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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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.

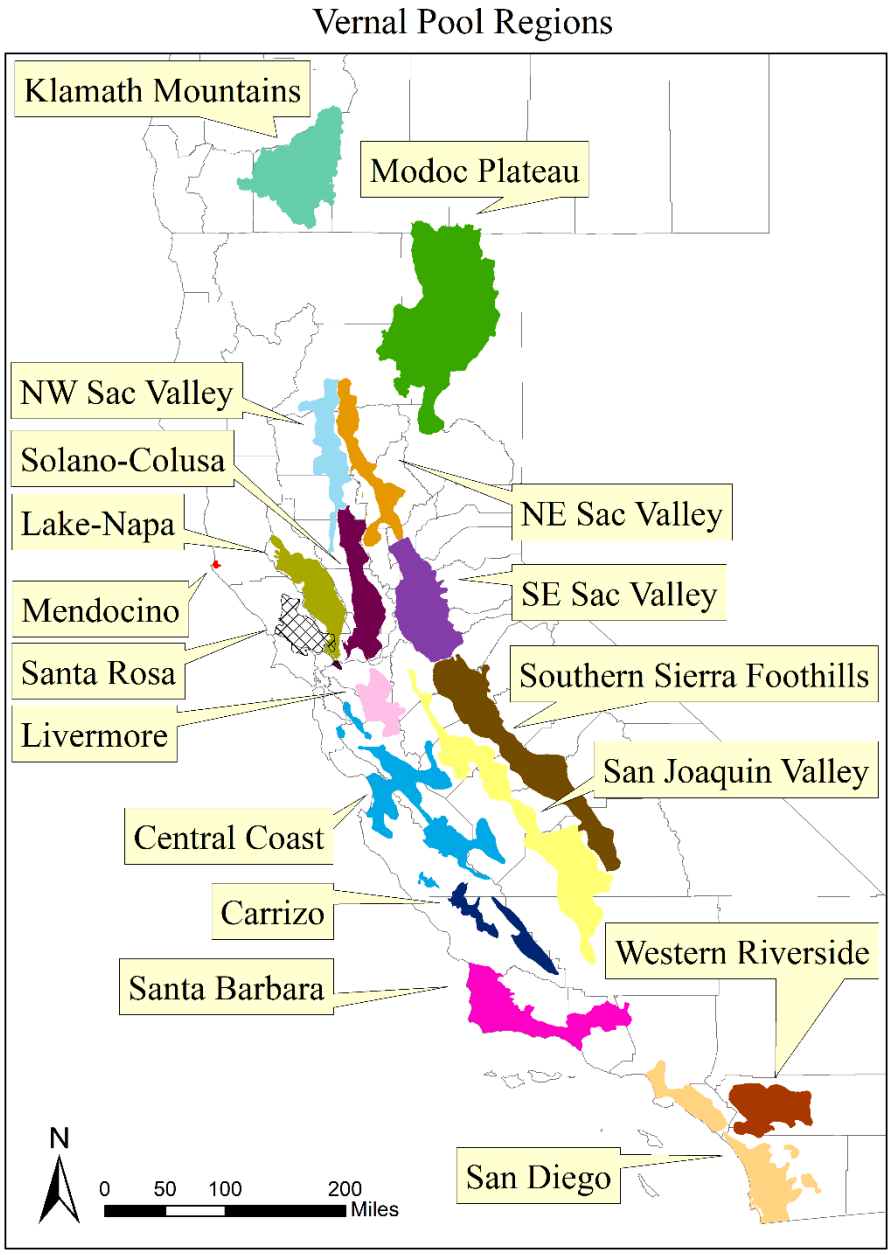

Figure 1.1. Map of the 16 vernal pool regions defined by the Recovery Plan. The Santa Rosa Vernal Pool Region, as defined by Keeler-Wolf et al. (1998), was not included in the Recovery Plan.

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.