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California Vernal Pool Assessment Preliminary Report

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Preface

This report is a summary of the current state-wide body of knowledge for vernal pools. We expect it to initiate widespread resource assessment by pointing out how much we still need to know. Because of this, we have chosen to facilitate further assessment by partitioning the state into distinct regions. The regions accentuate the variety of distinct natural resources encompassed in California vernal pools: the rare and endemic plants and animals, the variety of vernal pool types, and the relationship of geography to these factors. Appropriate conservation and impact assessment of California vernal pools varies immensely, based not only on pool biology and ecology but also on the diversity of human influences on pools throughout the state. Human impacts are vastly different in areas such as the Modoc Plateau and San Diego County. Division of the state into vernal pool regions can also enable us to understand the widely varying management concerns for the state's pools.

We caution against regarding these vernal pool regions as analogous to vernal pool management areas which might be equated to such things as mitigation banking zones. The detailed information needed to establish vernal pool management areas per se is not available except perhaps in the few best known areas. The boundaries of the vernal pool regions defined here are informal at this time and can only be firmly established with additional inquiries and field research. They should not be used in the absence of field work to determine that vernal pools do or do not exist in a particular area.

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Introduction

Vernal pools are unique and highly threatened wetlands of California's landscape. For the purposes of this report, we define them as seasonally flooded landscape depressions underlain by a subsurface which limits drainage. They result from an unusual combination of soil conditions, summer-dry Mediterranean climate, topography and hydrology, and support a specialized biota, including a relatively large number of threatened and endangered species (Cheatham 1976, Zedler 1987, Holland and Jain 1988).

In order to limit the scope of this document, we have restricted the definition of vernal pools to exclude other ephemeral wetlands. Vernal lakes and other larger intermittent wetlands as well as other more persistent wetlands (with emergent vegetation dominated by taxa of *Scirpus*, *Carex*, or *Typha*) are excluded from this treatment. Likewise, desert or semi-desert playas and mountain snowmelt pools are also excluded at this time. Our state of ecological knowledge about these related ecosystems is relatively poor, although we do know that some species are shared between all of these ephemeral wetlands. We view all ephemeral wetlands as a series of environmental continua and when more knowledge is available for other types, it would be wise to include them in any state-wide or regional assessment.

Vernal pools may occur singly or in complexes. A complex is a set of naturally occurring pools in close proximity. Intervening non-pool terrain within a vernal pool complex is commonly referred to as upland and often includes wetland or partially wetland swales that can interconnect pools within the complex. Pools can usually be distinguished from uplands by a distinct change in vegetation and soils characteristics.

Vernal pools are reported from a diverse array of areas in California including the Central Valley and cismontane foothills, lowlands in the Transverse and Coast Ranges, southern coastal mesas and the extreme northeast corner of the state on the Modoc Plateau (Holland and Jain 1988), yet all share a common suite of characteristics which distinguish them from other types of seasonal and perennial wetlands (Jokerst 1990). Vernal pools typically occur in depressions which are underlain by a subsurface layer which limits drainage (Holland 1976). The impervious substrate of vernal pools varies from hardpan or claypan to basalt or other materials that prevent downward percolation of water (Thorne 1981); many vernal pool soils are old (600,000 and greater years BP) (Harden 1987). These soils and California's Mediterranean climate contribute to the most striking characteristic of vernal pools, a hydrology distinguished by periodic or continuous ponding during the late fall, winter and spring followed by desiccation during the dry season (Holland 1976, Zedler 1987, Holland and Jain 1988, Jokerst 1990). Direct precipitation appears to be the primary water source but overland runoff and groundwater in seasonal perched water tables may also be important (Jokerst 1990).

Depending on the size of the depression, the amount of rainfall and climate conditions following rainfall, a pool will remain inundated for a week to several months before pool drying. The period of soil saturation is also variable. Because of the unusual ecological situation created by the drastic seasonal change from wet to dry, only plants and animals especially suited to the ephemeral nature of vernal pools routinely occupy the habitat. Species

inhabiting vernal pools must be able to tolerate the wide range of hydrologic conditions and/or complete their life cycles (grow and reproduce) in the short time when the pool provides a suitable environment (Zedler 1987). Vernal pool biota also varies from year to year in response to the amount and distribution of rainfall (Jokerst 1990).

Although the number of plant species found in any individual vernal pool is typically low (15-25 species) (Holland 1976 but see Taylor 1992), the available data suggest that the pools support a uniquely adapted flora which contains a significant proportion of regional and localized endemic species (Stone 1990) as well as an abundance of rare, threatened, or endangered species (Skinner and Pavlik 1994). Nearly 200 plant species (predominantly annuals) are known to be restricted to, or commonly associated with, vernal pools. Of these, 91% are considered native to California, and 55% have ranges entirely within the state (Holland 1976, see also Appendix C).

Vernal pools are also characterized by a specialized suite of animal species with life histories enabling them to inhabit the highly variable vernal pool ecosystem. The fauna includes a variety of crustaceans (e.g. fairy shrimp, clam shrimp, and tadpole shrimp) (Simovich *et al*. 1992, USFWS 1994, King *et al.* In prep.) and insects (e.g. beetles and solitary bees) (Thorp 1990, Thorp and Leong 1995) as well as the more conspicuous spadefoot toads (*Scaphiopus hammondii*), tiger salamanders (*Ambystoma californiense*) (Zedler 1987), waterbirds such as killdeer, avocet, greater yellowlegs, cinnamon teal, and mallard also frequently utilize vernal pool habitat (Jokerst 1990).

Unfortunately, these pools, largely endemic to California and harboring a large proportion of sensitive species, are extremely vulnerable to destruction because they most often occur on flat, easily developed, easily accessible land (Cheatham 1976). In fact, some estimates place losses of vernal pool habitat in California at more than 90% (Holland 1978). Agriculture, heavy-grazing, and urbanization are the greatest threats although hydrologic alterations, brush clearing and off-road vehicle use have also had an impact (Skinner 1996). Presently vernal pools are thought to be among the most threatened wetland ecosystems in the state (Stone 1990). They contain a very large share of the state-listed species when considered in the light of how little area pool habitat covers. They are also unique in their high relative percentage of all native species, supporting a much higher percentage of native species than surrounding uplands.

Efforts to protect the remaining vernal pool habitat in the state will be most successful if the role of vernal pools in the landscape is considered. Since many vernal pool taxa are geographically restricted and since different types of vernal pools occur in different areas, conservation areas must be scattered throughout the state. In addition, because of the complex dispersal and colonization relationships among pools within an area, at least some preserves ought to contain many pools (Skinner 1996, J. King, pers. comm. 1995). Finally, it is essential that the surrounding watershed areas and upland terrain, as well as the pools themselves and their spatial arrangement, be considered in conservation efforts. The integrity of the upland will influence not only the hydrology of the vernal pool but also the likelihood of maintaining some characteristic pool fauna (e.g. spadefoot toads require estivation sites outside the vernal pool itself, S.R. Morey, pers. comm.) and interactions among species (e.g. bee pollinators which require upland for nesting sites) (Thorp and Leong 1995). Preserving large,

unfragmented adjacent habitat has the additional advantage of incidentally protecting rare non-pool plant species in the area (Zedler 1987). Large area conservation also meets the State's goals of approaching conservation from an ecosystem basis, rather than a piecemeal, postage-stamp approach.

Vernal pool organisms generally exhibit distribution characteristics of metapopulations (a population comprising several local populations that are spatially separated but linked by species migration, allowing for recolonization of unoccupied habitat patches after local extinction events). Their population structure, genetic structure, gene flow, and sensitivity to demographic uncertainties need to be investigated further and considered in all management and preservation plans (J. King pers. comm. 1995). Some studies have shown high diversity within a pool complex and even within individual pools, while others (e.g. Butte County meadowfoam (Dole & Sun 1992) show greater diveristy exists between complexes than within.

Developing effective management plans for California's remaining vernal pool habitat requires incorporating as much information as possible on a variety of pools throughout the State. This inventory summarizes the current body of knowledge regarding vernal pool ecosystems throughout the State by partitioning the state into 17 regions. For each region, we describe the extent of the resource (types of pools, sensitive plants and animals) and current condition (known protected areas, viability, and restoration possibilities). We hope that it will serve both as a source of information for development of recovery and management plans and as the basis for future research on vernal pool ecosystems.

A Note on Vernal Pool Taxonomy

The current classification of vernal pools is undergoing a substantial revision. Holland (1986) is the primary source for taxonomy in this report, largely because it is the only state-wide classification for pools available. Recently, new classification concepts have emerged that have included vernal pools. Ferren et al. (1996) have developed a hierarchical classification for wetlands that includes vernal pool habitats in both palustrine and lacustrine systems and considers vernal pools to be defined by their hydrogeomorphology and their dominant vegetation. Sawyer and Keeler-Wolf (1995) have described vernal pools as special ecosystems that do not integrate well into the hierarchical vegetation classification system they discuss for California. The whole concept of vernal pools as typically defined is in need of serious revision. Many wetland biologists and ecologists believe that vernal pools (defined as small ephemeral wetlands in cismontane Mediterranean California) are but a segment of an entire class of wetlands that include all manner of ephemeral types from vernal pools to vernal lakes, desert playas, tehajas, and marshes. The philosophy of this report is to be inclusive of many of these ephemeral wetlands. However, we have chosen not to include desert playas, or isolated rockbound pools in the hills and mountains (filled from snowmelt or from flowing water) largely for one reason -- little is known about the distribution and biology of these types of wetlands. We believe that a range-wide biologically-driven perspective is the best way to understand the variety of vernal pool types.

Conservation

A functioning vernal pool ecosystem is complicated, and its viability depends on maintaining more than just the areas that fill with water. In some vernal pool complexes, some pools are connected by intermittent drainages that also support vernal pool species. These drainages are referred to as vernal swales. Some pools fill from precipitation that falls directly into them, but other pools are supplemented by surface runoff or subsurface flow. In dry years, some pools may not fill with water. In very wet years, several, normally-separate pools may coalesce to form very large pools. Pools that occur very close together and appear very similar can support a very different suite of animals and plants, and the same pool can support different plants and animals in different years due to differences in the pattern and amount of rainfall. Some vernal pool organisms, such as amphibians, use the pool sites only when they are inundated, and spend the majority of their life in the surrounding upland. Some vernal pool plants depend for pollination upon rare, specialized bees that nest in the surrounding upland. Migrating waterfowl and shorebirds may transport dormant seed and eggs of vernal pool organisms from one location or region to another, either internally in food, or attached in mud to their legs or feathers.

In order to protect and maintain vernal pools and their biota at a site, an adequate variety and distribution of pools must be protected to provide habitat for different vernal pool species, to allow dispersal and recolonization of vernal pool biota, and to provide habitat during years with different rainfall patterns. In addition, the hydrological system must be protected and sufficient upland habitat must be protected to maintain vernal pool-associated species that also require upland. As the amount of upland or wetland habitat associated with vernal pools at a site is degraded or destroyed, the viability of the pools and their biota can be impaired due to disruption of hydrology, decreased nesting habitat available for pollinators, decreased summer habitat for amphibians, or decreased attractiveness to waterfowl (dispersers of vernal pool plants and invertebrates) .

