5.85 acres (70%) of which have been sold. On Deadman Creek, the Conservancy fairy shrimp was first observed in 2008 and has been consistently observed during regular monitoring, most

recently in 2019 (Diversity Database 2022). On Dutchman Creek, the species was observed in 6 of 42 sampled pools in 2008, 6 additional pools in 2010, and most recently in 2016 (Westervelt Ecological Services 2016; Diversity Database 2022). On Vieira-Sandy Mush Road, the species was observed in one pool in 2014 (Diversity Database 2022).

9.5. Habitat Conservation Plans

There are two regional Habitat Conservation Plans (HCPs) and three project-level HCPs within the San Joaquin Valley Vernal Pool Region that include one or more of the three shrimp species as a Covered Species (**Figure 9.11**).

9.5.1. Kern Water Bank HCP

The Kern Water Bank HCP covered the development and operation of the Kern Water Bank Project, which includes the creation of a bank for water conservation as well as the creation of a conservation bank on the property (Kern Water Bank Authority 1997). This HCP was permitted in 1997 and has a 75-year permit term. The permittee is the Kern Water Bank Authority. The HCP includes 164 covered species, covering any species that may have conceivably been present in the area; this is no longer common practice when developing an HCP. All three shrimp species are covered species; however, no vernal pool habitat was present or impacted by the development of the water bank, and the conservation bank does not contain any vernal pool habitat or provide credits for the three shrimp species.

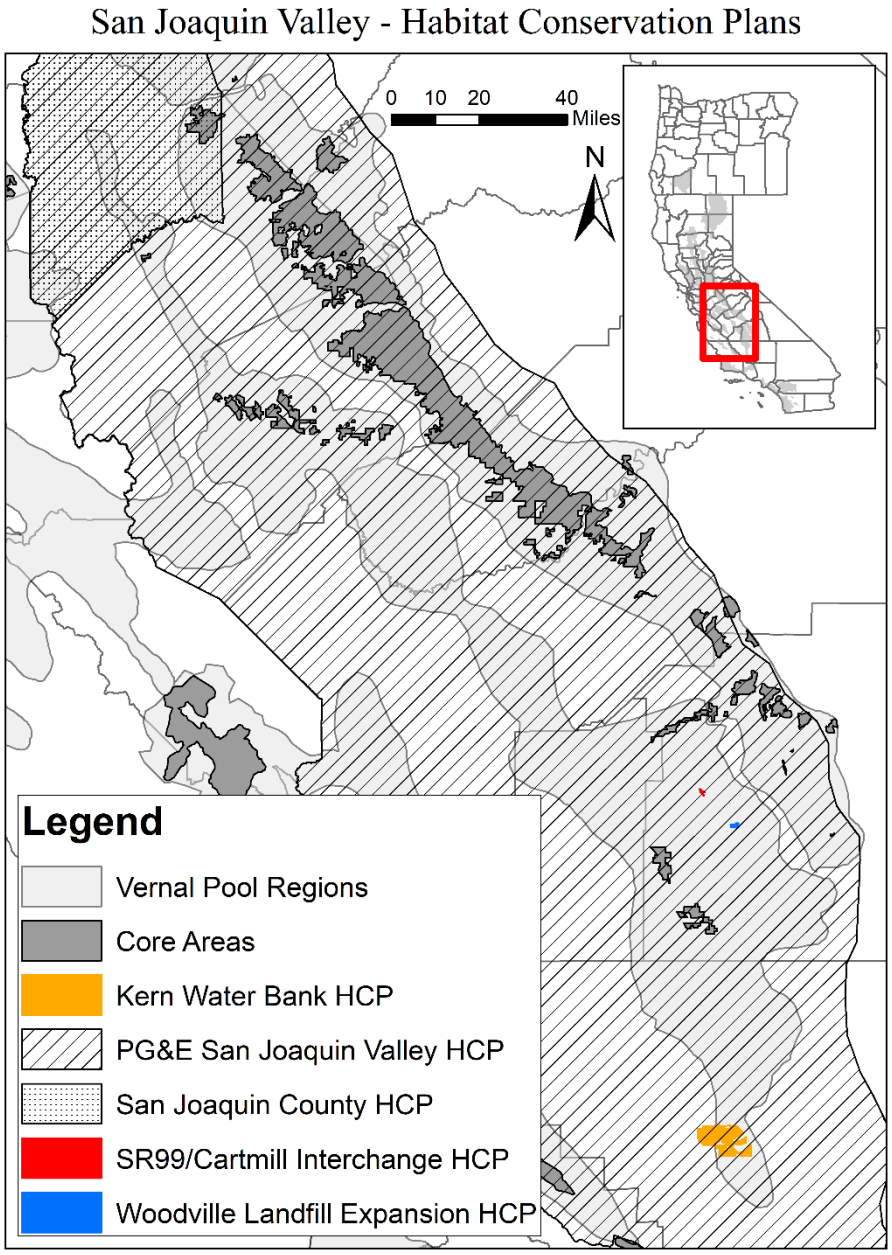


Figure 9.11. Map of the habitat conservation plans (HCPs) within the San Joaquin Valley Vernal Pool Region that include any of the three shrimp species as Covered Species.

9.5.2. PG&E San Joaquin Valley Operations and Maintenance HCP

The Pacific Gas & Electric Company's (PG&E) San Joaquin Valley Operations and Maintenance HCP covers PG&E activities within portions of nine San Joaquin Valley counties, spanning the San Joaquin Valley Vernal Pool Region, Southern Sierra Foothills Vernal Pool Region, and the southernmost extent of the Southeastern Sacramento Valley Vernal Pool Region in San Joaquin County (Jones and Stokes Associates 2006b). This HCP was permitted in 2007 and has a 30-year permit term. The purpose of the HCP is to enable PG&E to continue to conduct current and future operations and maintenance activities within the 9 San Joaquin Valley counties while avoiding, minimizing, and mitigating temporary and permanent impacts on threatened and endangered species habitat. The HCP's conservation strategy includes mitigation for permanent and temporary impacts to species habitat, which may be in the form of purchasing and/or placing easements on high quality habitat, purchase of conservation bank credits, contributions to existing conservation planning and recovery efforts, or habitat enhancement or restoration.

The HCP estimated that less than 1 acre of vernal pool fairy shrimp and vernal pool tadpole shrimp habitat will be permanently or temporarily lost annually, and 2 acres of vernal pool fairy shrimp habitat and 1 acre of vernal pool tadpole shrimp habitat will experience other less intensive disturbance each year (Jones and Stokes Associates 2006b). The Conservancy fairy shrimp is not a covered species. Permanent loss of vernal pool fairy shrimp and vernal pool tadpole shrimp habitat will be mitigated at a 3:1 ratio and temporary habitat loss at a 0.5:1 ratio. The actual amount of mitigation will depend on the actual acreage of effects documented when projects are implemented. The HCP does not specify in which vernal pool region this habitat will be preserved, but it does estimate that, over the first 5 years, 1.03 acres will be preserved in the northern San Joaquin Valley, 2.31 acres in the central San Joaquin Valley, and 0.55 acres in the southern San Joaquin Valley based on the anticipated locations of covered activities. As of December 31, 2017, there had only been 0.01 acre of permanent loss and 0.07 acre of temporary loss for vernal pool fairy shrimp habitat and no permanent loss and 0.06 acre of temporary loss for vernal pool tadpole shrimp habitat (PG&E 2018). A total of 9.28 acres and 7.97 acres of mitigation had been purchased as conservation credits for the vernal pool fairy shrimp and vernal pool tadpole shrimp, respectively, far exceeding the mitigation need (PG&E 2018). Of these credits, 2.44 acres were purchased from Great Valley Conservation Bank in the northern San Joaquin Valley for both shrimp species, 5.53 acres from Drayer Conservation Bank in the central San Joaquin Valley for both shrimp species, and 1.31 acres from Sand Creek Conservation Bank in the southern San Joaquin Valley for the vernal pool fairy shrimp only; all three of these banks are in the Southern Sierra Foothills Vernal Pool Region.

9.5.3. San Joaquin County HCP

See section 6.5.3 for a description of this HCP.

9.5.4. State Route 99/Cartmill Avenue Interchange Low-effect HCP

The State Route 99/Cartmill Avenue Interchange Low-effect HCP covers the construction of road improvements at the intersection of State Route 99, M Street, and Cartmill Avenue between post miles 31.2 and 32.4 in the City of Tulare (ICF 2013). The Permit Area encompasses 218.9 acres, including the 54.32-acre project construction area and the 164.58-acre area of potential

indirect effects. This HCP was permitted in 2013 and had a 5-year permit term that ended in 2018, and the permittee is the City of Tulare.

The vernal pool fairy shrimp was the only shrimp species included as a covered species. There were two small seasonal wetlands within or near the project that provide potential habitat for the vernal pool fairy shrimp. One of these wetlands was filled by the project, resulting in 0.071 acres of habitat loss. This loss was mitigated with the purchase of 0.213 acres of preservation credits for the vernal pool fairy shrimp from the Deadman Creek Conservation Bank.

9.5.5. Woodville Solid Waste Disposal Site Expansion HCP

The Woodville Solid Waste Disposal Site Expansion HCP covers the expansion of a Tulare County landfill site 7 miles southeast of the City of Tulare (Jones and Stokes Associates 2006c). The Permit Area encompasses 414.11 acres, including the 53.32-acre expansion area, the 77.58-acre borrow area, the 158.26-acre vernal pool conservation area, and the 124.95-acre silage area and San Joaquin kit fox (*Vulpes macrotis mutica*) conservation area. This HCP was permitted in 2007 and has a 41-year permit term, and the permittee is the County of Tulare.

The vernal pool fairy shrimp was the only shrimp species included as a covered species. There were 1.77 acres of vernal pools that provided potential habitat for the vernal pool fairy shrimp in the expansion area that were filled by the project. This loss was mitigated with the preservation of the 158.26-acre vernal pool conservation area, which contains 5.35 acres of vernal pools. This preserve was placed under conservation easement and is regularly monitored and managed. Monitoring over the past 10 years has only positively identified the versatile fairy shrimp (*Branchinecta lindalhi*) on site (Kamansky's Ecological Consulting 2022). However, these surveys did not include the pools in the southwestern corner of the site that are most likely to support the vernal pool fairy shrimp; these pools were extensively thatch-covered and did not yield sufficient hydrology to support the vernal pool fairy shrimp during most surveys (Kamansky's Ecological Consulting 2022).

9.6. Other Preserves

The California Department of Fish and Wildlife (CDFW) owns five Ecological Reserves within or adjacent to the San Joaquin Valley Vernal Pool Region that contain vernal pool habitat: Alkali Sink, Kerman, Allensworth, Semitropic, and Buttonwillow. None of these preserves have final management plans (J. Battistoni, CDFW, *in litt*. 2022). Alkali Sink and Kerman Ecological Reserves are located in Fresno County, are approximately 930 acres and 1,800 acres in size, respectively, and are almost entirely composed of vernal pool grasslands, as well as a small patch of vernal pool grasslands south of Alkali Sink on the Mendota Wildlife Area (see **Figure 9.3**; Witham 2021). The most recent surveys of these Ecological Reserves by CDFW happened in 2012 (Battistoni, *in litt*. 2022). On the Alkali Sink Ecological Reserve, the vernal pool fairy shrimp was found in two vernal pools, while the vernal pool tadpole shrimp and Conservancy fairy shrimp were not found (Battistoni, *in litt*. 2022); the vernal pool fairy shrimp was also observed immediately north of the preserve in 2009 (Diversity Database 2022). On the Kerman Ecological Reserve, there are historic records of the vernal pool fairy shrimp and vernal pool tadpole shrimp, but only the common species *Branchinecta lindahli* and *B. mackini* were identified during recent surveys (Battistoni, *in litt*. 2022). The Allensworth, Semitropic, and

Buttonwillow Ecological Reserves are located in the Tulare Basin in Tulare and Kern Counties and are approximately 5,100 acres, 14,900 acres, and 1,400 acres in size, respectively (**Figure 9.4**). A majority of these preserves are mapped as vernal pool grasslands (Witham 2021), though CDFW describes the habitat as alkali rain slicks/pools and not proper vernal pools (Battistoni, *in litt*. 2022). Only the common species *B. lindahli* and *B. mackini* were identified during recent surveys. The vernal pool tadpole shrimp has never been observed as far south as these Ecological Reserves. Both Allensworth and Buttonwillow Ecological Reserves had historic records of potential vernal pool fairy shrimp that could not be conclusively identified, and on both preserves the pools where those occurrences were documented have since been destroyed or disturbed (Battistoni, *in litt*. 2022).

CDFW also owns three Wildlife Areas within the San Joaquin Valley Vernal Pool Region that contain vernal pool habitat: North Grasslands, Los Banos, and Volta. None of these Wildlife Areas have final management plans (Battistoni, *in litt*. 2022). All three areas are located in Merced County adjacent to the San Luis National Wildlife Refuge Complex and are 7,400 acres, 6,200 acres, and 3,800 acres in size, respectively. An estimated 1,379 acres, 4,950 acres, and 2,918 acres of vernal pool grasslands have been mapped within each Ecological Reserve, respectively (Witham 2021). No occurrences of the three shrimp have been recorded within these Wildlife Areas; the nearest known occurrences are from the San Luis National Wildlife Refuge (Diversity Database 2022).

The California Department of Parks and Recreation (CDPR) owns the 2,862-acre Great Valley Grasslands State Park in Merced County along the San Joaquin River and the northern border of the San Luis National Wildlife Refuge Complex. Based on aerial imagery, approximately 1,360 acres of vernal pool grassland was mapped in the part of the park south of the San Joaquin River and adjacent to the San Luis National Wildlife Refuge Complex (Witham 2021). The vernal pool fairy shrimp has not been recorded within this State Park. The vernal pool tadpole shrimp was recorded in four vernal pools in the southern portion of this State Park, most recently in 2003 (Diversity Database 2022). The Conservancy fairy shrimp was recorded within this State Park in 7 of 93 pools surveyed in 1995 (Diversity Database 2022). The Service is not aware of any more recent observations of the Conservancy fairy shrimp within the State Park.

The Center for Natural Lands Management (CNLM) owns two preserves within the San Joaquin Valley Vernal Pool Region that contain vernal pool habitat: Pixley Vernal Pools Preserve and Semitropic Ridge Preserve. The Pixley Vernal Pools Preserve is a 40-acre preserve located in Tulare County, all of which contains vernal pool grasslands. The preserve has a very high density of vernal pools, with 100 pools in 10-20 vernal pool complexes (CNLM, *in litt*. 2021a). The vernal pool fairy shrimp was first documented here in the mid-1980's by The Nature Conservancy and has been frequently detected since; the most recent survey documenting the vernal pool fairy shrimp occurred in 2019 (CNLM, *in litt*. 2021a). The Semitropic Ridge Preserve is a 3,700-acre preserve in Kern County adjacent to CDFW's Semitropic Ecological Reserve. As with the Semitropic Ecological Reserve, alkali playas are interspersed through much of the preserve, but the vernal pool fairy shrimp has not been reported to occur on the preserve (CNLM 2022a). The other two shrimp species have not been observed on either of these preserves, and these preserves are farther south than the known range of the vernal pool tadpole shrimp.

Vollmar et al. (2017) identified 17 other protected properties within the San Joaquin Valley Vernal Pool Region, including three conservation easements held by CDFW, 10 very small mitigation parcels owned by CDFW adjacent to Pixley National Wildlife Refuge, 3 conservation easements held by the Natural Resources Conservation Service (NRCS), and one preserve owned by the Sequoia Riverlands Trust.

9.7. Vernal Pool Core Areas

There are four Core Areas within the San Joaquin Valley Vernal Pool Region, all of which are designated in the Recovery Plan for the vernal pool fairy shrimp: Caswell, Cross Creek, Grassland Ecological Area, and Pixley. The Cross Creek and Grassland Ecological Area Core Areas are also designated for the vernal pool tadpole shrimp, and the Caswell and Grassland Ecological Area Core Areas are also designated for the Conservancy fairy shrimp. The Caswell Core Area has met the targeted amount of vernal pool habitat protected (see Caswell section below) and the Grasslands Ecological Area is very close. As of 2018, none had lost enough habitat, compared to the baseline level of habitat that was present in 2005, to make the protection targets unattainable (see **Table 9.1**; Vollmar et al. 2017; Witham 2021).

9.7.1. Caswell

This is a zone 1 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and 95% of vernal pool habitat for the Conservancy fairy shrimp. The core area is located in Stanislaus County and is entirely within the San Joaquin River National Wildlife Refuge.

There were approximately 395 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were still 395 acres of vernal pool grassland remaining, with no habitat losses occurring since 2005 (see **Figure 9.12**, **Table 9.1**; Witham 2021). Finer scale, on the ground mapping of individual vernal pools on the Refuge has been consistently identified as a priority in recent years, but has not yet occurred (Service 2018b; Takahashi, *in litt*. 2021). Vollmar et al. (2017) estimated that there were roughly 311 acres of vernal pool grassland protected within this core area as of 2017 (Vollmar et al. 2017), representing 78.7% of the 2005 baseline. The southern portion of Mapes Ranch, the only part of the core area not identified as protected in Vollmar et al.'s (2017) database, is also now protected under conservation easement, meaning that 100% of the 2005 baseline has been protected (**Figure 9.13**).

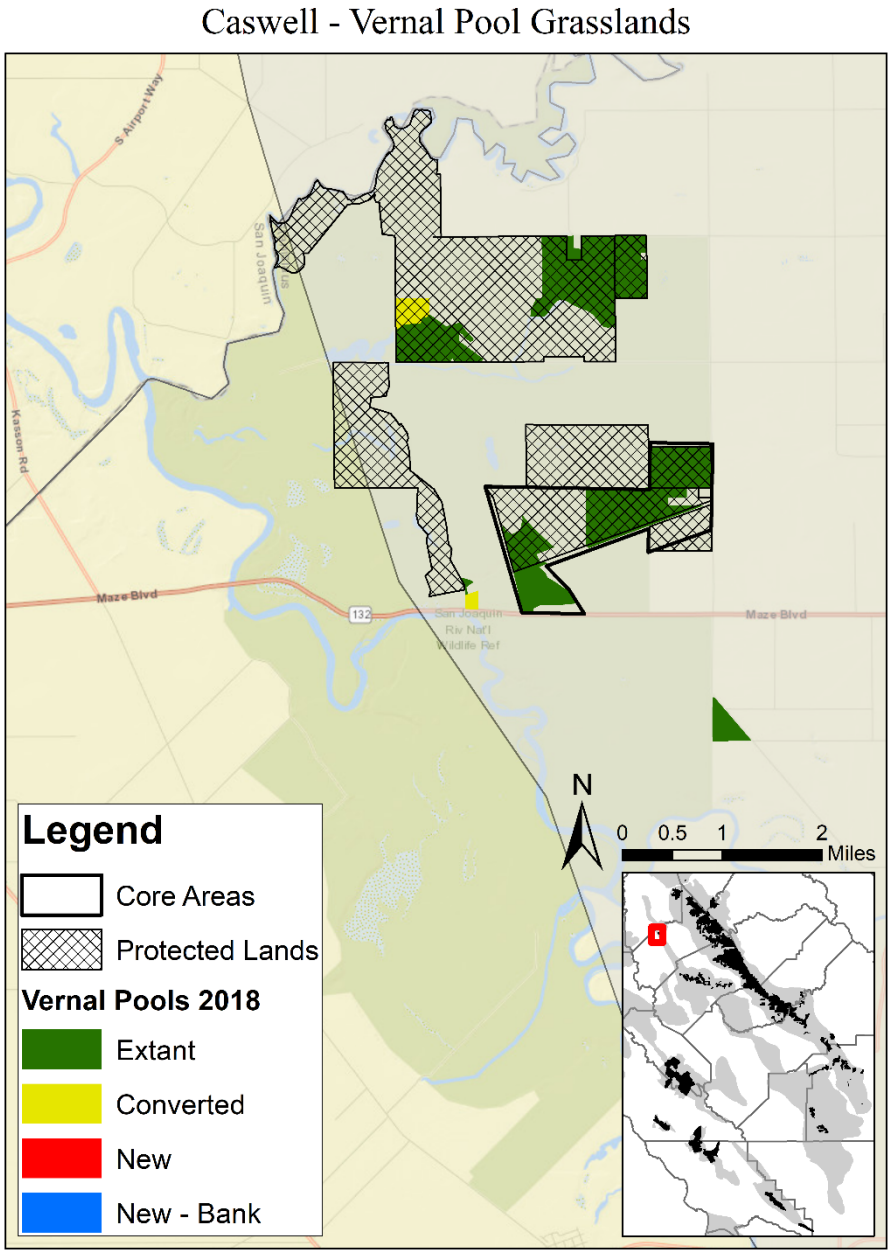


Figure 9.12. Map of vernal pool grassland habitat within the Caswell Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

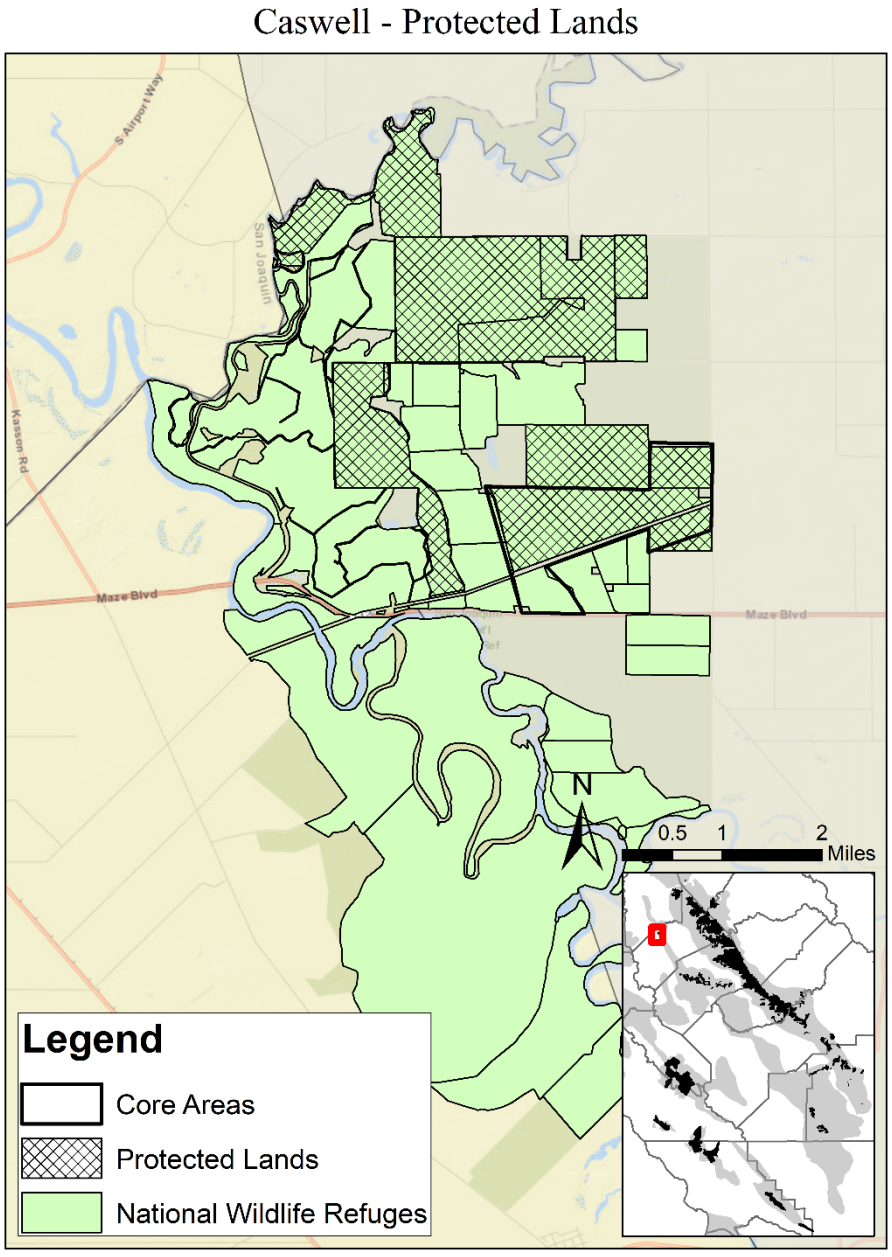


Figure 9.13. Map of protected areas within the Caswell Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves.

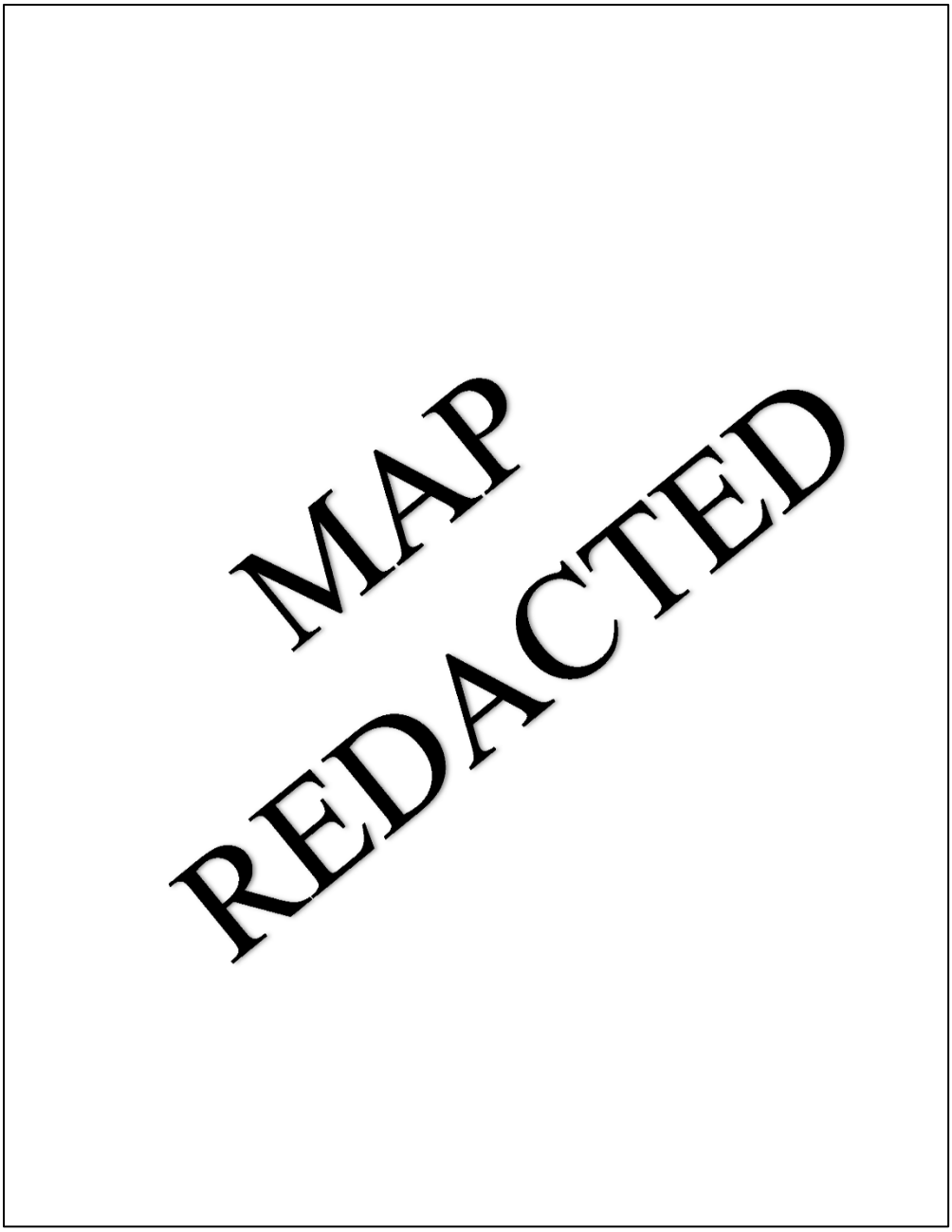


Figure 9.14. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Caswell Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

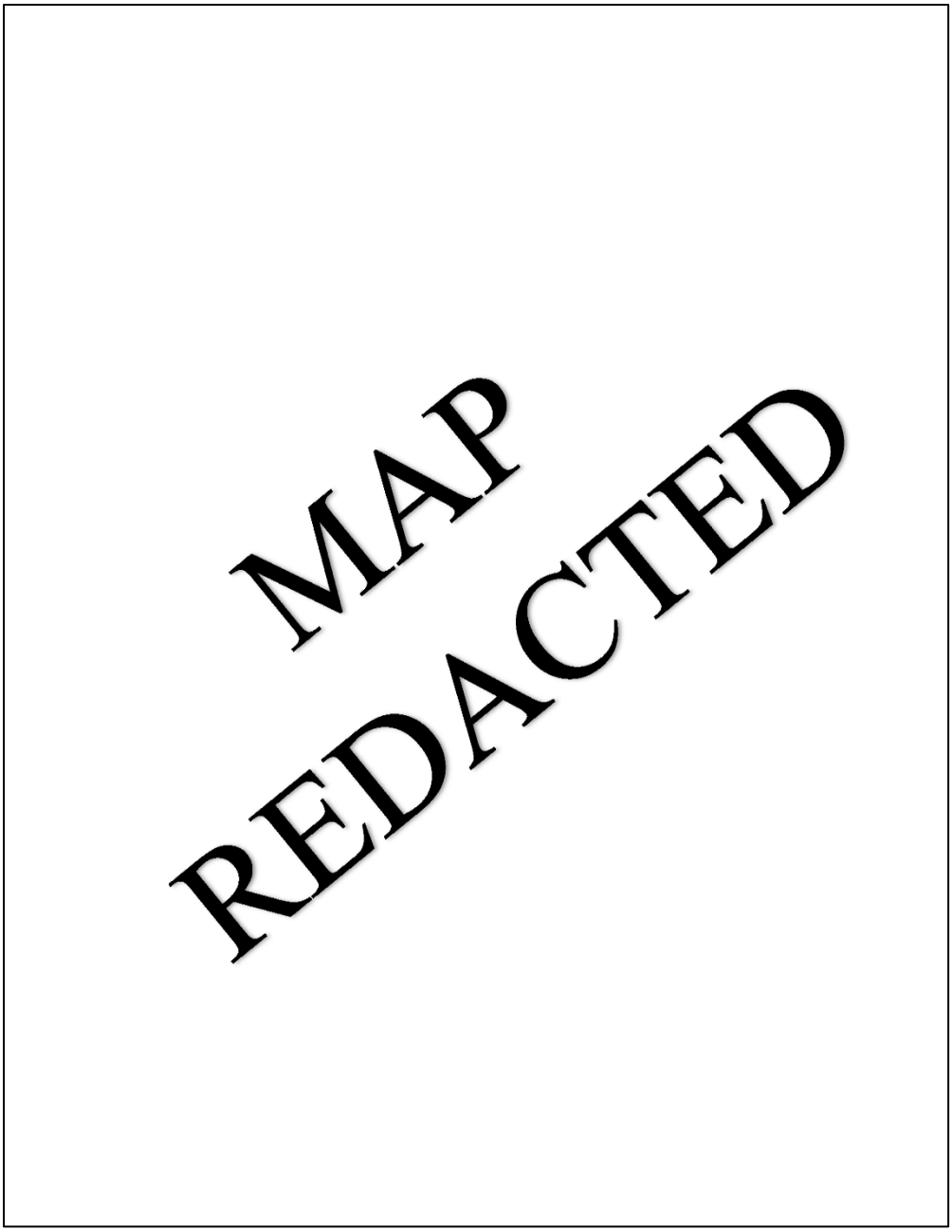


Figure 9.15. Map of known occurrences of Conservancy fairy shrimp recorded in the Diversity Database (2022) within the Caswell Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

9.7.1.1.Vernal Pool Fairy Shrimp Occurrences

There are two Diversity Database occurrence records for the vernal pool fairy shrimp within this core area, both of which are entirely protected within the Refuge (see **Figure 9.14**; Diversity Database 2022). All occurrences are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). Of the two records, one was known at the time of listing in 1994 and both were known at the time the Recovery Plan was published in 2005. The western occurrence is located within Mapes Ranch; this part of the Refuge was not identified as a protected area in Vollmar et al.'s (2017) database, but this report considers all Refuge lands to be protected unless management is inconsistent with species needs. The vernal pool fairy shrimp was observed in 1991 and 1998, and *Branchinecta* cysts were identified during dry season surveys in 2011 despite no shrimp being observed during the previous year's wet season survey (Diversity Database 2022). The eastern occurrence is located within pastureland just south of Nelson Field and was observed in 1998 near the base of an electrical transmission line tower (Service 2006b; Diversity Database 2022). Vernal pool surveys occurred most recently on the San Joaquin River National Wildlife Refuge in 2017, but the survey occurred too late in the season to detect the vernal pool fairy shrimp (Service 2018b).

9.7.1.1.Conservancy Fairy Shrimp Occurrences

There is one Diversity Database occurrence record for the Conservancy fairy shrimp within this core area, which are entirely protected within the Refuge (see **Figure 9.15**; Diversity Database 2022). This single occurrence represents the entire Mapes Ranch population of the Conservancy fairy shrimp. The occurrence is presumed extant by the Diversity Database and is within extant vernal pool grasslands (Witham 2021). It was first recorded in 1991in two vernal pools located within Mapes Ranch. This part of the Refuge was not identified as a protected area in Vollmar et al.'s (2017) database, but this report considers all Refuge lands to be protected unless management is inconsistent with species needs. Based on the information available to the Service at the time, the previous 5-year review (Service 2012c) stated that the Mapes Ranch occurrence was still privately owned and that the hydrology on the site may have been altered, possibly extirpating the Conservancy fairy shrimp. However, this portion of Mapes Ranch was acquired by the Refuge in 2010, so the property should be being managed according to the Refuge's Comprehensive Conservation Plan (Service 2006). Surveys of Mapes Ranch are needed to determine if the Conservancy fairy shrimp remains extant. Vernal pool surveys occurred most recently on the Refuge in 2017, but not the portion of the Refuge with the Conservancy fairy shrimp (Service 2018b).

9.7.2. Cross Creek

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and vernal pool tadpole shrimp. The core area is located in Kings and Tulare Counties on either side of Highway 99 north of Visalia. This core area is nearly contiguous with the Cottonwood Creek Core Area to the east in the Southern Sierra Foothills Vernal Pool Region.

There were approximately 3,800 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 3,393 acres of vernal pool grassland remaining, with 407 acres lost since 2005 (see **Figure 9.16**, **Table 9.1**;

Witham 2021). All losses were due to agricultural conversion, including conversion to rice, row crops, dairies, or nurseries (235.0 acres, 57.8%), alfalfa and irrigated pasture (126.5 acres, 31.1%), orchards, vineyards, or eucalyptus (39.4 acres, 9.7%), and bare plowed agricultural land (5.8 acres, 1.4%) (see **Table 9.2**; Witham 2021). No vernal pool grasslands are currently known to be protected within this core area (Vollmar et al. 2017).

9.7.2.1.Vernal Pool Fairy Shrimp Occurrences

There are seven Diversity Database occurrence records for the vernal pool fairy shrimp within this core area (see **Figure 9.17**; Diversity Database 2022). As of 2018, none of the occurrences were within protected areas (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). Of the seven records, three were known at the time of listing in 1994 and five were known at the time the Recovery Plan was published in 2005. The three occurrences east of Highway 99 were observed in 1992-1993 and have not been surveyed since, to the Service's knowledge (Diversity Database 2022). Of the four occurrences west of Highway 99, two were first observed in 1999, and all four were observed in 2017 when the Cross Creek properties were being evaluated as potential mitigation lands for the California High Speed Rail Authority (Diversity Database 2022).

9.7.2.1.Vernal Pool Tadpole Shrimp Occurrences

There are seven Diversity Database occurrence records for the vernal pool tadpole shrimp within this core area (see **Figure 9.18**; Diversity Database 2022). As of 2018, none of the occurrences were within protected areas (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). Of the seven records, two were known at the time of listing in 1994 and five were known at the time the Recovery Plan was published in 2005. The two newer occurrences are immediately west of Highway 99 between several of the older occurrences. Six of the seven occurrences were most recently observed between 2011 and 2018, with four observed in 2017 when the Cross Creek properties were being evaluated as potential mitigation lands for the California High Speed Rail Authority (Diversity Database 2022).

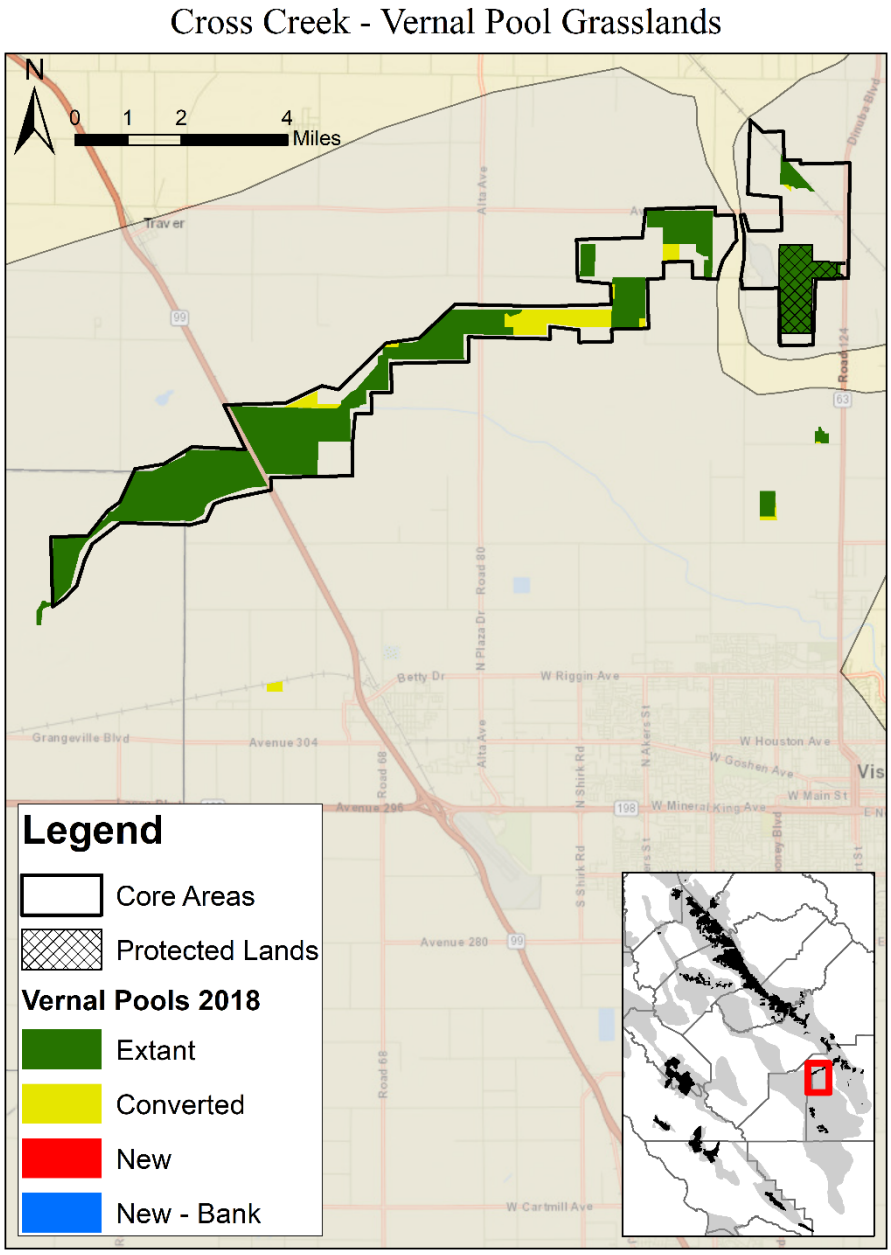


Figure 9.16. Map of vernal pool grassland habitat within the Cross Creek Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

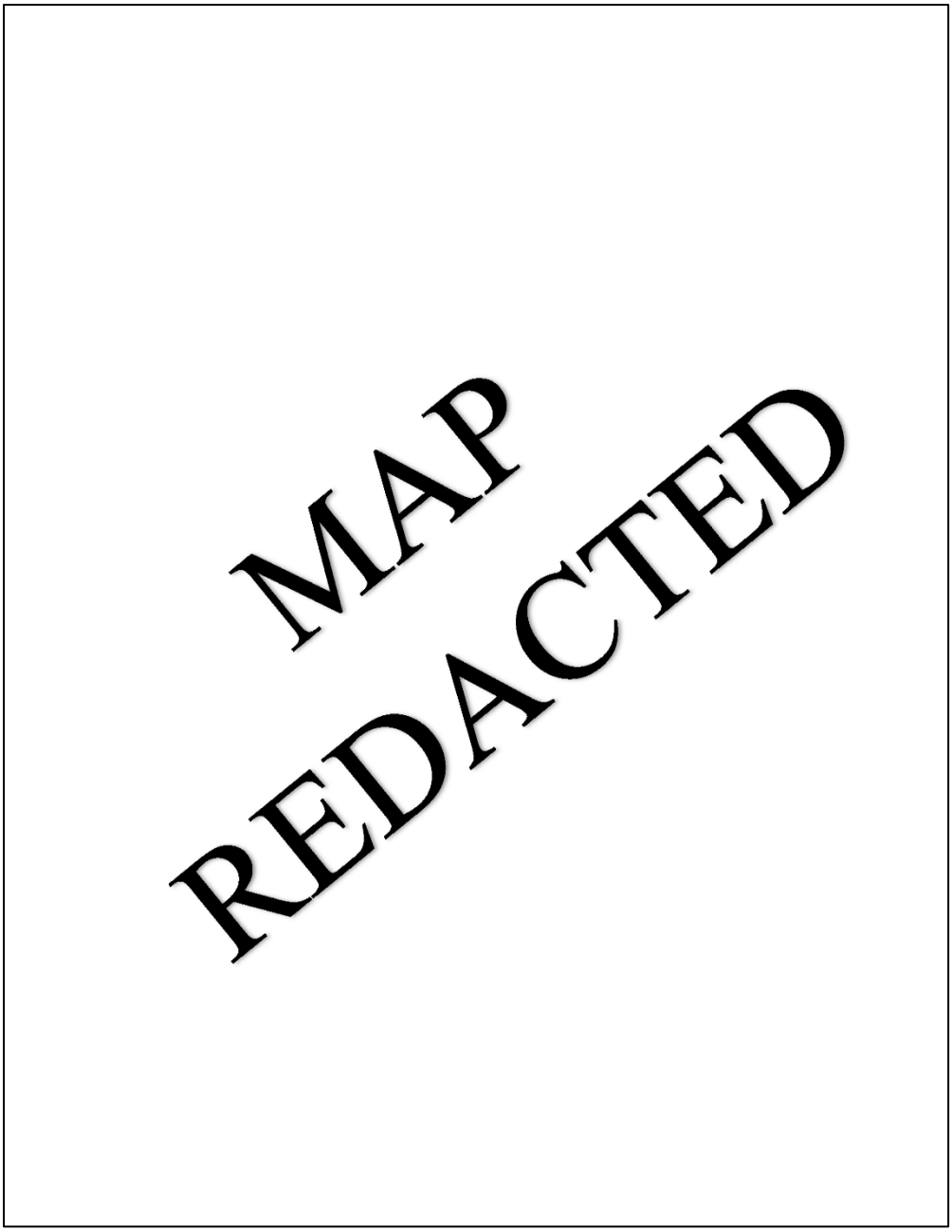


Figure 9.17. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Cross Creek Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

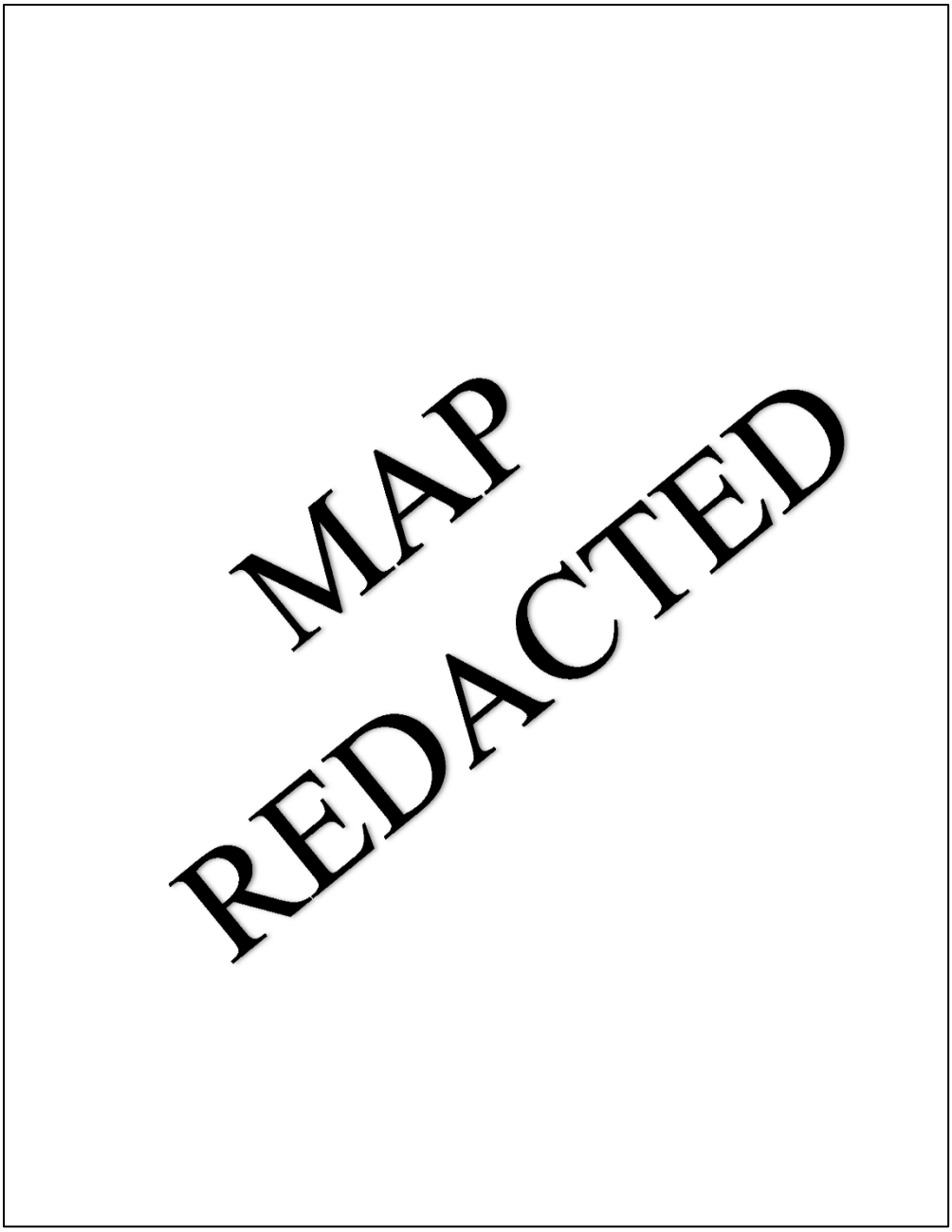


Figure 9.18. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Cross Creek Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

9.7.3. Grassland Ecological Area

This is a zone 1 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and 95% of vernal pool habitat for the vernal pool tadpole shrimp and Conservancy fairy shrimp. The core area is located in Merced County across the northern extent of the Grassland Ecological Area, the largest continuous block of freshwater wetlands remaining in California that is found in the historic San Joaquin River Basin.

There were approximately 30,830 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 30,525 acres of vernal pool grassland remaining (see **Figure 9.19**, **Table 9.1**; Witham 2021). Approximately 331 acres had been lost since 2005, though 26 additional acres were identified that were either not present or not visible on the 2005 aerial imagery. All losses were due to agricultural conversion to either alfalfa and irrigated pasture (175.8 acres, 53.1%) or bare plowed agricultural land (155.1 acres, 46.9%) (see **Table 9.2**; Witham 2021). Vollmar et al. (2017) estimated that there were roughly 23,221 acres of vernal pool grassland protected within this core area as of 2017 (Vollmar et al. 2017), representing 75.3% of the 2005 baseline. There are an additional 843 acres of vernal pool grassland within the Grasslands Wildlife Management Area near the Deadman Creek and Vieira-Sandy Mush Road Conservation Banks that are not included in Vollmar et al.'s (2017) database. This means a total of 24,064 acres of vernal pool grassland area protected, representing 78.1% of the 2005 baseline.

There are three conservation banks with vernal pool fairy shrimp and vernal pool tadpole shrimp preservation credits, and which also support the Conservancy fairy shrimp, in this core area: Deadman Creek, Dutchman Creek, and Vieira-Sandy Mush Road (**Figure 9.20**). These banks total 1,548 acres in size and have 113.92 acres of preservation credits for the vernal pool fairy shrimp and vernal pool tadpole shrimp (49.5% of which have already been sold). Other protected areas within this core area include the San Luis National Wildlife Refuge, Merced National Wildlife Refuge, Grasslands Wildlife Management Area, and Great Valley Grasslands State Park (**Figure 9.20**).

9.7.3.1. Vernal Pool Fairy Shrimp Occurrences

There are 12 Diversity Database occurrence records for the vernal pool fairy shrimp within this core area and 1 additional occurrence immediately adjacent (see **Figure 9.21**; Diversity Database 2022). As of 2018, all 13 of these occurrences were at least partially within protected areas (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). Of the 13 records, 6 were known at the time of listing in 1994 and 7 were known at the time the Recovery Plan was published in 2005; these records are located throughout the San Luis National Wildlife Refuge Complex and on the Deadman Creek and Vieira-Sandy Mush Road Conservation Banks. The six newer occurrences were identified between 2008 and 2016 and are located on the Dutchman Creek Conservation Bank and on the Refuge Complex near the older occurrences.

9.7.3.1.Vernal Pool Tadpole Shrimp Occurrences

There are 17 Diversity Database occurrence records for the vernal pool tadpole shrimp at least partially within this core area and 2 adjacent to the core area (see **Figure 9.22**; Diversity Database 2022). As of 2018, 18 of these 19 occurrences were protected (Vollmar et al. 2017); several of these occurrence records are large polygons that encompass entire sections of the San Luis National Wildlife Refuge Complex. All occurrences are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). Of the 19 records, 8 were known at the time of listing in 1994 and 13 were known at the time the Recovery Plan was published in 2005; these records are located throughout the San Luis National Wildlife Refuge Complex and on the Great Valley Grasslands State Park, Vieira-Sandy Mush Road Conservation Bank, and one private property to the east. The six newer occurrences were identified between 2008 and 2015 and are located on the Deadman Creek, Dutchman Creek, and Vieira-Sandy Mush Road Conservation Banks and on the eastern side of the Refuge Complex (Diversity Database 2022).

9.7.3.1.Conservancy Fairy Shrimp Occurrences

There are 13 Diversity Database occurrence records for the Conservancy fairy shrimp within this core area (see **Figure 9.23**; Diversity Database 2022). As of 2018, all 13 of these occurrences were at least partially within protected areas (Vollmar et al. 2017). The western 10 occurrences, which make up the Highway 165/Grasslands Ecological Area population, are within the San Luis National Wildlife Refuge Complex and the Great Valley Grasslands State Park. The eastern three occurrences, which make up the Sandy Mush Road population, are all within conservation banks. All occurrences are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). Of the 13 records, 3 were known at the time of listing in 1994 and 4 were known at the time the Recovery Plan was published in 2005; these records are located in the Great Valley Grasslands State Park, the San Luis Refuge's Kesterson and East Bear Creek units, and the Merced Refuge's Arena Plains unit (all within the Highway 165/Grasslands Ecological Area population). The nine newer occurrences were identified between 2008 and 2016; these records are located on the San Luis Refuge's Kesterson and East Bear Creek units, the Merced Refuge's Snobird unit (Highway 165/Grasslands Ecological Area population), and the Deadman Creek, Dutchman Creek, and Vieira-Sandy Mush Road Conservation Banks (Sandy Mush Road population).

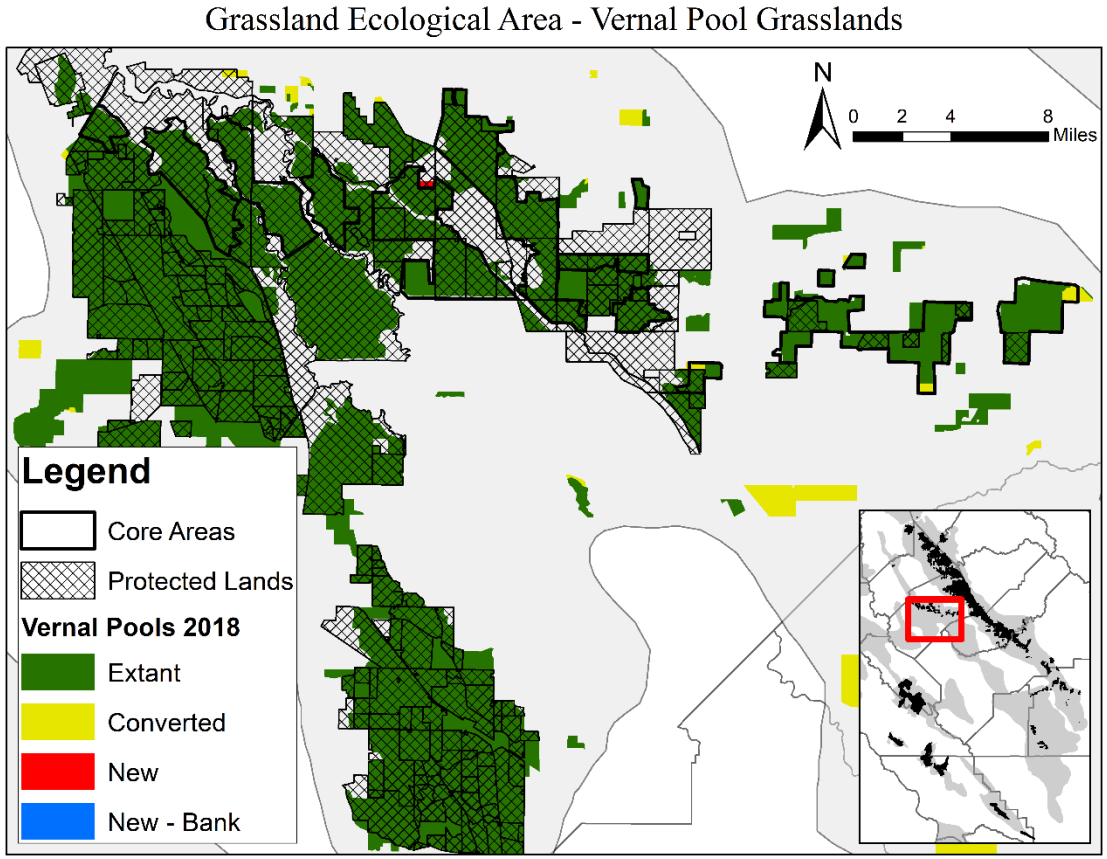


Figure 9.19. Map of vernal pool grassland habitat within the Grassland Ecological Area Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

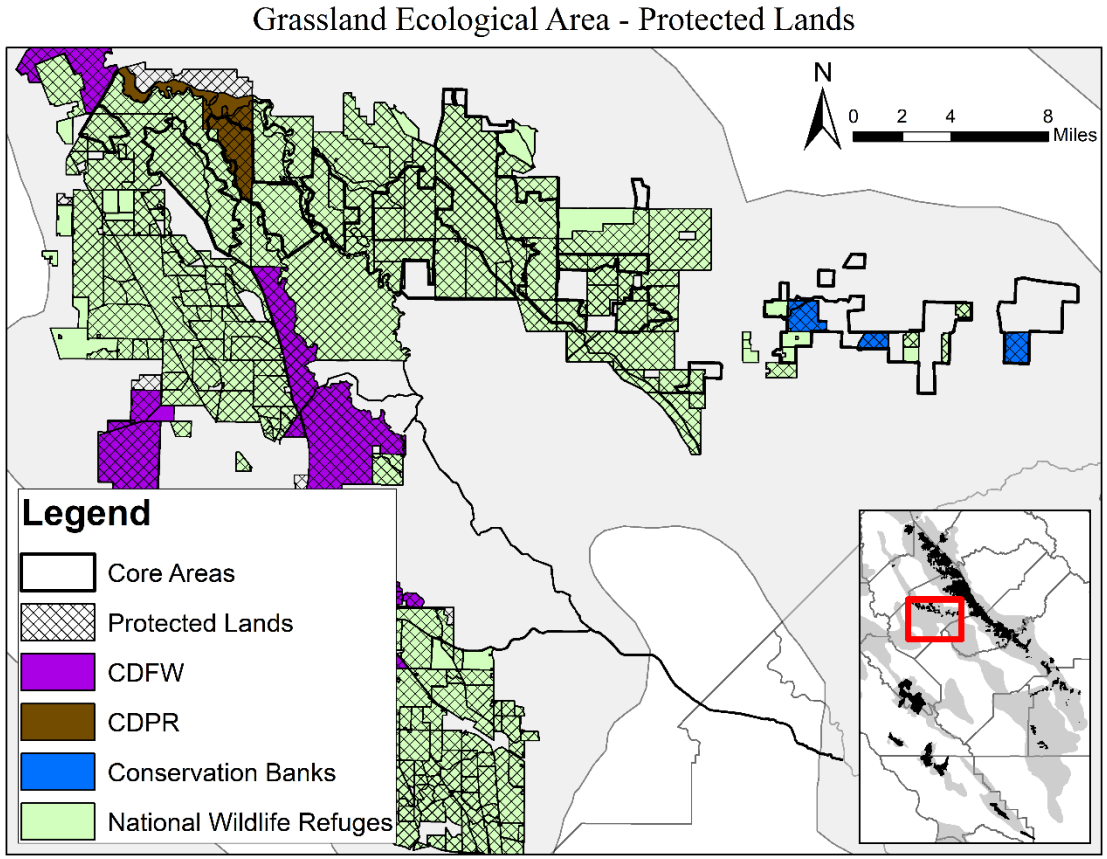


Figure 9.20. Map of protected areas within the Grassland Ecological Area Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. CDFW = California Department of Fish and Wildlife, CDPR = California Department of Parks and Recreation.

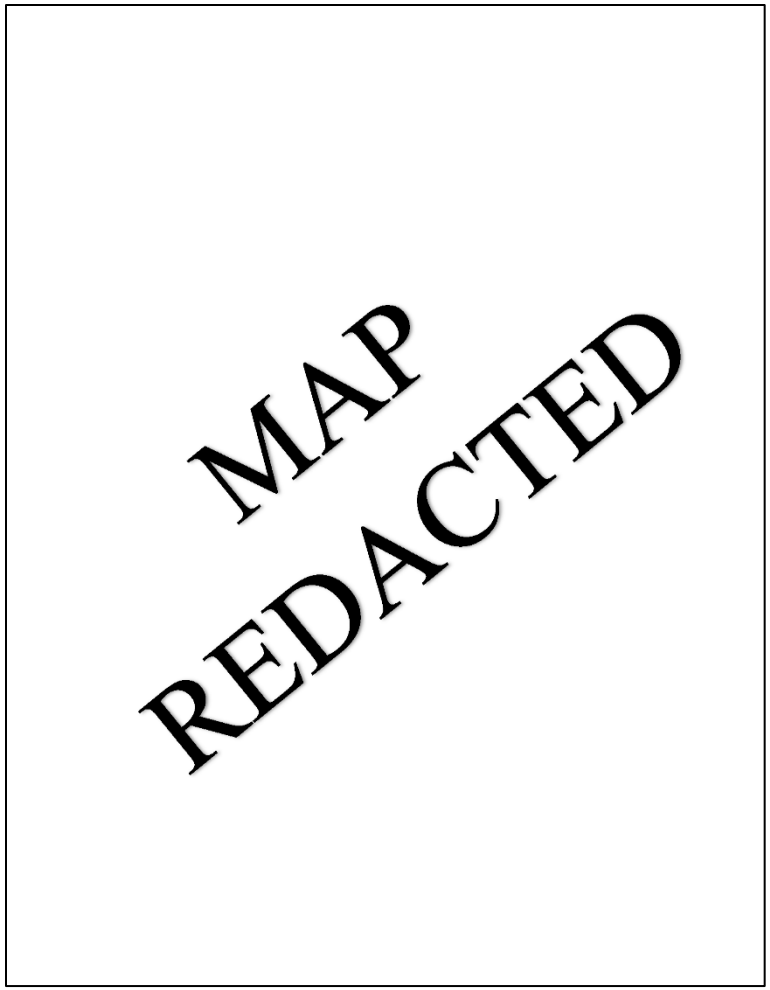


Figure 9.21. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Grassland Ecological Area Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

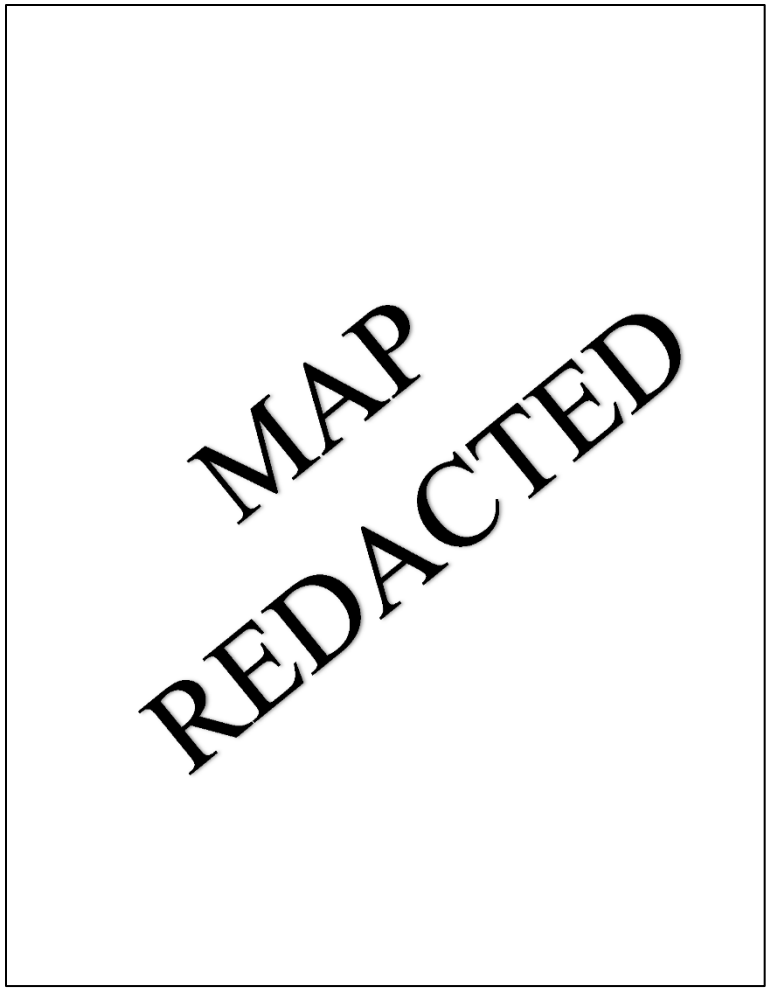


Figure 9.22. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Grassland Ecological Area Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

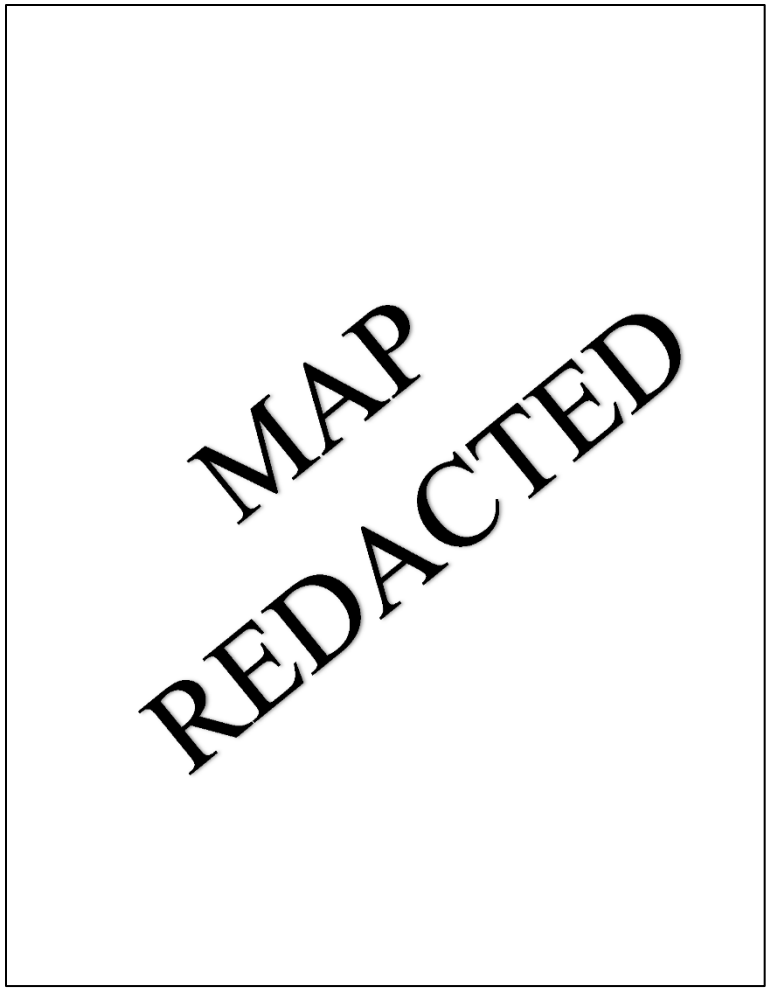


Figure 9.23. Map of known occurrences of Conservancy fairy shrimp recorded in the Diversity Database (2022) within the Grassland Ecological Area Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

9.7.4. Pixley

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is located in southwestern Tulare County between Highway 99 and Highway 43 around the Pixley National Wildlife Refuge.

There were approximately 10,745 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 10,476 acres of vernal pool grassland remaining (see **Figure 9.24**, **Table 9.1**; Witham 2021). Approximately 270 acres had been lost since 2005. All losses were due to agricultural conversion, primarily to bare plowed agricultural land (195.4 acres, 72.5%) and rice, row crops, or dairies (70.1 acres, 26.0%) (see **Table 9.2**; Witham 2021). These numbers were based on aerial imagery, which identified almost all of Pixley National Wildlife Refuge as vernal pool grassland. However, the 2021 Natural Resources Management Plan for the refuge only identifies four units within the central portion of the refuge as containing vernal pools (Service 2021a). Other units of the refuge may not contain the vernal pools suggested by the aerial imagery, or vernal pools may be present and not documented. Vollmar et al. (2017) estimated that there were roughly 5,173 acres of vernal pool grassland protected within this core area as of 2017 (Vollmar et al. 2017), representing 48.1% of the 2005 baseline. There are 44 small parcels totaling 276 acres on Pixley National Wildlife Refuge that are almost entirely mapped as vernal pool grassland but not included in Vollmar et al.'s database. This means a total of 5,449 acres of vernal pool grassland area are protected, representing 50.7% of the 2005 baseline.

Protected areas within this core area include Pixley National Wildlife Refuge, part of CDFW's Allenworth Ecological Reserve, and 10 very small mitigation parcels owned by CDFW adjacent to Pixley National Wildlife Refuge (**Figure 9.25**).

9.7.4.1.Vernal Pool Fairy Shrimp Occurrences

There are four Diversity Database occurrence records for the vernal pool fairy shrimp within this core area (see **Figure 9.26**; Diversity Database 2022). As of 2018, two of these occurrences were within protected areas (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database and overlap extant vernal pool grasslands, although one of the occurrences is centered over an area that was not mapped as vernal pool grassland (Witham 2021). All four occurrence were known at the time of listing in 1994. The northern two occurrences are located on private land, and the southern two occurrences are located on the central portion of Pixley National Wildlife Refuge. In 2022, six vernal pools within the Centerfield unit of Pixley National Wildlife Refuge (the area with the Diversity Database occurrences) were surveyed; the vernal pool fairy shrimp was identified in five of the pools (Jimenez, *in litt*. 2023).

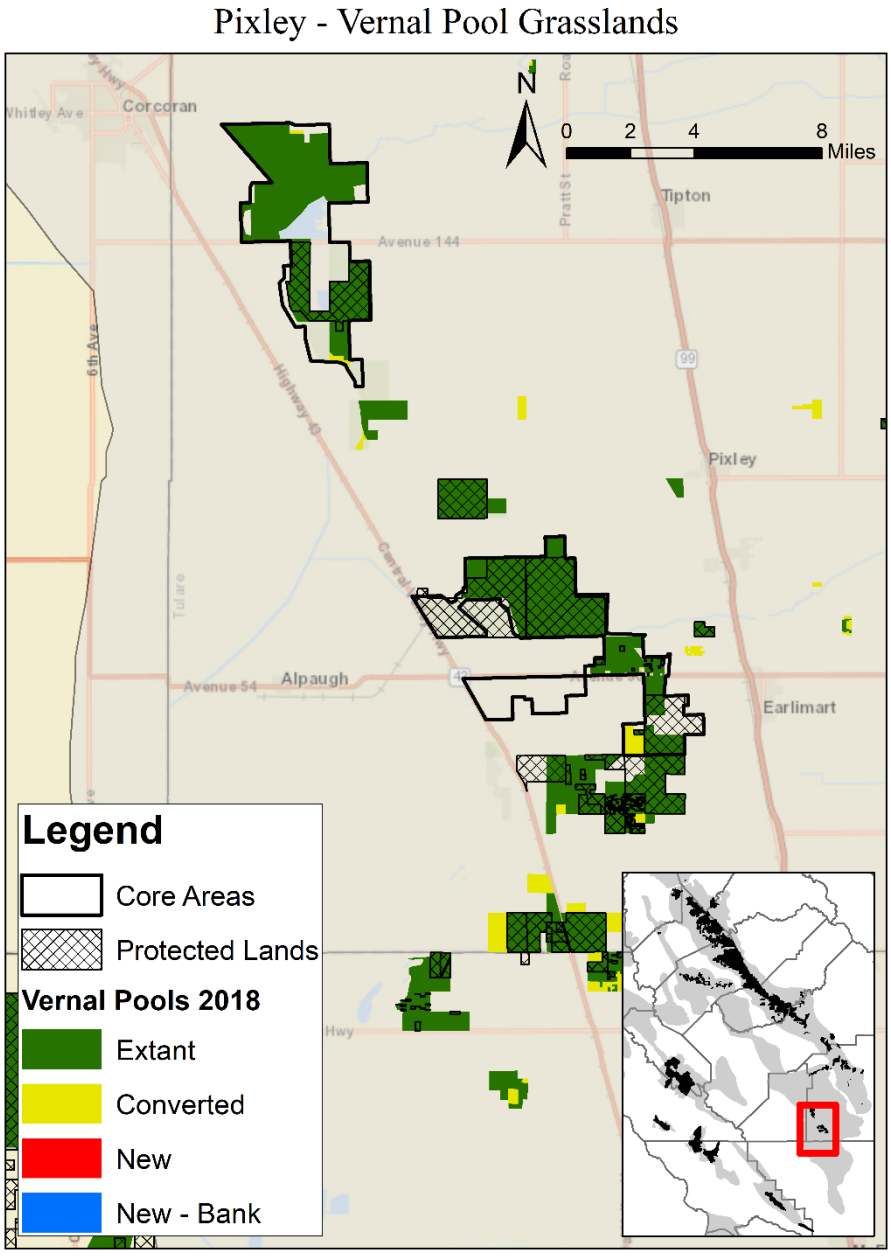


Figure 9.24. Map of vernal pool grassland habitat within the Pixley Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

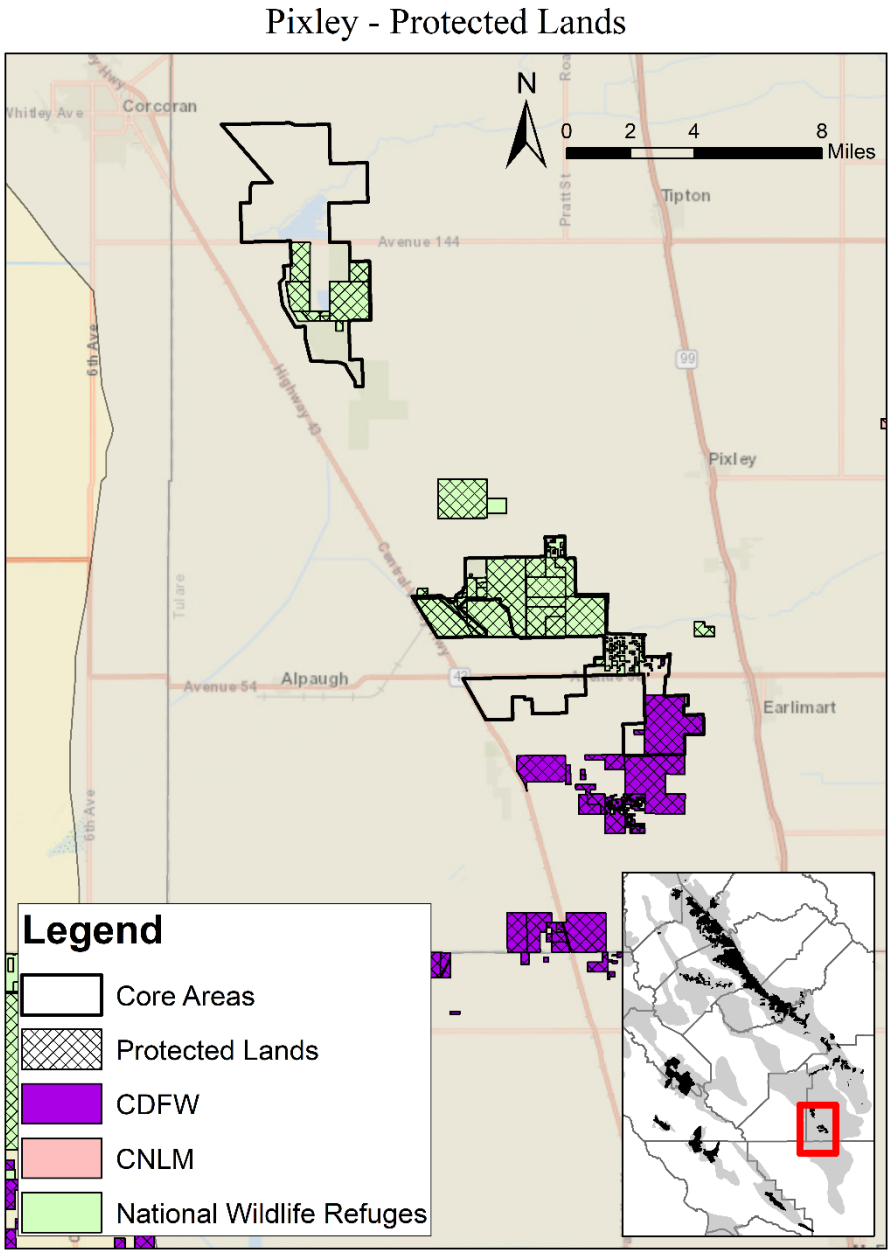


Figure 9.25. Map of protected areas within the Pixley Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. CDFW = California Department of Fish and Wildlife, CNLM = Center for Natural Lands Management.

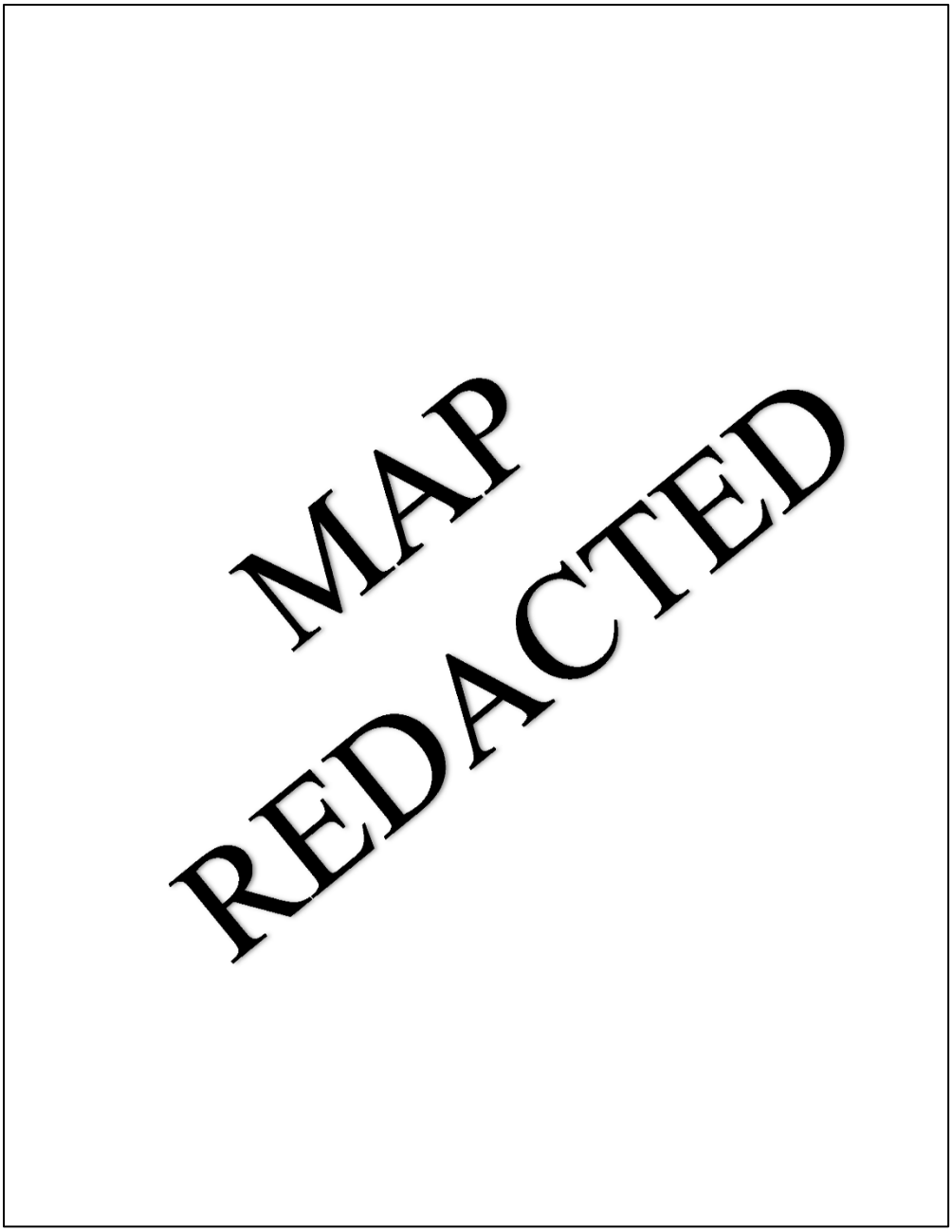


Figure 9.26. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Pixley Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

10. SANTA BARBARA VERNAL POOL REGION

The vernal pool fairy shrimp and Conservancy shrimp are both known to occur within the Santa Barbara Vernal Pool Region. The vernal pool tadpole shrimp is not known to occur within this region.

10.1. Vernal Pool Habitat

Holland (2003) mapped the vernal pool complexes of the Central Coast of California based on 1994 aerial imagery. The study area consisted of 9,574,099 acres and encompassed all of San Benito, Monterey, San Luis Obispo, Santa Barbara, and Ventura Counties; this encompasses most of the Santa Barbara Vernal Pool Region, as well as the Carrizo and parts of the Central Coast Vernal Pool Regions. The Service does not have a copy of the geodatabase for this study, so we cannot break down the exact acreage of vernal pool complexes in each of the vernal pool regions. In total, 42,488 acres of vernal pool complexes were mapped throughout the study area (see **Figure 10.1**; Holland 2003), though comparison with high-resolution vernal pool mapping at Camp Roberts indicated that Holland's broad scale map is almost certainly an underestimate of both the number and size of vernal pool complexes in the Central Coast. Most of the mapped habitat within the Santa Barbara Vernal Pool Region is within the low elevation areas of eastern and central Santa Barbara County.

As in the Central Valley, many vernal pool complexes along the Central Coast, including the Santa Barbara Vernal Pool Region, are found in older alluvial soils with a claypan/duripan layer (Holland 2003). However, vernal pools are also found in two additional geomorphic settings not well represented in the Central Valley: sag ponds along faults and active Quaternary landslides on structurally incompetent mountain slopes. Holland (2003) also compared the 1994 imagery with satellite imagery from 2000 and found that 4,931 acres had been lost, a loss of 11.6% over the 6-year interval. Subsequent ground truthing in 2001 of 27 of the remaining polygons found that 15 had been converted to other uses, a loss of more than half of the polygons in the ground truthing area in just a year.

Because the Service does not know the exact acreage of vernal pool complexes in this region and because there has not been a comprehensive assessment of all protected lands within this region, we cannot estimate the amount or percentage of vernal pool habitat that has been protected. Lands with some level of protection include Los Padres National Forest, Vandenberg Space Force Base, Burton Mesa Ecological Reserve, Del Sol Vernal Pool Preserve, and the Jack and Laura Dangermond Preserve (**Figure 10.2**).

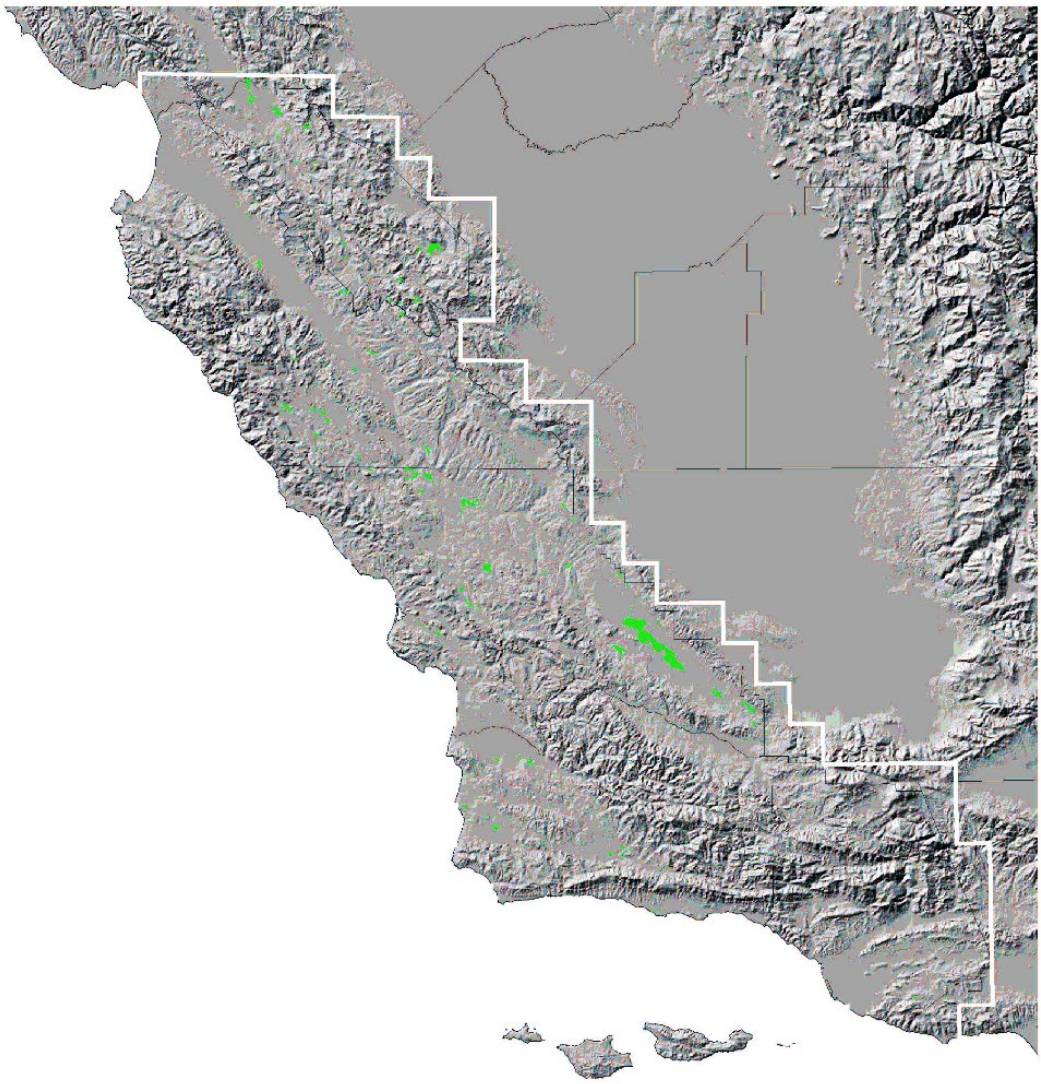


Figure 10.1. Map of vernal pool complexes in green along the Central Coast of California in 1994 mapped by Holland (2003). Taken from Figure 4 of Holland's report submitted to the Service.

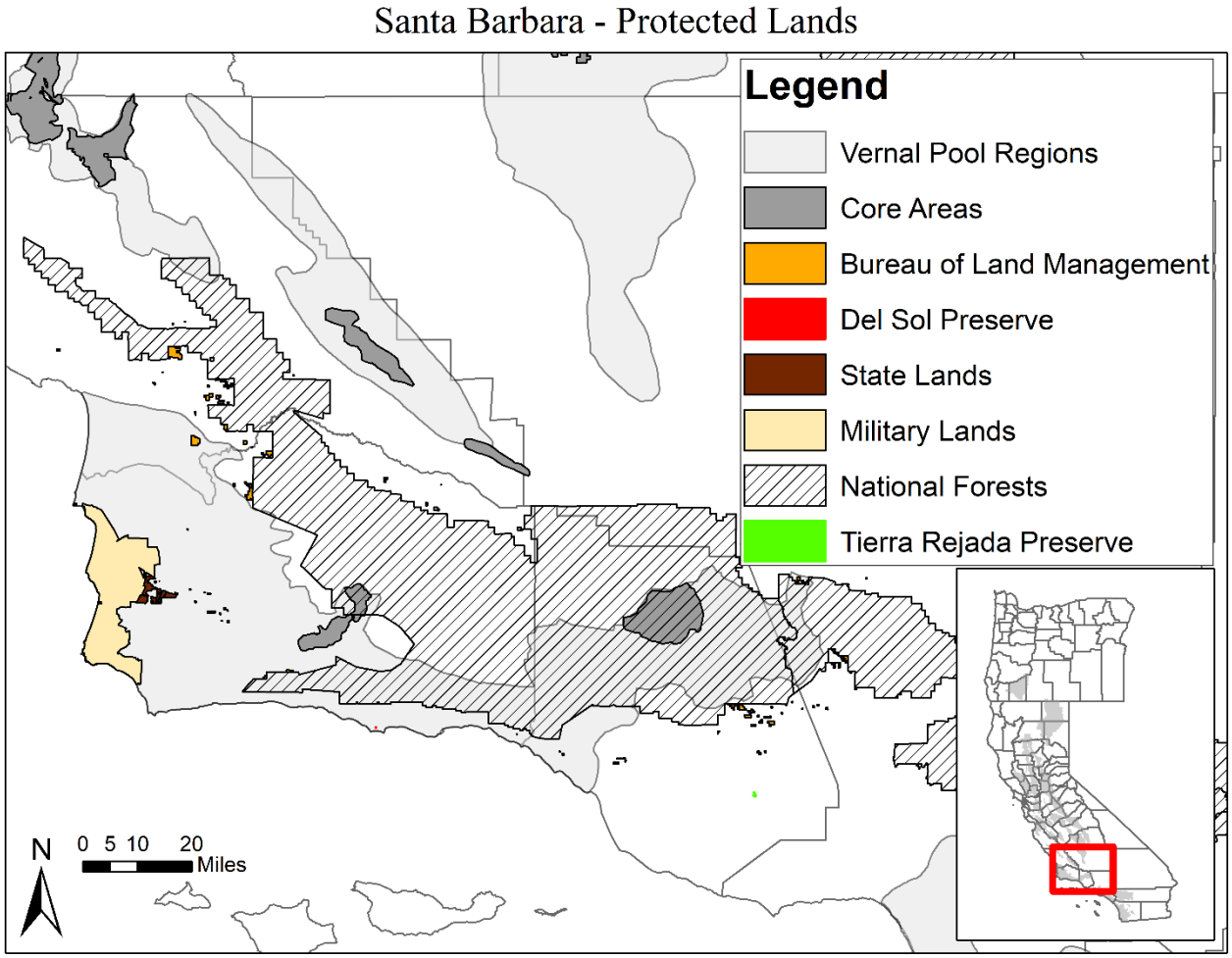


Figure 10.2. Map of protected areas that contain vernal pool grassland habitat and/or vernal pool fairy shrimp or Conservancy fairy shrimp within the Santa Barbara Vernal Pool Region. Zoom in for finer resolution. The Dangermond Preserve is not depicted.

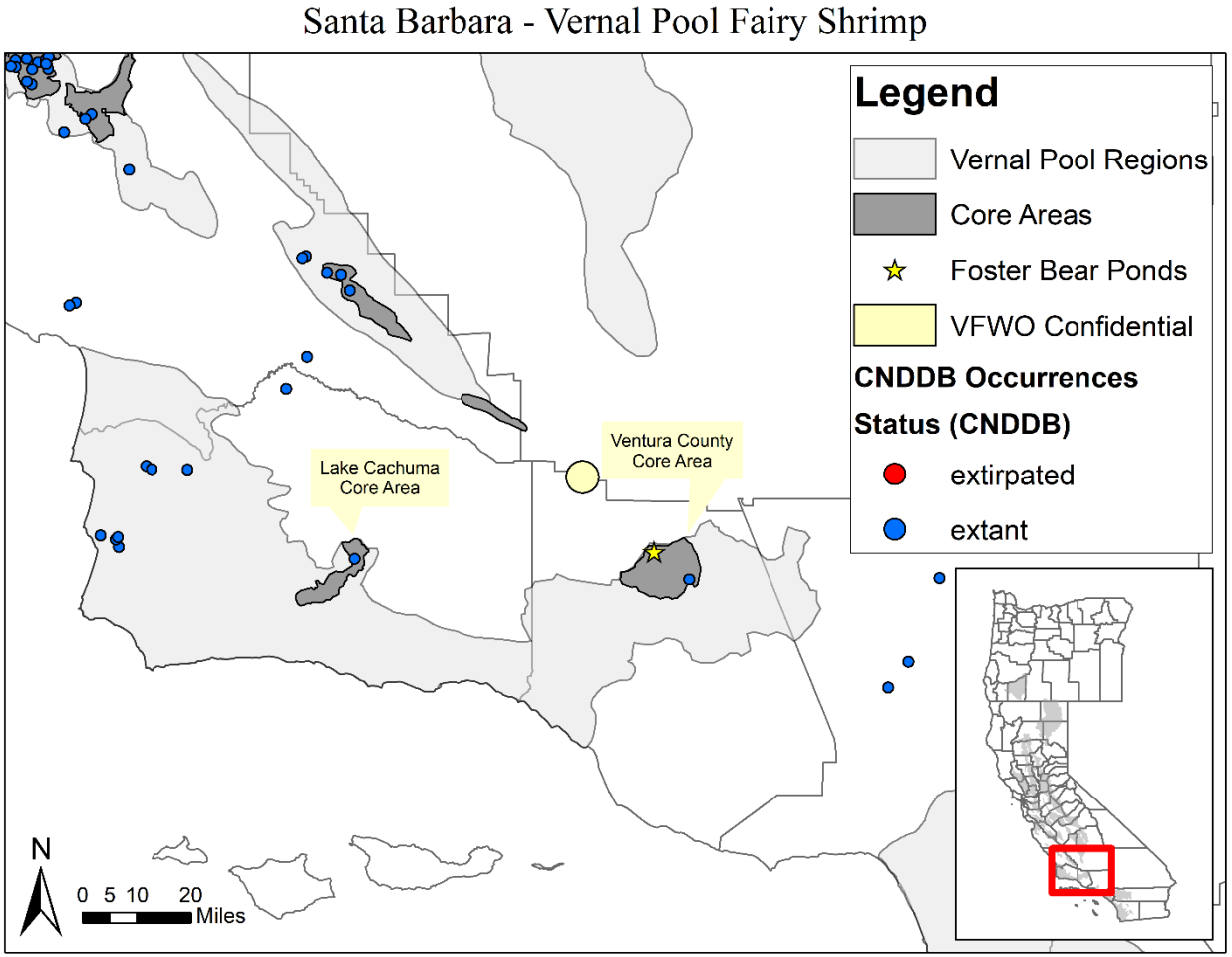


Figure 10.3. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) or provided by the Service's Ventura Fish and Wildlife Office (VFWO) (Ogonowski, *in litt*. 2023a) in the Santa Barbara Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes.

10.2. Species Occurrences

10.2.1. Vernal Pool Fairy Shrimp

There are 15 occurrence records of the vernal pool fairy shrimp documented within, or immediately adjacent to, the Santa Barbara Vernal Pool Region in the Diversity Database (see **Figure 10.3**; Diversity Database 2022). Of these 15 occurrences, 7 are located on federal land, 3 on local government land, and 5 on private land or with landowner unknown (Diversity Database 2022). All occurrences are presumed extant by the Diversity Database, although it is possible that some of the 15 occurrences are no longer extant, but have not been surveyed recently. Only nine of these occurrences are actually within the defined boundary of the Santa Barbara Vernal Pool Region; three are to the east in Los Angeles County, one is to the north within the Los Padres National Forest between this region and the Carrizo Vernal Pool Region, and two are to the northwest just south of the City of San Luis Obispo. There is also one additional confidential occurrence location that was surveyed by the Ventura Fish and Wildlife Office in 2023 (Ogonowski, *in litt*. 2023a). This occurrence is between the Santa Barbara and Carrizo Vernal Pool Regions near Cuddy Valley Road to the northwest of the Ventura County Core Area.