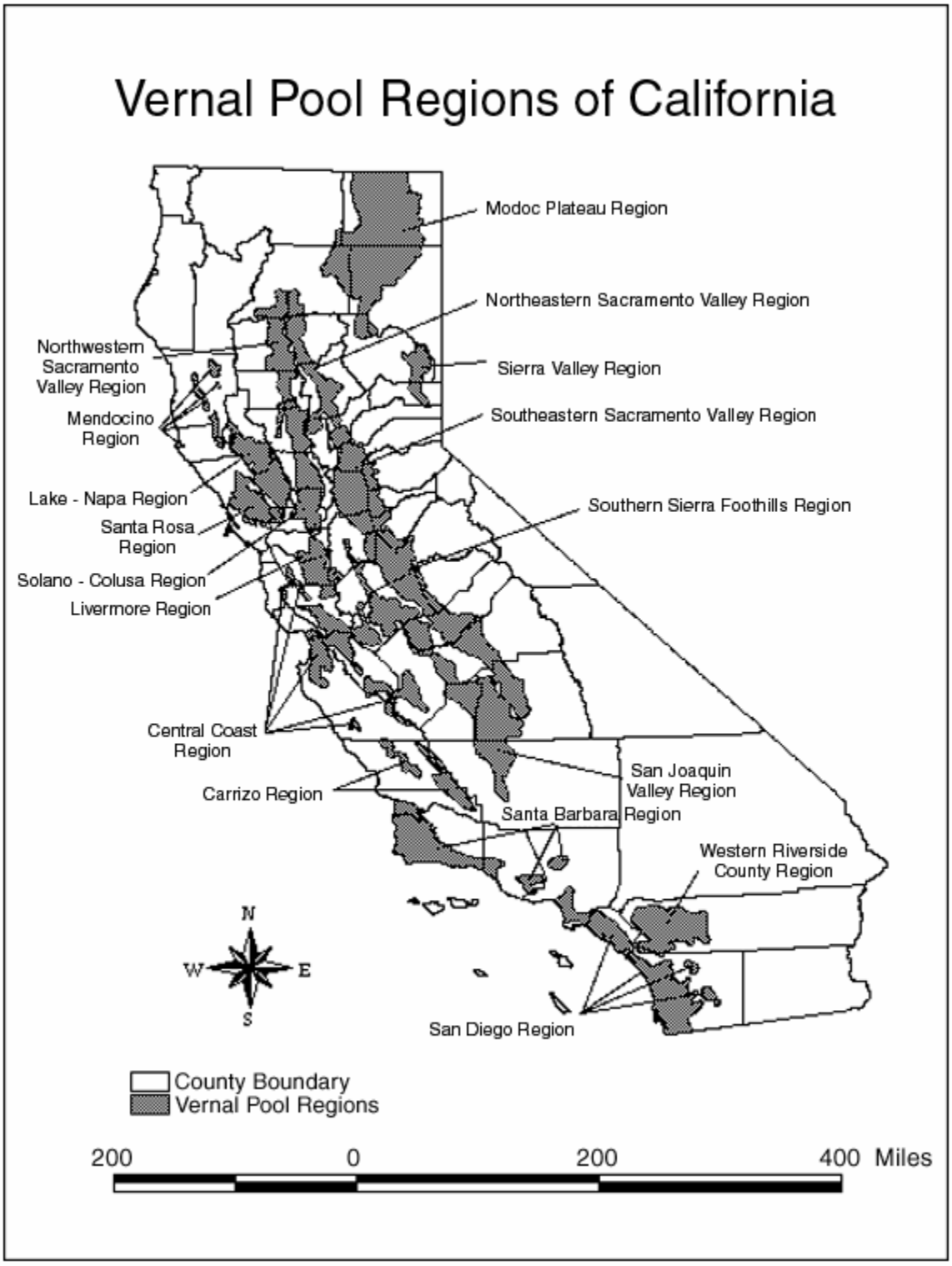

Figure 1. Map of the Vernal Pool Regions of California

Methods

How Regions Were Defined

The emphasis for region definition is based on biology. Thus, a region is defined largely by its biological uniqueness, based on known locations of endemic vernal pool species. Regions reflect general ranges of localized endemic vernal pool species and may include a variety of categories of geomorphic pool types. Some regions are consistently defined by both biology and abiotic features such as soils and geomorphology. All regions tend to have a preponderance of certain pool types (based on type of restricting substrate and on hydro-geomorphology, see Ferren, et al. 1996), but the correlation between biology and pool type has not been clearly demonstrated for most of California. Further research is planned in 1998 to test the correlation of abiotic and biotic factors in several regions of California. Results of these studies will refine the regions and allow them to be used as better indicators of the range of variability of pool types in California.

The first source of the biological information used to develop the regional descriptions was the California Department of Fish and Game's (DFG's) Natural Diversity Data Base (NDDB). The NDDB currently contains over 2600 individual records on sensitive vernal pool plant, animal, and community occurrences throughout the state. A map and a text report for each of these records was produced by the DFG Geographic Information System (GIS) staff. The individual records were queried based on their listed habitat associations (such as vernal pool, marsh, grassland) and were divided up into facultative and restricted vernal pool elements. Vernal pool elements (plant and animal taxa) were considered restricted if they were associated primarily with vernal pool habitats and had a limited geographic range. Restricted elements were associated in the NDDB and/or California Native Plant Society (CNPS) records only with vernal pool habitat or with vernal pool habitat and only one other habitat type. Facultative vernal pool elements included plant and animal taxa that were listed from more than one other habitat (such as marshes and swamps, valley and foothill grassland, or cismontane woodland) in addition to vernal pool habitats, and/or were geographically widespread. While facultative taxa are included in the descriptions of the regions, only restricted taxa were used to help define them. Preliminary boundaries to vernal pool regions were drawn based on NDDB records and information from the CNPS Electronic Inventory of Rare and Endangered Vascular Plants. A list of all sensitive vernal pool elements tracked by the NDDB and considered in this report is given in Appendix A. For each of these taxa, habitat associations and distribution by vernal pool regions are summarized in Appendix B. Further, because the NDDB and CNPS only track sensitive elements, a broader list of vernal pool taxa including all plants and animals indicative of vernal pools is being developed using a wide range of sources (Appendix C).

Boundary refinement and additional report information was obtained by reviewing published and unpublished documents on file with the DFG Natural Heritage Division's NDDB and Plant Conservation Program, in particular reports from the U.S.D.A. State Cooperative Soil Survey. A limited amount of additional information was obtained by contacting knowledgeable field sources. The taxa included in this report include both Federal

and State listed, proposed and candidate species, down to the level of Federal category 3c as well as CNPS listed plants of higher concern than those on CNPS list 4 (the watch list).

The criteria for distinguishing regions were weighted toward biology and ecology. If, for example, an area was known to contain a group of endemic plants and was typified by a distinct type of vernal pool community, boundaries were drawn to include all known sites with these characteristics. If only incomplete information for pools was available, boundaries of the regions were drawn to include soil series known to support pools in other parts of the same region. Thus, the definitions of the regions were conservative. Recent county-by-county vernal pool mapping efforts by U.S. Fish and Wildlife Service (USFWS) have also been used to refine region boundaries for pool regions within the Central Valley. Nevertheless, because of incomplete knowledge of pool distribution and the amorphous definitions of vernal pools in some cases, it is still likely that some pools exist outside certain regions. For example, structural basin vernal pools in the Central Coastal Region tend to follow fault lines. Because of their local, widely-separated distribution, some isolated individual pools may occur outside of our mapped areas . Major uncertainties stem from the lack of synoptic state-wide coverage of vernal pool species in our data sources. Not all rare species are inventoried, and pools without rare species are under-represented in our databases. Other uncertainties stem from imprecise ecological definition of pools and the vague distinction between such communities as vernal pools, vernal lakes, and intermittent alkali wetlands.

In some cases, the degree of human impact and our management responses to that impact have influenced the delineation of the vernal pool regions. For example, although there are some biological distinctions, many biological similarities exist between the vernal pools of Sonoma, Lake, and Napa counties. Yet, we have chosen to distinguish the Santa Rosa Vernal Pool Region in some measure due to its distinct treatment by local, State, and Federal agencies and the cooperative management that is now developing around the area's pool resources.

Reporting the Information

Each region summary includes entries on the definition of the region, the types of pools known from the region, descriptions of the pools based on Holland's classification (see Appendix D), the sensitive plants and animals, known protected areas within the region, and viability and restoration opportunities. Rare plants and animals are listed by current and/or proposed Federal and State status (FPT = Federal Proposed Threatened, FPE = Federal Proposed Endangered, CSC = California Species of Special Concern). The letters SC refer to special concern status for plants identified as a species worthy of tracking in the NDDB. The discussion of viability includes information on specific impacts known to pools and the general ecological status of the region's pools. Viability is considered high when unnatural impacts are low, and low when serious impacts affect large areas of the pools in a region.

The section on restoration possibilities includes discussions of what likely opportunities exist in the region for restoration and what types of restoration have been undertaken. We emphasize that not all agricultural practices have an equal effect on vernal pools. Restoration potential is higher when impacts are relatively superficial and reversible (e.g., high-intensity

grazing, some truck crops) and lower when impacts are severe and difficult to reverse (e.g., destruction of surface micro topography, soil profile, and seed bank by intensive agricultural practices such as deep ripping for orchard or vineyard planting). Grazing impacts as perceived in this report vary depending on intensity, duration, and timing and may be negative or positive depending on the situation. One way of assessing restoration potential for a region's pools is by determining the area theoretically covered by soil series supporting pools and subtracting the developed and heavily altered agricultural land from that total. We did not attempt this analysis in the present report, but it could be done with access to available soils information and additional pool mapping. This method assumes that pools can only be restored on soils which historically supported them and which have been relatively unaltered.

Sensitive plants enumerated include Federal listed and proposed endangered or threatened taxa, State listed endangered, threatened, or rare taxa, and California Native Plant Society (CNPS) listed taxa without State or Federal status. Sensitive animals are listed by their Federal and State status. In general, information for animals, particularly invertebrates, is less complete than for plants.

The information for each region is summarized in a table arranged by pool type (after the Holland classification, Appendix D) and containing entries on acreage of pools in protection, viability, restoration opportunity, and number of sensitive taxa. Since pool acreage is not often known, rankings of low, moderate, and high have been adopted based on the estimated acreage of pools in protection relative to the estimated total acreage of pools in the region. Finally, for each region a small-scale map showing the region boundary, county lines, and occurrences of vernal pool species and natural community locations in the Natural Diversity Data Base is displayed.