Of the 15 Diversity Database occurrence records, 7 (47%) receive some level of protection by virtue of being located on federal land on Los Padres National Forest or Vandenberg Space Force Base (**Figure 10.2**).

10.2.2. Conservancy Fairy Shrimp

The Conservancy fairy shrimp is only known from a single location in the Santa Barbara Vernal Pool Region: a single vernal pool complex within the Los Padres National Forest known as Foster Bear Ponds (Diversity Database 2022). The exact location of the occurrence record in the Diversity Database does not align with the location of the Foster Bear Ponds due to the poor location data provided, but the Foster Bear Ponds are within the Ventura County Core Area. This single occurrence makes up the entirety of the Los Padres National Forest population. The Conservancy fairy shrimp was first identified at this site in 1989. See the Ventura County Core Area section for more details.

10.3. Federal Lands

10.3.1. National Wildlife Refuges

There are no National Wildlife Refuges with known occurrences of the vernal pool fairy shrimp or Conservancy fairy shrimp in the Santa Barbara Vernal Pool Region.

10.3.2. Military Lands

The 99,579-acre Vandenberg Space Force Base (previously Vandenberg Air Force Base) is located in western Santa Barbara County and is owned by the Department of Defense (DOD) (**Figure 10.2**). An update to the Base's Integrated Natural Resource Management Plan was finalized in 2015 and includes the vernal pool fairy shrimp (DOD 2015a). A large portion of the Base is managed as open space that acts as a security buffer and mostly persists in a natural state (ManTech SRS Technologies 2022). Vernal pools occur throughout the Base, including the

developed north Cantonment Area in the center of the Base; this cantonment overlaps a historical vernal pool complex and supports the largest extant vernal pool complex on the Base. Other pools that have known occurrences of the vernal pool fairy shrimp or may potentially be suitable for the species occur in the northwest and southeast of the Base.

The vernal pool fairy shrimp was first detected on the Base in 2004 (DOD 2015a), and at least 88 occupied pools have been documented since then (ManTech SRS Technologies 2022). The most recent survey effort occurred in February 2021 on the north Cantonment Area, as well as the El Rancho Oeste Area in the northwest and the Arguello Ridge Area in the southeast (ManTech SRS Technologies 2022). Of the 96 targeted pools in the north Cantonment Area, only 17 pooled water in 2021; 14 of these historically supported the vernal pool fairy shrimp, but only 4 were occupied in 2021. Of the 10 targeted pools in the El Rancho Oeste Area, only 4 pooled water in 2021. The vernal pool fairy shrimp has never been detected in this area, though five of the pools are potentially suitable. The species was not detected in 2021, though only two of the four ponded pools were considered suitable for the species. Of the 19 targeted pools in the Arguello Ridge Area, only 8 pooled water in 2021, and the vernal pool fairy shrimp was not detected. Seven of the 19 pools were historically occupied by the species, but the pools were no longer extant, either due to disturbance from burrowing mammals, infill by upland vegetation, or firebreak maintenance. Only one historically occupied pool remains in the Arguello Ridge Area.

There are no military lands with known occurrences of the Conservancy fairy shrimp in the Santa Barbara Vernal Pool Region.

10.3.3. Bureau of Land Management

There are several small parcels of BLM land, likely grazing allotments, throughout the Santa Barbara Vernal Pool Region, but there are no known occurrences of the vernal pool fairy shrimp or Conservancy fairy shrimp within them (Diversity Database 2022).

10.3.4. Other Federal Lands

There are two National Forests, owned and managed by the Forest Service, within the Santa Barbara Vernal Pool Region: Los Padres and Angeles (**Figure 10.2**). The Los Padres National Forest is 1,781,364 acres in size and is spread across Kern, Los Angeles, Monterey, San Luis Obispo, Santa Barbara, and Ventura Counties (USDA 2005a). This National Forest overlaps the eastern half of the Santa Barbara Vernal Pool Region and extends along the Coast Range mountains to the northwest between the Santa Barbara and Carrizo Vernal Pool Regions. Vernal pools are known to occur on the National Forest within the 197-acre Foster Bear Ponds area within the Piru Allotment (USDA 2005b). The Foster Bear Ponds, which are actually a vernal pool complex with one true pond, are a unique occurrence of vernal pool habitat in a montane environment surrounded by pine forest. The vernal pool fairy shrimp and Conservancy fairy shrimp were both documented within the Foster Bear Ponds in 1989 (Diversity Database 2022) and the Conservancy fairy shrimp was identified there again in 2023 (Ogonowski, *in litt*. 2023a). Outside of the Foster Bear Ponds area, the vernal pool fairy shrimp has also been documented in Cachuma Canyon in central Santa Barbara County, in two ranches on either side of the Santa Barbara-San Luis Obispo County border, and near Cuddy Valley Road near the border of Ventura and Kern Counties (Diversity Database 2022; Ogonowski, *in litt*. 2023a).

The Angeles National Forest is 662,983 acres in size and located in the northern portion of Los Angeles County, with small portions extending into Ventura and San Bernardino Counties (USDA 2005a). This National Forest overlaps the eastern edge of the Santa Barbara Vernal Pool Region and extends to the east. Vernal pools are never mentioned in the Angeles National Forest's most recent Land Management Plan (USDA 2005c), so the Service assumes that no vernal pool habitat is known to be present. However, there are three occurrences of the vernal pool fairy shrimp in Los Angeles County, all of which are within 2 miles of the Angeles National Forest (Diversity Database 2022).

10.4. Conservation Banks

There are no conservation or mitigation banks that provide credits for preserved vernal pools that support the vernal pool fairy shrimp or the Conservancy fairy shrimp in the Santa Barbara Vernal Pool Region. However, one outlying occurrence of the vernal pool fairy shrimp in Los Angeles County does occur on the Petersen Ranch Mitigation Bank (Diversity Database 2022). This bank sells credits for both preserved and created wetlands and streams (RIBITS 2021). Vernal pool fairy shrimp were first detected here in 2020 within depressional wetland feature "W62" in Area A of the bank (Diversity Database 2022). This area generally consisted of grassland with a series of seeps, swales, and depressions associated with fault lines with underlying Castaic-Balcom silty clay loam and Millsholm rocky loam soils (Diversity Database 2022).

10.5. Habitat Conservation Plans

There is one regional Habitat Conservation Plan (HCP) within the Santa Barbara Vernal Pool Region that includes the three shrimp species as Covered Species.

10.5.1. PG&E Multiple Region Operations and Maintenance HCP

See section 2.5.1 for a description of this HCP.

10.6. Other Preserves

The California Department of Fish and Wildlife (CDFW) owns the 5,186-acre Burton Mesa Ecological Reserve in western Santa Barbara County (**Figure 10.2**). The Ecological Reserve was acquired to preserve the rich botanical diversity of the area, particularly within the Burton Mesa Chaparral (Condor Environmental Planning Services 2007). There are two vernal wetland areas at the Ecological Reserve, both on the west side. The northern vernal wetland area is located southwest of Cabrillo High School in the Santa Lucia Management Unit. It occurs on a gently sloping drainage that was farmed in previous years, with many weeds in the area. The southern vernal wetland area is located south of Highway 1 in the Vandenberg Management Unit. The vernal pool fairy shrimp was documented in 2004 in several vernal pools on the Vandenberg Management Unit (Condor Environmental Planning Services 2007), though this occurrence is not recorded in the Diversity Database. The Land Management Plan, completed in 2007, includes a goal to protect the vernal pools on the Ecological Reserve. Specific associated tasks include installing fencing to prevent unauthorized vehicle access, retiring and restoring existing trails and roads, evaluating the existing habitat and the feasibility of vernal pool restoration/creation onsite, and coordinating with the Service on any activities that could adversely affect the vernal pool fairy shrimp (Condor Environmental Planning Services 2007).

The Del Sol Vernal Pool Preserve is an 11.8-acre preserve in the City of Isla Vista, approximately 10 miles west of the City of Santa Barbara (**Figure 10.2**). It is owned and managed by the Isla Vista Recreation and Park District and was one of the first areas of vernal pool preservation in California, being acquired in 1978–1979 (Pritchett and Ferren 1988; Ferren et al. 1998). Natural, restored, and created vernal pools exist on the preserve. The vernal pool fairy shrimp has not been recorded on the preserve despite various survey efforts.

The Jack and Laura Dangermond Preserve is a 24,364-acre preserve at Point Conception, the southwestern corner of Santa Barbara County, owned by The Nature Conservancy (TNC). Wetlands occur in a small portion of this preserve near Point Conception. Some of these wetlands were surveyed for vernal pool fairy shrimp in the 2022 dry season during planning for ice plant (*Carpobrotus* spp.) removal within a 310-acre portion of coastal terrace within the preserve (Ogonowski, *in litt*. 2023a). *Branchinecta* cysts were identified within two of the seven wetland features surveyed, but the cysts could not be successfully hatched to confirm species identification. Based on the location, these cysts likely belong to the vernal pool fairy shrimp or versatile fairy shrimp (*Branchinecta lindahli*).

The Tierra Rejada Preserve is an approximately 80-acre preserve in the City of Moorpark, Ventura County, about 20 miles southeast of the boundary of the Santa Barbara Vernal Pool Region (Ogonowski, *in litt*. 2023b). It is located on the west side of Moorpark Highway (State Road 23) between Los Angeles Avenue and Tierra Rejada Road. The preserve was protected in 2001 as mitigation for the adjacent residential development and is owned and managed by the Mountains Recreation and Conservation Authority. There is one large vernal pool within the southern portion of the preserve. The vernal pool fairy shrimp has not been observed within this pool, though the Riverside fairy shrimp (*Streptocephalus woottoni*) and California Orcutt grass (*Orcuttia californica*) both occur there (Diversity Database 2022; Ogonowski, *in litt*. 2023b). This preserve was designated as critical habitat unit 1A for the Riverside fairy shrimp in 2012 (Service 2012d).

There are no other protected lands for the Conservancy fairy shrimp within the Santa Barbara Vernal Pool Region.

10.7. Vernal Pool Core Areas

There are two Core Areas within the Santa Barbara Vernal Pool Region that are designated in the Recovery Plan for the vernal pool fairy shrimp: Lake Cachuma and Ventura County. The Ventura County Core Area is also designated for the Conservancy fairy shrimp. Because the Service does not know how much vernal pool habitat existed in this region in 2005, how much still exists today, and how much has been protected, we do not know if any of the core areas have met the target of 85% of vernal pool habitat protected.

10.7.1. Lake Cachuma

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is located in central Santa Barbara County.

There is no estimate of how many acres of vernal pool complex existed in this core area in 2005 or today, and so the Service cannot assess what percentage of vernal pool habitat has been

protected. The northern third of the core area is within the Los Padres National Forest and there is a small parcel of BLM land in the core area as well. The Service generally assumes that vernal pool habitat and species occurrences receive some level of protection on all federal lands. However, given the lack of knowledge regarding vernal pool habitat within this area, any vernal pool habitat within these federal lands may not be adequately protected since it cannot be properly managed or monitored until survey or mapping efforts locate the habitat.

10.7.1.1. Vernal Pool Fairy Shrimp Occurrences

There is one occurrence record for the vernal pool fairy shrimp within this core area (see **Figure 10.4**; Diversity Database 2022). This record was collected in 1965 in the vicinity of Happy Canyon Road on the Los Padres National Forest. The location was described in the Diversity Database as "Cachuma Canyon Pond #2" in an area of "seasonally astatic 'vernal earth-slump' pools in canyon grassland." The Service is not aware of any surveys or other records from the area since 1965.

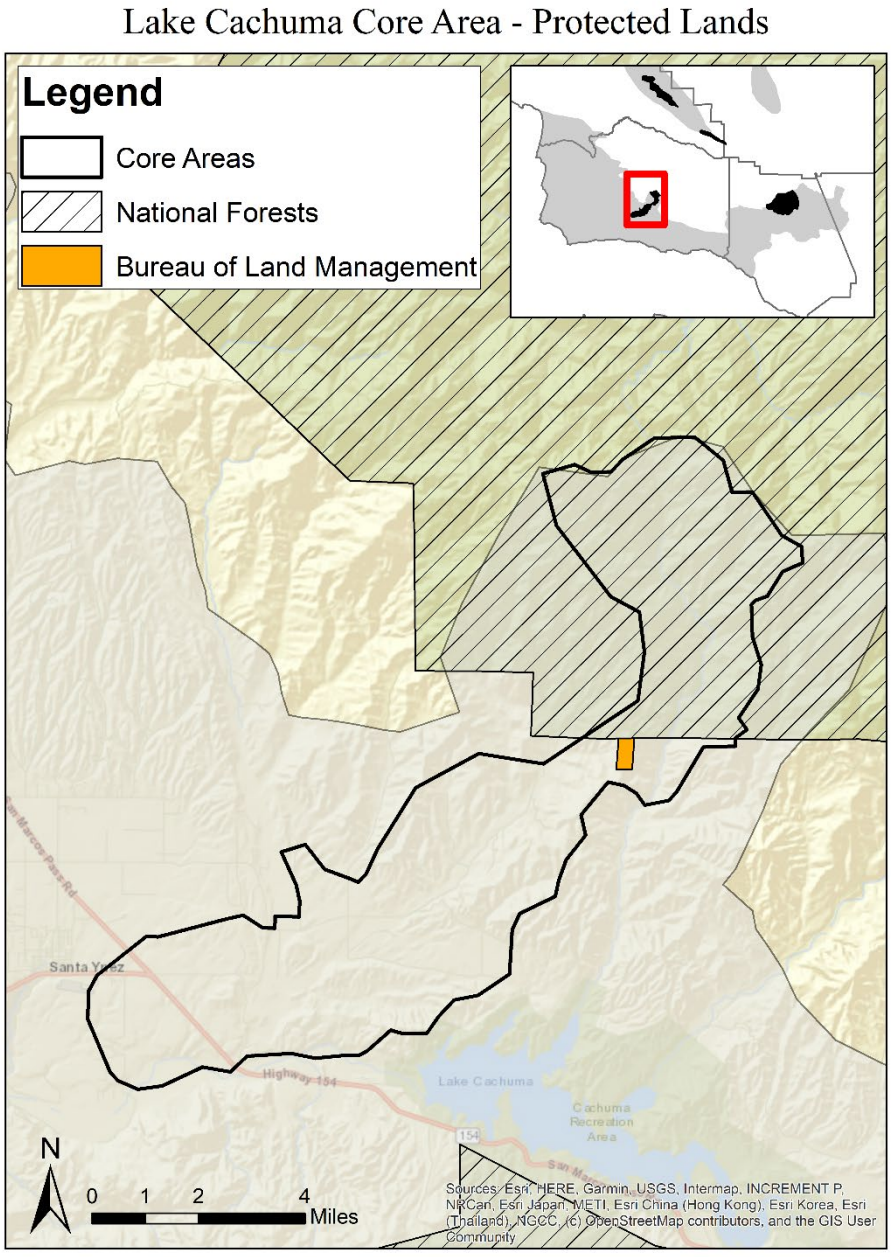


Figure 10.4. Map of all protected lands within the Lake Cachuma Core Area. Diversity Database (2022) records have been redacted from the map to comply with CDFW's Diversity Database Data Use Guidelines.

10.7.2. Ventura County

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and Conservancy fairy shrimp. The core area is located in Ventura County and is entirely within the Los Padres National Forest.

Known vernal pool habitat within this core area consists of the 197-acre Foster Bear Ponds area within the Piru Allotment of the National Forest (USDA 2005b). The Foster Bear Ponds, which are actually a vernal pool complex with one true pond, are a unique occurrence of vernal pool habitat in a montane environment surrounded by pine forest. Other isolated wetlands do occur within the core area, such as the seasonal wetland between Mutau Creek and Little Mutau Creek described in the vernal pool fairy shrimp occurrence record (Diversity Database 2022). The entire core area is within the Los Padres National Forest in a known environmentally sensitive area (USDA 2005b), so all vernal pool habitat within the core area should be protected.

10.7.2.1. Vernal Pool Fairy Shrimp Occurrences

There are two Diversity Database occurrence records for the vernal pool fairy shrimp within this core area, which is entirely protected within the National Forest (see **Figure 10.5**; Diversity Database 2022). However, only one occurrence is properly documented in the Diversity Database as a record for the vernal pool fairy shrimp. This occurrence was documented in 1989 in a seasonal wetland between Mutau Creek and Little Mutau Creek. There is also an occurrence record for the Conservancy fairy shrimp from 1989 in the Foster Bear Ponds area that states that the vernal pool fairy shrimp was also present (Diversity Database 2022). These occurrences are presumed extant by the Diversity Database. The Foster Bear Ponds were resurveyed by the Ventura Fish and Wildlife Service on May 17, 2023. The vernal pool fairy shrimp was not identified, though this does not demonstrate that the species no longer occupies these pools given the single day of surveys very late in the wet season (Ogonowski, *in litt*. 2023a). The Ventura Fish and Wildlife Office also documented a new occurrence of the vernal pool fairy shrimp in 2023 at a confidential location near Cuddy Valley Road to the northwest of the core area.

10.7.2.2. Conservancy Fairy Shrimp Occurrences

There is one Diversity Database occurrence record for the Conservancy fairy shrimp within this core area, which is entirely protected within the National Forest (see **Figure 10.6**; Diversity Database 2022). Note that the Diversity Database occurrence as mapped is incorrectly located due to the poor location data provided to the Diversity Database; as described in the location details, the correct location for the occurrence is the Foster Bear Ponds. This single occurrence represents the entire Los Padres National Forest population of the Conservancy fairy shrimp. The occurrence is presumed extant by the Diversity Database. It was first recorded in 1989 when it was cultured from mud samples (Diversity Database 2022). The Conservancy fairy shrimp was again identified in one of the three ponds at Foster Bear Ponds during surveys conducted by the Ventura Fish and Wildlife Office in 2023 (Ogonowski, *in litt*. 2023a).

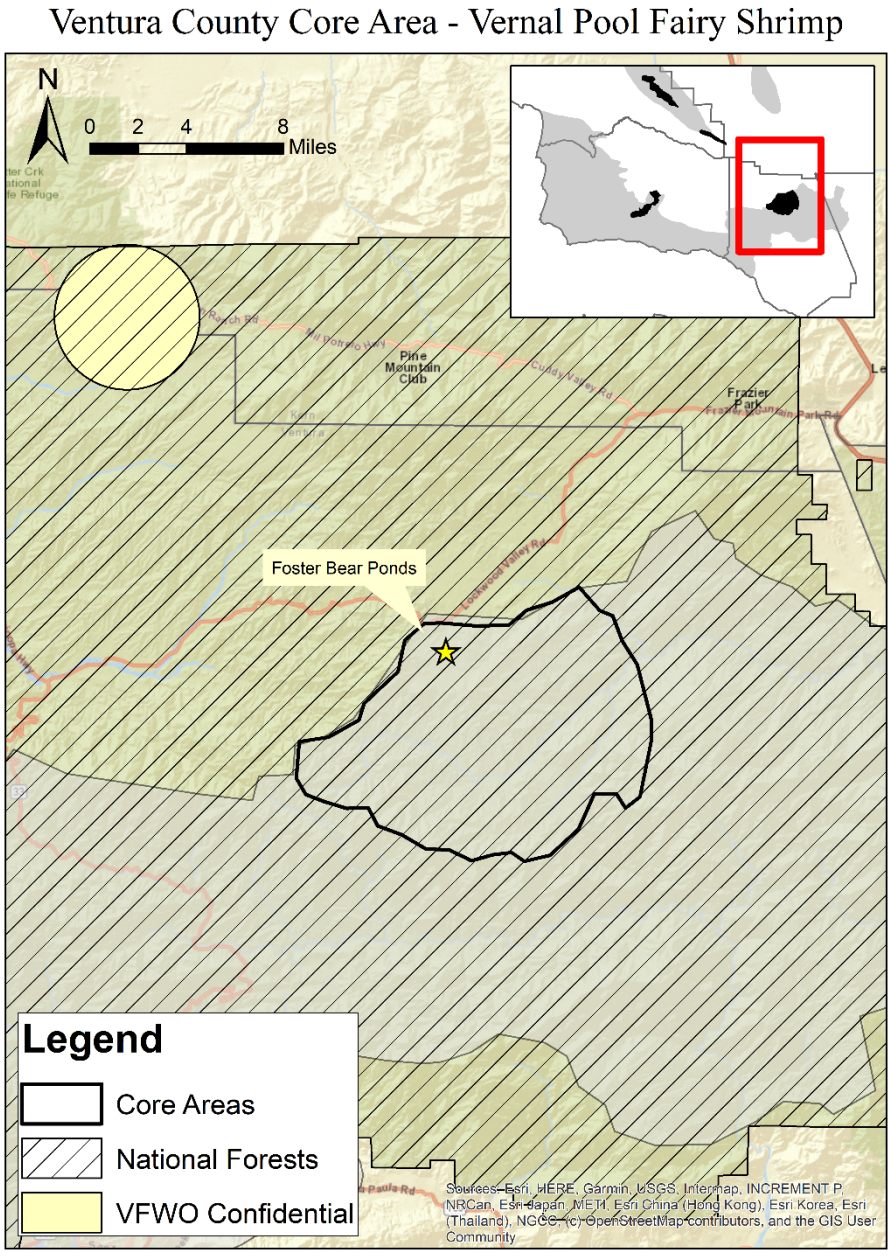


Figure 10.5. Map of known occurrences of vernal pool fairy shrimp provided by the Service's Ventura Fish and Wildlife Office (VFWO) (Ogonowski, *in litt*. 2023a) within the Ventura County Core Area. The location of the Foster Bear Ponds in the northwest of the core area is highlighted. Diversity Database (2022) records have been redacted from the map to comply with CDFW's Diversity Database Data Use Guidelines.

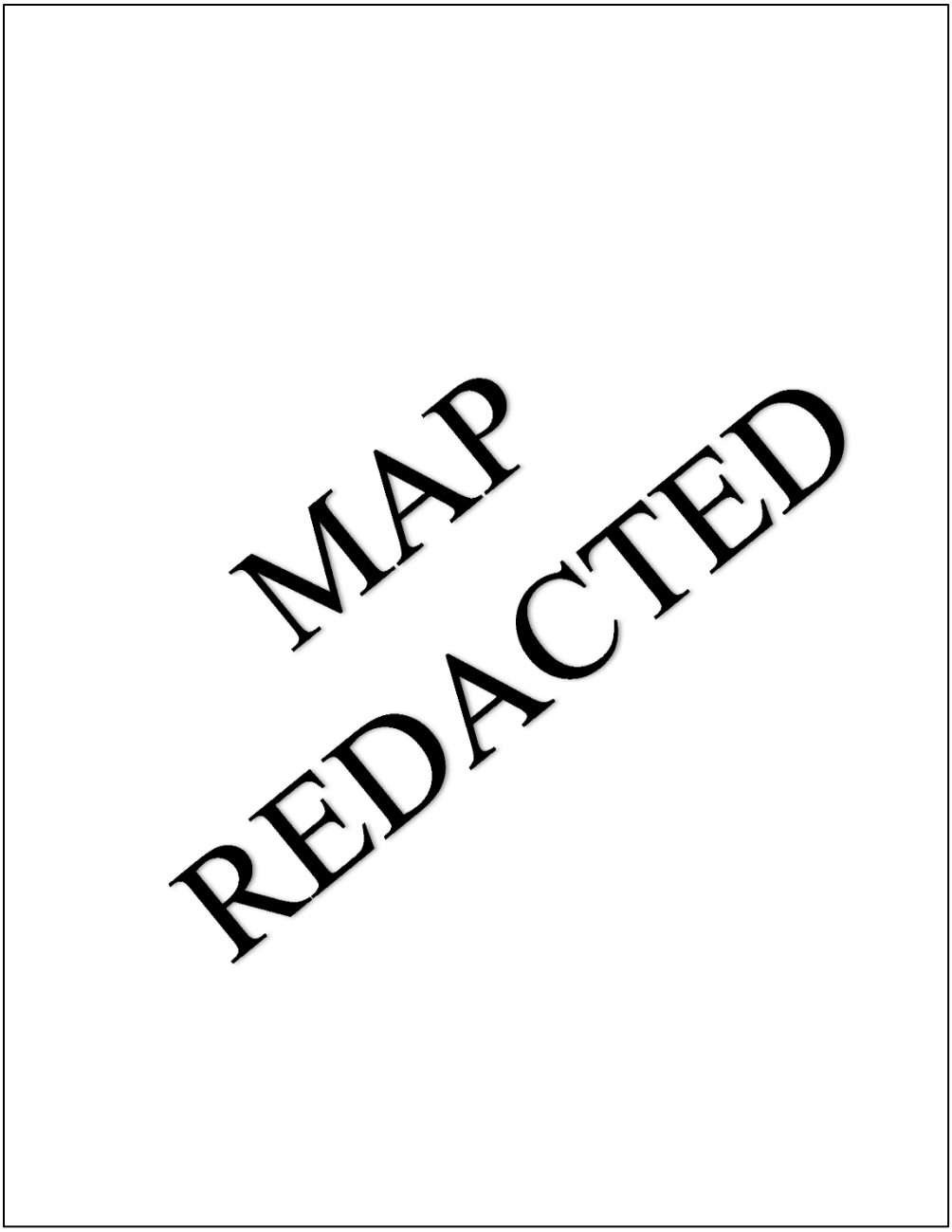


Figure 10.6. Map of known occurrences of Conservancy fairy shrimp recorded in the Diversity Database (2022) within the Ventura County Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on the Diversity Database. The location of the Foster Bear Ponds in the northwest of the core area is highlighted. Note that the Diversity Database occurrence as mapped is incorrectly located due to the poor location data provided to the Diversity Database; as described in the location details, the correct location for the occurrence is the Foster Bear Ponds.

11. SOLANO-COLUSA VERNAL POOL REGION

All three shrimp species occur within the Solano-Colusa Vernal Pool Region.

11.1. Vernal Pool Habitat

Approximately 45,918 acres of vernal pool grassland existed within, or immediately adjacent to, this region when the Recovery Plan was published in 2005 (see **Figure 11.1**, **Table 11.1**; Witham et al. 2013). Witham et al.'s (2013) study area did not include the small portion of this vernal pool region in Contra Costa County (**Figure 1.1**), which includes the Rodeo Creek Core Area, so there is a small amount of vernal pool habitat that has not been accounted for in this and subsequent acreage figures. Approximately 45,276 acres remained as of 2012, with 814 acres (1.8% of 2005 total) lost between 2005 and 2012 (Witham et al. 2014). However, 172 acres of new vernal pool grassland were created over that same period on vernal pool mitigation banks and other managed wetlands. Of the habitat lost, 111 acres (13.6%) were to urbanization and 703 acres (86.4%) were to agricultural conversion (49.3% to rice or row crops, 36.0% to bare plowed agricultural land, and 1.1% to agricultural residences) (Witham et al. 2014).

By 2018, approximately 44,553 acres of vernal pool grassland remained, with a total of 1,740 acres (3.8% of 2005 total) lost between 2005 and 2018 (see **Table 11.1**; Witham 2021). However, 203 acres of new vernal pool grassland were identified in the 2018 aerial imagery that were either not present or not visible on both the 2005 and 2012 aerial imagery. Of the habitat lost since 2005, 349 acres (20.0%) were to urbanization and 1,392 acres (80.0%) were to agricultural conversion (47.6% to bare plowed agricultural land, 15.4% to orchards or vineyards, 9.0% to alfalfa or irrigated pasture, 7.5% to rice or row crops, and 0.5% to agricultural residences) (see **Table 11.2**; Witham 2021). Note the changing composition of agricultural uses in this region; many areas are in the transitory state of bare plowed land, and there has been a large shift from rice and row crops in 2012 to a mix of orchards, vineyards, alfalfa, irrigated pasture, rice, and row crops in 2018.

Agricultural land conversion was the main cause of vernal pool losses, although this region did have the second lowest amount of agricultural conversions in the Central Valley, both in terms of acres lost and percentage of the 2005 baseline, second only to the Northeastern Sacramento Valley Vernal Pool Region (Witham 2021). This region also had a fairly small amount of vernal pool losses due to urbanization. However, because the total amount of vernal pool losses in this region was so low, the Solano-Colusa Vernal Pool Region actually exhibited the highest percentage of losses that were due to urbanization (20.0%). This was even greater than the percentage of losses due to urbanization in the quickly growing Southeastern Sacramento Valley Vernal Pool Region (18.4%), although the actual acreage of losses was much higher in that region (2,976 acres). These losses were concentrated around the populous cities of Vacaville and Fairfield.

Solano County had a population of approximately 459,857 in 2020, up 11.2% from 2010 (County of Solano and Solano Economic Development Corporation 2022). The cities of Vacaville and Fairfield represent approximately half the population of Solano County. The population is expected to continue growing over the next several decades, although the pace of growth is expected to slow, with a projected population of 479,372 in 2030 (4.2% increase over

10 years) (County of Solano and Solano Economic Development Corporation 2022). Thus, urbanization will likely continue to be a significant cause of habitat loss for the vernal pool fairy shrimp within this region.

As of 2018, roughly 18,347 acres of vernal pool grassland were estimated to be protected in this region, or immediately adjacent to it (see **Figure 11.1**, **Figure 11.2**, **Table 11.1**; Witham 2021; Vollmar et al. 2017). This represents 41% of the currently remaining vernal pool grassland in the region and 40% of the vernal pool grassland that existed in the region in 2005, the Recovery Plan's baseline.

11.2. Species Occurrences

11.2.1. Vernal Pool Fairy Shrimp

There are 46 occurrence records of the vernal pool fairy shrimp documented within, or immediately adjacent to, the Solano-Colusa Vernal Pool Region in the Diversity Database (see **Figure 11.3**; Diversity Database 2022). There are a wide variety of private and public landowners listed in the Diversity Database for these occurrences. All 46 occurrences are presumed extant by the Diversity Database; 31 occur within extant vernal pool habitat based on Witham's (2021) mapping efforts and 15 are outside of mapped vernal pool habitat.

The protected areas contain, at least partially, 26 of the 46 Diversity Database records (57%) for the vernal pool fairy shrimp in this region. However, this does not mean that 57% of all occurrences of the vernal pool fairy shrimp in this region have been protected, as the Diversity Database is not an appropriate source for determining all known occurrences (individual Diversity Database records are not necessarily equivalent to occurrences, and some known occurrences may not be documented in the Diversity Database). Only 11 of the 46 Diversity Database polygons (24%) are entirely within the protected areas; the difference between the number of records partially and entirely within the mapped protected areas is likely a reflection of the irregular size and shape of polygons in the Diversity Database, as well as slight discrepancies in the overlap between the two databases.

11.2.2. Vernal Pool Tadpole Shrimp

There are 41 occurrence records of the vernal pool tadpole shrimp documented within the Solano-Colusa Vernal Pool Region in the Diversity Database (see **Figure 11.4**; Diversity Database 2022). There are a wide variety of private and public landowners listed in the Diversity Database for these occurrences. All 41 occurrences are presumed extant by the Diversity Database; 33 occur within extant vernal pool habitat based on Witham's (2021) mapping efforts, 1 is within extirpated vernal pool habitat, and 7 are outside of mapped vernal pool habitat.

The protected areas contain, at least partially, 35 of the 41 Diversity Database records (85%) for the vernal pool tadpole shrimp in this region. Only 17 of the 41 Diversity Database polygons (41%) are entirely within the protected areas; the difference between the number of records partially and entirely within the mapped protected areas is likely a reflection of the irregular size and shape of polygons in the Diversity Database, as well as slight discrepancies in the overlap between the two databases.

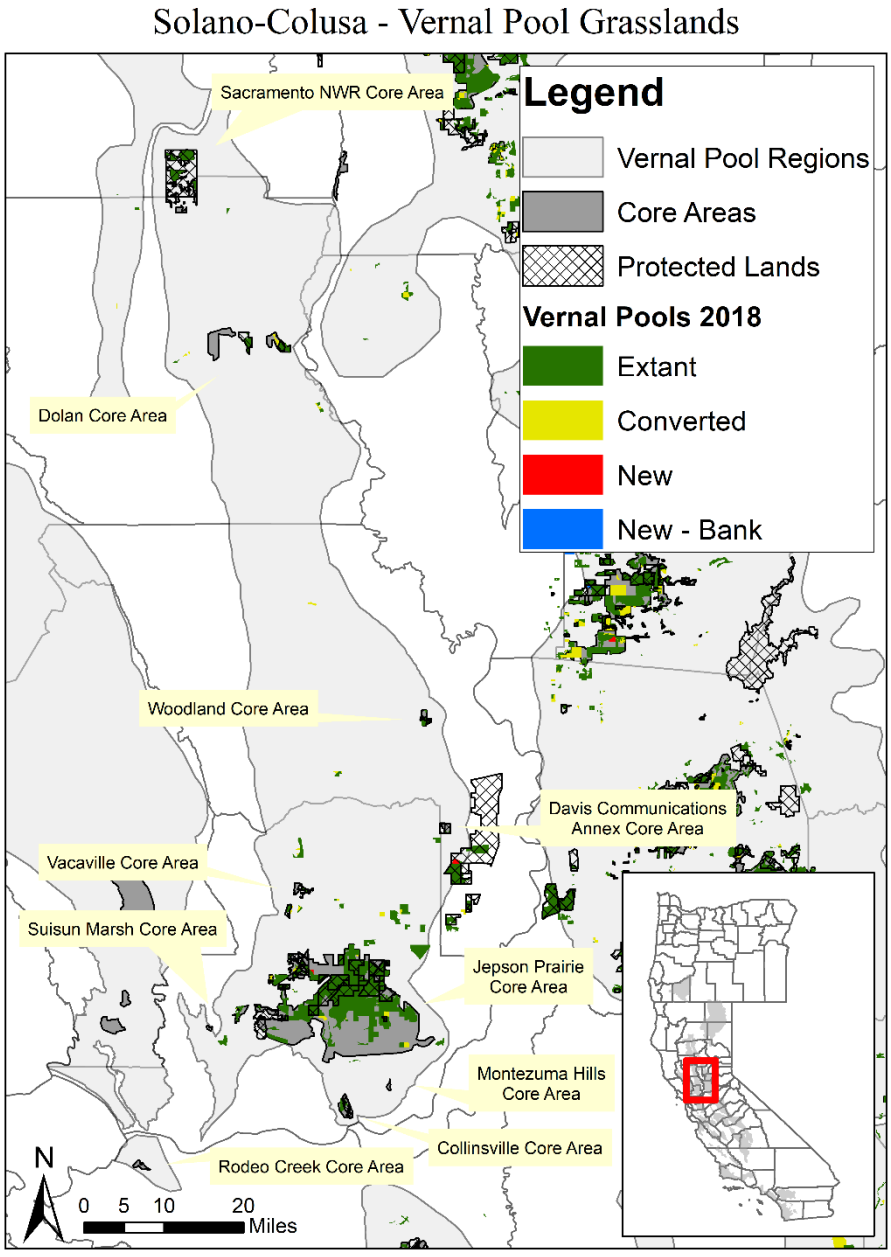


Figure 11.1. Map of vernal pool habitat within the Solano-Colusa Vernal Pool Region mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

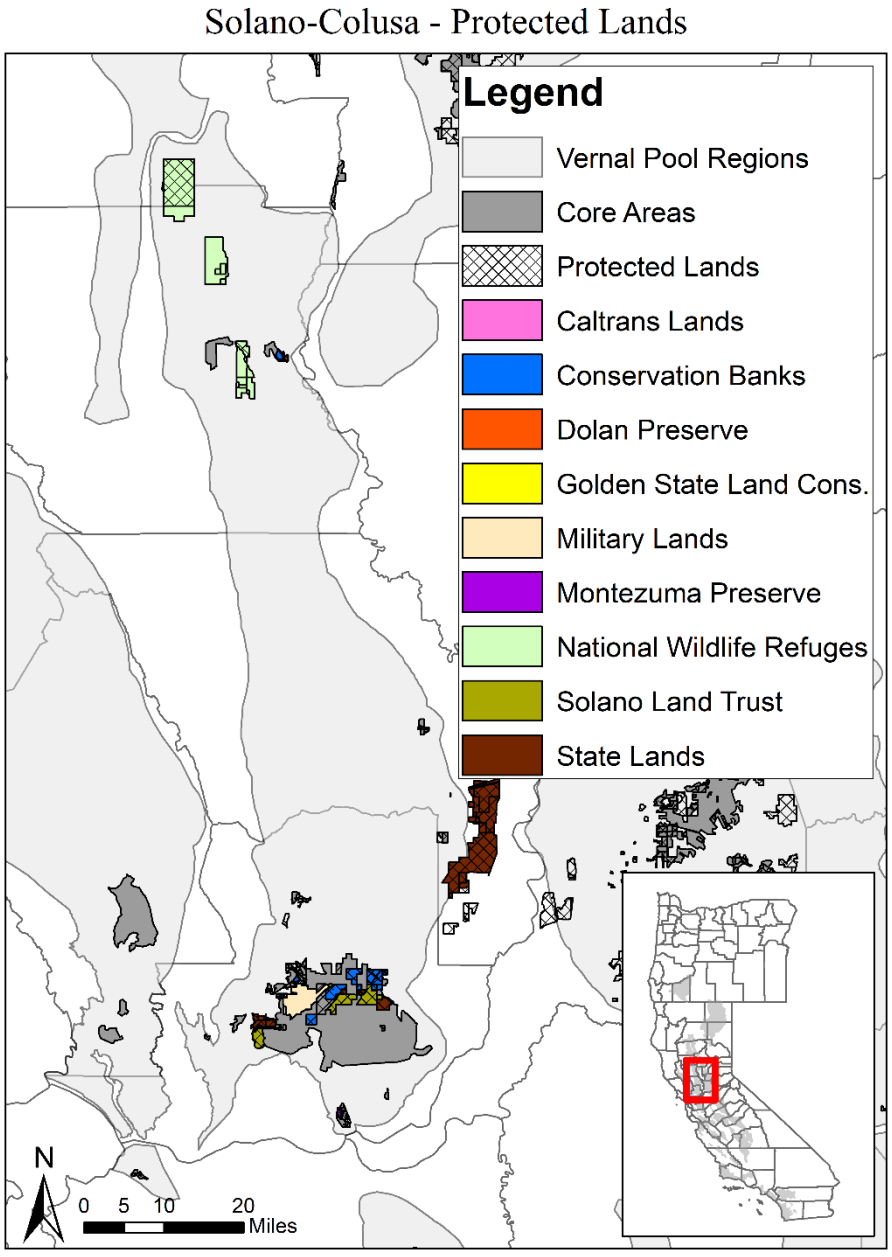


Figure 11.2. Map of protected areas that contain vernal pool grassland habitat and/or the three shrimp species within the Solano-Colusa Vernal Pool Region**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. Zoom in for finer resolution.

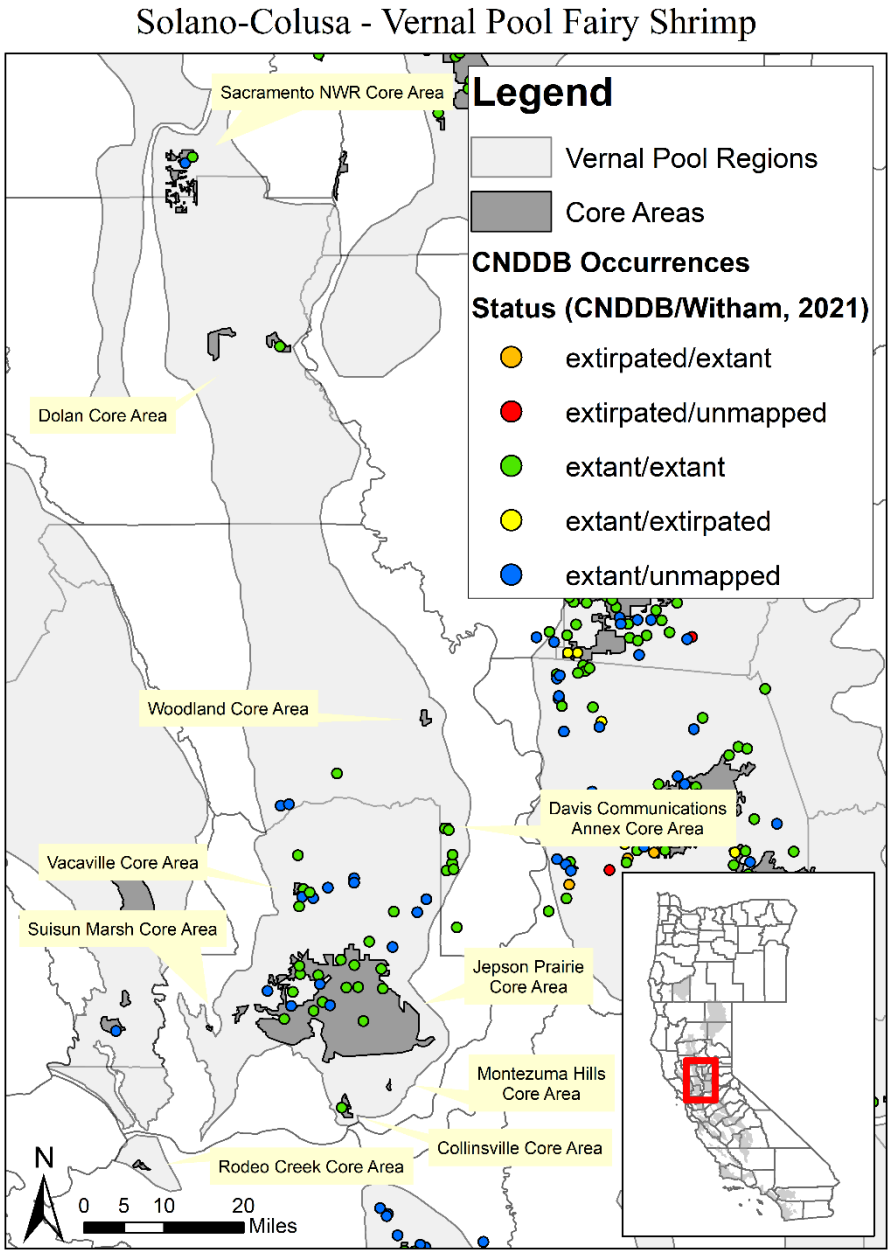


Figure 11.3. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) in the Solano-Colusa Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both Diversity Database occurrence records and Witham's (2021) map of vernal pool habitat. All 10 core areas in the region are displayed, though not all core areas are designated for the vernal pool fairy shrimp.

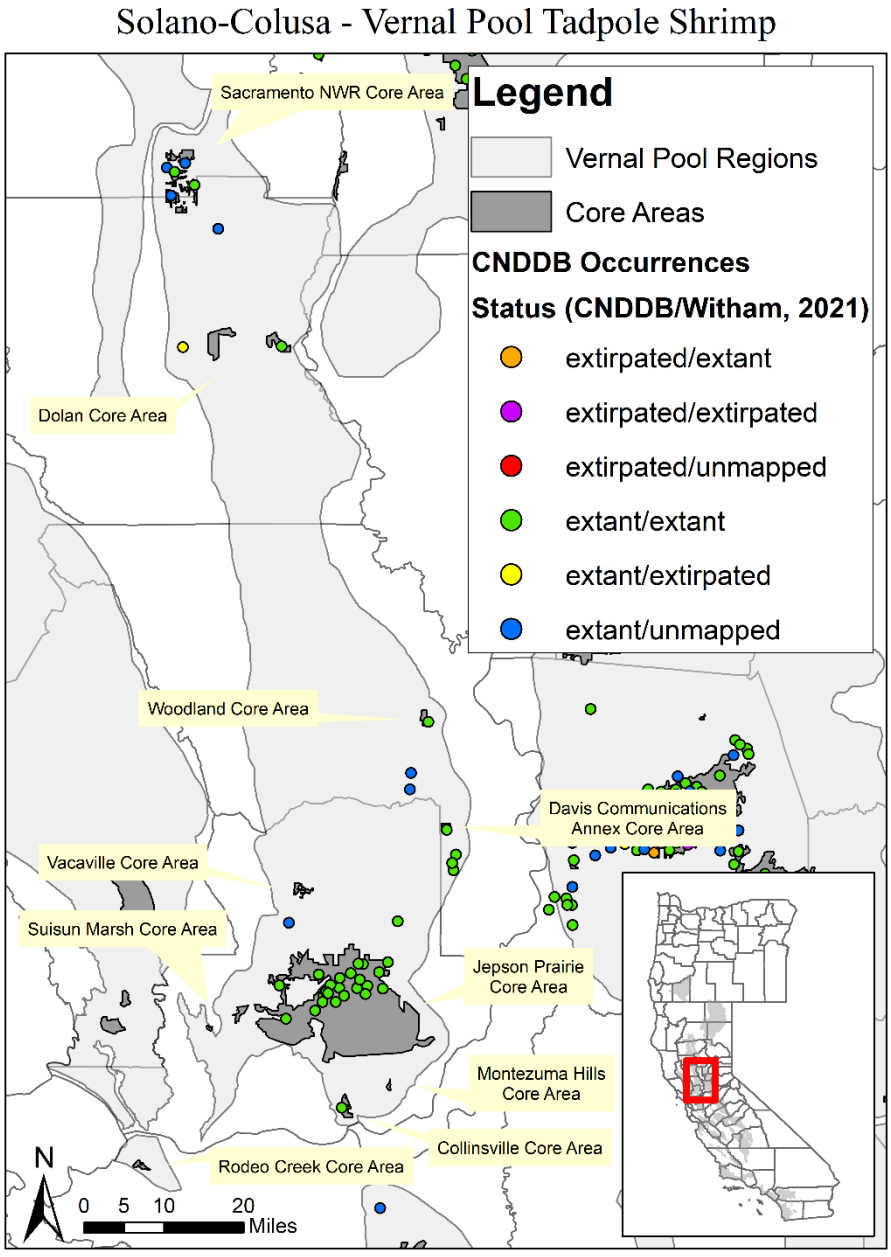


Figure 11.4. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) in the Solano-Colusa Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both Diversity Database occurrence records and Witham's (2021) map of vernal pool habitat. All 10 core areas in the region are displayed, though not all core areas are designated for the vernal pool tadpole shrimp.

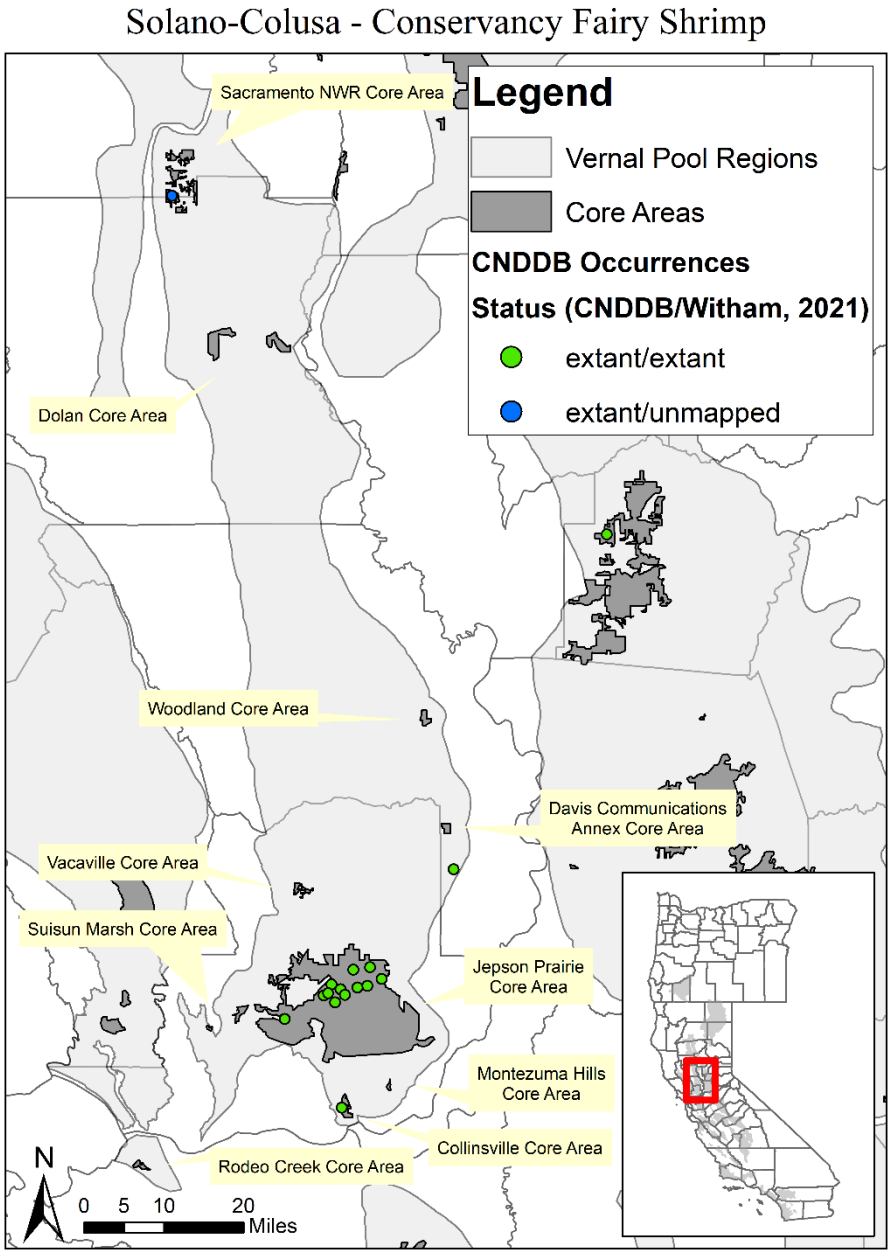


Figure 11.5. Map of known occurrences of Conservancy fairy shrimp recorded in the Diversity Database (2022) in the Solano-Colusa Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both Diversity Database occurrence records and Witham's (2021) map of vernal pool habitat. All 10 core areas in the region are displayed, though not all core areas are designated for the Conservancy fairy shrimp.

Table 11.1. Acreage of vernal pool habitat and habitat converted within the Solano-Colusa Vernal Pool Region mapped by Witham (2021). All habitat labeled as not converted, altered, or new was considered extant. Protected acreage is based on Vollmar et al. (2017).

Core Area	2005 Acres	2018 Acres Total	2018 Acres Extant (% of Total)	2018 Acres Converted – Agriculture (% of Total)	2018 Acres Converted – Urban Development (% of Total)	2018 Acres Protected (% of Total)
Collinsville	410.2	410.2	410.2 (100.0%)	0.0 (0.0%)	0.0 (0.0%)	154.7 (37.7%)
Davis Communications Annex	99.6	100.4	100.4 (100.0%)	0.0 (0.0%)	0.0 (0.0%)	100.0 (99.7%)
Dolan	565.5	565.5	395.1 (69.9%)	170.4 (30.1%)	0.0 (0.0%)	248.0 (43.9%)
Jepson Prairie	31,467.3	31,526.6	30,822.5 (97.8%)	506.4 (1.6%)	197.8 (0.6%)	11,203.5 (35.5%)
Sacramento National Wildlife Refuge	1,530.1	1,530.1	1,530.1 (100.0%)	0.0 (0.0%)	0.0 (0.0%)	1,530.1 (100.0%)
Vacaville	164.3	164.3	164.3 (100.0%)	0.0 (0.0%)	0.0 (0.0%)	154.6 (94.1%)
Woodland	337.7	337.7	337.7 (100.0%)	0.0 (0.0%)	0.0 (0.0%)	187.8 (55.6%)
Solano-Colusa Vernal Pool Region Total	**45,918.3**	**46,292.9**	**44,552.8 (96.2%)**	**1,391.5 (3.0%)**	**348.7 (0.8%)**	**18,346.9 (39.6%)**

Table 11.2. Acreage of vernal pool habitat losses within the Solano-Colusa Vernal Pool Region between 2005 and 2018 mapped by Witham (2021), broken down by what the land use was converted to. All categories besides urban development and managed wetlands are considered agricultural conversions.

Core Area	Urban, Commercial, & Industrial	Orchards, Vineyards, Eucalyptus	Alfalfa and Irrigated Pasture	Bare Plowed Agricultural Lands	Other Ag (Rice, Row Crops, Dairy, Nurseries)	Agricultural Residential	Managed Wetlands	Total Losses	% Losses Urban Development	% Losses Agricultural Conversions
Collinsville	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Davis Communications Annex	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Dolan	0.0	170.4	0.0	0.0	0.0	0.0	0.0	170.4	0.0%	100%
Jepson Prairie	197.8	0.0	0.0	502.2	0.0	4.2	0.0	506.4	28.1%	71.9%
Sacramento National Wildlife Refuge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Vacaville	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Woodland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Solano-Colusa Vernal Pool Region Total	**348.7**	**267.8**	**156.1**	**828.9**	**129.9**	**8.8**	**0.0**	**1,391.5**	**20.0%**	**80.0%**

11.2.3. Conservancy Fairy Shrimp

There are 15 occurrence records of the Conservancy fairy shrimp documented within, or immediately adjacent to, the Solano-Colusa Vernal Pool Region in the Diversity Database (see **Figure 11.5**; Diversity Database 2022). These occurrences include the Sacramento National Wildlife Refuge, Yolo Bypass Wildlife Area, and Jepson Prairie populations. The Sacramento National Wildlife Refuge and Yolo Bypass Wildlife Area occurrences are on federal and state land, respectively, and both consist of only a single vernal pool. The other 13 occurrences are all on private land, though all of these occurrences are at least partly within protected lands (Vollmar et al. 2017). All 15 occurrences are presumed extant by the Diversity Database; 14 occur within extant vernal pool habitat based on Witham's (2021) mapping efforts and 1 is outside of mapped vernal pool habitat.

The protected areas contain, at least partially, all 15 of the Diversity Database records (100%) for the Conservancy fairy shrimp in this region. Only 4 of the 15 Diversity Database polygons (27%) are entirely within the protected areas; the difference between the number of records partially and entirely within the mapped protected areas is likely a reflection of the irregular size and shape of polygons in the Diversity Database, as well as slight discrepancies in the overlap between the two databases.

11.3. Federal Lands

11.3.1. National Wildlife Refuges

Within the Solano-Colusa Vernal Pool Region, vernal pool grassland complexes are known to occur on three Refuges within the Sacramento National Wildlife Refuge Complex: Colusa National Wildlife Refuge, Delevan National Wildlife Refuge, and Sacramento National Wildlife Refuge (**Figure 11.2**). The vernal pool fairy shrimp and Conservancy fairy shrimp are known to occur on the Sacramento National Wildlife Refuge, but not on the Colusa or Delevan National Wildlife Refuges. The vernal pool tadpole shrimp is known to occur throughout the Sacramento Refuge and in one vernal pool on the Delevan Refuge, but not the Colusa Refuge.

The primary purpose of the Refuge Complex is to maintain managed wetlands that support habitat for birds on the Pacific Flyway, but there are also many other habitats such as vernal pool grasslands throughout the complex given that they are some of the last large areas of undeveloped lands in an otherwise agricultural landscape. A Comprehensive Conservation Plan was prepared for these three Refuges, as well as the Sutter National Wildlife Refuge, in 2009 that included the three shrimp species (Service 2009b).

All three Refuges are located between Interstate 5 and the Sacramento River in eastern Colusa and Glenn Counties. The Colusa National Wildlife Refuge is 4,868 acres, 619 acres of which are vernal pool complexes or alkali meadows (Service 2009b). The Delevan National Wildlife Refuge is 5,877 acres, 461 acres of which are vernal pool complexes or alkali meadows (Service 2009b). The Sacramento National Wildlife Refuge is 10,819 acres, 2,941 acres of which are vernal pool complexes or alkali meadows (Service 2009b). The Sacramento National Wildlife Refuge specifically has a core area that encompasses the potential locations of vernal pool complexes on the Refuge. Witham's (2021) mapping identified only 529, 0, and 1,641 acres of

vernal pool grassland within each of the Refuges, respectively, so there is more vernal pool habitat in this region than aerial imagery indicate. Management on the Refuges consists of grassland and invasive species management through grazing, mowing, or prescribed fire, habitat restoration, and regular monitoring of plant and animal populations (Service 2009b).

A total of 11 years of vernal pool shrimp surveys have occurred within the Sacramento National Wildlife Refuge Complex between 1993 and 2017 (D'Errico, *in litt*. 2022), though likely not every Refuge or every pool was surveyed each year. On the Sacramento Refuge, the vernal pool fairy shrimp was definitively identified in 1 pool in 2004 and in 6 pools out of 45 sampled in 2017, all in the northeast of the Refuge (Helm Biological Consulting 2017; D'Errico, *in litt*. 2022). However, numerous pools throughout the Refuge were documented as having *Branchinecta* individuals that were not identified to the species level during surveys from 1993-1998; there are three other species of *Branchinecta* known within the Refuge, but it is likely that at least some of these occurrences represent the vernal pool fairy shrimp (D'Errico, *in litt*. 2022). The vernal pool tadpole shrimp was identified in 6 pools out of 45 sampled in 2017, located in the north, west, and south of the Refuge (Helm Biological Consulting 2017). The vernal pool tadpole shrimp had also previously been identified in two pools in the southeast in 1993, 1994, and 2002 (D'Errico, *in litt*. 2022). All of these pools line up with the locations of Diversity Database records within the Sacramento Refuge. The Conservancy fairy shrimp is known from just one pool in the southwest of the Refuge, where it was observed in 1993, 1994, and 2004 (D'Errico, *in litt*. 2022; Diversity Database 2022).

On the Delevan Refuge, the vernal pool tadpole shrimp was identified in one vernal pool at the northern edge of the Refuge in 1994, but it has not been observed in any subsequent surveys (Diversity Database 2022; Helm Biological Consulting 2017; D'Errico, *in litt*. 2022). The vernal pool fairy shrimp and Conservancy fairy shrimp have not been detected within the Colusa or Delevan Refuges, including in the 7 and 11 pools surveyed within each Refuge in 2017, respectively, and the vernal pool tadpole shrimp has not been detected within the Colusa Refuge (Helm Biological Consulting 2017).

11.3.2. Military Lands

The 5,137-acre Travis Air Force Base is located in Solano County east of the City of Fairfield and is owned by the Department of Defense (DOD). Over 90% of the remaining natural habitat within the Base is northern claypan vernal pool grassland complex (DOD 2022). There are 1,735 acres of annual grassland throughout the Base, and over 600 vernal pools and swales have been identified, with the highest quality pools located in the northwestern portion of the Base (**Figure 11.6**). Witham (2021) only mapped 169 acres of extant vernal pool grassland within the Base, and this was mostly located in the northwestern portion of the Base. Of the 600 pools, 256 were created as part of a long-term mitigation study; the created pools continue to exhibit similar hydrology to adjacent natural pools and the soil seed bank remains relatively dominated by native plant species (DOD 2022).

The vernal pool fairy shrimp was first identified on the Base in 2005 and has been consistently documented during survey efforts (DOD 2022). The most recent surveys, completed in 2018, found the vernal pool fairy shrimp in many vernal pools on the Base and on three offsite geographically separated units (GSUs): the 70-acre Railroad Right-of-Way GSU, the 0.23-acre

Outer Runway Marker GSU, and the 1.86-acre Middle Runway Marker GSU. The vernal pool tadpole shrimp has never been documented on the Base itself, though it was documented within one offsite GSU, the Railroad Right-of-Way GSU to the north, in 2005 (see **Figure 11.6**; DOD 2022). There are also several occurrences of the vernal pool tadpole shrimp on properties immediately adjacent to the Base (Diversity Database 2022). The Conservancy fairy shrimp has never been documented within the Base or any GSUs. Wetland management on the Base focuses on protection from human disturbance, managing the grassland and invasive plant species through grazing, mowing, and prescribed fire, and monitoring of vernal pools and endemic plant and animal species like the vernal pool fairy shrimp (DOD 2022).

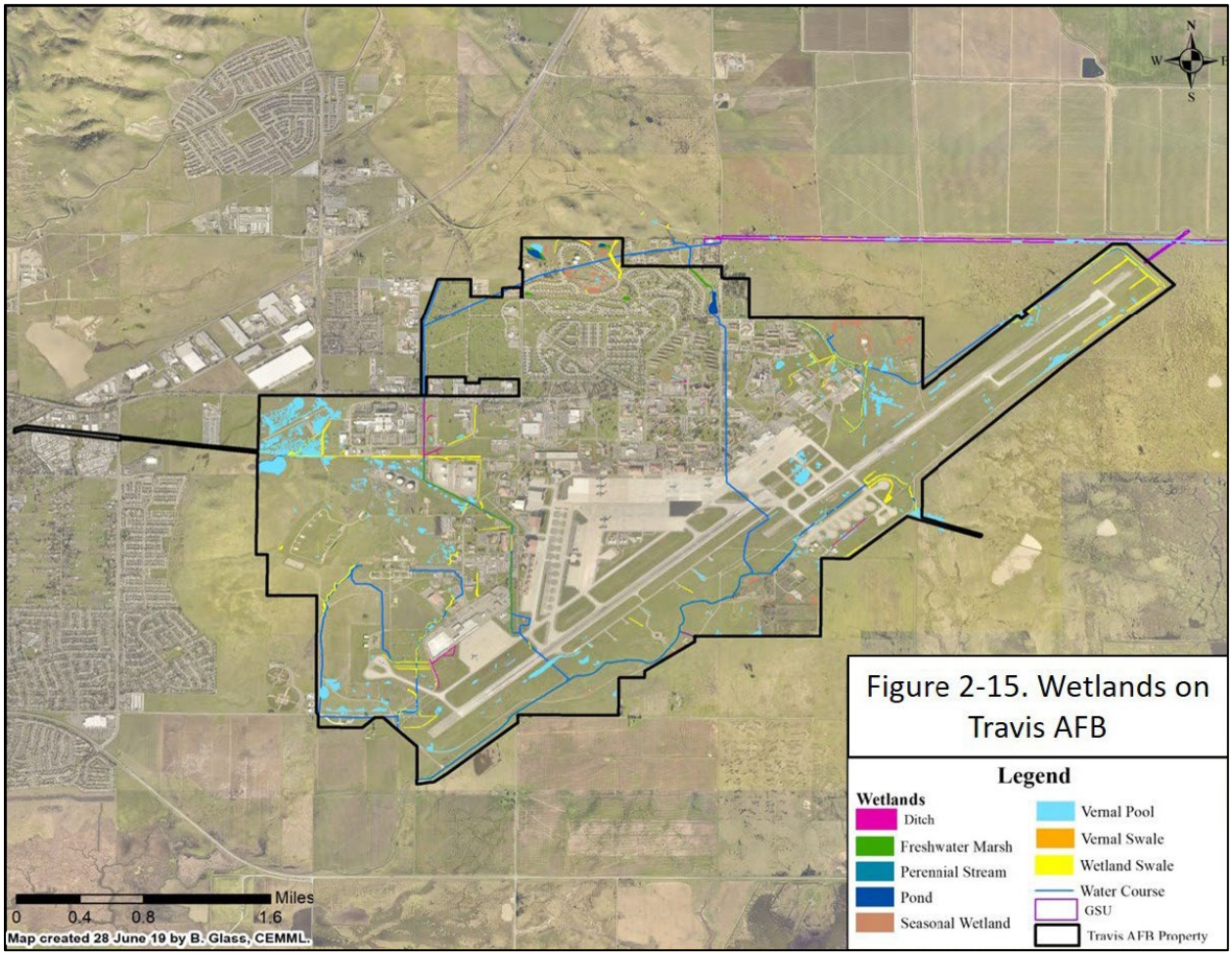


Figure 11.6. Map of vernal pools and other wetland features on Travis Air Force Base (AFB). Taken from Figure 2-15 of the 2022 Integrated Natural Resources Management Plan for Travis Air Force Base (DOD 2022).

11.3.3. Bureau of Land Management

There are no Bureau of Land Management lands with known occurrences of the three shrimp species in the Solano-Colusa Vernal Pool Region.

11.3.4. Other Federal Lands

There are no other federal lands with known occurrences of the three shrimp species in the Solano-Colusa Vernal Pool Region.

11.4. Conservation Banks

This region has the second largest number of banks and total acreage protected within banks, and it has the largest acreage of vernal pool preservation credits (acreage of the pools only, not the grassland complex). Conservation banks account for almost 30% of all protected vernal pool grasslands and 12% of all remaining extant vernal pool grasslands within this region (**Figure 11.2**). Thus, this is the region with the most significant contribution from conservation banking toward vernal pool conservation.

There are seven conservation or mitigation banks within the Solano-Colusa Vernal Pool Region that provide credits for preserved vernal pools that support the vernal pool fairy shrimp: Burke Ranch, Campbell Ranch, Dolan Ranch, Elsie Gridley, Muzzy Ranch, Noonan Ranch, and North Suisun (RIBITS 2021). These banks protect a total of 5,299 acres of land, including 961.197 acres of preserved vernal pools, 839.207 acres of which provide habitat for the vernal pool fairy shrimp (Table 6). The seven banks have sold a total of 116.424 acres of preservation credits (14%) for the vernal pool fairy shrimp (RIBITS 2021).

There are seven conservation or mitigation banks within the Solano-Colusa Vernal Pool Region that provide credits for preserved vernal pools that support the vernal pool tadpole shrimp: Burke Ranch, Campbell Ranch, Dolan Ranch, Elsie Gridley, Goldfields, Muzzy Ranch, and North Suisun (RIBITS 2021). These banks protect a total of 5,262 acres of land, including 962.217 acres of preserved vernal pools, 634.917 acres of which provide habitat for the vernal pool tadpole shrimp (Table 6). The seven banks have sold a total of 123.614 acres of preservation credits (19%) for the vernal pool tadpole shrimp (RIBITS 2021).

There are two conservation or mitigation banks within the Solano-Colusa Vernal Pool Region that provide credits for preserved vernal pools that support the Conservancy fairy shrimp: Elsie Gridley and Muzzy Ranch (RIBITS 2021). These banks protect a total of 3,126 acres of land, including 505.60 acres of preserved vernal pools, 121.99 acres of which provide habitat for the Conservancy fairy shrimp (Table 6). The two banks have sold a total of 13.044 acres of preservation credits (11%) for the Conservancy fairy shrimp (RIBITS 2021). On Elsie Gridley, the Conservancy fairy shrimp was first detected in 2008 within two large preserved pools in the northwest corner; the species was observed in 2013 in these pools again as well as six restored pools in the southeast corner, and again in 2017 in one preserved pool and three restored pools (WRA Environmental Consultants 2017; Diversity Database 2022). On Muzzy Ranch, the Conservancy fairy shrimp was first detected in 2011 within five pools and was most recently detected in 2021 within five pools (Diversity Database 2022; LSA 2022).

The Burke Ranch Conservation Bank also supports the Conservancy fairy shrimp, though it does not sell any preservation credits for the species. This bank is 960 acres and contains 273.6 acres of preserved vernal pools for the vernal pool fairy shrimp and vernal pool tadpole shrimp (RIBITS 2021). On Burke Ranch, the Conservancy fairy shrimp was first detected in 1999 and has frequently been observed within multiple pools during regular monitoring since, most recently in 2023 (Westervelt Ecological Services 2019b; Diversity Database 2022; S. O'Brien, ICF, *in litt*. 2023).

11.5. Habitat Conservation Plans

There are two regional Habitat Conservation Plans (HCPs) within the Solano-Colusa Vernal Pool Region that include the three shrimp species as Covered Species. A third HCP, the Yolo HCP, covers all of Yolo County and includes vernal pool plant species, but does not include the three shrimp species as Covered Species (ICF 2018). Vernal pool habitat will be preserved as a result of the Yolo HCP, some of which may be occupied by the three shrimp species.

11.5.1. PG&E Bay Area Operations and Maintenance HCP

See section 3.5.1 for a description of this HCP.

11.5.2. PG&E Multiple Region Operations and Maintenance HCP

See section 2.5.1 for a description of this HCP.

11.6. Other Preserves

The California Department of Fish and Wildlife (CDFW) owns three preserved areas in this region with vernal pool habitat: Yolo Bypass Wildlife Area, Calhoun Cut Ecological Reserve, and Hill Slough Wildlife Area. They also hold conservation easements over three properties: the Dixon Vernal Pools, Saxon, and Skyraker conservation easements.

The Yolo Bypass Wildlife Area consists of 16,770 acres of managed wildlife habitat and agricultural land within the Yolo Bypass, south of Interstate 80 along the Sacramento River, with the main focus of the Wildlife Area being managed wetlands for waterfowl (CDFW 2008). A survey from 2003 documented 1,600 acres of vernal pool grassland complexes within the Wildlife Area (CDFW 2008), and mapping from aerial imagery in 2018 estimated 2,016 acres of vernal pool grassland in the southern portion, mostly within Tule Ranch, and an additional 940 acres that may be vernal pool grassland or may be marsh (Witham 2021). The Land Management Plan, completed in 2008, generally states that management activities will be implemented to maintain, enhance, and/or restore vernal pool species, including following accepted scientific principles regarding grazing, prescribed fire, and herbicide use, but does not include more specific discussion of vernal pool management (CDFW 2008). Vernal pool surveys are not conducted due to the lack of funding and staffing available and because vernal pools are not the main focus of the Wildlife Area (J. Hobbs, CDFW, *in litt*. 2022). At the southern end of the Wildlife Area, there are two conservation easements held by CDFW, Saxon and Skyraker, adjacent to the Wildlife Area that slightly overlap with mapped vernal pool grassland, as well as a separate conservation easement held by the Natural Resources Conservation Service (NRCS).

There are four Diversity Database occurrences of the vernal pool fairy shrimp and three occurrences of the vernal pool tadpole shrimp within the Yolo Bypass Wildlife Area, all within Tule Ranch in the southern portion of the Wildlife Area (Diversity Database 2022). For both species, two of these occurrences were first identified in 2002 and are found along disturbed habitat associated with the railroad grade. The other occurrences, first identified in 2003 for the vernal pool tadpole shrimp and 2008 for the vernal pool fairy shrimp, were found in more natural habitat within Tule Ranch. The Conservancy fairy shrimp is known from one vernal pool on the Tule Ranch in the southern portion of the Wildlife Area (Diversity Database 2022); this single pool makes up the entirety of the Yolo Bypass Wildlife Area population. The species was first detected in 2003 and again in 2008 (Diversity Database 2022). The Service is not aware of any more recent surveys.

The Calhoun Cut Ecological Reserve is composed of the original 971-acre eastern property acquired by CDFW in 1990 and the more recently acquired 234-acre western property. The Ecological Reserve is located on either side of the Jepson Prairie Preserve and Highway 113 in Solano County. Approximately half of the eastern property and all of the western property are mapped as vernal pool grassland (Witham 2021). The Ecological Reserve is managed according to a general management plan from 1991 that mentions the importance of the vernal pool habitat and includes grazing (CDFW 1991). The three shrimp species have not been documented within the Ecological Reserve, but all three have been found immediately adjacent in the Jepson Prairie Preserve, Wilcox Ranch Preserve, and the PG&E pipeline right-of-way (Diversity Database 2022). CDFW does not monitor the vernal pools, and currently the position overseeing CDFW's Solano County vernal pool properties is vacant (B. Shelton, CDFW, *in litt*. 2022). CDFW also holds a conservation easement, known as the Dixon Vernal Pools conservation easement, over a 161-acre property on the Jepson Prairie between the Muzzy Ranch Conservation Bank and the Wilcox Ranch Preserve.

The Hill Slough Wildlife Area is located in Suisun Marsh south of Suisun City in Solano County. The primary purpose of this Wildlife Area is to protect marsh habitat, though there is a 96-acre patch of vernal pool grassland mapped by Witham (2021) in the northern portion of the Wildlife Area adjacent to Suisun City. The Hill Slough Wildlife Area is managed under the Grizzly Island Wildlife Area management plan from 1988, which does not describe management of vernal pool habitat (CDFW 1988; Shelton, *in litt*. 2022). The three shrimp species are not known to occur within the Hill Slough Wildlife Area, though all three species do occur adjacent to the southeastern corner within two mitigation sites.

There are various other protected mitigation and non-mitigation lands throughout the Solano-Colusa Vernal Pool Region, primarily within the greater Jepson Prairie area of Solano County (see **Figure 11.2**; Vollmar et al. 2017). In addition to the state lands and conservation or mitigation banks throughout the Jepson Prairie, there is a sizable amount of land preserved by the Solano Land Trust and/or The Nature Conservancy. The Solano Land Trust owns the Jepson Prairie Preserve and the Wilcox Ranch Preserve, both of which were previously acquired by The Nature Conservancy who still hold the conservation easements. The Jepson Prairie Preserve in particular has been an extremely important location for research and public education programs related to vernal pool species. The Nature Conservancy also holds conservation easements over the land east of Travis Air Force Base and west of Muzzy Ranch Conservation Bank and the Wilcox Ranch Preserve. Solano Land Trust also owns Rush Ranch in the Suisun Marsh area,

which has a small amount of mapped vernal pool grassland. One preserve not fully captured in Vollmar et al.'s (2017) database of protected lands is the Paradise Crest Wetland located in northeastern Fairfield that has a conservation easement held by the Golden State Land Conservancy. Another is the Montezuma Wetlands Project Preserve located in the Collinsville Core Area that has a conservation easement held by Solano County.

One preserve outside of Solano County not captured in Vollmar et al.'s (2017) database is the 121-acre Dolan Preserve, located adjacent to the Dolan Ranch Conservation Bank in the Dolan Core Area, Colusa County. In addition, Vollmar et al.'s (2017) and Witham's (2021) study areas did not extend to the San Francisco Bay Area, so there is a small amount of vernal pool grassland and protected land within the disconnected area of this vernal pool region in Contra Costa County that is not accounted for in their databases. Within this area, habitat that supports Contra Costa goldfields (*Lasthenia conjugens*), a vernal pool plant species, occurs within the Hercules Easement (a.k.a. State Route 4 Preserve) in the Rodeo Creek Core Area, which has a conservation easement held by Caltrans and managed by the Muir Heritage Land Trust (Service 2013). There are also various lands owned by, or with easements held by, the East Bay Regional Park District, but the Service is not aware of any vernal pool habitat that occurs within these protected lands.

11.7. Vernal Pool Core Areas

There are three Core Areas within the Solano-Colusa Vernal Pool Region that are designated in the Recovery Plan for the vernal pool fairy shrimp: Jepson Prairie, Sacramento National Wildlife Refuge, and Vacaville. There are three additional Core Areas that were not designated for the vernal pool fairy shrimp in the Recovery Plan, but that have known occurrences of the species in the Diversity Database: Collinsville, Davis Communications Annex, and Dolan (Diversity Database 2022). For the Davis Communications Annex Core Area, the vernal pool fairy shrimp was not identified until 2010, which is why this core area was not designated for the vernal pool fairy shrimp in the Recovery Plan. For the Collinsville and Dolan Core Areas, the Diversity Database occurrences includes information about surveys that occurred before December 2005, so the two core areas likely should have been designated for the vernal pool fairy shrimp in the Recovery Plan; however, it is possible that these occurrence records were not uploaded to the Diversity Database until after 2005.

There are five Core Areas within the Solano-Colusa Vernal Pool Region that are designated in the Recovery Plan for the vernal pool tadpole shrimp: Collinsville, Davis Communications Annex, Dolan, Jepson Prairie, and Sacramento National Wildlife Refuge. There is one additional Core Area that was not designated for the vernal pool tadpole shrimp in the Recovery Plan, but that has known occurrences of the species in the Diversity Database: Woodland (Diversity Database 2022). The vernal pool tadpole shrimp was not identified in the Woodland Core Area until 2011, which is why this core area was not designated for the vernal pool tadpole shrimp in the Recovery Plan.

There are three Core Areas within the Solano-Colusa Vernal Pool Region that are designated in the Recovery Plan for the Conservancy fairy shrimp: Collinsville, Jepson Prairie, and Sacramento National Wildlife Refuge.

Of these seven core areas, three have met the target amount of vernal pool habitat protected based on mapped habitat: Davis Communications Annex, Sacramento National Wildlife Refuge, and Vacaville (see **Table 11.1**; Vollmar et al. 2017; Witham 2021). However, the Vacaville Core Area likely has more vernal pool habitat than what was mapped, meaning that less than 85% is protected, and the Davis Communications Annex was mapped by Vollmar et al. (2017) as entirely protected because it is all public land, but more detailed information about the area shows that these public lands likely do not meet the requirements for protected lands in the Recovery Plan. As of 2018, one core area had lost 30% of the amount of vernal pool habitat that remained in 2005, making the targeted amount of protected habitat unattainable without habitat creation or restoration (see **Table 11.1**; Vollmar et al. 2017; Witham 2021).

11.7.1. Collinsville

This is a zone 1 core area with a goal of protecting 95% of vernal pool habitat for the vernal pool tadpole shrimp and Conservancy fairy shrimp. This core area was not designated for the vernal pool fairy shrimp in the Recovery Plan, but the species is known to occur there. The core area is located in southern Solano County north of the Sacramento River as it enters Suisun Bay.

This core area is entirely encompassed within the upland portions of the Montezuma Wetlands Project. This is a 2,400-acre tidal marsh restoration project, and the adjacent upland area with vernal pools was preserved as mitigation for the loss of vernal pools caused by Phase I of the project (C. Pinnell, Vollmar Natural Lands Consulting, pers. comm. 2022), which was completed in 2003 (Vollmar Natural Lands Consulting 2020). The tidal marsh restoration area included pockets of subsided land that had unnatural vernal pools that had developed after the marsh was dyked in the 1800's. As mitigation, the landowner preserved approximately 3.765 acres of existing vernal pools and 3.777 acres of created vernal pools on the 245-acre Montezuma Wetlands Project Preserve (**Figure 11.7**). Several pools within the preserve totaling 1.361 acres were avoided by the project but are expected to be hydrologically disturbed and thus did not count as mitigation (Pinnell, pers. comm. 2022). Also, 7.403 acres of pools (mostly one large pool) located outside of the conservation easement along the railroad tracks will be hydrologically disturbed in the future; these pools are not natural and are already highly disturbed (Pinnell, pers. comm. 2022), though they have been found to support the vernal pool fairy shrimp and vernal pool tadpole shrimp in some years (Diversity Database 2022).

There were approximately 410 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005, with another 44 acres immediately adjacent (Witham et al. 2013). As of 2018, there were still 410 acres of vernal pool grassland remaining, with no habitat losses occurring since 2005 (see **Figure 11.8**, **Table 11.1**; Witham 2021). Roughly 245 acres of vernal pool grassland are protected within the Montezuma Wetlands Project Preserve and an additional 115 acres are owned by Montezuma Wetlands, LLC and protected by a deed restriction (see **Figure 11.9**; Vollmar et al. 2017; Pinnell, *in litt*. 2022). However, only 331 acres are within the boundaries of the core area. This represents 81% of the 2005 baseline within the core area (410 acres) protected and 79% of the 2005 baseline including the habitat outside of the core area boundaries (454 acres).

11.7.1.1. Vernal Pool Fairy Shrimp Occurrences

There is one Diversity Database occurrence record for the vernal pool fairy shrimp within this core area (see **Figure 11.10**; Diversity Database 2022). As of 2018, this occurrence was partially protected within the Montezuma Wetlands Project Preserve (C. Pinnell, Vollmar Natural Lands Consulting, *in litt*. 2022). The occurrence is presumed extant by the Diversity Database and is within extant vernal pool grasslands (Witham 2021). The vernal pool fairy shrimp was first documented here in 2002 (Diversity Database 2022), and thus the Recovery Plan likely should have designated this core area for the vernal pool fairy shrimp. The vernal pool fairy shrimp has been consistently observed within multiple pools during monitoring of the preserve (Vollmar Natural Lands Consulting 2020; Diversity Database 2022).

11.7.1.1. Vernal Pool Tadpole Shrimp Occurrences

There is one Diversity Database occurrence record for the vernal pool tadpole shrimp within this core area (see **Figure 11.11**; Diversity Database 2022). As of 2018, this occurrence was partially protected within the Montezuma Wetlands Project Preserve (C. Pinnell, Vollmar Natural Lands Consulting, *in litt*. 2022). The occurrence is presumed extant by the Diversity Database and is within extant vernal pool grasslands (Witham 2021). The vernal pool tadpole shrimp was first documented here in 2000 (Diversity Database 2022) and has been consistently observed within multiple pools during monitoring of the preserve (Vollmar Natural Lands Consulting 2020; Diversity Database 2022).

11.7.1.2. Conservancy Fairy Shrimp Occurrences

There is one Diversity Database occurrence record for the Conservancy fairy shrimp within this core area (see **Figure 11.12**; Diversity Database 2022). As of 2018, this occurrence was partially protected within the Montezuma Wetlands Project Preserve (C. Pinnell, Vollmar Natural Lands Consulting, *in litt*. 2022). The occurrence is presumed extant by the Diversity Database and is within extant vernal pool grasslands (Witham 2021). The Conservancy fairy shrimp was first documented here in 2000 and has been consistently observed within multiple pools during monitoring of the preserve (Vollmar Natural Lands Consulting 2020; Diversity Database 2022). The species has been observed within 15 of the 30 vernal pools onsite: 6 natural pools, 3 enhanced pools, and 6 created pools (Diversity Database 2022). This occurrence is part of the Jepson Prairie population. Although this occurrence is 13 miles to the south of the rest of the Jepson Prairie occurrences, genetic information, along with the site's proximity and ecological similarity to the other Jepson Prairie occurrences, does support the placement of this occurrence within the Jepson Prairie population as opposed to its own distinct population (Kieran and Finger 2020).

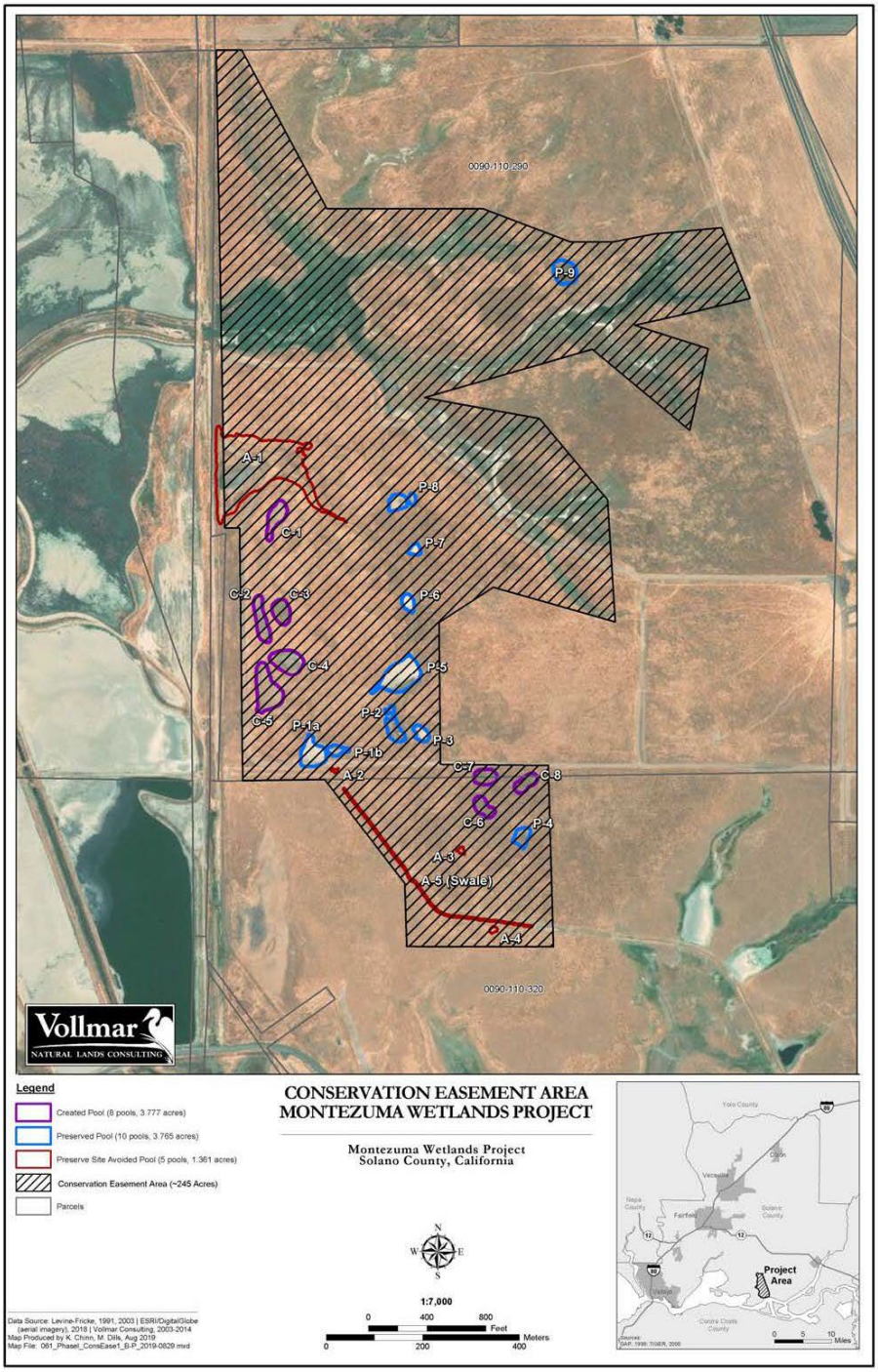


Figure 11.7. Map of the conservation easement and vernal pools within the Montezuma Wetlands Project Preserve provided by Vollmar Natural Lands Consulting (Pinnell, *in litt*. 2022).

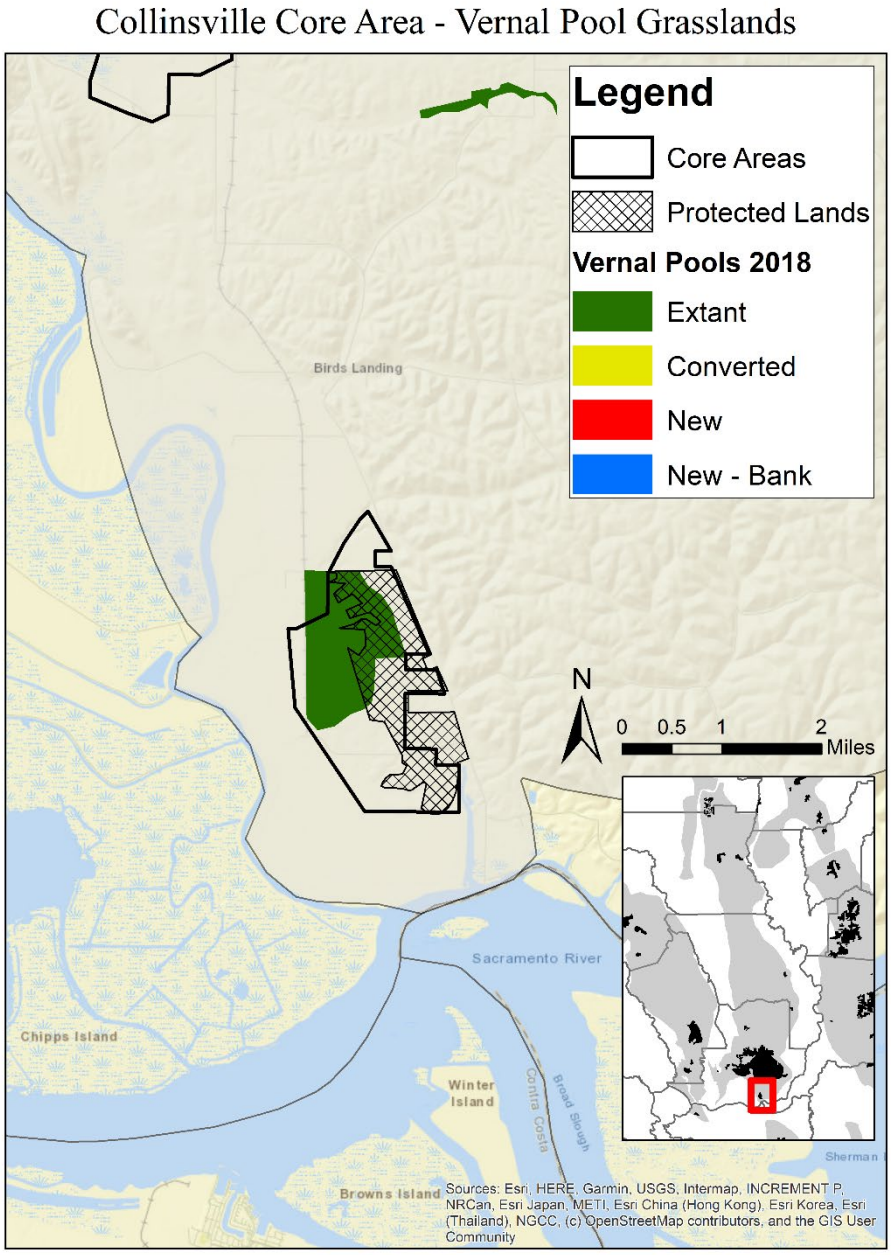


Figure 11.8. Map of vernal pool grassland habitat within the Collinsville Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

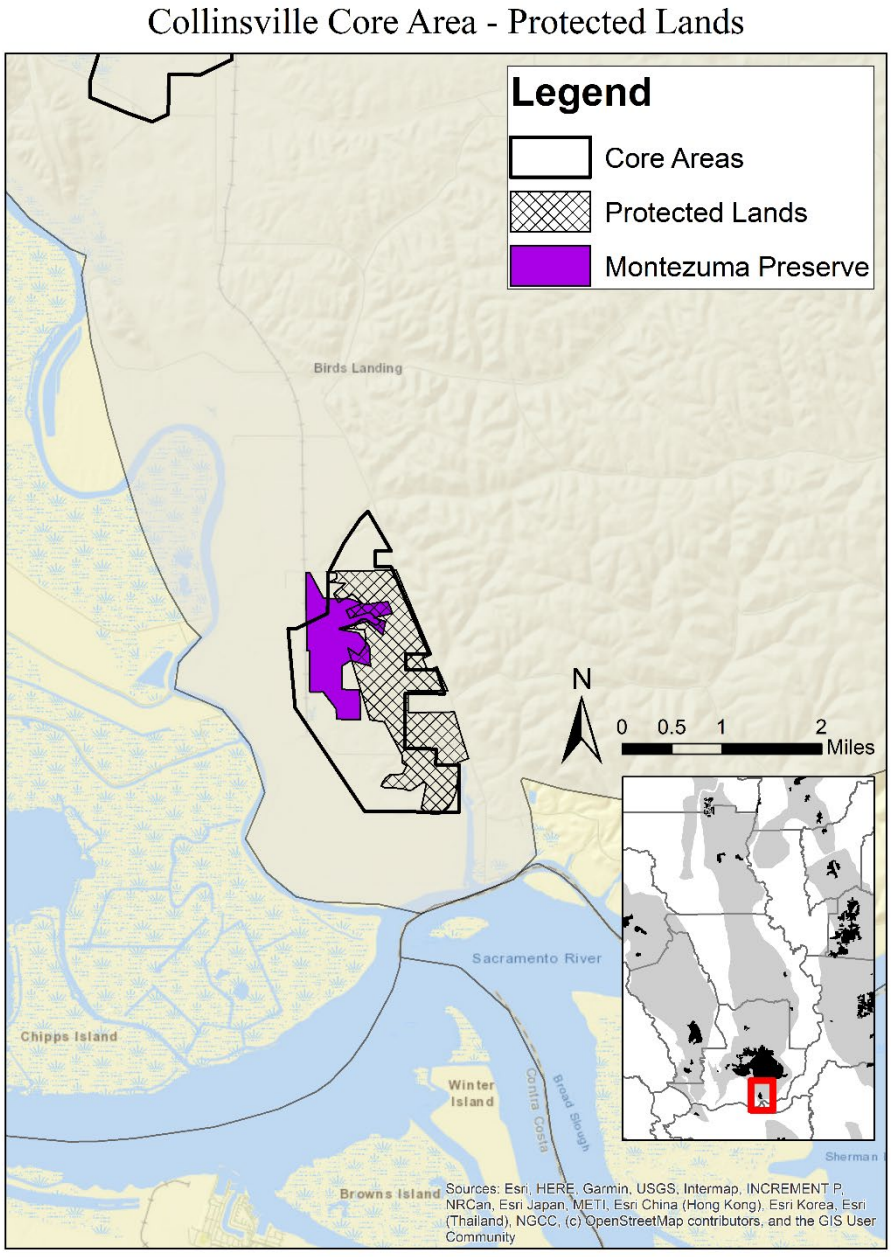


Figure 11.9. Map of protected areas within the Collinsville Core Area**.** Protected lands are based on Vollmar et al. (2017). Montezuma Wetlands Project Preserve boundary provided by Vollmar Natural Lands Consulting (Pinnell, *in litt*. 2022).