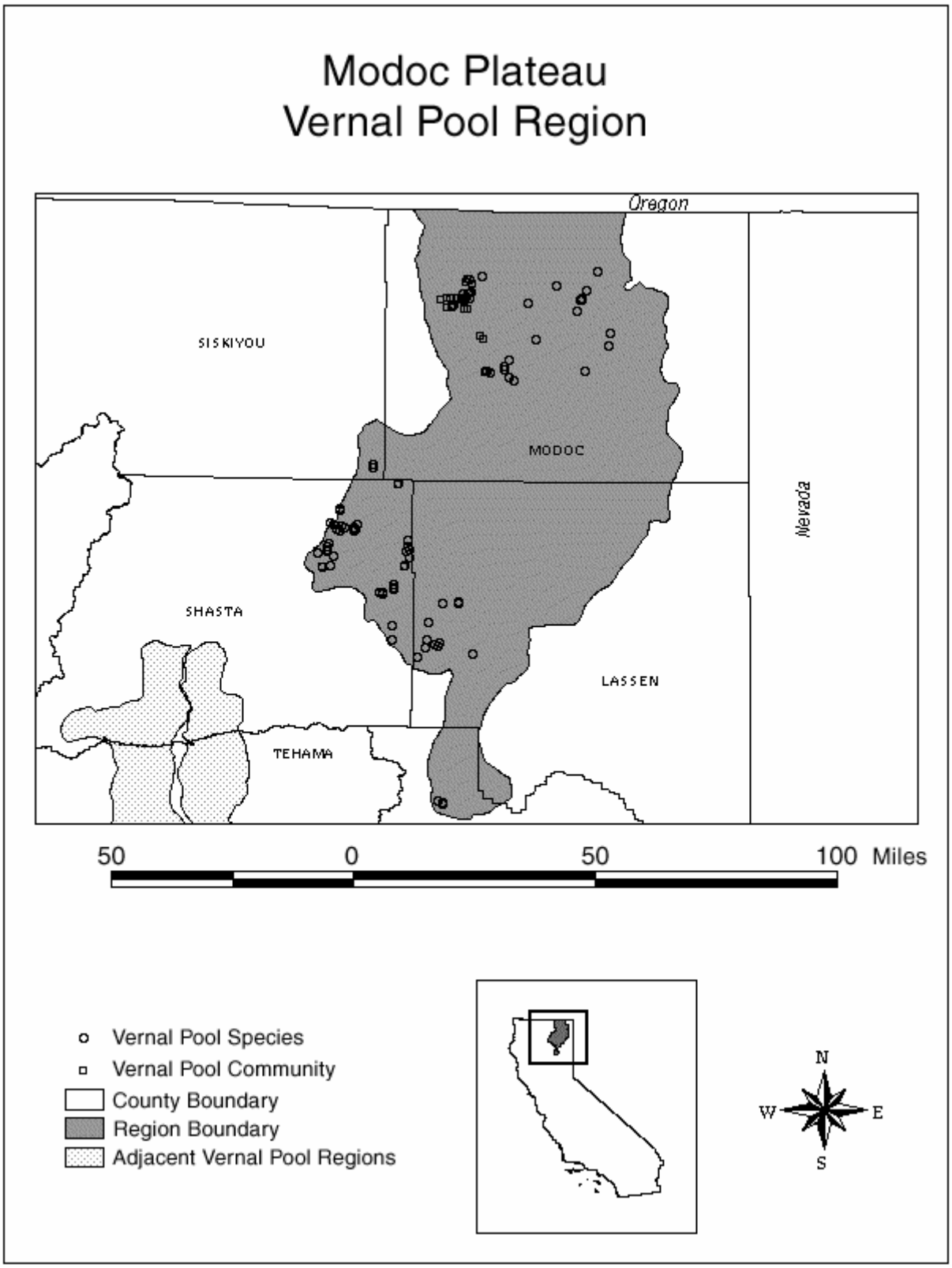

Figure 2. Map of the Modoc Plateau Vernal Pool Region

Modoc Plateau Region

Region Defined

The Modoc Plateau Vernal Pool Region is defined by a group of geologically related soils derived from Pleistocene and Pliocene basaltic lavas which cover much of the Modoc Plateau. The region stretches from the Oregon border between Goose Lake and the Tule Lake Valley south across the Devils Garden and east to the base of the Warner Mountains. It also includes the area of lower elevation in the Fall River, Big Valley, and Burney areas ranging south to the vicinity of Poison Lake in Lassen County. The region has been extented in this draft to include isolated vernal pools that stretch into the Southern Cascades as far south and west as the western shores of Lake Almanor, Lassen County. Some suggestion that a separate Cascades Region exists is indicated by certain invertebrate species distribution patterns (R.Hill pers. comm. 1996). However, lacking sufficient knowledge of distribution and species composition for the Cascades, we include pools in the Cascades with the Modoc Region at this time.

The area contains numerous pools and vernal lakes. It has the coldest climate of any vernal pool region in the state and supports several endemic vernal pool plants such as *Pogogyne floribunda, Polygonum polygaloides* ssp. *esotericum, Eryngium mathiasiae,* and *Mimulus pygmaeus.* The highest concentration of pools occurs in the Devil's Garden area. These pools may be very large, and some converge upon vernal lakes which have a different flora, dominated by silver sagebrush (*Artemisia cana*) and sticky rabbitbrush (*Chrysothamnus viscidiflorus*).

Pool Types

The region includes Northern Basalt Flow Vernal Pools as well as other types which are undefined and as in such examples as Egg Lake, Modoc County, may be extremely large vernal lakes. Some may be Northern Volcanic Mudflow Vernal Pools.

Pool Descriptions

Northern Basalt Flow Vernal Pools are the most common type. They range from fractions of an acre to over 100 acres in size. On the Devil's Garden they occur singly or in clusters of several large pools on flat plains surrounded by sagebrush scrub and juniper woodland. Vernal lakes are more permanent and have vernal pool-like features at their margins while having marsh-like vegetation in the deeper portions. These include such prominent ones as Poison Lake and Egg Lake. Some of the larger vernal lakes have deeper clay-rich soils (Deven series) which, due to frost heave**,** are self-churning vertisols. Some pools are underlain by very shallow soil over bedrock. Pools in the Fall River area such as those at Timbered Crater Research Natural Area (RNA) are underlain by Supan series soils and are floristically transitional to northern Sacramento Valley pools. Hydrology is flashy on the shallow-soil

pools with longer inundation periods for the deeper-soil pools. Current acreage for types is unavailable.

Viability

The majority of the region is not heavily impacted, being one of the most sparsely populated areas of the state. However, conversion of valley area pools near Burney, Fall River Mills, and Alturas to agriculture has had some overall negative impact. Long-term intensive livestock grazing is the principal unnatural impact over much of the region. Although most indications are that its effects are slight to moderate, effects of livestock management such as digging out and damming of pools to form stock ponds have had some negative impact.

Restoration Opportunities

Most of the region does not require major restoration. Restoration opportunities for areas impacted by long-term intensive cattle or sheep grazing are widely available. No likely opportunities exist in the small percentage of the area which has been converted to agriculture.

Protected Areas

The majority of the area is publicly owned, managed by the Modoc and Lassen National Forests; additional lands are under Bureau of Land Management (BLM) control. Although public ownership affords some protection, the only natural areas with vernal pool vegetation are at Timbered Crater Research Natural Area (RNA), Ash Creek, Wildlife Area, Clear Lake National Wildlife Refuge, and Devil's Garden RNA. Of these areas only Timbered Crater RNA will be specifically established to preserve vernal pools (it is not yet formally established, B. Corbin pers. comm. 1996). Additional protection and study is warranted for the unclassified vernal pool/vernal lake systems. Acreage of pools within preserves is relatively small.

Sensitive Plants

State Endangered Species:
Boggs Lake hedge-hyssop (*Gratiola heterosepala*)
Slender Orcutt grass (*Orcuttia tenuis*) (FT)

State Rare Species:
Greene's tuctoria (*Tuctoria greenei*) (FE)

Federal Category 2 Species:
Egg Lake monkeyflower (*Mimulus pygmaeus*) (SC)

CNPS List 1B Species:
Profuse-flowered pogogyne (*Pogogyne floribunda)* (SC)
Modoc County knotweed (*Polygonum polygaloides* ssp. *esotericum*)

CNPS list 2 Species:
Playa Phacelia (*Phacelia inundata*)

CNPS List 3 Species:
Nelson's pepperwort (*Marsilea oligospora*)

Sensitive Animals

None identified in the NDDB although unidentified fairy shrimp and tadpole shrimp (Corbin, pers. comm.) have been noted in several areas.

Table 1. Information Summary for the Modoc Plateau Vernal Pool Region.

Modoc Plateau					
VERNAL POOL TYPE	VIABILITY (H, M, L)	RESTORATION OPPORTUNITY (H, M, L)	PROTECTED AREAS (Total Acres) or (H, M, L)	SENSITIVE PLANTS (No. of spp.)	SENSITIVE ANIMALS (No. of spp.)
Northern Basalt Flow	H	H	M*	8	none known
Northern Volcanic Mudflow	H	H	M*		

* Combination of protected and multi-use (USFS, DFG, and BLM).

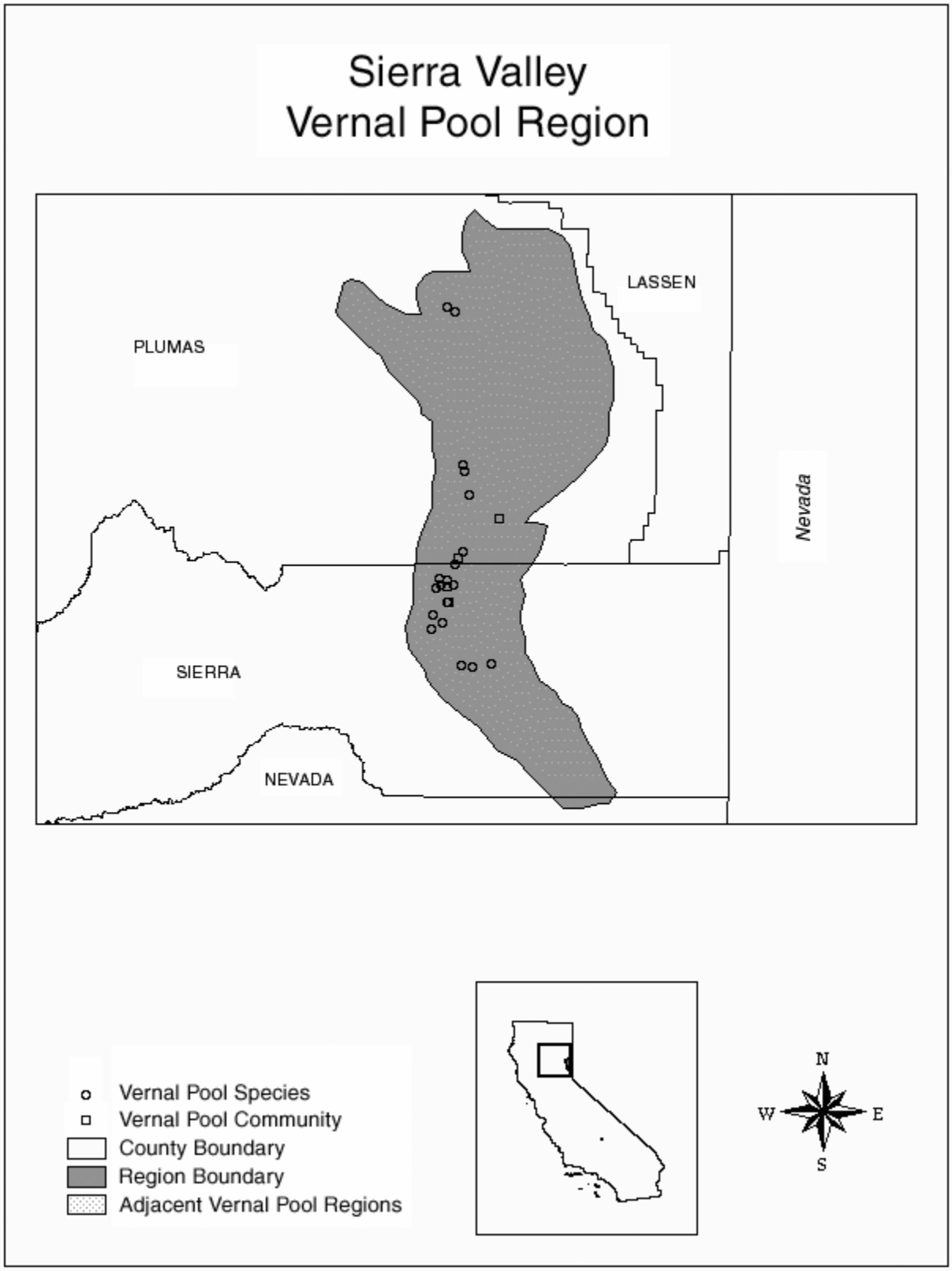

Figure 3. Map of the Sierra Valley Vernal Pool Region

Sierra Valley Region

Region Defined

The Sierra Valley Vernal Pool Region occupies the western portion of Sierra Valley, the intermountain valleys of the Diamond Mountains such as Squaw Queen and Davis Lake valleys, and runs southward to the vicinity of Truckee in eastern Plumas and adjacent Sierra counties. There are no extensive complexes in this region; the pools occur in small complexes and swales or as isolated individuals. This is one of the highest elevation sites for pools, with elevations similar to those in much of the Modoc Plateau Region. However, precipitation is higher, and temperatures somewhat more moderate than most of the Modoc Plateau pools. A number of relatively widespread vernal pool plants are known from the three occurrences inventoried within this region. Three sensitive plant species has been noted from vernal pools in the region; Sierra Valley Ivesia (*Ivesia aperta*), Plumas Ivesia (*Ivesia sericoleuca*), and Modoc County knotweed (*Polygonum polygaloides* ssp. *esotericum*). The first two serve as biological indicators of this Region. Other taxa listed from these vernal pools include three species of *Downingia, Eryngium alismaefolium, Navarretia leucocephala* ssp. *minima, Veronica scutellata, Plagiobothrys hispidulus, Perideridia bolanderi, Myosurus minimus, Eleocharis acicularis,* and *Deschampsia danthonoides*. The pools described in the NDDB are all surrounded by rush (*Juncus* sp.) meadows. Those of the Squaw Queen Valley are surrounded by low sagebrush (*Artemisia arbuscula*) scrub and are underlain by Pleistocene lakebed sediments.

Pool Types

The four vernal pool natural community occurrences in the NDDB for this region are identified as Northern Vernal Pool, a general classification class for pools with unclear taxonomic status. Those of the Squaw Queen Valley area are a combination of a few small-to-moderately-sized pools and very low gradient swales.

Pool Descriptions

The pools on private land in Sierra Valley are described as small with several in each occurrence. They occupy relatively moist soils, substantiated by the presence of rushes surrounding the pool areas. The soils are not described for the pools, but Lovejoy series, a hardpan soil known from the western edge of the Sierra Valley, is likely to underlie at least some of the pool complexes. Lovejoy soils are underlain by a hardpan at a depth of 10 to 30 inches. The hardpan is described as being indurated and massive, moderately alkaline, with lime in distinct bands. The surface of these soils has been described as level or very gently sloping with a hummocky micro topography. Pools in Davis Lake, Squaw Queen, and Frenchman Reservoir areas include swale and individual mid-to-small size pools on somewhat alkaline soils derived from lakebed sediments.

Viability

The pools in the area are on range land. The few comments in the NDDB records suggest that long-term intensive grazing is an impact in at least two of the three known occurrences. Because the soils that likely support these pools are only locally distributed in this small region, the pools' viability is likely to be compromised by few sites, small size, and varying impacts from livestock ranching. Plumas National Forest botanists are monitoring the pools on forest service land at Squaw Queen Valley and results suggest that viability of the sensitive Plumas ivesia has diminished in areas where regular long duration grazing persists. Pool extent has been reduced by the construction of both Davis Lake and Frenchmans Reservoir. Road construction and maintenance has affected pool extent and hydrology in the western portion of Sierra Valley.

Restoration Opportunities

Much of the Sierra Valley portion of the region is under single ownership. The Plumas National Forest lands are all subjected to regular grazing. Exclosures in Squaw Queen Valley (USFS) demonstrate increased vitality of Plumas ivesia and other pool species compared to surrounding grazed lands.

Protected Areas

No protected areas of vernal pools are known from the region except for small exclosures of less that 1 acre in Squaw Queen Valley. The majority of the Sierra Valley region is privately owned and managed for livestock. The Wild and Scenic designation of the channel of the Middle Fork of the Feather River may include some pool areas in the northern part of the region.

Sensitive Plants

CNPS List 1B Species:

Modoc County knotweed (*Polygonum polygaloides* ssp. *esotericum*)
Sierra Valley Ivesia (*Ivesia aperta* var. *aperta)*
Plumas Ivesia (*Ivesia sericoleuca)*

Sensitive Animals

None known although some fairy shrimp (unidentified species) have been collected in the region.

Table 2. Information Summary for the Sierra Valley Vernal Pool Region.

Sierra Valley					
VERNAL POOL TYPE	VIABILITY (H, M, L)	RESTORATION OPPORTUNITY (H, M, L)	PROTECTED AREAS (Total Acres) or (H, M, L)	SENSITIVE PLANTS (No. of spp.)	SENSITIVE ANIMALS (No. of spp.)
Northern Vernal Pool	M	M	none known	3	none known

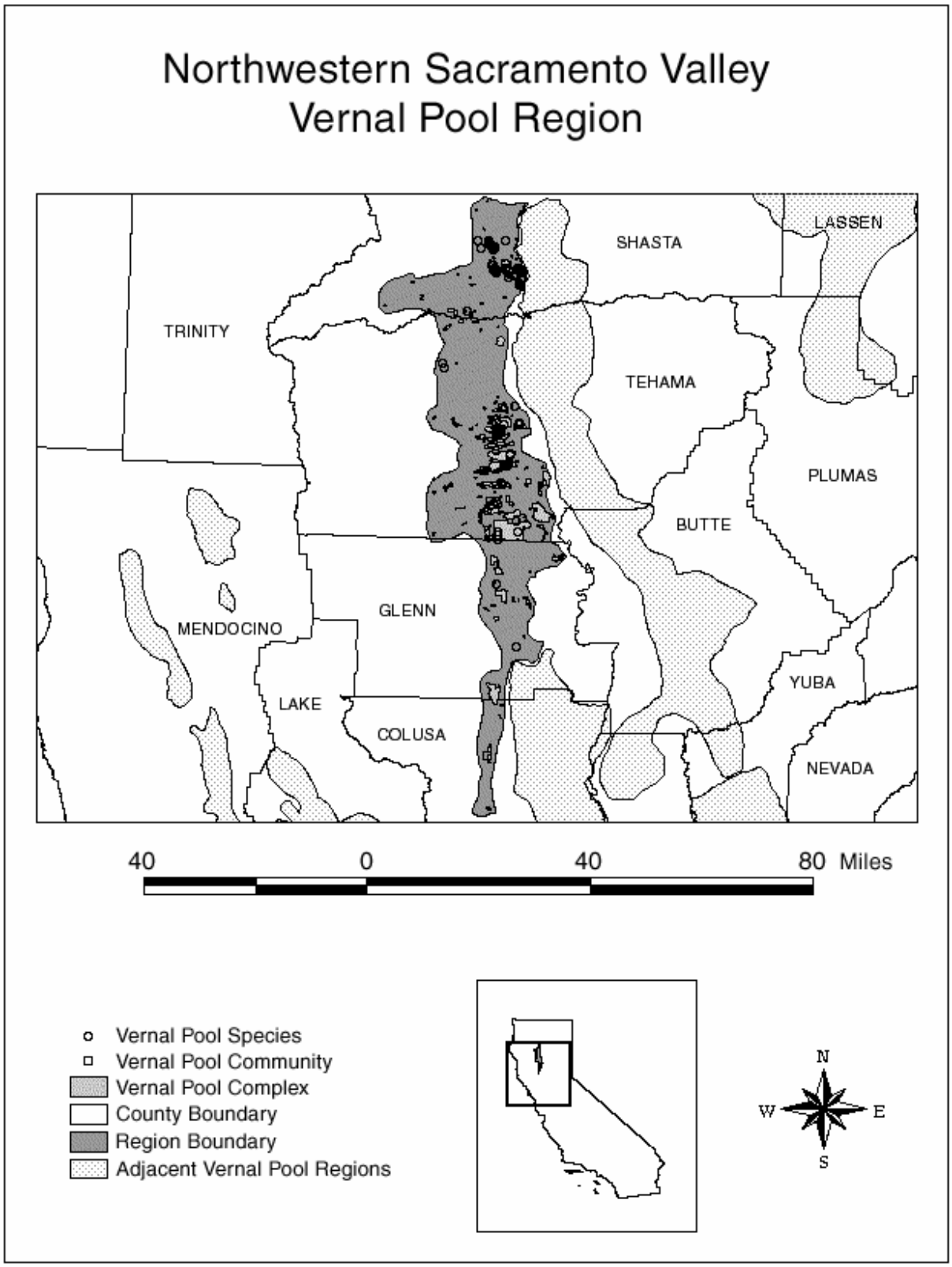

Figure 4. Map of the Northwestern Sacramento Valley Vernal Pool Region

Northwestern Sacramento Valley Region

Region Defined

The Northwestern Sacramento Valley Vernal Pool Region occupies the northwestern portion of the Sacramento Valley ranging from the Redding area south and west to the Inner Coast Range foothills west of Williams in Colusa County. Several well-defined, large pool complexes exhibiting mima mound topography occur in Tehama County west of Red Bluff, Gerber, Corning, and Henleyville. Other pools occur in Shasta County in the vicinity of Redding (Stillwater Plains). The main distribution of pools is tied to the Redding and Corning soil series and related complexes. They occupy old alluvial terraces perched above the valley bottom largely west of the Sacramento River. These soils diminish in extent further to the south (west of Orland), and pools are much more scattered from this point south into Colusa County. Specific pool information is lacking from the southwestern portion of the area which was included based on small patches of these soils in the Stony Creek drainage. The southeastern portion of the region abuts the Solano-Colusa Vernal Pool Region with it's valley basin, often alkaline soils (as near the Sacramento National Wildlife Refuge). Pools in the Northwest Sacramento Valley Region are almost entirely the Northern Hardpan type. The majority of species occurring in the region are shared with the adjacent Northeastern Sacramento Valley Region. However, the soil conditions and geological substrate differ.

Pool Types

The region includes primarily Northern Hardpan vernal pools and possibly Northern Volcanic Mudflow Vernal Pools to a limited extent in vicinity of Black Butte Reservoir.

Pool Descriptions

The majority of pools are Northern Hardpan types and exist in complexes on the reddish iron-silica cemented soils of the Redding, Corning, Corning-Newville, and Redding-Corning gravelly loams. The individual pools are typically small and occupy regularly mounded, mima-mound topography. Several complexes cover more than one section of land. Because pools are small they typically do not hold water for long periods and lack many of the long inundation period species such as Tadpole shrimp. Exceptionally large pools up to several acres occur on the Stillwater Plains near Redding Municipal Airport.

Viability

Subdivisions of the old ranches and land grant areas west of Red Bluff, Corning, and Orland have taken their toll on pools in the region. Urban expansion of Redding has also caused substantial pool losses. Although the pools are on soils not typically used for intensive agriculture, recently thousands of acres of this area have been converted into *Eucalyptus* farms, and some have been converted into orchards. Areas that have been used as grazing land

for over 100 years have been modified by damming of pools, road construction, and OHV use as well as long-term intensive grazing. However, grazed areas have a greater likelihood of being restored than other altered areas.

Restoration Opportunities

Restoration opportunities are limited in subdivided areas near Redding and Red Bluff and in graded agricultural lands elsewhere in the region. However, the grazing land stretching from west of Red Bluff to northwest of Orland offers several areas of substantial acreage that could be restored by appropriate timing and intensity of grazing. Acreage of soil series available for restoration (minus developed and heavily altered agricultural land) is not available.

Protected Areas

DFG has recently acquired title to a site northwest of Corning, to be called the Thomes Creek Ecological Preserve. A 3,000 acre conservation easement has been obtained by Simpson Lumber Co. as mitigation for pool losses associated with its Eucalyptus plantation. The Natural Resources Conservation Service has acquired conservation easements on several parcels near the Redding Airport and DFG is working with local landowners to expand vernal pool preservation in this area. Region I of DFG has been negotiating with land owners in the Redding Area to establish a mitigation banking site in this region near the Redding airport. There is a clear need for representation of Northern Hardpan types. Total acreage of each pool type in protected status is very small.