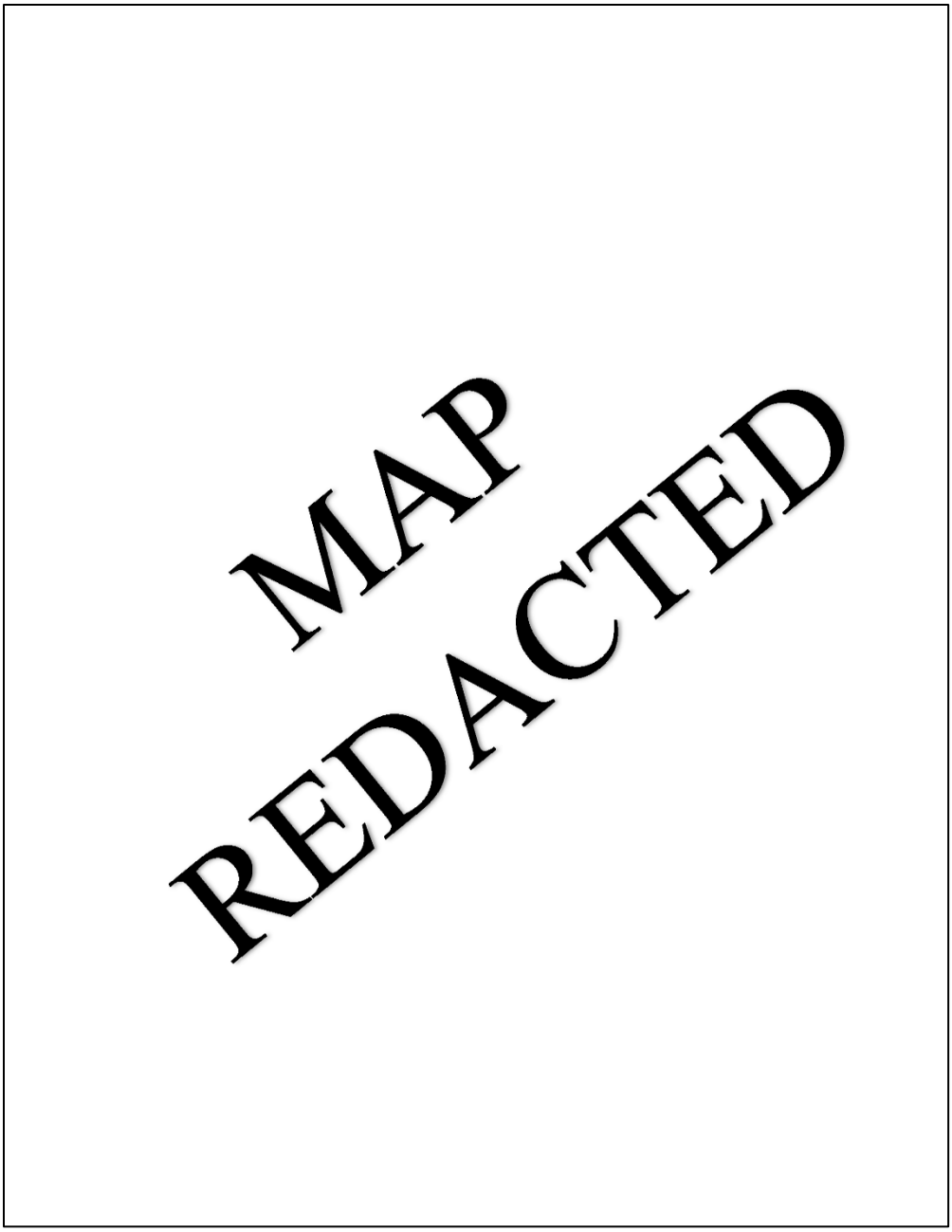


Figure 11.10. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Collinsville Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

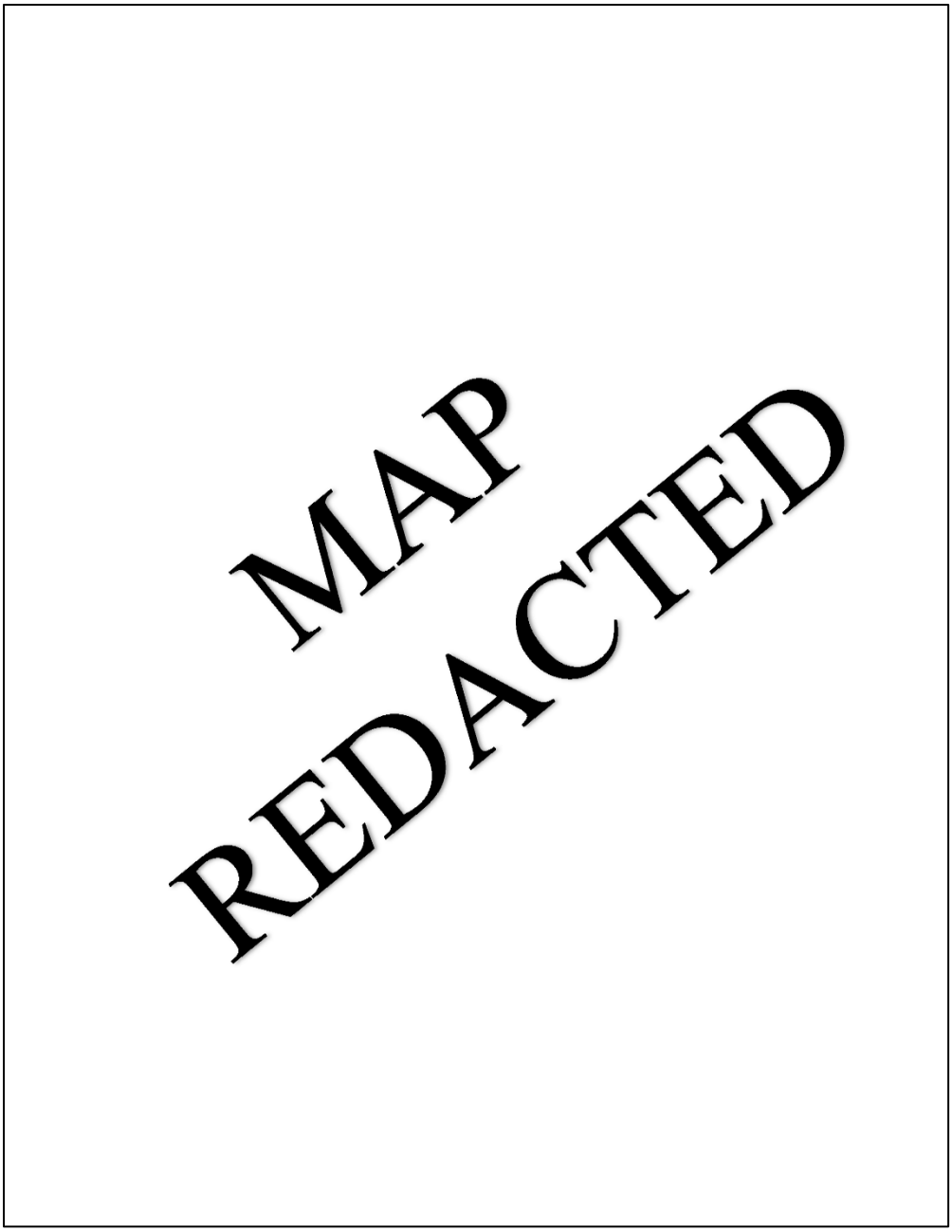


Figure 11.11. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Collinsville Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

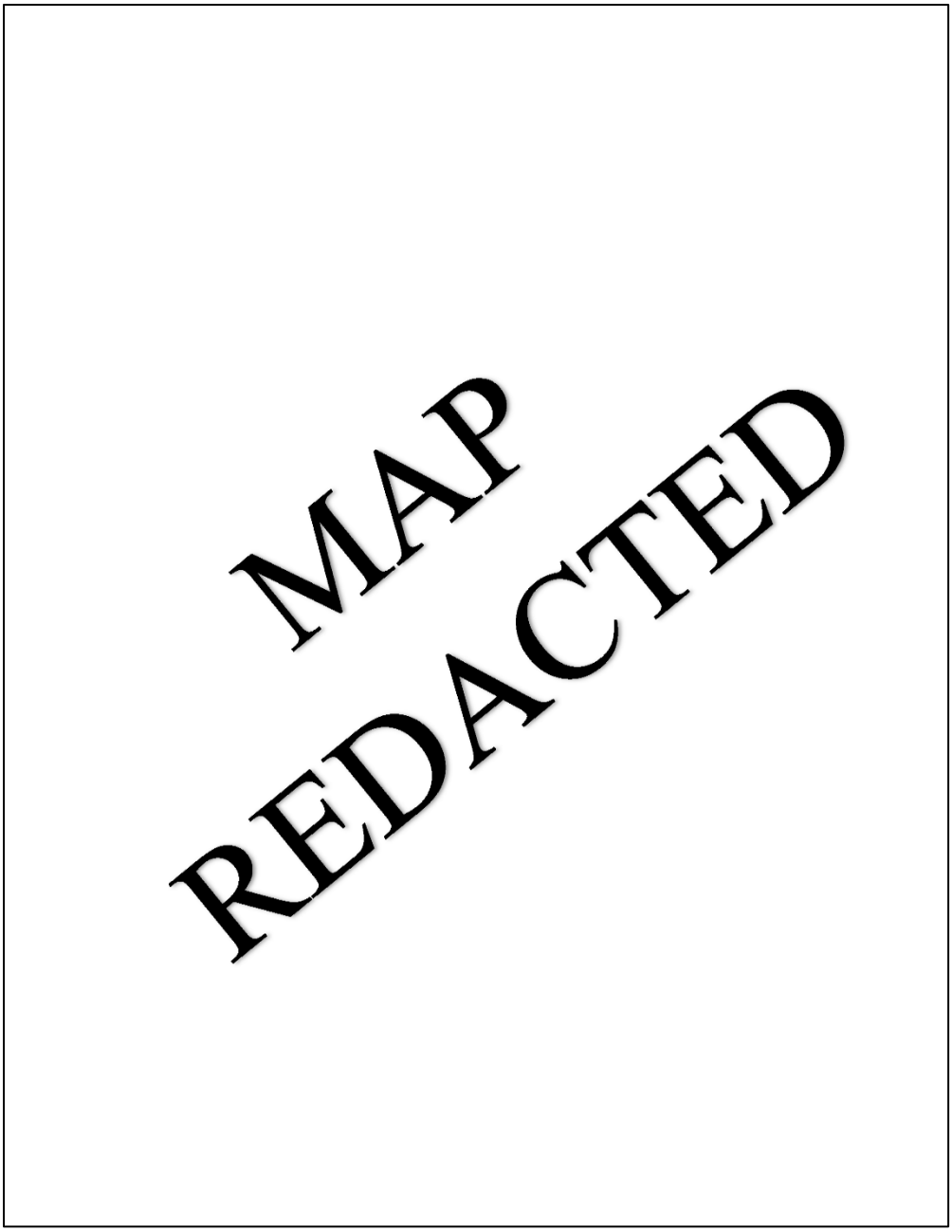


Figure 11.12. Map of known occurrences of Conservancy fairy shrimp recorded in the Diversity Database (2022) within the Collinsville Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

11.7.2. Davis Communications Annex

This is a zone 1 core area with a goal of protecting 95% of vernal pool habitat for the vernal pool tadpole shrimp. This core area was not designated for the vernal pool fairy shrimp in the Recovery Plan, but the species is known to occur there. The core area is located in southern Yolo County south of the City of Davis.

The 1-square mile (640-acre) area east of Mace Boulevard between County Road 35 and County Road 36 is composed of the Yolo County Grasslands Regional Park on the west and the former Davis Communications Site on the east. The Davis Communications Annex Core Area is 440 acres in size and is composed of the entire former Davis Communications Site and the northeastern portion of Grasslands Regional Park. The Davis Communications Site was part of McClellan Air Force Base, which closed in 2003. As part of the base closure, this site was transferred to the National Park Service as an intermediary, with the eventual plan to transfer the entire site to Yolo County and for Yolo County to place a 173-acre conservation easement over the portion of the property with vernal pools (Service 2004). However, conservation easements cannot be placed on former military lands per federal regulations, so the National Park Service and Yolo County are now considering a deed restriction as an alternative mechanism to protect the site (K. Berry and A. Stewart, Service, pers. comm. 2019). Yolo County assumed management responsibility over the former Davis Communications Site in 2007 as they were awaiting transfer of ownership, and the site is currently managed as part of Grasslands Regional Park (Helm Biological Consulting 2010).

There were approximately 102 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were still 102 acres of vernal pool grassland remaining, with no habitat losses occurring in the mapped areas since 2005 (see **Figure 11.13**; Witham 2021). However, a 30-acre solar development was built in 2013 that partially overlaps the northwestern corner of the core area, and there were concerns at the time that the wetland feature filled during construction may have provided habitat for vernal pool species (C. Mustin, Service, *in litt*. 2013). A wetland delineation conducted in 2010 identified approximately 11.6 acres of vernal pools throughout the core area, including five small created vernal pools (Helm Biological Consulting 2010) that were created in 2007–2008 (Yolo County Parks, *in litt*. 2023). The locations of the vernal pools generally line up with Witham's (2021) mapped vernal pool grasslands; the area of created pools is noticeable as a distinct separate patch of habitat (**Figure 11.13**). This core area is generally highly disturbed, both from historical uses (agricultural and military development) and recent activities (grassland enhancement and demolition activities) (Helm Biological Consulting 2010).

Vollmar et al. (2017) mapped the entire core area as being protected as all public lands counted as "preserved" in their study. However, due to the historic disturbance of the core area, the current lack of a mechanism to protect the vernal pool grasslands in perpetuity, and concerns that Yolo County does not have sufficient funds to establish an endowment once the Davis Communications Site is protected (K. Berry, Service, *in litt*. 2017), the Grasslands Regional Park and former Davis Communications Site do not currently meet the requirements for protected habitat outlined in the Recovery Plan's recovery criteria.

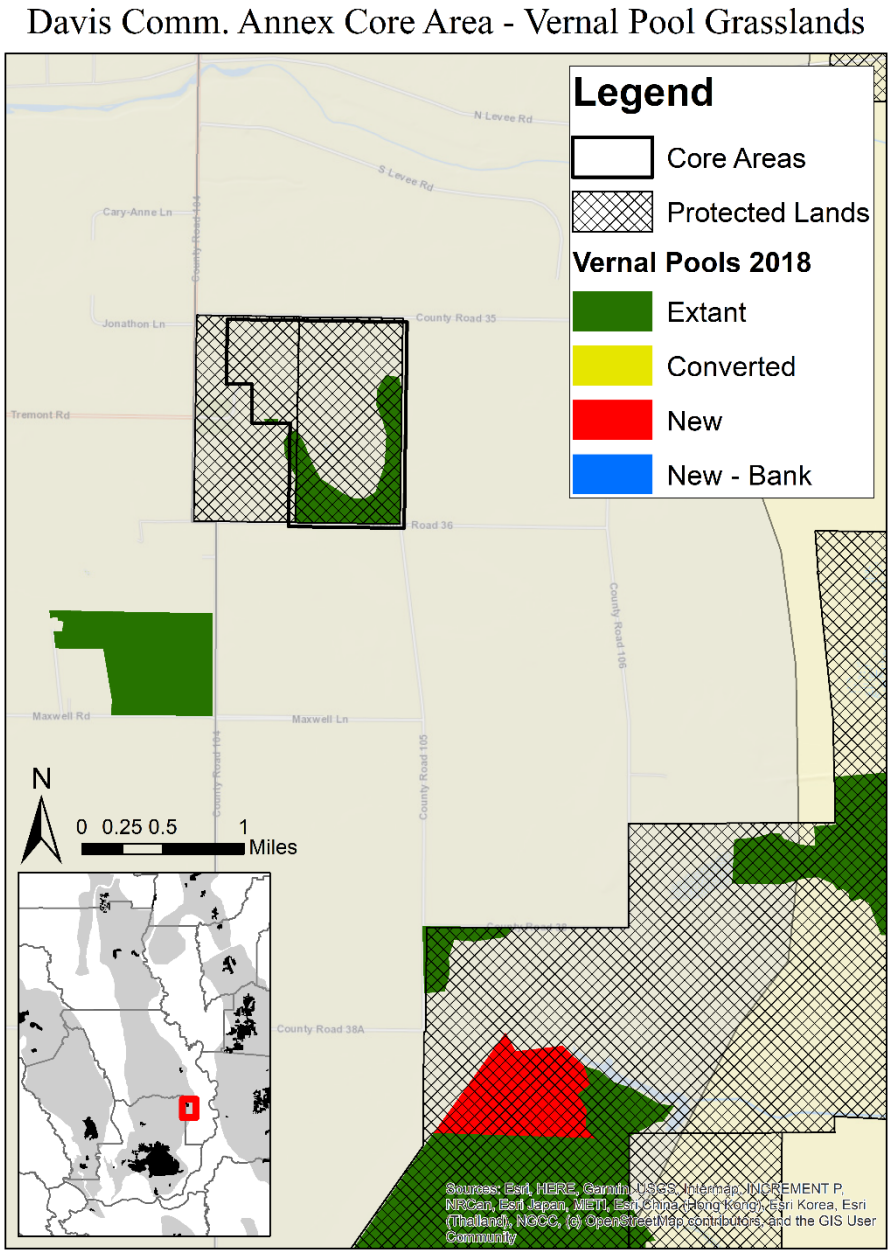


Figure 11.13. Map of vernal pool grassland habitat within the Davis Communications Annex Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

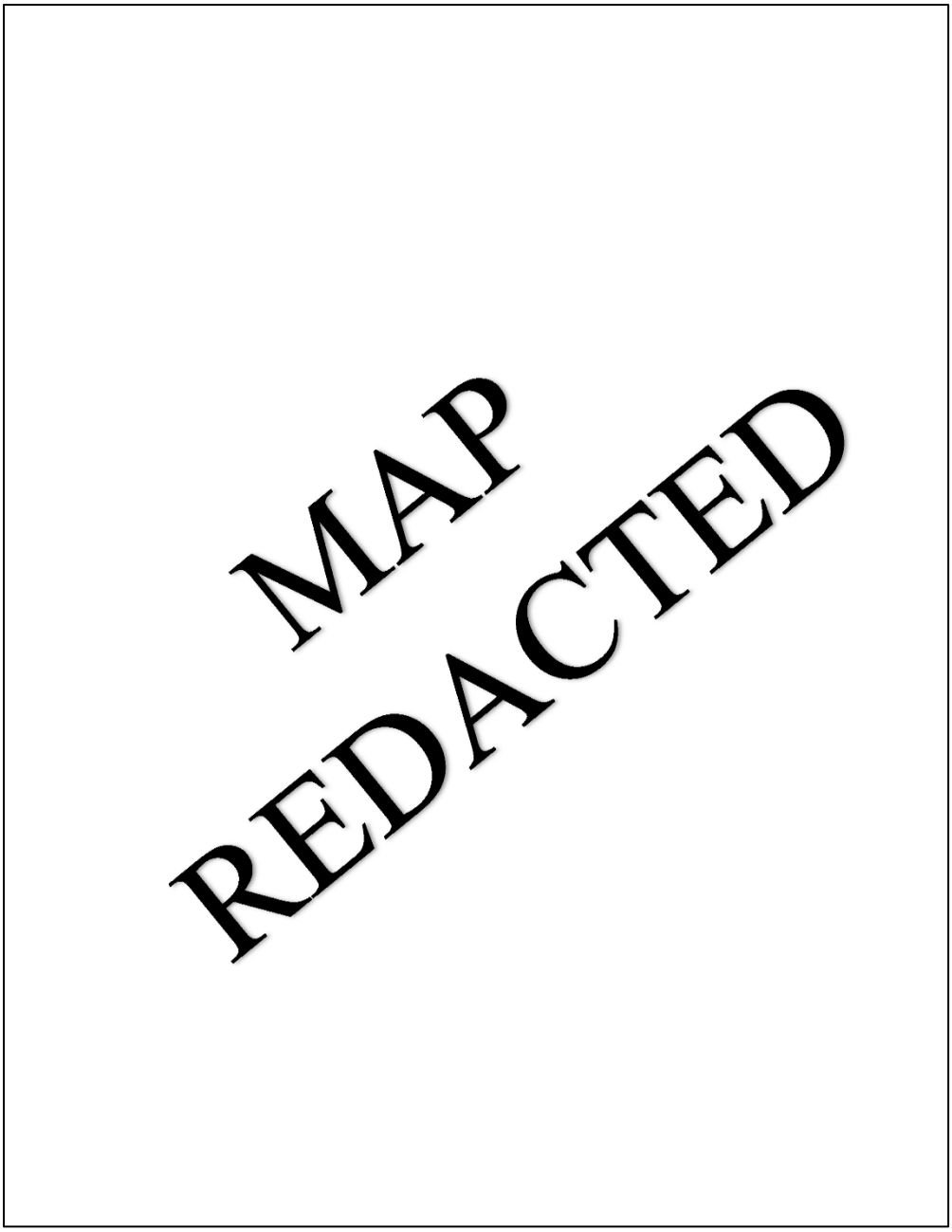


Figure 11.14. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Davis Communications Annex Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

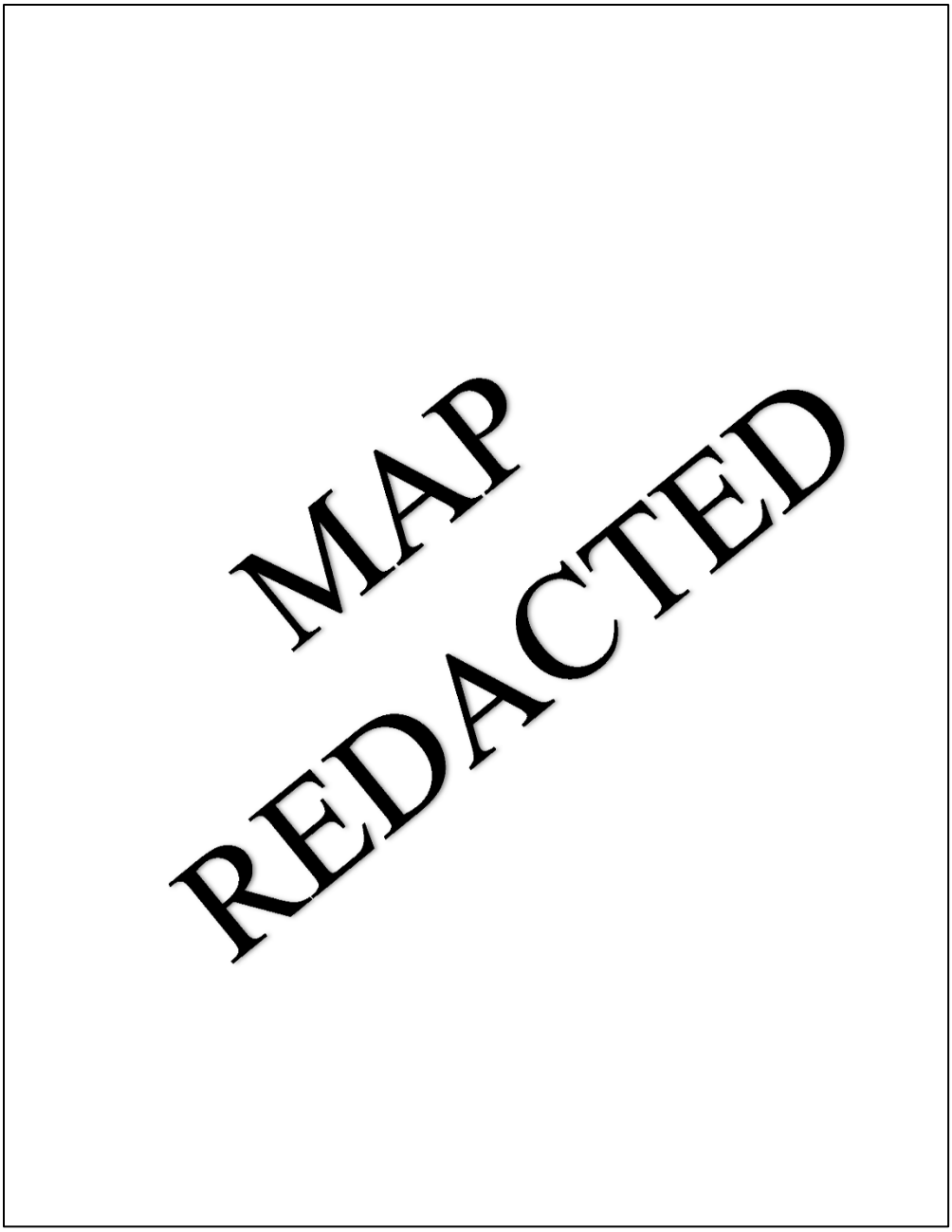


Figure 11.15. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Davis Communications Annex Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

11.7.2.1. Vernal Pool Fairy Shrimp Occurrences

There are two Diversity Database occurrence records for the vernal pool fairy shrimp within this core area (see **Figure 11.14**; Diversity Database 2022). As of 2018, both occurrences were entirely protected within the former Davis Communications Site (Vollmar et al. 2017). The occurrences are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). The vernal pool fairy shrimp was first documented here in 2010 (Diversity Database 2022), after the Recovery Plan was published. The Service is not aware of any monitoring that has occurred since 2010.

11.7.2.2. Vernal Pool Tadpole Shrimp Occurrences

There is one Diversity Database occurrence record for the vernal pool tadpole shrimp within this core area (see **Figure 11.15**; Diversity Database 2022). As of 2018, the occurrence was entirely protected within the former Davis Communications Site (Vollmar et al. 2017). The occurrence is presumed extant by the Diversity Database and is within extant vernal pool grasslands (Witham 2021). The vernal pool tadpole shrimp was first documented here in 1993 and was most recently observed in 2010 (Diversity Database 2022). The Service is not aware of any monitoring that has occurred since 2010.

11.7.3. Dolan

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool tadpole shrimp. This core area was not designated for the vernal pool fairy shrimp in the Recovery Plan, but the species is known to occur there. The core area is located in eastern Colusa County on either side of the Colusa National Wildlife Refuge.

There were approximately 566 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005, all mapped within the eastern unit of the core area (Witham et al. 2013). As of 2018, there were 395 acres of vernal pool grassland remaining (see **Figure 11.16**, **Table 11.1**; Witham 2021). Approximately 170 acres had been lost since the Recovery Plan's 2005 baseline, with all losses due to agricultural conversion to orchards (see **Table 11.2**; Witham 2021). This represents a loss of more than 15% of the amount of vernal pool habitat that remained in 2005, making the 85% target unattainable without habitat creation or restoration. Roughly 248 acres of vernal pool grassland were protected within this core area as of 2017 (Vollmar et al. 2017), representing 44% of the 2005 baseline.

Protected areas within this core area include the Dolan Ranch Conservation Bank and the Dolan Ranch Preserve (**Figure 11.17**).

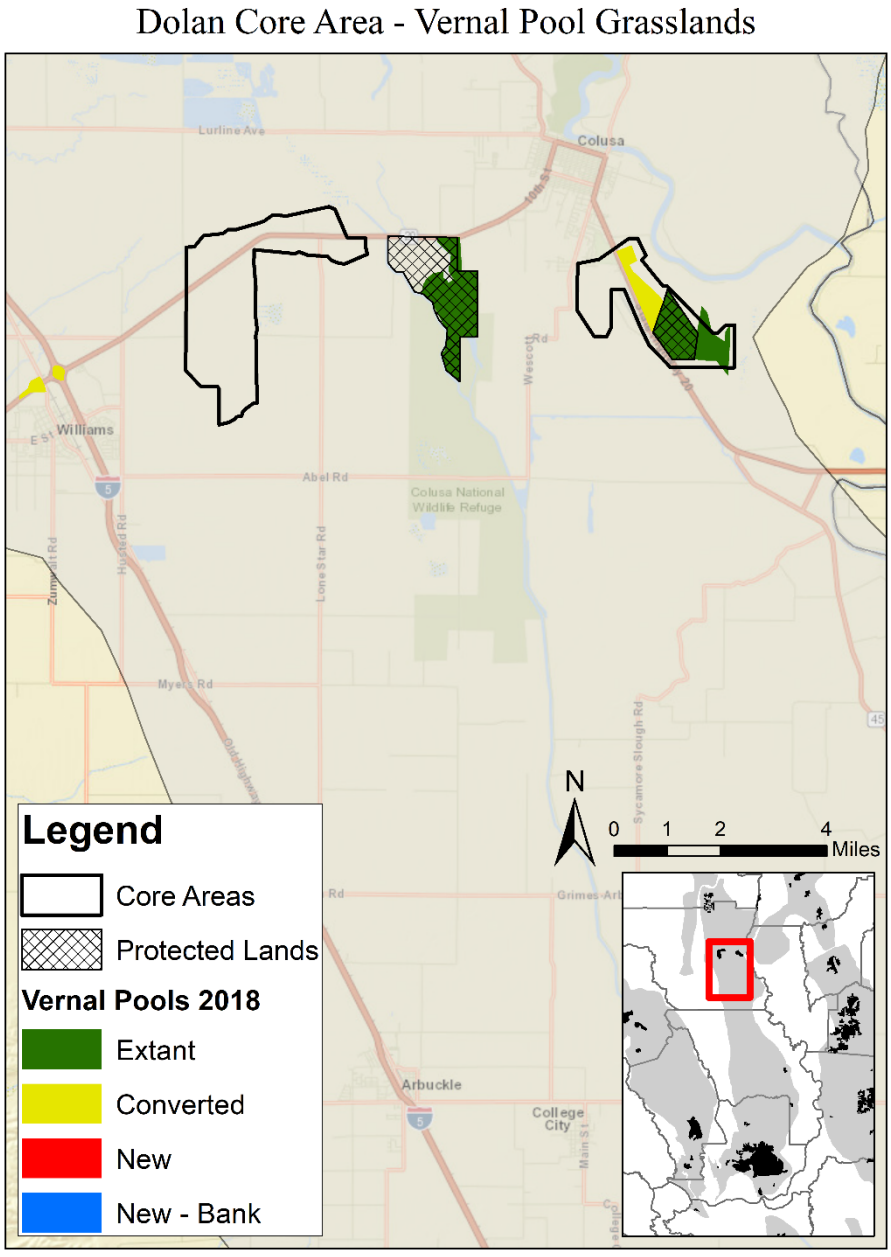


Figure 11.16. Map of vernal pool grassland habitat within the Dolan Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

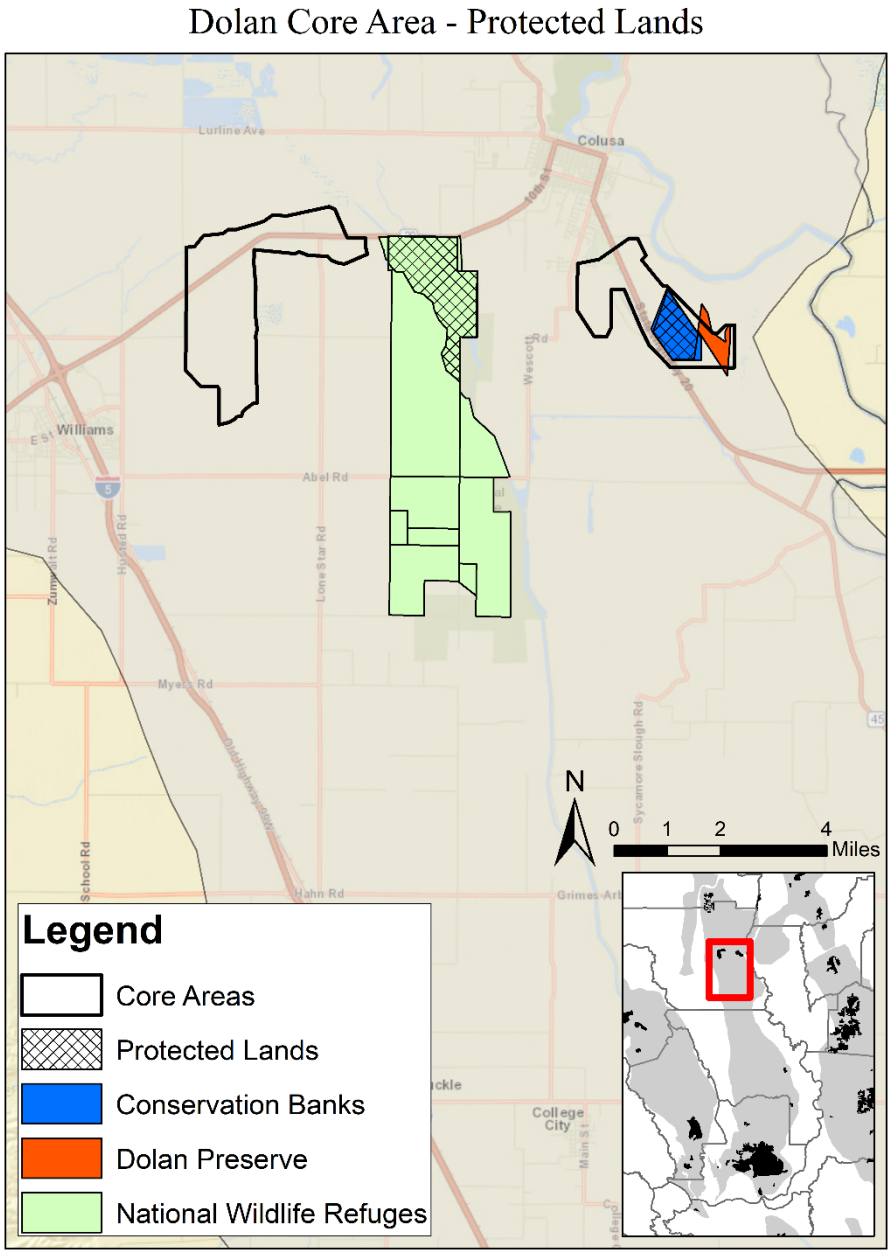


Figure 11.17. Map of protected areas within the Dolan Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves.

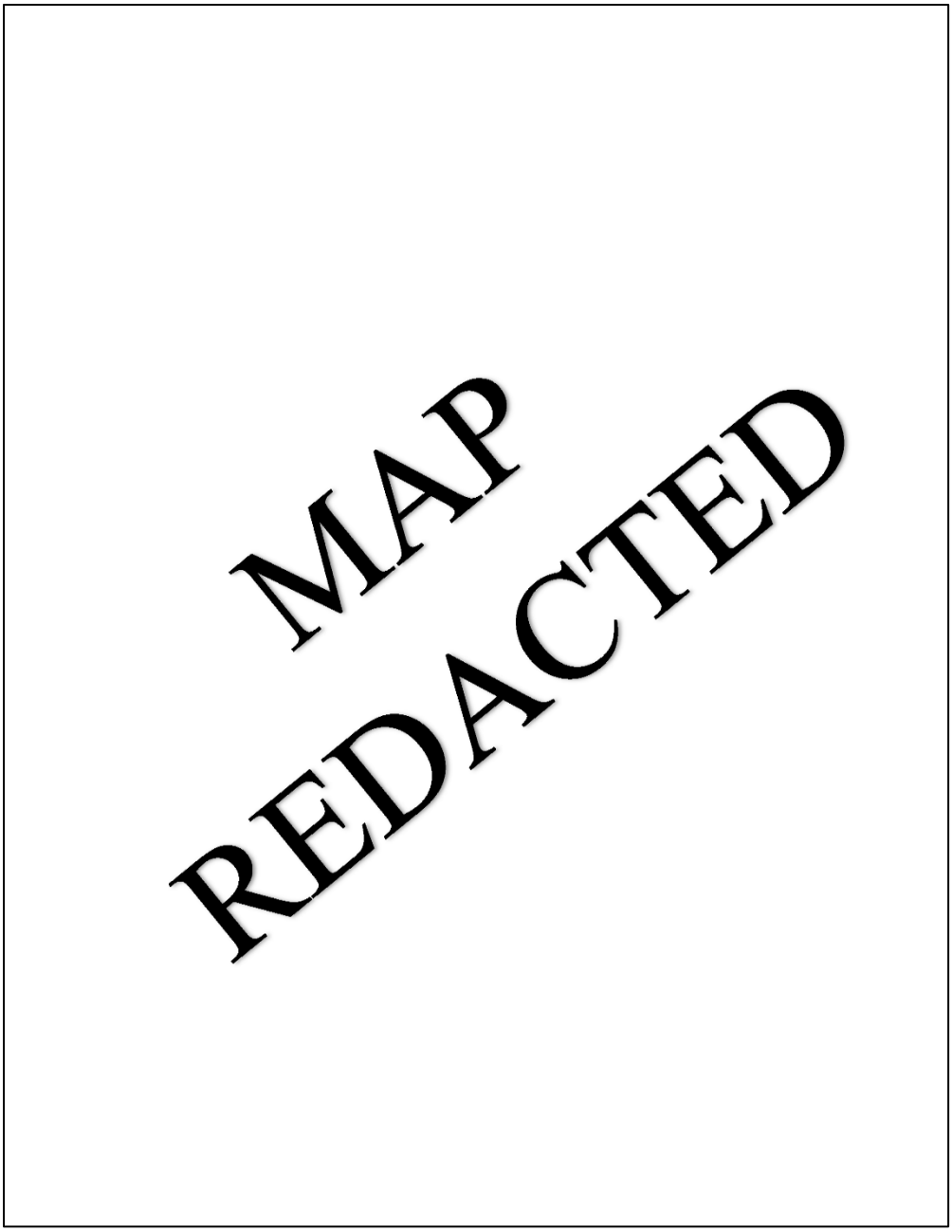


Figure 11.18. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Dolan Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

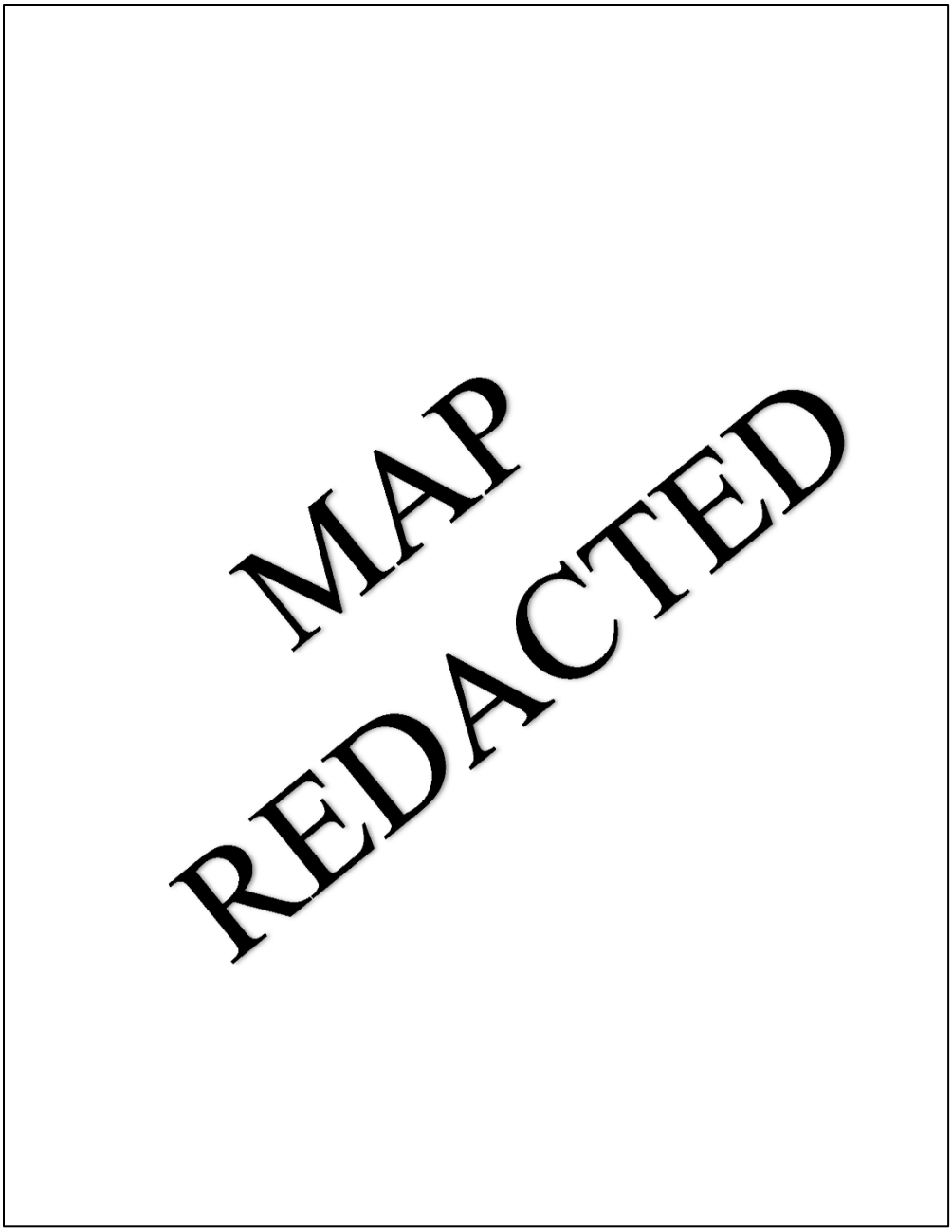


Figure 11.19. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Dolan Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

11.7.3.1. Vernal Pool Fairy Shrimp Occurrences

There is one Diversity Database occurrence record for the vernal pool fairy shrimp within this core area (see **Figure 11.18**; Diversity Database 2022). As of 2018, this occurrence was entirely protected within the Dolan Ranch Conservation Bank (Vollmar et al. 2017). The occurrence is presumed extant by the Diversity Database and is within extant vernal pool grasslands (Witham 2021). The vernal pool fairy shrimp was first documented here in January 2005 (Diversity Database 2022), and thus the Recovery Plan likely should have designated this core area for the vernal pool fairy shrimp. The vernal pool fairy shrimp was identified again in 2012, 2017, and 2022 during regular 5-year monitoring on the bank (Wildlands 2017a; Diversity Database 2022; Resource Environmental Solutions 2022).

11.7.3.2. Vernal Pool Tadpole Shrimp Occurrences

There is one Diversity Database occurrence record for the vernal pool tadpole shrimp within this core area (see **Figure 11.19**; Diversity Database 2022). As of 2018, this occurrence was entirely protected within the Dolan Ranch Conservation Bank (Vollmar et al. 2017). The occurrence is presumed extant by the Diversity Database and is within extant vernal pool grasslands (Witham 2021). The vernal pool tadpole shrimp was first documented here in 2002 (Diversity Database 2022). The species was identified again in 2017 and 2022 during regular 5-year monitoring on the bank (Wildlands 2017a; Resource Environmental Solutions 2022).

11.7.4. Jepson Prairie

This is a zone 1 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and 95% of vernal pool habitat for the vernal pool tadpole shrimp and Conservancy fairy shrimp. The core area is located in central Solano County east of the City of Fairfield. The greater Jepson Prairie area is the last remaining large, mostly contiguous stretch of vernal pool grasslands within the Solano-Colusa Vernal Pool Region, representing over half of all extant vernal pool habitat in this region.

There were approximately 31,467 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005, which represents 68.5% of all vernal pool grasslands mapped within the Solano-Colusa Vernal Pool Region (Witham et al. 2013). As of 2018, there were 30,823 acres of vernal pool grassland remaining (see **Figure 11.20**, **Table 11.1**; Witham 2021). Approximately 704 acres had been lost since the Recovery Plan's 2005 baseline, though 16 additional acres were created on banks that were not previously mapped as vernal pool grassland in 2005 and 43 acres were identified that were either new or missed in previous mapping efforts. The majority of losses were attributable to agricultural conversions (502 acres [71.3%] to bare plowed agricultural land and 4 acres [0.6%] to agricultural residences), though a significant amount of the losses were caused by urbanization (198 acres, 28.1%), mostly on the outskirts of Fairfield (**Table 11.2**). Roughly 11,204 acres of vernal pool grassland were protected within this core area as of 2017 (Vollmar et al. 2017), representing 35.6% of the 2005 baseline. The protected lands within this core area represent 61% of all protected habitat within the vernal pool region.

There are seven conservation banks with vernal pool fairy shrimp or vernal pool tadpole shrimp preservation credits in this core area: Burke Ranch, Campbell Ranch, Elsie Gridley, Goldfields, Muzzy Ranch, Noonan, and North Suisun (**Figure 11.21**). Other protected areas within this core area include CDFW's Calhoun Cut Ecological Reserve, Dixon Vernal Pools conservation easement, and part of the Hill Slough Wildlife Area; the Solano Land Trust's Jepson Prairie Preserve, Wilcox Ranch Preserve, and part of Rush Ranch; the Golden State Land Conservancy's Paradise Crest Wetland preserve; a small part of Travis Air Force Base (most of the Base was purposefully excluded from the core area); the County-owned land with a conservation easement held by The Nature Conservancy to the east of Travis Air Force Base; and six other mitigation sites that have been protected, likely as part of proposed conservation measures during Section 7 interagency consultations (see **Figure 11.21**; Vollmar et al. 2017).

11.7.4.1. Vernal Pool Fairy Shrimp Occurrences

There are 15 Diversity Database occurrence records for the vernal pool fairy shrimp within this core area (see **Figure 11.22**; Diversity Database 2022). As of 2018, 12 of these occurrences were at least partially within protected areas (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database; 13 are within extant mapped vernal pool grasslands and 2 are outside of mapped vernal pool grasslands (Witham 2021). Vernal pool fairy shrimp were first detected within this core area in 1993 and new Diversity Database records were consistently reported up through 2009 (Diversity Database 2022). Of the 15 records, 1 was known at the time of listing in 1994 and 9 were known at the time the Recovery Plan was published in 2005; these records are located throughout the core area. The six newer records are mostly located near older records, with two newer records on the eastern boundary of the core area. This confirms that most vernal pool grasslands in this core area are occupied by the vernal pool fairy shrimp.

11.7.4.2. Vernal Pool Tadpole Shrimp Occurrences

There are 22 Diversity Database occurrence records for the vernal pool tadpole shrimp within this core area (see **Figure 11.23**; Diversity Database 2022). As of 2018, all 22 of these occurrences were at least partially within protected areas (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database and are within extant mapped vernal pool grasslands (Witham 2021). Vernal pool tadpole shrimp were first detected within this core area in 1980 and new Diversity Database records were consistently reported up through 2012 (Diversity Database 2022). Of the 22 records, 5 were known at the time of listing in 1994 and 14 were known at the time the Recovery Plan was published in 2005; these records are located throughout the northern and western parts of the core area. The eight newer records are mostly located near older records, though two of the records fill in significant gaps in the species distribution that had existed in the center of the core area. This confirms that the majority of vernal pool grasslands in this core area are occupied by the vernal pool tadpole shrimp.

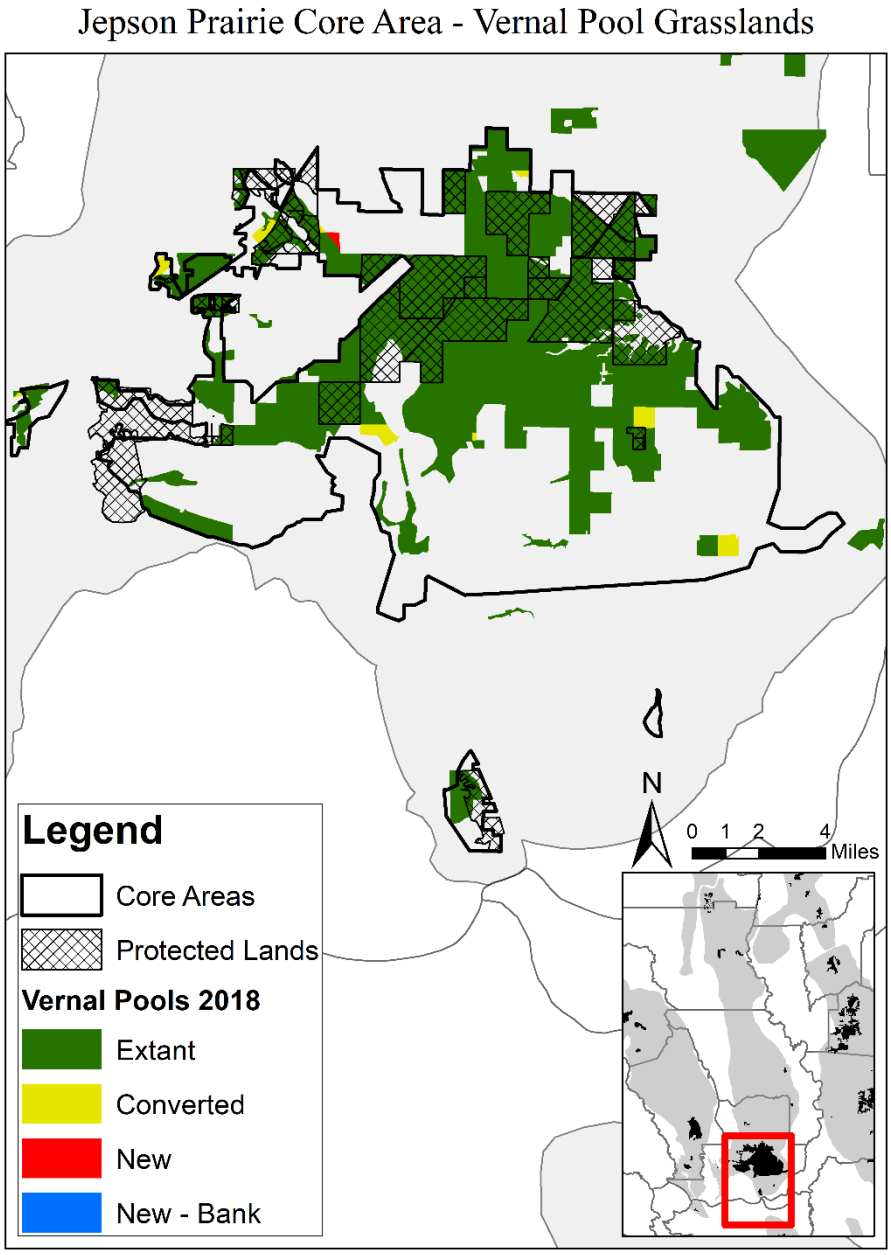


Figure 11.20. Map of vernal pool grassland habitat within the Jepson Prairie Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

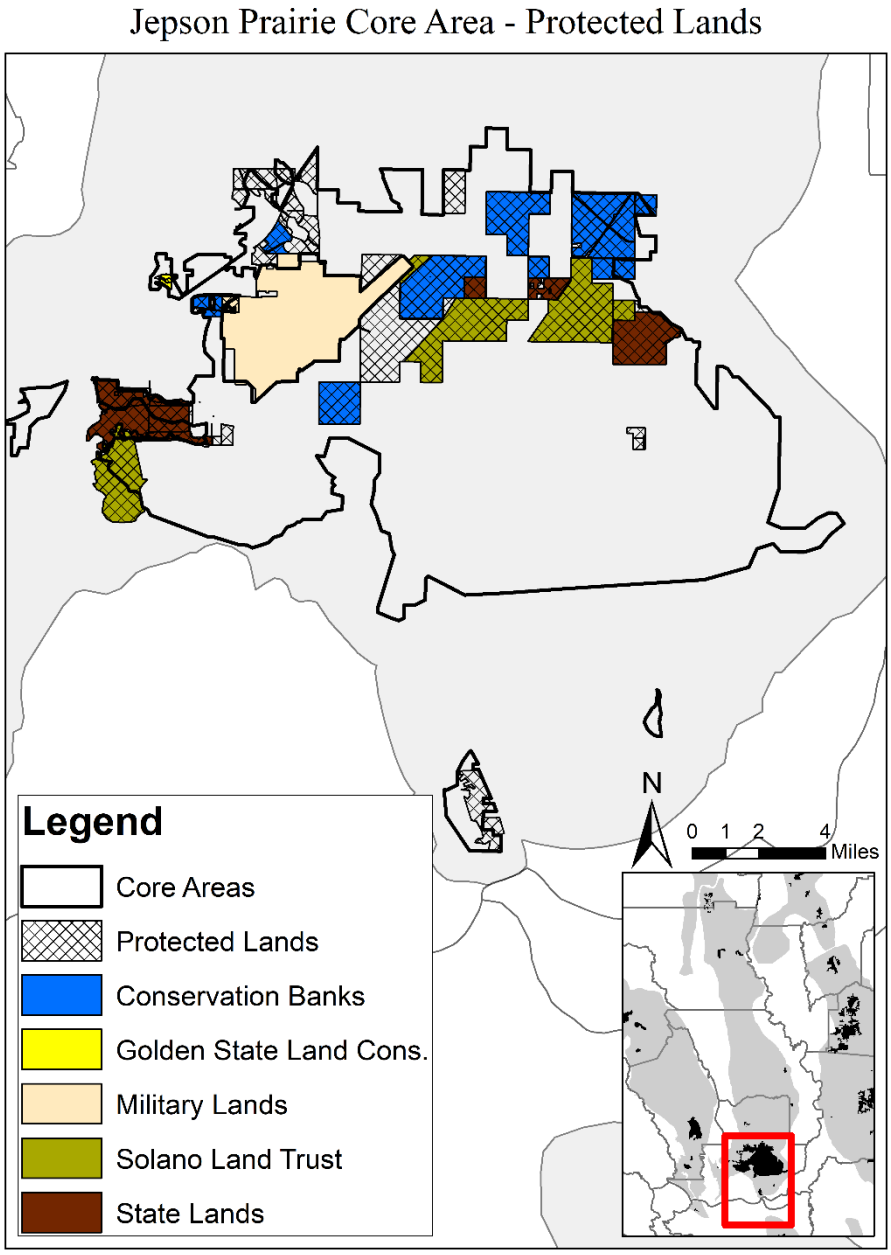


Figure 11.21. Map of protected areas within the Jepson Prairie Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves.

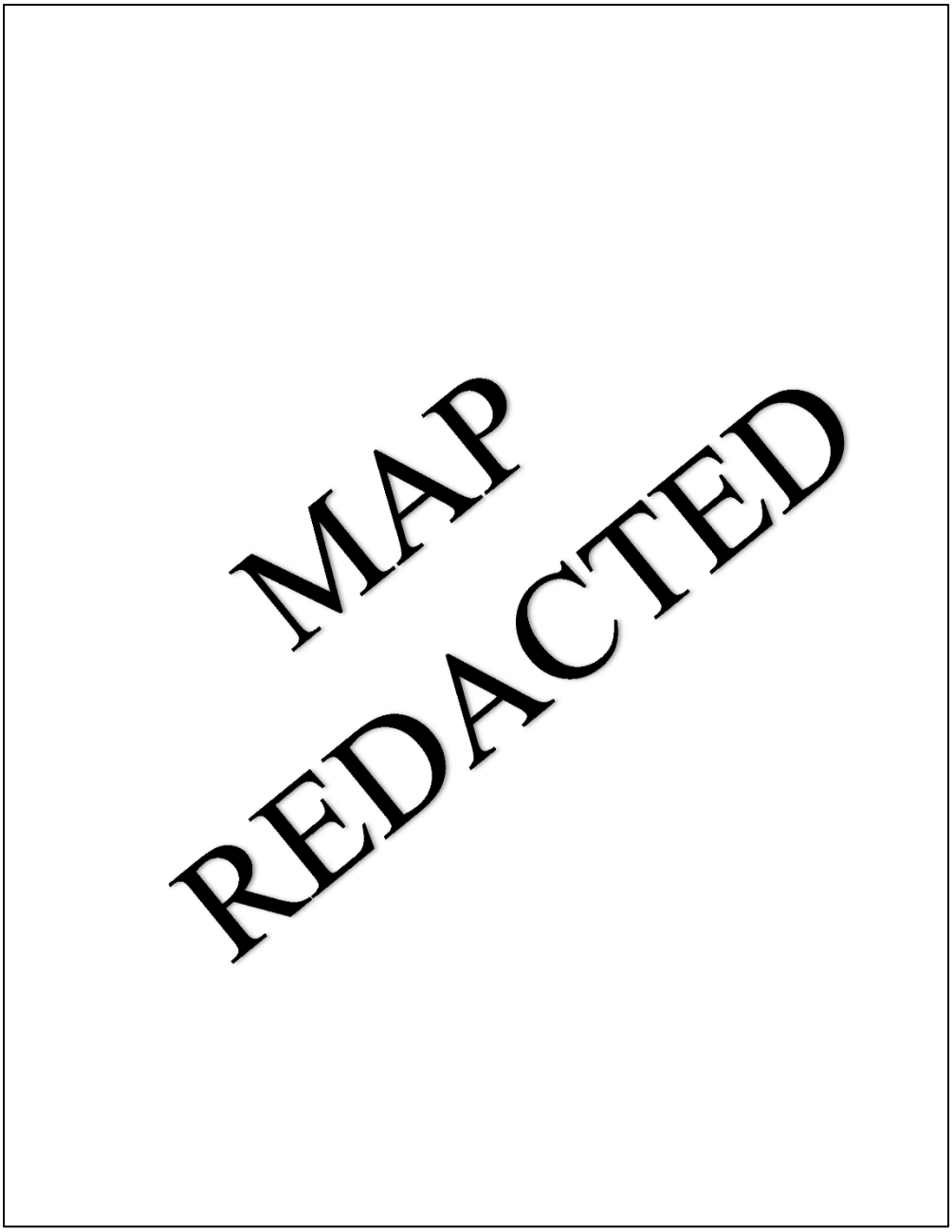


Figure 11.22. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Jepson Prairie Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

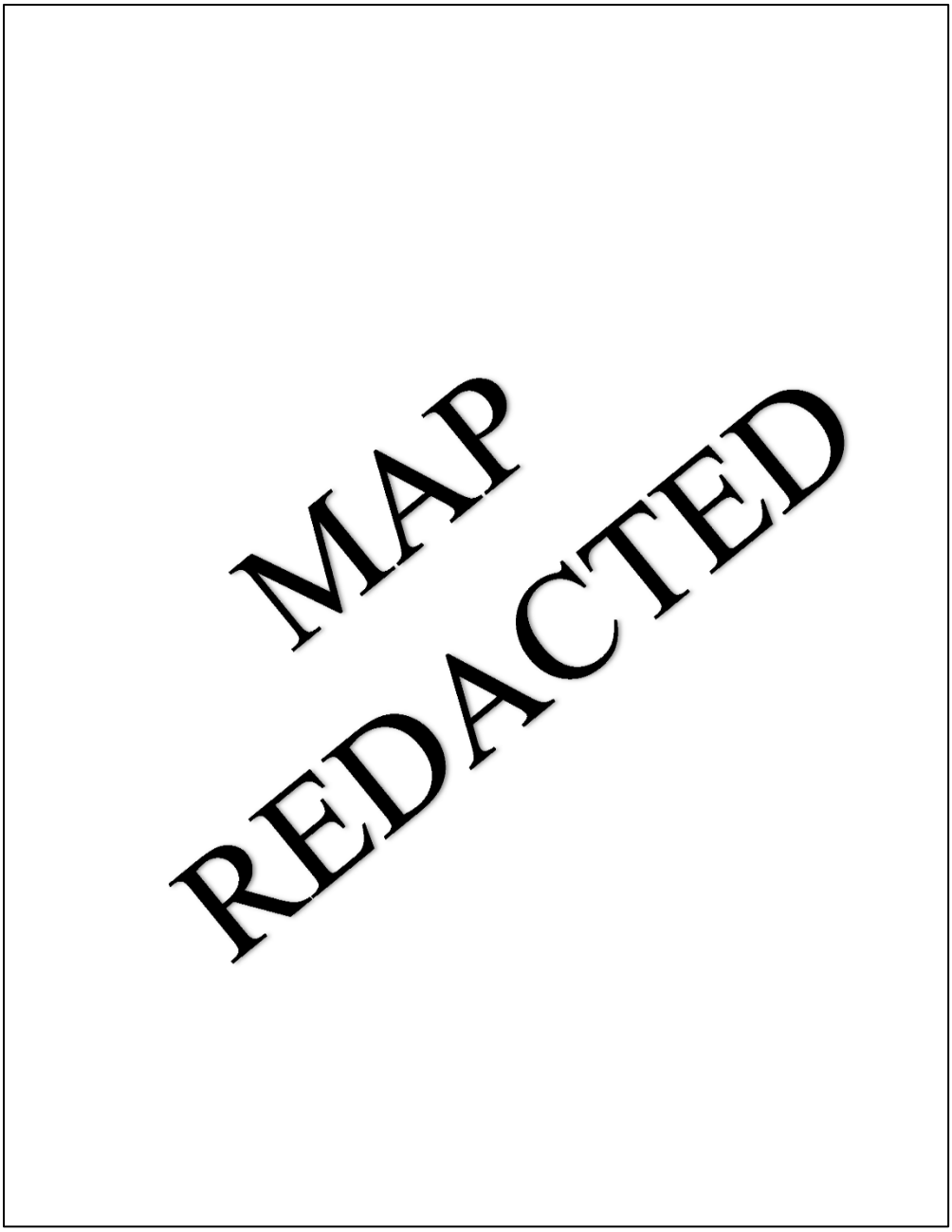


Figure 11.23. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Jepson Prairie Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

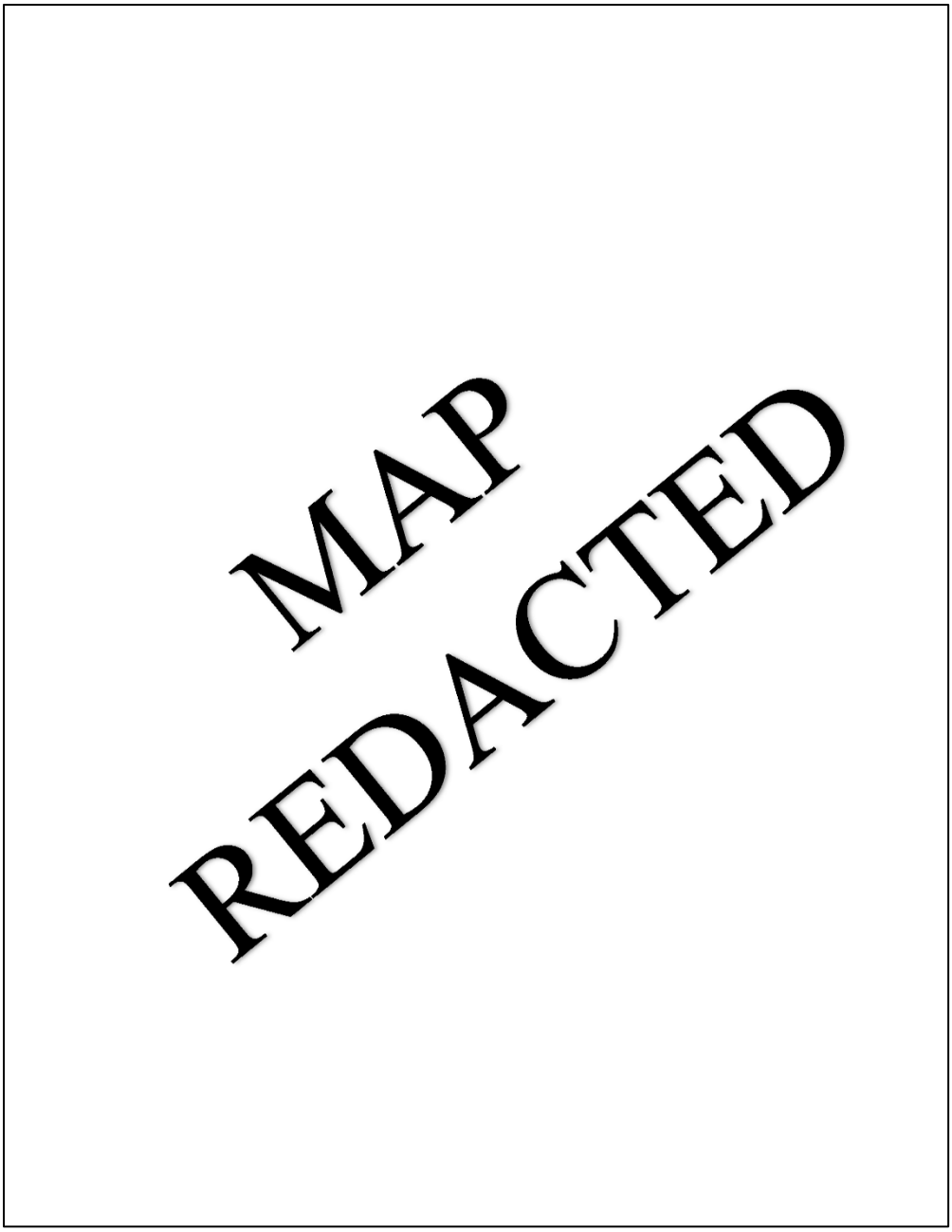


Figure 11.24. Map of known occurrences of Conservancy fairy shrimp recorded in the Diversity Database (2022) within the Jepson Prairie Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

11.7.4.3. Conservancy Fairy Shrimp Occurrences

There are 12 Diversity Database occurrence records for the Conservancy fairy shrimp within this core area (see **Figure 11.24**; Diversity Database 2022). As of 2018, all these occurrences were at least partially within protected areas (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database and are within extant mapped vernal pool grasslands (Witham 2021). The Conservancy fairy shrimp was first detected within this core area in 1979 in Olcott Lake; this is the largest vernal pool in California and the type locality for the Conservancy fairy shrimp (Diversity Database 2022). Of the 12 records, 1 was known at the time of listing in 1994 and 9 were known at the time the Recovery Plan was published in 2005; these records are located throughout the north of the core area and one in the southwest. The three newer records are located near older records, with two in the northeast within Burke Ranch Conservation Bank and one in the center within Muzzy Ranch Conservation Bank.

11.7.5. Sacramento National Wildlife Refuge

This is a zone 1 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and 95% of vernal pool habitat for the vernal pool tadpole shrimp and Conservancy fairy shrimp. The core area is located entirely within the Sacramento National Wildlife Refuge in Colusa and Glenn Counties.

Witham et al.'s (2013) mapping effort estimated that there were 1,530 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005, and as of 2018 no habitat losses were estimated to have occurred (see **Figure 11.25**, **Table 11.1**; Witham 2021). However, the Comprehensive Conservation Plan prepared for this Refuge in 2009 identified 2,941 acres of vernal pool complexes or alkali meadows within the Refuge (Service 2009b). All of these vernal pool grassland complexes are protected within the Sacramento National Wildlife Refuge (**Figure 11.26**).

11.7.5.1. Vernal Pool Fairy Shrimp Occurrences

There are two Diversity Database occurrence records for the vernal pool fairy shrimp within this core area, both of which are entirely protected within the Sacramento National Wildlife Refuge (see **Figure 11.27**; Diversity Database 2022). All occurrences are presumed extant by the Diversity Database; one is within extant mapped vernal pool grasslands and one is outside of mapped vernal pool grasslands (Witham 2021). A total of 11 years of vernal pool shrimp surveys have occurred on the Sacramento National Wildlife Refuge between 1993 and 2017 (D'Errico, *in litt*. 2022), though it is possible that not every pool was surveyed each year. The vernal pool fairy shrimp was definitively identified in one pool in 2004 and in six pools out of 45 sampled in 2017, all in the northeast of the Refuge (Helm Biological Consulting 2017; D'Errico, *in litt*. 2022). However, numerous pools throughout the Refuge were documented as having *Branchinecta* individuals that were not identified to the species level during surveys from 1993-1998; there are three other species of *Branchinecta* known within the Refuge, but it is likely that at least some of these occurrences represent the vernal pool fairy shrimp (see **Figure 11.28**; D'Errico, *in litt*. 2022).

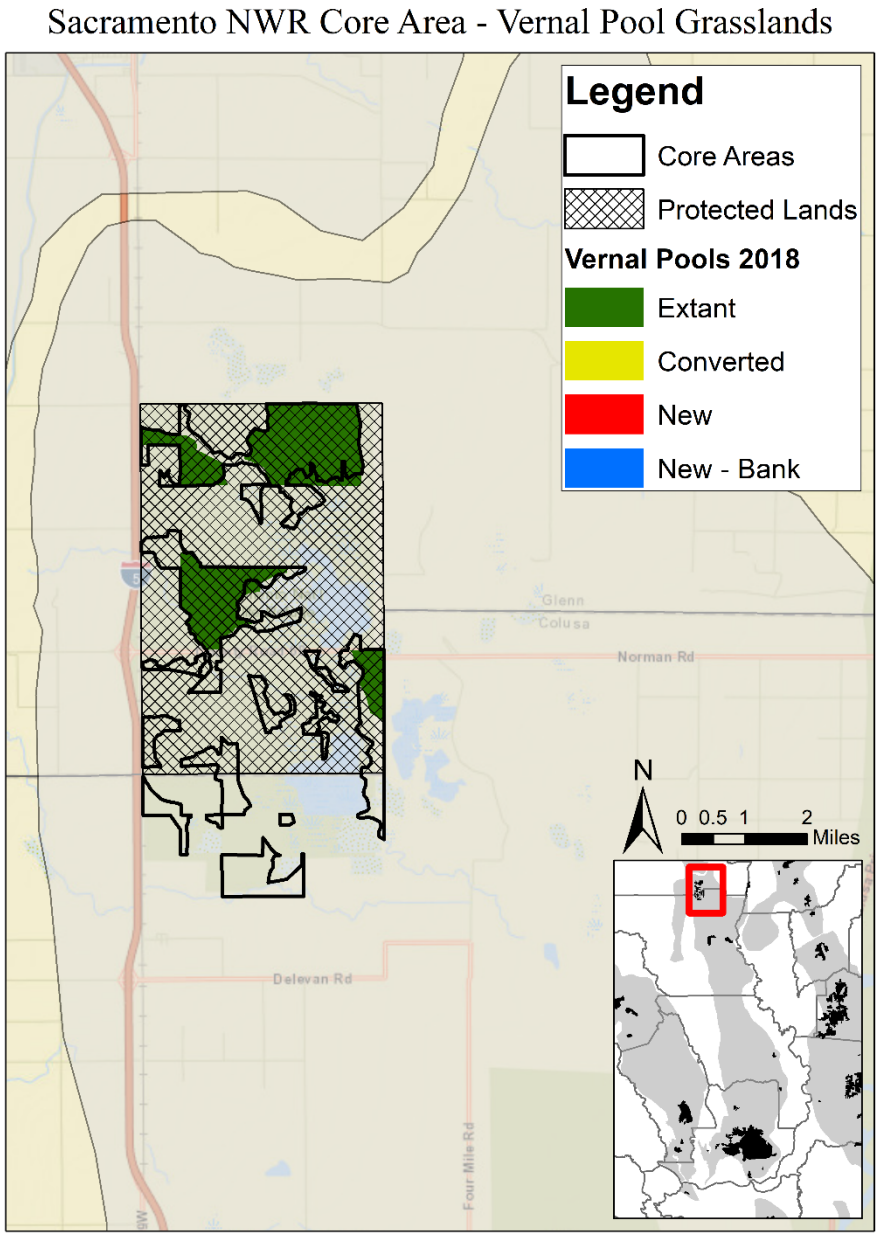


Figure 11.25. Map of vernal pool grassland habitat within the Sacramento National Wildlife Refuge (NWR) Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

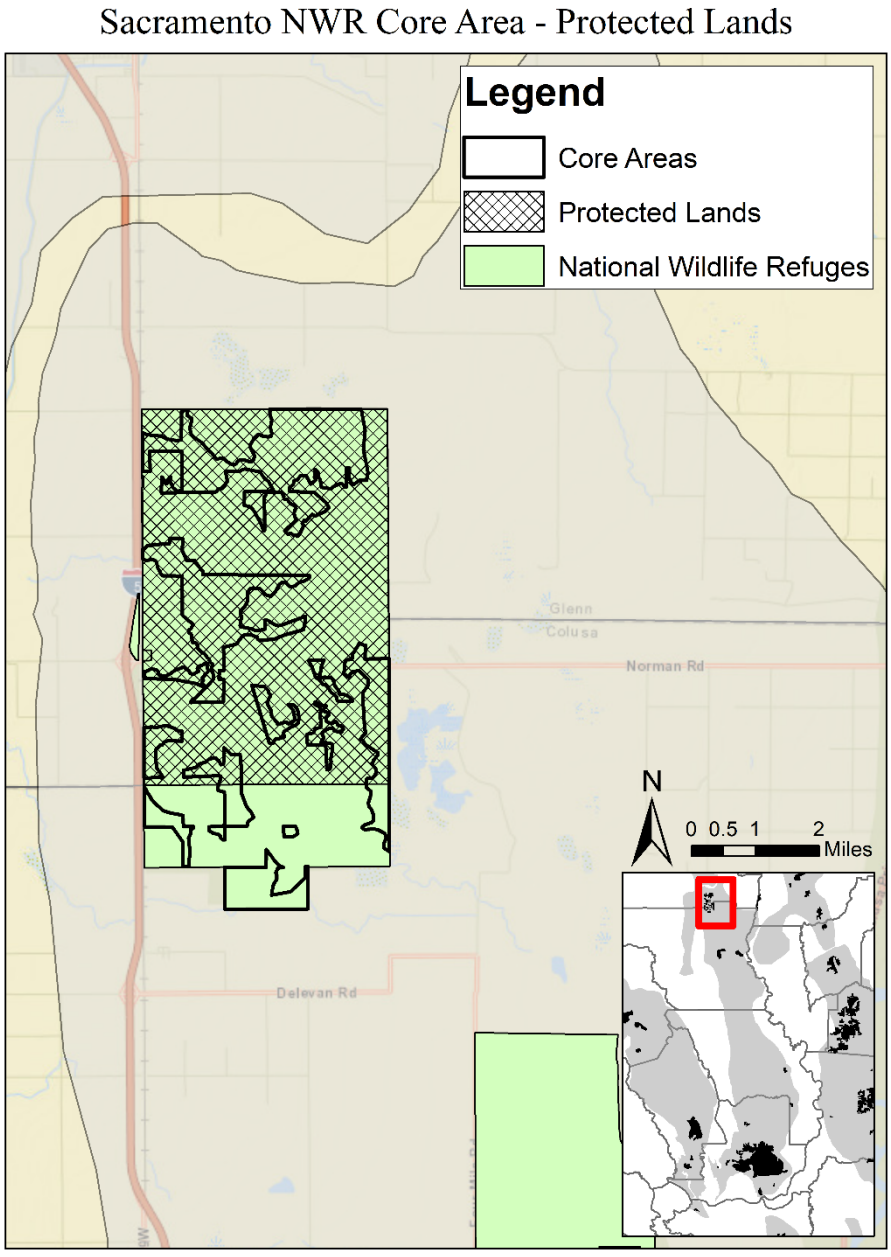


Figure 11.26. Map of protected areas within the Sacramento National Wildlife Refuge (NWR) Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves.

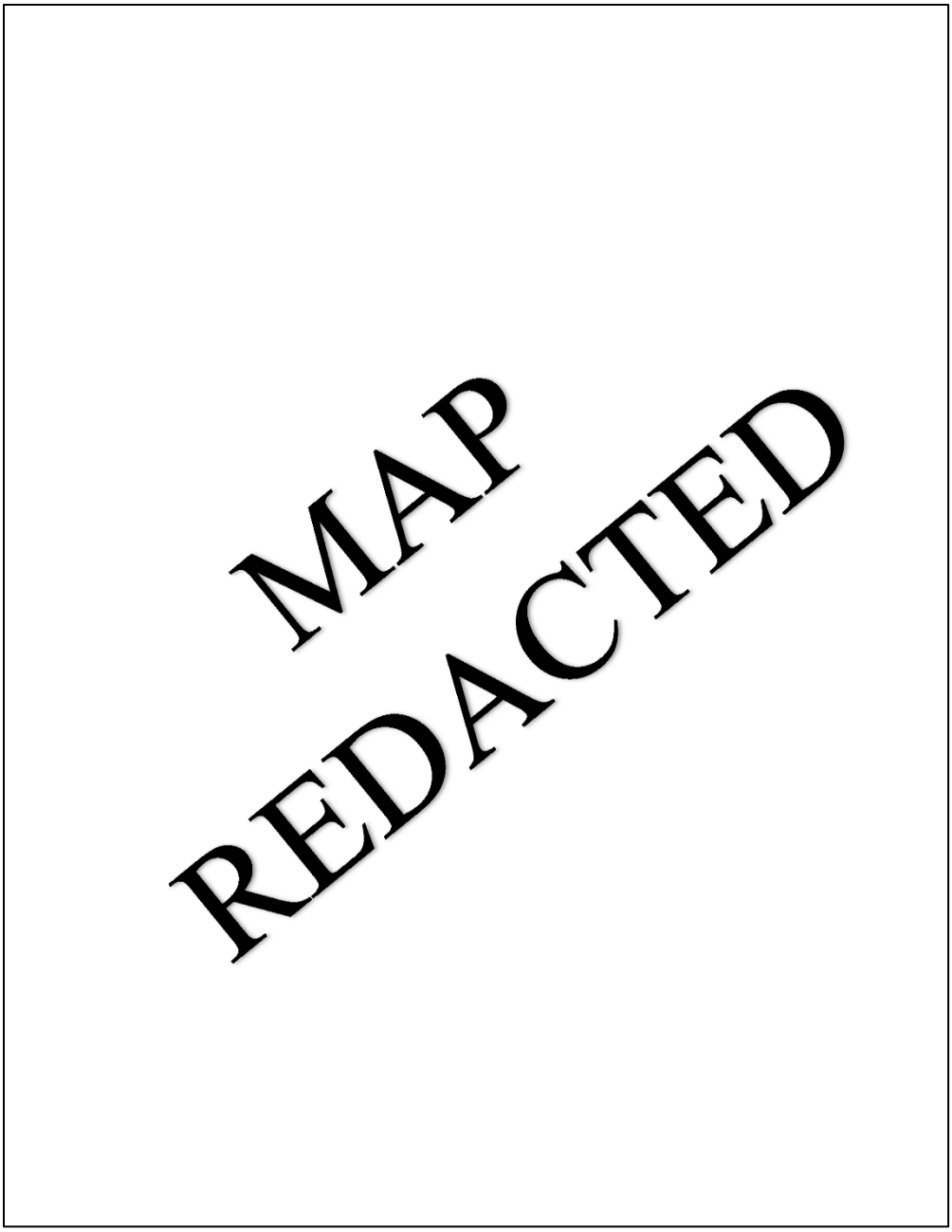


Figure 11.27. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Sacramento National Wildlife Refuge (NWR) Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

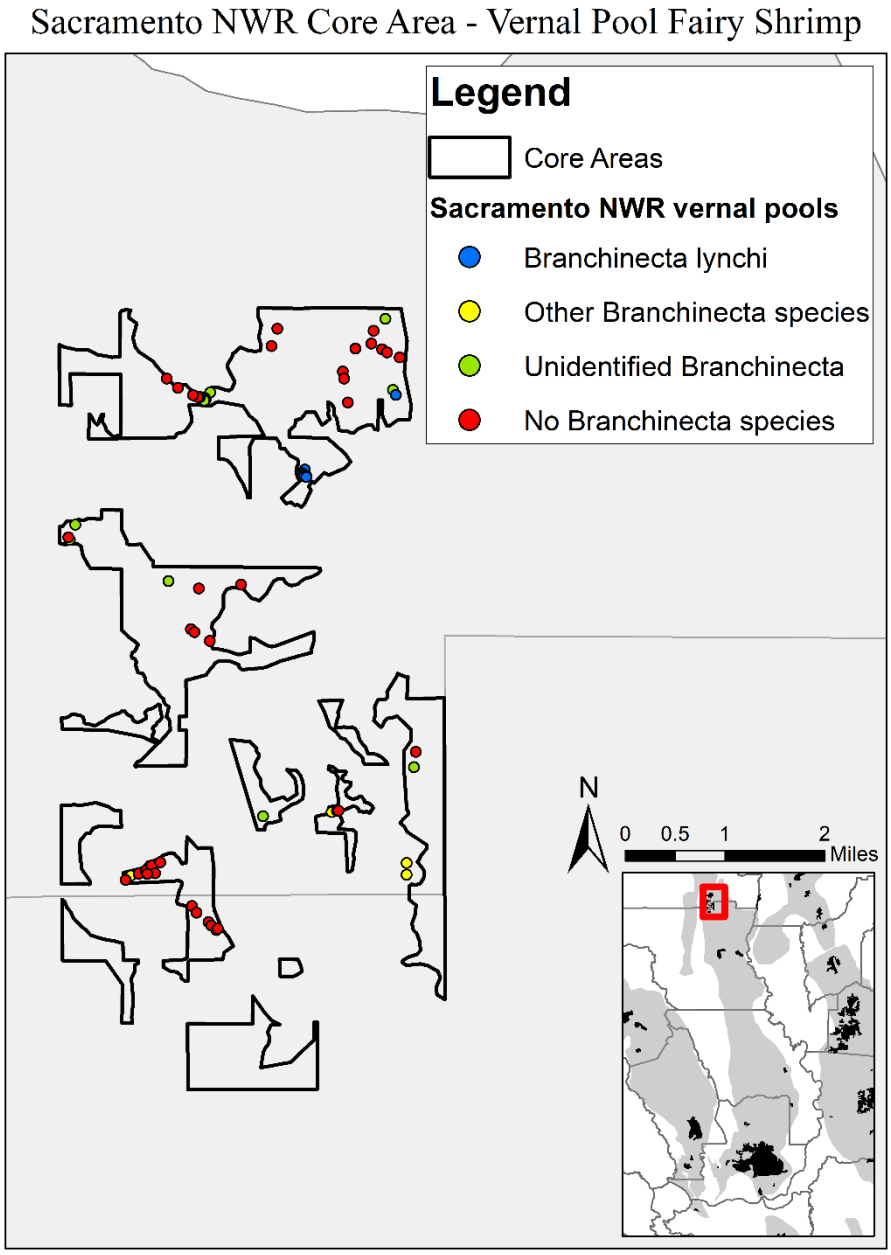


Figure 11.28. Map of known occurrences of vernal pool fairy shrimp (*Branchinecta lynchi*) and other *Branchinecta* species based on Sacramento National Wildlife Refuge (NWR) surveys from 1993 to 2017 (D'Errico, *in litt*. 2022). Pools where the vernal pool fairy shrimp has ever been definitively identified are in blue. Pools where the vernal pool fairy shrimp has not been definitively identified but where some surveys observed *Branchinecta* that were not identified to the species level are in green. Pools where only other *Branchinecta* species have been identified (with no unidentified records) are in yellow. Pools that have never contained any *Branchinecta* species are in red.

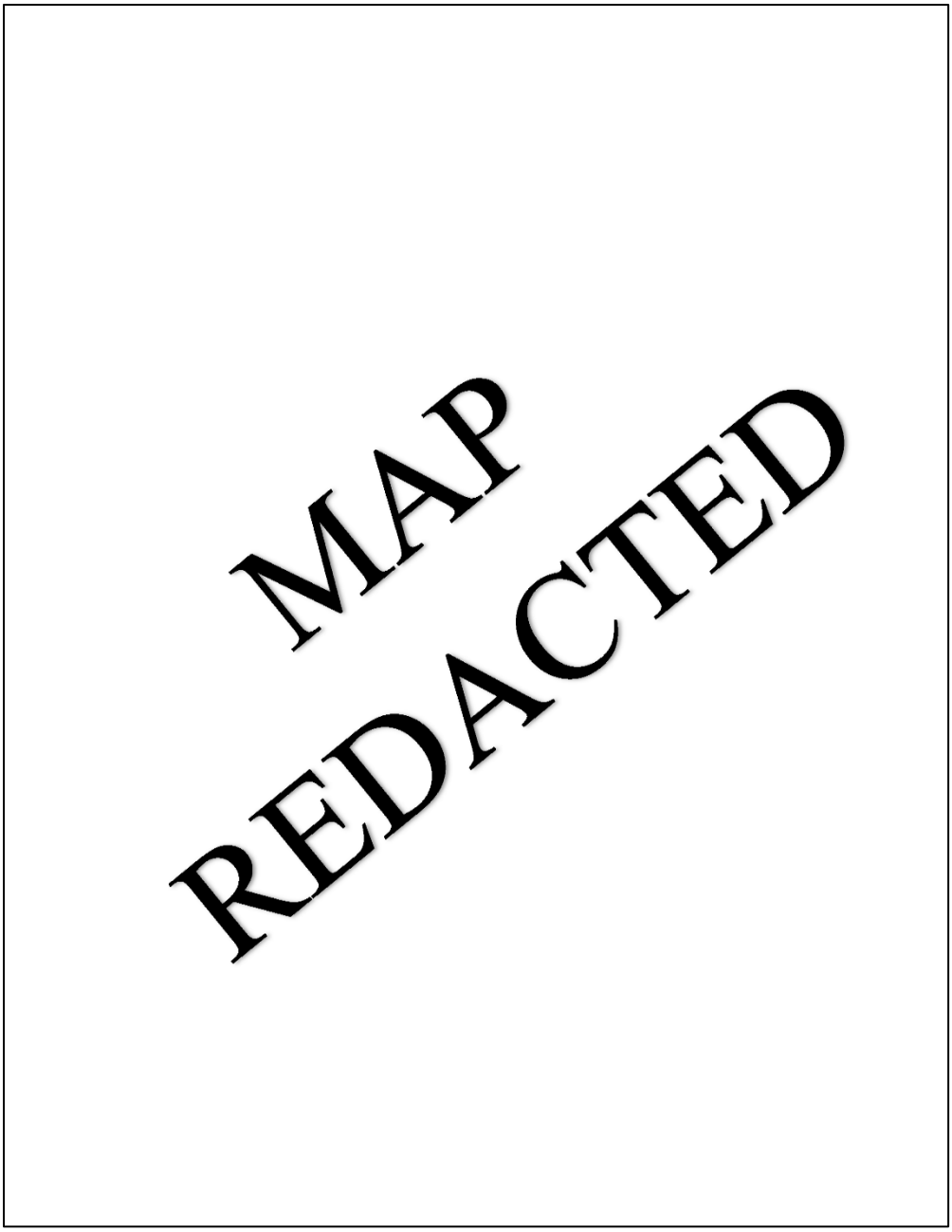


Figure 11.29. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Sacramento National Wildlife Refuge (NWR) Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

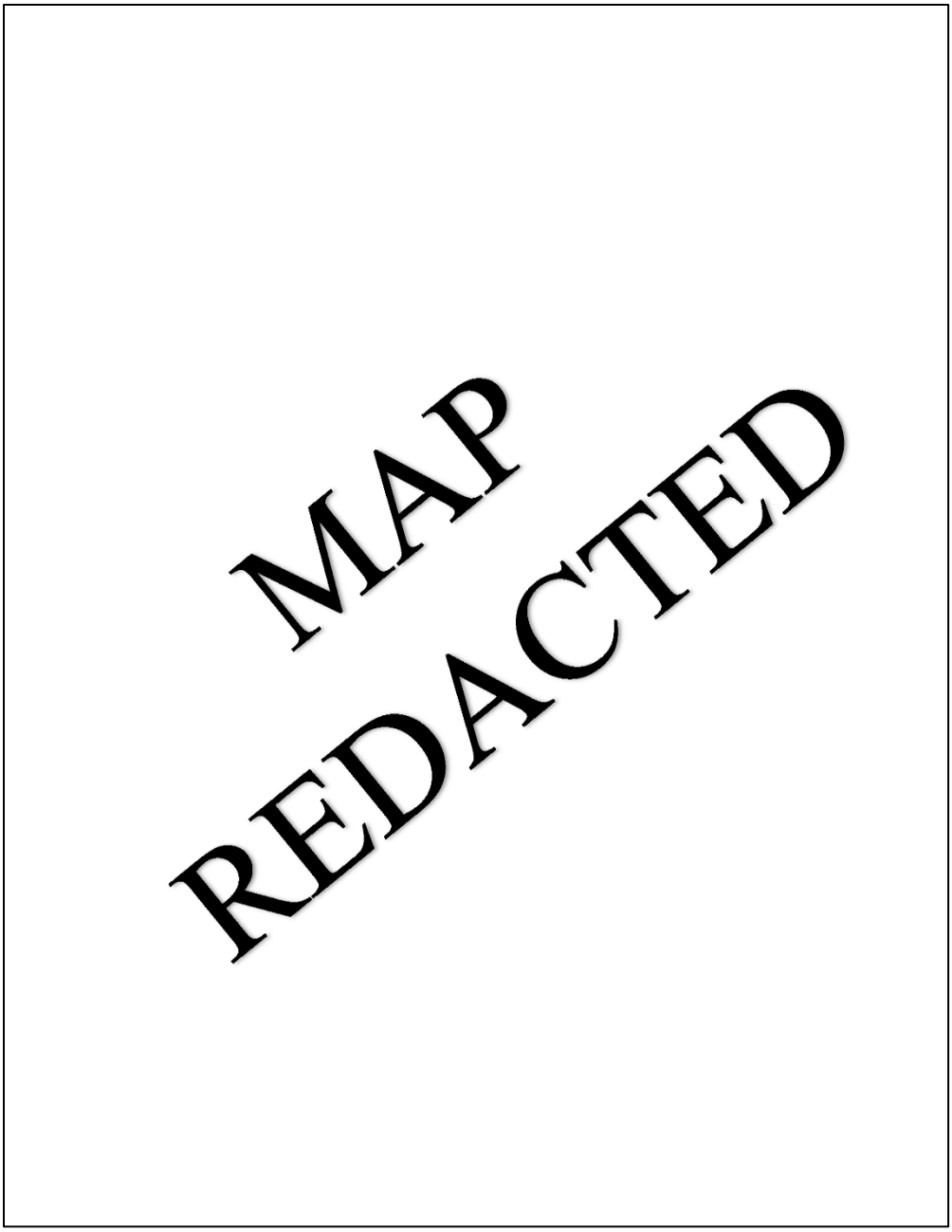


Figure 11.30. Map of known occurrences of Conservancy fairy shrimp recorded in the Diversity Database (2022) within the Sacramento National Wildlife Refuge (NWR) Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

11.7.5.2. Vernal Pool Tadpole Shrimp Occurrences

There are five Diversity Database occurrence records for the vernal pool tadpole shrimp within this core area, all of which are entirely protected within the Sacramento National Wildlife Refuge (see **Figure 11.29**; Diversity Database 2022). All occurrences are presumed extant by the Diversity Database; two are within extant mapped vernal pool grasslands and three are outside of mapped vernal pool grasslands (Witham 2021). A total of 11 years of vernal pool shrimp surveys have occurred on the Sacramento National Wildlife Refuge between 1993 and 2017 (D'Errico, *in litt*. 2022), though it is possible that not every pool was surveyed each year. The vernal pool tadpole shrimp was identified in 6 pools out of 45 sampled in 2017, located in the north, west, and south of the Refuge (Helm Biological Consulting 2017). The vernal pool tadpole shrimp had also previous been identified in two pools in the southeast in 1993, 1994, and 2002 (D'Errico, *in litt*. 2022). All of these pools line up with the locations of Diversity Database records within the Sacramento Refuge.

11.7.5.3. Conservancy Fairy Shrimp Occurrences

There is one Diversity Database occurrence records for the Conservancy fairy shrimp within this core area, which is entirely protected within the Sacramento National Wildlife Refuge (see **Figure 11.30**; Diversity Database 2022). The occurrence is presumed extant by the Diversity Database and is outside of mapped vernal pool grasslands (Witham 2021). A total of 11 years of vernal pool shrimp surveys have occurred on the Sacramento National Wildlife Refuge between 1993 and 2017 (D'Errico, *in litt*. 2022), though it is possible that not every pool was surveyed each year. The Conservancy fairy shrimp is known from just one pool in the southwest of the Refuge, where it was observed in 1993, 1994, and 2004 (D'Errico, *in litt*. 2022; Diversity Database 2022). This single pool represents the entirety of the Sacramento National Wildlife Refuge population.

11.7.6. Vacaville

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is located in the City of Vacaville in Solano County on either side of Interstate 505 near the intersection with Interstate 80.

Witham et al.'s (2013) mapping effort estimated that there were 164 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005, and as of 2018 no habitat losses were estimated to have occurred (see **Figure 11.31**, **Table 11.1**; Witham 2021). All of the vernal pool grasslands mapped by Witham (2021) are within protected lands, as the entire core area east of Interstate 505 is within the North Preserve unit of the Michael Remy Vernal Pool Preserve. However, any unmapped vernal pool grasslands that may exist west of Interstate 505 are not within protected lands, so the true percentage of the 2005 baseline that is protected may be closer to around 50%. No vernal pool shrimp species have been identified west of Interstate 505, but there is an occurrence record of bearded popcorn flower (*Plagiobothrys hystriculus*) that confirms that some vernal pool habitat not mapped by Witham (2021) does exist west of Interstate 505, at least as recently as 2016 (Diversity Database 2022).

The only protected land within this core area is the North Preserve unit of the Michael Remy Vernal Pool Preserve. This 220-acre preserve was protected in 2004 as mitigation for the surrounding North Village residential development project (CNLM 2022b), and the irregular shape of the core area east of Interstate 505 was designed to contain this preserve. The Center for Natural Lands Management (CNLM) holds the conservation easement and manages the preserve. Numerous vernal pools and non-vernal pool palustrine wetlands are scattered throughout the North Preserve, and 17.86 acres of seasonal wetlands have been created within the preserve (see **Figure 11.32**; CNLM 2022b). There are no protected lands in the portion of the core area west of Interstate 505.