Sensitive Plants

State Endangered Species:
- Boggs Lake hedge-hyssop (*Gratiola heterosepala*)
- Slender Orcutt grass (*Orcuttia tenuis*) (FT)

State Rare Species:
- Greene's tuctoria (*Tuctoria greenei*) (FE)

Federal Category 2 Species:
- Henderson's bent grass (*Agrostis hendersonii*) (SC*)
- Legenere (*Legenere limosa*) (SC)
- Ahart's paronychia (*Paronychia ahartii*) (SC)
- Sanfords arrowhead (*Sagittaria sanfordii*) (SC)

CNPS List 1B Species:
- Red Bluff dwarf rush (*Juncus leiospermus* var. *leiospermus)*
- Baker's navarretia (*Navarretia leucocephala* ssp. *bakeri*)

CNPS List 2 Species:
- Dwarf downingia (*Downingia pusilla*)

Sensitive Animals

Federal Endangered Species:
Conservancy fairy shrimp (*Branchinecta conservatio*)
Vernal pool tadpole shrimp (*Lepidurus packardi*)

Federal Threatened Species:
Vernal pool fairy shrimp (*Branchinecta lynchi*)

Federal Category 2 Species:
Western spadefoot toad (*Scaphiopus hammondii*) (CSC)

Table 3. Information Summary for the Northwestern Sacramento Valley Vernal Pool Region.

Northwestern Sacramento Valley					
VERNAL POOL TYPE	VIABILITY (H, M, L)	RESTORATION OPPORTUNITY (H, M, L)	PROTECTED AREAS (Total Acres) or (H, M, L)	SENSITIVE PLANTS (No. of spp.)	SENSITIVE ANIMALS (No. of spp.)
Northern Hardpan	M	M	none known	10	4
Northern Claypan	M	M	L		

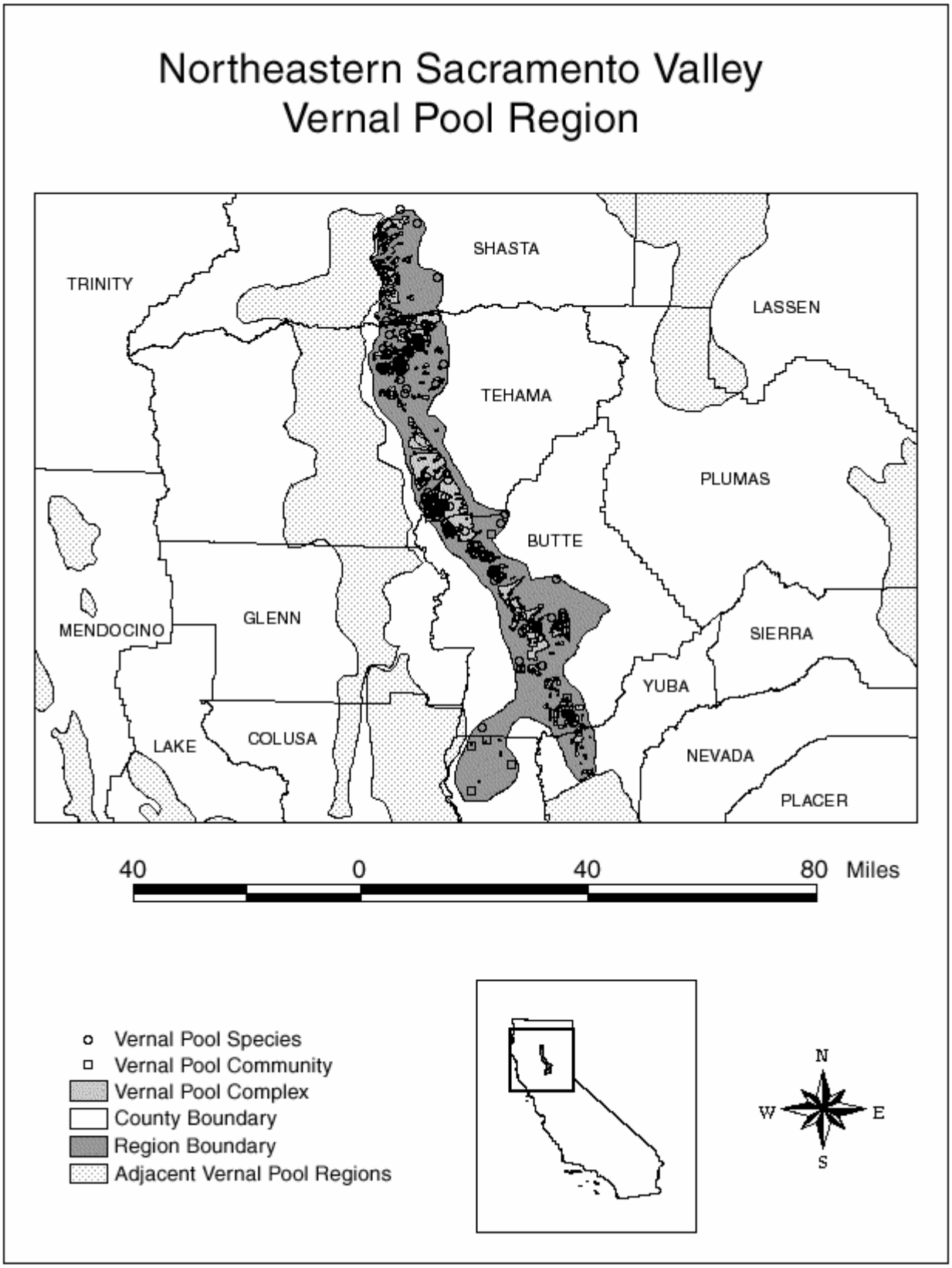

Figure 5. Map of the Northeastern Sacramento Valley Vernal Pool Region

Northeastern Sacramento Valley Region

Region Defined

The Northeastern Sacramento Valley Vernal Pool Region ranges from the Sutter Buttes and the Sierra foothills in southern Butte County and the lower valley terraces east of the Sacramento River north to the vicinity of Millville Plains east of Redding in Shasta County. The area contains several well known pool complexes including Dales Lake-Manton, Vina Plains, Llano Seco Rancho unit of the Sacramento River NWR, Richvale, and North Table Mountain. The majority of the area is underlain by soils derived from volcanic rock of the southern Cascade Range. The area is also characterized by the endemic plant, Butte County meadowfoam (*Limnanthes floccosa* ssp. *californica*), which occurs in the southern part of the region. It is differentiated from the adjacent Northwestern Sacramento Valley Region primarily by soil type. The soils in the Northeastern Sacramento Valley Region are derived primarily from basalt and volcanic mudflows emanating from the southern Cascades and the adjacent northern Sierra Nevada.

Pool Types

The region includes Northern Hardpan, Northern Basalt Flow and Northern Volcanic Mudflow vernal pools.

Pool Descriptions

Volcanic Mudflow Vernal Pools cover the largest part of the region although average pool size is typically small (<100 m^2) and the pools are irregularly spaced and do not form large pool complexes. These pools have characteristically shallow soils, < 30 cm deep, (commonly Toomes series) underlain by impervious mudflow welded tuff. They have a "flashy hydrology," filling and refilling many times over the wet season. Northern Basalt Flow pools are the most restricted in the area, confined to massive basalt flows such as Table Mountain north of Oroville. They also have flashy hydrology and are generally small, underlain by a very shallow soil overlaying basalt and occurring as regularly-spaced small depressions on the top of sinuous basalt flows.

Northern Hardpan pools are typically found in complexes in areas of hummocky ground on old terraces above the recent river flood plains and below the foothills. They occur on Tuscan soils which are alluvial and derived from the volcanic Tuscan Formation (e.g. at Vina Plains) or on terrace-alluvial derived Redding soils (in the Chico area) . Some hardpans in the Chico area are lime-silica based (Llano Seco). These pools are often larger than the other two types. Some may be over 1 acre. The hydrology is less flashy, with pools remaining filled longer than the previous types.

Viability

Foothill areas of Volcanic Mudflow and Northern Basalt Flow pools are not heavily threatened although some grazing practices or regimes may have a negative impact. Northern Basalt Flow types are restricted to a few sites such as North Table Mountain and near Big Chico Creek. Northern Hardpan types are most threatened due to lower valley positions in areas of urban expansion (Chico, Oroville, Gridley areas), agriculture, and long-term intensive grazing.

Restoration Opportunities

Large areas around Chico have been subdivided and urbanized and are unavailable for restoration. Much of the Northern Hardpan type is privately owned and is grazing land. It would be the most likely for restoration and mitigation. The foothill Northern Mudflow and Northern Basalt Flow types are managed largely as rangelands and could benefit by exclusion and short duration grazing practices.

Protected Areas

The Nature Conservancy has over 20 medium to large Northern Hardpan pools and a number of swales preserved at Vina Plains Preserve. TNC also has a preserve at Richvale. The BLM has protected vernal pool sites at Paynes Creek, Hog Lake, and Seven Mile Lake. DFG has an ecological preserve at Dales Lake and some pool habitat protected at Thermalito (Oroville Wildlife Area). Small portions of Bidwell Park in Chico, Llano Seco Ranch, Llano Seco Unit of Sacramento River NWR, and North Table Mountain protect Northern Basalt Flow and Volcanic Mudflow pools. The city of Chico has a 14 acre preserve southeast of the city. The Wurlitzer Ranch northwest of Chico has natural and some created pools protected. The US Fish and Wildlife Service has some vernal pool acreage at their Llano Seco unit of the Sacramento River NWR. Total acreage of each type in protection is not available.

Sensitive Plants

Federal Endangered Species:
Butte County meadowfoam (*Limnanthes floccosa* ssp. *californica*) (FE)

State Endangered Species :
Boggs Lake hegde-hyssop (*Gratiola heterosepala*)
Butte County meadowfoam (*Limnanthes floccosa* ssp. *californica*) (FE)
Hairy Orcutt grass (*Orcuttia pilosa*) (FE)
Slender Orcutt grass (*Orcuttia tenuis*) (FT)

State Rare Species:
Greene's tuctoria (*Tuctoria greenei*) (FE)

Federal Proposed Threatened Species:
Hoover's spurge (*Chamaesyce hooveri*) (FT)

Federal Category 1 Species:
Ahart's dwarf rush (*Juncus leiospermus* var. *ahartii*) (SC)

Federal Category 2 Species:
Henderson's bent grass (*Agrostis hendersonii*) (SC*)
Legenere (*Legenere limosa*) (SC)
Ahart's paronychia (*Paronychia ahartii)* (SC)
Sanford's arrowhead (*Sagittaria sanfordii*) (SC)

CNPS List 1B Species:
Red Bluff dwarf rush (*Juncus leiospermus* var. *leiospermus*)

CNPS List 2 Species:
Dwarf downingia (*Downingia pusilla*)

CNPS List 3 Species:
Douglas' pogogyne (*Pogogyne douglasii* ssp. *parviflora*)

Sensitive Animals

Federal Endangered Species:
Conservancy fairy shrimp (*Branchinecta conservatio*)
Vernal pool tadpole shrimp (*Lepidurus packardi*)

Federal Threatened Species:
Vernal pool fairy shrimp (*Branchinecta lynchi)*

Federal Category 1 Species:
California tiger salamander (*Ambystoma californiense*) (CSC)

Federal Category 3c:
California linderiella (*Linderiella occidentalis*)

Table 4. Information Summary for the Northeastern Sacramento Valley Vernal Pool Region.