11.7.6.1. Vernal Pool Fairy Shrimp Occurrences

There are three Diversity Database occurrence records for the vernal pool fairy shrimp within this core area; there is also one occurrence that very slightly overlaps the core area due to the large margin of error of the record, but it most likely does not occur within the core area (see **Figure 11.33**; Diversity Database 2022). As of 2018, all three occurrences were at least partially within protected areas (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database; two are within extant mapped vernal pool grasslands and one is outside of mapped vernal pool grasslands (Witham 2021). Of the three records in the core area, none were known at the time of listing in 1994 (though the nearby imprecise record was) and two were known at the time the Recovery Plan was published in 2005. The one newer record is located in the North Preserve unit of the Michael Remy Vernal Pool Preserve in the easternmost section of the core area. This confirms that the entire portion of the core area east of Interstate 505 is occupied by the vernal pool fairy shrimp. CNLM monitors 22 natural pools and 22 created pools on the North Preserve every 5 years; in 2021-2022, the vernal pool fairy shrimp was observed in 4 natural pools and 8 created pools (see **Figure 11.32**; CNLM 2022b). No vernal pool shrimp species have been identified west of Interstate 505, but there is an occurrence record of bearded popcorn flower (*Plagiobothrys hystriculus*) that confirms that some vernal pool habitat not mapped by Witham (2021) does exist west of Interstate 505, at least as recently as 2016 (Diversity Database 2022).

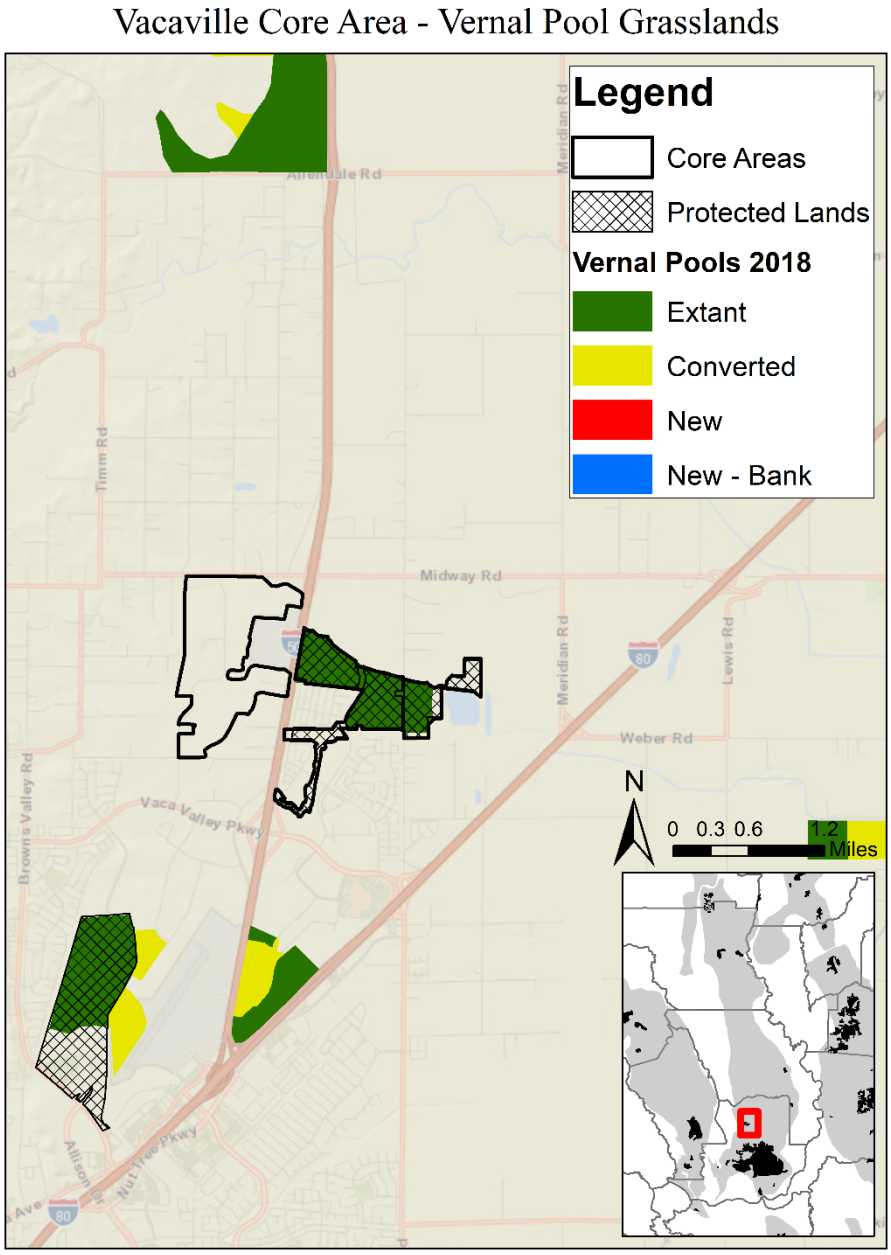


Figure 11.31. Map of vernal pool grassland habitat within the Vacaville Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

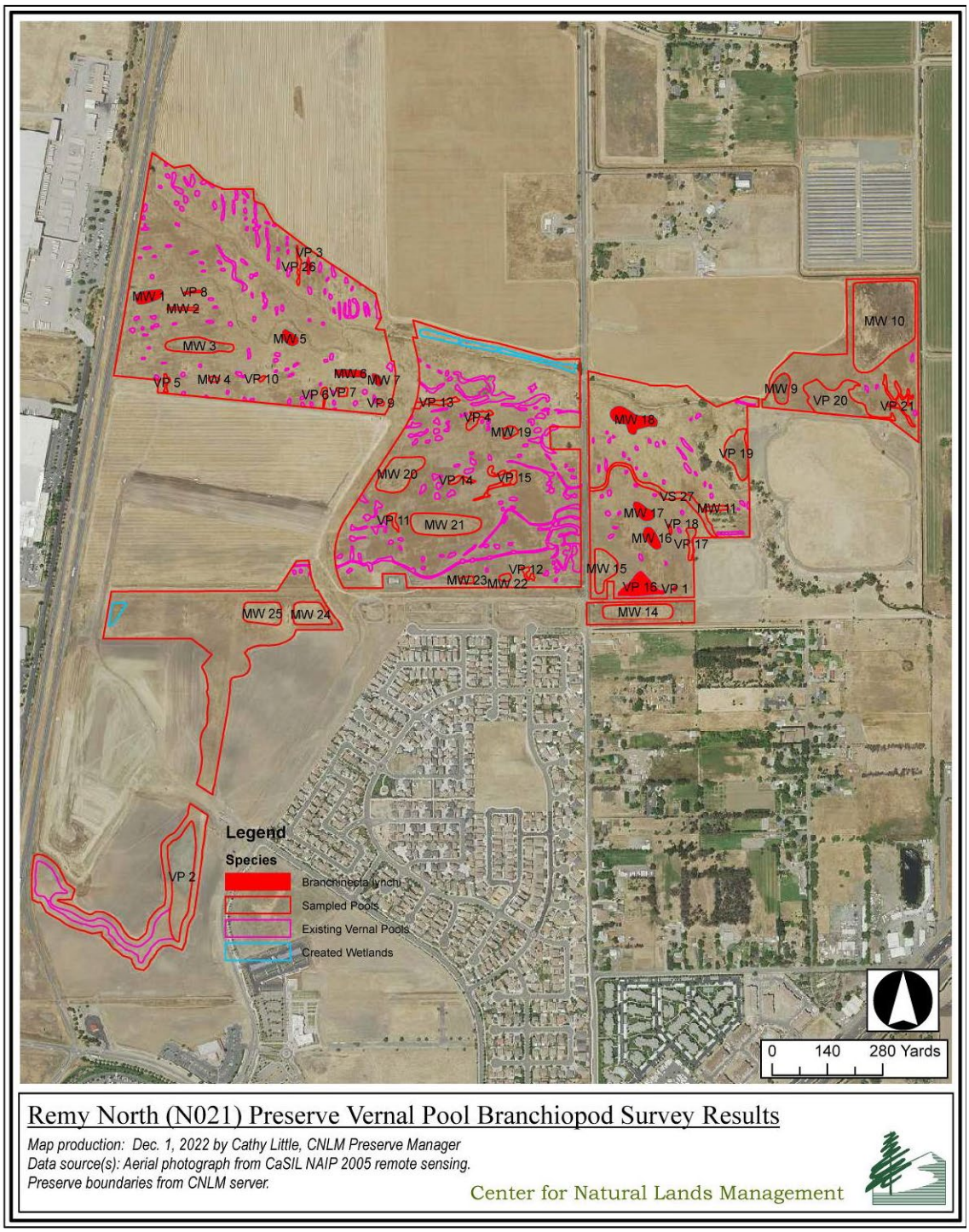


Figure 11.32. Map of natural vernal pools, existing vernal pools, and created wetlands within the North Preserve unit of the Michael Remy Vernal Pool Preserve in Vacaville, Solano County, including results of 2022 surveys for the vernal pool fairy shrimp. Taken from Figure 7 of the 2022 Annual Report for the preserve (CNLM 2022b).

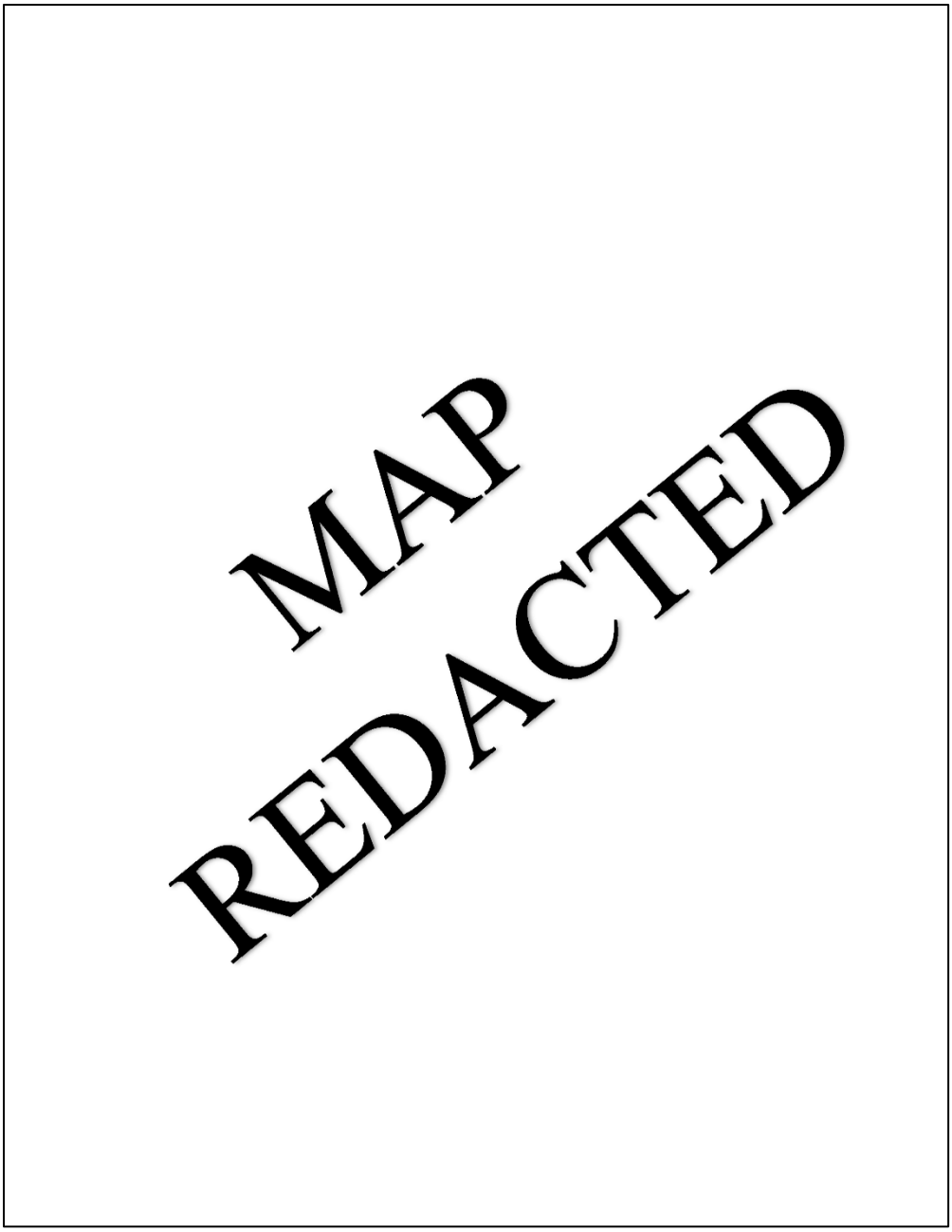


Figure 11.33. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Vacaville Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

11.7.7. Woodland

This is a zone 2 core area, but it was not designated for the vernal pool tadpole shrimp in the Recovery Plan. It was designated for alkali milk vetch (*Astragalus tener* var. *tener*) with a goal of protecting 85% of vernal pool habitat. The core area is located east of County Road 102 in the City of Woodland, Yolo County.

There were approximately 338 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were still 338 acres of vernal pool grassland remaining, with no habitat losses occurring since 2005 (see **Figure 11.34**, **Table 11.1**; Witham 2021). Roughly 188 acres of vernal pool grassland were protected within this core area as of 2017 within the Alkali Grasslands Preserve (Vollmar et al. 2017), representing 56% of the 2005 baseline.

There is one protected land within this core area: the Alkali Grasslands Preserve. This 180-acre preserve is located in the center of the core area on either side of County Road 25 and is composed of four units. The northern three units are owned by the City of Woodland and the southern unit is privately owned. These parcels were preserved as mitigation for several projects, and a conservation easement was recorded in 2005 (CNLM 2022c). The Center for Natural Lands Management (CNLM) is the easement holder and the land manager. The preserve is dominated by alkali grassland habitat intermixed with alkali scalds, meadows, pools, and swales, with nine pools mapped onsite (CNLM 2022c). Witham (2021) mapped the entire preserve as extant vernal pool grassland. Management on the preserve includes grazing, monitoring thatch levels, invasive species management, and various biotic surveys, primarily for rare plants (CNLM 2022c).

11.7.7.1. Vernal Pool Tadpole Shrimp Occurrences

There is one Diversity Database occurrence record for the vernal pool tadpole shrimp within this core area (see **Figure 11.35**; Diversity Database 2022). As of 2018, this occurrence was entirely protected within the Alkali Grasslands Preserve (Vollmar et al. 2017). The occurrence is presumed extant by the Diversity Database and is within extant vernal pool grasslands (Witham 2021). The vernal pool tadpole shrimp was first documented here in 2011 (Diversity Database 2022), after the Recovery Plan was published. Wet-season surveys are conducted on the preserve annually (CNLM 2022c), and the vernal pool tadpole shrimp was observed in most years that had sufficient ponding for the species, including 2011, 2012, 2013, 2016, and 2017 (CNLM, *in litt*. 2021b; Diversity Database 2022).

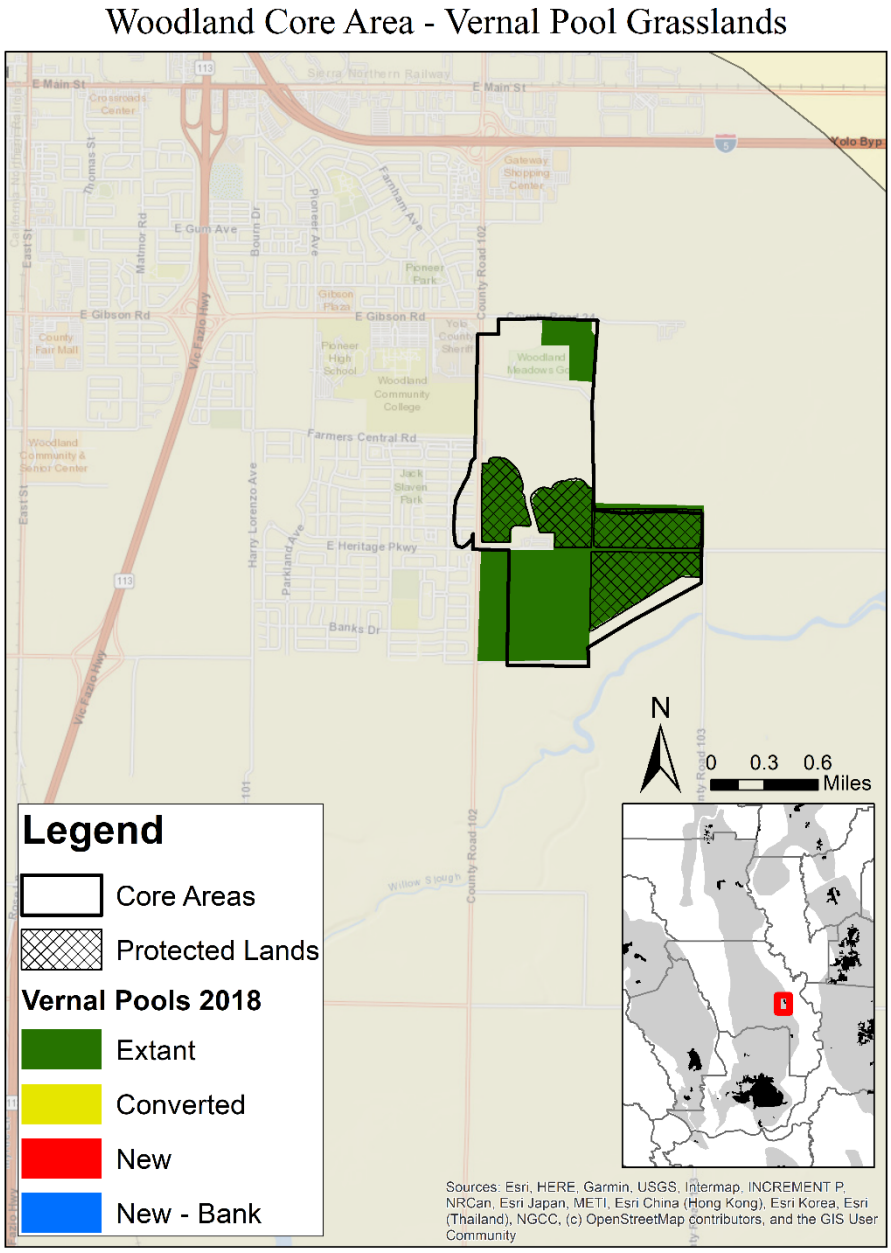


Figure 11.34. Map of vernal pool grassland habitat within the Woodland Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

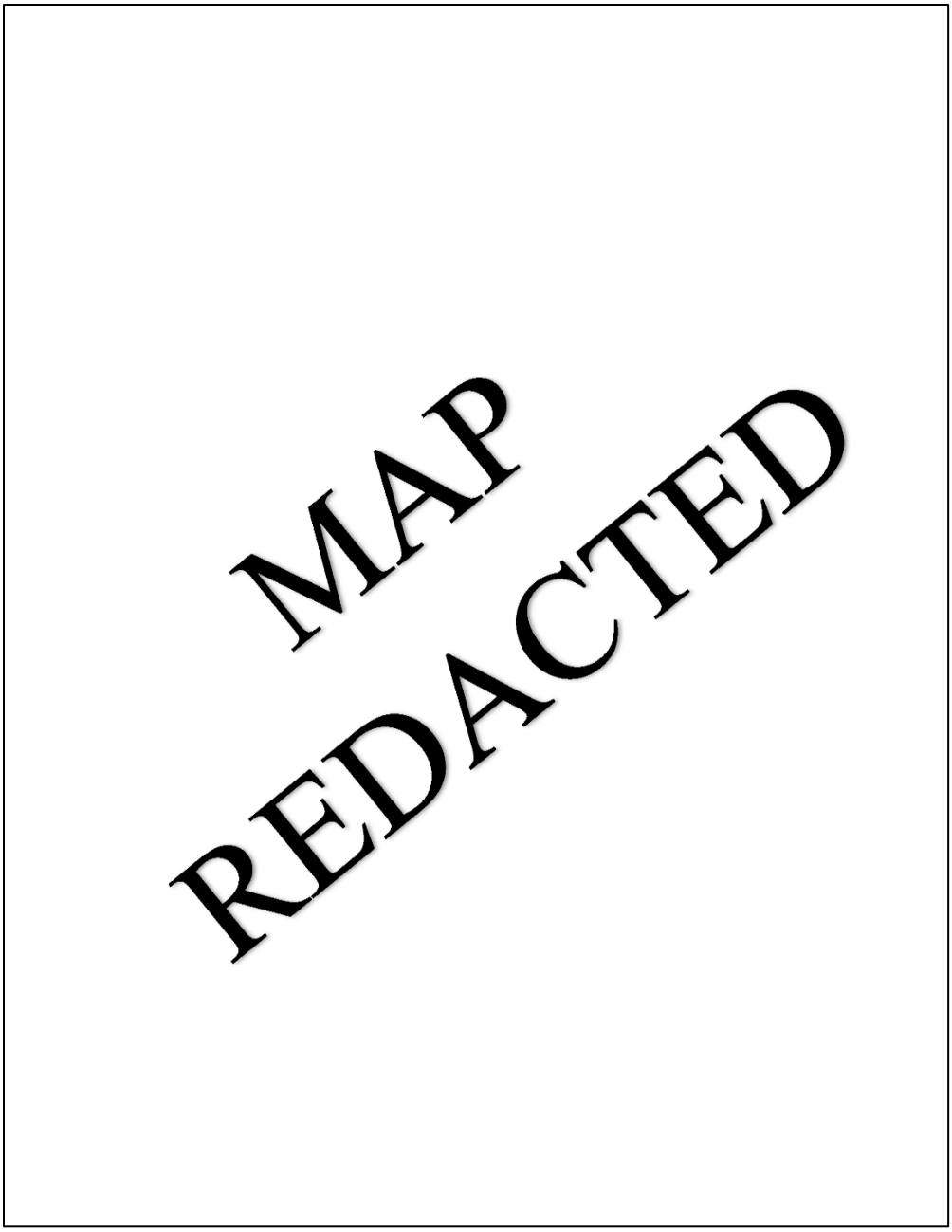


Figure 11.35. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Woodland Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

12. SOUTHEASTERN SACRAMENTO VALLEY VERNAL POOL REGION

All three shrimp species occur within the Southeastern Sacramento Valley Vernal Pool Region.

12.1. Vernal Pool Habitat

Approximately 136,688 acres of vernal pool grassland existed within, or immediately adjacent to, this region when the Recovery Plan was published in 2005 (see **Figure 12.1**, **Table 12.1**; Witham et al. 2013). Approximately 128,630 acres remained as of 2012, with 8,058 acres (5.9% of 2005 total) lost between 2005 and 2012 (Witham et al. 2014). However, 1,348 acres of new vernal pool grassland were created over that same period on vernal pool mitigation banks and other managed wetlands, and 354 additional acres were identified that were either not present or not visible on the 2005 aerial imagery. Of the habitat lost, 1,363 acres (16.9%) were to urbanization and 6,696 acres (83.1%) were to agricultural conversion (64.6% to bare plowed agricultural land, 15.9% to orchards, and 2.6% to other agricultural conversions) (Witham et al. 2014).

By 2018, approximately 122,790 acres of vernal pool grassland remained, with a total of 16,159 acres (11.8% of 2005 total) lost between 2005 and 2018 (see **Table 12.1**; Witham 2021). A total of 560 acres of new vernal pool grassland were identified in the 2018 aerial imagery: 396 acres on new mitigation banks created since 2012 and 164 acres that were either not present or not visible on both the 2005 and 2012 aerial imagery. Of the habitat lost since 2005, 2,976 acres (18.4%) were to urbanization and 13,184 acres (81.6%) were to agricultural conversion (38.1% to bare plowed agricultural land, 38.0% to orchards, and 5.5% to other agricultural conversions) (see **Table 12.2**; Witham 2021). Note that many patches of vernal pool grassland that had been converted to bare plowed land in 2012 had been fully converted to agricultural use, mainly orchards, by 2018.

Although agricultural land conversion was the main cause of vernal pool losses, this region exhibited the highest amount of losses to urbanization of any vernal pool region (Witham et al. 2014; Witham 2021). Placer and Sacramento Counties had the highest amount of vernal pool losses to urbanization from 2005 to 2012 (682 and 600 acres, respectively) and from 2005 to 2018 (1,842 and 933 acres, respectively). The Greater Sacramento area (the six-county area surrounding the city of Sacramento) had a population of approximately 2,578,590 in 2020 (SACOG 2022), up 11.3% from 2010. The population is expected to continue growing over the next 20 years, with a projected population of 2,996,832 in 2040 (16.2% increase over 20 years) (SACOG 2020), so urbanization will likely continue to be a significant cause of habitat loss for the three shrimp species within this region.

As of 2018, roughly 43,847 acres of vernal pool grassland was estimated to be protected in this region, or immediately adjacent to it, typically under a conservation easement (see **Figure 12.1**, **Figure 12.2**, **Table 12.1**; Witham 2021; Vollmar et al. 2017). This represents 36% of the currently remaining vernal pool grassland in the region and 32% of the vernal pool grassland that existed in the region in 2005, the Recovery Plan's baseline. More parcels of vernal pool grassland have been protected since 2018, such as preserves for the South Sacramento and Western Placer County Habitat Conservation Plans and private preserves such as the Rio del Oro Onsite Preserve and Cook Unit of the Sacramento Valley Vernal Pool Preserve.

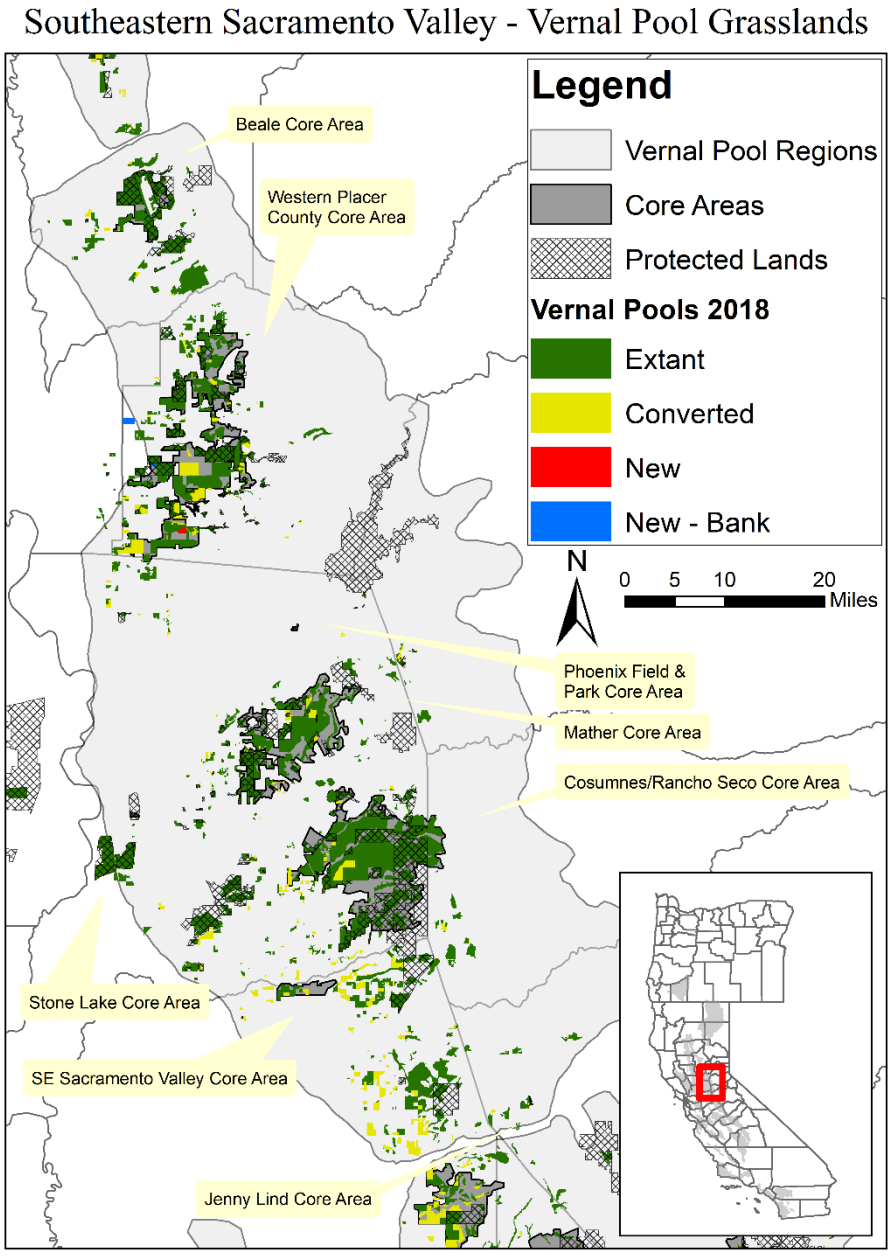


Figure 12.1. Map of vernal pool habitat within the Southeastern Sacramento Valley Vernal Pool Region mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

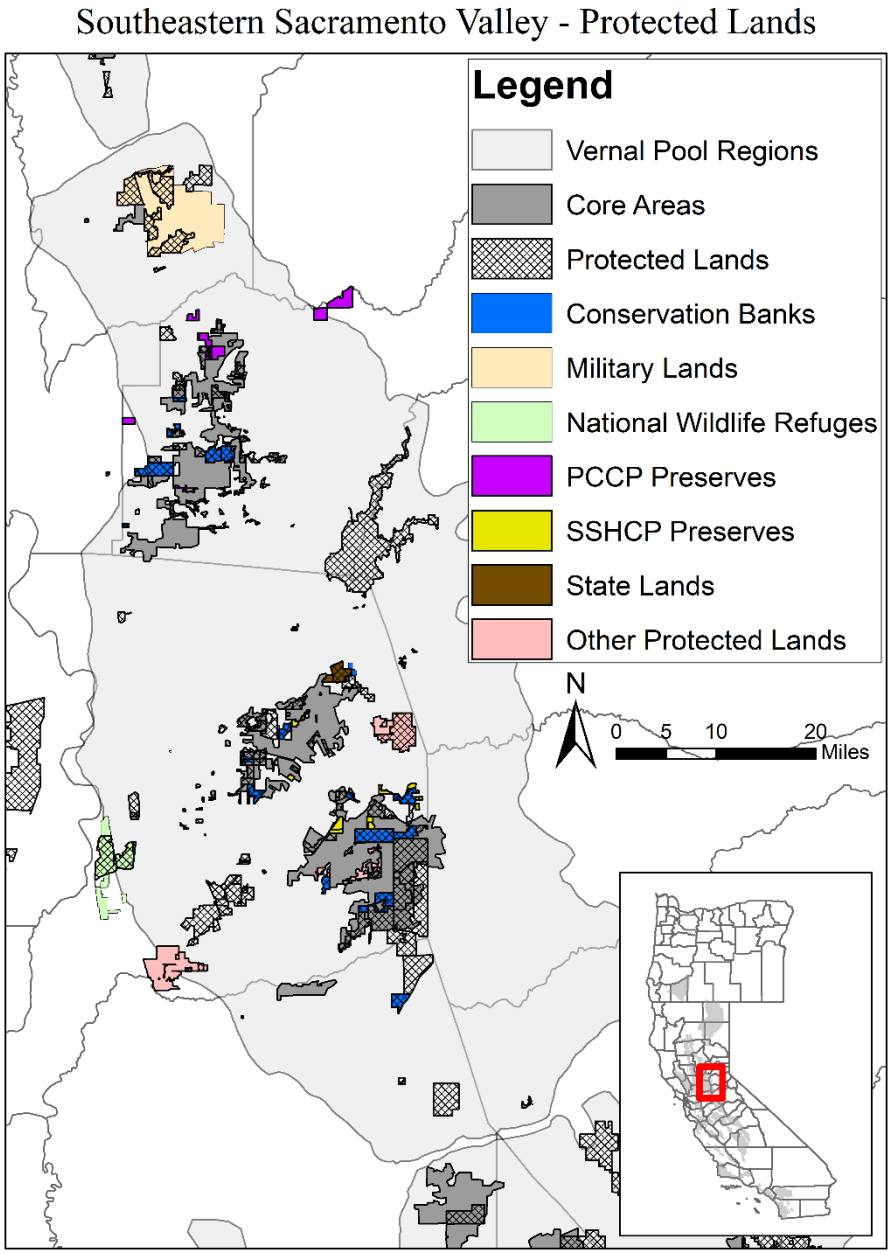


Figure 12.2. Map of protected areas that contain vernal pool grassland habitat and/or the three shrimp species within the Southeastern Sacramento Valley Vernal Pool Region**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. Zoom in for finer resolution.

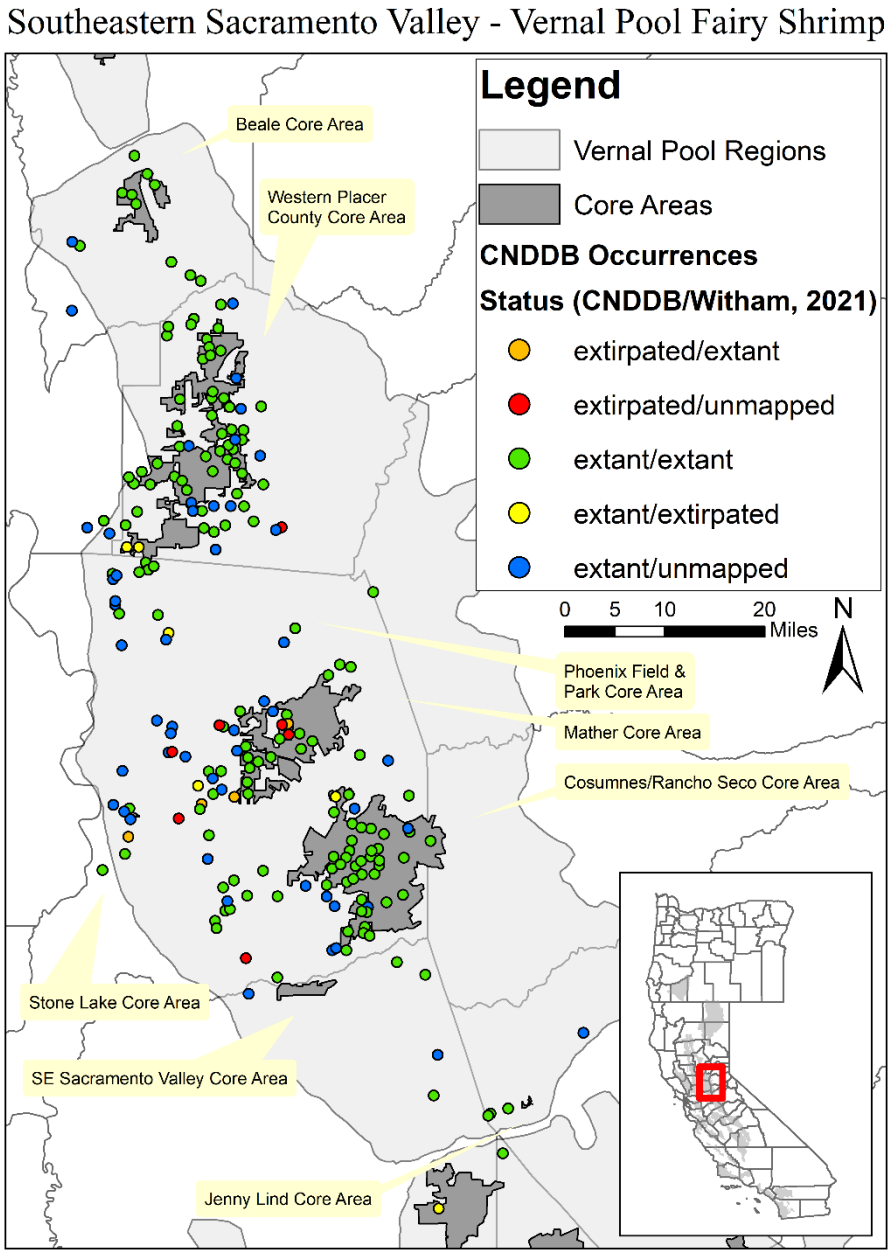


Figure 12.3. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) in the Southeastern Sacramento Valley Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both Diversity Database occurrence records and Witham's (2021) map of vernal pool habitat. All 8 core areas in the region are displayed, though not all core areas are designated for the vernal pool fairy shrimp.

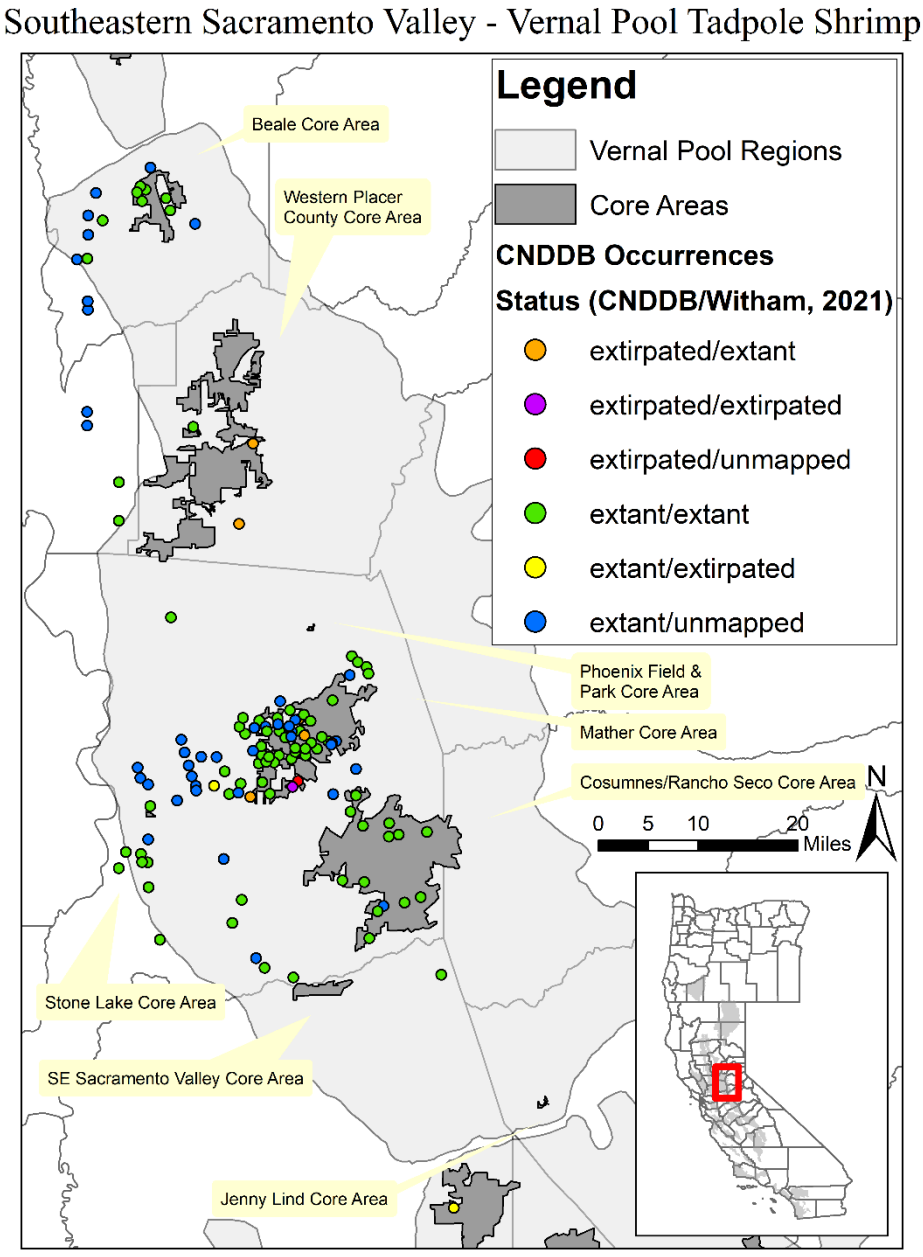


Figure 12.4. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) in the Southeastern Sacramento Valley Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both Diversity Database occurrence records and Witham's (2021) map of vernal pool habitat. All eight core areas in the region are displayed, though not all core areas are designated for the vernal pool tadpole shrimp.

Table 12.1. Acreage of vernal pool habitat and habitat converted within the Southeastern Sacramento Valley Vernal Pool Region mapped by Witham (2021). All habitat labeled as not converted, altered, or new was considered extant. Protected acreage is based on Vollmar et al. (2017).

Core Area	2005 Acres	2018 Acres Total	2018 Acres Extant (% of Total)	2018 Acres Converted – Agriculture (% of Total)	2018 Acres Converted – Urban Development (% of Total)	2018 Acres Protected (% of Total)
Beale	4,978.2	4,978.2	4,967.5 (99.8%)	10.7 (0.2%)	0.0 (0.0%)	3,541.4 (71.1%)
Cosumnes/Rancho Seco	30,748.5	31,188.6	30,020.6 (96.3%)	1,168.0 (3.7%)	0.0 (0.0%)	12,488.5 (40.0%)
Mather	14,036.6	14,052.0	13,330.9 (94.9%)	106.0 (0.8%)	615.0 (4.4%)	3,933.5 (28.0%)
Phoenix Field and Phoenix Park	17.7	17.7	17.7 (100.0%)	0.0 (0.0%)	0.0 (0.0%)	17.3 (97.7%)
Southeast Sacramento Valley	921.7	921.7	734.2 (79.7%)	187.5 (20.3%)	0.0 (0.0%)	0.0 (0.0%)
Stone Lake	60.7	60.7	60.7 (100.0%)	0.0 (0.0%)	0.0 (0.0%)	60.7 (100.0%)
Western Placer County	22,611.6	23,126.3	20,129.2 (87.0%)	1,981.5 (8.6%)	1,015.6 (4.4%)	6,742.4 (29.2%)
Southeastern Sacramento Valley Vernal Pool Region Total	**136,688.0**	**138,949.6**	**122,790.3 (88.4%)**	**13,183.7 (9.5%)**	**2,975.7 (2.1%)**	**43,847.0 (31.6%)**

Table 12.2. Acreage of vernal pool habitat losses within the Southeastern Sacramento Valley Vernal Pool Region between 2005 and 2018 mapped by Witham (2021), broken down by what the land use was converted to. All categories besides urban development and managed wetlands are considered agricultural conversions.

Core Area	Urban, Commercial, & Industrial	Orchards, Vineyards, Eucalyptus	Alfalfa and Irrigated Pasture	Bare Plowed Agricultural Lands	Other Ag (Rice, Row Crops, Dairy,	Agricultural Residential	Managed Wetlands	Total Losses	% Losses Urban Development	% Losses Agricultural Conversions
Beale	0.0	0.0	0.0	0.0	10.7	0.0	0.0	10.7	0.0%	100%
Cosumnes/Rancho Seco	0.0	233.3	0.0	918.9	0.0	15.8	0.0	1,168.0	0.0%	100%
Mather	615.0	65.5	0.0	1.7	0.0	38.9	0.0	721.1	85.3%	14.7%
Phoenix Field and Phoenix Park	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Southeast Sacramento Valley	0.0	0.0	106.8	80.6	0.0	0.0	0.0	187.5	0.0%	100%
Stone Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Western Placer County	1,015.6	37.8	0.0	1,943.7	0.0	0.1	0.0	2,997.1	33.9%	66.1%
Southeastern Sacramento Valley Vernal Pool Region Total	**2,975.7**	**6,138.7**	**546.2**	**6,150.3**	**182.7**	**165.7**	**0.0**	**16,159.4**	**18.4%**	**81.6%**

12.2. Species Occurrences

12.2.1. Vernal Pool Fairy Shrimp

There are 219 occurrence records of the vernal pool fairy shrimp documented within, or immediately adjacent to, the Southeastern Sacramento Valley Vernal Pool Region in the Diversity Database (see **Figure 12.3**; Diversity Database 2022). The vast majority of these occurrences are on privately owned land and are therefore vulnerable to extirpation, though there are a large number of preserves and conservation/mitigation banks in this region, many of which are privately owned. Of these 219 occurrences, 11 are listed by the Diversity Database as extirpated or possibly extirpated, and 5 are labeled by the Diversity Database as presumed extant but are completely within extirpated vernal pool habitat based on Witham's (2021) mapping efforts. Thus, there are a total of at least 16 extirpated occurrences. There are 59 occurrences that are outside of vernal pool habitat mapped by Witham (2021), 7 of which are listed as extirpated or possibly extirpated.

The protected areas contain, at least partially, 112 of the 219 Diversity Database records (51%) for the vernal pool fairy shrimp in this region. However, this does not mean that 51% of all occurrences of the vernal pool fairy shrimp in this region have been protected, as the Diversity Database is not an appropriate source for determining all known occurrences (individual Diversity Database records are not necessarily equivalent to occurrences, and some known occurrences may not be documented in the Diversity Database). Only 19 of the 219 Diversity Database polygons (9%) are entirely within the protected areas; the difference between the number of records partially and entirely within the mapped protected areas is likely a reflection of the irregular size and shape of polygons in the Diversity Database, as well as slight discrepancies in the overlap between the two databases.

12.2.2. Vernal Pool Tadpole Shrimp

There are 127 occurrence records of the vernal pool tadpole shrimp documented within, or immediately adjacent to, the Southeastern Sacramento Valley Vernal Pool Region in the Diversity Database (see **Figure 12.4**; Diversity Database 2022). The majority of these occurrences are on privately owned land and are therefore vulnerable to extirpation, though there are a large number of preserves and conservation/mitigation banks in this region, many of which are privately owned. Of these 127 occurrences, 8 are listed by the Diversity Database as extirpated or possibly extirpated, and 1 is labeled by the Diversity Database as presumed extant but is completely within extirpated vernal pool habitat based on Witham's (2021) mapping efforts. Thus, there are a total of at least nine extirpated occurrences. There are 76 presumed extant occurrences that are within extant mapped vernal pool habitat and 42 outside of vernal pool habitat mapped by Witham (2021).

The protected areas contain, at least partially, 63 of the 127 Diversity Database records (50%) for the vernal pool tadpole shrimp in this region. Only 17 of the 127 Diversity Database polygons (13%) are entirely within the protected areas; the difference between the number of records partially and entirely within the mapped protected areas is likely a reflection of the irregular size and shape of polygons in the Diversity Database, as well as slight discrepancies in the overlap between the two databases.

12.2.3. Conservancy Fairy Shrimp

The Conservancy fairy shrimp is only known from a single location in the Southeastern Sacramento Valley Vernal Pool Region: a single vernal pool within the Mariner Vernal Pool Conservation Bank, which makes up the entirety of the Mariner Ranch population (Diversity Database 2022). The Conservancy fairy shrimp was first identified at this site in 2007 and therefore the Recovery Plan (Service 2005) does not discuss the Conservancy fairy shrimp within this vernal pool region.

12.3. Federal Lands

12.3.1. National Wildlife Refuges

There is one National Wildlife Refuge with known occurrences of the vernal pool fairy shrimp within the Southeastern Sacramento Valley Vernal Pool Region: Stone Lakes National Wildlife Refuge (**Figure 12.2**). The Refuge completed a Comprehensive Conservation Plan in 2007, which covered the vernal pool fairy shrimp and included the objective to annually maintain 136 acres of vernal pools (Service 2007c). The vast majority of vernal pools within the Refuge can be found on the 1,400-acre Wetland Preserve Unit, with the rest on the North Stone Lake and Beach Lake Units. The Wetland Preserve Unit is owned in fee title by AKT Development Corporation and managed by the Refuge under a conservation easement (Service 2007c). Only 12% of the vernal pools on the Refuge are naturally occurring; the remainder were created, starting in 1993, as mitigation by AKT for vernal pool losses due to development. Vernal pool fairy shrimp and vernal pool tadpole shrimp have been found throughout the Wetland Preserve Unit (Service 2007c), as well as on a few vernal pools and other wetland features in the North Stone Lake Unit (B. Treiterer and B. McDermott, Service, *in litt*. 2021). The vernal pools created by AKT were monitored for five years after mitigation was completed, but have not been monitored regularly since (B. Treiterer, Service, *in litt*. 2022). The Service did attend a site visit to the Wetland Preserve Unit on January 21, 2022, with Dr. Shannon Kieran and Anderson Tate-Montenegro of UC Davis who were testing eDNA survey protocols; the vernal pool fairy shrimp and vernal pool tadpole shrimp were observed in a few pools during dipnetting (I. Perkins-Taylor and E. Bickerstaff, Service, pers. comm. 2022), and the Service has not yet received the eDNA results. This is the only known monitoring of the Wetland Preserve Unit since the Refuge's Comprehensive Conservation Plan was completed in 2007 (Treiterer, *in litt*. 2022). The most recent survey of vernal pools on the North Stone Lake Unit occurred in February-March 2009; the vernal pool fairy shrimp was identified in seven pools and the vernal pool tadpole shrimp was identified in four pools (Treiterer and McDermott, *in litt*. 2021).

12.3.2. Military Lands

There are two Department of Defense (DOD) installations in the Southeastern Sacramento Valley Vernal Pool Region with known occurrences of the vernal pool fairy shrimp and vernal pool tadpole shrimp: Beale Air Force Base (AFB) in Yuba County and the Navy Operational Support Center in the City of Sacramento (**Figure 12.2**). In addition, the vernal pool fairy shrimp and vernal pool tadpole shrimp are known from the former McClellan AFB in Sacramento County, which closed in 2003 and is now the privately owned McClellan Park neighborhood. Within the McClellan Park neighborhood there were at least 267 acres of vernal pool grassland

remaining in 2018 out of 339 acres that were extant as of 2005 (Witham 2021), but these vernal pool grasslands no longer have the protections afforded by the Department of Defense to natural resources on military lands.

Within Beale AFB, vernal pools cover approximately 1,380 acres on the western, central, and southern portions of the base. Vernal pool fairy shrimp were first detected in 1992 and have been consistently detected in all surveys through 2018 (DOD 2019). However, in the most recent wet season survey for winter 2020-2021, no vernal pool fairy shrimp or vernal pool tadpole shrimp were detected; this is likely because rainfall was only 37% of average and 63% of the 138 sampled vernal pools never filled during the survey period (H.T. Harvey and Associates 2021). Two restoration sites (510 acres and 156 acres) and one preservation site (257 acres) have been designated as Conservation Areas on Beale AFB, preserving 923 acres of vernal pool grassland as long as the Department of Defense continues to manage the land. There are 35 acres of man-made vernal pools at the two restoration sites on the base. Vernal pool monitoring has occurred annually since 2004 for plant and animal species, restoration/mitigation effectiveness, and other physical attributes. Beale AFB's Integrated Natural Resource Management Plan was finalized in 2019 and includes the vernal pool fairy shrimp and vernal pool tadpole shrimp (DOD 2019). The Management Plan's performance standard for the two shrimp species is to maintain or increase the populations on Beale AFB in alignment with the Recovery Plan; this will be achieved through monitoring and appropriate habitat management, including grazing and invasive plant control (DOD 2019). The vernal pool tadpole shrimp was also observed in 1997 and 2013 on the 235-acre Lincoln Receiver Site, a geographically separated unit (GSU) operated by Beale AFB in Placer County (DOD 2019). The entire site is mapped as extant vernal pool grassland (Witham 2021) and the same performance standards and management apply to this site as for Beale AFB (DOD 2019).

The Navy Operational Support Center in Sacramento is a 13.6-acre installation that is located within the former Sacramento Army Depot; the Sacramento Army Depot was closed in and most land was transferred to the city in 1995. There are 0.48 acres of vernal pools on site. An Integrated Natural Resource Management Plan was finalized in 2015 and includes the vernal pool fairy shrimp and vernal pool tadpole shrimp (DOD 2015b). The two shrimp species were not found during protocol-level wet season surveys conducted in 2012-2013 and thus were not known to occur within the Navy Operational Support Center at the time the Management Plan was finalized in 2015. However, the two shrimp species are known to occur immediately adjacent to the site to the south (Diversity Database 2022). One of the Management Plan's objectives was to conserve and monitor potential shrimp habitat within the installation. Specific measures included conducting surveys following accepted protocols and, if the vernal pool fairy shrimp or vernal pool tadpole shrimp are found, evaluating proposed projects for their likelihood to threaten or disturb habitat in order to avoid impacts. Since 2015, the vernal pool fairy shrimp has been found during surveys in 2018 and 2021; despite the drought in 2021, vernal pool fairy shrimp were identified in a pool that contained only 1 inch of water (Vollmar Natural Lands Consulting 2021). However, the vernal pools onsite are likely too shallow and too flashy to support the vernal pool tadpole shrimp.

12.3.3. Bureau of Land Management

There are no Bureau of Land Management lands with known occurrences of the three shrimp species in the Southeastern Sacramento Valley Vernal Pool Region.

12.3.4. Other Federal Lands

There are no other federal lands with known occurrences of the three shrimp species in the Southeastern Sacramento Valley Vernal Pool Region.

12.4. Conservation Banks

This region has the greatest number and total acreage of banks with vernal pool species credits, though it is second or third in terms of the number of vernal pool fairy shrimp and vernal pool tadpole shrimp preservation credits, respectively (acreage of the pools only, not the grassland complex). This region is one of only three regions with creation credits for the vernal pool fairy shrimp and vernal pool tadpole shrimp and it has the vast majority, though other regions may have artificial vernal pools created outside of banks.

There are 17 conservation or mitigation banks within the Southeastern Sacramento Valley Vernal Pool Region that provide credits for preserved and created vernal pools that support the vernal pool fairy shrimp: Antonio Mountain Ranch, Arroyo Seco, Bryte Ranch, Clay Station, Fitzgerald Ranch, Gill Ranch, Laguna Creek, Laguna Terrace East, Locust Road, Mariner Ranch, Orchard Creek, SMUD Nature Preserve, Sunrise Douglas, Toad Hill Ranch, Van Vleck Ranch, Western Placer Schools, and White Rock Road Properties – Scott Road (see **Figure 12.2**; RIBITS 2021). These banks protect a total of 10,897 acres of land, including 790.7 acres of preserved vernal pools and 212.1 acres of created vernal pools for the vernal pool fairy shrimp (Table 6). Four of the 17 banks are completely sold out of credits, and the 17 banks have sold a total of 616.9 acres (78%) of preservation credits and 153.1 acres (72%) of creation credits for the vernal pool fairy shrimp (RIBITS 2021).

There are 11 conservation or mitigation banks within the Southeastern Sacramento Valley Vernal Pool Region that provide credits for preserved and created vernal pools that support the vernal pool tadpole shrimp: Arroyo Seco, Bryte Ranch, Clay Station, Gill Ranch, Laguna Creek, SMUD Nature Preserve, Sunrise Douglas, Toad Hill Ranch, Van Vleck Ranch, Western Placer Schools, and White Rock Road Properties – Scott Road (see **Figure 12.2**; RIBITS 2021). These banks protect a total of 8,228 acres of land, including 507.3 acres of preserved vernal pools and 169.1 acres of created vernal pools for the vernal pool tadpole shrimp (Table 6). Two of the 11 banks are completely sold out of credits, and the 11 banks have sold a total of 385.2 acres (76%) of preservation credits and 132.8 acres (79%) of creation credits for the vernal pool tadpole shrimp (RIBITS 2021).

The Mariner Vernal Pool Conservation Bank (a.k.a., Mariner Ranch) contains the only known occurrence of the Conservancy fairy shrimp in the Southeastern Sacramento Valley Vernal Pool Region. This 160-acre bank is located in western Placer County, adjacent to the 531-acre Rockwell Ranch Vernal Pool Preserve, and contains approximately 374 vernal pools and associated swales that total 25.63 wetted acres (Westervelt Ecological Services 2023). This bank only provides credits for the vernal pool fairy shrimp and has been sold out and closed since

2018 (RIBITS 2021; Westervelt Ecological Services 2023). Aquatic invertebrate monitoring occurs every five years in a subset of the vernal pools. A single male Conservancy fairy shrimp was first identified on the bank in 2007 in a single vernal pool. The species was observed again during targeted surveys in 2008 and 2011 in the same pool (Helm Biological Consulting 2011). The vernal pool fairy shrimp was also found in the pool during these targeted surveys, but the two species appeared to be segregated spatially within the pool; this segregation did not appear to be due to differences in topography, vegetation, or turbidity (Helm Biological Consulting 2011). Regular monitoring of the subset of vernal pools in 2012 and 2017 again identified the Conservancy fairy shrimp in the same vernal pool, though the species was not identified in 2022 (Westervelt Ecological Services 2013; Westervelt Ecological Services 2018; Westervelt Ecological Services 2023).

12.5. Habitat Conservation Plans

There are six regional Habitat Conservation Plans (HCPs) within the Southeastern Sacramento Valley Vernal Pool Region that include the vernal pool fairy shrimp and vernal pool tadpole shrimp as Covered Species (**Figure 12.5**). Three of these HCPs also include the Conservancy fairy shrimp as a Covered Species.

12.5.1. Natomas Basin HCP

The Natomas Basin HCP covers the 53,537-acre area inside the system of levees surrounding the Natomas Basin in northern Sacramento County and southern Sutter County, and is partially within the vernal pool region (NBHCP 2002). This HCP was permitted in 2003 and has a 50-year permit term, and the permittees are the City of Sacramento, Sutter County, The Natomas Basin Conservancy, Reclamation District 1000, and Natomas Central Mutual Water Company. The purpose of the HCP is to promote biological conservation in conjunction with economic and urban development by creating a multi-species conservation program to minimize and mitigate the expected loss of habitat values and incidental take of Covered Species that could result from urban development, operation and maintenance of irrigation and drainage systems, and certain management activities associated with the reserve system. The HCP's Operating Conservation Program will result in 8,750 acres of Mitigation Lands to be preserved in perpetuity.

As of 2018, there was only a small amount of vernal pool grassland on the eastern edge of the HCP area (Witham 2021). However, pre-construction surveys for past City of Sacramento projects in the area have identified small, isolated vernal pools (NBHCP 2002). There are no known natural occurrences of the vernal pool fairy shrimp or vernal pool tadpole shrimp within the HCP area, though there are several immediately outside of the eastern boundary, and there is one occurrence from a man-made pool surrounded by industrial and agricultural land uses (Diversity Database 2022). The HCP requires that pre-construction surveys be conducted to identify any vernal pools within a project area. If vernal pools are present then the project will either avoid and dedicate the land for an onsite preserve or mitigate for vernal pool losses by purchasing credits at a conservation bank. To date there have been no impacts to the vernal pool fairy shrimp or vernal pool tadpole shrimp from Covered Activities. The Natomas Basin Conservancy has tried to construct and inoculate vernal pools for the two shrimp species, but those efforts were not successful at creating occupied habitat (J. Roberts, TNBC, *in litt*. 2021). Creation efforts may continue in the future, and obtaining inoculum from local vernal pools that

are adapted to the local soil and water conditions may be especially important given the historical deep flooding of the Natomas Basin before the levees were built (Roberts, *in litt*. 2021).

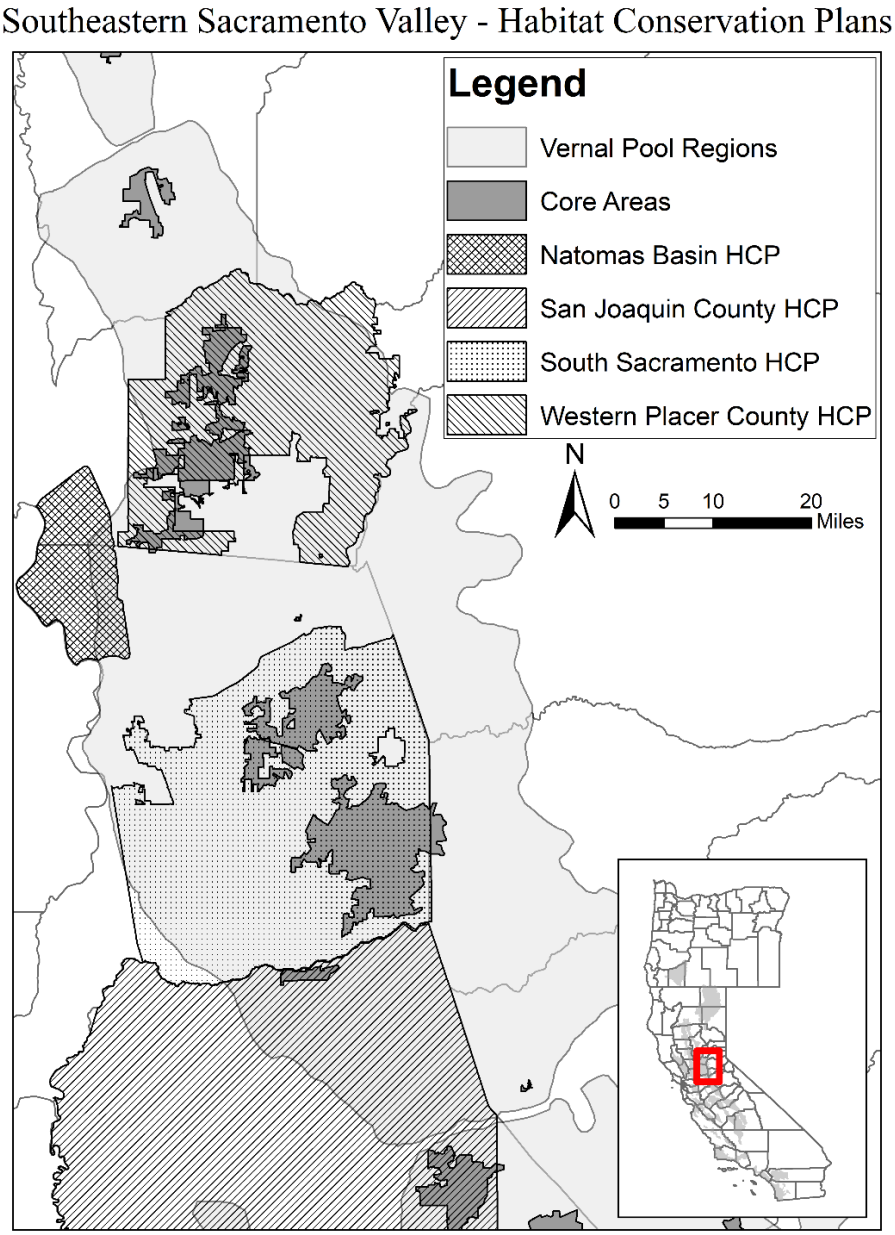


Figure 12.5. Map of the habitat conservation plans (HCPs) within the Southeastern Sacramento Valley Vernal Pool Region that include any of the three shrimp species as Covered Species. The PG&E San Joaquin Valley and PG&E Multiple Region Operations and Maintenance HCPs are not shown, but they cover San Joaquin County and the entirety of the Vernal Pool Region except for San Joaquin County, respectively.

12.5.2. PG&E Multiple Region Operations and Maintenance HCP

See section 2.5.1 for a description of this HCP.

12.5.3. PG&E San Joaquin Valley Operations and Maintenance HCP

See section 9.5.2 for a description of this HCP.

12.5.4. San Joaquin County HCP

See section 6.5.3 for a description of this HCP.

12.5.5. South Sacramento HCP

The South Sacramento HCP covers the southern and eastern portions of unincorporated Sacramento County as well as the Cities of Rancho Cordova and Galt, and is entirely within the vernal pool region (SSHCP 2018). This HCP was permitted in 2019 and has a 50-year permit term, and the permittees are the South Sacramento Conservation Agency, Sacramento County, City of Rancho Cordova, City of Galt, Sacramento County Water Agency, and the Southeast Connector Joint Powers Authority. The goal of the HCP is to provide development and infrastructure projects with streamlined, predictable federal and state permitting processes while creating a Preserve System to protect habitat, open space, and agricultural lands. The HCP's Conservation Strategy will result in an interconnected Preserve System totaling 36,282 acres of land preserved in perpetuity.

Habitat for the vernal pool fairy shrimp and vernal pool tadpole shrimp was modeled as all Vernal Pool (4,534 acres), Swale (1,253 acres), Stream/Creek (vernal pool invertebrate habitat) (73 acres), and Valley Grassland (135,150 acres) land cover types within the HCP area. Effects on the two shrimp species from Covered Activities include loss of vernal pool habitat and degradation due to edge effects that result in changes to hydrology of adjacent vernal pools. Over the 50-year permit term, Covered Activities will permanently affect 17,259 acres of vernal pool fairy shrimp and vernal pool tadpole shrimp modeled habitat (787 acres of vernal pools/aquatic habitat and 16,472 of surrounding grassland matrix). The HCP has a variety of biological goals, measurable objectives, and conservation actions related to protecting the two shrimp species, including: preserving 1,270 acres of aquatic modeled habitat (966 acres of Vernal Pools, 278 acres of Swales, and 26 acres of Stream/Creek vernal pool invertebrate habitat), preserving 22,014 acres of Valley Grassland within the Vernal Pool Ecosystem, mitigating impacts to vernal pools within/adjacent to the Mather and Cosumnes/Rancho Seco Core Areas within/adjacent to the Core Area, creating 389 acres of functional vernal pools including 50 acres within/adjacent to the Mather Core Area, and collecting topsoil from vernal pools to be converted by Covered Activities for later use as inoculum for the created pools.

As of September 30, 2021, Covered Activities have directly impacted 17.59 acres and indirectly impacted 1.18 acres of vernal pools, swales, and other water features that provide habitat for the vernal pool fairy shrimp and vernal pool tadpole shrimp, and 558.57 acres of valley grassland (SSCA 2022). More impacts have been authorized and had fees collected, but not all of the authorized projects have gone to construction as of the end of 2021 (K. Hudson, SSCA, *in litt*. 2021). Seven preserves with vernal pool habitat were protected in perpetuity using HCP funds by

the end of 2021: Gill Ranch (acquisitions 1 and 2), Ogden Ranch, Arista del Sol, Mahon Ranch, The Ranch, Van Vleck (acquisitions 1 and 2), and Rooney 2 (SSCA 2022).

12.5.6. Western Placer County HCP

The Western Placer County HCP covers the western portion of unincorporated Placer County and the City of Lincoln, and is almost entirely within the vernal pool region (PCCP 2020). This HCP was permitted in 2020 and has a 50-year permit term, and the permittees are Placer County, City of Lincoln, South Placer Regional Transportation Authority, Placer County Water Agency, and the Placer Conservation Authority. The purpose of the HCP is to protect and enhance ecological diversity and function, including aquatic resource functions and values, in the greater portion of western Placer County while allowing appropriate and compatible growth in accordance with applicable laws. The HCP's Conservation Strategy includes creating a Preserve System of 47,300 acres of natural and semi-natural community protected and restored habitat that will be preserved in perpetuity.

Habitat for the vernal pool fairy shrimp and vernal pool tadpole shrimp was modeled as all Vernal Pool Complex land cover type (44,278 acres), including associated wetland habitat (2,230 acres), within the Plan Area. Over the 50-year permit term, Covered Activities will result in permanent direct effects to up to 12,550 acres of vernal pool complex (including up to 580 acres of wetland habitat), temporary direct effects to up to 455 acres of vernal pool complex (including up to 30 acres of wetland habitat), and indirect effects to up to 1,796 acres of vernal pool complex and an additional 66 acres of wetland habitat. The HCP has a variety of biological goals, measurable objectives, and conservation actions related to protecting the two shrimp species, including: preserving 17,000 acres of vernal pool complex (790 wetted acres), creating or restoring 3,000 acres of vernal pool complex (minimum of 30 wetted acres, 900 wetted acres if maximum allowable loss occurs), collecting topsoil from vernal pools to be converted by Covered Activities for later use as inoculum for the created pools, and maintaining a vernal pool fairy shrimp and vernal pool tadpole shrimp occupancy rate greater than or equal to the occupancy of vernal pools lost due to Covered Activities.

As of December 31, 2022, Covered Activities have permanently impacted 600.6 acres of vernal pool complex, including 12.32 acres of wetland habitat (PCA 2023). Six preserves with vernal pool habitat were protected in perpetuity by the end of 2022: Amoruso Ranch, Bradley, East Sheridan 297, Ellis, Markham Ravine, and Redwing South. These preserves total 1,667.8 acres in size and protect 1,350.8 acres of vernal pool complex, including 181.8 acres of wetland features (PCA 2023). One of these preserves, the Markham Ravine In Lieu Fee Site, is a 297-acre vernal pool restoration site. Wetland restoration efforts were completed in 2018 and include 24.01 acres of vernal pools and 11.23 acres of seasonal wetlands and swales (vernal pool complex) (Helm Biological Consulting 2021). In 2021, the vernal pool fairy shrimp was detected in 8 of 54 wetlands sampled at Markham Ravine (Helm Biological Consulting 2021). The vernal pool fairy shrimp is also known to occur on the Amoruso Ranch, Bradley, East Sheridan 297, and Redwing South preserves (PCA 2023). The vernal pool tadpole shrimp is not yet known to occur on any of the preserves.

Habitat for the Conservancy fairy shrimp was not modeled since it is restricted to the Mariner Vernal Pool Conservation Bank and large, turbid pools are generally not found throughout Placer

County. Although currently known from only one location, surveys may detect the Conservancy fairy shrimp at additional locations in the future. Therefore, the HCP includes several conservation measures specific to the Conservancy fairy shrimp: pre-construction surveys for the species will be required in the two watersheds that straddle the known occurrence, and if take occurs due to HCP projects then two new occurrences must be protected for the first occurrence taken, and three new occurrences must be protected for any subsequent occurrences taken.

12.6. Other Preserves

Various vernal pool preserves outside of federal lands, banks, and HCP preserve systems have been established in this vernal pool region (Vollmar et al. 2017). Many of these are private preserves that were protected by landowners as part of proposed conservation measures during Section 7 interagency consultations and are thus referred to as "permittee responsible mitigation" (PRM) or "turn-key" sites. There are many PRM sites particularly in the Southeastern Sacramento Valley Vernal Pool Region due to the large number of Section 7 consultations in the Greater Sacramento area related to urban development projects. Almost all of these preserves are protected by a conservation easement with a Service-approved management plan and an endowment that covers annual monitoring and management costs. Although these PRM sites do submit annual reports to the Service, there is currently no comprehensive list of all PRM sites, their locations, species and habitat acreage present, etc. The Sacramento Fish and Wildlife Office is currently in the process of compiling a comprehensive list of preserves.

As part of larger conservation planning efforts that informed the South Sacramento and Western Placer County HCPs, these HCPs did attempt to document preserves that already existed within their jurisdictions. The South Sacramento HCP documented 64,500 acres of protected lands in southern Sacramento County as of 2018, though this included wildlife refuges and conservation banks as well as private preserves, and not all of those preserves include vernal pool grasslands (SSHCP 2018). The Western Placer County HCP documented 7,068 acres of vernal pool grassland within existing preserves in western Placer County as of 2020 (PCCP 2020), 5,421 acres of which was within the Western Placer County Core Area. This included lands preserved within the City of Roseville under the Roseville Open Space Preserve Overarching Management Plan, a city-run preserve system that the Service consulted on in 2011. The Management Plan includes annual monitoring of vernal pool invertebrates and plant species as well as outlining appropriate management practices for vernal pool grasslands related to thatch management, invasive plant management, maintaining natural vernal pool hydrology, and enhancement and restoration where applicable.

There are two State-owned lands with vernal pools in this vernal pool region. The Prairie City State Vehicular Recreation Area is an off-highway vehicle park in eastern Sacramento County operated by the California Department of Parks and Recreation (CDPR). This state park has many vernal pools and the vernal pool fairy shrimp and vernal pool tadpole shrimp have been observed there. CDPR is currently preparing a Wildlife Habitat Protection Plan for this area, which includes management of the vernal pools (CDPR 2022b). The state park hosts annual vernal pool tours for the public, which contribute to the Recovery Plan's goals for public awareness and outreach. The Phoenix Field Ecological Reserve is a small preserve owned by CDFW near Phoenix Park in the City of Fair Oaks. The vernal pool fairy shrimp and vernal pool tadpole shrimp are not known to occur within this preserve, but the land management plan does

have goals related to the protection, management, and monitoring of the vernal pool habitat and species that are known to occur on the preserve (ESA Associates 2006b).

12.7. Vernal Pool Core Areas

There are four Core Areas within the Southeastern Sacramento Valley Vernal Pool Region that are designated in the Recovery Plan for the vernal pool fairy shrimp and vernal pool tadpole shrimp: Beale, Cosumnes/Rancho Seco, Mather, and Western Placer County. None have met the target amount of vernal pool habitat protected, but as of 2018 none had lost enough habitat, compared to the baseline level of habitat that was present in 2005, to make the target unattainable (see **Table 12.1**; Vollmar et al. 2017; Witham 2021). Technically the Mather Core Area had lost 5.1% of the 2005 baseline, but the HCP's Conservation Strategy is designed to meet the six criteria for alternative conservation mechanisms in the Recovery Plan (described in the Recovery Plan Concepts section above), and therefore successful implementation of the HCP should result in meeting this core area's recovery goals at the end of the HCP's 50-year permit term.

There are also three additional Core Areas that were not designated for the vernal pool fairy shrimp in the Recovery Plan and two additional Core Areas that were not designated for the vernal pool tadpole shrimp in the Recovery Plan, but that have known occurrences of the species in the Diversity Database: Phoenix Field and Phoenix Park (vernal pool fairy shrimp only), Southeast Sacramento Valley (both species), and Stone Lake (both species) (Diversity Database 2022). All of the occurrences were known prior to 2005, but the core areas may not have been designated for the vernal pool fairy shrimp and vernal pool tadpole shrimp in the Recovery Plan due to only slight overlap with the core areas or potential extirpation. The Phoenix Field and Phoenix Park and Stone Lake Core Areas have met the 85% protection target, and the Southeast Sacramento Valley Core Area has lost more than 15% of the amount of vernal pool habitat that remained in 2005, making the 85% target unattainable without habitat creation or restoration (see **Table 12.1**; Vollmar et al. 2017; Witham 2021).

The one known occurrence of the Conservancy fairy shrimp within the Southeastern Sacramento Valley Vernal Pool Region is located in the Western Placer County Core Area. The Recovery Plan does not provide habitat preservation goals for the Conservancy fairy shrimp in this core area, as the occurrence was not known in 2005. However, the Recovery Plan does recommend the protection of 100% of newly discovered populations as a criteria for delisting.

12.7.1. Beale

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and vernal pool tadpole shrimp. The majority of this core area is within Beale AFB in Yuba County.

There were approximately 4,967.5 acres of vernal pool grassland within this core area as of 2018, with only 10.7 acres of habitat lost since the Recovery Plan's 2005 baseline (see **Figure 12.6**, **Table 12.1**, **Table 12.2**; Witham 2021). Roughly 3,541 acres of vernal pool grassland has been protected within this core area, representing 71% of the 2005 baseline (Vollmar et al. 2017). However, no vernal pool grasslands within this core area have been permanently

protected. Beale AFB has preserved 923 acres of vernal pool grassland within three Conservation Areas (DOD 2019), and Vollmar et al. (2017) considered most of the Air Force Base within the core area to be protected land (**Figure 2.9**). However, these areas are not protected in perpetuity under a conservation easement or deed restriction, and could conceivably be subject to changes in management if Federal priorities shift or if the base is ever closed and the land is transferred to a different landowner (DOD 2019).

12.7.1.1. Vernal Pool Fairy Shrimp Occurrences

There are five Diversity Database occurrence records for the vernal pool fairy shrimp within this core area; all are within Beale AFB, though one record represents the entire western portion of the vernal pool grasslands on Beale AFB (see **Figure 12.8**; Diversity Database 2022). Vernal pool fairy shrimp were first detected on Beale AFB in 1992 and have been consistently detected in all surveys since (2008, 2010, 2012, 2014, and 2015-2018) (DOD 2019). Surveys of 1,000 vernal pools at Beale AFB in 1995 and 1996 found vernal pool fairy shrimp in 134 of the pools (Jones and Stokes Associates 1998 as cited in DOD 2019). The southwestern portion of the core area extends outside of Beale AFB, and although there is vernal pool grassland habitat in this area (Witham 2021), no records of the vernal pool fairy shrimp have been reported to the Diversity Database (Diversity Database 2022), which may be due to lack of sampling.

12.7.1.2. Vernal Pool Tadpole Shrimp Occurrences

There are four Diversity Database occurrence records for the vernal pool tadpole shrimp within this core area; all are within Beale AFB (see **Figure 12.9**; Diversity Database 2022). Vernal pool tadpole shrimp were first detected in 1996 and have been consistently detected in surveys through 2018 (DOD 2019). Surveys of 1,000 vernal pools at Beale AFB in 1995 and 1996 found vernal pool tadpole shrimp in 29 of the pools (Jones and Stokes Associates 1998). The southwestern portion of the core area extends outside of Beale AFB, and although there is vernal pool grassland habitat in this area (Witham 2021), no records of the vernal pool tadpole shrimp have been reported to the Diversity Database (Diversity Database 2022), which may be due to lack of sampling.

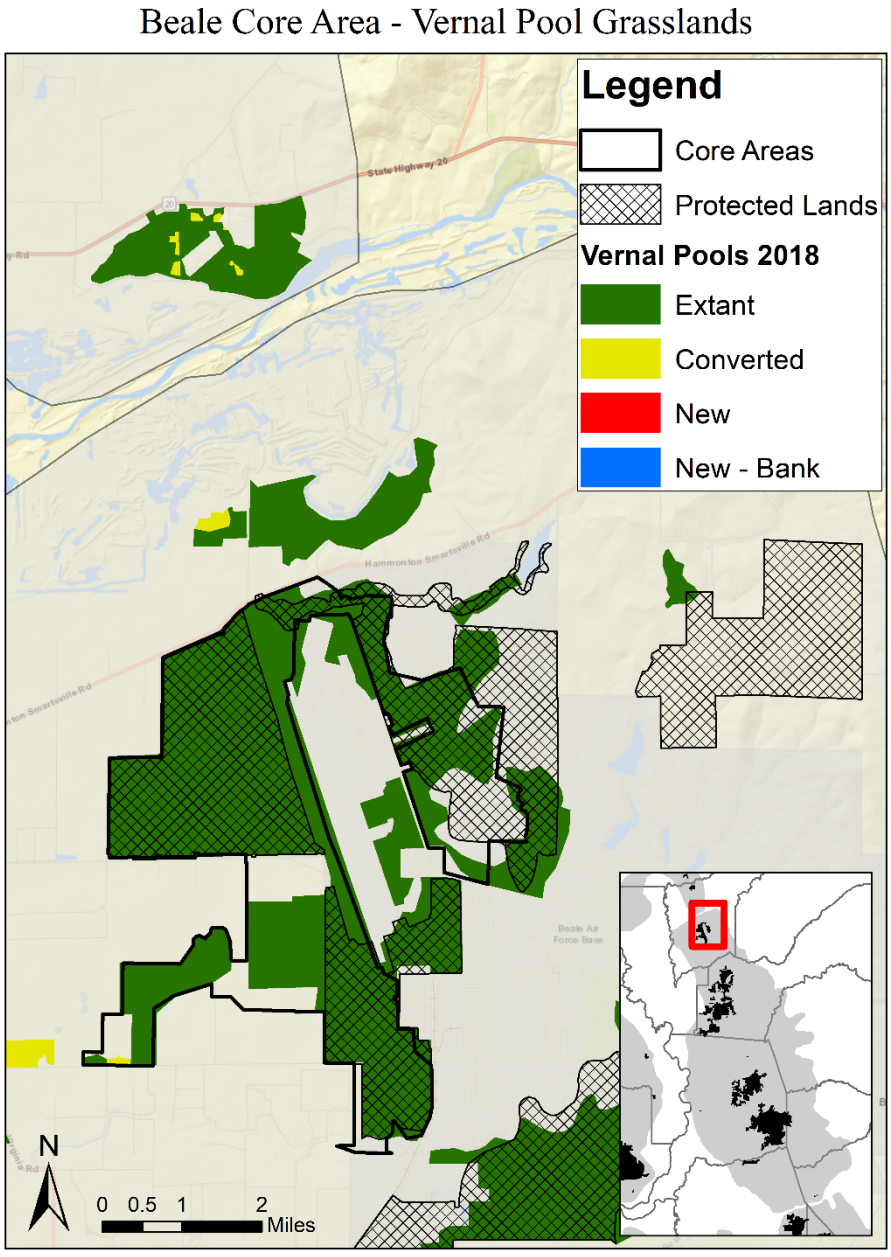


Figure 12.6. Map of vernal pool grassland habitat within the Beale Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

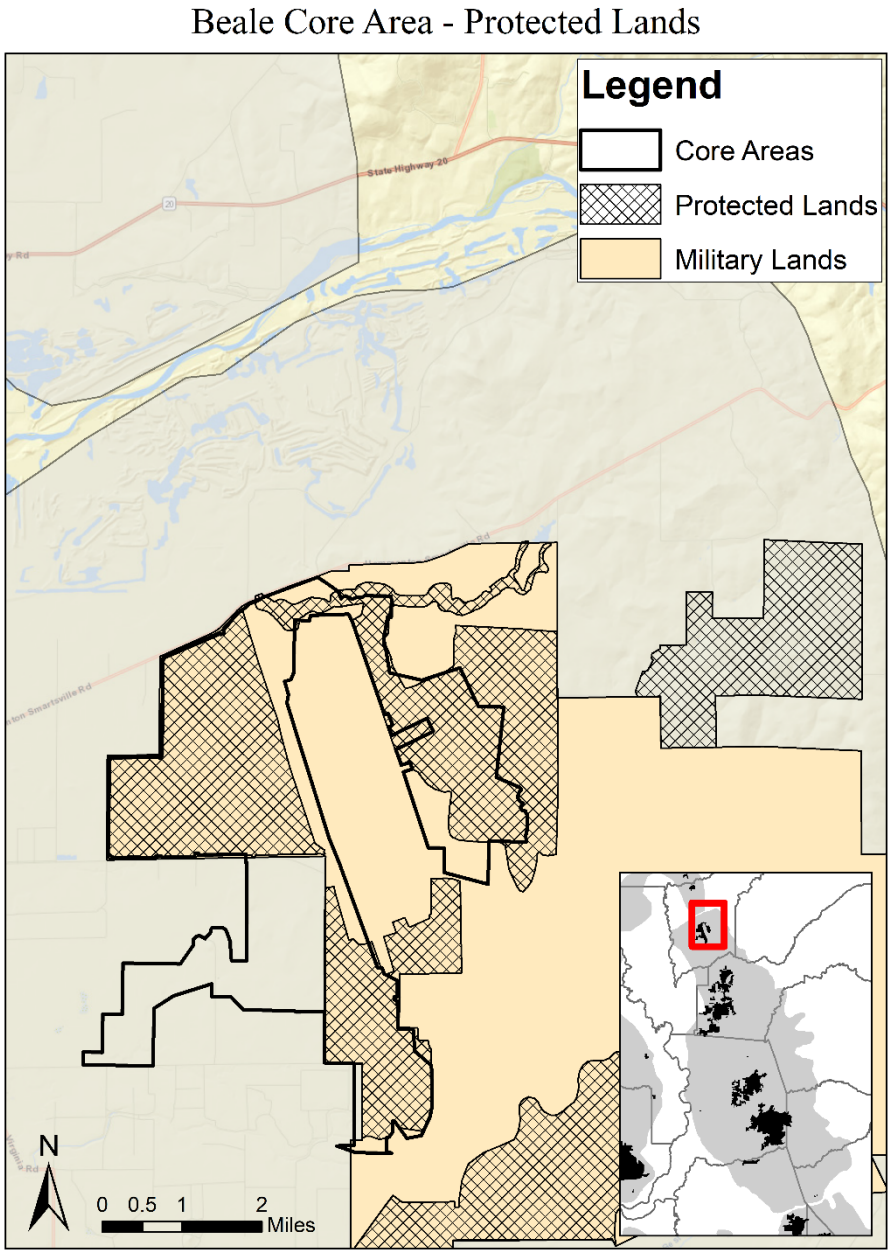


Figure 12.7. Map of protected areas within the Beale Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves.

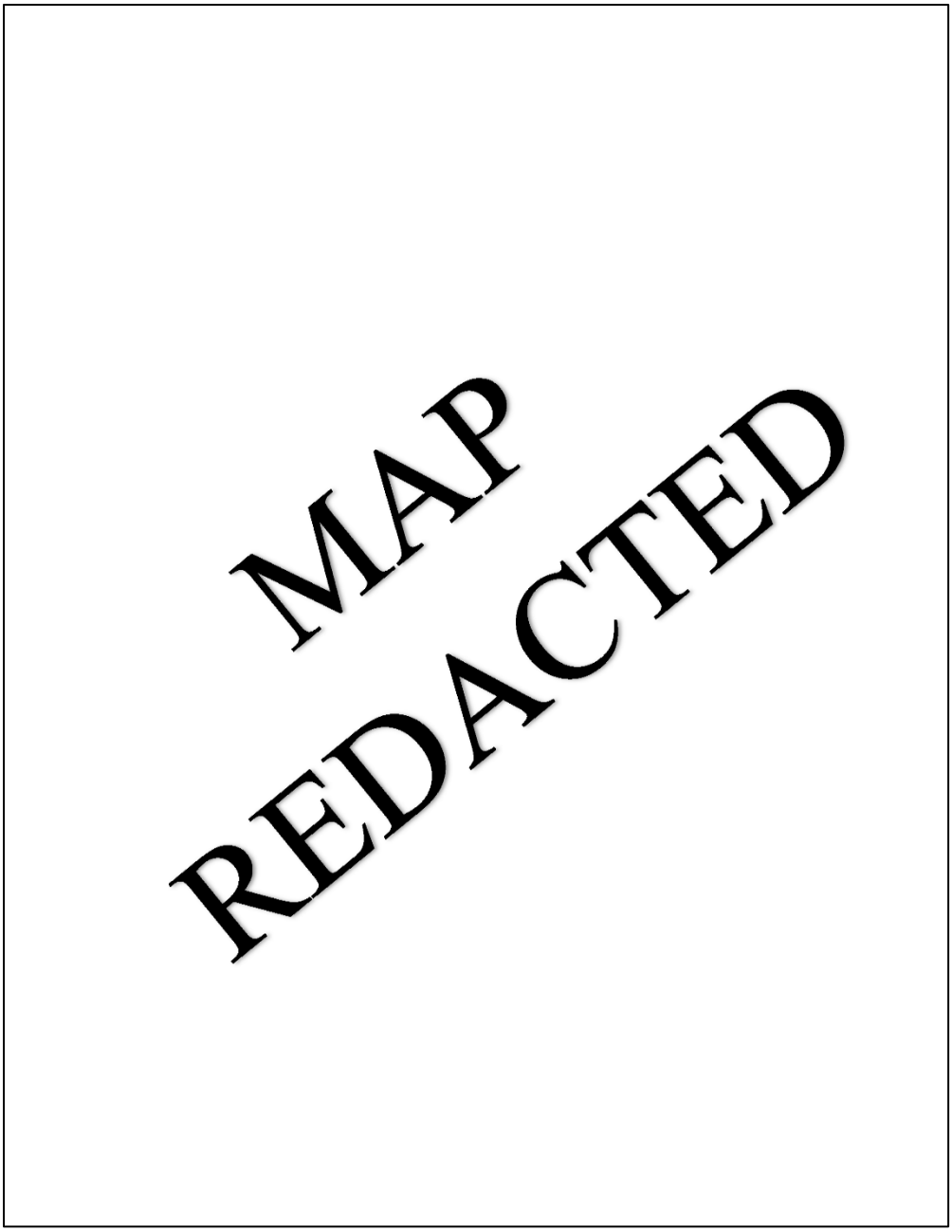


Figure 12.8. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Beale Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

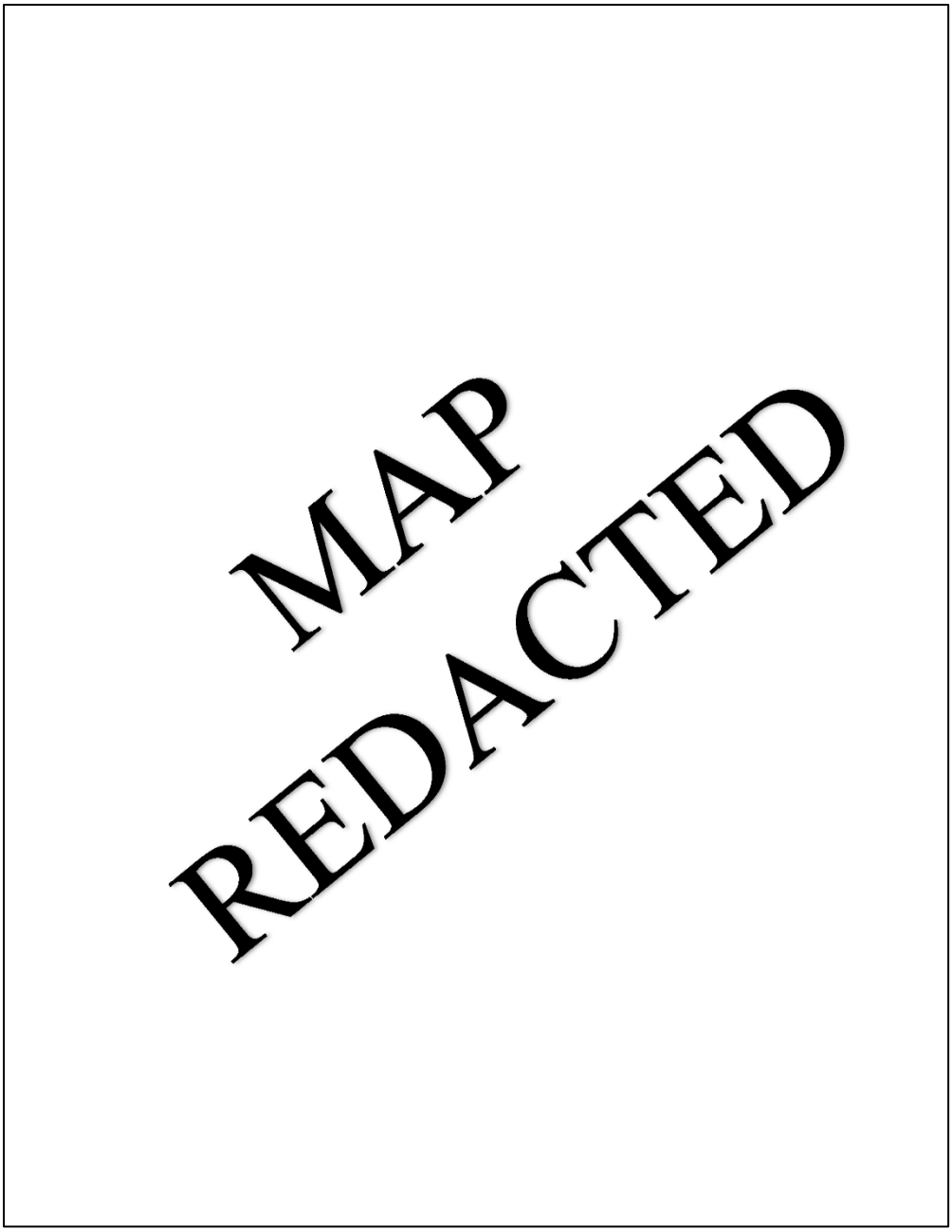


Figure 12.9. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Beale Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

12.7.2. Cosumnes/Rancho Seco

This is a zone 1 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and 95% of vernal pool habitat for the vernal pool tadpole shrimp. The core area is located in southeastern Sacramento County and a small portion of adjacent El Dorado County.

There were approximately 30,749 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 30,021 acres of vernal pool grassland remaining (see **Figure 12.10**, **Table 12.1**; Witham 2021). Approximately 1,168 acres had been lost since the Recovery Plan's 2005 baseline, though 440 additional acres were created on banks that were not previously mapped as vernal pool grassland in 2005. All of the habitat losses were attributable to agricultural conversions (233.3 acres [20.0%] to orchards, 918.9 acres [78.7%] to bare plowed agricultural land, and 15.8 acres [1.4%] to agricultural residences) (**Table 12.2**). Roughly 12,489 acres of vernal pool grassland were estimated to be protected within this core area as of 2017 (Vollmar et al. 2017), representing 41% of the 2005 baseline (**Figure 12.11**). There are additional areas of protected vernal pool habitat within lands that were protected after 2017 or were otherwise not captured in Vollmar et al.'s (2017) database, so the actual amount of protected habitat is higher.

This core area is entirely within the boundaries of the South Sacramento HCP, except for the small portion in El Dorado County. The HCP estimates that 53 acres of vernal pool grassland within this core area will be permanently lost due to Covered Activities (SSHCP 2018). These losses will be required to be mitigated at HCP preserves within the core area; however, additional acres of vernal pool grassland beyond what is necessary to offset the loss of these 53 acres will likely be preserved within the core area. While the Recovery Plan's goal of protecting 85%/95% of vernal pool habitat is still achievable, the Recovery Plan also acknowledges that alternative mechanisms such as HCPs may be deemed equivalent to implementation of the recovery plan if they contain the six elements specified for meeting equivalency (Service 2005a). The HCP's Conservation Strategy is designed in a way that should meet these six criteria, and therefore successful implementation of the HCP should result in meeting this core area's recovery goals at the end of the HCP's 50-year permit term even if 85%/95% protection has not been achieved. To date, the South Sacramento Conservation Agency (the entity in charge of implementing the HCP) has preserved two properties within the core area that contain vernal pool fairy shrimp habitat: Gill Ranch and Mahon Ranch (SSCA 2022).

There are five conservation banks with vernal pool fairy shrimp and vernal pool tadpole shrimp preservation credits in the core area: Clay Station, Gill Ranch, Laguna Creek, Laguna Terrace East, SMUD Nature Preserve (**Figure 12.11**). These banks total 4,327 acres in size and have 237.4 acres of preservation credits for the vernal pool fairy shrimp (63% of which have already been sold), 192.0 acres of preservation credits for the vernal pool tadpole shrimp (61% sold), and 109.7 acres of creation credits for both species (69% sold). Although most activities within the core area are covered under the South Sacramento HCP, these banks can continue to sell credits to compensate for activities that are outside of the jurisdiction of, or otherwise not covered by, the South Sacramento HCP.