Northeastern Sacramento Valley					
VERNAL POOL TYPE	VIABILITY (H, M, L)	RESTORATION OPPORTUNITY (H, M, L)	PROTECTED AREAS (Total Acres) or (H, M, L)	SENSITIVE PLANTS (No. of spp.)	SENSITIVE ANIMALS (No. of spp.)
Northern Hardpan	M	M	L	15	5
Northern Basalt Flow	M	H	L		
Northern Volcanic Mudflow	M	H	L		

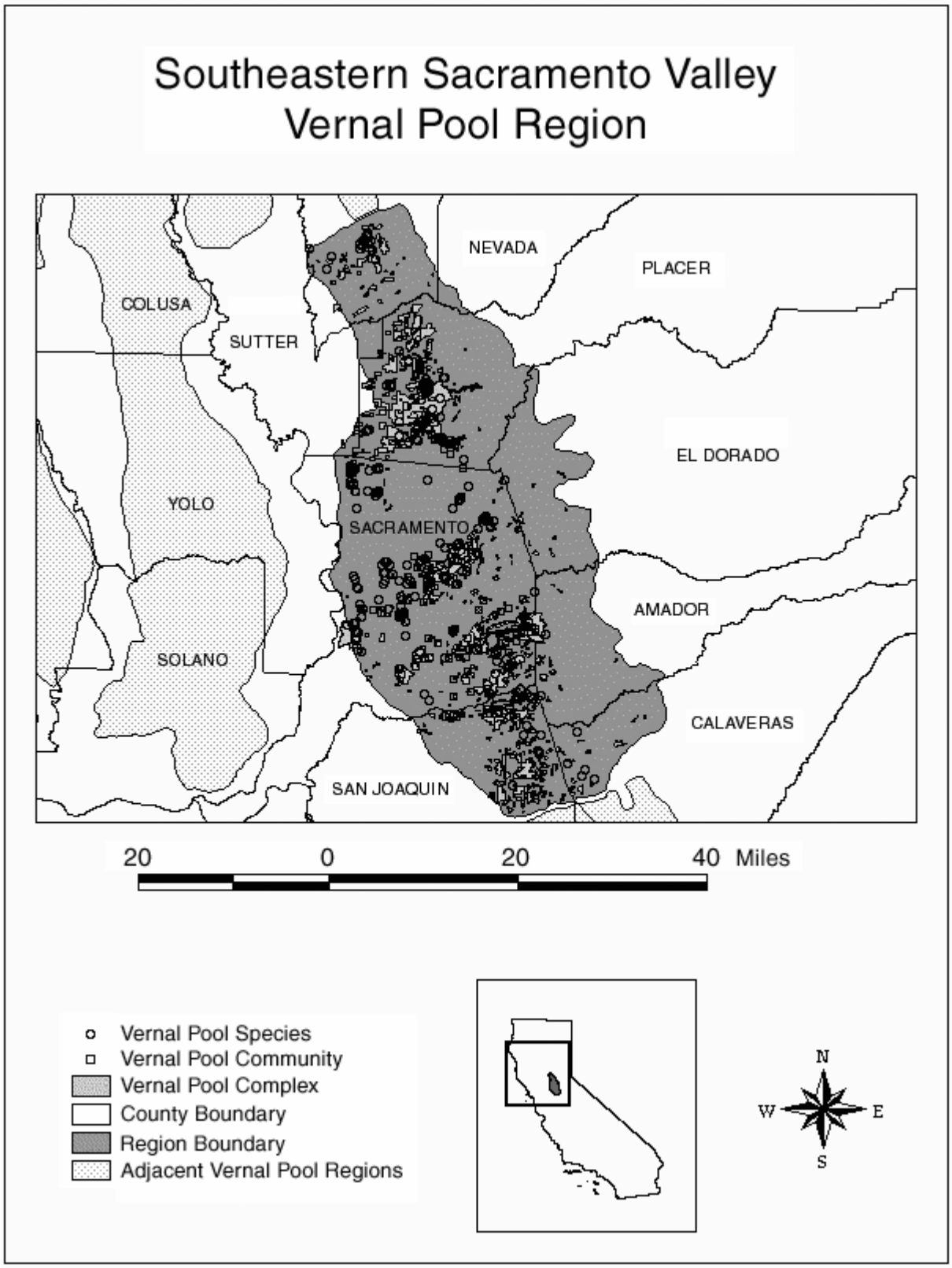

Figure 6. Map of the Southeastern Sacramento Valley Vernal Pool Region

Southeastern Sacramento Valley Region

Region Defined

The Southeastern Sacramento Valley Vernal Pool Region is centered on the foothill zone of the Northern Sierra Nevada Province and the adjacent Northern Sacramento Valley Province. It ranges from Beale Air Force Base in southern Yuba County, south through Placer and Sacramento counties to the Calaveras River and New Hogan Reservoir in northern Calaveras County. This area is one of the best known vernal pool regions in the state.

Although a great deal of study and inventory work on vernal pool resources has been conducted here, the division between this area and the adjacent Southern Sierra Nevada Foothills Region is not clearly defined. Recent mapping of vernal pool habitat by consultants using soils information suggests that the foothill belt of pools, located from Sacramento south to Merced County, is largely continuous. However, floristic information suggests that there is some merit to the differentiation between the northern and southern Sierra foothill vernal pool zones. For example, several species such as Ahart's dwarf rush (*Juncus leiospermus* var. *ahartii*), slender Orcutt grass (*Orcuttia tenuis*), and Sacramento Orcutt grass (*Orcuttia viscida*) are restricted to the northern pool zones and do not inhabit the Southern Sierra Foothill Region.

Although the dividing line has varied somewhat, management and assessment of the two areas has been conducted separately due to the division of northern and southern Sierra and northern and southern Great Valley regions by several agencies and bioregional assessment teams. The division of the regions in this report should be regarded as provisional and subject to change based on further ecological information.

Pool Types

Northern Hardpan and Northern Volcanic Mudflow pools are known from the area. Northern Claypan pools in the vicinity are more properly assigned to the adjacent San Joaquin Valley or Solano-Colusa vernal pool regions.

Pool Descriptions

The most extensive pools in the region are Northern Hardpan. In Sacramento County alone they are estimated to occupy 51,500 acres of pool/matrix (pool and intervening upland habitat) with tens of thousands of pools known to exist. Seventy seven of the 139 occurrences in the entire state for Northern Hardpan Vernal Pools (generally analogous to complexes) in the NDDB are in this region. Numerous small pools and swales in mounded topography make up most of the habitat. Soil types for these complexes include Pentz-Pardee-Red Bluff, San Joaquin, San Joaquin-Alamo, and Redding-Corning. Pools in the vicinity of Beale Air Force Base are not comprehensively inventoried in the NDDB although extensive field survey work by The Nature Conservancy has been completed recently.

The Northern Volcanic Mudflow pools are located on volcanic substrate. In this region they are largely tied to the Mehrten Formation where they occur on Exchequer soils. Virtually all of the area's mudflow pools occur in Placer County. Five occurrences of these pool types are noted in the NDDB for the region. Acreage listed in the NDDB is about 1400 including non-pool matrix (intervening upland habitat). More recent detailed mapping by Region 2 of Department of Fish and Game and US Fish and Wildlife Service shows only 1918 acres of vernal pools remain on the Mehrten Formation, none of which are in designated preserves.

Viability

Many of the pools in this region are threatened by development and conversion of grazing land to vinyards (approximately 10,000 acre during 1996-1997 fide T Roscoe pers. comm). Some avoidance mitigation has been undertaken, but the "postage-stamp reserves" surrounded by incompatible land use may not support long-term ecosystem function. The long term viability of these preserves is compromised by their small size, proximity to development, alterations in hydrology, and isolated location. The most seriously reduced and threatened pool types in the region are the volcanic mudflow pools with only a handful remaining. Nearly all of the mudflow pools have development proposed (65% or 3500 acres of the remaining 5410 acres of mudflow pools are slated for development an in land use entitlements) or approved with less than 1% preserved (J. Horenstein pers. Comm. 1997). Current distribution of the volcanic mudflow pools not in land use entitlements suggests 900 acres (about half of all acres available for conservation in the region) is on one property between Lincoln and Roseville. Another 500 acres occurs in a nearly continuous block in the Roseville city limits. Total area of pools protected is not available. However, large areas of hardpan pools on private ranch land in the southeast part of the region remain in relatively good condition and are the best chance for large preserves.

Restoration Opportunities

Large sums of money have been spent on restoration and creation of pools in this region. Creation of habitat is typically done in concert with the inoculation seed and egg banks from existing disturbed pools. Soils, plants, and animal eggs are taken from the destroyed pools and are used to help create new vernal pool habitat. Results of creation attempts reported by USFWS and other agencies have been generally inconclusive or negative due to limited duration of monitoring and lack of baseline data from "donor" sites**.** The greatest opportunities for successful restoration exist in the larger, less disturbed pool complexes southeast of Sacramento. There the principal impacts have been due to long-term intensive grazing which has had only a light to moderate effect on pool type habitat.

Protected Areas

The largest protected area of vernal pools in the region includes the recently acquired Valensin Ranch in the Cosumnes River drainage (through joint action of the Wildlife

Conservation Board and The Nature Conservancy). The actual acreage of pools is undetermined at this time. The Phoenix Field Park (14 acres of pools within a 60 acre park; Fair Oaks Recreation and Parks District) and Ecological Reserve (8 acres managed by DFG) preserves a small island of the hardpan pools which are surrounded by suburban development. Beale Air Force Base offers some protection to its pools, and McClellan AFB has a portion of its vernal pool lands (ca 15 acres) set aside for conservation). The Nature Conservancy has some minor vernal pools in its Cosumnes River Reserve. Some of the Sacramento County pools are privately owned by ranches and corporations that are party to conservation agreements for the pools and their rare species. There are currently three large wetland mitigation banks which contain vernal pool habitat: Wildlands Inc. (Placer County), the Sacramento County Vernal Pool Bank (south of Mather Field), and Laguna Creek Bank (south east Sacramento County). There are no protected areas for volcanic mudflow pools.

Sensitive Plants

State Endangered Species:
- Boggs Lake hedge-hyssop (*Gratiola heterosepala*)
- Slender Orcutt grass (*Orcuttia tenuis*) (FT)
- Sacramento Orcutt grass (*Orcuttia viscida*) (FE)

Federal Category 1 Species:
- Ahart's dwarf rush (*Juncus leiospermus* var. *ahartii*) (SC)

Federal Category 2 Species:
- Henderson's bent grass (*Agrostis hendersonii*) possibly extirpated from the region. (SC*)
- Legenere (*Legenere limosa*) (SC)
- Sanford's arrowhead (*Sagittaria sanfordii*) (SC)

CNPS List 1B Species:
- Pincushion navarretia (*Navarretia myersii* ssp. *myersii*)

CNPS List 2 Species:
- Dwarf downingia (*Downingia pusilla*)

Sensitive Animals

Federal Endangered Species:
- Conservancy fairy shrimp (*Branchinecta conservatio*)
- Vernal pool tadpole shrimp (*Lepidurus packardi*)

Federal Threatened Species:
- Vernal pool fairy shrimp (*Branchinecta lynchi)*

Federal Category 1 Species:
- California tiger salamander (*Ambystoma californiense*) (CSC)

Federal Category 2 Species:
- Western spadefoot toad (*Scaphiopus hammondii*) (CSC)

Federal Category 3c:
California Linderiella (*Linderiella oocidentalis*)

The "Mid-Valley Fairy Shrimp" ("*Branchinecta mesovalliensis*") has not been formally described but has been considered as a rare endemic to this area.

Table 5. Information Summary for the Southeastern Sacramento Valley Vernal Pool Region.