Other preserves within the core area include: the South Sacramento HCP Gill Ranch and Mahon Ranch preserves, GiuTere Preserve, Silva Ranch, Borden Ranch, Gill Ranch: Vineyard Pointe,

Brown's Creek Vernal Pool Preserve, Laguna Terrace Vernal Pool Preserve, five other mitigation properties from Vollmar et al.'s (2017) database, and a large extent of private ranchland on the east side of the core area with conservation easements held by CDFW, the Natural Resources Conservation Agency, or The Nature Conservancy.

12.7.2.1. Vernal Pool Fairy Shrimp Occurrences

There are 39 Diversity Database occurrence records for the vernal pool fairy shrimp within this core area (see **Figure 12.12**; Diversity Database 2022). As of 2018, 25 of these occurrences were at least partially within protected areas (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database, though one occurrence was partially within areas mapped as having vernal pool habitat loss (Witham 2021). Vernal pool fairy shrimp were first detected within this core area in 1982 and new Diversity Database records were consistently reported up through 2014 (Diversity Database 2022). Of the 39 records, 5 were known at the time of listing in 1994 and 14 were known at the time the Recovery Plan was published in 2005; these records are mostly located in the central, southern, and northeastern portions of the core area. The 25 newer records are mostly located in the northwestern portion of the core area, with a few in the southern and a few in the northeastern (El Dorado County) portions. This confirms that the vast majority of vernal pool grasslands in this core area are occupied by the vernal pool fairy shrimp.

12.7.2.2. Vernal Pool Tadpole Shrimp Occurrences

There are 14 Diversity Database occurrence records for the vernal pool tadpole shrimp within this core area (see **Figure 12.13**; Diversity Database 2022). As of 2018, 12 of these occurrences were at least partially within protected areas (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database; 13 are within extant vernal pool habitat and 1 is outside of mapped vernal pool habitat (Witham 2021). Of the 14 records, 2 were known at the time of listing in 1994 and 7 were known at the time the Recovery Plan was published in 2005; these records are mostly located in the northern and southwestern portions of the core area. The seven newer records are mostly located throughout the core area, though the vernal pool tadpole shrimp has never been observed in the center of the core area.

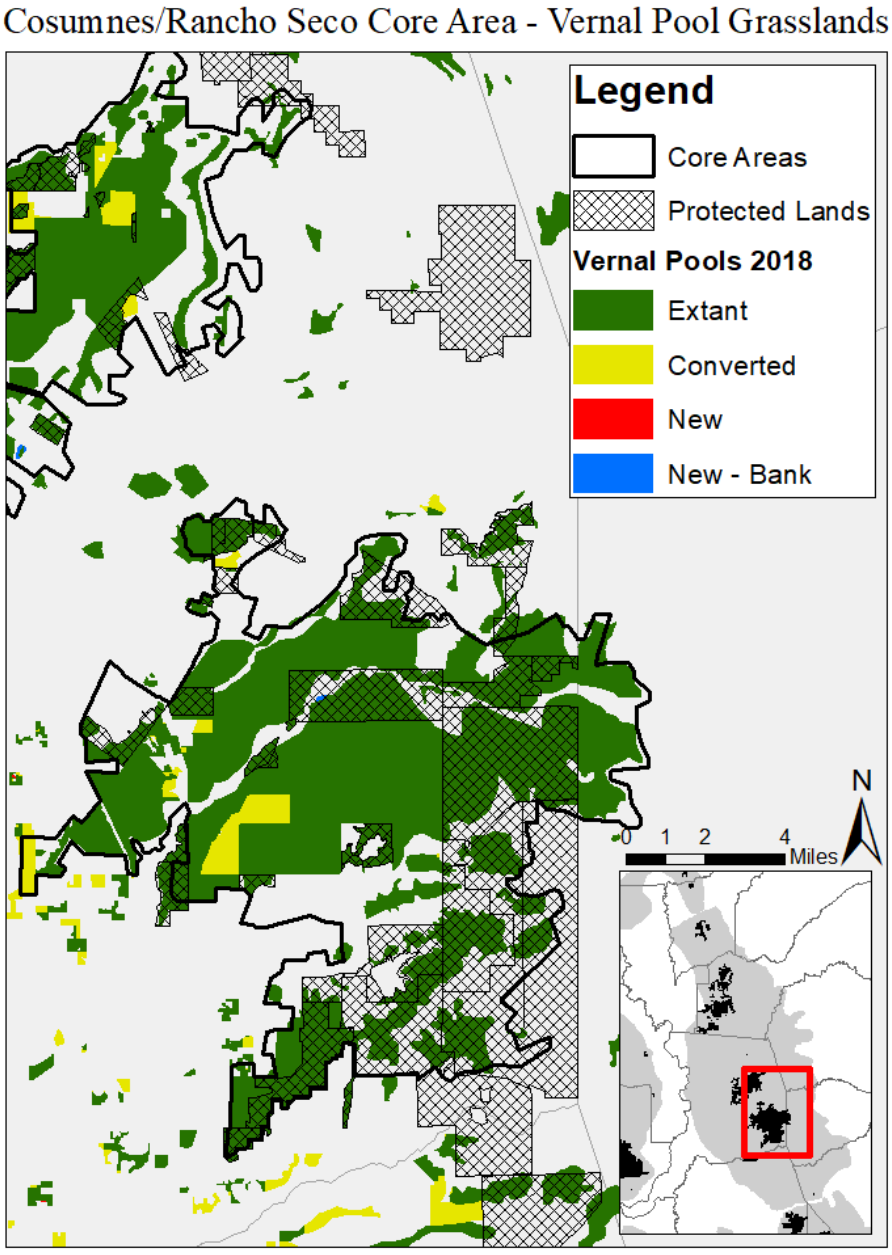


Figure 12.10. Map of vernal pool grassland habitat within the Cosumnes/Rancho Seco Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

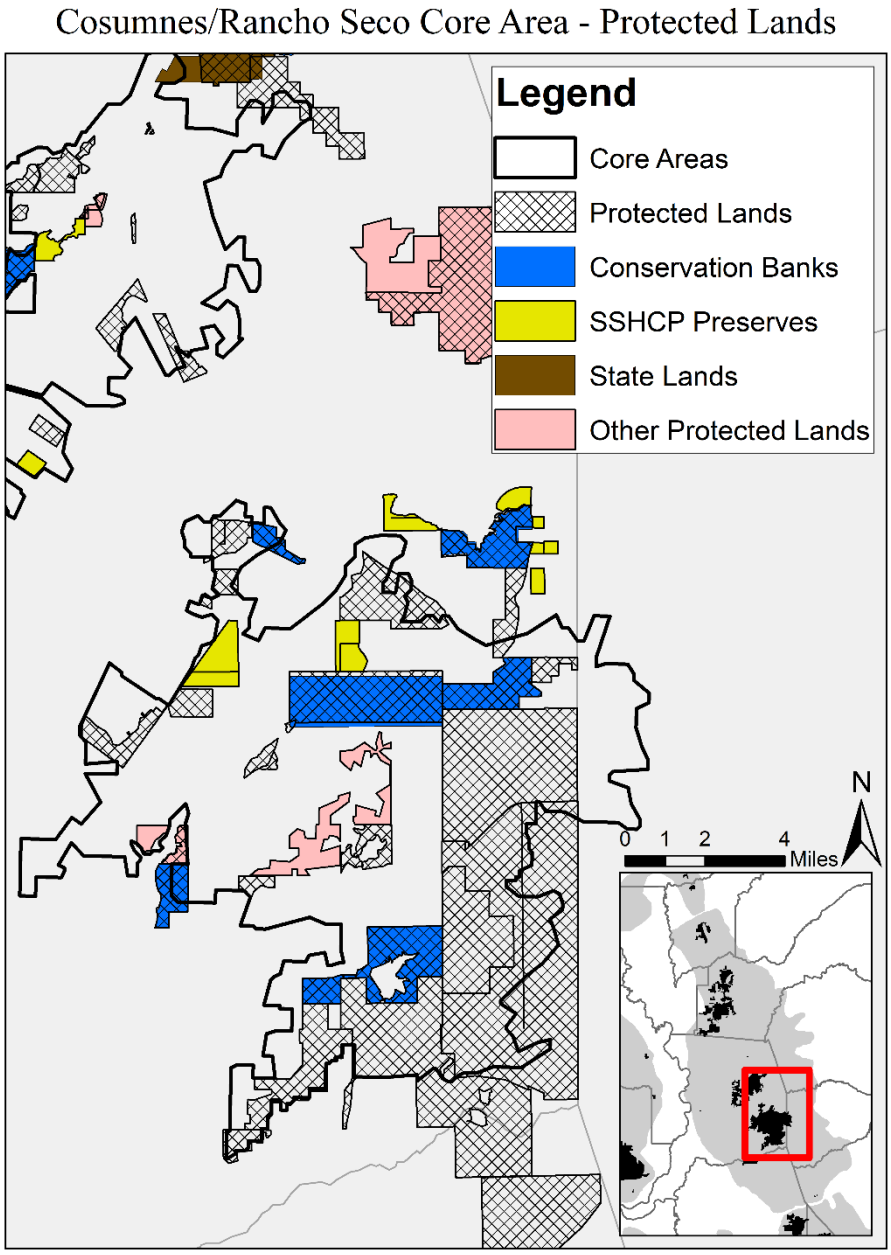


Figure 12.11. Map of protected areas within the Cosumnes/Rancho Seco Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves.

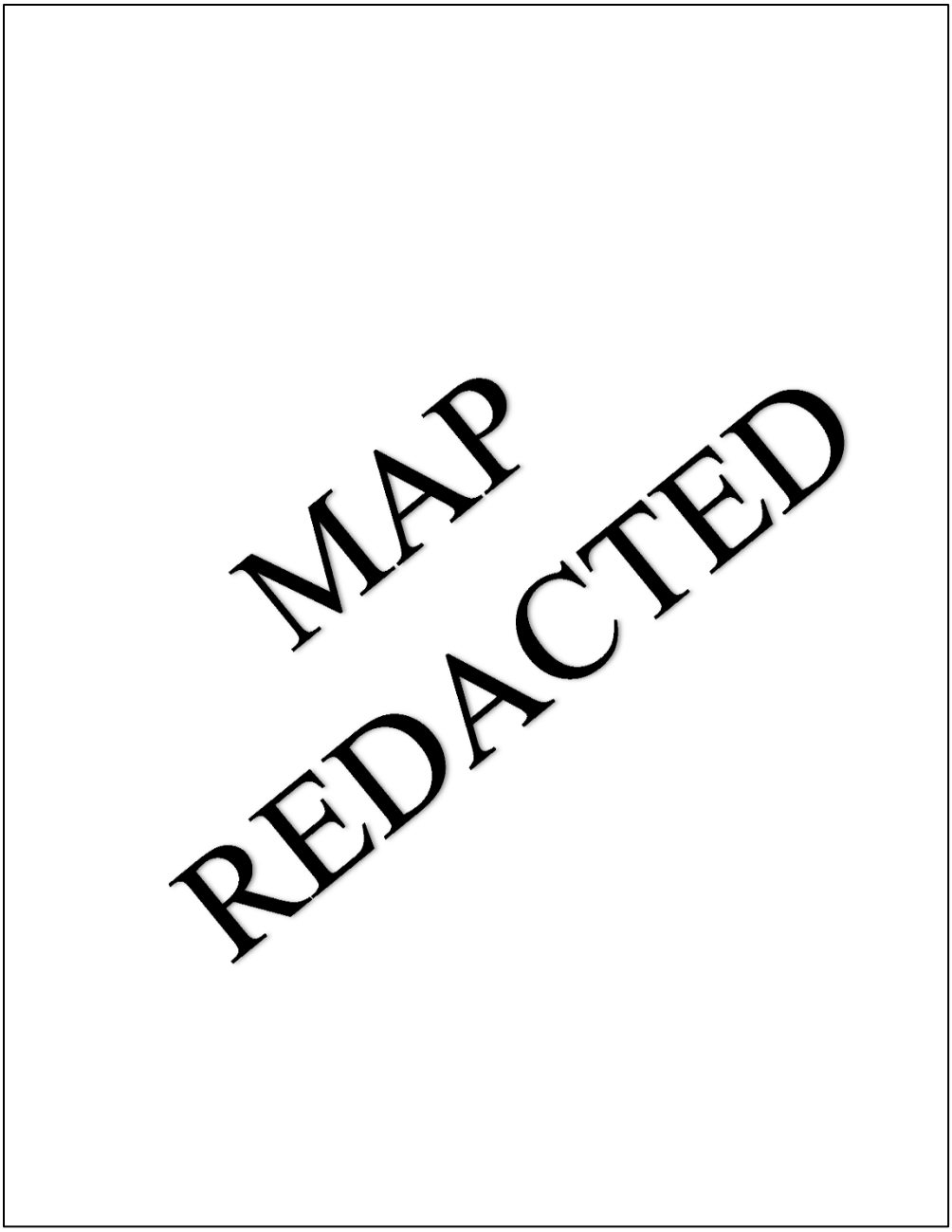


Figure 12.12. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Cosumnes/Rancho Seco Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

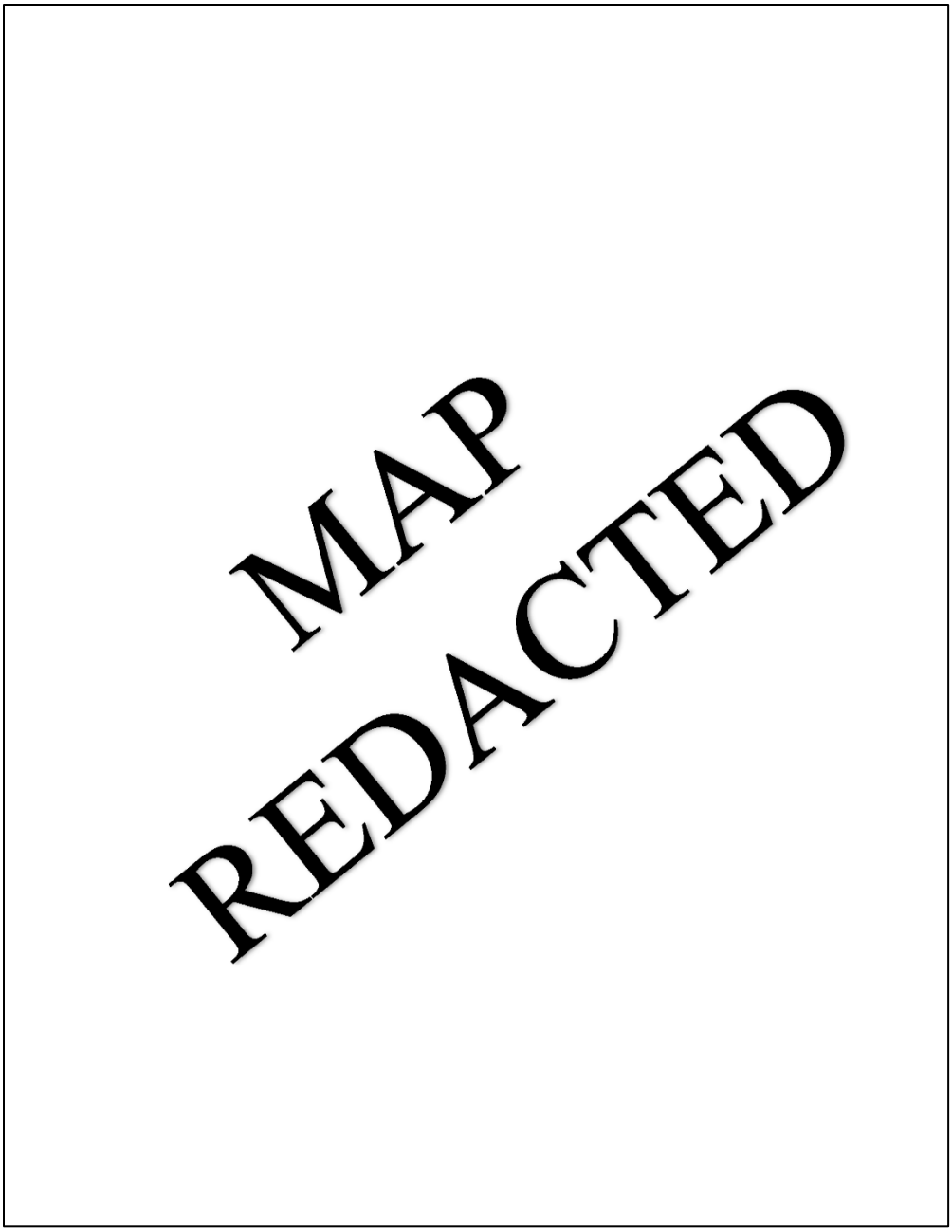


Figure 12.13. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Cosumnes/Rancho Seco Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

12.7.3. Mather

This is a zone 1 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and 95% of vernal pool habitat for the vernal pool tadpole shrimp. The core area is located in eastern Sacramento County.

There were approximately 14,037 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 13,331 acres of vernal pool grassland remaining (see **Figure 12.14**, **Table 12.1**; Witham 2021). Approximately 721 acres had been lost since the Recovery Plan's 2005 baseline, though 13 additional acres were created on banks that were not previously mapped as vernal pool grassland in 2005 and 2 acres were identified that were either new or missed in previous mapping efforts (Witham 2021). The majority of losses were due to urbanization (615.0 acres, 85.3%), with other losses due mostly to conversion to orchards and agricultural residences (**Table 12.2**). Continuing urbanization is a major concern within this core area, as it is on the periphery of existing development in the cities of Sacramento and Rancho Cordova, and pressure to build more residential developments will likely increase as the human population continues to grow. Roughly 3,934 acres of vernal pool grassland were estimated to be protected within this core area as of 2017 (Vollmar et al. 2017), representing 28% of the 2005 baseline. There are additional areas of protected vernal pool habitat within lands that were protected after 2017 or were otherwise not captured in Vollmar et al.'s (2017) database, so the actual amount of protected habitat is higher.

This core area is entirely within the boundaries of the South Sacramento HCP (SSHCP 2018). The HCP estimates that 8,500 acres of vernal pool grassland within this core area will be permanently lost due to Covered Activities. These losses will be required to be mitigated at HCP preserves within the core area. The HCP estimated the total amount of vernal pool grassland within the core area to be 17,023 acres, which is more than Witham's (2021) estimate, but this would still represent a loss of 50% of vernal pool grasslands due to Covered Activities. However, the HCP's Conservation Strategy is designed to meet the six criteria for alternative conservation mechanisms in the Recovery Plan (described in the Recovery Plan Concepts section above), and therefore successful implementation of the HCP should result in meeting this core area's recovery goals at the end of the HCP's 50-year permit term. To date, the South Sacramento Conservation Agency (the entity in charge of implementing the HCP) has preserved several properties within the core area that contain vernal pool fairy shrimp habitat and is in the process of preserving several more, including Arista del Sol, The Ranch, Rooney 2, Werre, Silver Springs East, Tracy Ranch, and The Preserve (Satellite Preserve S-1) (SSCA 2022).

There are three conservation banks with vernal pool fairy shrimp and vernal pool tadpole shrimp preservation credits in the core area: Arroyo Seco Conservation Bank, Bryte Ranch Conservation Bank, and Sunrise Douglas Mitigation Bank (aka Anatolia Preserve) (**Figure 12.15**). These banks total 1,295 acres in size and have 262.20 acres of preservation credits for the vernal pool fairy shrimp and vernal pool tadpole shrimp (86.5% of which have already been sold). None of these banks have created vernal pools for the two shrimp species. Although most activities within the core area are covered under the South Sacramento HCP, these banks can continue to sell credits to compensate for activities that are outside of the jurisdiction of, or otherwise not covered by, the South Sacramento HCP.

Other preserves within the core area include: Sacramento Valley Vernal Pool Preserve (Werre South, Laguna, Kassis, Cook, and Sylva units), Klotz Property Open Space Preserve, Excelsior 184, Triangle Rock Vernal Pool Preserve, Laguna Creek Corridor Preserve, Illa M. Collin Conservation Preserve, Montelena Preserve, Sunridge Park Open Space Preserve, Douglas 103 Preserve, Grantline 208 Preserve, Rio del Oro Onsite Preserve, and Kiefer Landfill Wetlands Preserve. The Prairie City State Vehicle Recreation Area is also partly within the core area, though the vast majority of vernal pool habitat on this site is outside of the core area (CDPR 2022b).

12.7.3.1. Vernal Pool Fairy Shrimp Occurrences

There are 15 occurrence records from the Diversity Database for the vernal pool fairy shrimp within this core area (see **Figure 12.16**; Diversity Database 2022). As of 2018, 13 of these occurrences were within protected areas (Vollmar et al. 2017), though one was identified in the Diversity Database as possibly extirpated. All occurrences are within extant mapped vernal pool grasslands (Witham 2021). Vernal pool fairy shrimp were first detected within this core area in 1989 (Diversity Database 2022). Of the 15 records, 7 were known at the time of listing in 1994 and 12 were known at the time the Recovery Plan was published in 2005; these records are located throughout the core area. The three newer records are located in the center and southwest of the core area.

12.7.3.2. Vernal Pool Tadpole Shrimp Occurrences

There are 36 occurrence records from the Diversity Database for the vernal pool tadpole shrimp within this core area (see **Figure 12.17**; Diversity Database 2022). As of 2018, 23 of these occurrences were at least partially within protected areas (Vollmar et al. 2017), though 3 were identified in the Diversity Database as possibly extirpated. In total, 30 occurrences are presumed extant by the Diversity Database and 6 are extirpated or possibly extirpated; 31 are within extant mapped vernal pool grasslands, 1 is within extirpated vernal pool grasslands, and 4 are outside of mapped vernal pool grasslands (Witham 2021). Vernal pool tadpole shrimp were first detected within this core area in 1989 and have been consistently documented through 2015 (Diversity Database 2022). Of the 36 records, 20 were known at the time of listing in 1994 and 30 were known at the time the Recovery Plan was published in 2005; these records are located throughout the core area. The six newer records are mostly located in the center of the core area.

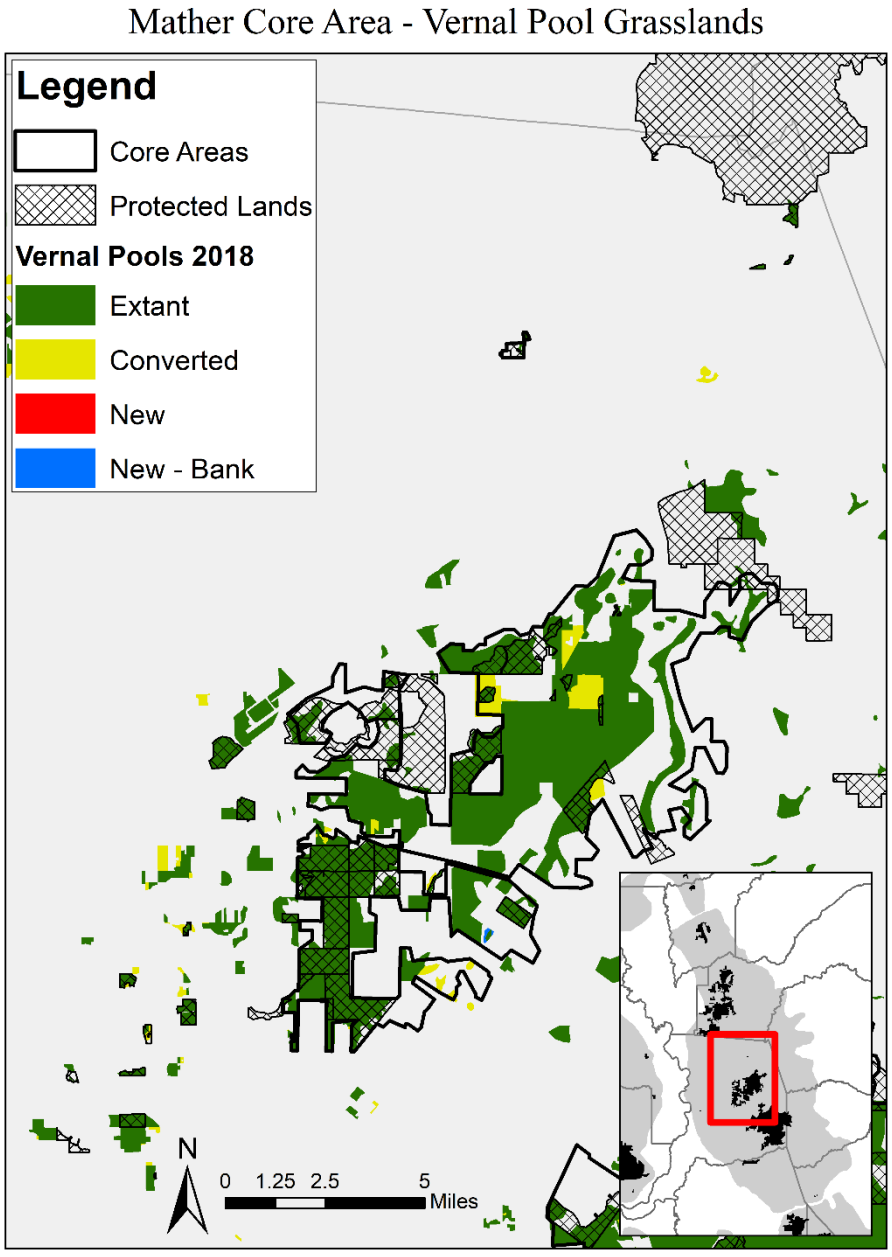


Figure 12.14. Map of vernal pool grassland habitat within the Mather Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

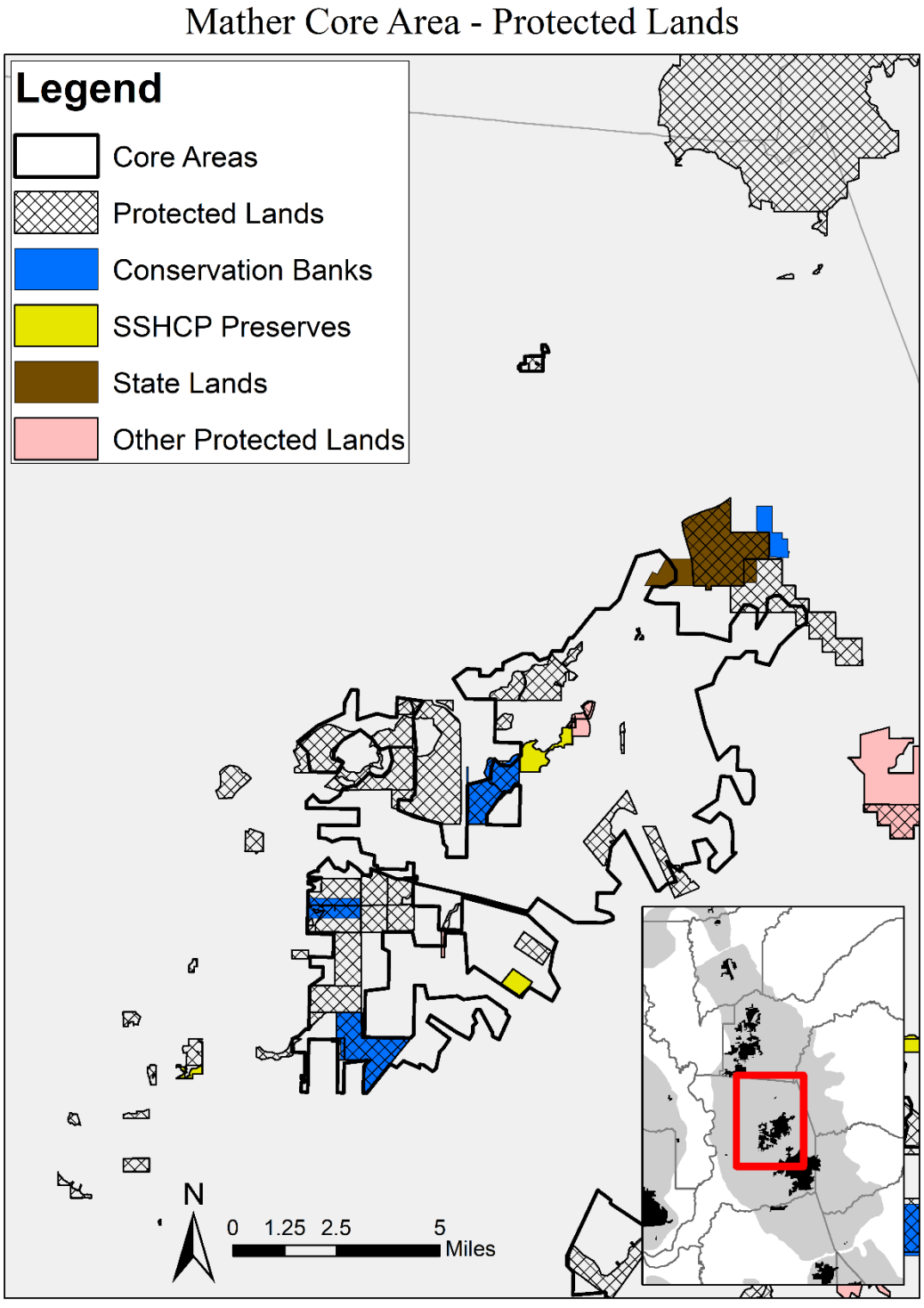


Figure 12.15. Map of protected areas within the Mather Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves.

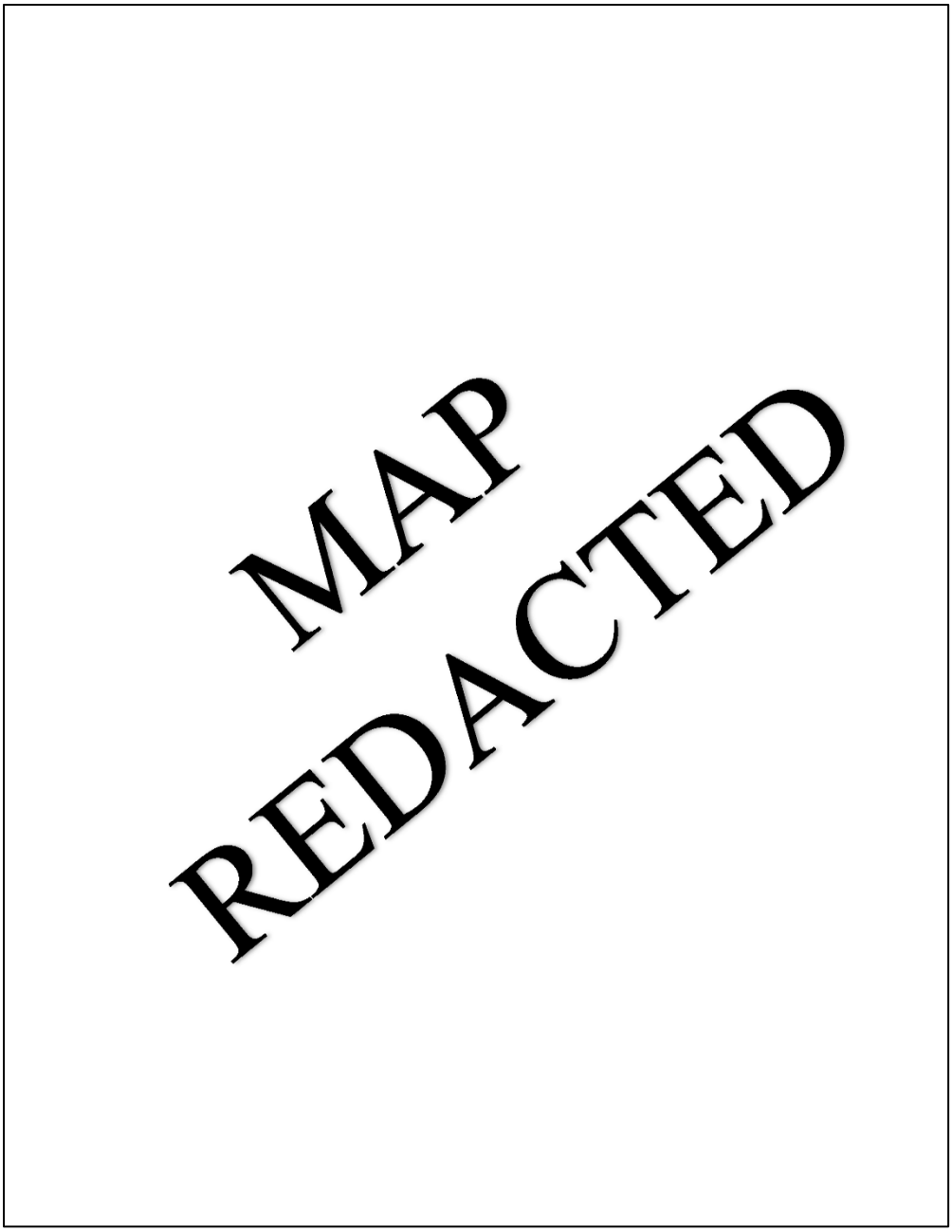


Figure 12.16. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Mather Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

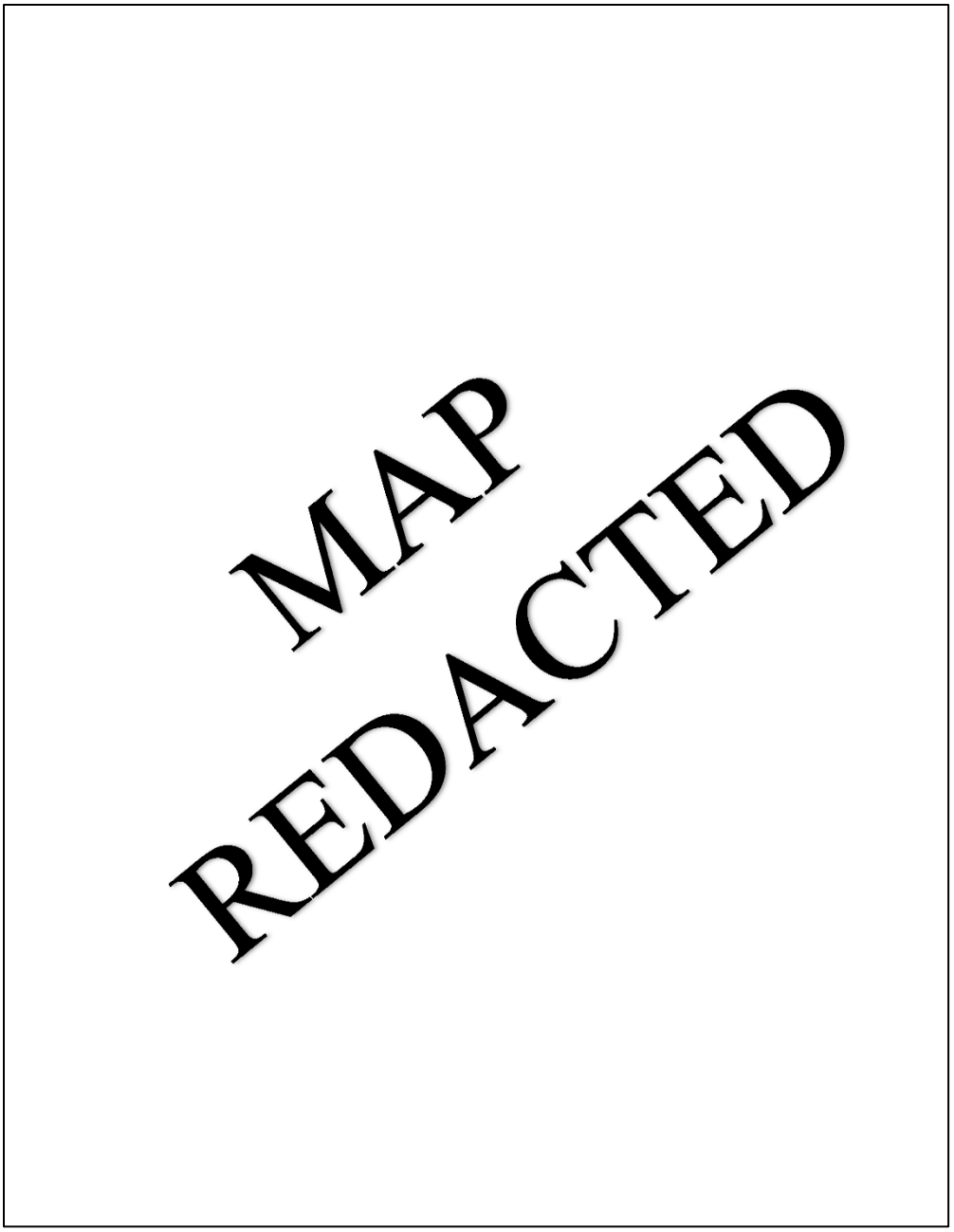


Figure 12.17. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Mather Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

12.7.4. Phoenix Field and Phoenix Park

This is a zone 1 core area, but it was not designated for the vernal pool fairy shrimp in the Recovery Plan. It was designated for Sacramento orcutt grass (*Orcuttia viscida*), California fairy shrimp (*Linderiella occidentalis*), and western spadefoot (*Spea hammondii*), with a goal of protecting 95% of vernal pool habitat. The core area is located in the City of Fair Oaks, Sacramento County, just north of the Nimbus Dam on the American River. This core area contains the Phoenix Park Vernal Pool Preserve, owned by the Fair Oaks Recreation and Park District, and the Phoenix Field Ecological Reserve, owned by CDFW.

There were approximately 17.7 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were still 17.7 acres of vernal pool grassland remaining, with no habitat losses occurring since 2005 (see **Figure 12.18**, **Table 12.1**; Witham 2021). All of the vernal pool grasslands within this core area are protected within the Phoenix Field Ecological Reserve and Phoenix Park Vernal Pool Preserve (**Figure 12.19**; Vollmar et al. 2017); the exact acreage protected is reported as 17.3 acres in **Table 12.1**, but this is simply due to slight boundary discrepancies between the shapefiles for vernal pool habitat and protected lands.

12.7.4.1. Vernal Pool Fairy Shrimp Occurrences

There is one occurrence record from the Diversity Database of the vernal pool fairy shrimp in this core area (see **Figure 12.20**; Diversity Database 2022). This occurrence record is from 1982, was identified by Denton Belk, and encompasses all of Phoenix Park. The Service is not aware of any more recent surveys that have identified the vernal pool fairy shrimp within this core area (E. Kleinfelter, CDFW, *in litt*. 2022) and the most recent management plan does not include the vernal pool fairy shrimp as a known species within the park or reserve (ESA Associates 2006b). Although this occurrence was known at the time the Recovery Plan was published, the lack of subsequent data confirming the 1982 identification is likely why this core area was not designated for the vernal pool fairy shrimp.

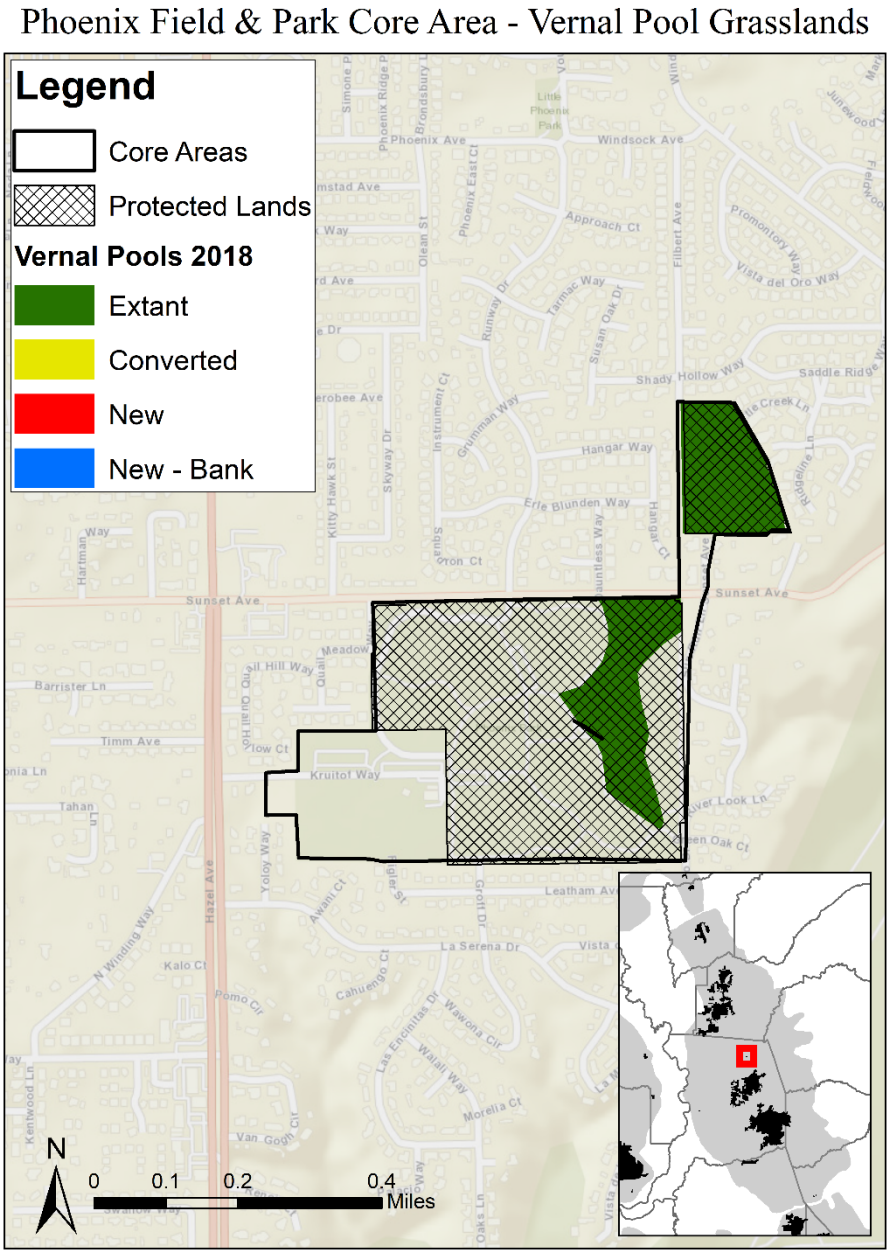


Figure 12.18. Map of vernal pool grassland habitat within the Phoenix Field and Park Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

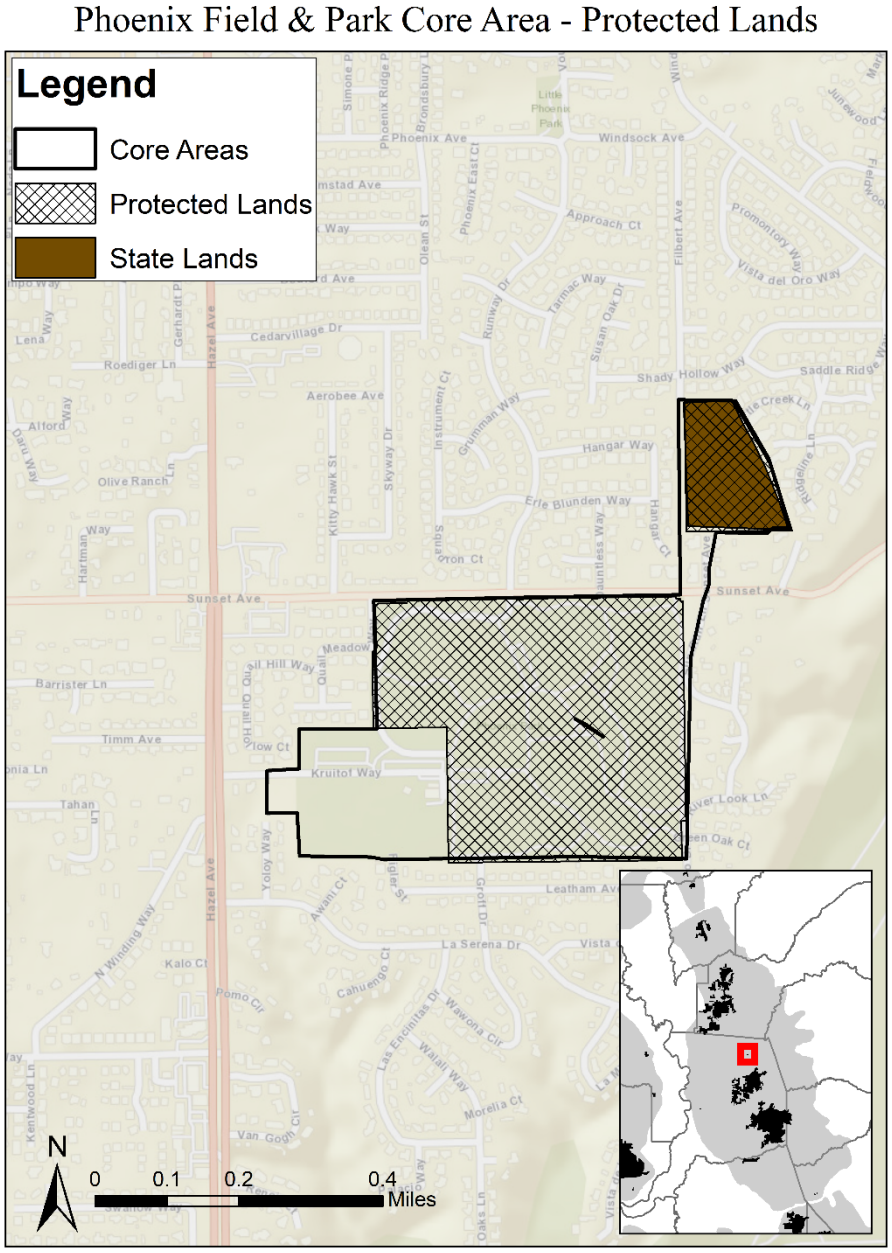


Figure 12.19. Map of protected areas within the Phoenix Field and Park Core Area**.** Protected lands are based on Vollmar et al. (2017).

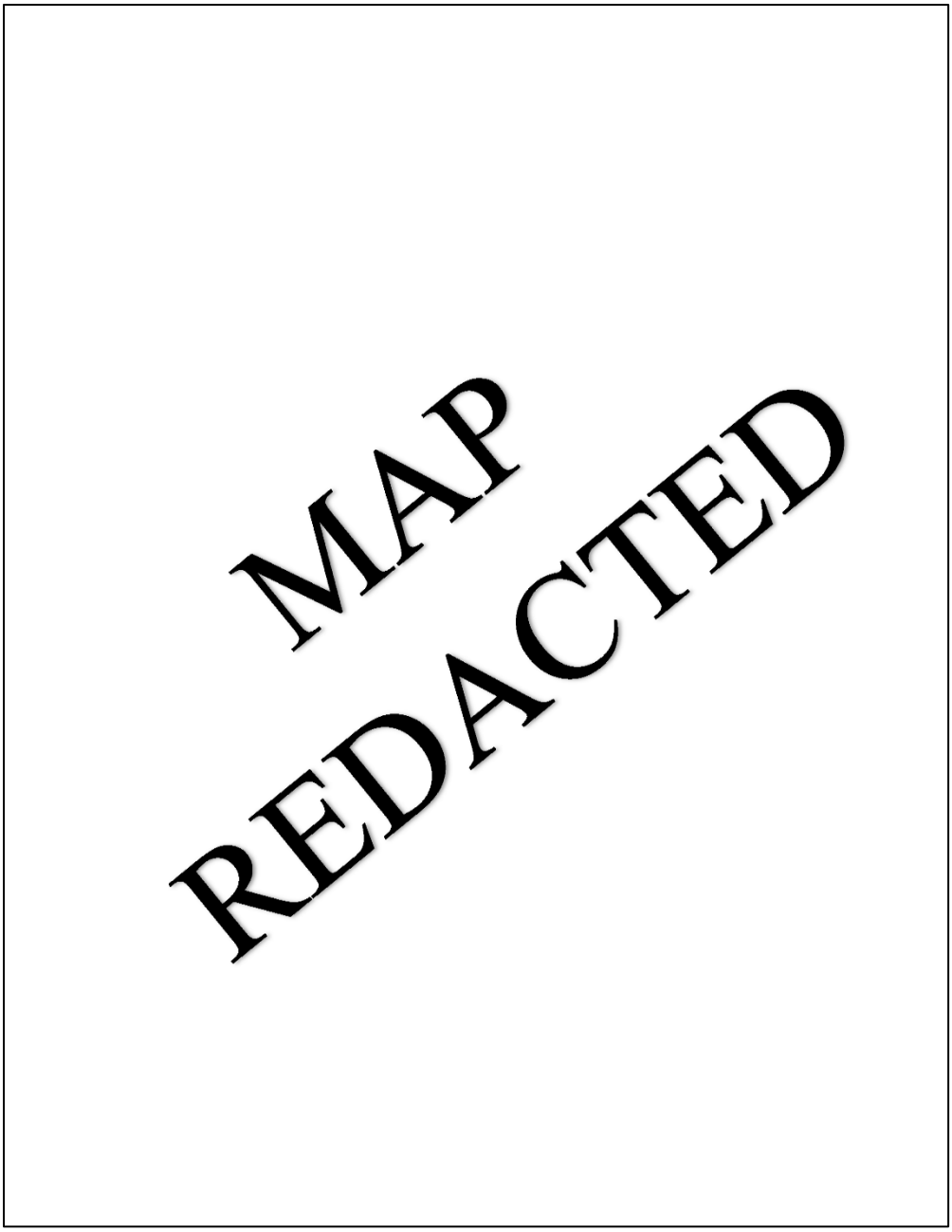


Figure 12.20. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Phoenix Field and Park Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

12.7.5. Southeast Sacramento Valley

This is a zone 2 core area, but it was not designated for the vernal pool fairy shrimp or vernal pool tadpole shrimp in the Recovery Plan. It was designated for fleshy owl's-clover (*Castilleja campestris* ssp. *succulenta*), with a goal of protecting 85% of vernal pool habitat. The core area is located in San Joaquin County just south of the border with Sacramento County, southeast of the City of Galt, and northeast of the City of Collierville.

There were approximately 922 acres of vernal pool grassland present in this core area in 2005, and only 734 acres remained as of 2018 (see **Figure 12.21**, **Table 12.1**; Witham 2021). This loss of 20% of vernal pool habitat precludes the goal of preserving 85% of habitat without habitat creation or restoration. Vollmar et al. (2017) did not document any protected lands within this core area. The Recovery Plan mentions that the Angraves Nature Study Area is within the core area (Service 2005a), but the Service could not find any further information about this site, indicating that it likely no longer exists.

12.7.5.1. Vernal Pool Fairy Shrimp Occurrences

There is one Diversity Database occurrence of the vernal pool fairy shrimp that slightly overlaps this core area (see **Figure 12.22**; Diversity Database 2022). This occurrence record documents the vernal pool fairy shrimp along the Central California Traction railroad tracks. Given the proximity of this occurrence to extant vernal pool grasslands, it is possible that the vernal pool fairy shrimp may occur throughout this core area.

12.7.5.2. Vernal Pool Tadpole Shrimp Occurrences

There is one Diversity Database occurrence of the vernal pool tadpole shrimp that slightly overlaps this core area (see **Figure 12.23**; Diversity Database 2022). This occurrence record documents the vernal pool tadpole shrimp along the Central California Traction railroad tracks. Given the proximity of this occurrence to extant vernal pool grasslands, it is possible that the vernal pool tadpole shrimp may occur throughout this core area.

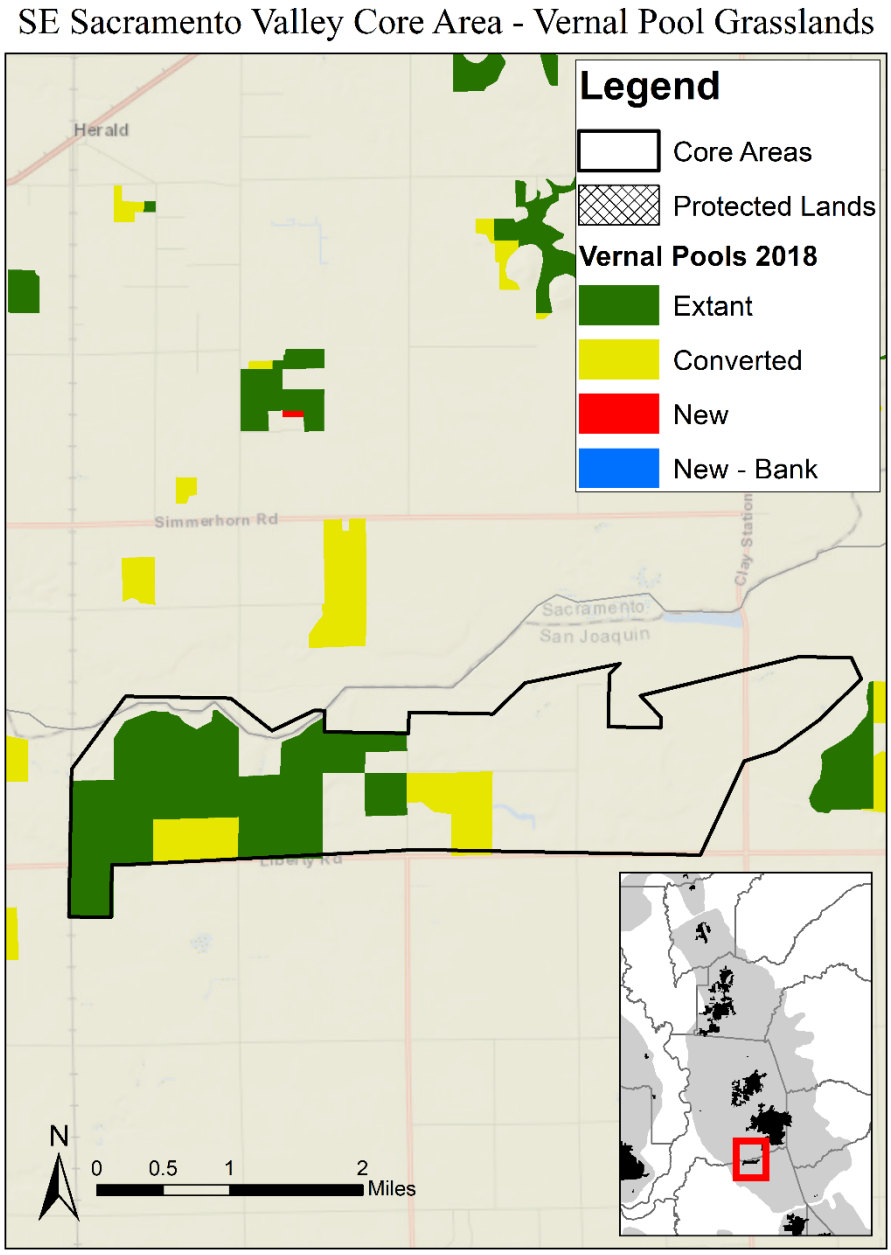


Figure 12.21. Map of vernal pool grassland habitat within the Southeast Sacramento Valley Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

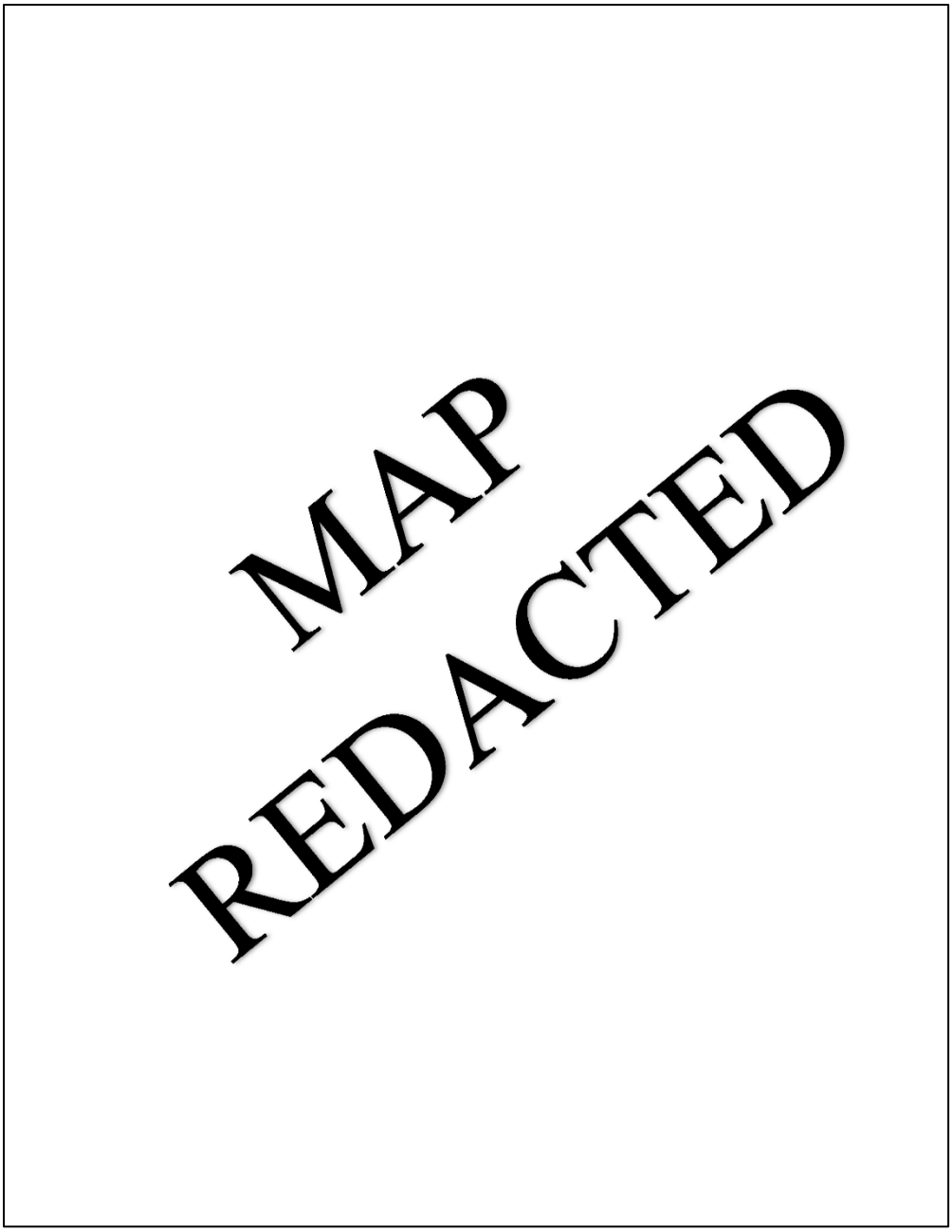


Figure 12.22. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Southeast Sacramento Valley Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

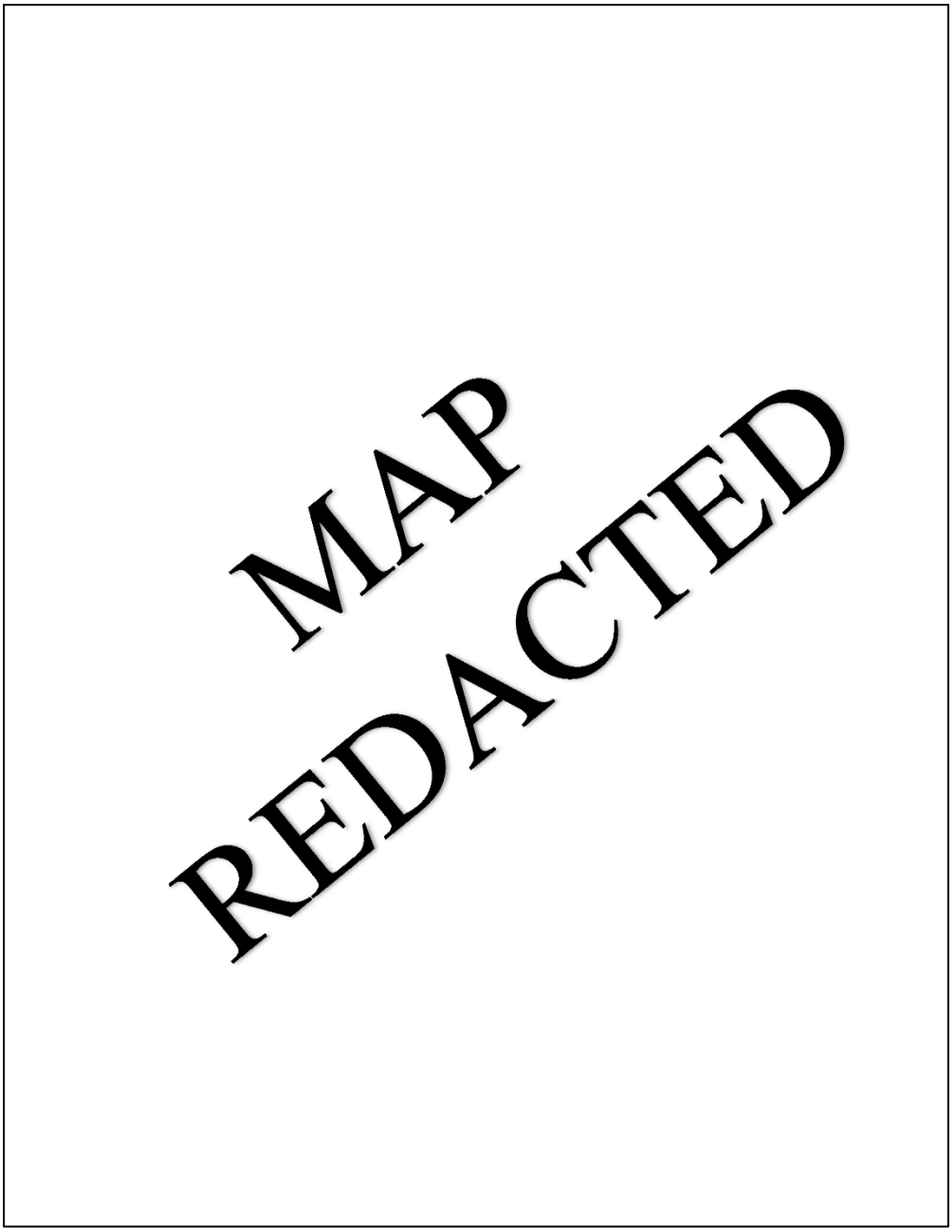


Figure 12.23. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Southeast Sacramento Valley Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

12.7.6. Stone Lake

This is a zone 2 core area, but it was not designated for the vernal pool fairy shrimp in the Recovery Plan. It was designated for legenere (*Legenere limosa*), with a goal of protecting 85% of vernal pool habitat. The core area is located entirely within the Sacramento Regional County Sanitation District's (Regional San) Bufferlands open space area in southern Sacramento County, just west of the City of Elk Grove, northeast of the Stone Lakes National Wildlife Refuge, and east of the Regional San wastewater treatment plant.

There are approximately 66 acres of vernal pool grassland that occur within this core area (see **Figure 12.24**, **Table 12.1**; Witham 2021), and all of this habitat was considered to be protected by Vollmar et al. (2017) due to being on public land owned by Regional San (see **Figure 12.25**). A master plan for the Bufferlands was published in 2000 to establish a long-term management direction that would maintain the existing buffer zone around the wastewater treatment plant, provide for future expansion and changes in operation of the plant, and protect and enhance the area's environmental resources (Carollo Engineers 2000). While the plan describes the vernal pool habitat and associated species known to occur onsite, it does not provide specific management recommendations for the vernal pools.

12.7.6.1. Vernal Pool Fairy Shrimp Occurrences

There is one Diversity Database occurrence of the vernal pool fairy shrimp, composed of multiple polygons, that partially overlaps this core area (see **Figure 12.26**; Diversity Database 2022). This occurrence record documents the vernal pool fairy shrimp within vernal pools that occur on either side of the railroad tracks that separate the Regional San facility on the west and Regional San's Bufferlands, which includes all of the Stone Lake Core Area, on the east. While the vernal pools within the core area have not been surveyed for the vernal pool fairy shrimp (besides the ones along the railroad tracks), it is likely that this species is present given the detection of the species along the adjacent railroad tracks.

12.7.6.2. Vernal Pool Tadpole Shrimp Occurrences

There is one Diversity Database occurrence of the vernal pool tadpole shrimp that encompasses the entirety of the Regional San Bufferlands, including this core area (see **Figure 12.27**; Diversity Database 2022). The vernal pool tadpole shrimp was documented within vernal pools that occur on either side of the railroad tracks that separate the Regional San facility on the west and Regional San's Bufferlands on the east in 1992, 1993, and 2012 (Diversity Database 2022). The species was also documented within 19 wetted acres of vernal pools throughout the 732-acre Bufferlands in 2000; specific locations were not given, so it is unclear how many of these pools are within the core area (Diversity Database 2022).

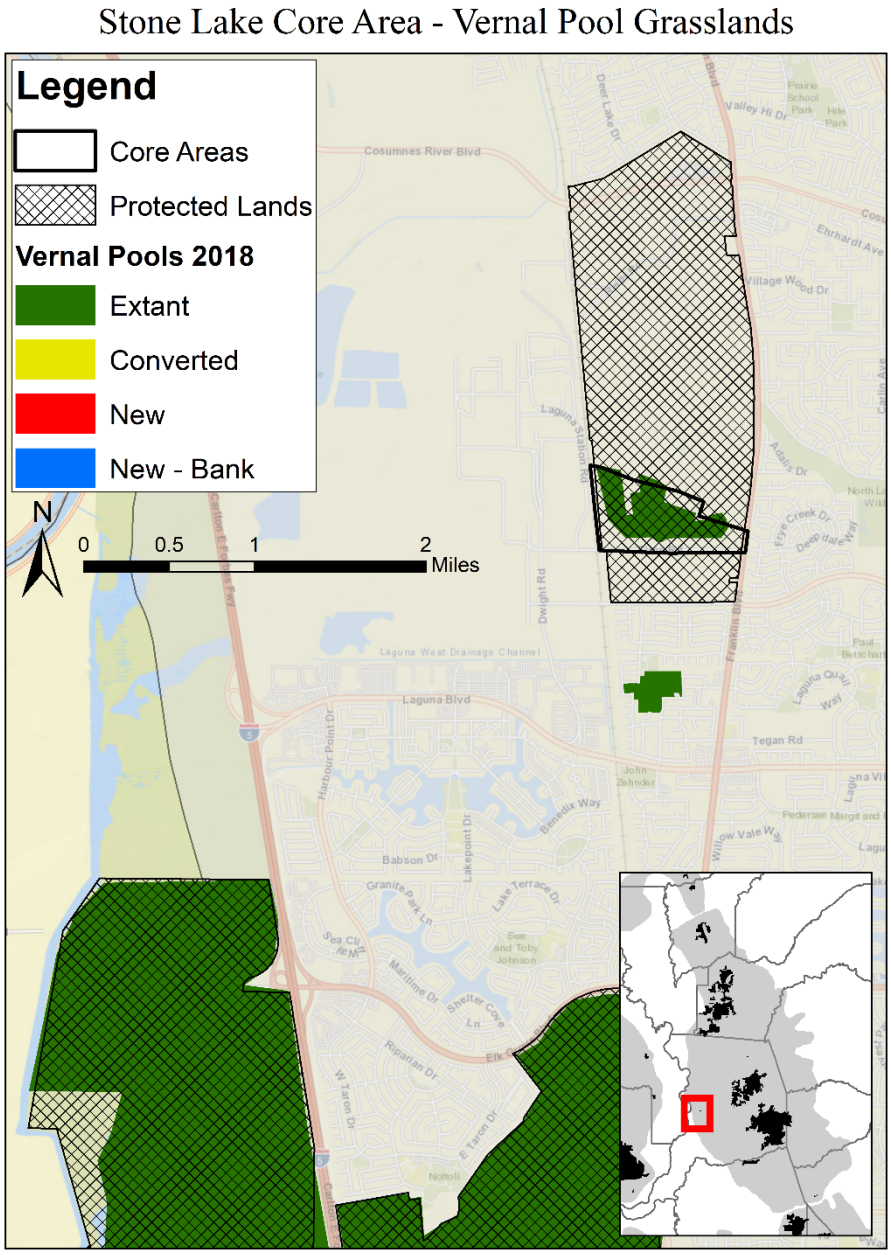


Figure 12.24. Map of vernal pool grassland habitat within the Stone Lake Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

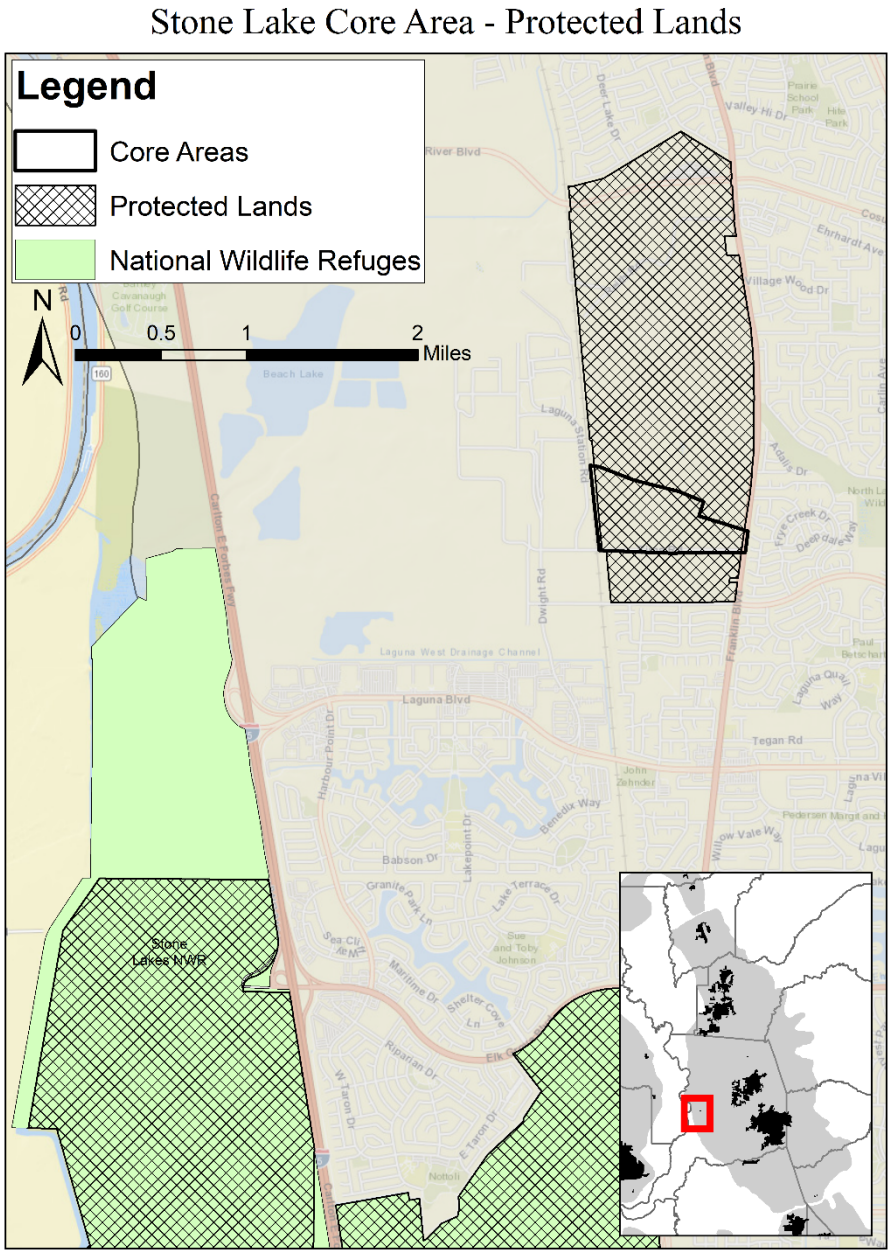


Figure 12.25. Map of protected areas within the Stone Lake Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves.

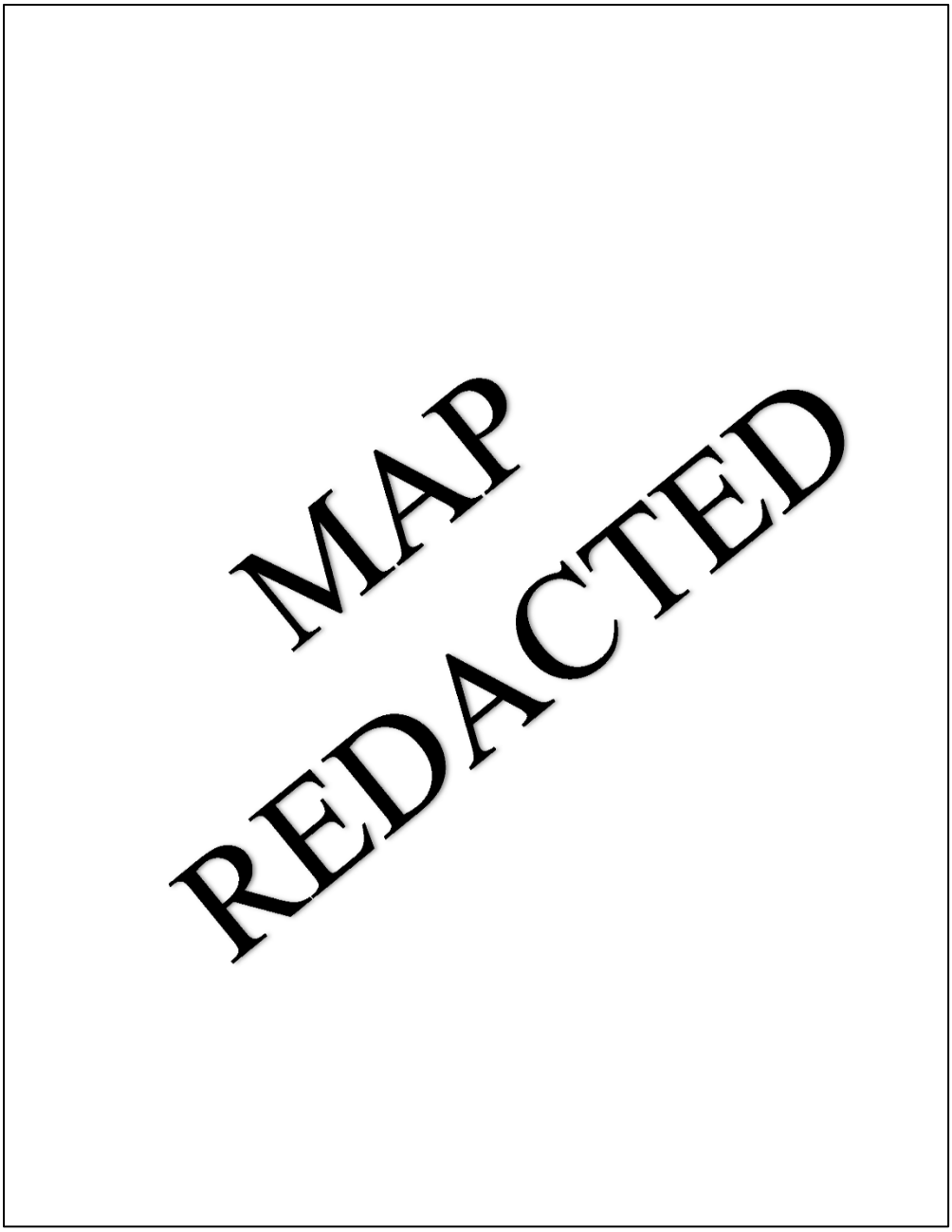


Figure 12.26. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Stone Lake Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

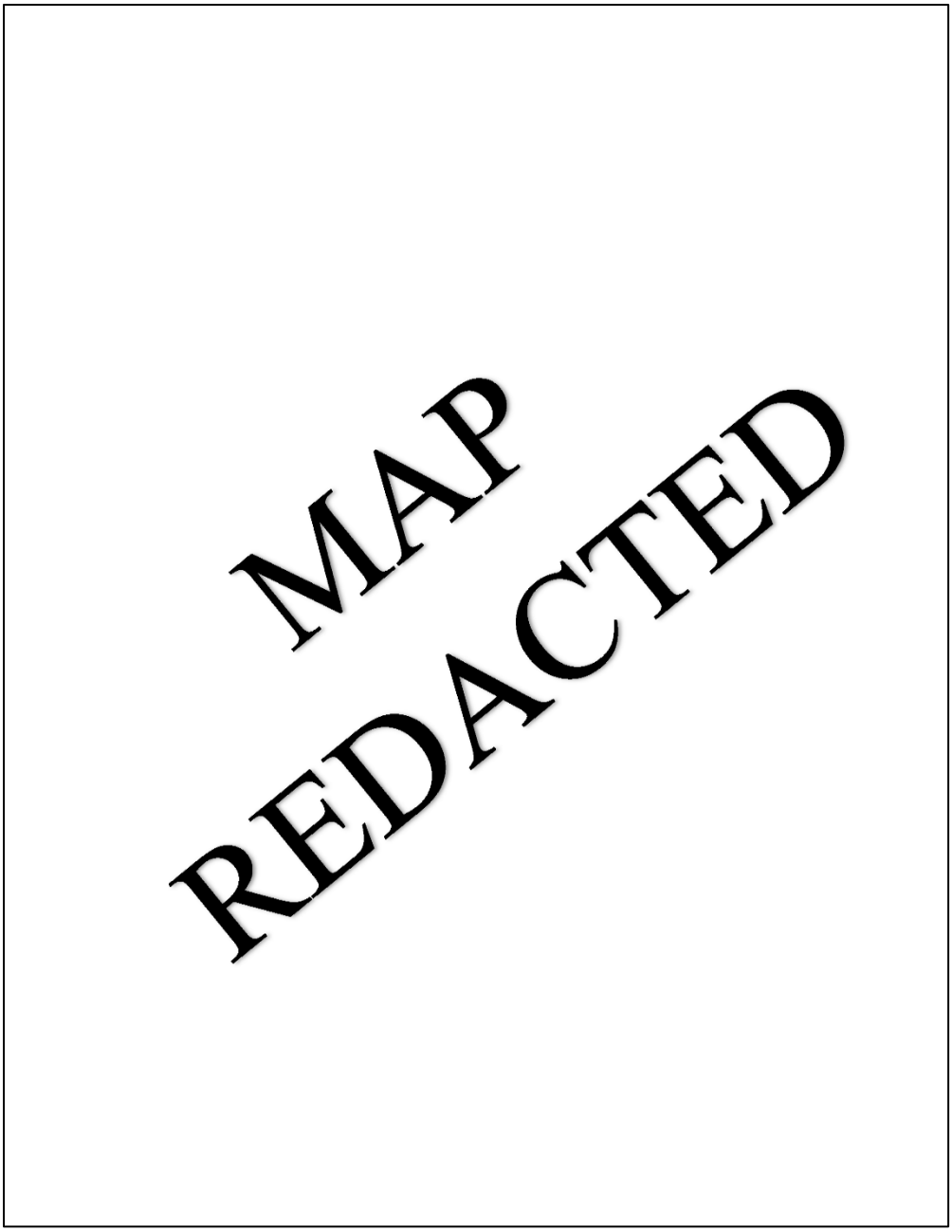


Figure 12.27. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Stone Lake Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

12.7.7. Western Placer County

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and vernal pool tadpole shrimp. This core area was not designated for the Conservancy fairy shrimp in the Recovery Plan, but the species is known to occur there. The core area is located in western Placer County and a very small portion of adjacent Sacramento County.

There were approximately 22,612 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 20,129 acres of vernal pool grassland remaining (see **Figure 12.28**, **Table 12.1**; Witham 2021). Approximately 2,997 acres had been lost since the Recovery Plan's 2005 baseline, though 254 additional acres were created on banks that were not previously mapped as vernal pool grassland in 2005 and 267 acres were identified that were either new or missed in previous mapping efforts (Witham 2021). The majority of losses were due to conversion to bare plowed agricultural lands (1,944 acres, 64.9%), with the remaining losses mainly due to urbanization (1,016 acres, 33.9%) (**Table 12.2**). Although losses to urbanization were not the majority, urbanization was a greater threat in this area than throughout the Southeastern Sacramento Valley Vernal Pool Region in general, where losses of vernal pool grassland to urbanization represented only 18.4% of losses.

Roughly 6,742 acres of vernal pool grassland were protected within this core area as of 2017 (Vollmar et al. 2017), representing 30% of the 2005 baseline. The Western Placer County HCP documented 5,421 acres of vernal pool grassland that were protected within the core area on existing preserves as of 2020 (PCCP 2020). Witham (2021) and the HCP did not use the same methodology to map vernal pool habitat so this number is not directly comparable to the 2005 baseline or the amount of protected habitat estimated by Vollmar et al. (2017). Six Western Placer County HCP preserves have been established, though one of these properties (Ellis Reserve) is already captured in Vollmar et al.'s (2017) database. These preserves protect 1,351 acres of vernal pool complex; very little of this habitat occurs on the Ellis Reserve. Thus, a total of approximately 8,093 acres of vernal pool grassland have been preserved in this core area as of 2023, representing 35.8% of the 2005 baseline.

This core area is entirely within the boundaries of the Western Placer County HCP, except for the 0.14 square mile portion of the core area in Sacramento County (PCCP 2020). Land cover mapping efforts for this HCP mapped 25,526 acres of vernal pool complexes within the core area, slightly higher than Witham's (2021) estimate. Combined with existing protected vernal pool complexes (5,421 acres, as estimated in the HCP), implementation of the HCP will result in protection of 51% of the vernal pool complexes in the core area. This falls short of the 85% goal of the Recovery Plan. However, the HCP will result in 27,068 acres of protected and restored vernal pool complexes throughout all of western Placer County, which is greater than the 85% (26,420 acres, as estimated in the HCP) of protected acreage recommended by the Recovery Plan. Section 5.4.11.3 of the HCP describes how the HCP meets the six criteria for alternative conservation mechanisms from the Recovery Plan (described in the Recovery Plan Concepts section above), meaning that successful implementation of the HCP should result in meeting this core area's recovery goals at the end of the HCP's 50-year permit term.

There are five conservation banks with vernal pool fairy shrimp preservation and/or creation credits in the core area: Antonio Mountain Ranch Mitigation Bank, Mariner Vernal Pool Conservation Bank, Orchard Creek Conservation Bank, Toad Hill Ranch Mitigation Bank, and Western Placer Schools Conservation Bank (**Figure 12.29**). These banks total 3,426 acres in size and have 194.21 acres of preservation credits and 74.79 acres creation credits for the vernal pool fairy shrimp (78.7% and 72.1% of which have already been sold, respectively). Although most activities within the core area are covered under the Western Placer County HCP, these banks can continue to sell credits to compensate for activities that are outside the jurisdiction of, or otherwise not covered by, the Western Placer County HCP.

Other preserves within the core area include: six Western Placer County HCP preserves (Amoruso Ranch, Bradley, East Sheridan 297, Ellis, Markham Ravine, and Redwing South), East Sheridan Vernal Pool Preserve, Yankee Slough, Doty Ravine, Swainson's Preserve, Lincoln Open Space Preserve (Foskett Ranch Open Space Preserve, Three D South Preserve, Lincoln Crossing Preserve, RG-1 Rodeo Grounds Preserve, and Sterling Pointe Preserve units), Rockwell Ranch Vernal Pool Preserve, Twelve Bridges Open Space Preserve, Orchard Creek, Moore Ranch Preserve (aka Woodcreek West and Highland Reserve North), Aitken Ranch, John D. Vincent, Reason Farms Environmental Preserve, and West Roseville Specific Plan Preserves. At least 776 acres of these are within the City of Roseville and are managed under the Roseville Open Space Preserve Overarching Management Plan, which the Service consulted on in 2011.

12.7.7.1. Vernal Pool Fairy Shrimp Occurrences

There are 41 occurrence records from the Diversity Database for the vernal pool fairy shrimp within this core area (see **Figure 12.30**; Diversity Database 2022). As of 2018, 25 of these occurrences were at least partially within protected areas (Vollmar et al. 2017). All are presumed extant by the Diversity Database, though two occurrences were partially within areas mapped as having vernal pool habitat loss (Witham 2021). Vernal pool fairy shrimp were first detected within this core area in 1980 and new Diversity Database records have been consistently reported up through 2016 (Diversity Database 2022). The vernal pool fairy shrimp has been found in vernal pool grasslands throughout the entire extent of this core area.

12.7.7.2. Vernal Pool Tadpole Shrimp Occurrences

There are two occurrence records from the Diversity Database for the vernal pool tadpole shrimp within this core area (see **Figure 12.31**; Diversity Database 2022). As of 2018, one of these occurrences was within protected areas (Vollmar et al. 2017). One is presumed extant by the Diversity Database and one is presumed extirpated; both are within extant vernal pool grassland (Witham 2021). The extant occurrence is located on the U.S. Air Force's Lincoln Receiver Site and adjacent Western Placer Schools Conservation Bank. It was first detected in 1994 and was consistently observed through 2013 (Diversity Database 2022). The presumed extirpated occurrence is located adjacent to Industrial Avenue just south of Highway 65. One cyst was detected during dry-season surveys in 2002. The occurrence is presumed extirpated because the pool where the cyst was found was paved over for a road expansion project, though it is possible that undisturbed vernal pools in the surrounding vernal pool complex may also support the vernal pool tadpole shrimp (Diversity Database 2022).

12.7.7.1. Conservancy Fairy Shrimp Occurrences

There is one occurrence record from the Diversity Database for the Conservancy fairy shrimp within this core area (Diversity Database 2022). The occurrence is protected within the Mariner Vernal Pool Conservation Bank (**Figure 12.29**). The species was first detected in 2007 and has been found during monitoring consistently through 2017. The Conservancy fairy shrimp has not been detected anywhere else within this core area despite numerous surveys conducted over the last 30 years associated with projects, conservation, and research activities.

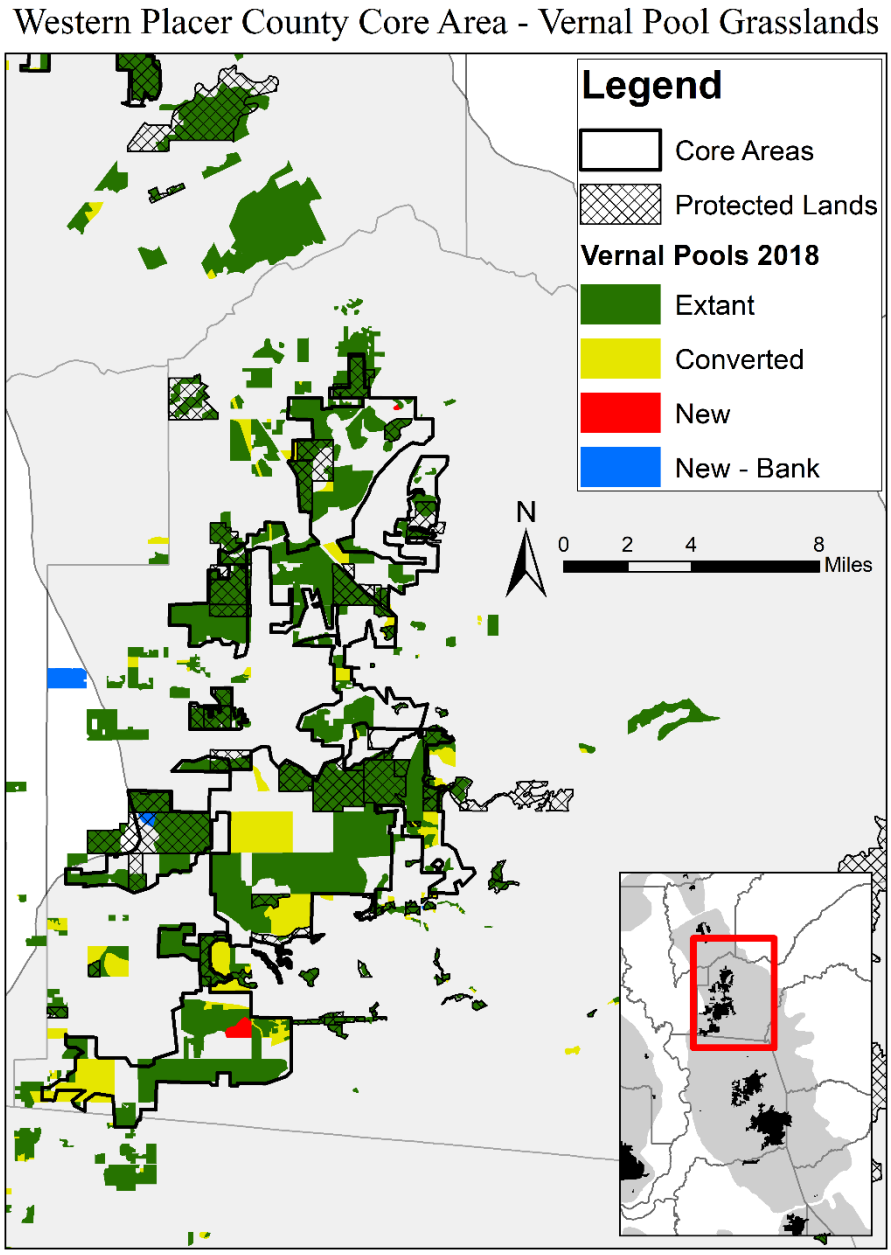


Figure 12.28. Map of vernal pool grassland habitat within the Western Placer County Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

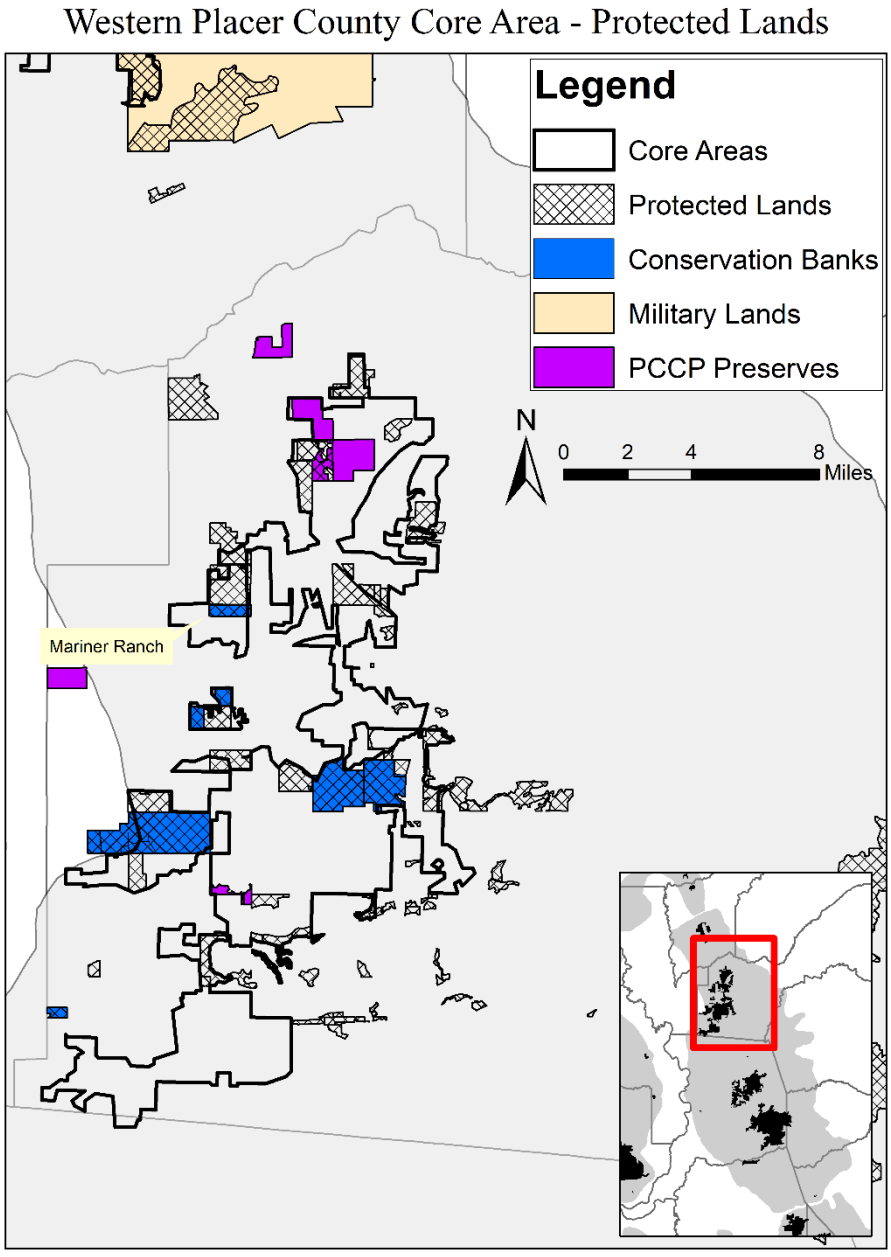


Figure 12.29. Map of protected areas within the Western Placer County Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves.

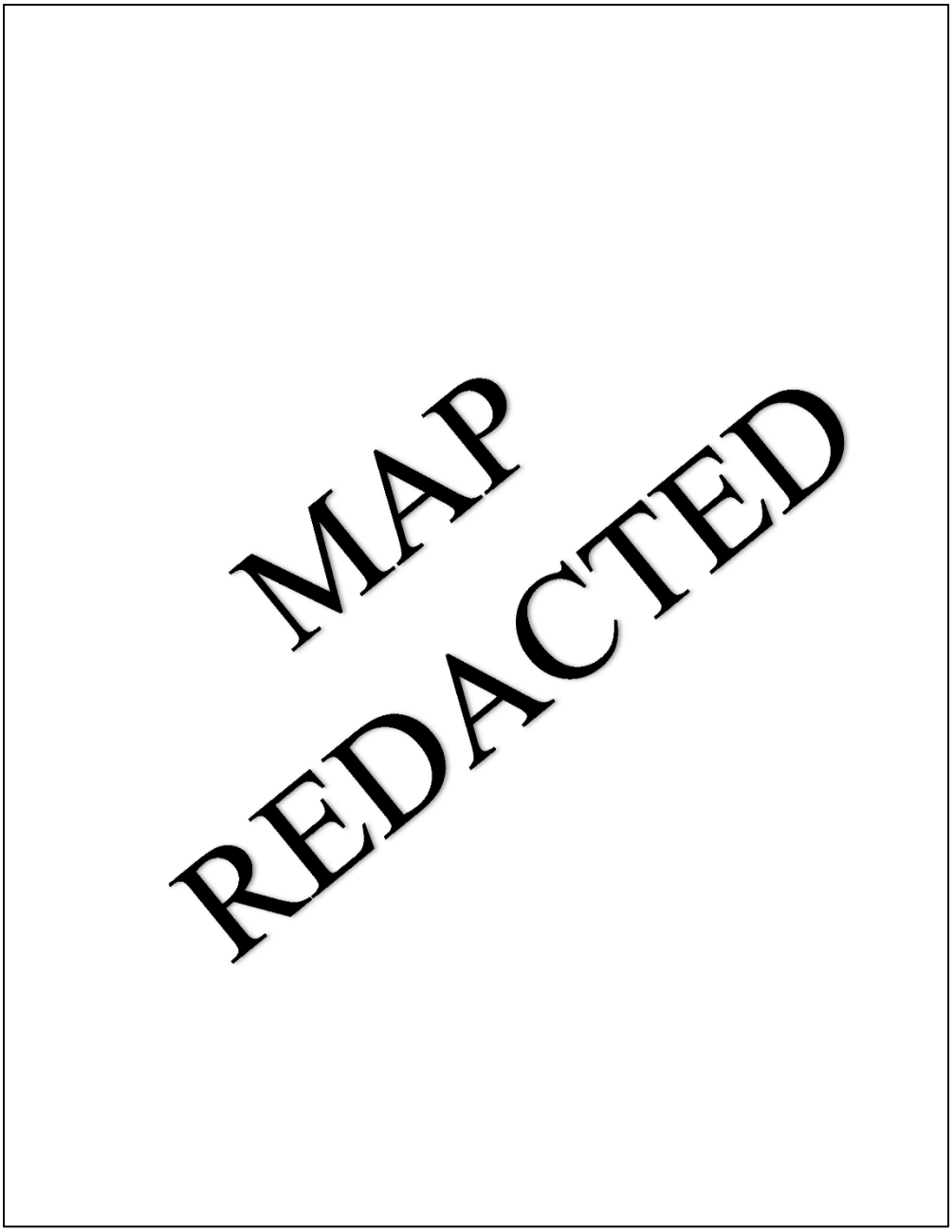


Figure 12.30. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Western Placer County Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

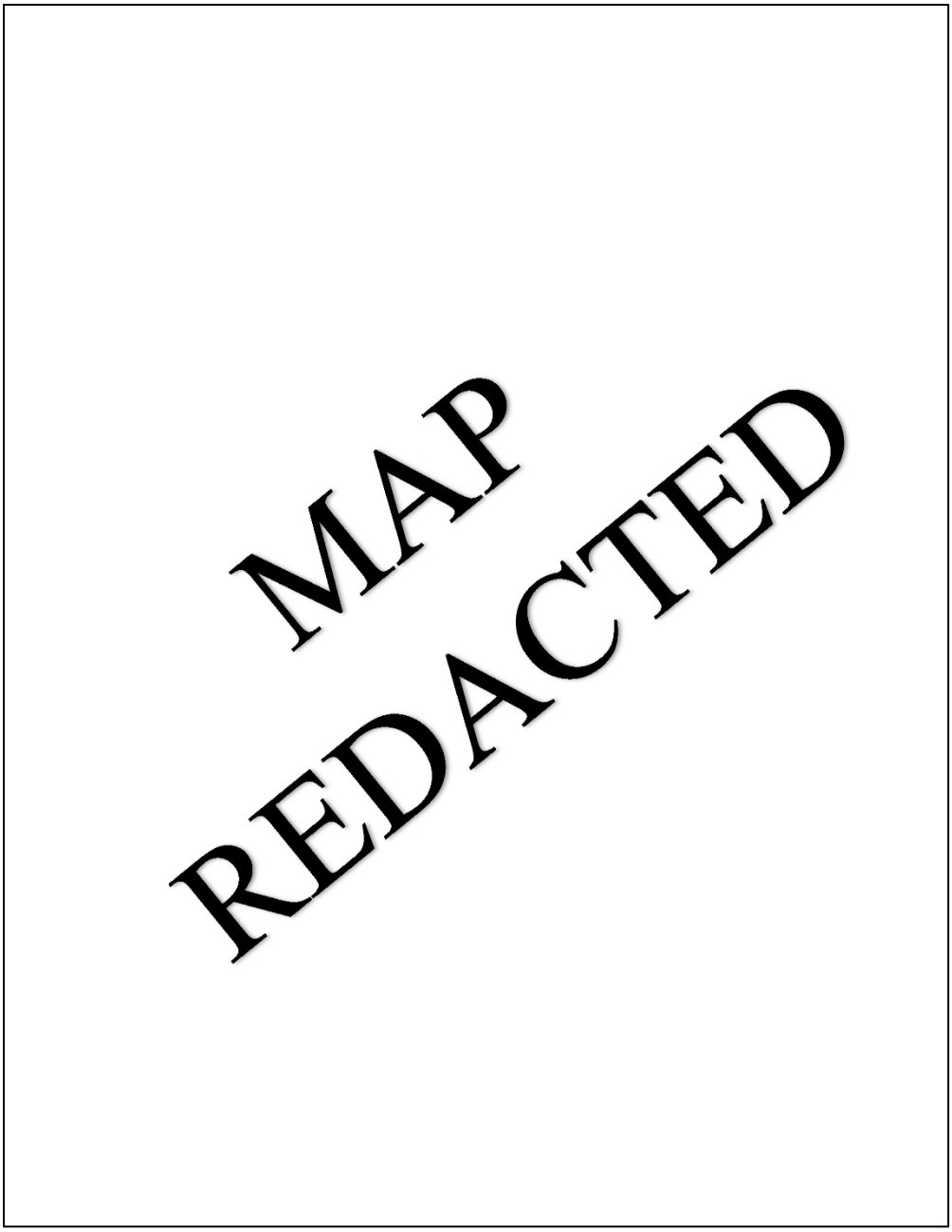


Figure 12.31. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Western Placer County Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

13. SOUTHERN SIERRA FOOTHILLS VERNAL POOL REGION

All three shrimp species occur within the Southern Sierra Foothills Vernal Pool Region.

13.1. Vernal Pool Habitat

Approximately 207,969 acres of vernal pool grassland existed within, or immediately adjacent to, this region when the Recovery Plan was published in 2005 (see **Figure 13.1**, **Table 13.1**; Witham et al. 2013). Approximately 190,042 acres remained as of 2012, with 17,927 (8.6% of 2005 total) lost between 2005 and 2012 (Witham et al. 2014). No new areas of vernal pool habitat were identified in 2012, either newly created habitat or habitat that had been missed in the 2005 aerial imagery. Of the habitat lost, 257 acres (1.4%) were to urbanization and 17,670 acres (98.6%) were to agricultural conversion (57.7% to orchards, 39.3% to bare plowed agricultural land, and 1.6% to other agricultural uses) (Witham et al. 2014).

By 2018, approximately 182,973 acres remained, with a total of 25,878 acres lost between 2005 and 2018 (see **Table 13.1**; Witham 2021). However, a total of 361 acres of new vernal pool grassland were identified in the 2018 aerial imagery: 61 acres on new mitigation banks created since 2012 and 260 acres that were either not present or not visible on both the 2005 and 2012 aerial imagery. Of the habitat lost since 2005, 299 acres (1.1%) were to urbanization and 25,878 acres (98.8%) were to agricultural conversions (75.6% to orchards, 21.7% to bare plowed agricultural land, and 1.5% to other agricultural uses) (see **Table 13.2**; Witham 2021). Note that many patches of vernal pool grassland that had been converted to bare plowed land in 2012 had been fully converted to agricultural use, mainly orchards, by 2018. There were also conversions of 12.6 acres of vernal pool grasslands to managed wetlands with hydrology that no longer supported vernal pool species.

This vernal pool region had the second highest amount of extant vernal pool habitat in 2005 of all the vernal pool regions, and this is still true today (Witham 2021). This region also exhibited the highest amount of vernal pool losses in the Central Valley, although proportional to total habitat it was second to the Northwestern Sacramento Valley Vernal Pool Region (Witham 2021). The vast majority of vernal pool losses within this region have been to agricultural conversions (98.8%), which is unsurprising given that the region is composed primarily of agricultural lands and very few cities or towns. The outskirts of Fresno and Merced extend into the vernal pool region, but there is not much vernal pool grassland directly adjacent to these urban areas with the exception of the area around the University of California Merced campus. Many of the losses in this region are likely due to land conversions to orchards that should be regulated by the Clean Water Act but that are proceeding illegally without the necessary 404 permit from the Corps (Witham et al. 2014; Witham 2021). This region had more than twice the losses to orchards compared to the next highest region, the neighboring San Joaquin Valley Vernal Pool Region. This region is also unique in the size of its Core Areas. There are 15 core areas designated by the Recovery Plan in this region totaling 820,569 acres in size, with the Madera and Merced being the two largest core areas. This is by far the largest acreage of core areas in a single vernal pool region, having three times the acreage of the next largest vernal pool region (Central Coast), and representing 33% of all land designated as core areas throughout all of California and southern Oregon.

As of 2018, roughly 32,737 acres of vernal pool grassland was estimated to be protected in this region, or immediately adjacent to it (see **Figure 13.1**, **Figure 13.2**, **Table 13.1**; Witham 2021; Vollmar et al. 2017). This represents 18% of the currently remaining vernal pool grassland in the region and 16% of the vernal pool grassland that existed in 2005, the Recovery Plan's baseline. This vernal pool region has the second lowest percentage of protected vernal pool habitat in the Central Valley, though the actual amount is still greater than the amount protected in the Northwestern Sacramento Valley and Solano-Colusa regions due to the Southern Sierra Foothills' large amount of extant habitat (Witham 2021).

13.2. Species Occurrences

13.2.1. Vernal Pool Fairy Shrimp

There are 307 occurrence records of the vernal pool fairy shrimp documented within, or immediately adjacent to, the Southern Sierra Foothills Vernal Pool Region in the Diversity Database (see **Figure 13.3**; Diversity Database 2022). There are a wide variety of private and public landowners listed in the Diversity Database for these occurrences, and occurrences on private land in particular are vulnerable to extirpation (Diversity Database 2022). One occurrence is listed as possibly extirpated by the Diversity Database; of the other 306 occurrences, 223 occur within extant vernal pool habitat based on Witham's (2021) mapping efforts, 9 occur within extirpated vernal pool habitat, and 74 are outside of mapped vernal pool habitat.

The protected areas contain, at least partially, 116 of the 307 Diversity Database records (38%) for the vernal pool fairy shrimp in this region. However, this does not mean that 38% of all occurrences of the vernal pool fairy shrimp in this region have been protected, as the Diversity Database is not an appropriate source for determining all known occurrences (individual Diversity Database records are not necessarily equivalent to occurrences, and some known occurrences may not be documented in the Diversity Database). There are 81 of the 307 Diversity Database polygons (26%) that are entirely within the protected areas; the difference between the number of records partially and entirely within the mapped protected areas is likely a reflection of the irregular size and shape of polygons in the Diversity Database, as well as slight discrepancies in the overlap between the two databases.

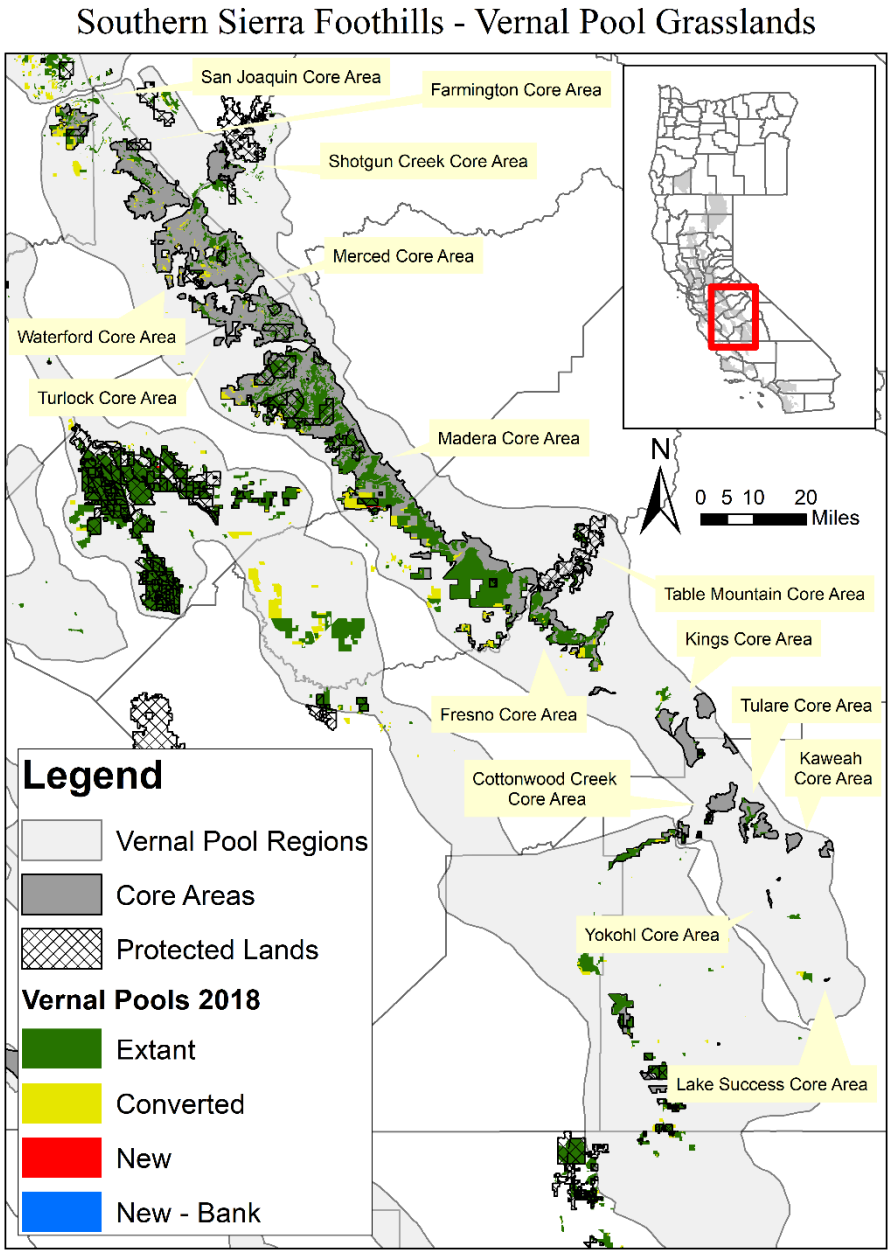


Figure 13.1. Map of vernal pool habitat within the Southern Sierra Foothills Vernal Pool Region mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

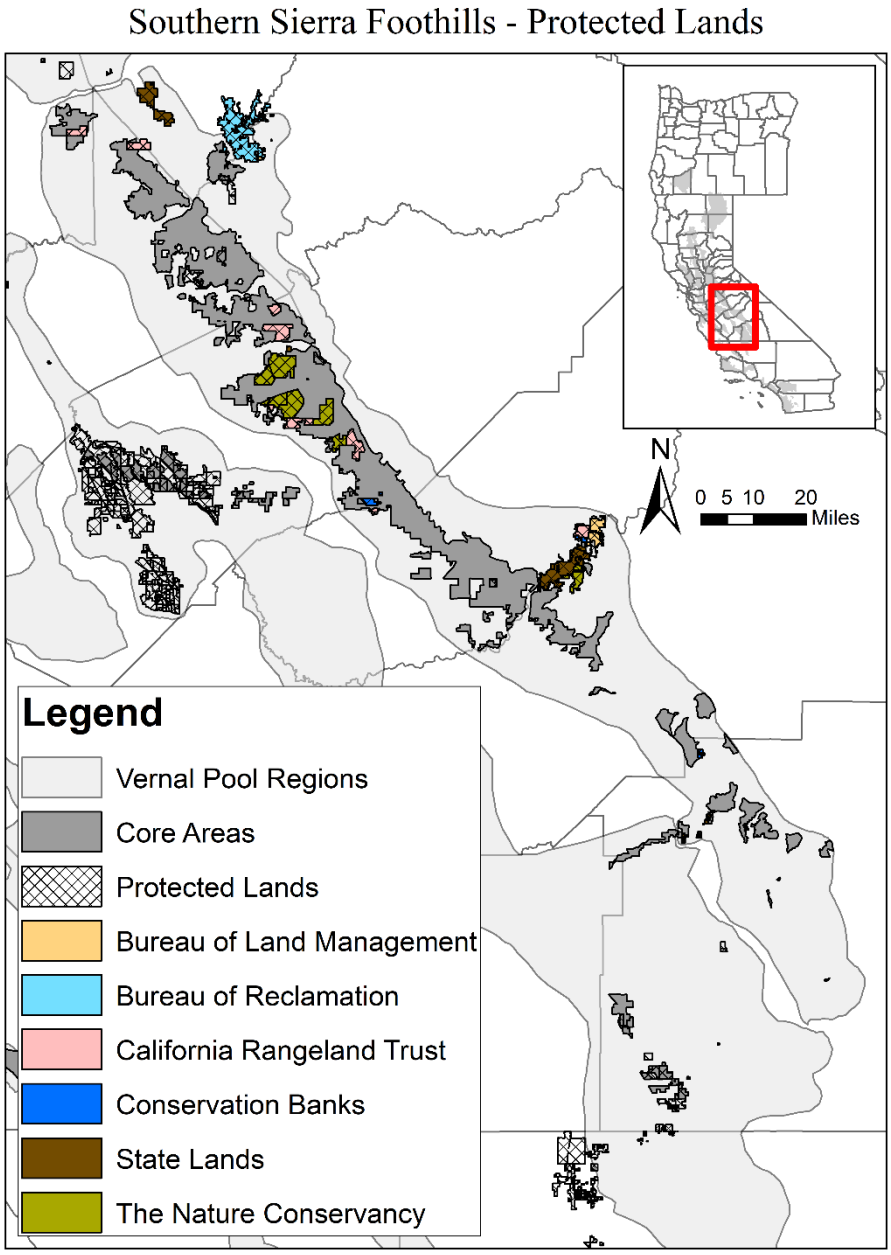


Figure 13.2. Map of protected areas that contain vernal pool grassland habitat and/or vernal pool fairy shrimp within the Southern Sierra Foothills Vernal Pool Region**.** Protected lands are based on Vollmar et al. (2017) and include various preserves. Zoom in for finer resolution.

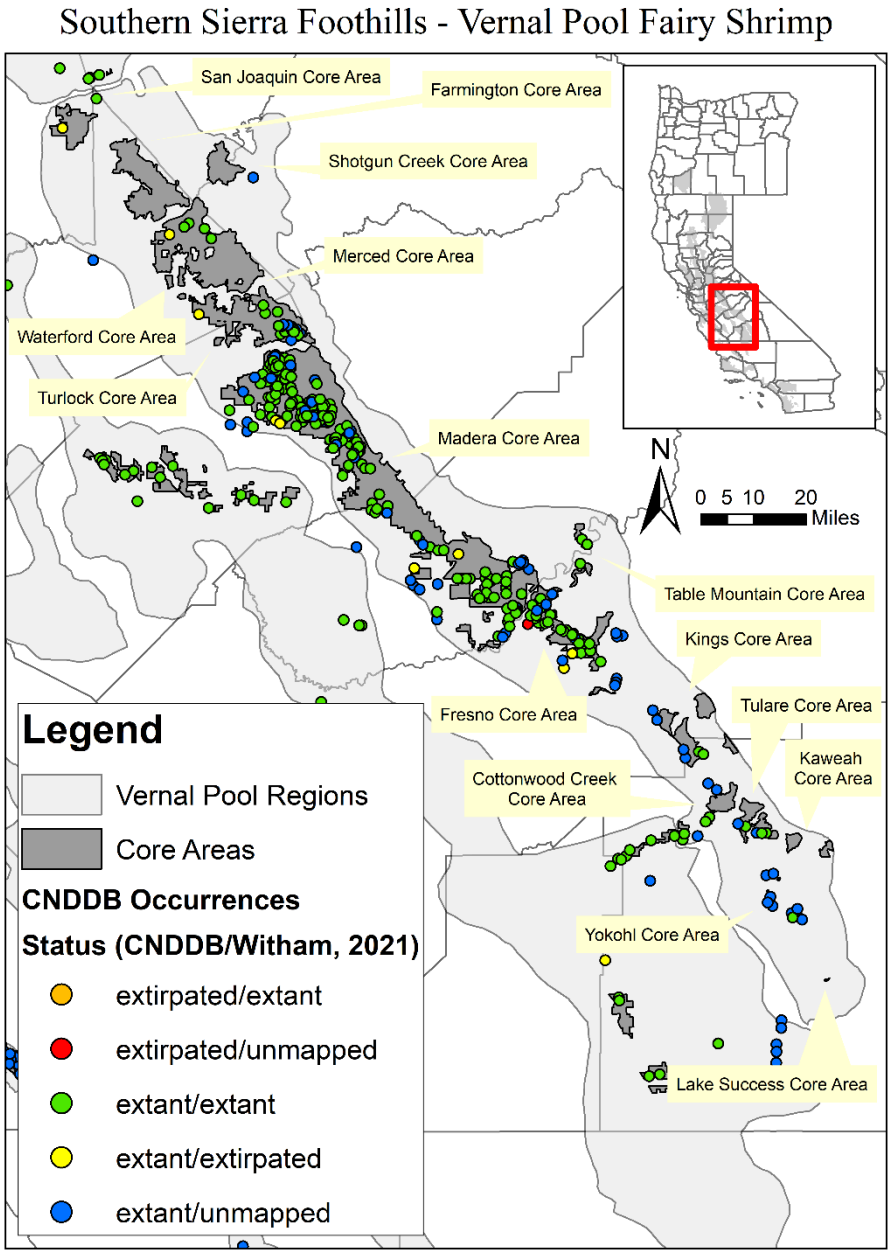


Figure 13.3. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) in the Southern Sierra Foothills Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both Diversity Database occurrence records and Witham's (2021) map of vernal pool habitat. All 15 core areas in the region are displayed, though not all core areas are designated for the vernal pool fairy shrimp.

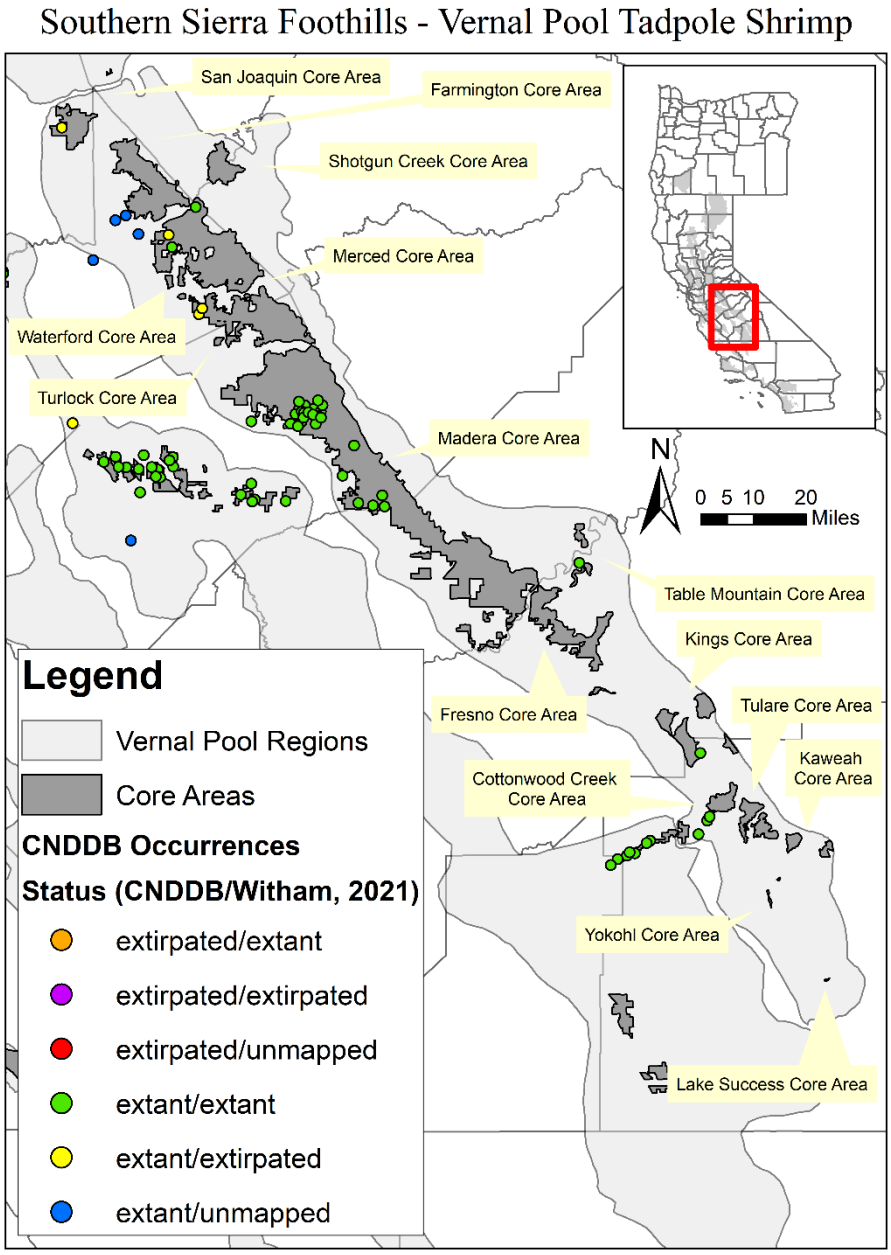


Figure 13.4. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) in the Southern Sierra Foothills Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both Diversity Database occurrence records and Witham's (2021) map of vernal pool habitat. All 15 core areas in the region are displayed, though not all core areas are designated for the vernal pool tadpole shrimp.

Table 13.1. Acreage of vernal pool habitat and habitat converted within the Southern Sierra Foothills Vernal Pool Region mapped by Witham (2021). All habitat labeled as not converted, altered, or new was considered extant. Protected acreage is based on Vollmar et al. (2017).

Core Area	2005 Acres	2018 Acres Total	2018 Acres Extant (% of Total)	2018 Acres Converted – Agriculture (% of Total)	2018 Acres Converted – Urban Development (% of Total)	2018 Acres Protected (% of Total)
Cottonwood Creek	1,049.0	1,049.0	1,045.4 (99.7%)	3.6 (0.3%)	0.0 (0.0%)	934.9 (89.1%)
Fresno	15,786.7	15,786.7	14,462.3 (91.6%)	1,324.4 (8.4%)	0.0 (0.0%)	18.0 (0.1%)
Kings	660.1	716.1	668.2 (93.3%)	47.9 (6.7%)	0.0 (0.0%)	341.5 (47.7%)
Madera	127,812.0	128,166.8	117,938.1 (92.0%)	9,988.2 (7.8%)	240.5 (0.2%)	24,564.0 (19.2%)
Merced	20,417.3	20,535.2	17,292.8 (84.2%)	3,229.8 (15.7%)	0.0 (0.0%)	3,161.1 (15.4%)
San Joaquin	7,259.0	7,259.0	4,229.1 (58.3%)	3,029.9 (41.7%)	0.0 (0.0%)	937.4 (12.9%)
Table Mountain	1,738.3	1,738.3	1,738.3 (100.0%)	0.0 (0.0%)	0.0 (0.0%)	1,460.0 (84.0%)
Tulare	1,584.3	1,584.3	1,584.3 (100.0%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)
Turlock	6.6	6.6	6.6 (100.0%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)
Southern Sierra Foothills Vernal Pool Region Total	**207,969.3**	**208,862.4**	**182,972.7 (87.5%)**	**25,878.2 (12.4%)**	**298.8 (0.1%)**	**32,737.1 (15.7%)**

Table 13.2. Acreage of vernal pool habitat losses within the Southern Sierra Foothills Vernal Pool Region between 2005 and 2018 mapped by Witham (2021), broken down by what the land use was converted to. All categories besides urban development and managed wetlands are considered agricultural conversions.

Core Area	Urban, Commercial, & Industrial	Orchards, Vineyards, Eucalyptus	Alfalfa and Irrigated Pasture	Bare Plowed Agricultural Lands	Other Ag (Rice, Row Crops, Dairy, Nurseries)	Agricultural Residential	Managed Wetlands	Total Losses	% Losses Urban Development	% Losses Agricultural Conversions
Cottonwood Creek	0.0	0.0	0.0	3.6	0.0	0.0	0.0	3.6	0.0%	100%
Fresno	0.0	312.2	0.0	876.2	9.9	126.1	0.0	1,324.4	0.0%	100%
Kings	0.0	0.0	0.0	47.9	0.0	0.0	0.0	47.9	0.0%	100%
Madera	240.5	8,030.0	0.0	1,912.0	45.3	0.9	0.0	9,988.2	2.4%	97.6%
Merced	0.0	2,829.4	11.4	331.9	56.7	0.4	12.6	3,229.8	0.0%	99.6%
San Joaquin	0.0	2,257.4	14.4	747.8	10.3	0.0	0.0	3,029.9	0.0%	100%
Table Mountain	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Tulare	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Turlock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Southern Sierra Foothills Vernal Pool Region Total	**298.8**	**19,804.8**	**41.9**	**5,684.4**	**154.9**	**192.2**	**12.6**	**25,878.2**	**1.1%**	**98.8%**

13.2.2. Vernal Pool Tadpole Shrimp

There are 42 occurrence records of the vernal pool tadpole shrimp documented within, or immediately adjacent to, the Southern Sierra Foothills Vernal Pool Region in the Diversity Database (see **Figure 13.4**; Diversity Database 2022). There are a wide variety of private and public landowners listed in the Diversity Database for these occurrences, and occurrences on private land in particular are vulnerable to extirpation (Diversity Database 2022). All are presumed extant by the Diversity Database; 34 occur within extant vernal pool habitat based on Witham's (2021) mapping efforts, 4 occur within extirpated vernal pool habitat, and 4 are outside of mapped vernal pool habitat.

The protected areas contain, at least partially, 21 of the 42 Diversity Database records (50%) for the vernal pool tadpole shrimp in this region. There are 5 of the 42 Diversity Database polygons (12%) that are entirely within the protected areas; the difference between the number of records partially and entirely within the mapped protected areas is likely a reflection of the irregular size and shape of polygons in the Diversity Database, as well as slight discrepancies in the overlap between the two databases.

13.2.3. Conservancy Fairy Shrimp

There are nine occurrence records of the Conservancy fairy shrimp documented within the Southern Sierra Foothills Vernal Pool Region in the Diversity Database (Diversity Database 2022). These occurrences are all considered part of the UC Merced population and are within the Madera Core Area. However, four of these occurrences were first documented in 2016 (after the last 5-year review in 2012) on Roen Ranch and are approximately 10 miles southeast of the previously known occurrences in the UC Merced population (Diversity Database 2022). Due to the proximity to the UC Merced population and the somewhat continuous stretch of vernal pool grasslands between the two locations, the Service will consider the Roen Ranch occurrences to be a southern extension of the UC Merced population unless future evidence suggests that these two locations should be considered separately. All occurrences are presumed extant by the Diversity Database and are within extant vernal pool grasslands (Witham 2021). See the Madera Core Area section for more details.

13.3. Federal Lands

13.3.1. National Wildlife Refuges

There are no National Wildlife Refuges with known occurrences of the three shrimp species in the Southern Sierra Foothills Vernal Pool Region.

13.3.2. Military Lands

There are no military lands with known occurrences of the three shrimp species in the Southern Sierra Foothills Vernal Pool Region.

13.3.3. Bureau of Land Management

The Bureau of Land Management (BLM) has lands with mapped vernal pool grasslands (Witham 2021) in Madera and Fresno Counties around the San Joaquin River Gorge, Table Mountain, and Kennedy Mountain and in Calaveras and Tuolumne Counties mainly around Table Mountain and New Melones Lake (**Figure 13.2**). Madera and Fresno Counties are within the jurisdiction of the BLM's Bakersfield Field Office; all of these lands are managed under that office's Resource Management Plan from 2014 (BLM 2014). Objectives specific to vernal pool habitat include maintaining the hydrologic regime of vernal pools, delineating the Table Mountain and Kennedy Table areas as areas of ecological importance for protection of vernal pools and vernal pool species (both areas are within the Table Mountain Core Area), avoiding vernal pools by 300 feet during certain project activities, and compensating for any impacts to vernal pool habitat by preserving habitat at a 5:1 ratio and replacing habitat at a 1:1 ratio (BLM 2014). Vernal pools are only known to occur within the 1,059-acre Table Mountain and 60-acre Kennedy Table areas of ecological importance, both of which provide known habitat for the vernal pool fairy shrimp and potential habitat for the vernal pool tadpole shrimp (BLM 2012). The nearest known occurrence of the vernal pool tadpole shrimp is on CDFW's Big Table Mountain Ecological Reserve (Diversity Database 2022).

Calaveras and Tuolumne Counties are within the jurisdiction of the BLM's Mother Lode Field Office; all of these lands are managed under the Sierra Resource Management Plan from 2008 (BLM 2008). The valley grassland and vernal pool conservation strategy within that plan has the objective to sustain and manage the valley grassland and vernal pool ecosystems within the Mother Lode Field Office area to support viable populations of several vernal pool animal species through management of ecosystem processes and associated species and through management of habitat on BLM land (BLM 2008). The plan then contains an extensive list of prioritized goals and avoidance measures, including identifying vernal pool habitat and inventorying vernal pool species occurrences within the Mother Lode Field Office's jurisdiction, protecting the Tuolumne County Table Mountain vernal pools through monitoring and range management, using compatible grazing strategies, and avoiding filling or grading vernal pools during projects (BLM 2008). BLM has seven separate parcels totaling 659 acres around New Melones Lake that overlap with mapped vernal pool grasslands. Four parcels are on or near the Tuolumne County Table Mountain and three are within the Shotgun Creek Core Area, which is not designated for the three shrimp species. Monitoring for vernal pool species has not occurred on any of these parcels (B. Brenneman, BLM, *in litt*. 2022). The nearest known occurrence of the vernal pool fairy shrimp is more than 3 miles to the southeast within the Grand Yosemite Golf and Wetland Preserve (Diversity Database 2022). The nearest known occurrence of the vernal pool tadpole shrimp is 6 miles southwest of the Shotgun Creek Core Area along Highway 108 at the Tuolumne-Stanislaus County border (Diversity Database 2022).

13.3.4. Other Federal Lands

The U.S. Bureau of Reclamation (BOR) manages the New Melones Lake Area in Calaveras and Tuolumne Counties. The New Melones dam was completed in 1979 and is the most recent major project incorporated into the Central Valley Project (BOR 2010). The New Melones Lake Area is approximately 30,000 acres in size (12,500 acres of New Melones Lake and 17,500 acres of surrounding areas). BOR has documented 1,179 acres of annual grassland across this area, as

well as 53 acres of vernal pools on Table Mountain in the southeastern portion of the New Melones Lake Area within the Peoria Wildlife Management Area (BOR 2010). Witham's (2021) mapping effort also identified vernal pool grassland within the Bowie Flat Management Area, a disjunct area to the southwest within the Shotgun Creek Core Area. The New Melones Lake Resource Management Plan includes goals related to protecting vernal pools (BOR 2010), but the three shrimp species have never been documented within this area (Diversity Database 2022). BOR also owns most of the lands surrounding Millerton Lake in Madera and Fresno Counties; this area is managed by the California Department of Parks and Recreation (CDPR).

13.4. Conservation Banks

There are three conservation banks within the Southern Sierra Foothills Vernal Pool Region that provide credits for preserved vernal pools that support the vernal pool fairy shrimp and vernal pool tadpole shrimp: Drayer Ranch Conservation Bank, Great Valley Conservation Bank at Flynn Ranch, and Sand Creek Conservation Bank (see **Figure 13.2**; RIBITS 2021). These banks protect a total of 1,820 acres of land, including 184.29 acres of preserved vernal pools for the two shrimp species (Table 6). The three banks have sold a total of 60.51 acres of preservation credits (33%) for the vernal pool fairy shrimp and vernal pool tadpole shrimp (RIBITS 2021).

A fourth conservation bank, Kennedy Table, also provides credits for protected vernal pools that support only the vernal pool fairy shrimp. This bank protects 600 acres of land, including 57.69 acres of preserved vernal pools for the vernal pool fairy shrimp (Table 6). This bank has sold 11.15 acres of preservation credits (19%) for the vernal pool fairy shrimp (RIBITS 2021).

There are no conservation banks within the Southern Sierra Foothills Vernal Pool Region that provide credits for the Conservancy fairy shrimp.

13.5. Habitat Conservation Plans

There are two regional Habitat Conservation Plans (HCPs) within the Southern Sierra Foothills Vernal Pool Region that include all three shrimp species as covered species. There is one additional regional HCP and one project-level HCP that include just the vernal pool fairy shrimp and vernal pool tadpole shrimp as Covered Species (**Figure 13.5**).

13.5.1. PG&E Multiple Region Operations and Maintenance HCP

See section 2.5.1 for a description of this HCP.

13.5.2. PG&E San Joaquin Valley Operations and Maintenance HCP

See section 9.5.2 for a description of this HCP.

13.5.3. San Joaquin County HCP

See section 6.5.3 for a description of this HCP.

13.5.4. Southern California Edison Cross Valley Transmission Line HCP

The Southern California Edison Cross Valley Transmission Line (a.k.a., Cross Valley Loop) HCP covers the construction and ongoing operations and maintenance activities associated with a 23-mile electrical transmission line in Tulare County (AECOM 2013). The HCP Planning Area encompasses approximately 3,385 acres surrounding the proposed project, which extends north from the Rector Substation outside of the City of Visalia to Avenue 368 and then east to an existing transmission line northeast of the City of Woodlake. This HCP was permitted in 2013 and has a 30-year permit term, and the permittee is Southern California Edison. The HCP's conservation strategy includes avoiding and minimizing impacts to Covered Species to the maximum extent practicable through project design and conservation measures, as well as mitigating for unavoidable impacts. Mitigation may be in the form of purchasing credits at a conservation or mitigation bank, preserving habitat at a Service-approved permittee-responsible mitigation site, restoring and protecting habitat onsite, or any other means acceptable to the Service.

The HCP Planning Area contains a total of 19.46 wetted acres of suitable habitat for the vernal pool fairy shrimp, and the species was detected in 1.90 acres of vernal pools during surveys in 2010-2012 (AECOM 2013). The HCP Planning Area contains a total of 18.60 wetted acres of suitable habitat for the vernal pool tadpole shrimp, although the species was not detected during surveys in 2010-2012 (AECOM 2013). Construction of the new transmission line was anticipated to have direct effects to 0.15 acres suitable of habitat, indirect effects to 4.71 acres of suitable habitat, and temporary effects to 0.16 acres of suitable habitat for the vernal pool fairy shrimp and direct effects to 0.14 acres of suitable habitat, indirect effects to 4.58 acres of suitable habitat, and temporary effects to 0.14 acres of suitable habitat for the vernal pool tadpole shrimp. Ongoing operations and maintenance activities were anticipated to have temporary effects to 0.09 acres and 0.08 acres of suitable habitat for each species, respectively. The HCP had three biological goals specific to the two shrimp species. The first goal was to avoid and minimize impacts to the species during construction of the new transmission line to the maximum extent practicable; construction is complete, and this goal was successfully achieved by implementing all applicable conservation measures from the HCP (Southern California Edison 2021). The second goal was to avoid and minimize impacts to the species during operations and maintenance activities to the maximum extent practicable; this work is ongoing, and to date the goal has been successfully achieved by implementing all applicable conservation measures from the HCP (Southern California Edison 2021). The third goal was to contribute to conservation of the species as mitigation by preserving a minimum of 14.86 acres and 14.40 acres of high quality vernal pools known to be occupied by the vernal pool fairy shrimp and vernal pool tadpole shrimp, respectively. This goal was achieved in fall of 2014 through the purchase of 14.86 acres of vernal pool preservation credits at the Sand Creek and Great Valley Conservation Banks (Southern California Edison 2021).

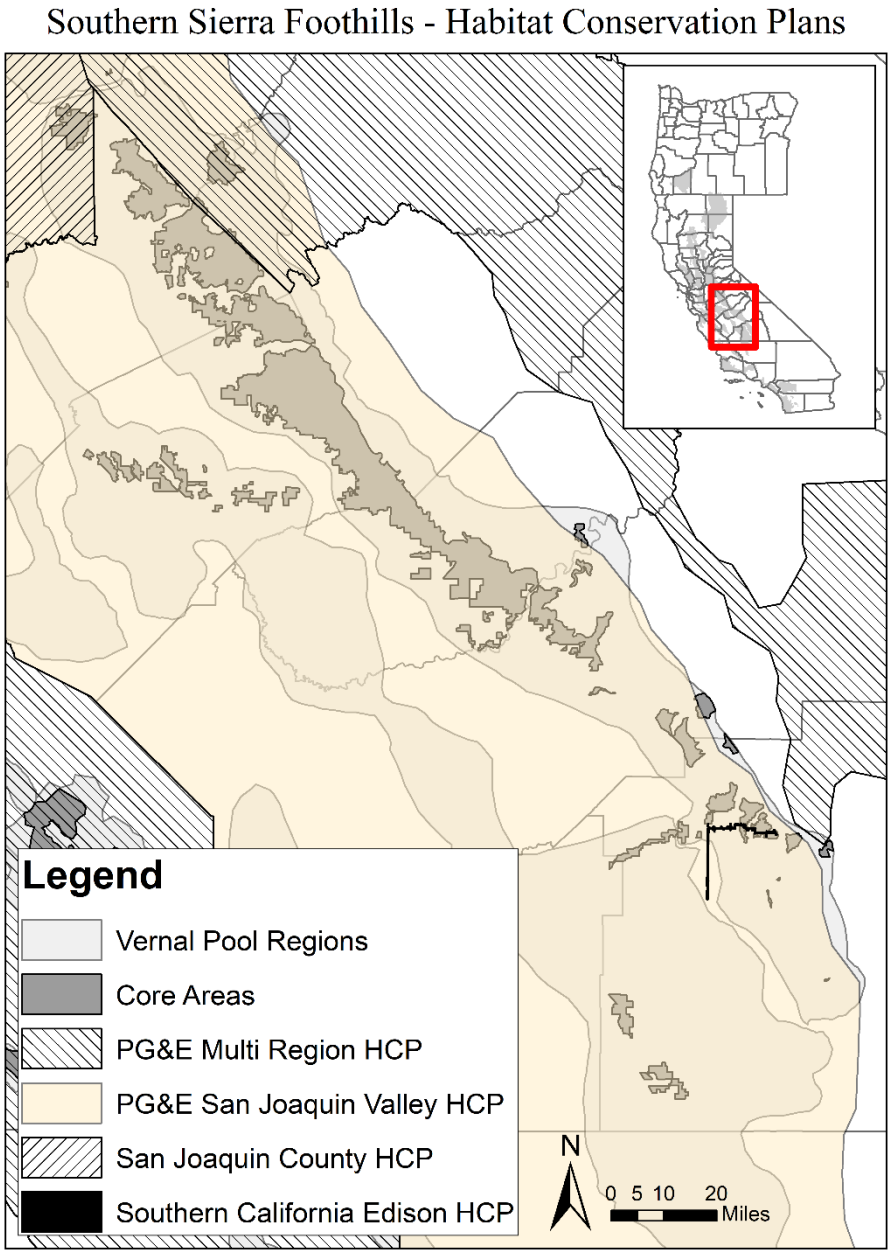


Figure 13.5. Map of the habitat conservation plans (HCPs) within the Southern Sierra Foothills Vernal Pool Region that include the three shrimp species as a Covered Species.

13.6. Other Preserves

The California Department of Fish and Wildlife (CDFW) owns two Ecological Reserves within the Southern Sierra Foothills Vernal Pool Region that contain vernal pool habitat: Big Table Mountain and Stone Corral (**Figure 13.2**). Neither of these preserves have final management plans (Battistoni, *in litt*. 2022).

The approximately 1,000-acre Big Table Mountain Ecological Reserve is a flat-topped volcanic mesa located in Fresno County adjacent to the Millerton Lake State Recreation Area. Approximately 197 acres of vernal pool grassland has been mapped in the southern part of this Ecological Reserve, which is within the Table Mountain Core Area. The vernal pool fairy shrimp and vernal pool tadpole shrimp were first recorded throughout the vernal pool grassland on the Ecological Reserve in 2001 and 1995, respectively (Diversity Database 2022), partly leading to its designation in 2007. The two shrimp species were most recently observed in 2012 (Battistoni, *in litt*. 2022).

The 981-acre Stone Corral Ecological Reserve is located in Tulare County north of Visalia and is entirely composed of vernal pool grasslands (Witham 2021). Vernal pool fairy shrimp were identified in multiple units of the Ecological Reserve in 1993 (which prompted the acquisition of the properties by CDFW) and throughout all units of the Ecological Reserve in 2008 (Diversity Database 2022). Vernal pool tadpole shrimp were identified in the northeastern unit of the Ecological Reserve in 1995 and the central unit in 2001 (Diversity Database 2022). The two shrimp species were most recently documented in 2012 (Battistoni, *in litt*. 2022).

CDFW also holds the 7,548-acre Salt Spring Valley Conservation Easement around the Salt Spring Valley Reservoir in Calaveras County. This site contains approximately 329 acres and 71 acres of vernal pool grassland mapped on the north and south sides of the reservoir, respectively (Witham 2021). The two shrimp species are not known to occur at this site; the nearest occurrence of the vernal pool fairy shrimp is 10 miles west, and the nearest occurrences of the vernal pool tadpole shrimp are 16 miles west and 16 miles south (Diversity Database 2022). CDFW's Merced River Hatchery also slightly overlaps mapped vernal pool grassland habitat (Witham 2021), with the nearest occurrence of the vernal pool fairy shrimp being on the Chance family ranch and the nearest occurrence of the vernal pool tadpole shrimp 10 miles to the south (Diversity Database 2022).

The California Department of Parks and Recreation (CDPR) manages the approximately 11,000-acre Millerton Lake State Recreation Area located on the Madera and Fresno County border around Millerton Lake and the San Joaquin River. Millerton Lake was created in 1944 by the construction of the Friant Dam on the San Joaquin River, and the lake and surrounding lands are owned by the Bureau of Reclamation (BOR). The Recreation Area is adjacent to CDFW's Big Table Mountain Ecological Area, BLM's Table Mountain area of ecological importance, and several preserves owned by the Sierra Foothill Conservancy. Almost all vernal pool habitat in the area is within these adjacent preserved lands, but there are small bits of vernal pool grassland that extend into the Millerton Lake State Recreation Area (Witham 2021). The two shrimp species have not been documented within the Recreation area, but both are known to occur on the Big Table Mountain Ecological Reserve and the vernal pool fairy shrimp occurs just south of Millerton Lake as well (Diversity Database 2022).

In eastern Merced County, there are many preserves associated with or surrounding the UC Merced campus expansion. The Nature Conservancy (TNC) owns one property and holds conservation easements on seven properties in eastern Merced County, totaling 27,889 acres, and California Rangeland Trust (CRT) holds conservation easements on four properties in the area, totaling 7,204 acres. Immediately adjacent to the UC Merced campus are the Cyril Smith Trust property owned by TNC and two preserves with TNC-held conservation easements: the Merced Vernal Pools and Grassland Reserve (formerly the Virginia Smith Trust and the Campus Natural Reserve) owned by the University of California and the Myers Easterly property jointly owned by the University of California and the Virginia Smith Trust. Management of these preserves is guided by the 2008 Management Plan for the UC Merced conservation lands (Airola Environmental Consulting 2008). Farther north of the campus are the Chance and Robinson family ranches, and southeast of the campus are the Carlson, Cunningham, and Nelson family ranches, all of which have conservation easements held by TNC or CRT. Unlike the TNC- or University of California-owned preserves, management of these lands is undertaken by the private landowners in accordance with requirements of the conservation easements, and thus the main management action discussed in the UC Merced Management Plan is easement compliance monitoring (Airola Environmental Consulting 2008). CRT also holds conservation easements on a mitigation site, on the Ichord family ranch adjacent to the UC Merced campus, and on a small portion of the Roen family ranch adjacent to the Nelson family ranch. TNC also holds a conservation easement on part of the Flying M Ranch east of the UC Merced campus. An estimated 20,671 acres of extant vernal pool grassland has been mapped on all of these properties (Witham 2021).

The vernal pool fairy shrimp is known to occur throughout all of the above preserves (Diversity Database 2022). The vernal pool tadpole shrimp is known to occur throughout most of the UC Merced-area preserves and the Nelson family Ranch (Diversity Database 2022). The Conservancy fairy shrimp is known to occur at the southern end of the Merced Vernal Pools and Grassland Reserve and on the adjacent Ichord family ranch (Diversity Database 2022). The species also occurs on adjacent unprotected areas, including unprotected portions of Ichord Ranch, the Flying M Ranch east of the UC Merced campus, and the Roen Ranch to the southeast between the Cunningham and Nelson family ranches (Diversity Database 2022).

TNC also holds a conservation easement over the 3,333-acre Ruth McKenzie Table Mountain Preserve owned by Sierra Foothill Conservancy in Fresno County adjacent to the Big Table Mountain Ecological Reserve and Millerton Lake State Recreation Area. An estimated 408 acres of vernal pool grassland have been mapped on the volcanic mesas within this preserve (Witham 2021). The vernal pool fairy shrimp and vernal pool tadpole shrimp have been documented immediately adjacent on the Big Table Mountain Ecological Reserve, but no occurrence records have been documented within the Table Mountain Preserve in the Diversity Database (Diversity Database 2022).

CRT also holds conservation easements on six properties in the Southern Sierra Foothills Vernal Pool Region outside of the UC Merced area. The 2,235-acre Cook Ranch is owned by the Cook Cattle Company and is located in eastern San Joaquin County. It contains 937 acres of extant vernal pool habitat (Witham 2021); the nearest known occurrence of the vernal pool fairy shrimp is 0.5 miles northeast and the nearest known occurrence of the vernal pool tadpole shrimp in 0.5 miles northwest (Diversity Database 2022). The Orvis family ranch is located on the border of

Calaveras and Stanislaus Counties. It contains 137 acres of extant vernal pool grassland (Witham 2021); the nearest known occurrence of the vernal pool fairy shrimp is 9 miles northwest and the nearest known occurrence of the vernal pool tadpole shrimp is 13 miles south (Diversity Database 2022). The 1,395-acre JCR Ranch and 4,447-acre Richards family ranch are both located in northeastern Merced County, north of the Merced River; they contain 541 acres and 1,151 acres of extant vernal pool grassland, respectively (Witham 2021). JCR Ranch has one occurrence record of the vernal pool fairy shrimp from 2008, representing a cluster of 5 vernal pools, and the Richards family ranch has 11 occurrence records of the vernal pool fairy shrimp from 2001, representing numerous vernal pools on the eastern portion of the property (Diversity Database 2022). The nearest known occurrences of the vernal pool tadpole shrimp are 13 miles west and 13 miles south (Diversity Database 2022). The 542-acre Lazy K Ranch mitigation site is composed of two parcels on the border of Merced and Madera Counties. These parcels contain 445 acres of extant vernal pool habitat and an additional 60 acres of newly created vernal pool grassland for mitigation (Witham 2021). The vernal pool fairy shrimp is known to occur throughout both parcels of Lazy K Ranch and the vernal pool tadpole shrimp is known to occur throughout the larger western parcel of Lazy K Ranch (Diversity Database 2022). The 2,294-acre Van Alen family ranch is located in the Kennedy Table area of Madera County adjacent to BLM land and the Kennedy Table Conservation Bank; it contains 392 acres of extant vernal pool grassland (Witham 2021), and the vernal pool fairy shrimp occurrence on the Kennedy Table Conservation Bank extends slightly onto the Van Alen family ranch as well (Diversity Database 2022). The nearest occurrence of the vernal pool tadpole shrimp is 5 miles south on the Big Table Mountain Ecological Reserve (Diversity Database 2022).

In addition to the many protected areas described here, Vollmar et al. (2017) identified 14 other protected properties within the Southern Sierra Foothills Vernal Pool Region. Five of these sites are private preserves that were protected as mitigation by landowners, likely as part of proposed conservation measures during Section 7 interagency consultations; ownership of these sites includes Caltrans, Merced County Regional Waste Management Authority, a private rancher, and two properties where the owner is unknown. Of the remaining nine sites, three are public land, four have a conservation easement held by the Natural Resources Conservation Service (NRCS), one has a conservation easement held by The Access Fund, and one has a conservation easement held by Central Valley Farmland Trust.

13.7. Vernal Pool Core Areas

There are seven Core Areas within the Southern Sierra Foothills Vernal Pool Region that are designated in the Recovery Plan for the vernal pool fairy shrimp: Cottonwood Creek, Fresno, Madera, Merced, San Joaquin, Table Mountain, and Turlock. There are two additional Core Areas that were not designated for the vernal pool fairy shrimp in the Recovery Plan, but that have known occurrences of the species in the Diversity Database: Kings and Tulare (Diversity Database 2022). For the Tulare Core Area, the vernal pool fairy shrimp was not identified until 2010, which is why this core area was not designated for the vernal pool fairy shrimp in the Recovery Plan. For the Kings Core Area, the Diversity Database occurrences include information about surveys that occurred before 2005, so the core area likely should have been designated for the vernal pool fairy shrimp in the Recovery Plan; however, it is possible that these occurrence records were not uploaded to the Diversity Database until after 2005. One of these nine core areas has met the target of 85% of vernal pool habitat protected based on mapped

habitat (see **Table 13.1**; Vollmar et al. 2017; Witham 2021). As of 2018, two of the nine core areas (Merced and San Joaquin) had lost more than 15% of the baseline level of habitat present in 2005, making the 85% target unattainable without habitat creation or restoration.

There are four Core Areas within the Southern Sierra Foothills Vernal Pool Region that are designated in the Recovery Plan for the vernal pool tadpole shrimp: Cottonwood Creek, Madera, Merced, Table Mountain. There are three additional Core Areas that were not designated for the vernal pool tadpole shrimp in the Recovery Plan, but that have known or nearby occurrences of the species in the Diversity Database: Kings, San Joaquin, and Turlock (Diversity Database 2022). For the Kings and San Joaquin Core Areas, the vernal pool tadpole shrimp was not identified until 2006 and 2011, respectively, which is why these core areas were not designated for the vernal pool tadpole shrimp in the Recovery Plan. The Turlock Core Area was designated for the vernal pool fairy shrimp and not the vernal pool tadpole shrimp. However, neither species is known to occur within the core area; the nearest occurrence of the vernal pool fairy shrimp is more than 3 miles away, while the nearest occurrence of the vernal pool tadpole shrimp is only 1 mile away, so we have decided to discuss this core area further here. None have met the target of vernal pool habitat protected (95% for zone 1 and 85% for zone 2) (see **Table 13.1**; Vollmar et al. 2017; Witham 2021). As of 2018, two of the zone 1 core areas (Madera and Merced) and one of the zone 2 core areas (San Joaquin) had lost more than 5% or 15%, respectively, of the baseline level of habitat present in 2005, making the target unattainable without habitat creation or restoration.

There is one Core Area within the Southern Sierra Foothills Vernal Pool Region that is designated in the Recovery Plan for the Conservancy fairy shrimp: Madera. This core area has not yet met the target of 95% of vernal pool habitat protected, and as of 2018 it had lost 8.0% of the baseline level of habitat that was present in 2005, making the 95% target unattainable without habitat creation or restoration (see **Table 13.1**; Vollmar et al. 2017; Witham 2021).

13.7.1. Cottonwood Creek

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and vernal pool tadpole shrimp. The core area is located in northwestern Tulare County, is composed of several polygons, and is adjacent to the Tulare Core Area to the east and the Cross Creek Core Area in the San Joaquin Valley Vernal Pool Region to the west.

There were approximately 1,049 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 1,045 acres of vernal pool grassland remaining (see **Figure 13.6**, **Table 13.1**; Witham 2021). The 3.6 acres that has been lost since the Recovery Plan's 2005 baseline were converted to bare plowed agricultural land (**Table 13.2**). Roughly 935 acres of vernal pool grassland were protected within this core area as of 2017 (Vollmar et al. 2017), representing 89.1% of the 2005 baseline. Stone Corral Ecological Reserve is the only protected area within this core area (**Figure 13.7**).

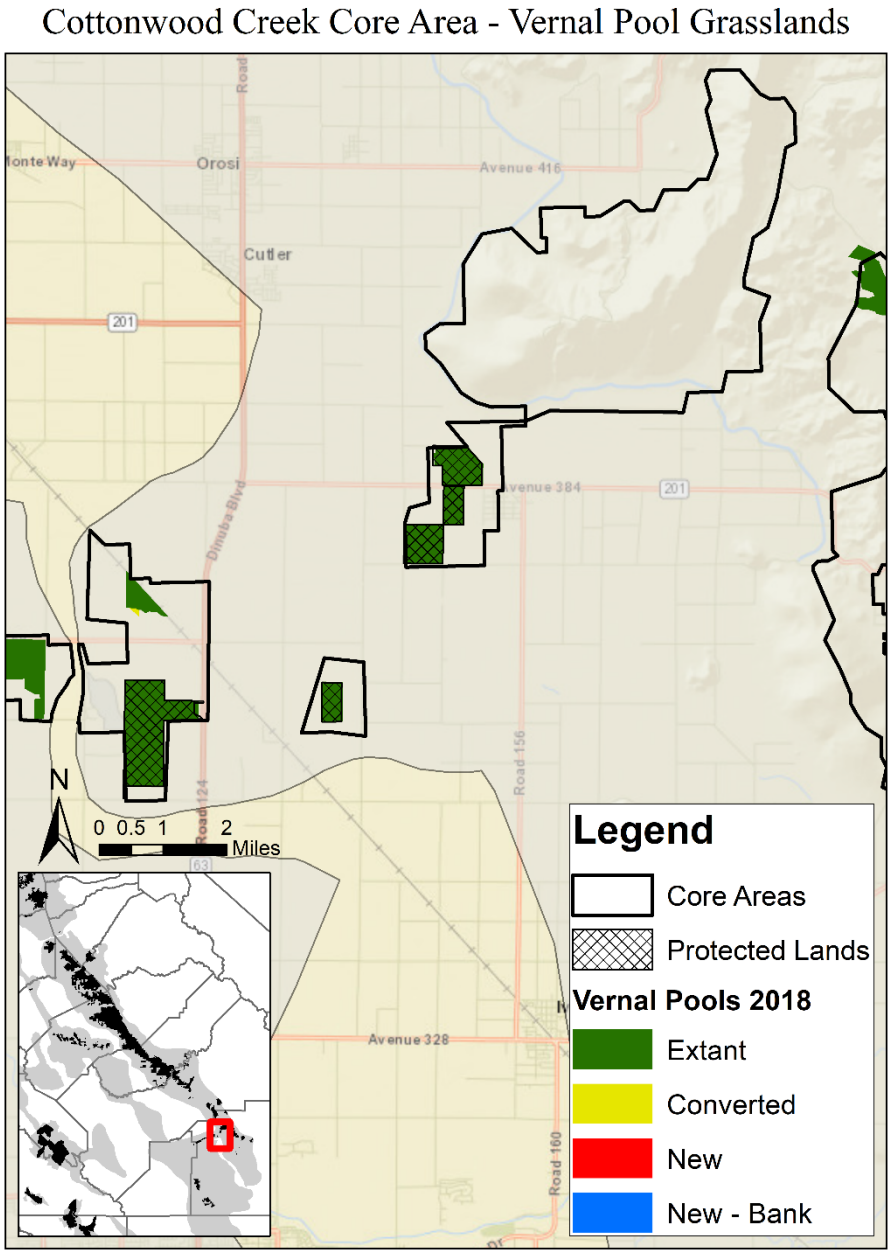


Figure 13.6. Map of vernal pool grassland habitat within the Cottonwood Creek Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

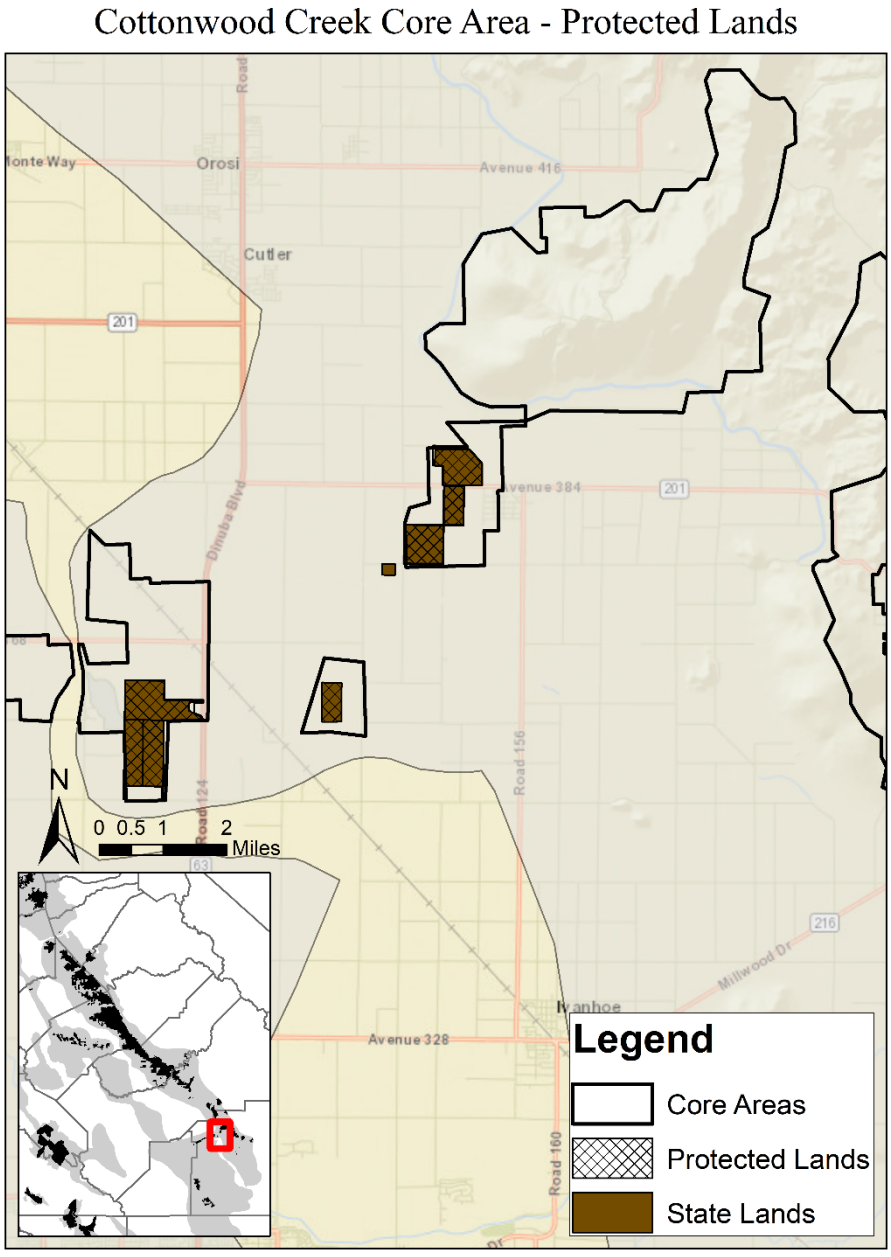


Figure 13.7. Map of protected areas within the Cottonwood Creek Core Area**.** Protected lands are based on Vollmar et al. (2017).

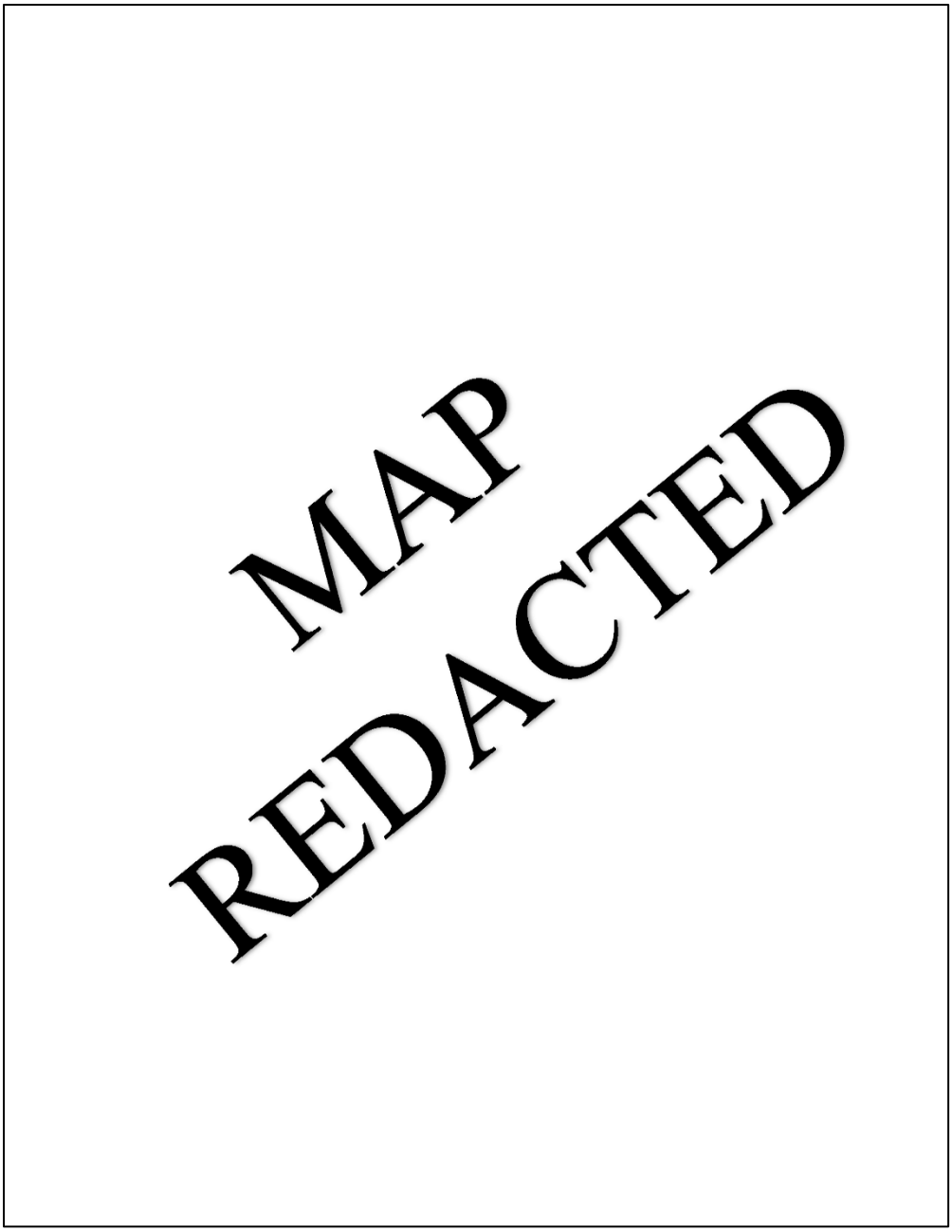


Figure 13.8. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Cottonwood Creek Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

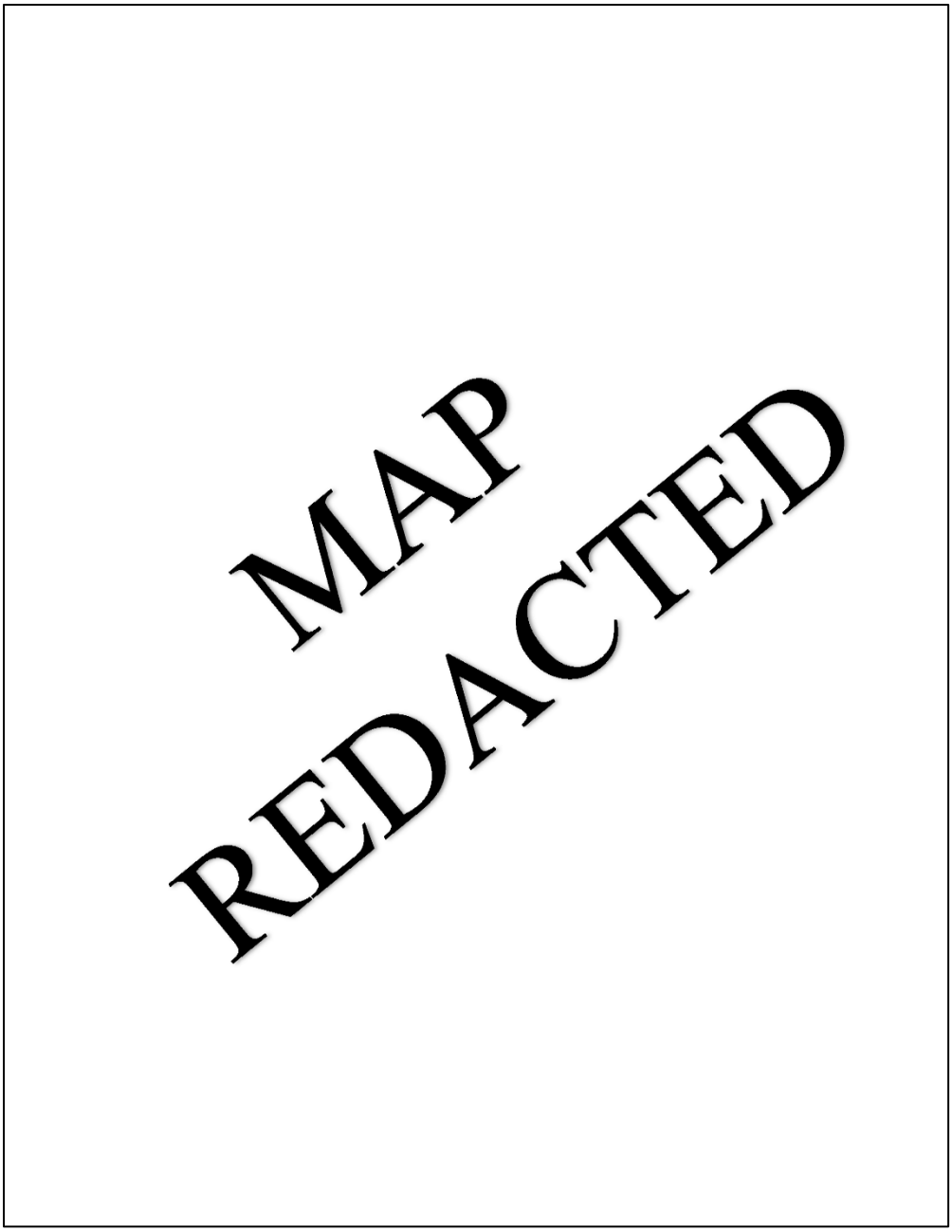


Figure 13.9. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Cottonwood Creek Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

13.7.1.1. Vernal Pool Fairy Shrimp Occurrences

There are five Diversity Database occurrence records for the vernal pool fairy shrimp within this core area (see **Figure 13.8**; Diversity Database 2022). As of 2018, four of these occurrences were protected within the Stone Corral Ecological Reserve (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database; four are within extant mapped vernal pool grasslands and one is outside of mapped vernal pool grasslands (Witham 2021). Of the five records, two were known at the time of listing in 1994 and three were known at the time the Recovery Plan was published in 2005; these records are located within the northeastern and southwestern units of Stone Corral Ecological Reserve and in private land adjacent to the central unit of the Ecological Reserve. The two newer records are located on adjacent portions of the northeastern and southwestern units of the Ecological Reserve, confirming that the vernal pool fairy shrimp occurs through the entire vernal pool complexes on these units.

13.7.1.2. Vernal Pool Tadpole Shrimp Occurrences

There are three Diversity Database occurrence records for the vernal pool tadpole shrimp within this core area (see **Figure 13.9**; Diversity Database 2022). As of 2018, all of these occurrences were protected within the Stone Corral Ecological Reserve (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database and are within extant mapped vernal pool grasslands (Witham 2021). One occurrence was known at the time of listing in 1994 and two were known at the time the Recovery Plan was published in 2005; these records are located within the northeastern and central units of Stone Corral Ecological Reserve. The newer occurrence was recorded in 2008 and is also within the northeastern unit of the Ecological Reserve (Diversity Database 2022).

13.7.2. Fresno

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is located along the northwestern edge of the Cities of Fresno and Clovis, with two smaller, disjointed polygons, one located on the southern side of Highway 168 (Sierra Freeway) and the other encompassing the Fresno Canal on either side of North Academy Avenue.

There were approximately 15,787 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 14,462 acres of vernal pool grassland remaining, with 1,324 acres lost since 2005 (see **Figure 13.10**, **Table 13.1**; Witham 2021). All losses were due to agricultural conversion, including conversion to bare plowed agricultural land (876.2 acres, 66.2%), orchards, vineyards, or eucalyptus (312.2 acres, 23.6%), agricultural residences (126.1 acres, 9.5%), and rice, row crops, dairies, or nurseries (9.9 acres, 0.7%) (see **Table 13.2**; Witham 2021). Notably, no vernal pool grasslands were identified within the two disjointed parts of this core area around Highway 165 and the Fresno Canal. The vernal pool fairy shrimp was never recorded in these locations; several vernal pool plant species were recorded there, but they were already considered extirpated by the 1980's (Diversity Database 2022). The only protected areas within this core area are the Millerton Lake State Recreation Area; note that Vollmar et al.'s (2017) mapped boundary of this area does not exactly line up with the boundary of the shapefile that the Service obtained from ArcGIS Online (**Figure**

13.11). Based on Vollmar et al.'s (2017) boundaries, which are slightly larger, roughly 18.0 acres of vernal pool grassland were protected within this core area as of 2017, representing 0.1% of the 2005 baseline.

13.7.2.1. Vernal Pool Fairy Shrimp Occurrences

There are 29 Diversity Database occurrence records for the vernal pool fairy shrimp within this core area (see **Figure 13.12**; Diversity Database 2022). As of 2018, none of these occurrences were protected (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database; 25 are within extant mapped vernal pool grasslands (though several of these are partially within extirpated habitat), 1 is entirely within vernal pool grasslands mapped as converted to agriculture, and 3 are outside of mapped vernal pool grasslands (Witham 2021). Of the 29 records, 2 were known at the time of listing in 1994 and 26 were known at the time the Recovery Plan was published in 2005; these records are located throughout the core area. The three newer records are located near the previously known occurrences, though one of the newer records is the occurrence that is presumed extirpated based on Witham's (2021) mapping.

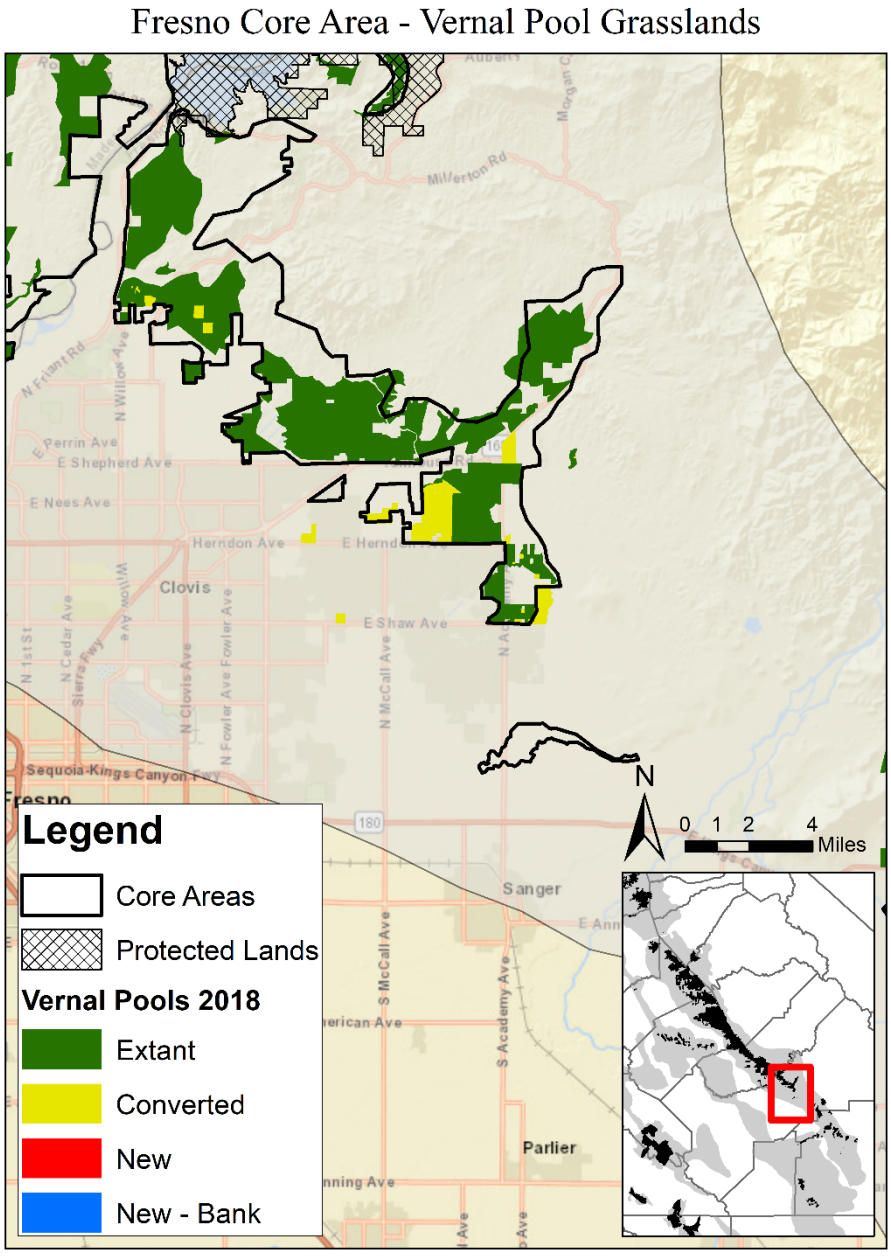


Figure 13.10. Map of vernal pool grassland habitat within the Fresno Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

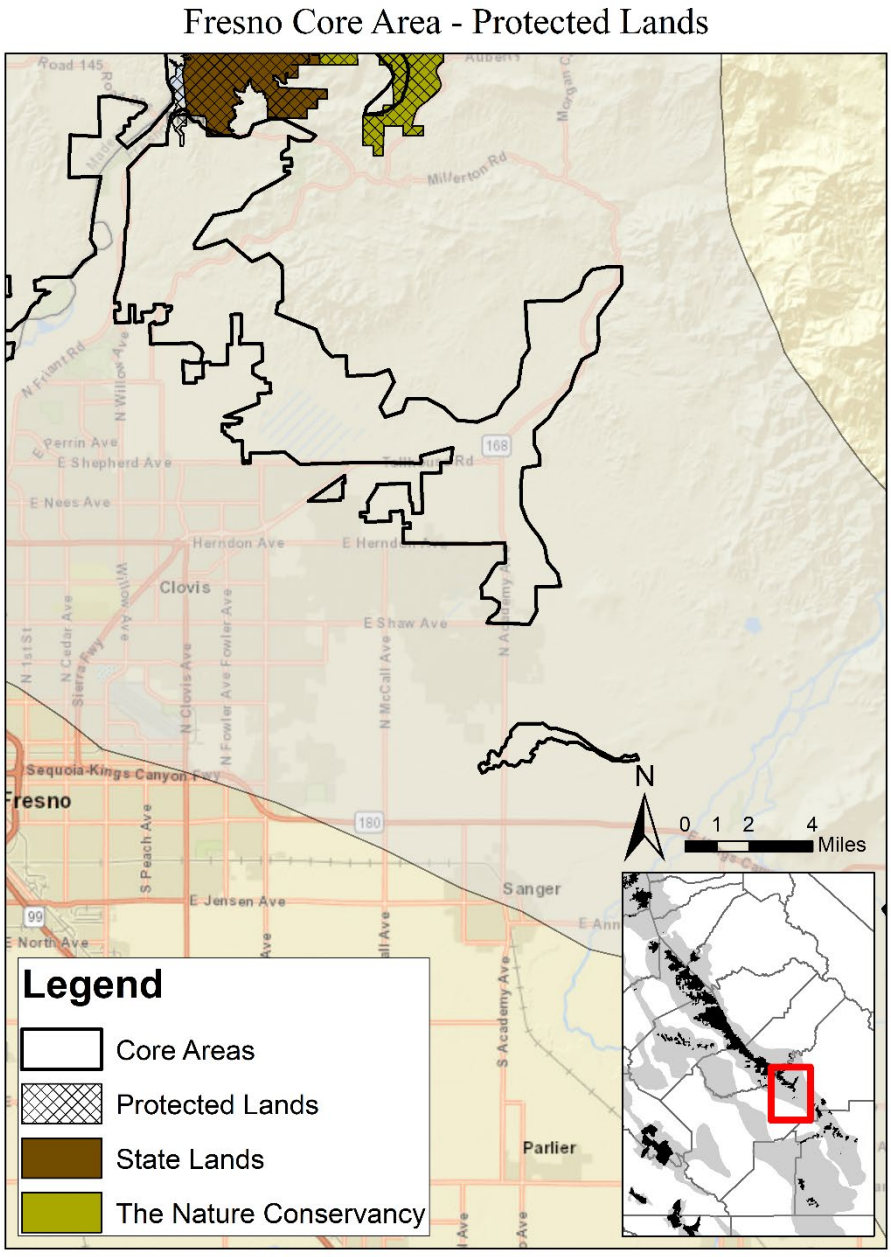


Figure 13.11. Map of protected areas within the Fresno Core Area**.** Protected lands are based on Vollmar et al. (2017).

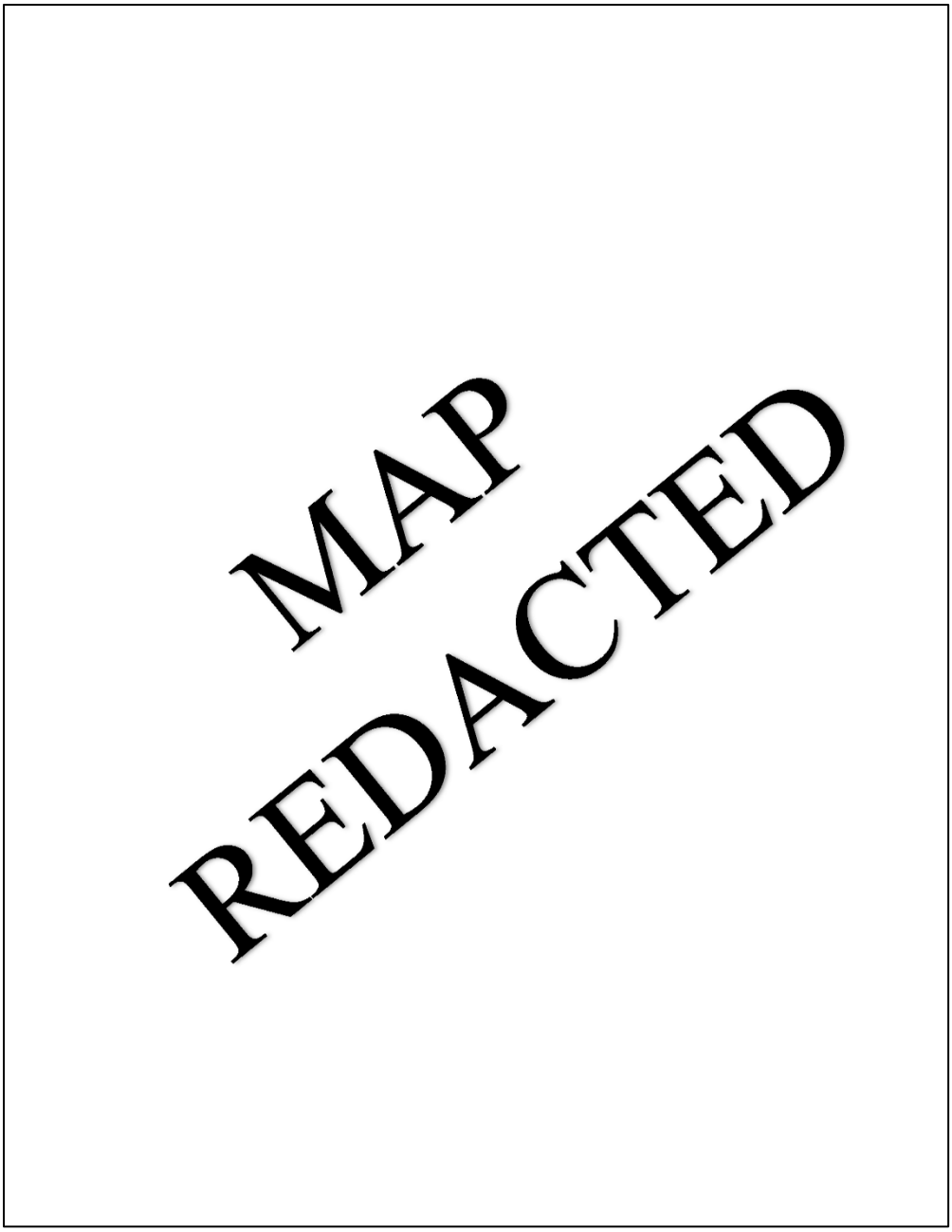


Figure 13.12. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Fresno Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

13.7.3. Kings

This is a zone 2 core area, but it was not designated for the vernal pool fairy shrimp or vernal pool tadpole shrimp in the Recovery Plan. It was designated for the spiny-sepaled button-celery (*Eryngium spinosepalum*), with a goal of protecting 85% of vernal pool habitat. The core area is located on the border of Fresno and Tulare Counties along a canal that is a tributary to the Kings River, as well as two disjoint polygons in the foothills to the east.

There were approximately 660 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 668 acres of vernal pool grassland remaining (see **Figure 13.13**, **Table 13.1**; Witham 2021). Approximately 48 acres had been lost since the Recovery Plan's 2005 baseline, though 56 additional acres were identified in 2012 aerial imagery that were either new or missed in previous mapping efforts. All of the habitat losses were attributable to agricultural conversions to bare plowed agricultural land (**Table 13.2**). The two disjoint polygons in the foothills to the east do not contain any mapped vernal pool grasslands. These areas were likely included in the core area because of nearby occurrences of spiny-sepaled button-celery; the occurrence records note that as of 1992 suitable habitat for this plant species was still present, but only in the form of an ephemeral water source and not actual vernal pool habitat (Diversity Database 2022). Roughly 342 acres of vernal pool grassland were protected within this core area as of 2017 (Vollmar et al. 2017), representing 51.8% of the 2005 baseline and 47.1% of the baseline plus the 56 additional acres identified in the 2012 aerial imagery.

The only protected land within this core area is the Sand Creek Conservation Bank (**Figure 13.14**). Note that Vollmar et al. (2017) mapped a slightly larger boundary for the bank than is present on the Service's shapefile.

13.7.3.1. Vernal Pool Fairy Shrimp Occurrences

There are four Diversity Database occurrence records for the vernal pool fairy shrimp within this core area and one more that is immediately adjacent (see **Figure 13.15**; Diversity Database 2022). As of 2018, 2 of these occurrences were protected within the Sand Creek Conservation Bank (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database; the two within Sand Creek Conservation Bank are within extant mapped vernal pool and the other three are outside of mapped vernal pool grasslands along the banks of the canal (Witham 2021). Of the five records, none were known at the time of listing in 1994, but all five were known at the time the Recovery Plan was published in 2005, and thus the Recovery Plan likely should have designated this core area for the vernal pool fairy shrimp.

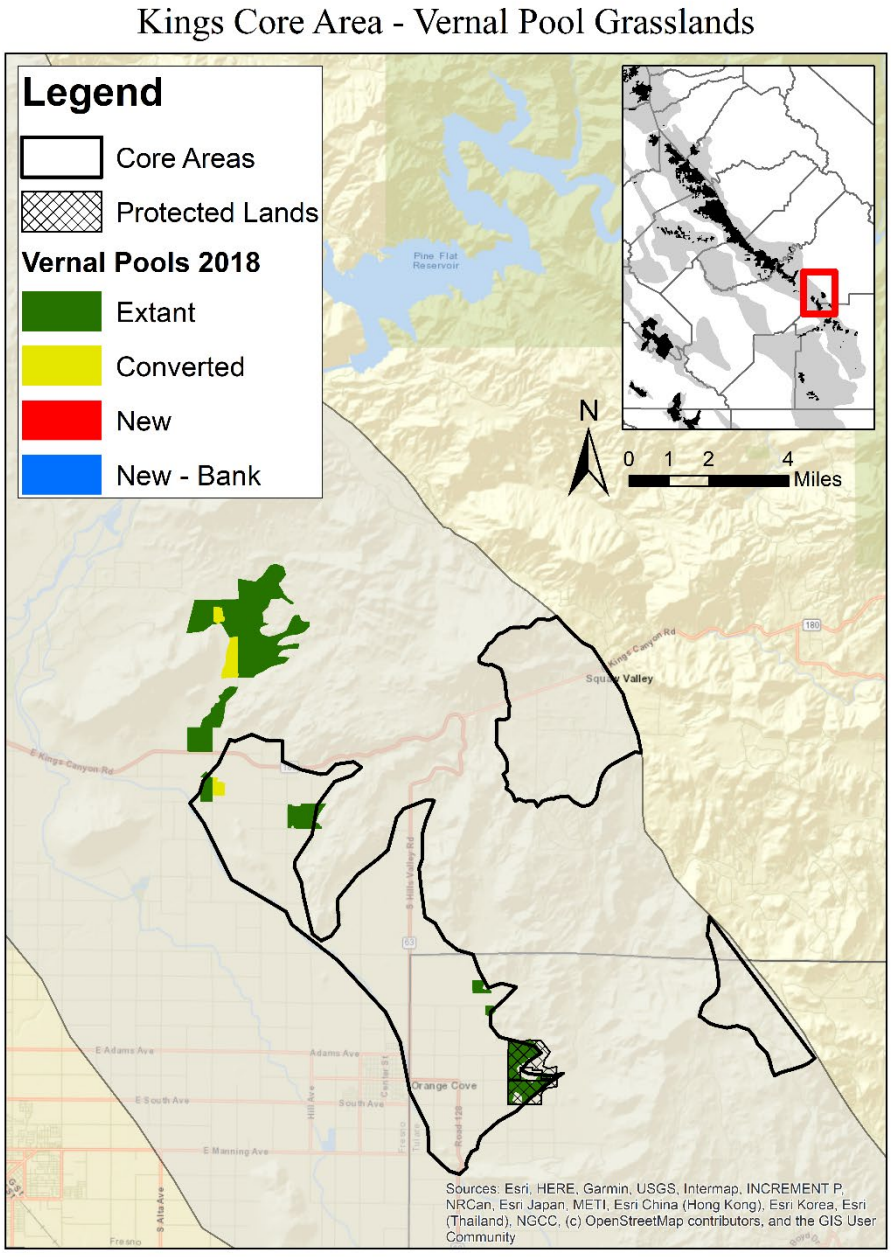


Figure 13.13. Map of vernal pool grassland habitat within the Kings Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

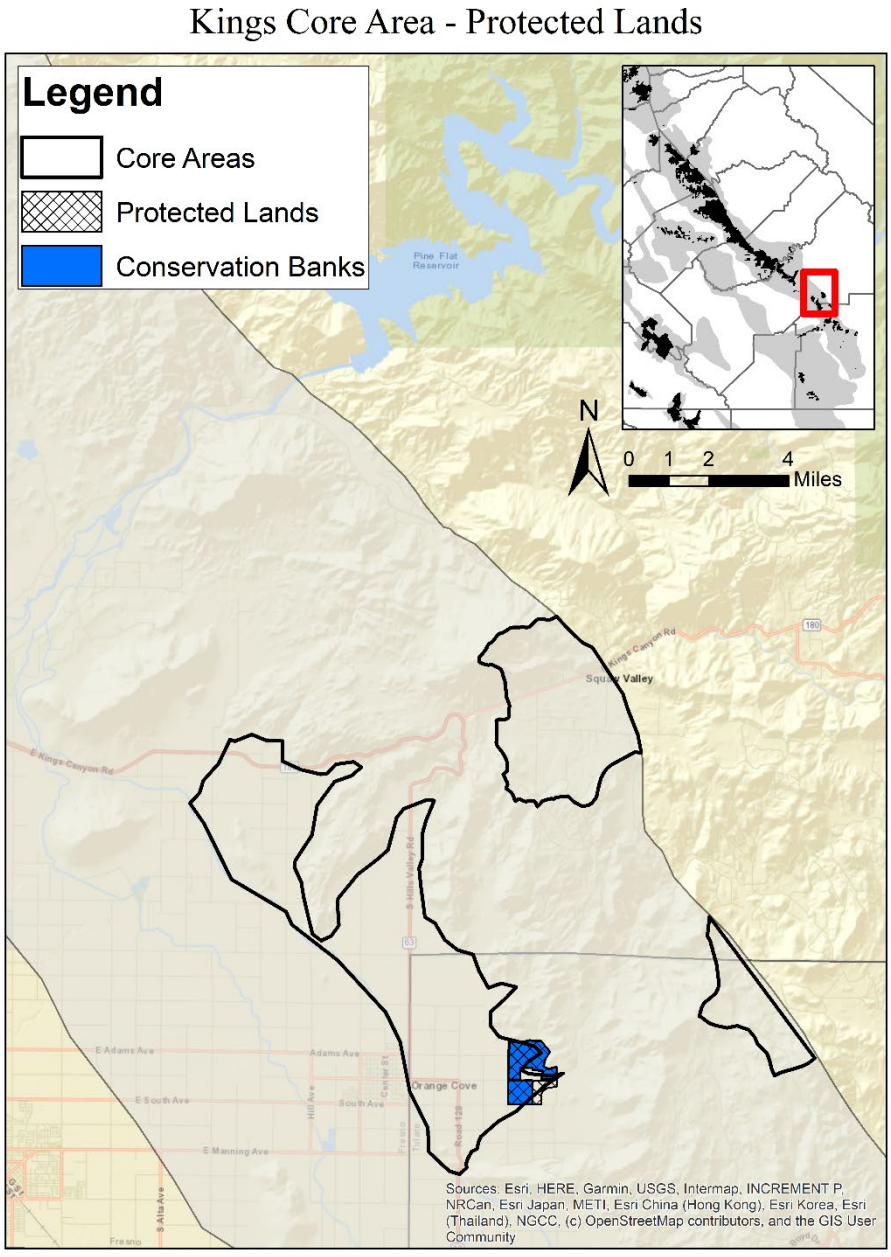


Figure 13.14. Map of protected areas within the Kings Core Area**.** Protected lands are based on Vollmar et al. (2017).