Southeastern Sacramento Valley					
VERNAL POOL TYPE	VIABILITY (H, M, L)	RESTORATION OPPORTUNITY (H, M, L)	PROTECTED AREAS (Total Acres) or (H, M, L)	SENSITIVE PLANTS (No. of spp.)	SENSITIVE ANIMALS (No. of spp.)
Northern Hardpan	M	M	L	9	6
Northern Volcanic Mudflow	M	M	L		

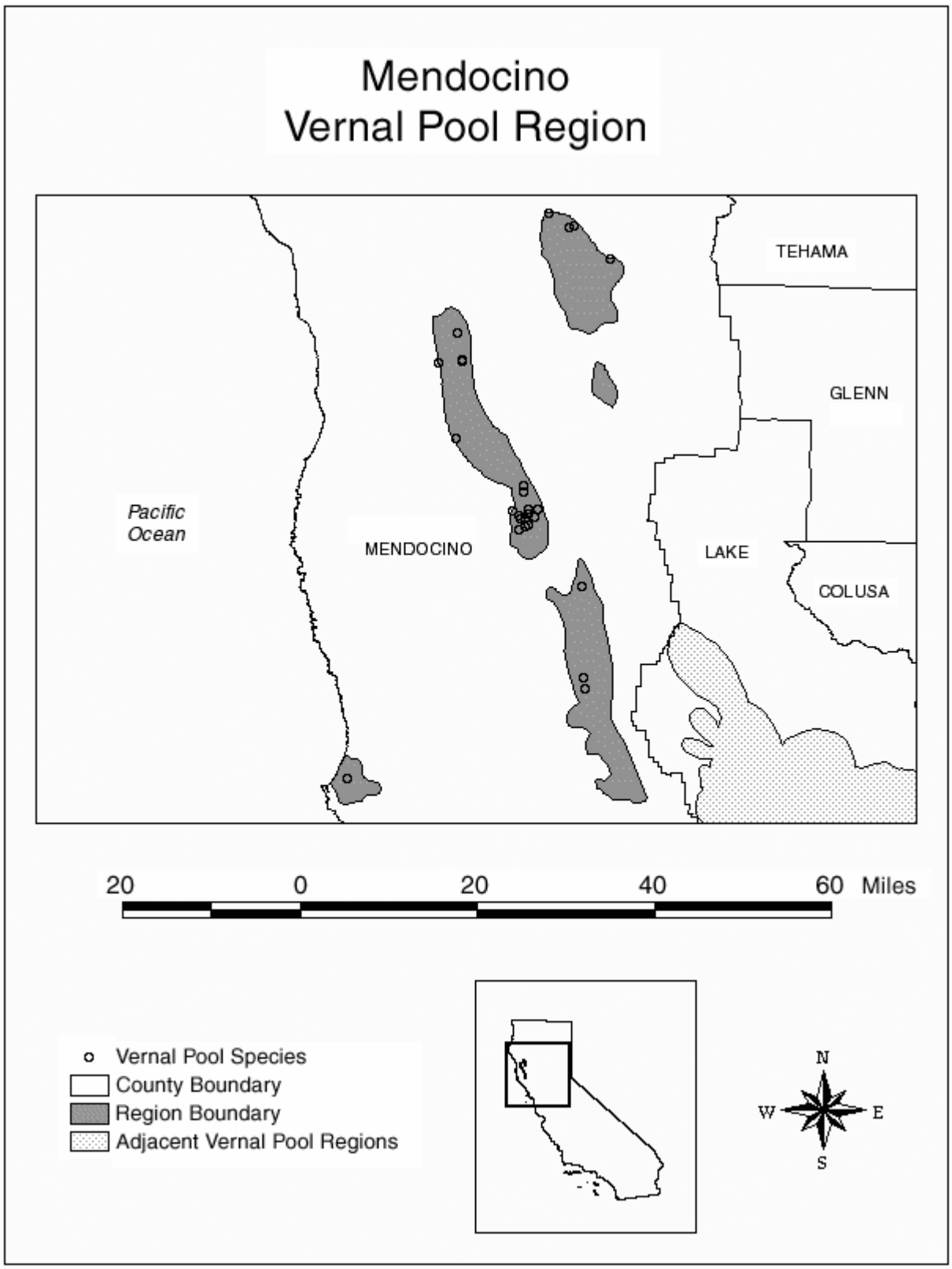

Figure 7. Map of the Mendocino Vernal Pool Region

Mendocino Region

Region Defined

The Mendocino Vernal Pool Region occupies the northwestern coastal portion of the state and is entirely within Mendocino County. It is one of the most poorly known of the vernal pool regions. The scattered reports of pools in this area suggest that they are largely restricted to structural valleys in the middle North Coast Ranges, such as in the areas around Laytonville, Willits, Longvale, and Ukiah and in Round and Eden valleys, with large areas of intervening inhospitable terrain. However, pools also exist along the coastal terrace near Manchester. Most of the pools occur on alluvial soils derived from sedimentary and metasedimentary rocks although those at Eden Valley are on serpentine soils. These pools have much in common with some of those in the Lake-Napa Region but are distinguished by the presence of the Mendocino County endemic Baker's meadowfoam (*Limnanthes bakeri*). This vernal pool region receives more rainfall on average than any other. Isolated reports of certain vernal pool invertebrates (fide R. Hill pers. comm. 1996) as far north as Humboldt and Del Norte counties suggest that other vernal pools exist in the north Coastal area. Further research may extend this region northward.

Pool Types

The pools of this region are not classified (generally known as Northern Vernal Pools).

Pool Descriptions

The few pools known are variously described as "wet depressions and seasonal wetlands." All occurrences from the NDDB are based on plant species records with little associated ecological information. Descriptions from the University of California Hopland Field Station (A. Merilander, pers. comm. 1997) suggest isolated structural or landslide origin pools, generally small, some of which are shaded and their chemistry and nutrient levels affected by overhanging oaks (*Quercus lobata*). Acreage of pools in the region is not available. Clearly, more information is needed.

Viability

The pool sites at Ukiah and Laytonville are threatened by discing and other agricultural practices.

Restoration Opportunities

It is likely that some of the locales in agricultural land could be restored. At least one species, Contra Costa goldfields (*Lasthenia conjugens*), has been extirpated from vernal pools of Mendocino County. Restoration and reintroduction may be a possibility.

Protected Areas

Very little vernal pool acreage is known to be protected in this region. The only known protection is at the University of California Hopland Field Station (about 20 individual pools have been inventoried), and a private nature reserve in the Laytonville area which contains a few small pools.

Sensitive Plants

Federal Endangered Species:
Burke's goldfields (*Lasthenia burkei*) (FE)

State Endangered Species:
Burke's goldfields (*Lasthenia burkei*) (FE)

State Rare Species:
Baker's meadowfoam (*Limnanthes bakeri*) (SC)
North Coast semaphore grass (*Pleuropogon hooverianus*) (SC)

Federal Category 1 Species:
Contra Costa goldfields (*Lasthenia conjugens*) now extirpated from Mendocino County. (FPE)

CNPS List 1B Species:
Baker's navarretia (*Navarretia leucocephala* ssp. *bakeri*)

CNPS List 3 Species:
Douglas' pogogyne (*Pogogyne douglasii* ssp. *parviflora*)

Sensitive Animals

Federal Category 3c:
California Linderiella (*Linderiella occidentalis*)

Table 6. Information Summary for the Mendocino Vernal Pool Region.

Mendocino					
VERNAL POOL TYPE	VIABILITY (H, M, L)	RESTORATION OPPORTUNITY (H, M, L)	PROTECTED AREAS (Total Acres) or (H, M, L)	SENSITIVE PLANTS (No. of spp.)	SENSITIVE ANIMALS (No. of spp.)
Northern Vernal Pool	M	M	L	7	1

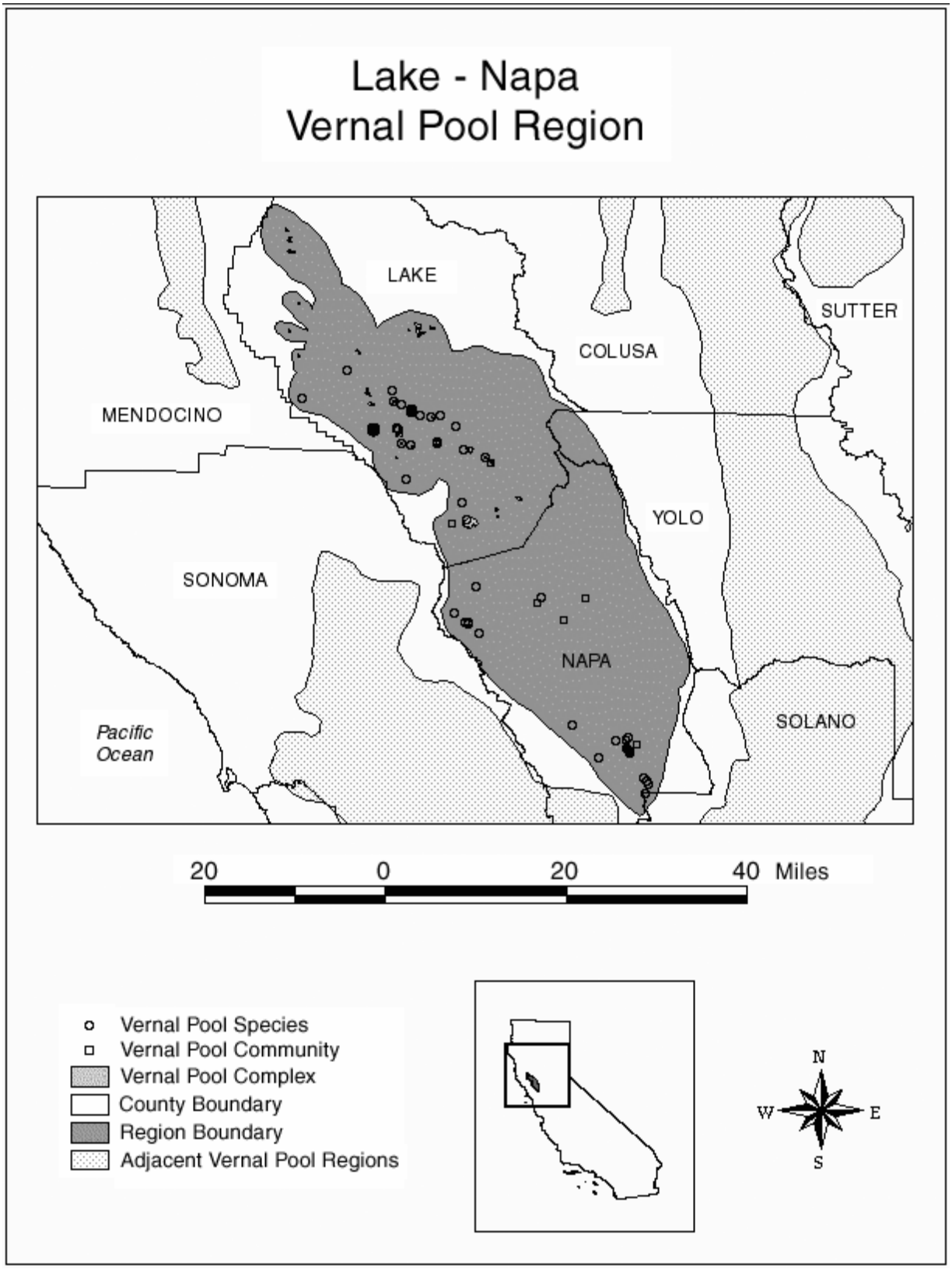

Figure 8. Map of the Lake - Napa Vernal Pool Region

Lake-Napa Region

Region Defined

The Lake-Napa Vernal Pool Region lies in the inner coast ranges north of the San Francisco Bay and south of Clear Lake. It occupies structural valleys such as Napa and Pope and valleys near Lower Lake, Clear Lake Highlands, and Middletown. Geologically it is a mixture of marine sedimentary and extrusive igneous rock. However, it is characterized by the volcanic highlands ranging from the vicinity of Atlas Peak north to Mt. Konocti where an endemic vernal pool community, the Northern Volcanic Ashflow exists. Loch Lomond and Boggs Lake are two well known locations of this community. Also characteristic of the area are four rare, endemic vernal pool plants: Calistoga popcornflower (*Plagiobothrys strictus*), Loch Lomond button-celery (*Eryngium constancei*), many flowered navarretia *(Navarretia leucocephala* ssp. *plieantha*) and few-flowered navarretia (*Navarretia leucocephala* ssp. *pauciflora*).