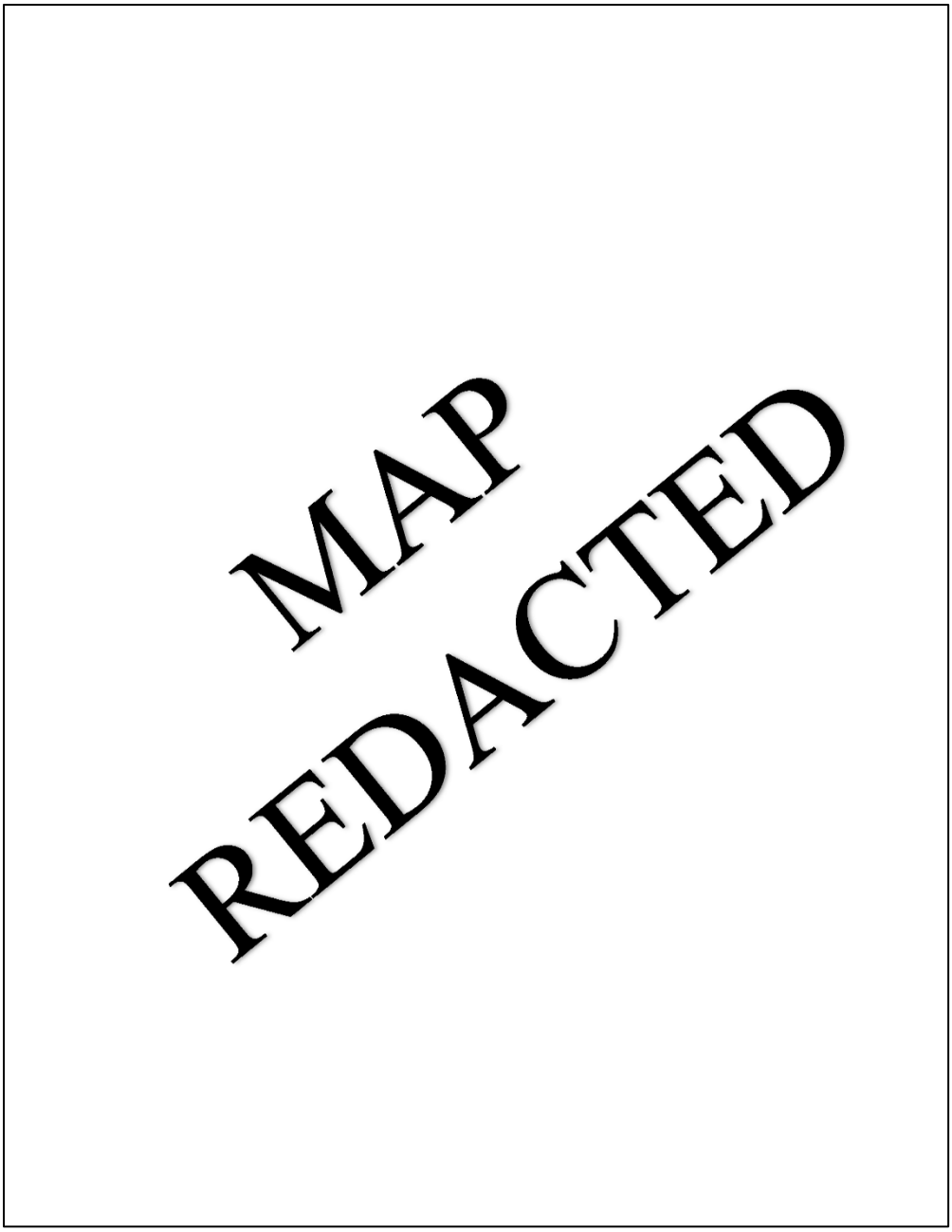


Figure 13.15. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Kings Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat. Several occurrences are located along the southern border of the core area; zoom in for finer resolution.

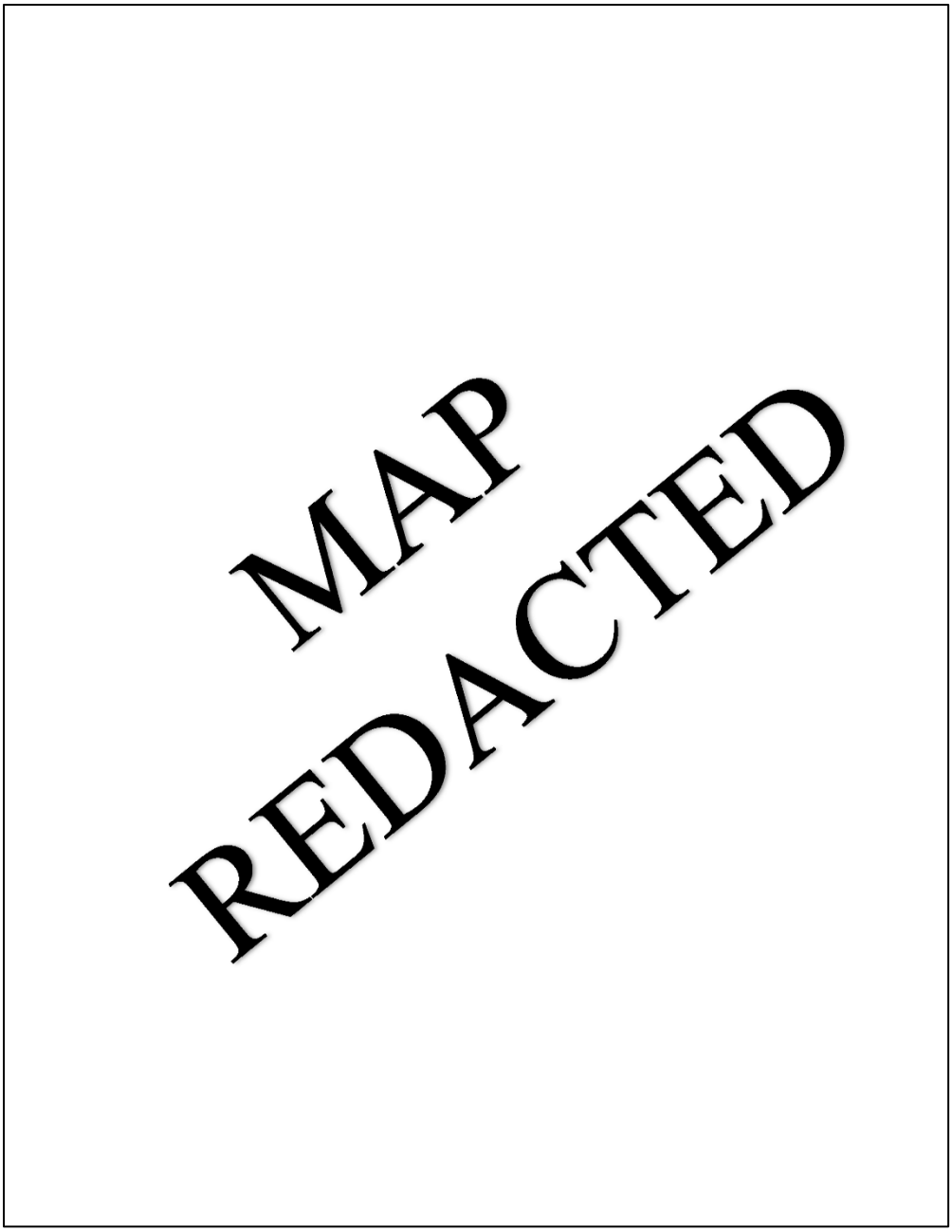


Figure 13.16. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Kings Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat. Several occurrences are located along the southern border of the core area; zoom in for finer resolution.

13.7.3.2. Vernal Pool Tadpole Shrimp Occurrences

There is one Diversity Database occurrence record for the vernal pool tadpole shrimp within this core area, which is protected within the Sand Creek Conservation Bank (see **Figure 13.16**; Diversity Database 2022). The occurrence is presumed extant by the Diversity Database and within extant mapped vernal pool grasslands (Witham 2021). The occurrence was first documented in 2006, but has not been documented during several rounds of monitoring conducted since, possibly due to drought conditions (Wildlands 2015; Wildlands 2017b; Diversity Database 2022).

13.7.4. Madera

This is a zone 1 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and 95% of vernal pool habitat for the vernal pool tadpole shrimp and Conservancy fairy shrimp. The core area is located in eastern Merced County and central Madera County, spanning the large extent of vernal pool grasslands from north of the City of Merced to east of the City of Madera and north of the City of Fresno. At 391,271 acres, the Madera Core Area is by far the largest core area designated by the Recovery Plan.

There were approximately 127,812 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013); this core area alone had more vernal pool grasslands than most Vernal Pool Regions. As of 2018, there were 117,938 acres of vernal pool grassland remaining (see **Figure 13.17**, **Table 13.1**; Witham 2021). Approximately 9,988 acres had been lost since the Recovery Plan's 2005 baseline, though 56 additional acres were created on banks that were not previously mapped as vernal pool grassland in 2005 and 299 acres were identified that were either new or missed in previous mapping efforts (Witham 2021). This was the only core area in the Southern Sierra Foothills Vernal Pool Region with losses caused by urbanization (240.5 acres, 2.4% of all losses), though the vast majority of losses were caused by agricultural conversions, mainly to orchards, vineyards, or eucalyptus (8,030.0 acres, 80.4%) (**Table 13.2**). Roughly 24,564 acres of vernal pool grassland were protected within this core area as of 2017 (Vollmar et al. 2017), representing 19.2% of the 2005 baseline.

There are two conservation banks with vernal pool fairy shrimp and vernal pool tadpole shrimp preservation credits in this core area: Drayer Ranch and Great Valley (**Figure 13.18**). These banks total 1,321 acres in size and have 162.22 acres of preservation credits for the two shrimp species (23.7% of which have already been sold). Other protected lands within this core area include the preserves associated with or adjacent to the UC Merced campus expansion, part of the Merced River Hatchery property, part of a mitigation site owned by Merced County Regional Waste Management Authority, a ranch with an easement held by NRCS, a ranch with an easement held by Central Valley Farmland Trust, a ranch being used as a mitigation site with an easement held by Sierra Foothill Conservancy, Caltrans' Madera Pools Mitigation Site, and two other mitigation sites with unknown landowners and easement holders (see **Figure 13.18**; Vollmar et al. 2017).

13.7.4.1. Vernal Pool Fairy Shrimp Occurrences

There are 183 Diversity Database occurrence records for the vernal pool fairy shrimp within this core area (see **Figure 13.19**; Diversity Database 2022). As of 2018, 95 of these occurrences were at least partially within protected lands (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database; 158 are within extant mapped vernal pool grasslands, 1 is entirely within vernal pool grasslands mapped as converted to agriculture, and 24 are outside of mapped vernal pool grasslands (Witham 2021). Of the 183 records, 21 were known at the time of listing in 1994 and 162 were known at the time the Recovery Plan was published in 2005; these records are located throughout the core area. The 21 newer records are located near the previously known occurrences, though several of the newer records are located closer to or further into the foothills to the east than the previously known occurrences.

13.7.4.2. Vernal Pool Tadpole Shrimp Occurrences

There are 26 Diversity Database occurrence records for the vernal pool tadpole shrimp within this core area (see **Figure 13.20**; Diversity Database 2022). As of 2018, 16 of these occurrences were at least partially within protected lands (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database and are within extant mapped vernal pool grasslands (Witham 2021). Of the 26 records, 5 were known at the time of listing in 1994 and 24 were known at the time the Recovery Plan was published in 2005; these records are located throughout the northern half of the core area. The two newer records are located in Merced County in and adjacent to the Ichord family ranch.

13.7.4.3. Conservancy Fairy Shrimp Occurrences

There are nine Diversity Database occurrence records for the Conservancy fairy shrimp within this core area (see **Figure 13.21**; Diversity Database 2022). These occurrences are all considered part of the UC Merced population. As of 2018, three of these occurrences were at least partially within protected lands (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database and all are within extant mapped vernal pool grasslands (Witham 2021). Of the nine records, one was known at the time of listing in 1994 and four were known at the time the Recovery Plan was published in 2005; these records are located northeast of the City of Merced near the UC Merced campus expansion. One of the five newer records is located near the previously known occurrences, while the other two are located approximately 10 miles to the southeast, east of the City of Merced and south of Highway 140.

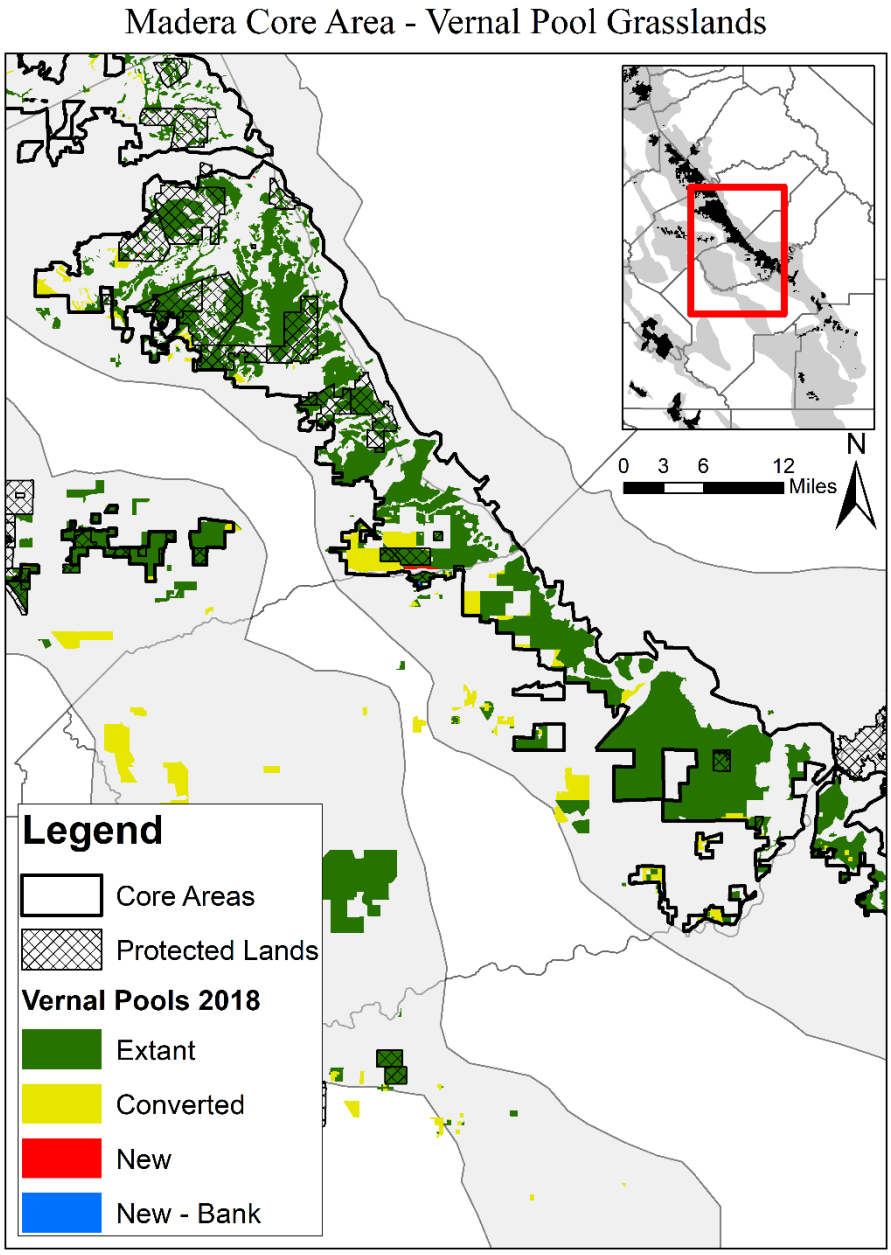


Figure 13.17. Map of vernal pool grassland habitat within the Madera Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

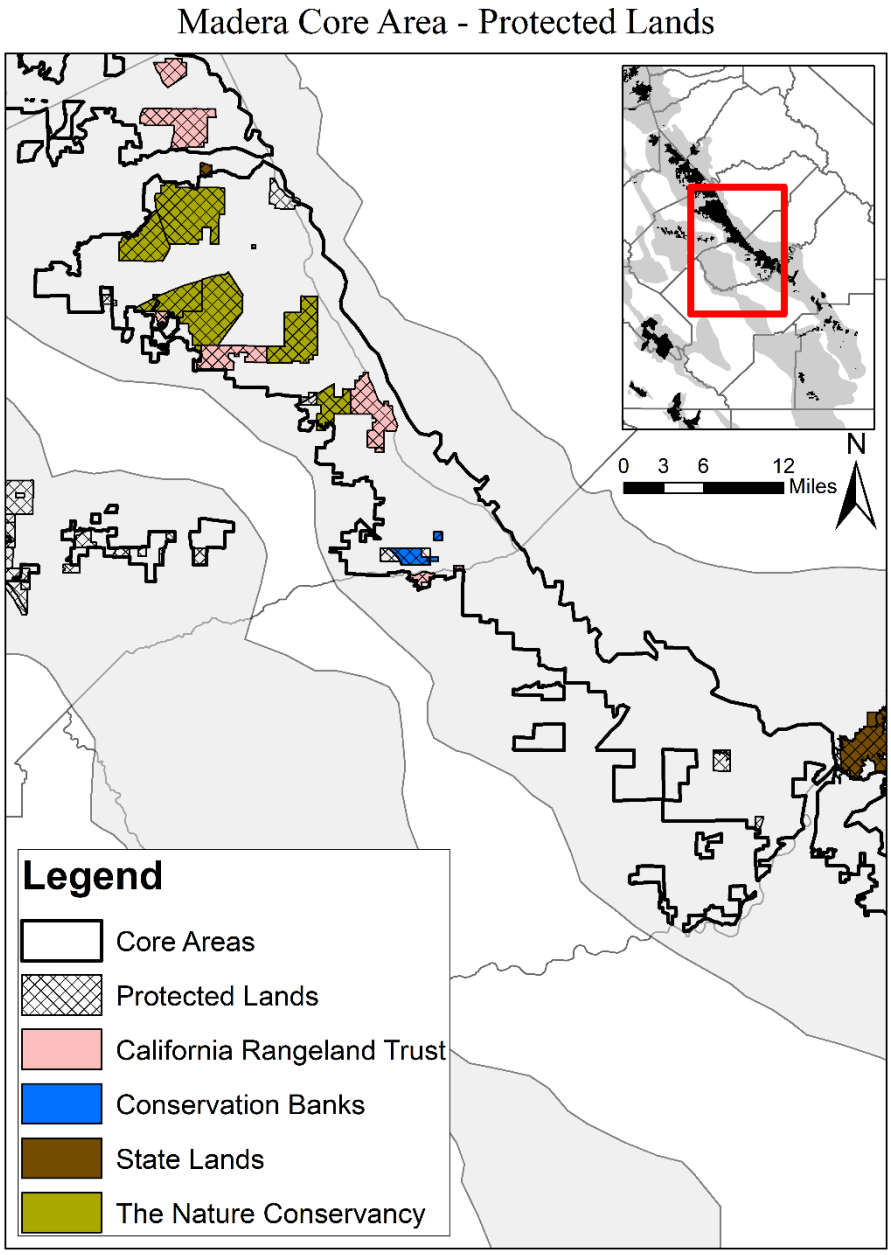


Figure 13.18. Map of protected areas within the Madera Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves.

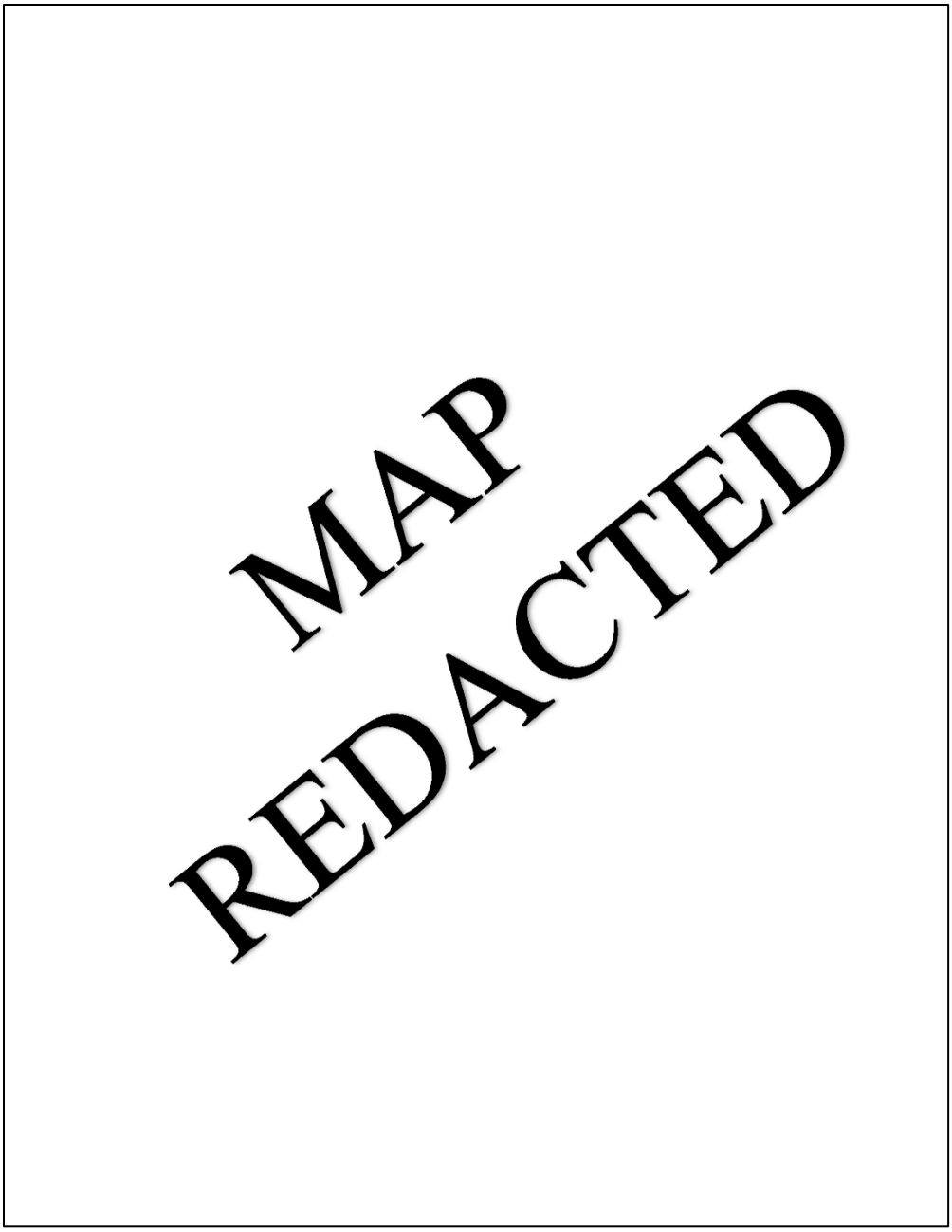


Figure 13.19. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Madera Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

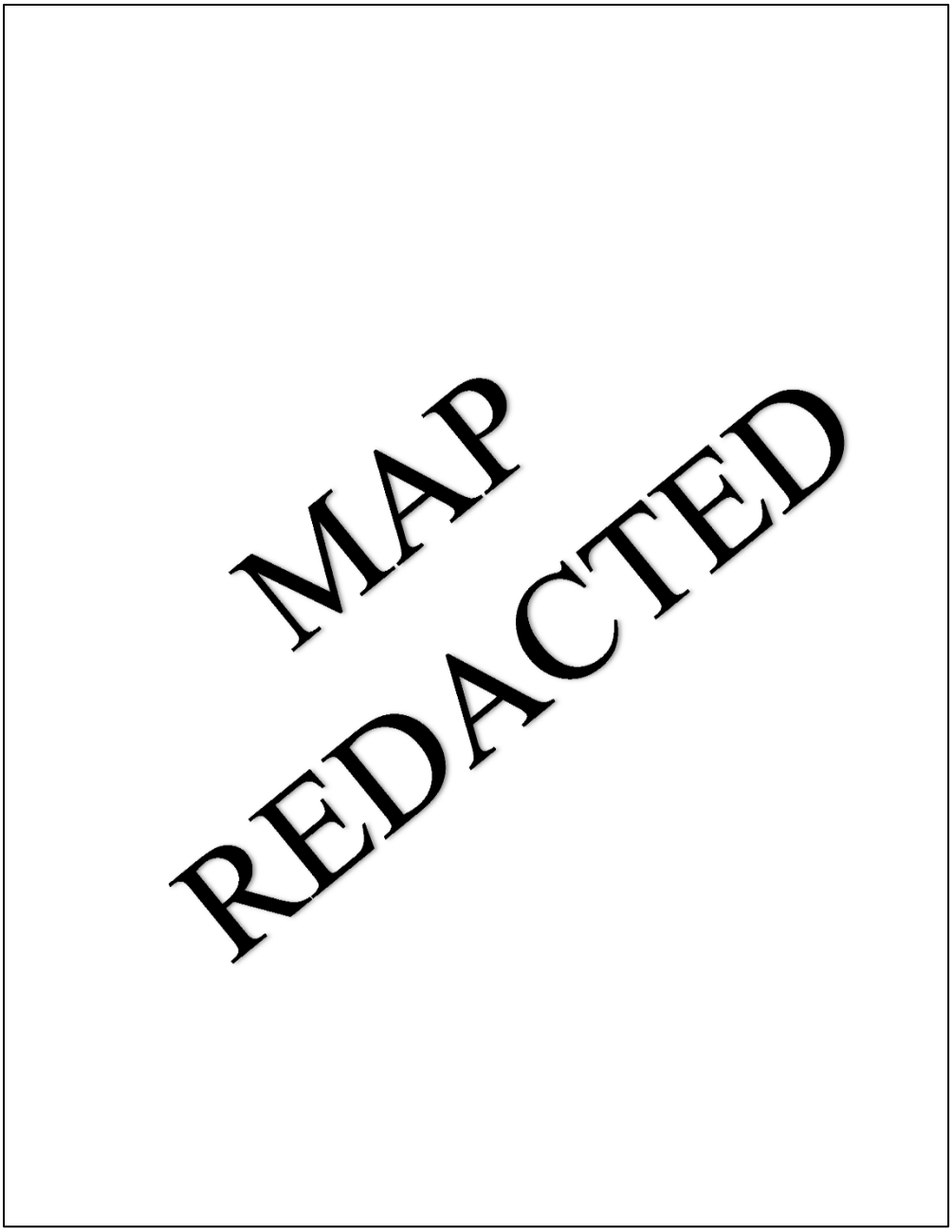


Figure 13.20. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Madera Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

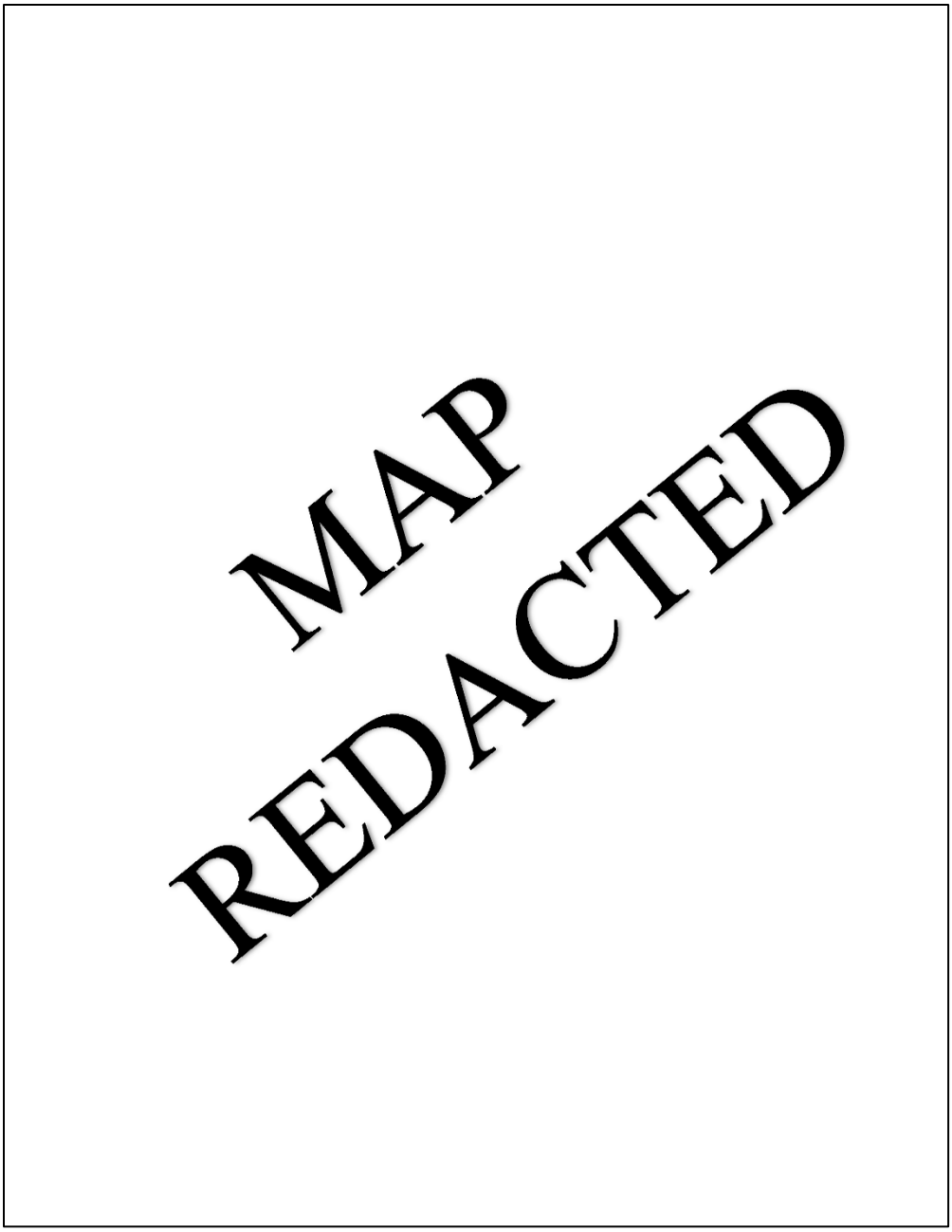


Figure 13.21. Map of known occurrences of Conservancy fairy shrimp recorded in the Diversity Database (2022) within the Madera Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

13.7.5. Merced

This is a zone 1 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and 95% of vernal pool habitat for the vernal pool tadpole shrimp. The core area is located in eastern Stanislaus and Merced Counties with the Stanislaus River to the north, the Merced River to the south, and the Tuolumne River between the core area's two polygons. The three small, disjoint polygons on the southwestern edge of the core area are the Waterford and Turlock Core Areas.

There were approximately 20,417 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 17,293 acres of vernal pool grassland remaining (see **Figure 13.22**, **Table 13.1**; Witham 2021). Approximately 3,230 acres had been lost since the Recovery Plan's 2005 baseline, though 118 additional acres were identified that were either new or missed in previous mapping efforts (Witham 2021). This represents a loss of more than 15% of the amount of vernal pool habitat that remained in 2005, making the 85% target unattainable without habitat creation or restoration. The vast majority of losses were caused by agricultural conversions, mainly to orchards, vineyards, or eucalyptus (2,829.4 acres, 87.6%), with a small amount of loss caused by conversion to managed wetlands (12.6 acres, 0.4%) (**Table 13.2**). Roughly 3,161 acres of vernal pool grassland were protected within this core area as of 2017 (Vollmar et al. 2017), representing 15.5% of the 2005 baseline.

Protected lands include a ranch with an easement held by NRCS, land owned by the County of Stanislaus, and the JCR Ranch and Richards family ranch with conservation easements held by California Rangeland Trust (**Figure 13.23**).

13.7.5.1. Vernal Pool Fairy Shrimp Occurrences

There are 29 Diversity Database occurrence records for the vernal pool fairy shrimp within this core area (see **Figure 13.24**; Diversity Database 2022). As of 2018, 12 of these occurrences were at least partially within protected lands (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database; 21 are within extant mapped vernal pool grasslands, 2 are partially within vernal pool grasslands mapped as converted to agriculture, and 6 are outside of mapped vernal pool grasslands (Witham 2021). Of the 29 records, 1 was known at the time of listing in 1994 and 23 were known at the time the Recovery Plan was published in 2005; these records are located in the northeastern portion of the northern polygon and in the southeastern and western portions of the southern polygon. The six newer records are located in the northwestern portion of the northern polygon and the northeastern portion of the southern polygon, expanding the known range of the vernal pool fairy shrimp in this core area.

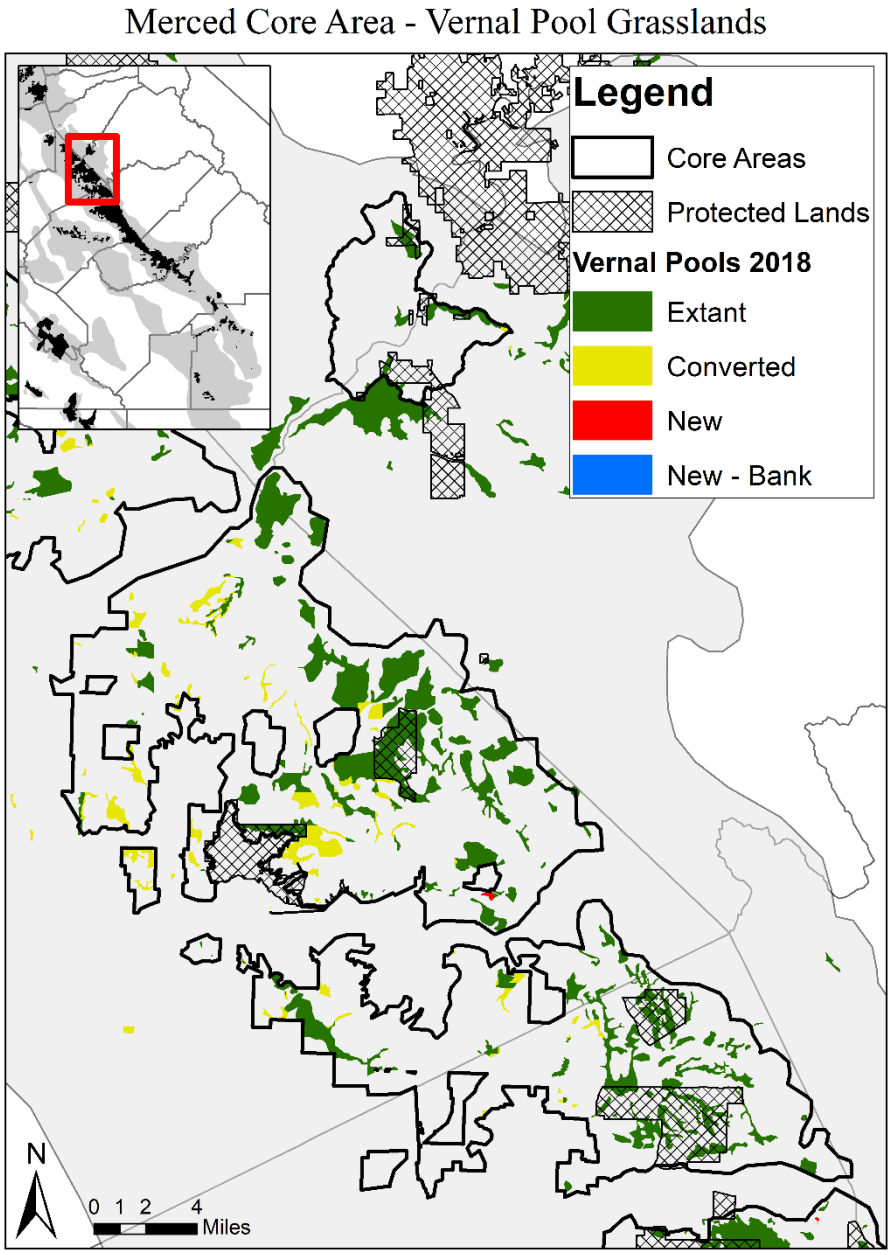


Figure 13.22. Map of vernal pool grassland habitat within the Merced Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

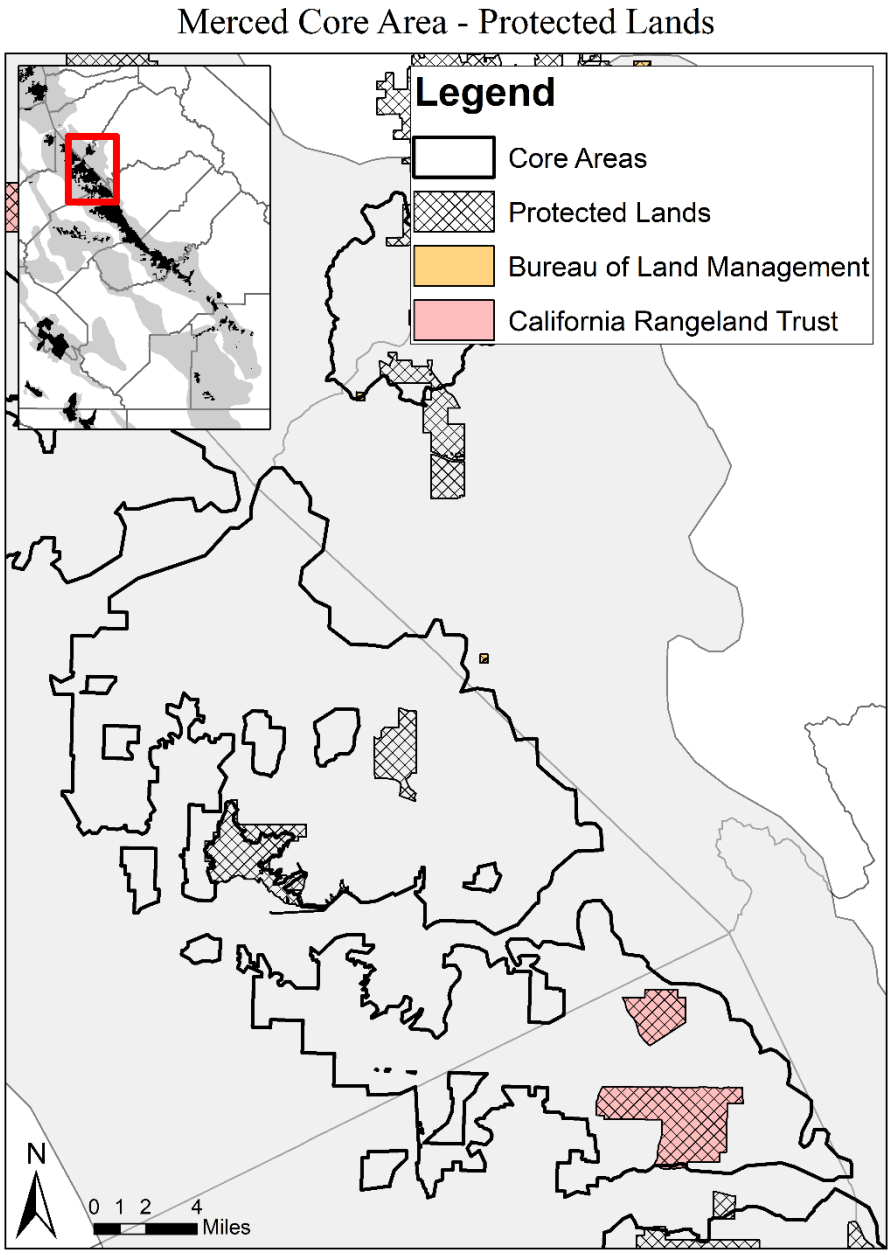


Figure 13.23. Map of protected areas within the Merced Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves.

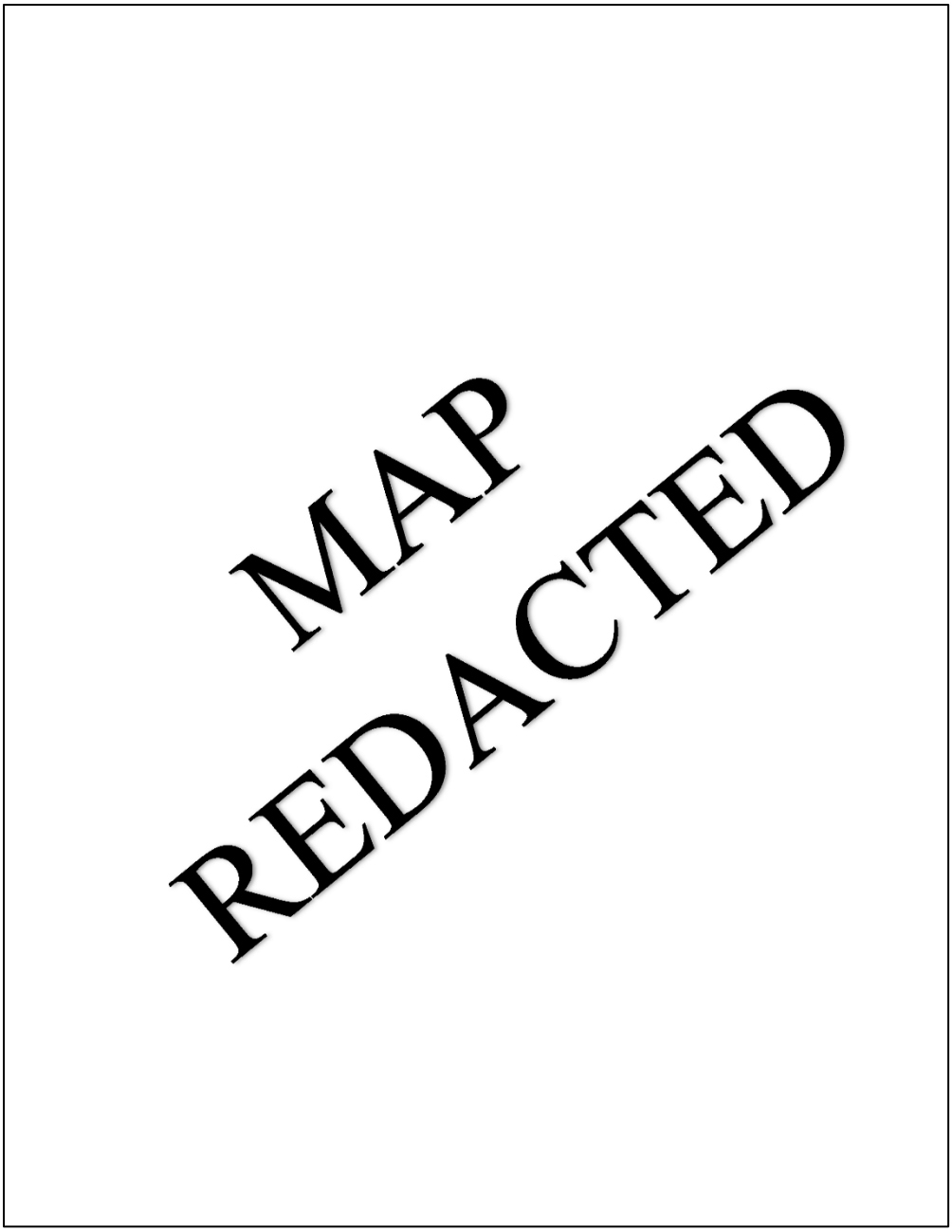


Figure 13.24. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Merced Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

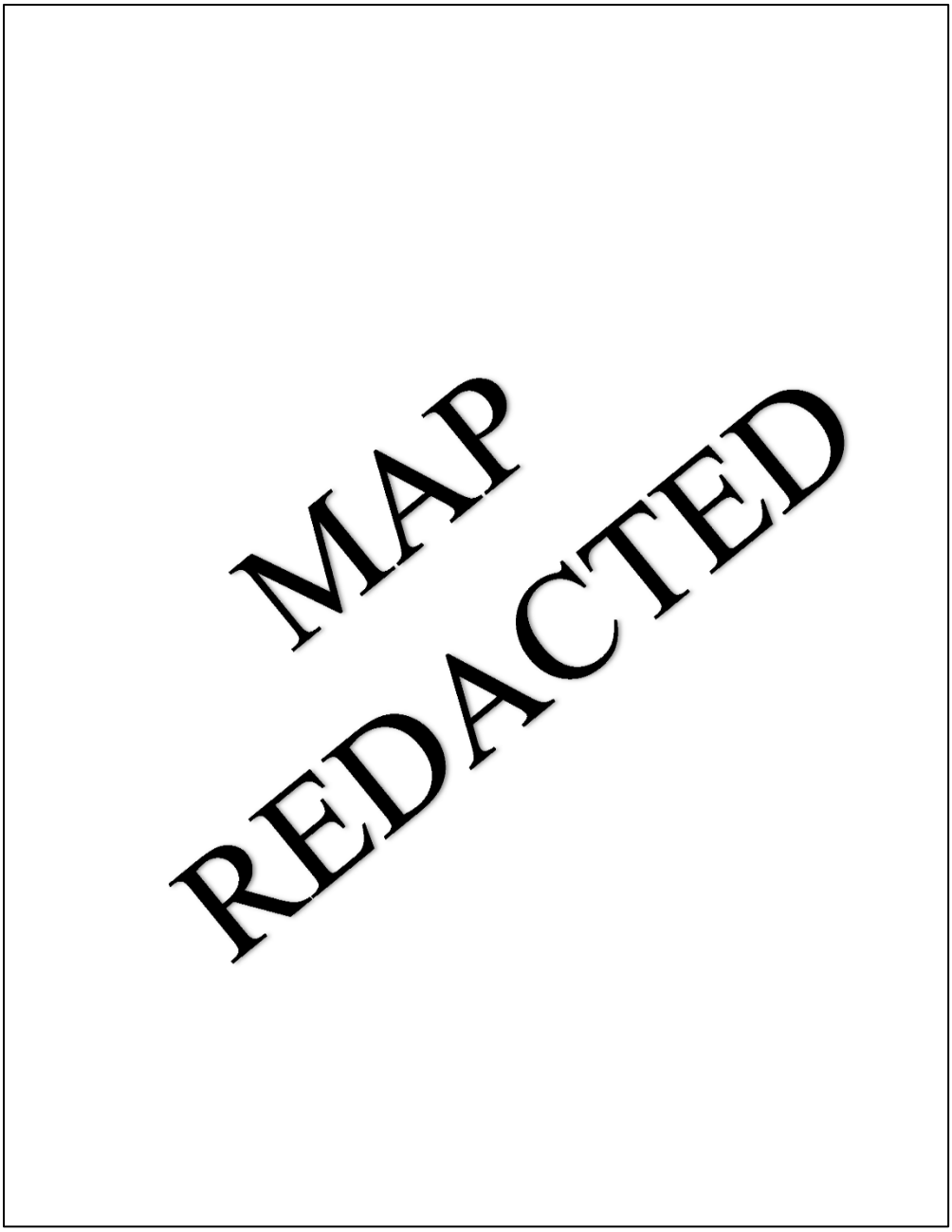


Figure 13.25. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Merced Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

13.7.5.2. Vernal Pool Tadpole Shrimp Occurrences

There are five Diversity Database occurrence records for the vernal pool tadpole shrimp within this core area (see **Figure 13.25**; Diversity Database 2022). As of 2018, none of these occurrences were protected (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database; two are within extant mapped vernal pool grasslands and three are partially within vernal pool grasslands mapped as converted to agriculture, though these three occurrences mostly overlap extant habitat (Witham 2021). Of the five records, two were known at the time of listing in 1994 and three were known at the time the Recovery Plan was published in 2005; these records are located in the northwestern portion of the northern polygon and in the northwestern portion of the southern polygon. The two newer records are located near the other known occurrences.

13.7.6. San Joaquin

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. This core area was not designated for the vernal pool tadpole shrimp in the Recovery Plan, but the species is known to occur there. The core area is located in eastern San Joaquin County east of the City of Stockton on either side of Escalon-Bellota Road.

There were approximately 7,259 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were 4,229 acres of vernal pool grassland remaining (see **Figure 13.26**, **Table 13.1**; Witham 2021). Approximately 3,030 acres had been lost since the Recovery Plan's 2005 baseline (Witham 2021). This represents a loss of more than 15% of the amount of vernal pool habitat that remained in 2005, making the 85% target unattainable without habitat creation or restoration. All losses were caused by agricultural conversions, with the majority due to orchards, vineyards, or eucalyptus (2,257 acres, 74.5%) (**Table 13.2**). This core area had the second largest percentage of vernal pool habitat loss since 2005 in the Central Valley. This is particularly significant given the size of the San Joaquin Core Area; the other five core areas in the top six of loss percentage were all small core areas (less than 6,000 acres) with a very small amount of vernal pool grasslands lost (less than 250 acres). At this point it is unlikely that the Recovery Plan's goal of protecting at least 6,170 acres of vernal pool grassland (85% of the 2005 baseline) will be achievable even with habitat creation or restoration. Therefore, efforts in this core area need to focus on preventing agricultural conversion of all remaining vernal pool habitat and working with landowners and other stakeholders to conserve these areas.

Roughly 937 acres of vernal pool grassland were protected within this core area as of 2017 (Vollmar et al. 2017), representing 12.9% of the 2005 baseline. The only protected area in this core area is the Cook Ranch, which is owned by the Cook Cattle Company with a conservation easement held by California Rangeland Trust (**Figure 13.27**).

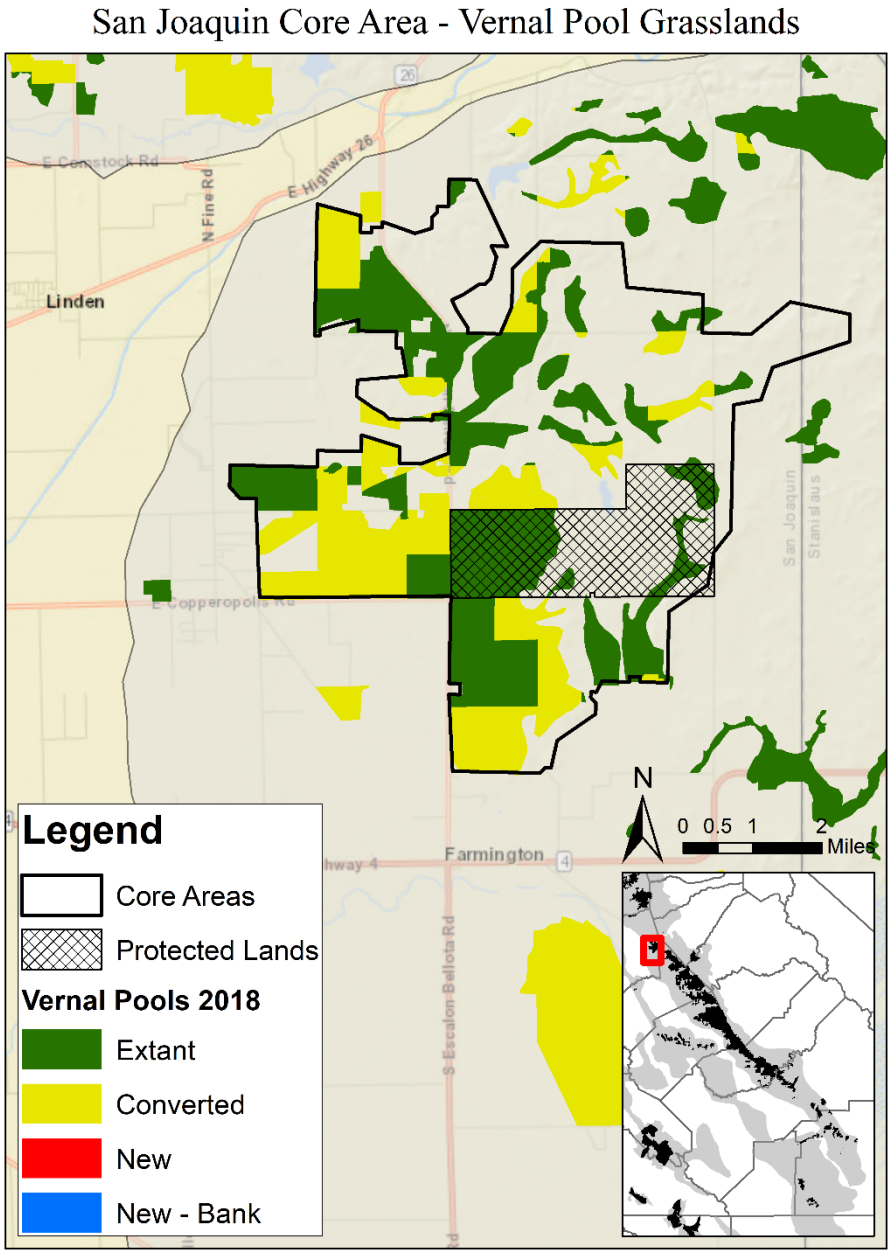


Figure 13.26. Map of vernal pool grassland habitat within the San Joaquin Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

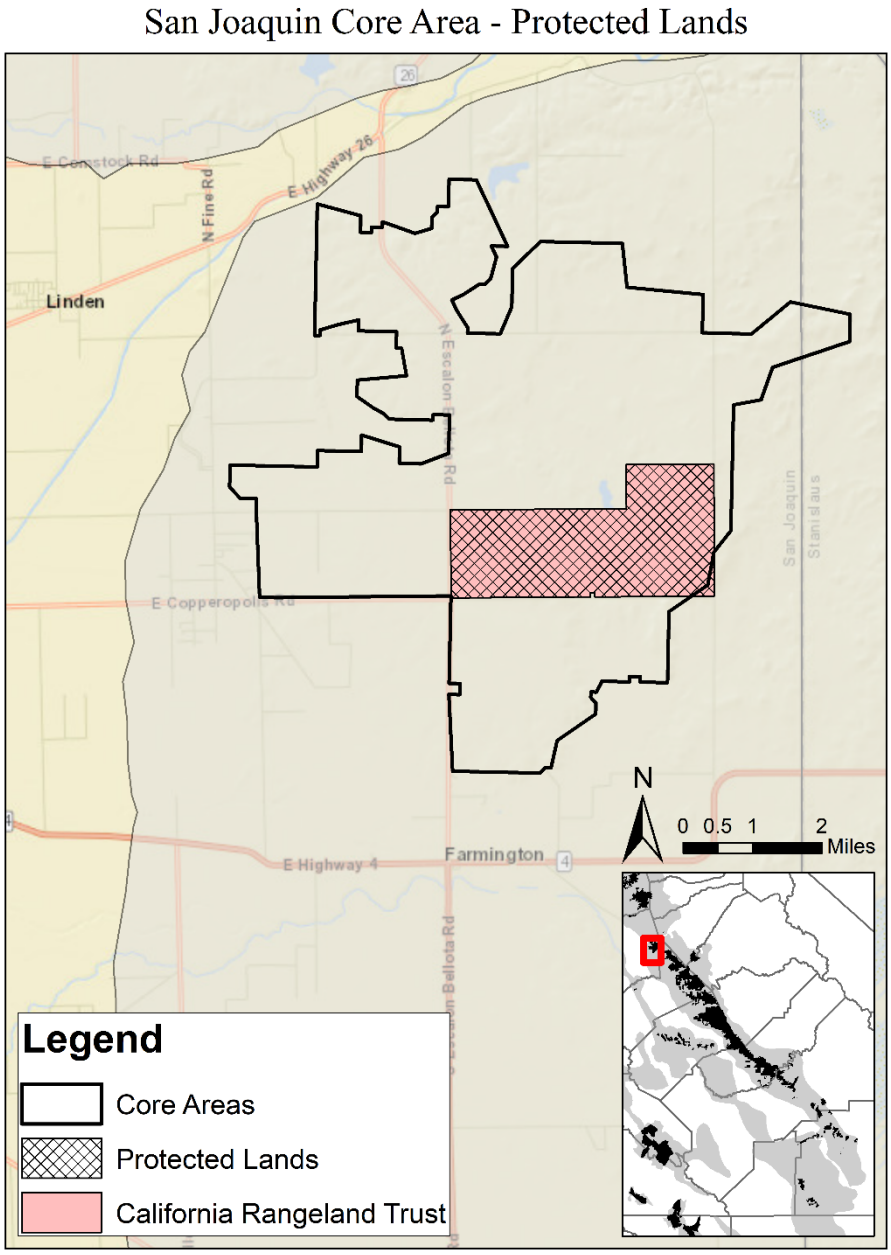


Figure 13.27. Map of protected areas within the San Joaquin Core Area**.** Protected lands are based on Vollmar et al. (2017).

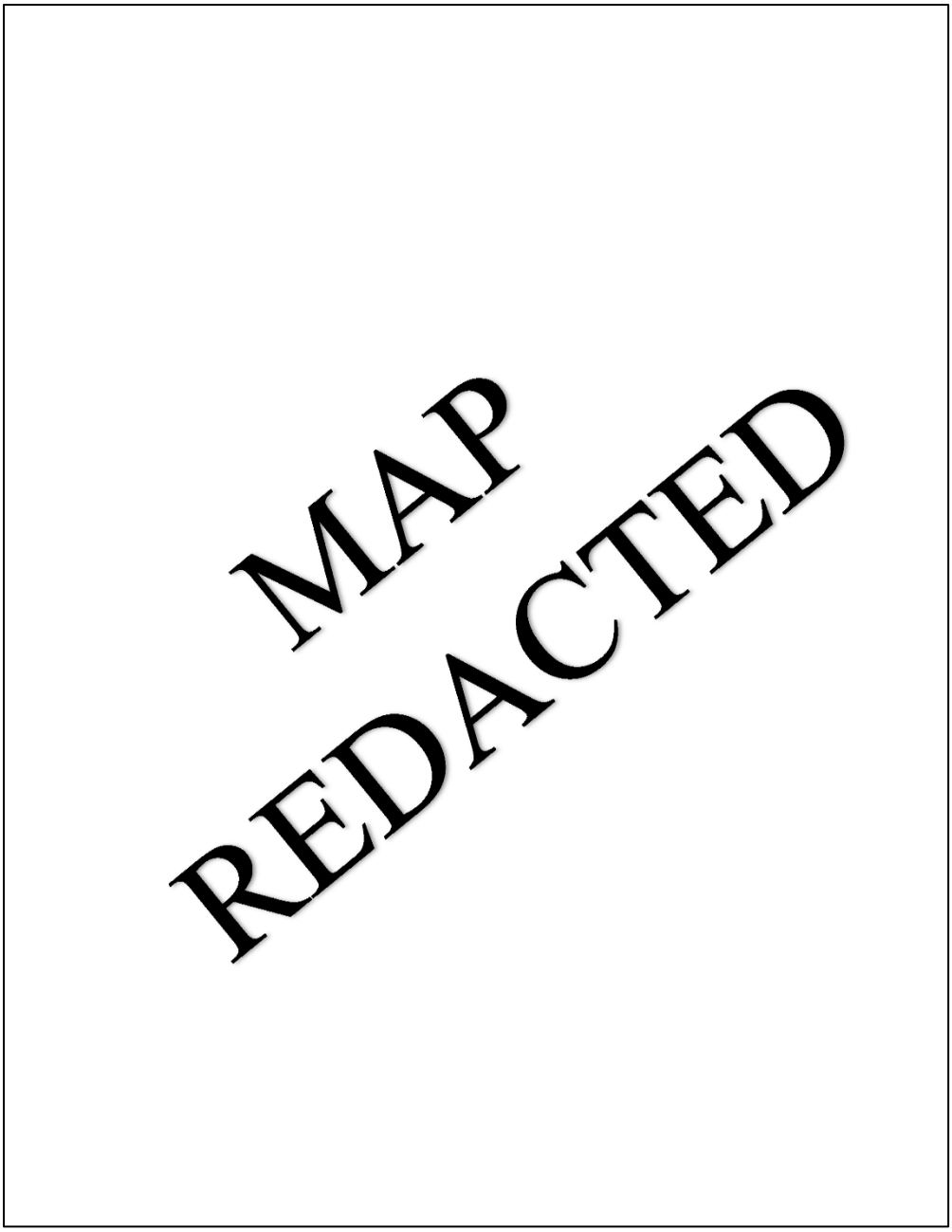


Figure 13.28. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the San Joaquin Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

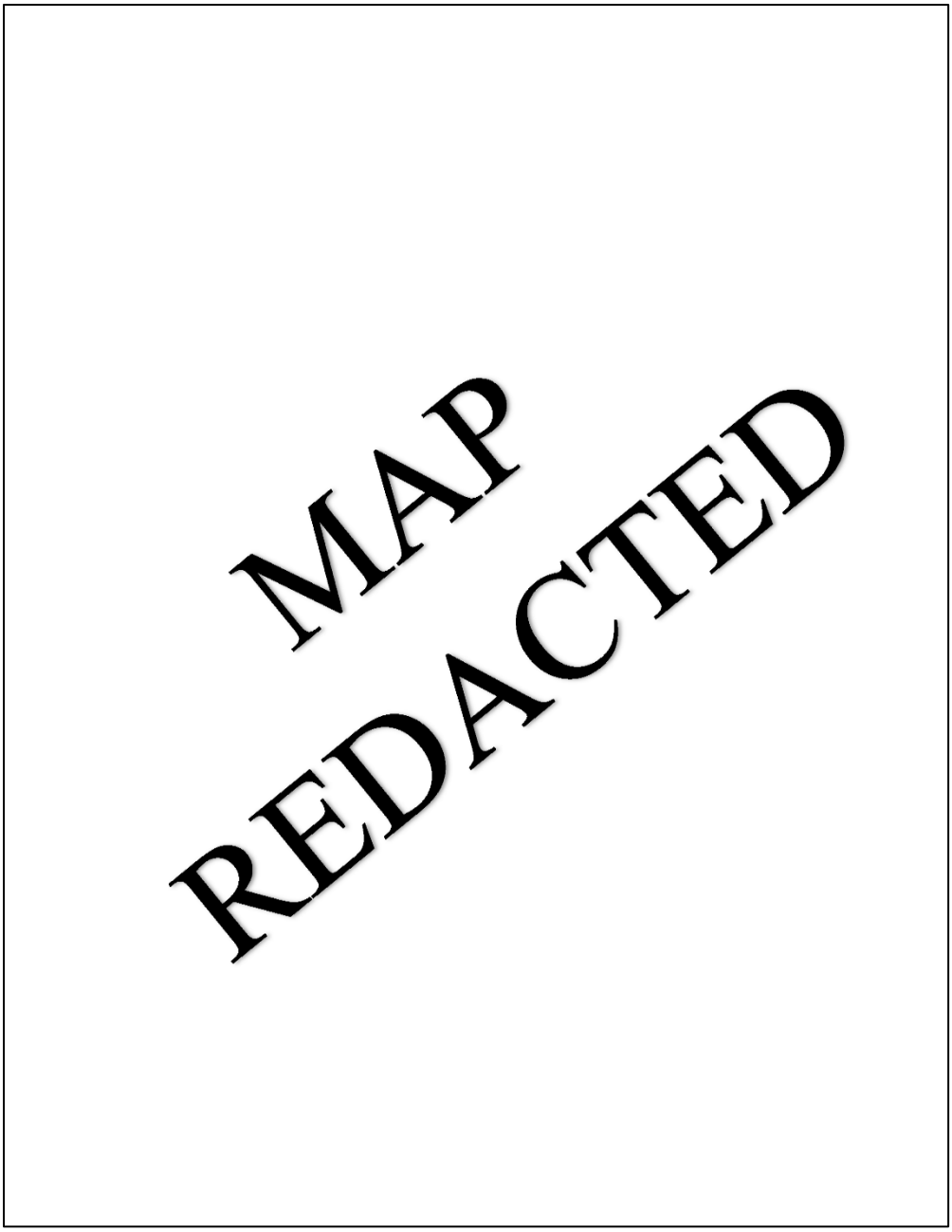


Figure 13.29. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the San Joaquin Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

13.7.6.1. Vernal Pool Fairy Shrimp Occurrences

There is one Diversity Database occurrence record for the vernal pool fairy shrimp within this core area (see **Figure 13.28**; Diversity Database 2022). This occurrence is not protected (Vollmar et al. 2017). It is presumed extant by the Diversity Database; it slightly overlaps extirpated vernal pool grasslands, but is primarily within extant mapped vernal pool grasslands (Witham 2021). This occurrence was recorded in 1997, after listing but prior to the Recovery Plan being published in 2005, and was subsequently observed in 1999 and 2011 (Diversity Database 2022).

13.7.6.2. Vernal Pool Tadpole Shrimp Occurrences

There is one Diversity Database occurrence record for the vernal pool tadpole shrimp within this core area (see **Figure 13.29**; Diversity Database 2022). This occurrence is not protected (Vollmar et al. 2017). It is presumed extant by the Diversity Database; it slightly overlaps extirpated vernal pool grasslands but is primarily within extant mapped vernal pool grasslands (Witham 2021). This occurrence was recorded in 2011, after the Recovery Plan was published, and was noted at the time as threatened due to nearby land conversion (Diversity Database 2022).

13.7.7. Table Mountain

This is a zone 1 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp and 95% of vernal pool habitat for the vernal pool tadpole shrimp. The core area is located on Table Mountain in Fresno County and Kennedy Table in Madera County on either side of the San Joaquin River north of Millerton Lake.

There were approximately 1,738 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were still 1,738 acres of vernal pool grassland remaining, with no habitat losses occurring since 2005 (see **Figure 13.30**, **Table 13.1**; Witham 2021). Roughly 1,460 acres of vernal pool grassland were protected within this core area as of 2017 (Vollmar et al. 2017), representing 84.0% of the 2005 baseline.

Protected lands within this core area include BLM's Table Mountain and Kennedy Table areas of ecological importance, CDFW's Big Table Mountain Ecological Reserve, the Sierra Foothill Conservancy's Ruth McKenzie Table Mountain Preserve, the Kennedy Table Conservation Bank, and the California Rangeland Trust's conservation easement over the Van Alen family ranch (**Figure 13.31**).

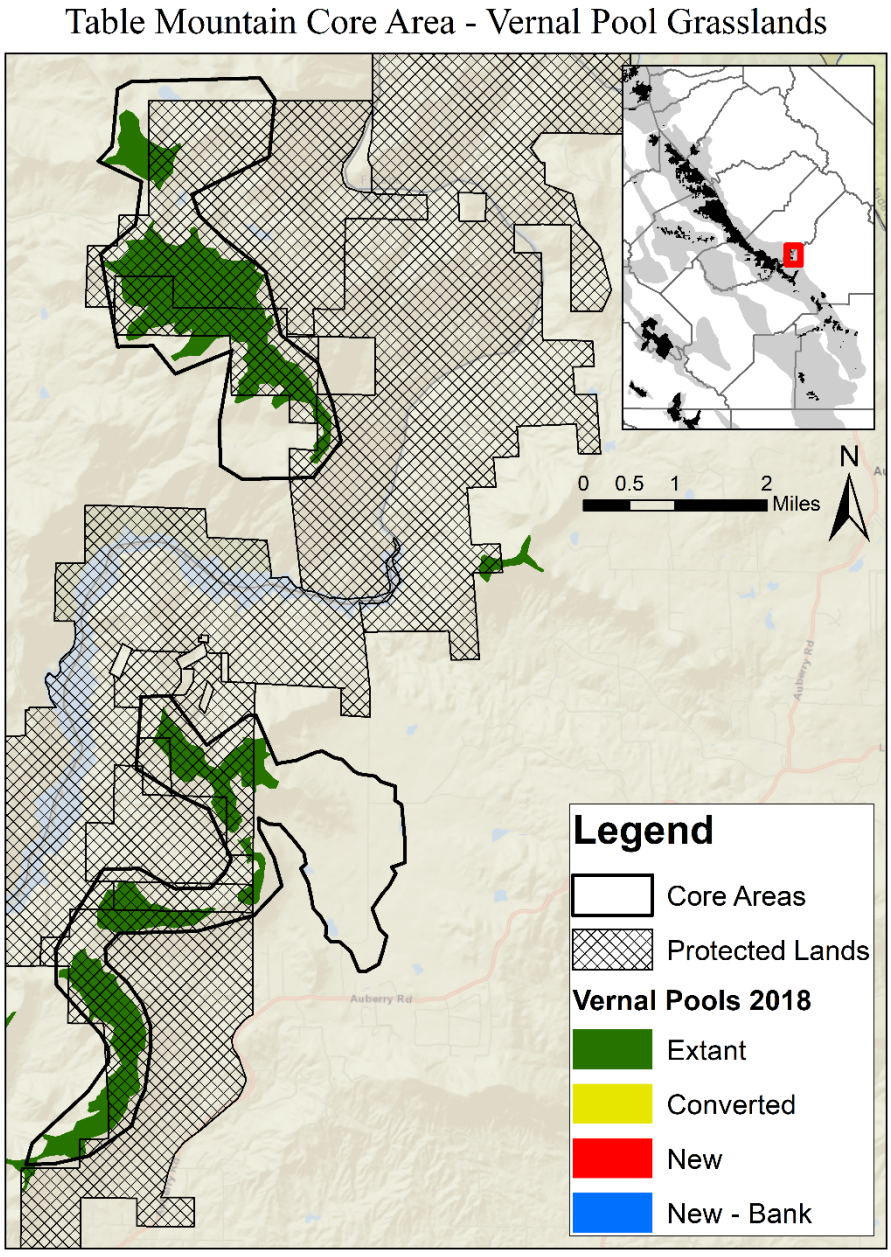


Figure 13.30. Map of vernal pool grassland habitat within the Table Mountain Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

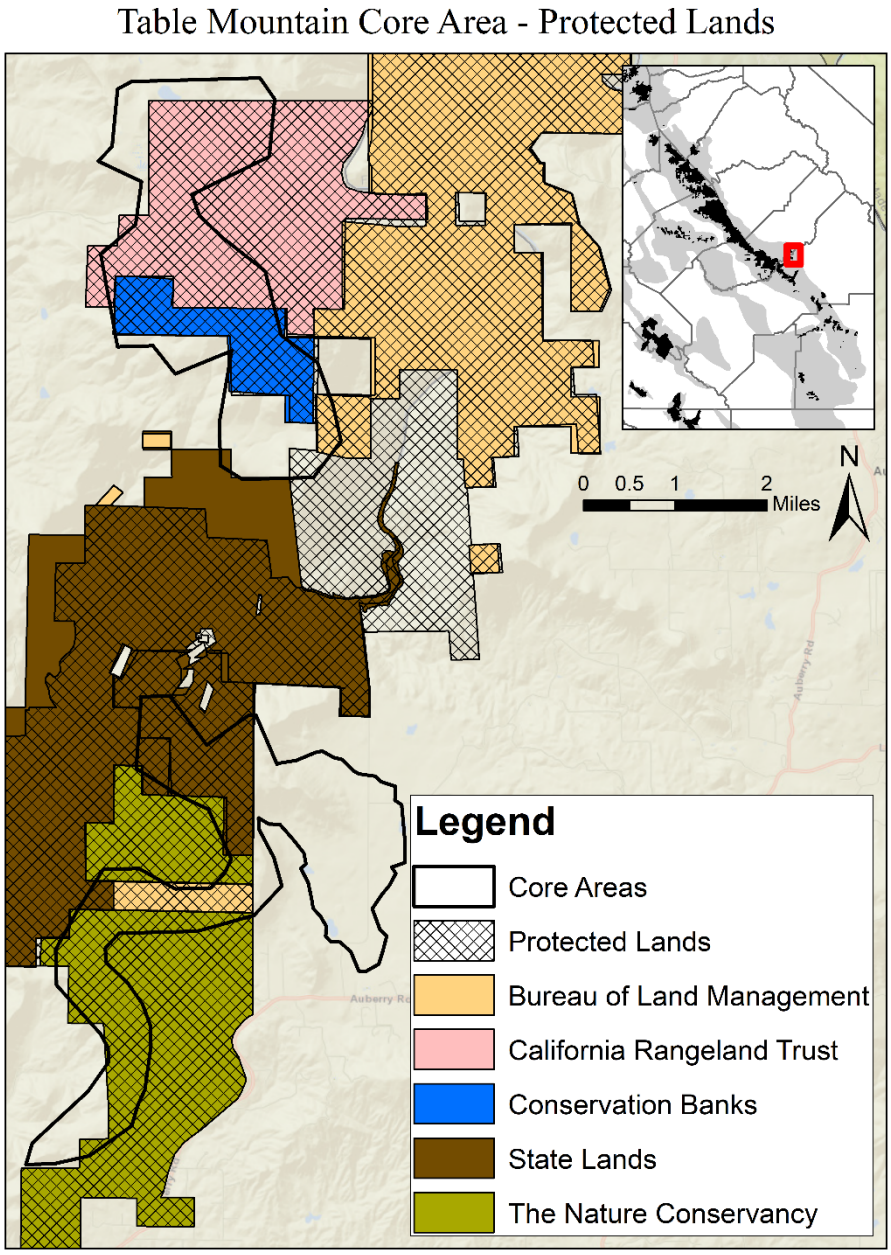


Figure 13.31. Map of protected areas within the Table Mountain Core Area**.** Protected lands are based on Vollmar et al. (2017) and include various preserves.

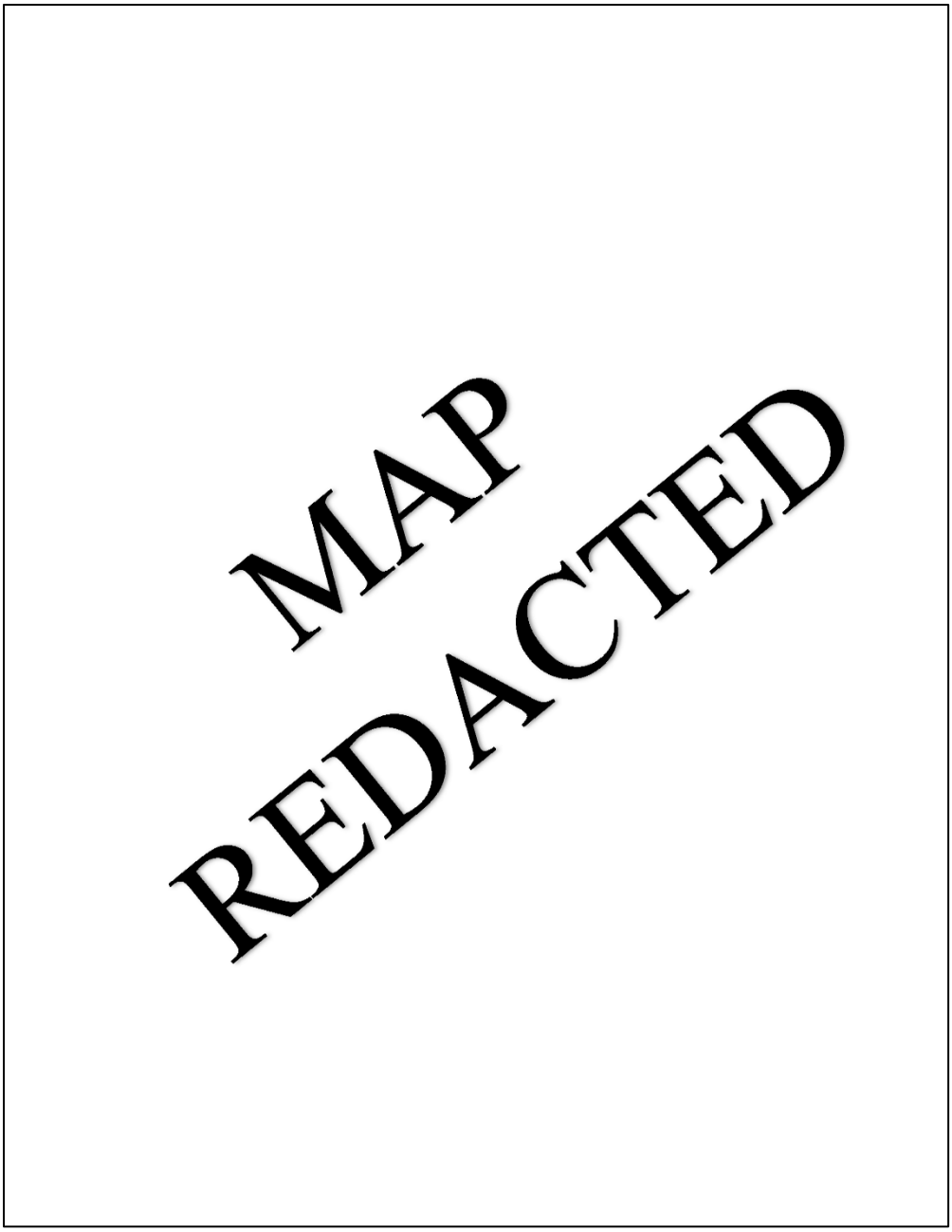


Figure 13.32. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Table Mountain Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

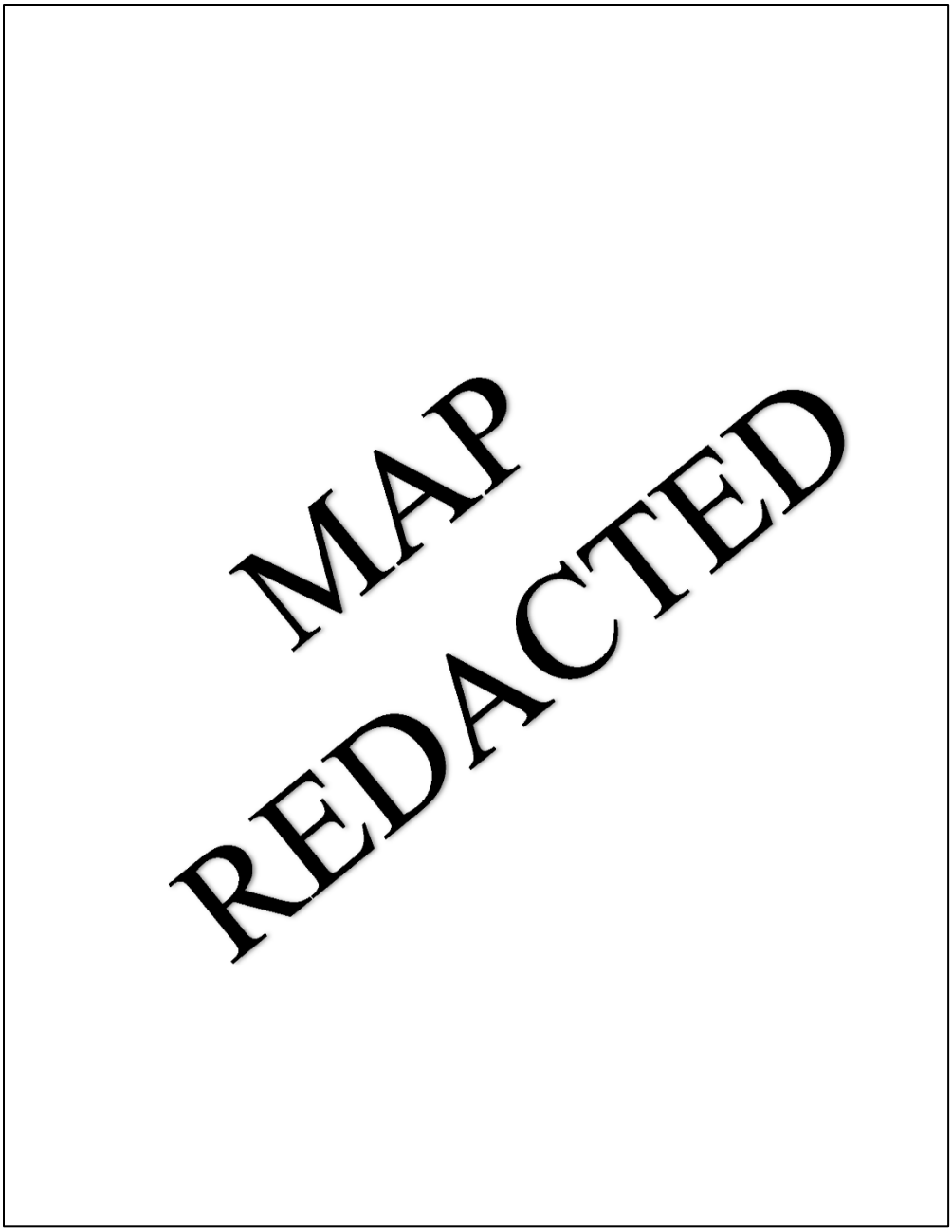


Figure 13.33. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) within the Table Mountain Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

13.7.7.1. Vernal Pool Fairy Shrimp Occurrences

There are three Diversity Database occurrence records for the vernal pool fairy shrimp within this core area (see **Figure 13.32**; Diversity Database 2022). As of 2018, all of these occurrences were protected (Vollmar et al. 2017). All three occurrences are presumed extant by the Diversity Database and are within extant mapped vernal pool grasslands (Witham 2021). Of the three records, none were known at the time of listing in 1994 and two were known at the time the Recovery Plan was published in 2005. One of these records is located in the central portion of Kennedy Table within the Kennedy Table Conservation Bank, and the other is located in the northern portion of Table Mountain within CDFW's Big Table Mountain Ecological Reserve. The one newer record was recorded in 2010 on BLM land in the southern portion of Kennedy Table.

13.7.7.2. Vernal Pool Tadpole Shrimp Occurrences

There is one Diversity Database occurrence record for the vernal pool tadpole shrimp within this core area (see **Figure 13.33**; Diversity Database 2022). As of 2018, the occurrence was protected within CDFW's Big Table Mountain Ecological Reserve (Vollmar et al. 2017). The occurrence is presumed extant by the Diversity Database and within extant mapped vernal pool grasslands (Witham 2021). The occurrence was first observed in 1995 and has been routinely observed since (Diversity Database 2022).

13.7.8. Tulare

This is a zone 2 core area, but it was not designated for the vernal pool fairy shrimp in the Recovery Plan. It was designated for Hoover's spurge (*Chamaesyce hooveri*), San Joaquin Valley Orcutt grass (*Orcuttia inaequalis*), and spiny-sepaled button-celery (*Eryngium spinosepalum*), with a goal of protecting 85% of vernal pool habitat. The core area is located in Tulare County on either side of Highway 245 east of Long Creek and north of the City of Woodlake.

There were approximately 1,584 acres of vernal pool grassland within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were still 1,584 acres of vernal pool grassland remaining, with no habitat losses occurring since 2005 (see **Figure 13.34**, **Table 13.1**; Witham 2021). The Service is not aware of any protected vernal pool habitat within this core area (Vollmar et al. 2017).

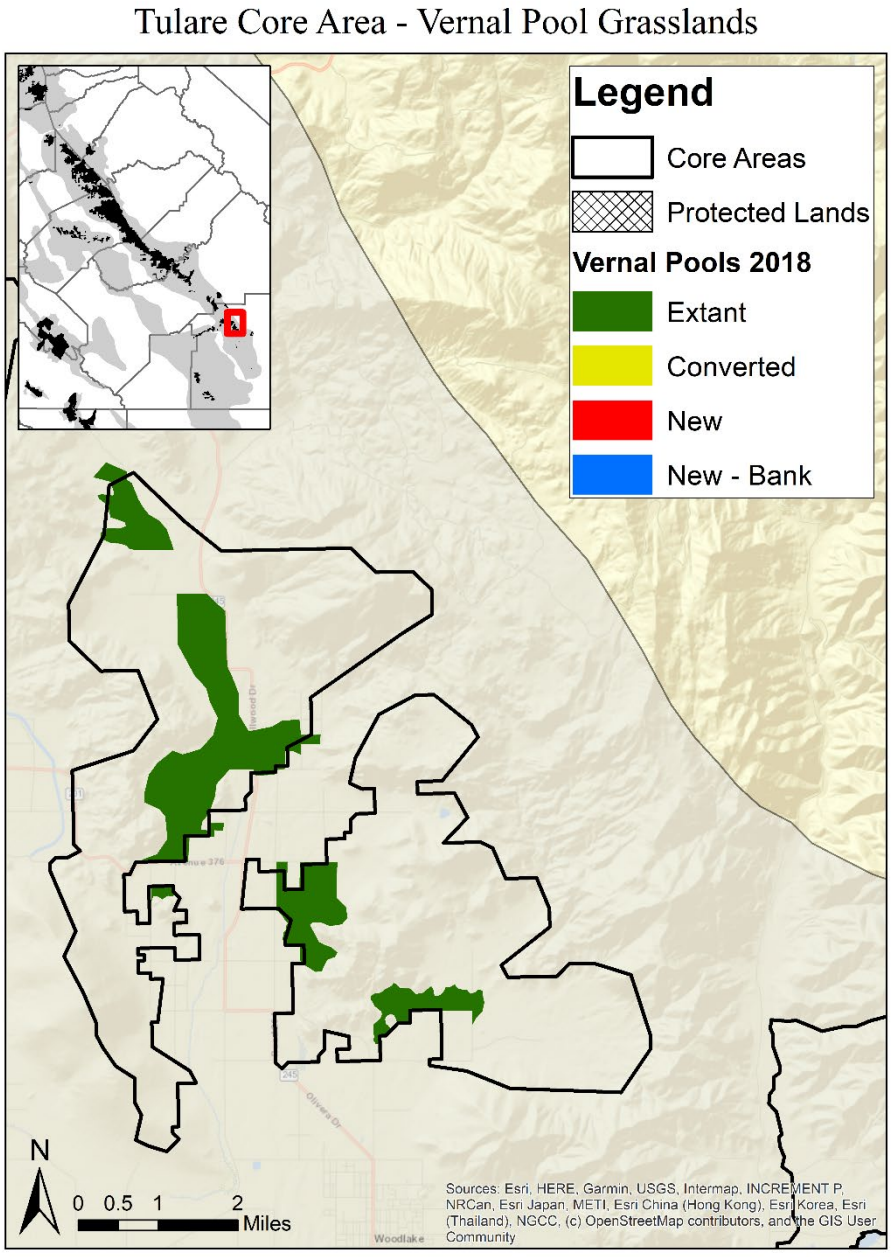


Figure 13.34. Map of vernal pool grassland habitat within the Tulare Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

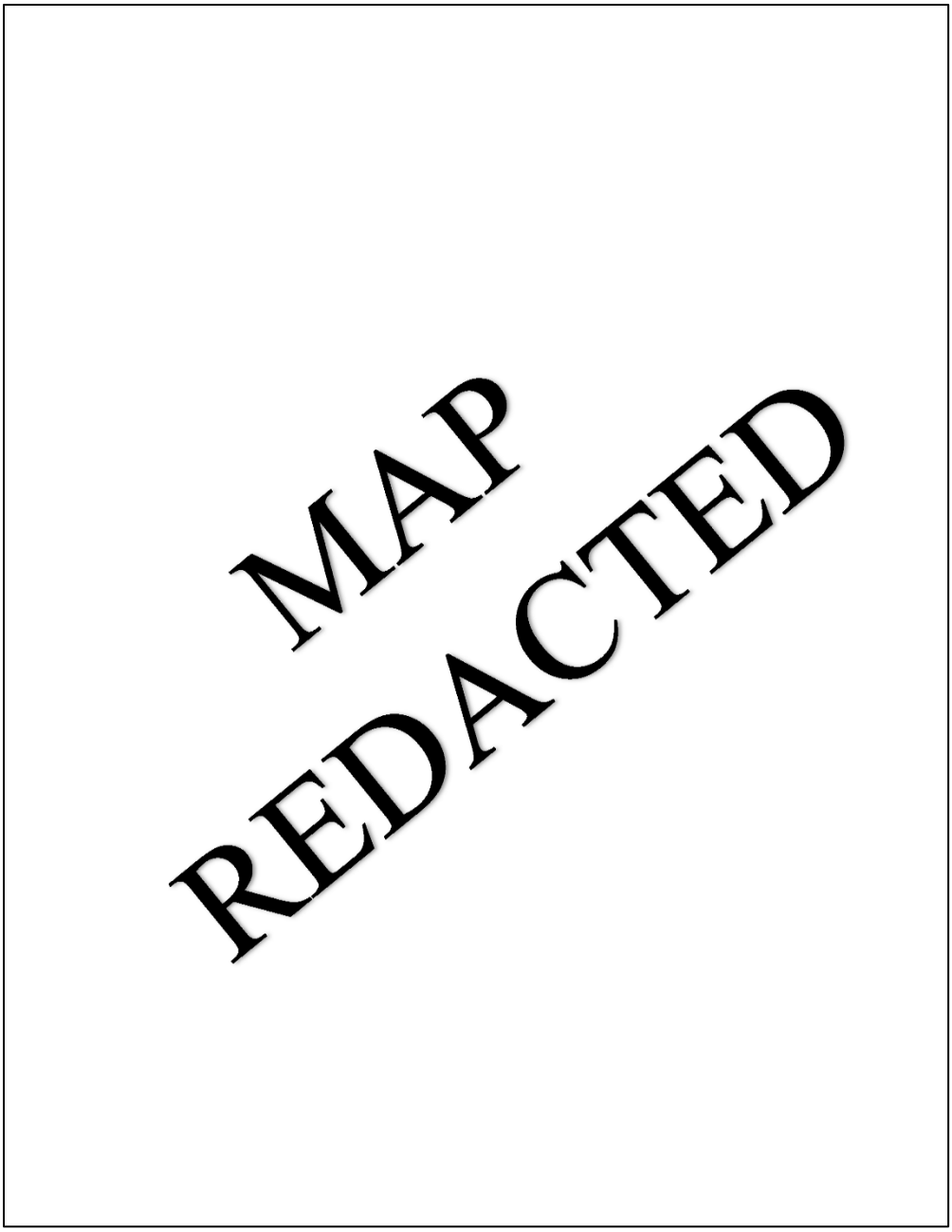


Figure 13.35. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) within the Tulare Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

13.7.8.1. Vernal Pool Fairy Shrimp Occurrences

There are four Diversity Database occurrence records for the vernal pool fairy shrimp within this core area and one additional occurrence immediately adjacent to it (see **Figure 13.35**; Diversity Database 2022). As of 2018, none of these occurrences were protected (Vollmar et al. 2017). All occurrences are presumed extant by the Diversity Database; three are within extant mapped vernal pool grasslands and two are outside of mapped vernal pool grasslands (Witham 2021). These five occurrences were all first documented between 2010 and 2012 after the Recovery Plan was published, representing an expansion of the known range of the vernal pool fairy shrimp. The occurrences are all located in the southern portions of the core area, only having been documented within the two smallest patches of mapped vernal pool grasslands or along roads outside of mapped vernal pool grasslands (Witham 2021; Diversity Database 2022). Although the vernal pool fairy shrimp has not yet been documented within the larger expanses of vernal pool grassland in this core area, that may be due to a lack of survey effort, as very few occurrences of any vernal pool species have been recorded in the Diversity Database in these areas (Diversity Database 2022).

13.7.9. Turlock

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. However, there are no known occurrences of the species within this core area, so this designation may need to be reconsidered. This core area was also not designated for the vernal pool tadpole shrimp, but that species is discussed below. The core area is composed of two small, disjoint polygons southwest of the Merced Core Area; one is in Stanislaus County east of the City of Hickman and south of the Tuolumne River, and the other is in Merced County at the eastern terminus of Monte Vista Avenue north of Dry Creek.

There were only 6.6 acres of vernal pool grassland mapped within this core area when the Recovery Plan was published in 2005 (Witham et al. 2013). As of 2018, there were still 6.6 acres of vernal pool grassland remaining, with no habitat losses occurring since 2005 (see **Figure 13.36**, **Table 13.1**; Witham 2021). The Service is not aware of any protected vernal pool habitat within this core area (Vollmar et al. 2017). The Recovery Plan states that this core area includes the Hickman vernal pool complex, although the majority of this complex is within the Merced Core Area. Based on aerial imagery, the northern polygon contains one 245-acre property that is composed of vernal pool grassland (Google Maps 2023b), though Witham et al. (2013) only mapped the two most prominent vernal pools on the property as 6.6 acres of vernal pool grassland. The southern polygon does not have any occurrences of vernal pool species within it and does not appear to have any vernal pool grassland based on aerial imagery or Witham et al. (2013), so it is unclear why this area was included in the core area's boundaries.

13.7.9.1. Vernal Pool Fairy Shrimp Occurrences

There are no occurrence records for the vernal pool fairy shrimp within this core area; the nearest known occurrence of the species is near the Merced Core Area between the two polygons of the Turlock Core Area, approximately 3 and 5 miles from the northern and southern polygons of the core area, respectively (see **Figure 13.37**; Diversity Database 2022). It is unclear why the vernal pool fairy shrimp was included in this core area; it may have been assumed that the species could

be present due to a lack of survey effort and known occurrences nearby, but this same logic does not seem to have been applied to other relevant core areas.

13.7.9.2. Vernal Pool Tadpole Shrimp Occurrences

There are no occurrence records for the vernal pool tadpole shrimp within this core area; the nearest known occurrence of the species is 1 mile to the east within the Hickman vernal pool complex on Robinson Ranch in the Merced Core Area (see **Figure 13.38**; Diversity Database 2022). Despite being designated for the vernal pool fairy shrimp, there are also no known occurrences of that species within the core area. The Recovery Plan says that this core area includes the Hickman vernal pool complex, so given that both the vernal pool fairy shrimp and vernal pool tadpole shrimp are known to occur in the adjacent portions of the Hickman vernal pool complex, the two species should be treated the same with regards to the Turlock Core Area. Either the vernal pool tadpole shrimp should be included in the core area or both species should be removed from the core area's designation.

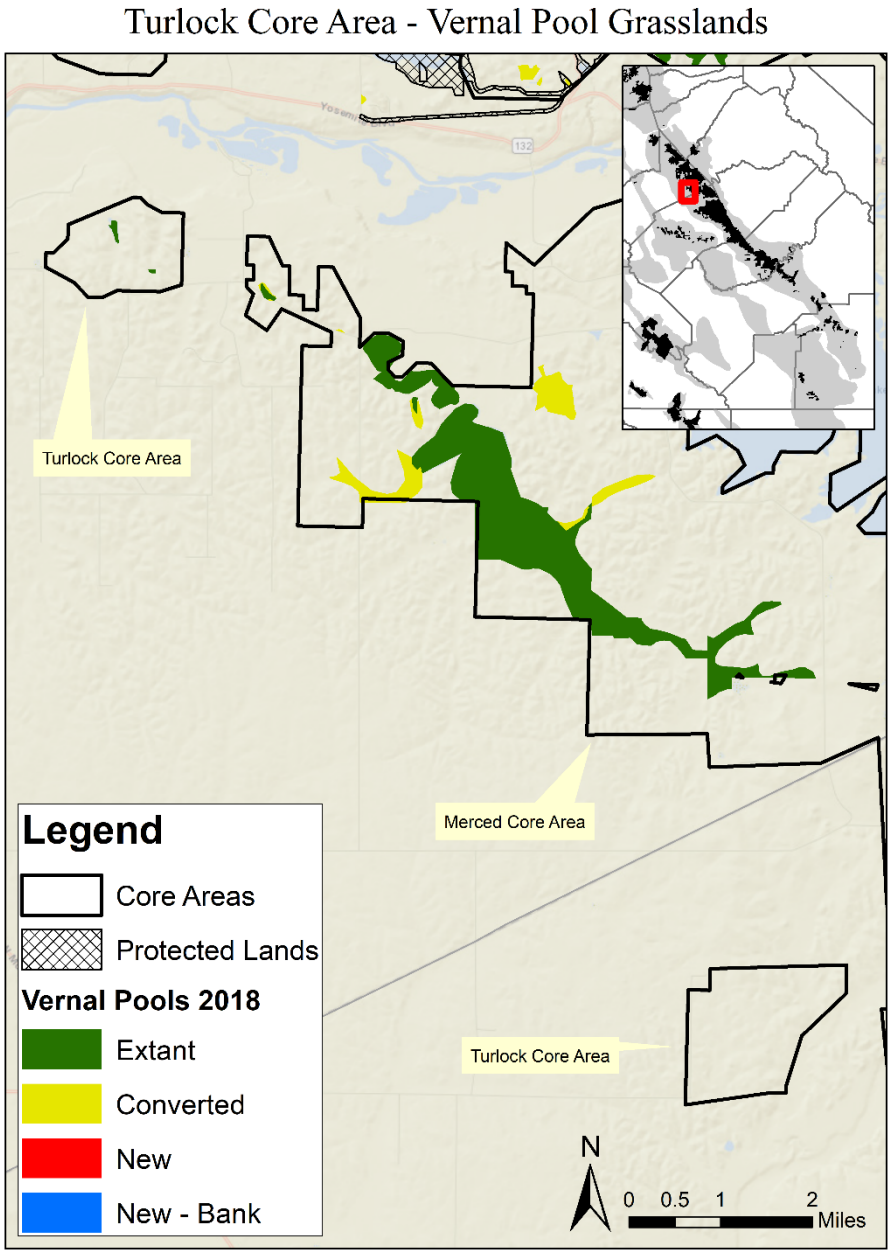


Figure 13.36. Map of vernal pool grassland habitat within the Turlock Core Area mapped by Witham (2021) created using aerial imagery from 2018 compared to 2005 and 2012. "New" vernal pool habitat refers to areas not seen in the 2005 or 2012 aerial imagery (either missed or restored). "New - bank" refers to newly created vernal pool habitat on mitigation lands. Converted habitat refers to vernal pool habitat that was seen in 2005 or 2012 aerial imagery and by 2018 was converted to other land uses. Modified habitat as described by Witham (2021) was altered but still provides suitable vernal pool habitat (e.g., mitigation banks, lands managed for waterfowl), and so is mapped as extant. Zoom in for finer resolution.

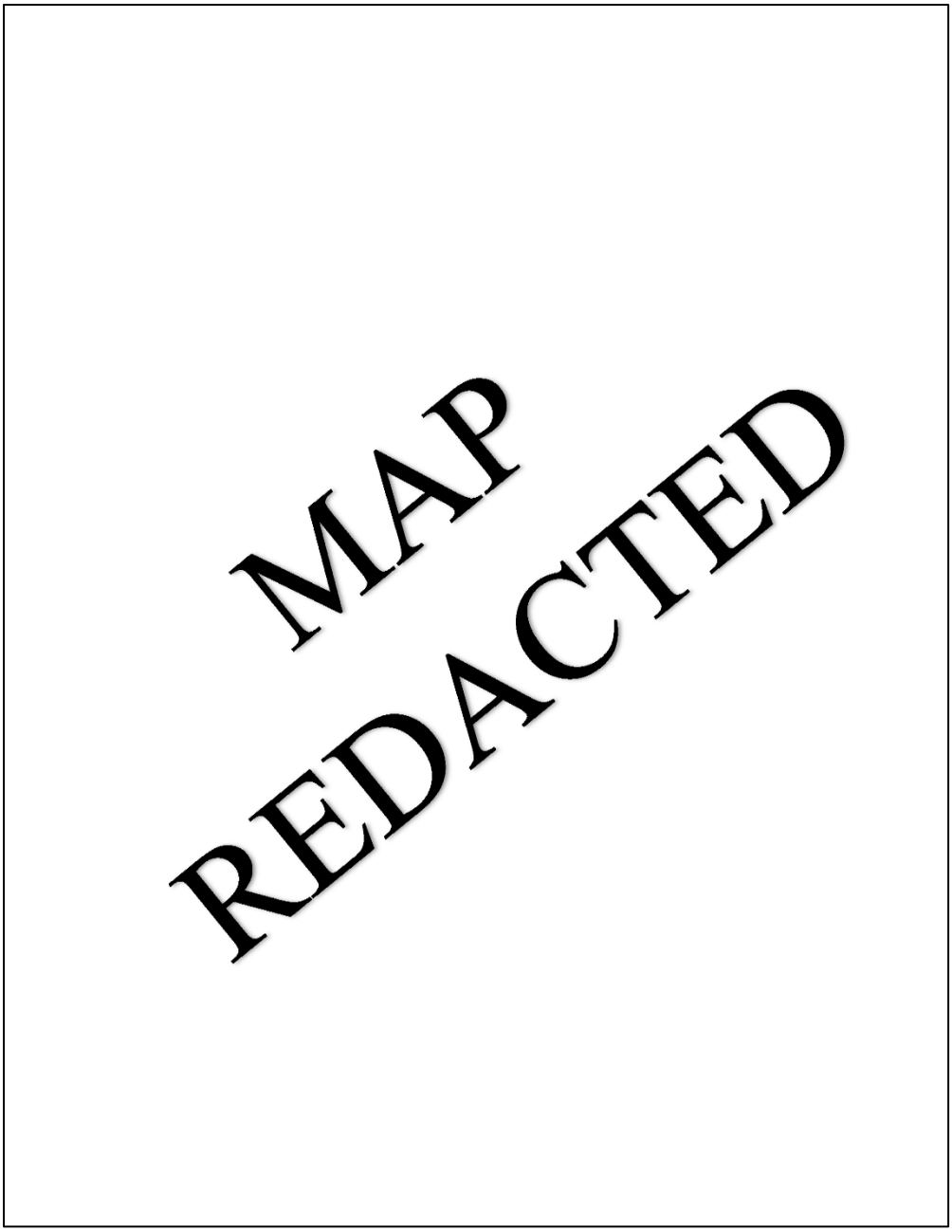


Figure 13.37. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) near the Turlock Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

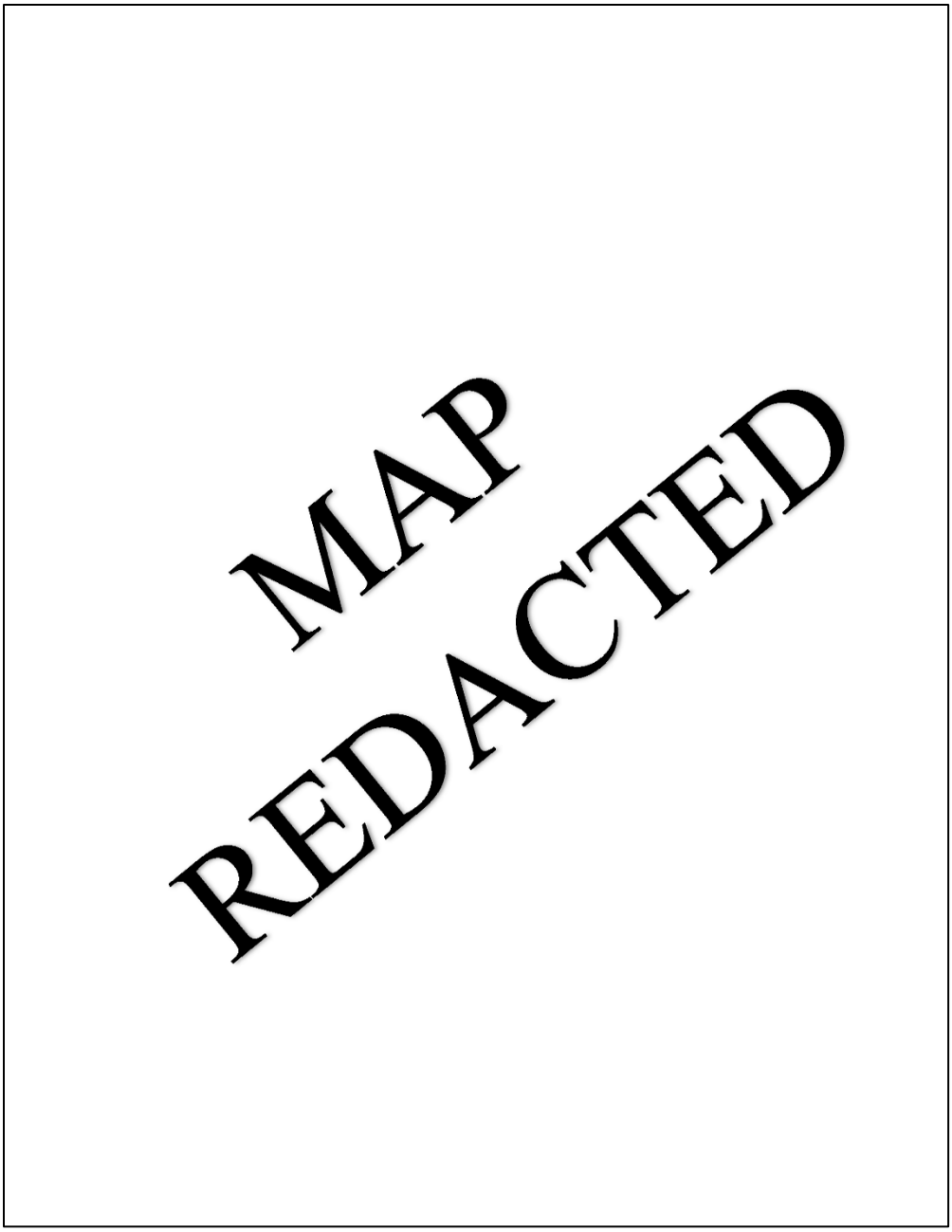


Figure 13.38. Map of known occurrences of vernal pool tadpole shrimp recorded in the Diversity Database (2022) near the Turlock Core Area. Polygons may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. Occurrences are color coded as extant or extirpated based on both the Diversity Database and Witham's (2021) map of vernal pool habitat.

14. WESTERN RIVERSIDE VERNAL POOL REGION

Only the vernal pool fairy shrimp is known to occur within the Western Riverside Vernal Pool Region.

14.1. Vernal Pool Habitat

The majority of the Western Riverside Vernal Pool Region is encompassed within the Western Riverside County Multi-Species Habitat Conservation Plan (Western Riverside HCP) (Dudek and Associates 2003a). Mapping of all vegetation types within the Western Riverside HCP Plan Area have occurred periodically. These mapping efforts have not been vernal pool specific, but one of the HCP's vegetation types is "playas and vernal pools." The first vegetation map was created in 1995 to provide information while preparing the Western Riverside HCP and was based on 1992-1993 aerial imagery (Dudek and Associates 2003a). The second vegetation map was created in 2005 after the HCP was permitted using different methodology and 2000-2001 aerial imagery; this map was updated in 2015 using 2012 aerial imagery (Aerial Information Systems 2015). For the most part, neither of these maps delineate entire vernal pool complexes that contain the pools and the specific upland areas that support them, and thus they cannot necessarily be used to assess recovery criteria success related to entire vernal pool complexes. Instead, individual pools and swales are typically delineated and surrounded by various vegetation communities (e.g., grassland, agricultural land, coastal sage scrub, chaparral, and woodland and forests).

The first vegetation map contains 42 polygons of playas and vernal pools for a total of 7,910 acres in 1992-1993, though most of this is in the area along Mystic Lake and the San Jacinto River where the vernal pool fairy shrimp is not known to occur (**Figure 14.1**; Dudek and Associates 2003a). The updated second vegetation map contains 78 polygons of playas and vernal pools totaling 2,655 acres in 2012 (**Figure 14.2**; Aerial Information Systems 2015). Differences are likely attributable mainly to methodological differences, though undoubtedly losses of vernal pools did occur during the 20-year gap between these two sets of aerial imagery. In some cases, there are known occurrence records of the vernal pool fairy shrimp that are not within the "playas and vernal pools" vegetation type or even adjacent grasslands, indicating that not all suitable habitat is captured by these vegetation maps.

The Western Riverside HCP mapped lands that were protected prior to the HCP being permitted and additional reserves protected by the HCP since being permitted (**Figure 14.3**). Not all of these protected lands contain vernal pool habitat.

14.2. Species Occurrences

14.2.1. Vernal Pool Fairy Shrimp

There are five occurrence records of the vernal pool fairy shrimp documented within the Western Riverside Vernal Pool Region in the Diversity Database (see **Figure 14.4**; Diversity Database 2022). All are presumed extant by the Diversity Database and all are within protected lands.

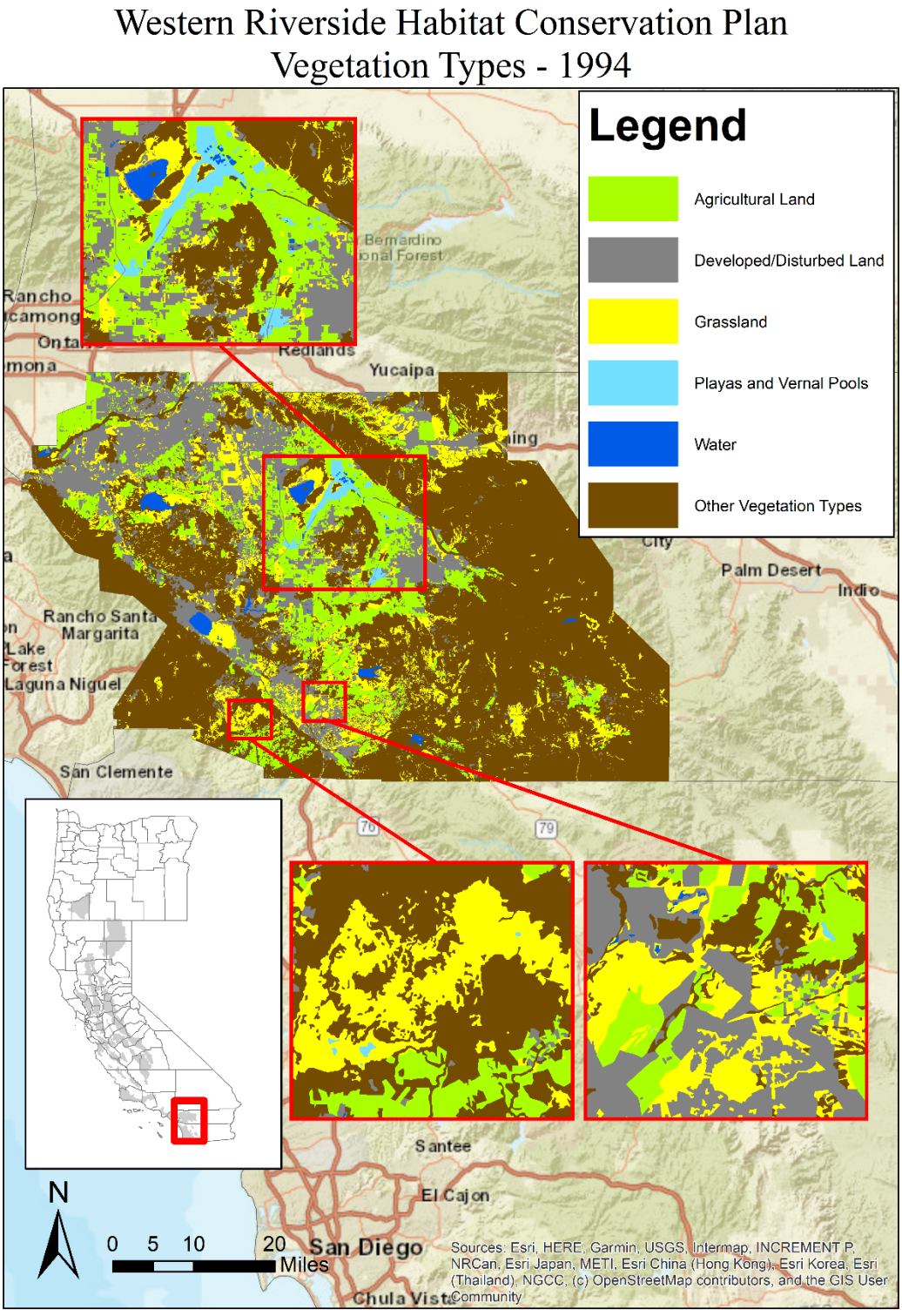


Figure 14.1. Map of vegetation types in western Riverside County in 1994, including playas and vernal pools (Dudek and Associates 2003a).

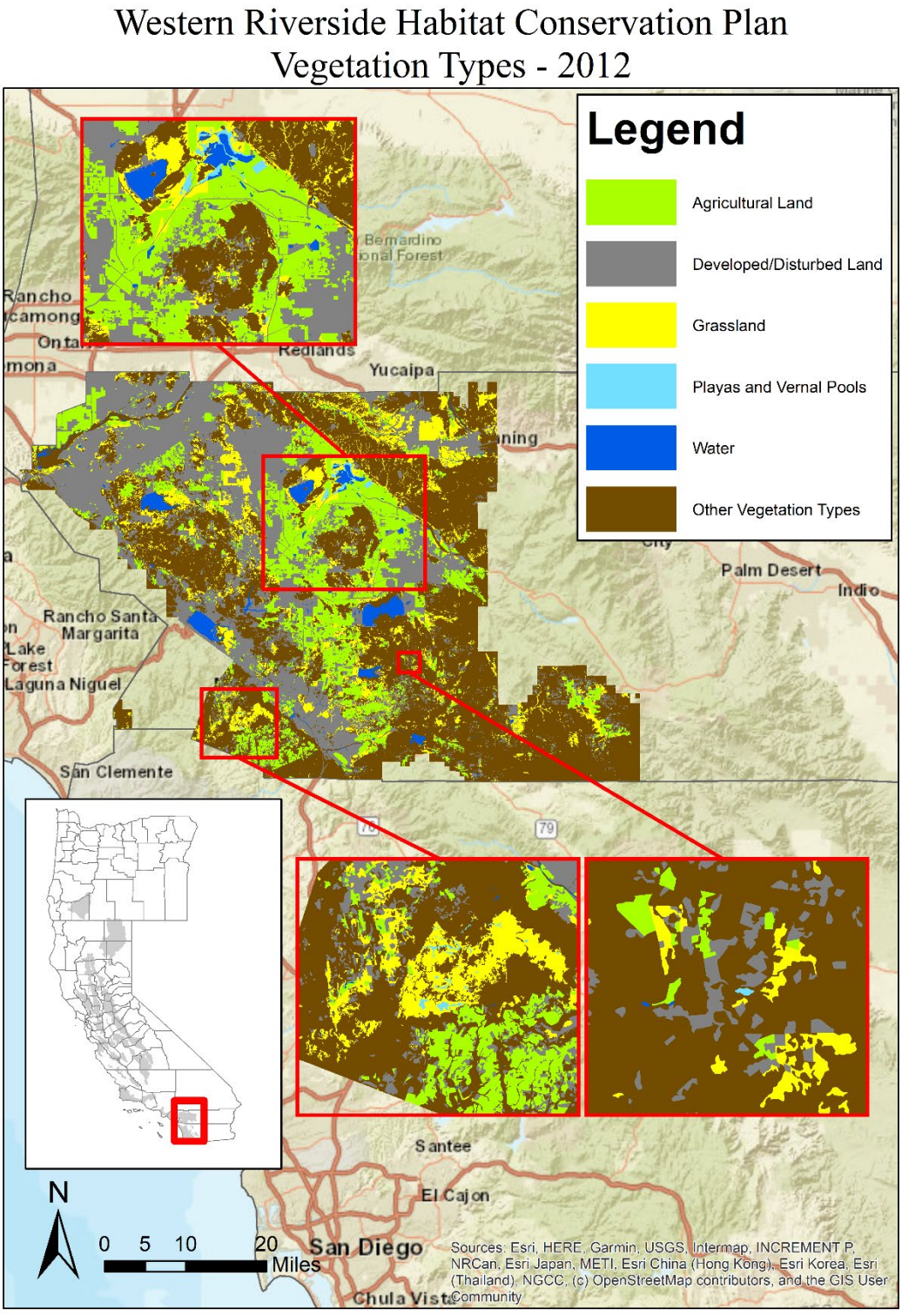


Figure 14.2. Map of vegetation types in western Riverside County in 2012, including playas and vernal pools (Aerial Information Systems 2015).

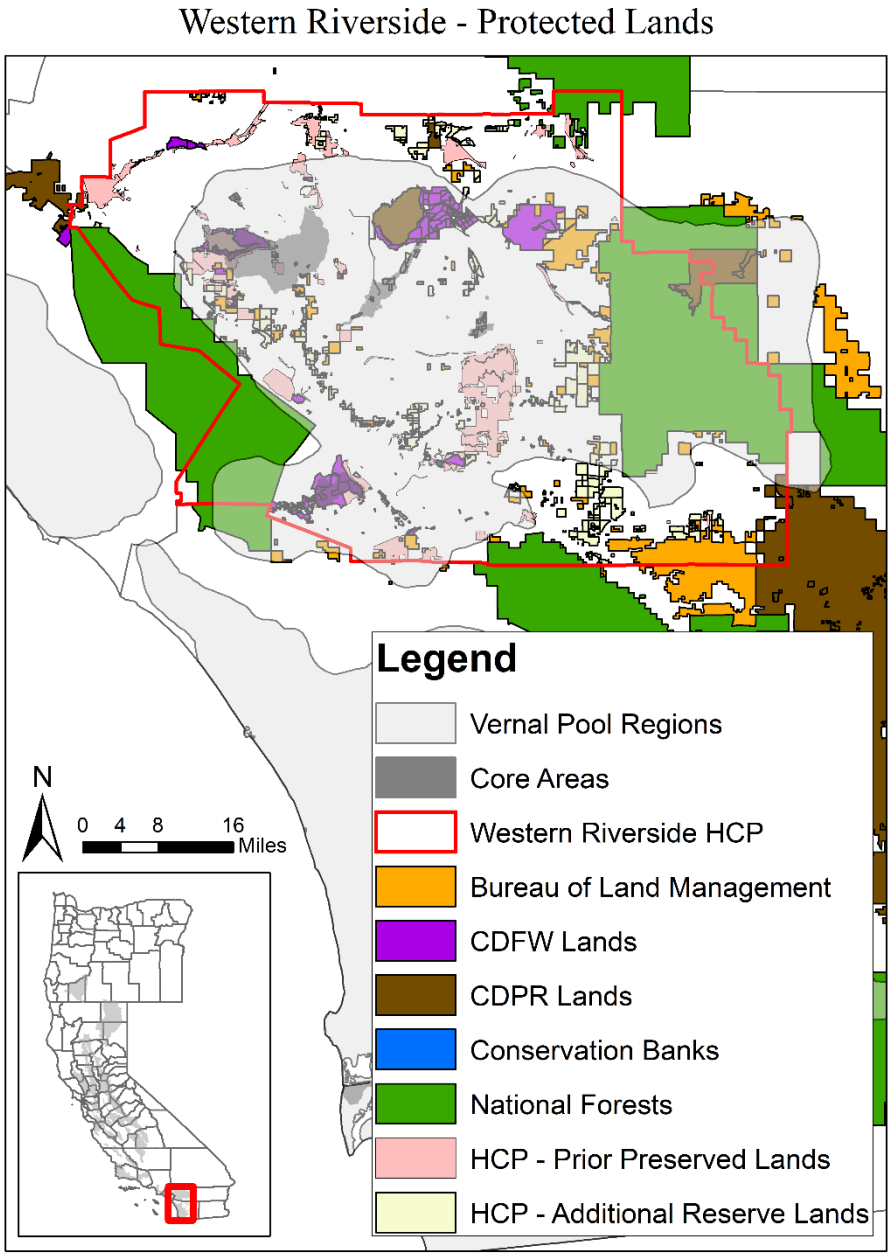


Figure 14.3. Map of protected areas and Habitat Conservation Plans (HCPs) within the Western Riverside Vernal Pool Region**.** Zoom in for finer resolution.

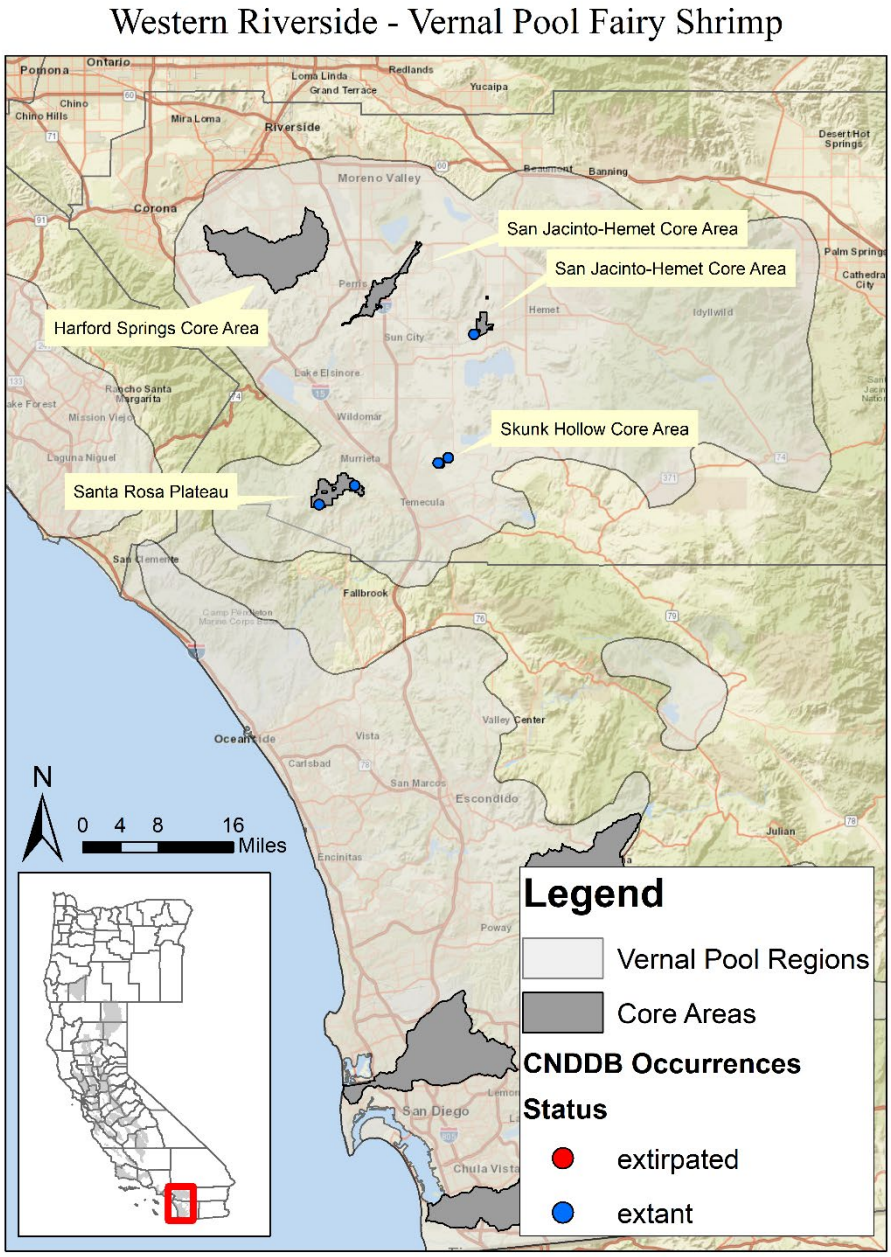


Figure 14.4. Map of known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) in the Western Riverside Vernal Pool Region. Points may represent individual pools, multiple pools, whole properties, or entire vernal pool grassland complexes. All four core areas in the region are displayed, though not all core areas are designated for the vernal pool fairy shrimp.

14.3. Federal Lands

14.3.1. National Wildlife Refuges

There are no National Wildlife Refuges with known occurrences of the vernal pool fairy shrimp in the Western Riverside Vernal Pool Region.

14.3.2. Military Lands

There are no military lands with known occurrences of the vernal pool fairy shrimp in the Western Riverside Vernal Pool Region.

14.3.3. Bureau of Land Management

The Western Riverside Vernal Pool Region is within the jurisdiction of the BLM's Palm Springs Office. Approximately 29,759 acres of BLM land occurs within the vernal pool region, though not in any of the areas with known occurrences of the vernal pool fairy shrimp.

14.3.4. Other Federal Lands

There are two National Forests, owned and managed by the Forest Service, within the Western Riverside Vernal Pool Region: Cleveland and San Bernardino (**Figure 14.3**). The Cleveland National Forest is 420,877 acres in size and is spread across Orange, Riverside, and San Diego Counties (USDA 2005a). A small portion of the northernmost unit of the Cleveland National Forest is within the Western Riverside Vernal Pool Region, and the southern units extend into the San Diego Vernal Pool Region. The only mention of vernal pools in the Cleveland National Forest's most recent Land Management Plan is in two potential management strategies: one to "survey wetlands, vernal pools, meadows, springs and stringer meadows for plant and wildlife species (e.g., spring snails, etc.)" and another to manage riparian conservation areas, which may include vernal pools (USDA 2005d). The San Bernardino National Forest is 665,753 acres in size and is spread across San Bernardino and Riverside Counties (USDA 2005a). A majority of the southern unit of the San Bernardino National Forest overlaps the eastern portion of the Western Riverside Vernal Pool Region. Vernal pools are never mentioned in the San Bernardino National Forest's most recent Land Management Plan (USDA 2005e), so the Service assumes that no vernal pool habitat is known to be present. There are no records of the vernal pool fairy shrimp within either the Cleveland or San Bernardino National Forests (Diversity Database 2022).

14.4. Conservation Banks

There is one mitigation banks with known occurrences of the vernal pool fairy shrimp in the Western Riverside Vernal Pool Region: Barry Jones Wetland Mitigation Bank (a.k.a., Skunk Hollow Vernal Pool Preserve) (**Figure 14.3**). This bank is located in the French Valley and was established in 1997 as mitigation for the adjacent Rancho Bella Vista development project (CNLM 2009). A CDFW conservation easement was placed over the property in 2002 and the Center for Natural Lands Management (CNLM) took fee-title and management responsibilities over the bank in 2003 (CNLM 2023). This bank protects one large vernal pool, the 33-acre Skunk Hollow pool, and 107 acres of uplands, which represents 90% of the pool's watershed

(CNLM 2009). There are seven additional smaller vernal pools within the watershed that can fill when precipitation is above average (CNLM 2023). The vernal pool fairy shrimp has been repeatedly documented within the Skunk Hollow pool (Diversity Database 2022). Management goals for the property include maintaining the vernal pool ecosystem function of the site, and management activities include monitoring and invasive species control (CNLM 2006). This property functions more like a preserve than a mitigation bank; the endowment was fully funded up front by the Rancho Bella Vista developer and the sale of mitigation credits simply allows some amount of financial return (CNLM 2006). There are a total of 136 credits available, which are Clean Water Act 404 credits for vernal pool preservation (RIBITS 2021).

14.5. Habitat Conservation Plans

There is one regional Habitat Conservation Plan (HCP) within the Western Riverside Vernal Pool Region that includes the vernal pool fairy shrimp as a Covered Species (**Figure 14.3**). One other HCP, the San Diego County Water Authority Subregional HCP, does not include the vernal pool fairy shrimp as a covered species, but does recognizes the possibility of future projects that extend into Riverside County (SDCWA and RECON Environmental 2010). If take coverage for the vernal pool fairy shrimp is required in the future then a Major Amendment to the plan will be required.

14.5.1. Western Riverside County Multiple Species HCP

The Western Riverside County Multiple Species HCP covers the westernmost quarter of Riverside County and overlaps the vast majority of the vernal pool region (Dudek and Associates 2003a). This HCP was permitted in 2004 and has a 75-year permit term, and the permittees are the Regional Conservation Authority, Riverside County, Riverside County Flood Control, Riverside County Parks, Riverside County Department of Waste Resources, Riverside County Transportation Commission, the Cities (Banning, Beaumont, Calimesa, Canyon Lake, Corona, Hemet, Lake Elsinore, Moreno Valley, Murrieta, Norco, Perris, Riverside, San Jacinto, and Temecula), Caltrans, and the California Department of Parks and Recreation. The goal of the HCP is to allow Riverside County and its Cities to better control local land-use decisions and maintain a strong economic climate in the region while addressing the requirements of the state and federal Endangered Species Acts. The HCP's conservation strategy will result in a Conservation Area of over 500,000 acres for 146 Covered Species, including 347,000 acres of already existing public/quasi-public lands and 153,000 acres of additional reserve lands (56,000 acres from federal and state partners and 97,000 acres from local permittees).

The vernal pool fairy shrimp is known to be present in vernal pools at three locations within the Plan Area: Santa Rosa Plateau Ecological Reserve, Skunk Hollow, and Salt Creek in west Hemet (Dudek and Associates 2003b). Habitat for the vernal pool fairy shrimp was modeled as all playas and vernal pools (543 acres) and alkali soils from the floodplain of the San Jacinto River and West Hemet portion of Salt Creek (6,663 acres). Over the permit term, Covered Activities may affect up to 67 acres (12%) of playa and vernal pool habitat within the Plan Area and up to 4,016 acres (60%) of alkali floodplain soils within the Plan Area. The HCP has four specific objectives related to protecting the vernal pool fairy shrimp:

1) Include in the Conservation Area at least 476 acres of suitable habitat by conserving vernal pool and playa habitat (does not include watershed acreages) in the three known occupied areas.
2) Include in the Conservation Area at least 2,647 acres of alkali playa in the floodplains of the San Jacinto River and west Hemet portion of Salt Creek, which contains suitable habitat for the species.
3) Include in the Conservation Area at least three HCP Core Areas (blocks of habitat of appropriate size, configuration, and vegetation characteristics to support the species) that include the three known occupied vernal pools/vernal pool complexes and their watersheds in the West Hemet portion of Salt Creek (4,043 acres), Santa Rosa Plateau Ecological Reserve (17,188 acres), and Skunk Hollow (156 acres).
4) Include in the Conservation Area any additional areas within the Criteria Area identified as important for the vernal pool fairy shrimp. If suitable vernal pool fairy shrimp habitat is identified within the boundary of a proposed project, a wet-season or dry-season survey will be conducted. If the vernal pool fairy shrimp is found, 90% of the occupied portions of the property shall be conserved.

As of December 31, 2021, a total of 64,123 acres of additional reserve land had been preserved (Western Riverside County Regional Conservation Authority 2022). All of the known occurrences of the vernal pool fairy shrimp have been protected within the HCP's Conservation Area.

14.6. Other Preserves

There are a variety of other preserved areas throughout this region either owned or with conservation easements held by CDFW, CDPR, other public agencies, and private land trusts (**Figure 14.3**). This section will focus only on the preserves that are in the immediate vicinity of the five known occurrences of the vernal pool fairy shrimp.

CDFW owns two preserves in this region: Santa Rosa Plateau Ecological Reserve and French Valley Wildlife Area. The 7,589-acre Santa Rosa Plateau Ecological Reserve comprises most of the Santa Rosa Plateau Core Area and also extends west of the Core Area. Land owned by Riverside County Parks abut the eastern side of the Ecological Reserve. Vegetation types on the Ecological Reserve were mostly mapped as grassland with vernal pools throughout (**Figure 14.1**, **Figure 14.2**). The vernal pool fairy shrimp was detected at the western end of the Santa Rosa Plateau in 1972 and on both the eastern and western end of the Plateau in 1988 (Diversity Database 2022). The species has been detected repeatedly throughout the years, with the most recent detections in 2010 (Diversity Database 2022). The 671-acre French Valley Wildlife Area is adjacent to the Skunk Hollow Core Area. Vegetation types on the Wildlife Area were mostly mapped as agricultural land (**Figure 14.1**, **Figure 14.2**). The vernal pool fairy shrimp has not been documented on the Wildlife Area, though it is known to occur on the Johnson Ranch Preserve immediately to the north (CNLM 2019).

Also in the French Valley area is the 930-acre Johnson Ranch Preserve, which surrounds the French Valley Wildlife Area. This preserve was established in 2000 as mitigation for the Assessment District 161 project and is owned by Riverside County and managed by CNLM

(CNLM 2019). CNLM is required to conduct period surveys for the Riverside fairy shrimp (*Streptocephalus woottoni*), and the vernal pool fairy shrimp has been documented during these surveys as well. The preserve protects multiple natural and artificial vernal pool features. One natural pool and one stock pond on the preserve have been found to support the vernal pool fairy shrimp. The vernal pool fairy shrimp was most recently documented in both of these features in 2019 (CNLM 2019). Part of the preserve is adjacent to the Barry Jones Wetland Mitigation Bank (a.k.a., Skunk Hollow Vernal Pool Preserve) and protects an additional 8% of the Skunk Hollow pool's watershed, beyond the 90% protected within the bank.

In addition to these preserved areas, there are numerous other protected lands that are part of the Western Riverside County Multispecies HCP's Conservation Area, both public/quasi-public lands that were already preserved when the HCP permit was issued in 2004 and additional reserve lands that have been acquired since. Several of these additional reserve lands are located on or near areas known to be occupied by the vernal pool fairy shrimp, generally within or adjacent to the three Core Areas that were designated for the vernal pool fairy shrimp in the region.

14.7. Vernal Pool Core Areas

There are four Core Areas within the Western Riverside Vernal Pool Region that are designated in the Recovery Plan for the vernal pool fairy shrimp: San Jacinto-Hemet, Santa Rosa Plateau, and Skunk Hollow. Two of the three core areas have met the target of 85% of vernal pool habitat protected.

14.7.1. San Jacinto-Hemet

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is composed of two disjunct areas located in western Riverside County: the area around Salt Creek west of the City of Hemet and the area around the San Jacinto River between the Ramona Expressway and Canyon Lake near the City of Perris.

There is no precise estimate of how many acres of vernal pool complex existed in this core area in 2005 or today, and so the Service cannot assess what percentage of vernal pool habitat has been protected. Still, we can attempt to approximate the percentage of protected vernal pool habitat based on other available information. Mapping of vegetation types within the Western Riverside HCP Plan Area based on 1992-1993 aerial imagery (see **Figure 14.5**; Dudek and Associates 2003a) show approximately 990 acres of vernal pool or playa habitat around Salt Creek and 1,260 acres of vernal pool or playa habitat around the San Jacinto River floodplain. This represents approximately 73% and 30% of the total area of the Salt Creek and San Jacinto River portions of the core area, respectively. However, it is possible that some of the adjacent areas classified as agricultural land or grassland are also habitat for the vernal pool fairy shrimp, or that some of the alkali playas are not suitable habitat for the vernal pool fairy shrimp. These areas were almost entirely reclassified as agricultural land or grassland based on 2012 aerial imagery (see **Figure 14.6**; Aerial Information Systems 2015), but this was mostly due to changes in the methods of mapping and classification. Because of these methodological changes, we cannot compare the two maps to estimate losses of vernal pool habitat between 1994 and 2012.

Approximately 543 acres have been protected within the Salt Creek portion of the core area and 1,137 acres have been protected within or adjacent to the San Jacinto River portion of the core area. This represents 40% and 27% of the entire area of the portions of the core area around Salt Creek and the San Jacinto River, respectively. Of these protected areas, 482 acres and 436 acres are within areas that were mapped as vernal pool or playa habitat in 1994 within the Salt Creek and San Jacinto River portions of the core area, respectively. Although this information is not sufficient to estimate percentages of loss and protection of vernal pool habitat since 2005, we can conclude that the target of protecting 85% of vernal pool habitat in the core area has not yet been achieved.

Protected lands within this core area include various preserves that were acquired as additional reserve land for the Western Riverside HCP Conservation Area and the channel owned by the Riverside County Flood Control District connecting Perris Reservoir to the San Jacinto River (**Figure 14.7**, **Figure 14.8**).

14.7.1.1. Vernal Pool Fairy Shrimp Occurrences

There is one Diversity Database occurrence record for the vernal pool fairy shrimp within this core area, which is protected within additional reserve lands for the Western Riverside HCP donated by the Riverside County Transportation Commission (see **Figure 14.7**; Diversity Database 2022). The vernal pool fairy shrimp was detected in one vernal pool within the greater Salt Creek vernal pool complex in 1998 and 2005 (Diversity Database 2022). There are no known occurrences of the vernal pool fairy shrimp around the San Jacinto River (**Figure 14.8**), though the Western Riverside HCP does say that there are alkali playas in the river's floodplain that provide suitable habitat for the vernal pool fairy shrimp (Dudek and Associates 2003b).

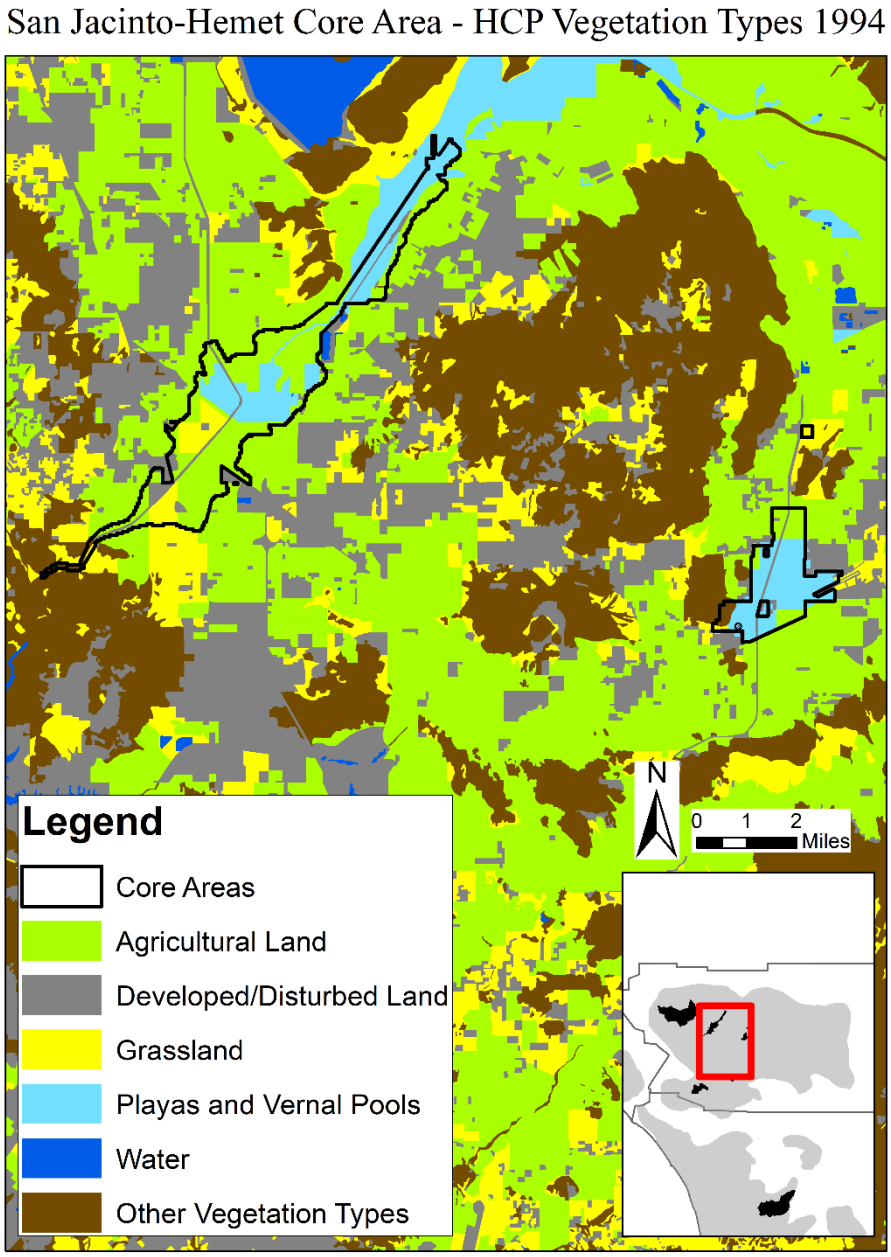


Figure 14.5. Map of vegetation types in the San Jacinto-Hemet Core Area in 1994, including playas and vernal pools, as mapped for the Western Riverside Habitat Conservation Plan (Dudek and Associates 2003a).

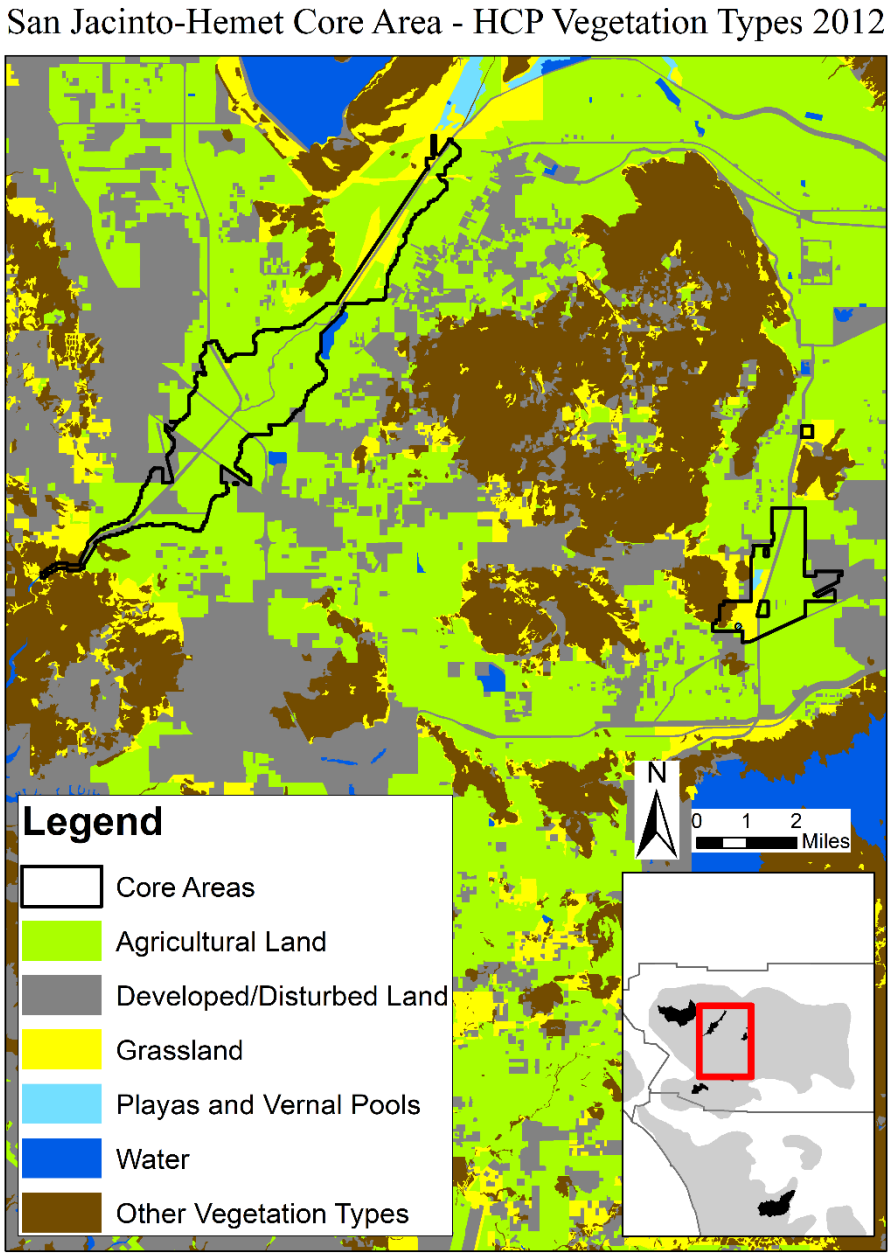


Figure 14.6. Map of vegetation types in the San Jacinto-Hemet Core Area in 2012, including playas and vernal pools, as mapped for the Western Riverside Habitat Conservation Plan (Aerial Information Systems 2015).

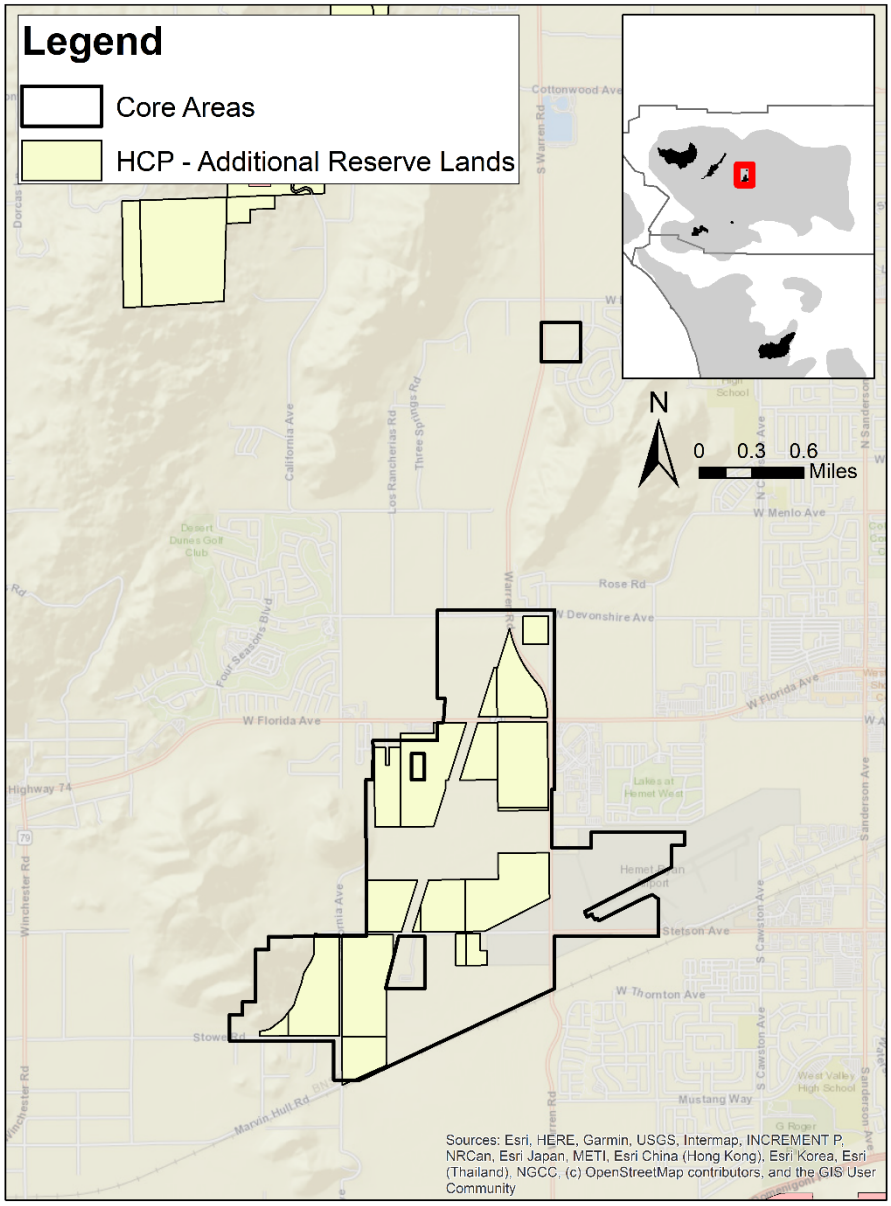


Figure 14.7. Map of all protected lands within the eastern portion of the San Jacinto-Hemet Core Area, which surrounds Salt Creek. Diversity Database (2022) records have been redacted from the map to comply with CDFW's Diversity Database Data Use Guidelines. HCP = Habitat Conservation Plan.

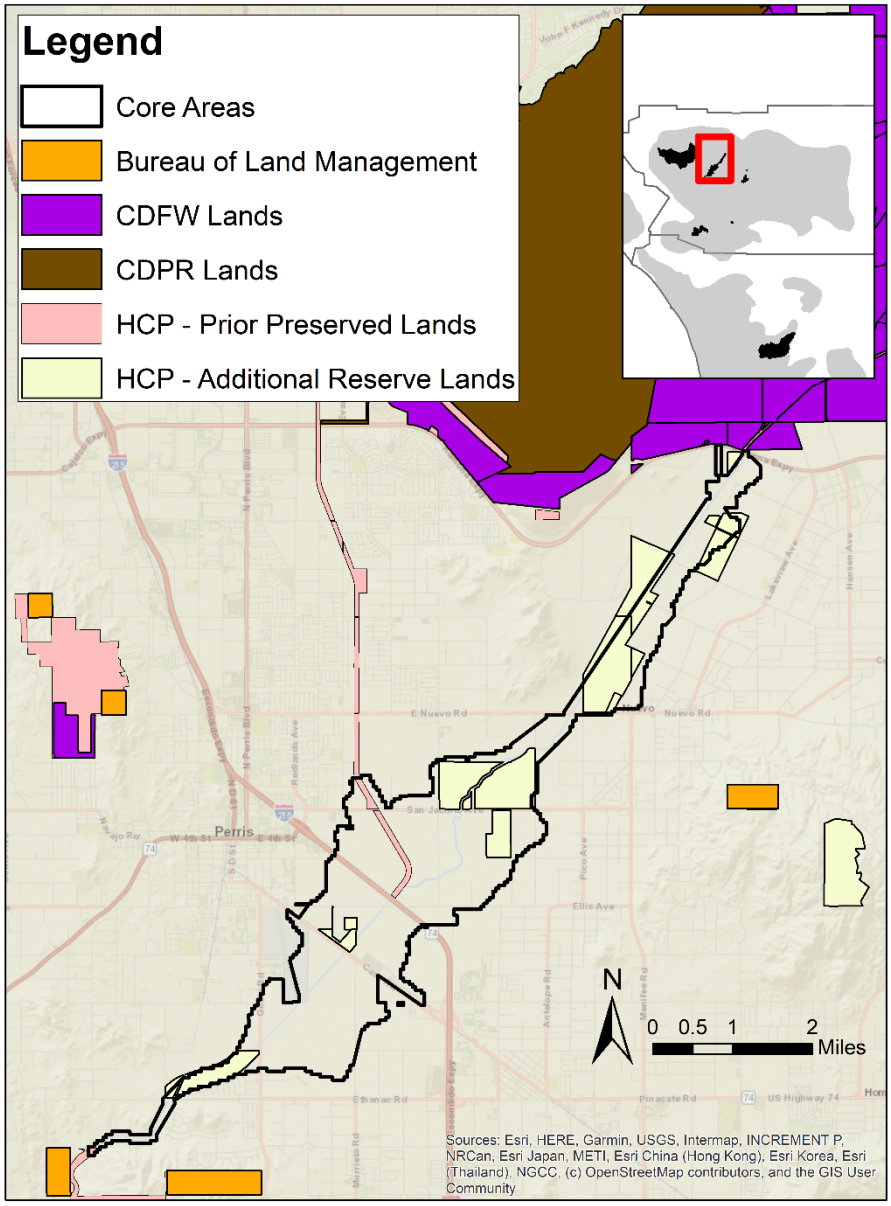


Figure 14.8. Map of all protected lands within the western portion of the San Jacinto-Hemet Core Area, which surrounds the San Jacinto River. There are no known occurrences of vernal pool fairy shrimp recorded in the Diversity Database (2022) in this portion of the core area. CDFW = California Department of Fish and Wildlife, CDPR = California Department Parks and Recreation, HCP = Habitat Conservation Plan.

14.7.2. Santa Rosa Plateau

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is located in southwestern Riverside County on the Santa Rosa Plateau southwest of the City of Murrieta.

There is no precise estimate of how many acres of vernal pool complex existed in this core area in 2005 or today, and so the Service cannot assess what percentage of vernal pool habitat has been protected. Still, we can attempt to approximate the percentage of protected vernal pool habitat based on other available information. Mapping of vegetation types within the Western Riverside HCP Plan Area based on 1992-1993 aerial imagery (see **Figure 14.9**; Dudek and Associates 2003a) and 2012 aerial imagery (see **Figure 14.10**; Aerial Information Systems 2015) both show that almost all of the core area is composed of grasslands, with playas or vernal pools in the southwestern and northeastern portions of the core area. However, not all of the grasslands on the Santa Rosa Plateau are vernal pool grasslands. Still, a comparison of these vegetation maps suggests that little to no losses of grasslands occurred within the core area between 1994 and 2012. Approximately 95% of the entire core area is within protected areas (**Figure 14.11**), including the areas occupied by the vernal pool fairy shrimp in the northeast and southwest. The only unprotected portion of the core area is a small bit of grassland in the southwestern corner of the core area. Therefore, it is very likely that the Recovery Plan's target of protecting 85% of vernal pool habitat in the core area has been achieved.

Protected lands within this core area include CDFW's Santa Rosa Plateau Ecological Reserve, several small preserves acquired by the Western Riverside HCP as additional reserve lands for the HCP's Conservation Area, and a small amount of Riverside County Parks land on the eastern edge of the Ecological Reserve (**Figure 14.11**).

14.7.2.1. Vernal Pool Fairy Shrimp Occurrences

There are two Diversity Database occurrence records for the vernal pool fairy shrimp within this core area, both of which are protected within CDFW's Santa Rosa Plateau Ecological Reserve (see **Figure 14.11**; Diversity Database 2022). The vernal pool fairy shrimp was detected at the western end of the Santa Rosa Plateau in 1972 and on both the eastern and western end of the Plateau in 1988 (Diversity Database 2022). The species has been detected repeatedly throughout the years, with the most recent detections in 2010 (Diversity Database 2022).

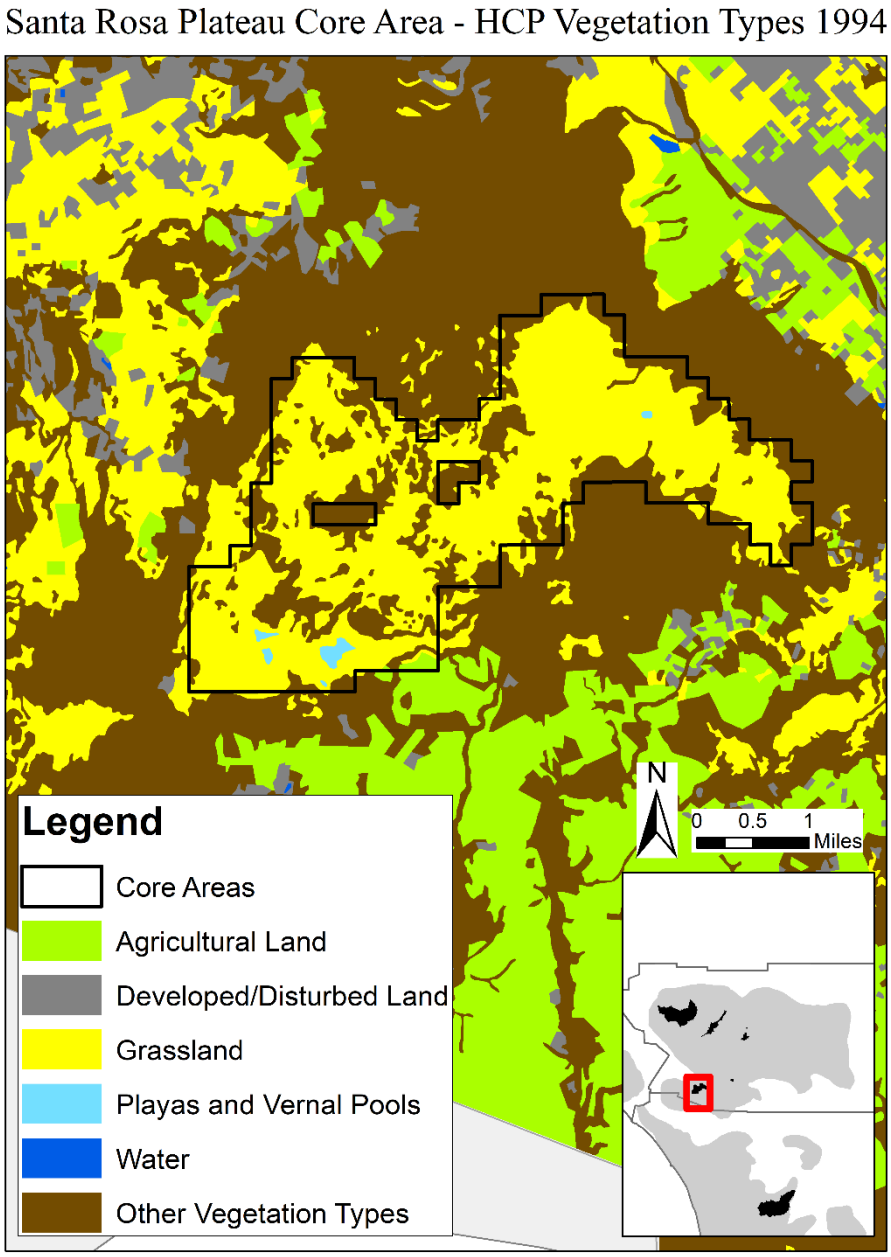


Figure 14.9. Map of vegetation types in the Santa Rosa Plateau Core Area in 1994, including playas and vernal pools, as mapped for the Western Riverside Habitat Conservation Plan (Dudek and Associates 2003a).

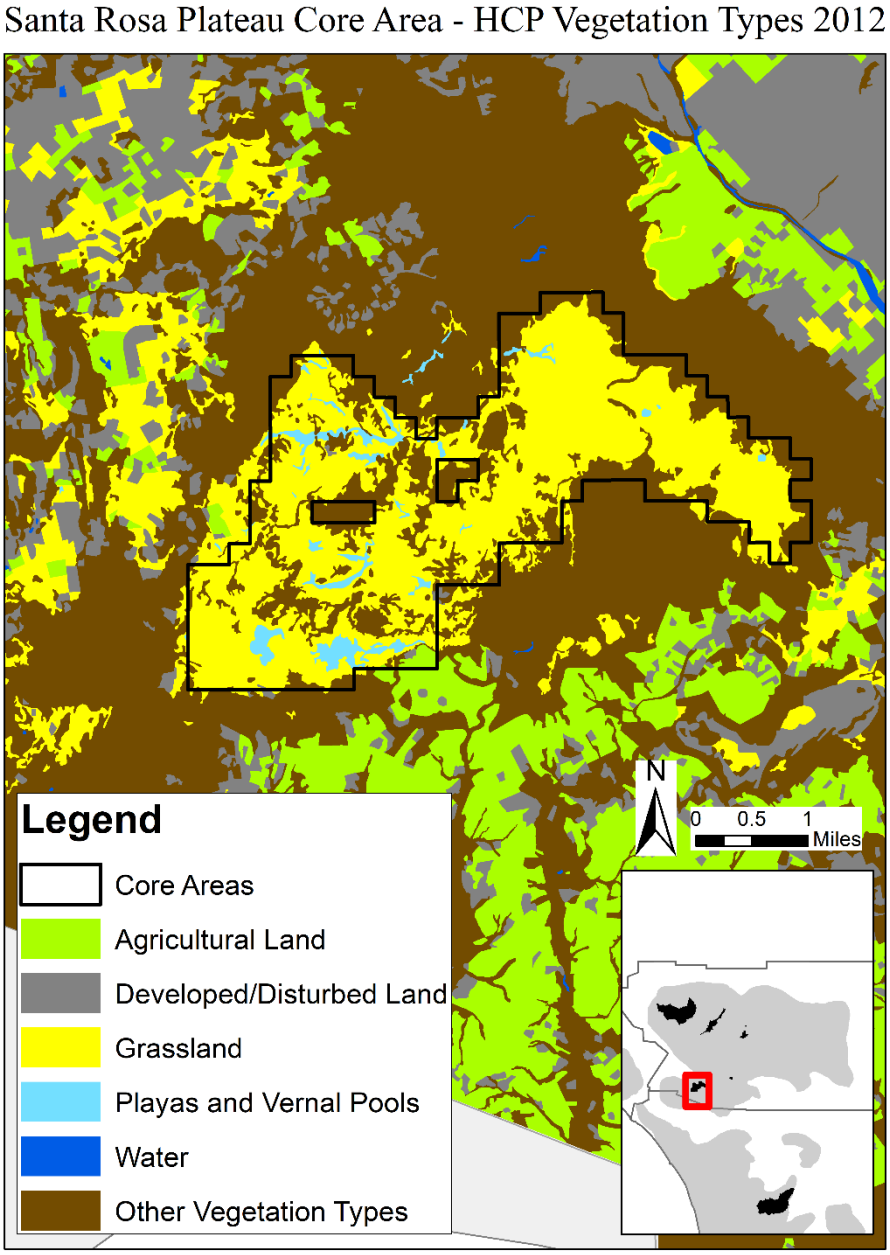


Figure 14.10. Map of vegetation types in the Santa Rosa Plateau Core Area in 2012, including playas and vernal pools, as mapped for the Western Riverside Habitat Conservation Plan (Aerial Information Systems 2015).

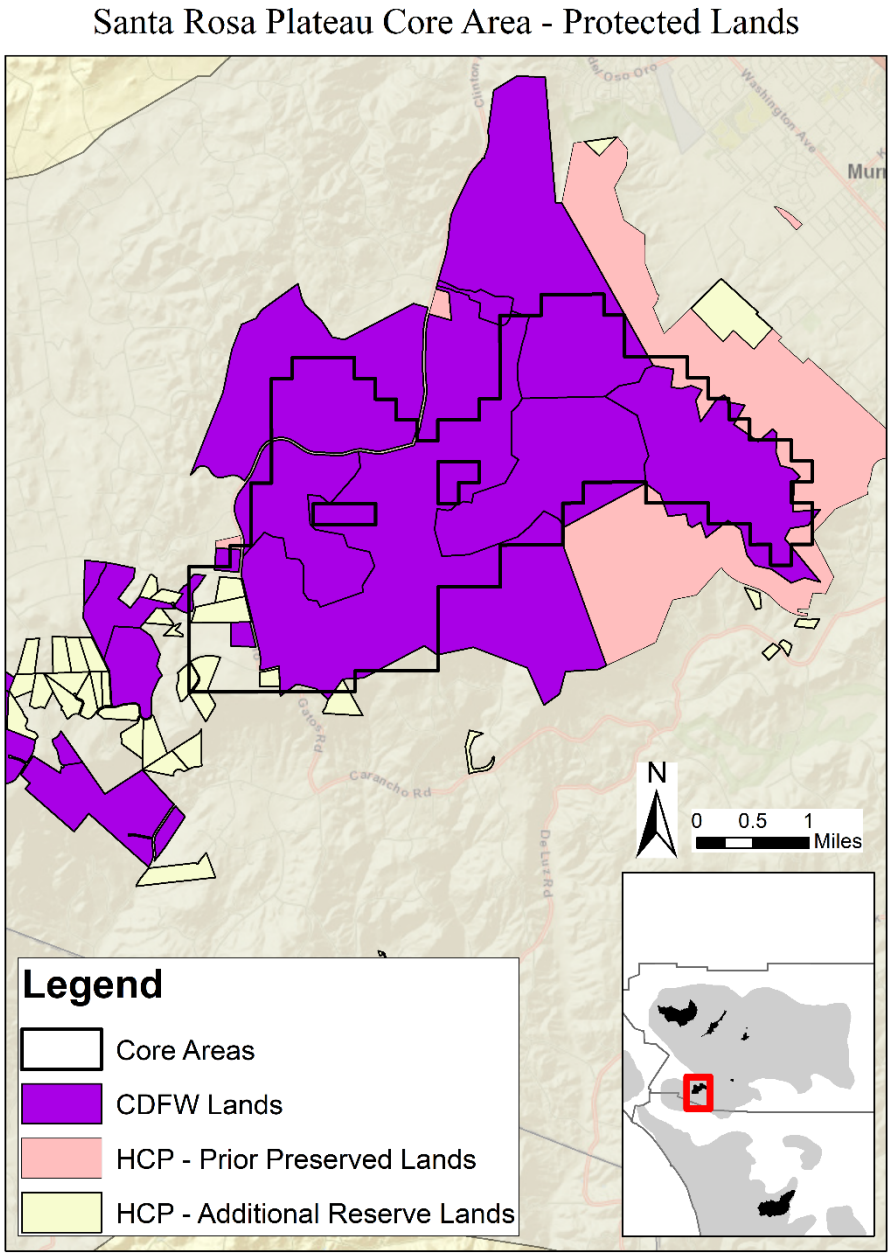


Figure 14.11. Map of all protected lands within the Santa Rosa Plateau Core Area. Diversity Database (2022) records have been redacted from the map to comply with CDFW's Diversity Database Data Use Guidelines. CDFW = California Department of Fish and Wildlife, HCP = Habitat Conservation Plan.

14.7.3. Skunk Hollow

This is a zone 2 core area with a goal of protecting 85% of vernal pool habitat for the vernal pool fairy shrimp. The core area is located in southwestern Riverside County adjacent to the Rancho Bella Vista development project in the French Valley. The core area was clearly designed to encompass the 33-acre Skunk Hollow vernal pool (the second largest vernal pool in California) and its watershed.

Mapping of vegetation types within the Western Riverside HCP Plan Area based on 1992-1993 aerial imagery (see **Figure 14.12**; Dudek and Associates 2003a) and 2012 aerial imagery (see **Figure 14.13**; Aerial Information Systems 2015) both show that almost all of the core area is composed of grasslands or agricultural land, with the Skunk Hollow vernal pool visible in the northwestern portion of the core area in the first map. A small amount of habitat was lost between 1992-1993 and 2012 around the edges of the core area with the construction of the Rancho Bella Vista development, though this loss occurred prior to the Recovery Plan's 2005 baseline. The rest of the core area is within several protected areas, all of which were established prior to the Recovery Plan's 2005 baseline as well. The Skunk Hollow vernal pool and 90% of its watershed are protected within the Barry Jones Wetland Mitigation Bank, and another 8% of the watershed is protected within the adjacent Johnson Ranch preserve (CNLM 2006). Therefore, given that the vast majority of the core area is protected and the only unprotected habitat was lost prior to 2005, the Service considers 100% of the vernal pool habitat in the core area to be protected, meeting the 85% target for the core area.

Protected lands within this core area include the Barry Jones Wetland Mitigation Bank, Johnson Ranch Preserve, and CDFW's French Valley Wildlife Area (**Figure 14.14**).

14.7.3.1. Vernal Pool Fairy Shrimp Occurrences

There is one Diversity Database occurrence record for the vernal pool fairy shrimp within this core area located in the Skunk Hollow vernal pool, which is protected within the Barry Jones Wetland Mitigation Bank (a.k.a., Skunk Hollow Vernal Pool Preserve) (see **Figure 14.14**; Diversity Database 2022). The vernal pool fairy shrimp was first documented within the Skunk Hollow pool in 1988 and has been repeatedly detected since (Diversity Database 2022), most recently in 2020 (CNLM 2020). There is one additional Diversity Database occurrence record that was detected in 2010 on the adjacent Johnson Ranch Preserve approximately 0.5 miles northeast of the core area. The vernal pool fairy shrimp has been identified in one natural vernal pool and one stock pond on Johnson Ranch Preserve, most recently in 2019 (CNLM 2019).

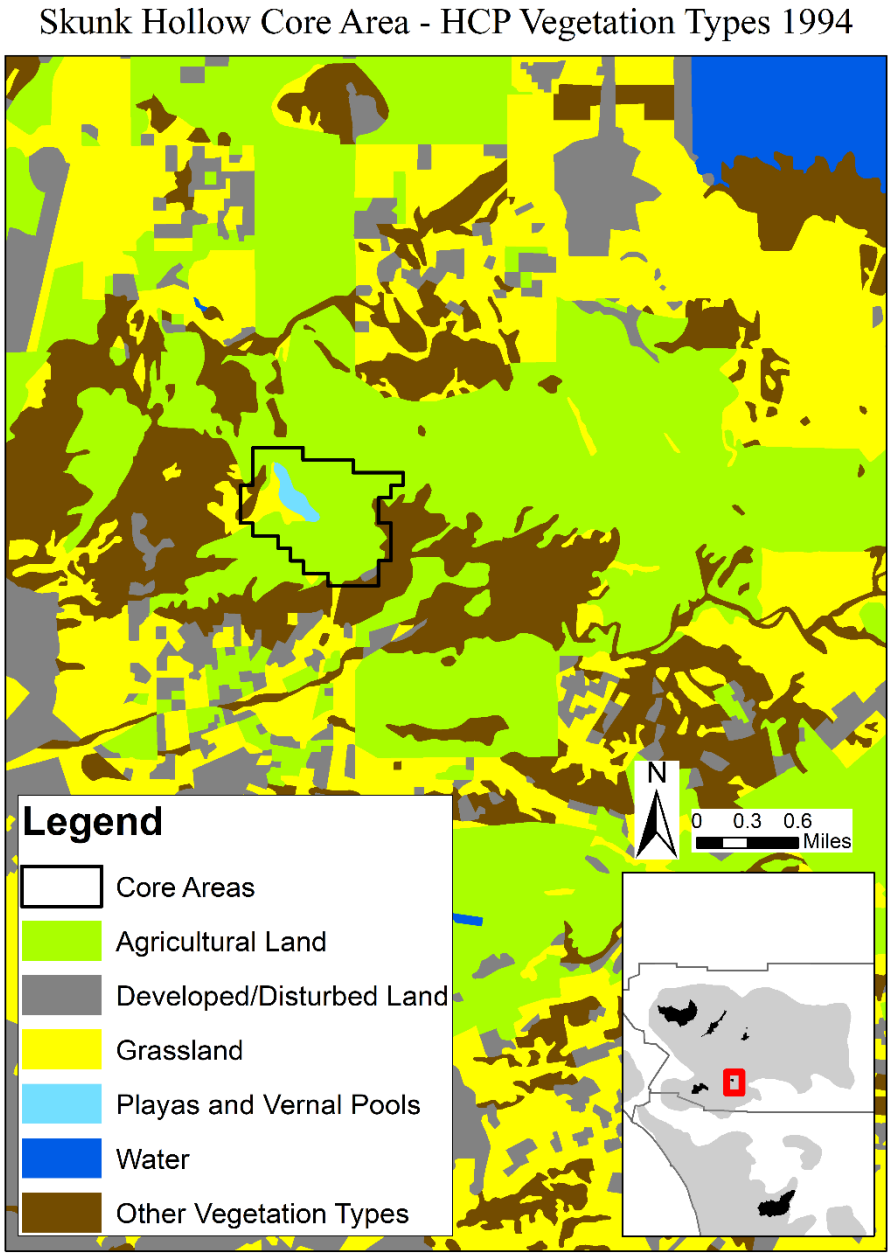


Figure 14.12. Map of vegetation types in the Skunk Hollow Core Area in 1994, including playas and vernal pools, as mapped for the Western Riverside Habitat Conservation Plan (Dudek and Associates 2003a).

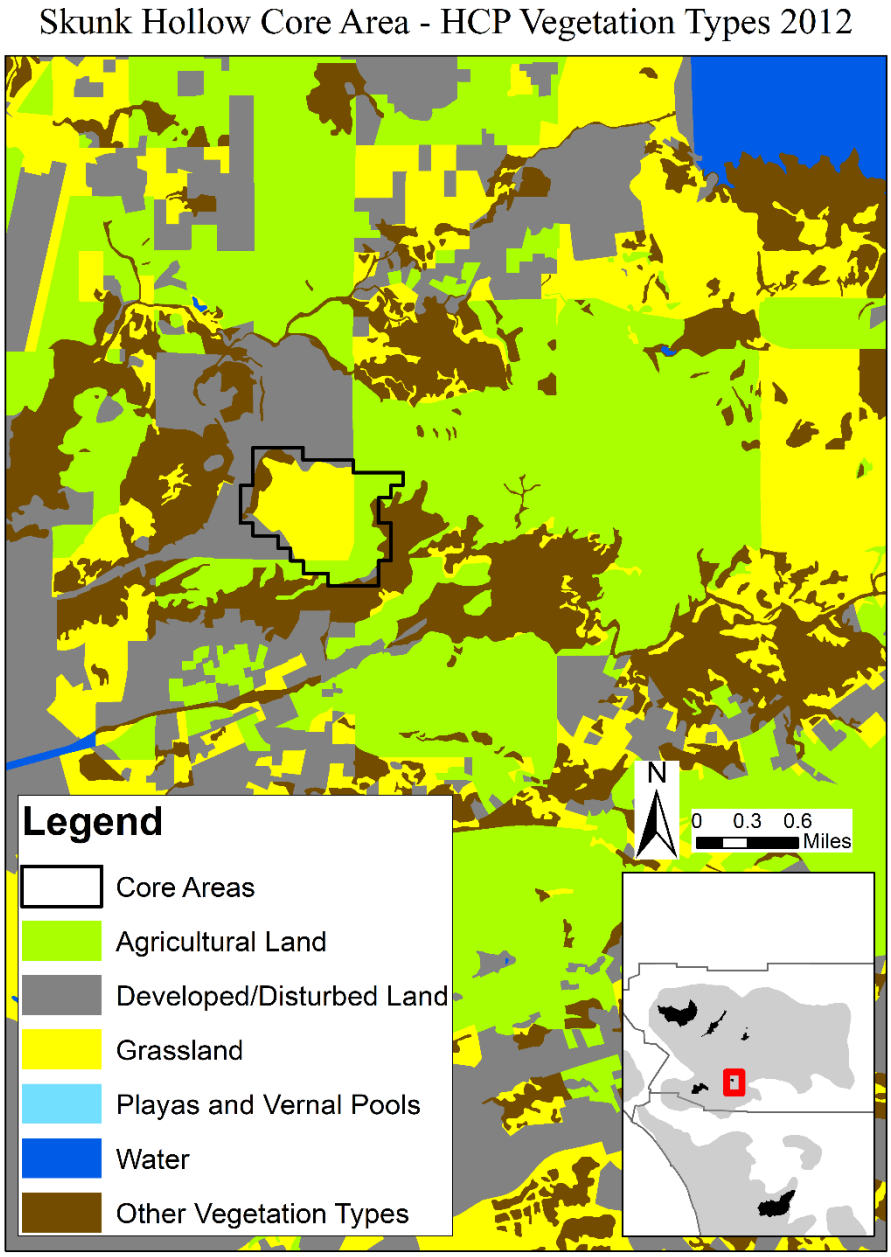


Figure 14.13. Map of vegetation types in the Skunk Hollow Core Area in 2012, including playas and vernal pools, as mapped for the Western Riverside Habitat Conservation Plan (Aerial Information Systems 2015).

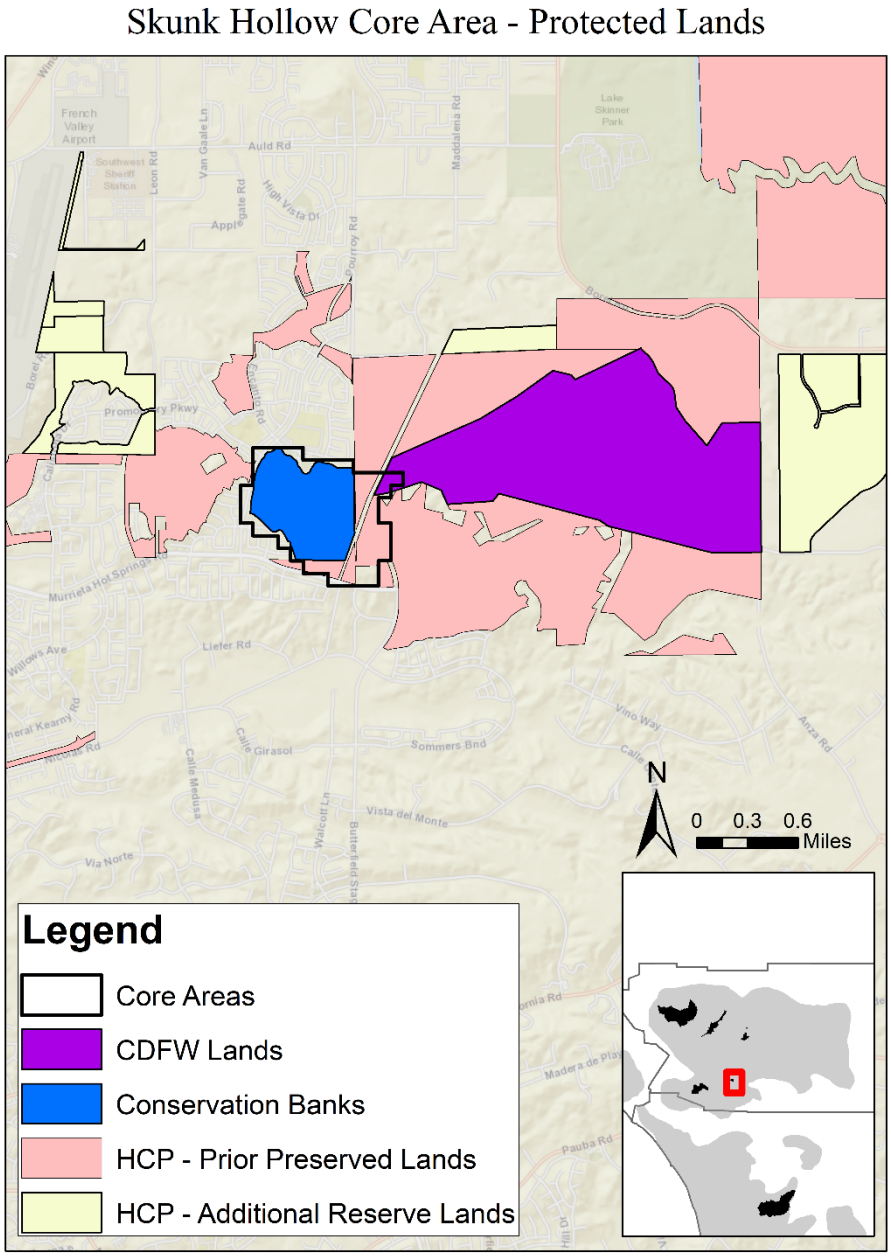


Figure 14.14. Map of all protected lands within the Skunk Hollow Core Area. Diversity Database (2022) records have been redacted from the map to comply with CDFW's Diversity Database Data Use Guidelines. CDFW = California Department of Fish and Wildlife, HCP = Habitat Conservation Plan.

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Carter-Ervin, Robin. 2022. California Department of Water Resources, Oroville Field Division, Oroville, California. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated September 19, 2022, with attached GIS shapefiles of the FERC boundary and vernal pools around the Thermalito and Oroville Dams. Subject: DWR Oroville Field Division Shapefiles.

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Fiehler, Craig. 2022. Environmental Scientist, California Department of Fish and Wildlife, Fresno, California. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated September 27, 2022. Subject: Vernal Pool Shrimp info on CDFW lands in Region 4.

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Hobbs, Joe. 2022. Yolo Bypass Wildlife Area Supervisor, California Department of Fish and Wildlife, Davis, California. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated July 18, 2022. Subject: Vernal pool shrimp at Yolo Bypass.

Hudson, Kim. 2021. Executive Director, South Sacramento Conservation Agency. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated September 14, 2021. Subject: Impacts to waters.

Jimenez, Kathryn. 2023. Wildlife Biologist, Kern National Wildlife Refuge Complex, Delano, California. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated January 4, 2023, with survey data attached. Subject: Kern NWRC vernal pool data.

Kleinfelter, Eric. 2022. Environmental Scientist, California Department of Fish and Wildlife, North Central Region (Region 2), California. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated July 29, 2022. Subject: Phoenix Field Ecological Reserve info.

Laymon, Steve. 2022. Bureau of Land Management, Redding Field Office, Redding, California. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated September 13, 2022. Subject: Vernal Pools GeoDB.

Lis, Richard. 2023. Senior Environmental Scientist, California Department of Fish and Wildlife, Northern Region (Region 1), Redding, California. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated March 24, 2023. Subject: CDFW Northern Region vernal pools (reply at last).

Loredo, Ivette. 2023. Wildlife Refuge Specialist, Don Edwards San Francisco Bay National Wildlife Refuge, U.S. Fish and Wildlife Service, Fremont, California. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated May 5, 2023, with spreadsheet of survey history on the Refuge attached. Subject: Vernal pool tadpole shrimp info on Don Edwards.

Morison, Molly. 2022. Southwest Oregon Preserves Manager, The Nature Conservancy. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated August 15, 2022, with map of Table Rocks parcel ownership attached. Subject: FW: TNC fairy shrimp information.

Mustin, Cori. 2013. U.S. Fish and Wildlife Service, Conservation Planning Division, Sacramento Fish and Wildlife Office, Sacramento, California. Email to Eric Tattersall, Mike Thomas, Kenneth Sanchez, and Kellie Berry, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated March 7, 2013. Subject: Yolo County HCP/NCCP and Grasslands Park.

O'Brien, Sean. 2023. Biologist, ICF International, Inc., Roseville, California. Letter to My Nguyen, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated March 20, 2023. Subject: 2023 Aquatic Survey Training for Larval California Tiger Salamander and Federally Listed Large Branchiopods at the Burke Ranch Conservation Bank in Solano County, California (USFWS # RP-Las Camas Solar-2023-0301).

Ogonowski, Mark. 2021. Senior Fish and Wildlife Biologist, Ventura Fish and Wildlife Office, U.S. Fish and Wildlife Service, Ventura, California. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated August 23, 2021. Subject: Looking for vernal pool shrimp info.

Ogonowski, Mark. 2023a. Senior Fish and Wildlife Biologist, Ventura Fish and Wildlife Office, U.S. Fish and Wildlife Service, Ventura, California. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated August 9, 2023, with link to OneDrive folder containing additional occurrence data. Subject: For review: Vernal pool shrimps draft 5-year review.

Ogonowski, Mark. 2023b. Senior Fish and Wildlife Biologist, Ventura Fish and Wildlife Office, U.S. Fish and Wildlife Service, Ventura, California. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated October 19, 2023, with updated information about additional occurrence data. Subject: For review: Appendix for vernal pool shrimps draft 5-year review.

Pinnell, Cassie. 2022. Senior Ecologist, Vollmar Natural Lands Consulting, Sacramento, California. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated December 1, 2022, with map and shapefile of the Montezuma Wetlands Project conservation easement attached. Subject: Vernal pool shrimp info on Montezuma Wetlands site.

Roberts, John. 2021. Executive Director, The Natomas Basin Conservancy. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated September 16 and September 23, 2021. Subject: Vernal pool shrimp impacts in Natomas Basin?

Roelofs, David. 2022. Bureau of Land Management, Medford District, Butte Falls Area, Medford, Oregon. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated August 15, 2022, with survey data attached. Subject: Table Rocks vernal pool survey data.

Shelton, Brian. 2022. Environmental Scientist, Lands Conservation and Planning Coordinator, Solano County Unit Biologist, Bay Delta Region (Region 3), Fairfield, California. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated November 22, 2022. Subject: CDFW's vernal pool protected lands in Solano County.

Stanfield, Melissa. 2022. Senior Environmental Scientist, California Department of Fish and Wildlife, North Central Region (Region 2), Chico, California. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated October 25, 2022, with three attachments: Stone Ridge Ecological Reserve Management Plan Summary, wetland delineation map from 2005, and Stone Ridge Ranch Acquisition Proposal. Subject: Stone Ridge ER info/management plan.

Stanfield, Melissa. 2023. Senior Environmental Scientist, California Department of Fish and Wildlife, North Central Region (Region 2), Chico, California. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated January 30, 2023. Subject: Stone Ridge Ecological Reserve – No Fairy Shrimp.

Takahashi, Fumika. 2021. San Luis National Wildlife Refuge Complex, U.S. Fish and Wildlife Service. Email to My Nguyen, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated August 27, 2021, with annual survey reports for 2018-2021 attached. Subject: Branchiopods in San Luis NWR Complex.

Treiterer, Beatrix and Bart McDermott. 2021. Stone Lakes National Wildlife Service, U.S. Fish and Wildlife Service. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated September 22, 2021, with a link to shapefiles

of vernal pools on the Stone Lakes National Wildlife Refuge. Subject: Vernal pool shrimp info for Stone Lakes NWR.

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Tuss, Craig. 2008. U.S. Fish and Wildlife Service, Roseburg Field Office, Roseburg, Oregon. Email to Dominic DiPaolo, Southern Oregon Land Conservancy, Ashland, Oregon and to Sam Friedman U.S. Fish and Wildlife Service, Roseburg Field Office, Roseburg, Oregon dated February 25, 2008. Subject: Wood's House.

Wingo, Sheli. 2022. U.S. Fish and Wildlife Service, Habitat Restoration Division, Partners for Fish and Wildlife Program, Auburn, California. Email to Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, dated November 29, 2022, with attached photo of vernal pool fairy shrimp sample. Subject: Vernal Pool Shrimp on Dye Creek Preserve.

Yolo County Parks. 2023. Informational signage at Yolo County Grasslands Regional Park. Photo taken by Ian Perkins-Taylor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California, on February 18, 2023.

15.2. Personal Communications

Berry, Kellie and Adam Stewart. 2019. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. Phone call with Phil Pogledich, Yolo County legal counsel, and Jeff Anderson, Yolo County Parks to discuss Grasslands Regional Park. December 19, 2019.

Carter-Ervin, Robin and Kevin Moncrief. 2022. California Department of Water Resources, Oroville Field Division, Oroville, California. Teams video call with Ian Perkins-Taylor, Sacramento Fish and Wildlife Office, U.S. Fish and Wildlife Service to discuss vernal pools within Department of Water Resources land around the Thermalito and Oroville dams. September 19, 2022.

Craig, Andrea. 2022. The Nature Conservancy, Redding, California. Teams video call with Ian Perkins-Taylor, Sacramento Fish and Wildlife Office, U.S. Fish and Wildlife Service to discuss TNC's vernal pool preserves in the Sacramento Valley. July 25, 2022.

Perkins-Taylor, Ian and Emma Bickerstaff. 2022. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. Site visit attended with Dr. Shannon Kieran and Anderson Tate-Montenegro, U.C. Davis, to Stone Lakes National Wildlife Refuge. January 21, 2022.

Pinnell, Cassie. 2022. Senior Ecologist, Vollmar Natural Lands Consulting, Sacramento, California. Teams video call with Ian Perkins-Taylor, Sacramento Fish and Wildlife

Office, U.S. Fish and Wildlife Service to discuss the Montezuma Wetlands Project and Preserve. December 1, 2022.

Wallace, Jim. 2007. Jim Wallace Environmental Consulting Services. Provided information on the occurrence of vernal pool fairy shrimp at the Napa Airport. June 8, 2007.