Pool Types

The region includes Northern Volcanic Ash Flow (so far as is known, endemic to this region), Northern Basalt Flow, and unclassified "Northern Vernal Pool" types. Some occur on serpentine soils.

Pool Descriptions

The endemic Northern Ash Flow pools are typically large (Boggs Lake is over 120 acres) and occupy single basins surrounded by coniferous forest. They are underlain by deep volcanic ash flows with most soils described as Oxalis variant silt loams. The pools at Boggs Lake and Loch Lomond do not dry completely in average or above average rainfall years. Thus, the vernal pool flora occupies the margins and isolated subsidiary pools while freshwater marsh species inhabit the deeper portions of the main pools.

Pools located at Steinhart Lake are classified as Northern Basalt Flow pools. They dry in most years, and vernal pool plants cover the entire bed. Soils associated with them are Konocti variant**s** (although actual soils underlying pools are probably different than the surrounding matrix but not mapped).

Pools in the southern portion of the region in Napa County are variable (Northern Vernal Pools in the broad sense). Those at Pope Valley are relatively small and underlain by a variety of soils including Contra Costa loams, Bressa-Dibble complex soils, and soils derived from serpentine. These may be surrounded by Valley Oak and Blue Oak woodland or by Serpentine Chaparral. Some pools occur near Atlas Peak on Aiken loam (derived from Rhyolite lava) and are surrounded by Chamise Chaparral.

Pools in the southernmost portion of the region (e.g., Suscol Creek near Napa) may occur as complexes of 20 or more individual pools scattered over a small area of nearly flat or rolling terrain derived from volcanic rock. There are also pools associated with hot springs near Calistoga. These have a different flora, soil, and water chemistry than other pools described for the region. They are the only known locations for the Calistoga popcornflower (*Plagiobothrys strictus*). Acreage of various pool types in the region is not available. (J. Ruygt pers. comm. 1996) estimates the number of acres of pool habitat (including surrounding uplands) from the 8 main sites in Napa County at 98 acres.

Viability

Although two of the Northern Ash Flow Vernal Pool sites are in reserves, several other high quality sites remain unprotected and are threatened by long-term intensive grazing, draining, deepening, and erosion. The best remaining pools in the Napa Valley are threatened by agriculture and development (Suscol Ridge). Road building, dumping, human-caused erosion, and long-term intensive grazing threaten several other pool areas in the region. The most viable unprotected sites are probably on private land near Pope Valley.

Restoration Opportunities

Although many former vernal pool areas have been lost in parts of the region due to agriculture and development, restoration of several remaining areas is possible. Grazing monitoring, with reduction or removal if appropriate, could be done at several sites. Mitigation planning at the Suscol Creek site and other areas on the Napa Valley could help preserve and restore pools there. Erosion control at Manning Flat may help restore ash flow pools there.

Protected Areas

Several small protected areas include vernal pools and vernal pool species. Some, such as Loch Lomond Ecological Reserve (less than 10 acres, DFG) and Boggs Lake Preserve (120 acres, The Nature Conservancy), have been established specifically for the vernal pools and are managed accordingly. Others, such as Wantrup Wildlife Refuge (private) and Napa River Ecological Reserve (DFG), contain natural values in addition to vernal pools and are managed for these as well. Mead Ranch, a privately owned parcel, protects the largest remaining vernal pools in Napa County through a Napa Land Trust conservation easement (J. Ruygt, pers. comm. 1995). Despite the area's reserves, there is a need for further protection of rare species associated with vernal pools that are not in the established reserves.

Sensitive Plants

Federal Endangered Species:

Loch Lomond button-celery (*Eryngium constancei*) (FE)
Burke's goldfields (*Lasthenia burkei*) (FE)
Sebastopol meadowfoam (*Limnanthes vinculans*) may have been introduced in this region. (FE)

State Endangered Species:
Loch Lomond button-celery (*Eryngium constancei*) (FE)
Boggs Lake hedge-hyssop (*Gratiola heterosepala*)
Burke's goldfields (*Lasthenia burkei*) (FE)
Sebastopol meadowfoam (*Limnanthes vinculans*) may be introduced in this region. (FE)
Many-flowered navarretia (*Navarretia leucocephala* ssp. *plieantha*) (FPE)
Napa blue grass (*Poa napensis*) (FPE)
Slender Orcutt grass (*Orcuttia tenuis*) (FT)
Lake County stonecrop (*Parvisedum leiocarpum)* (FPE)

State Threatened Species:
Few-flowered navarretia (*Navarretia leucocephala* ssp. *pauciflora*) (FPE)
Calistoga popcornflower (*Plagiobothrys strictus*) (FPE)

Federal Category 1 Species:
Contra Costa goldfields (*Lasthenia conjugens*) (FPE)

Federal Category 2 Species:
Bolander's horkelia (*Horkelia bolanderi*) (SC)
Legenere (*Legenere limosa*) (SC)

CNPS List 1B Species:
Alkali milkvetch (*Astragalus tener* var. *tener*) (SC)
Dwarf downingia (*Downingia pusilla*)
Baker's navarretia (*Navarretia leucocephala* ssp. *bakeri*)
Pincushion navarretia (*Navarretia myersii* ssp. *deminuta*)

CNPS List 3 Species:
Douglas' pogogyne (*Pogogyne douglasii* ssp. *parviflora*)

Sensitive Animals

No current status, but considered sensitive by NDDB:
California Linderiella (*Linderiella occidentalis*)

Table 7. Information Summary for the Lake-Napa Vernal Pool Region.

Lake-Napa					
VERNAL POOL TYPE	VIABILITY (H, M, L)	RESTORATION OPPORTUNITY (H, M, L)	PROTECTED AREAS (Total Acres) or (H, M, L)	SENSITIVE PLANTS (No. of spp.)	SENSITIVE ANIMALS (No. of spp.)
Northern Volcanic Ash Flow	M	H	125±	21	1
Northern Basalt Flow	M	H	L		
Northern Vernal Pool	M	M	L		

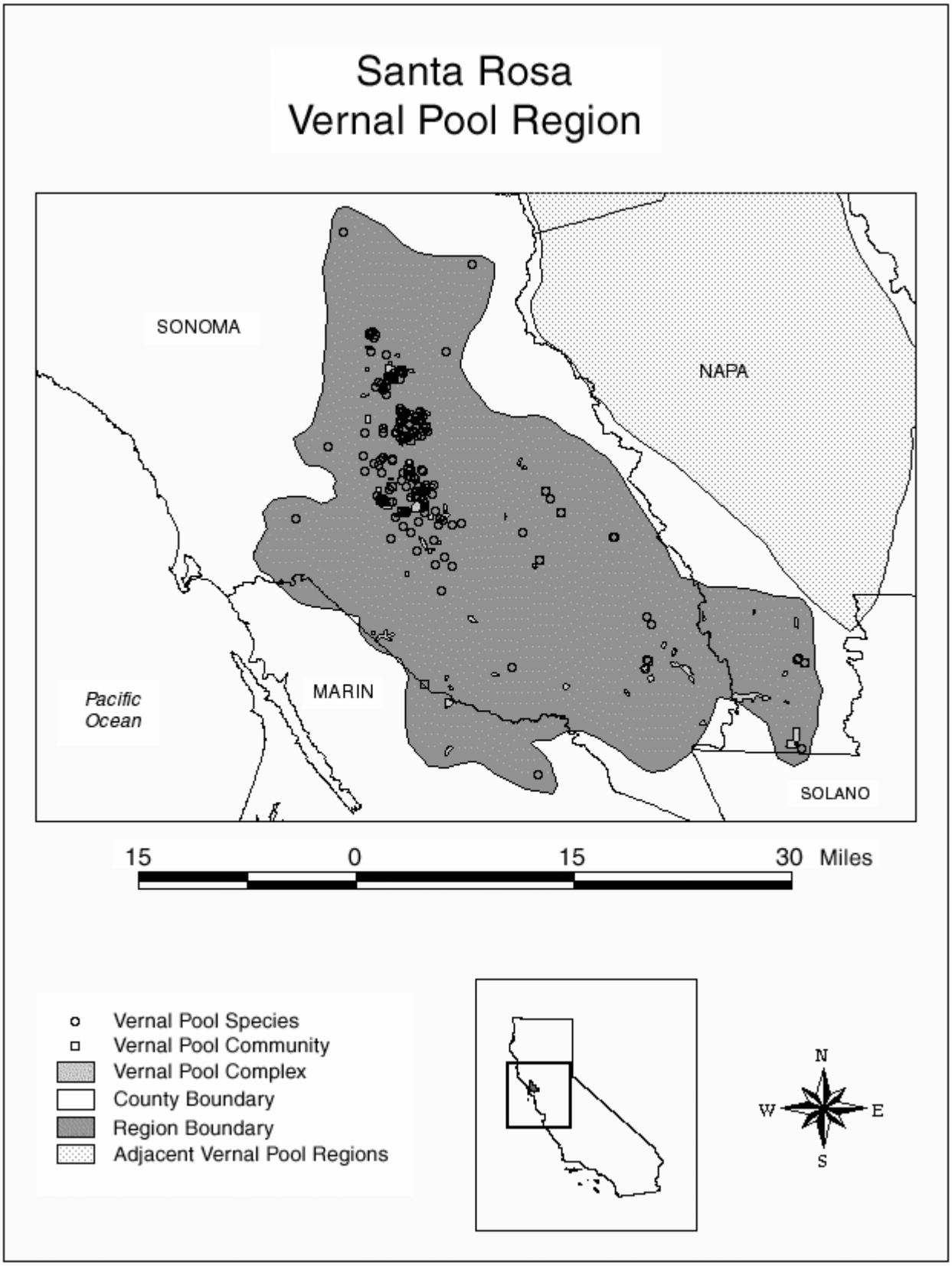

Figure 9. Map of the Santa Rosa Vernal Pool Region

Santa Rosa Region

Region Defined

The Santa Rosa Vernal Pool Region lies primarily in Sonoma County and is centered in the Santa Rosa Plain between the Russian River, Sebastapol, and the city of Santa Rosa. It ranges south to Petaluma, just edging into Marin County, and then extends eastward to the vicinity of Sonoma. This region includes the site of the recently developed Santa Rosa Plain Vernal Pool Ecosystem Preservation Plan. It is distinguished primarily by the localized occurrence of Burke's goldfields (*Lasthenia burkei*), Sonoma sunshine (*Blennosperma bakeri*), and Sebastapol meadowfoam (*Limnanthes vinculans*), all State and Federal endangered plants endemic to Sonoma County. The region also includes pools outside of the Santa Rosa Plain in Annadel State Park and the Valley of the Moon area.

Pool Types

Northern Hardpan pools are noted in parts of Santa Rosa Plain. Unclassified pools called Northern Vernal Pools in the NDDB occur in much of the area. Pools in Annadel State Park resemble the Northern Volcanic Ash Flow type in soil type and pool size.

Pool Descriptions

The Santa Rosa Plain pools occur as remnants in a matrix of agriculture, development, and fragmented remains of Valley Oak Woodland, grassland, and persistent wetland vegetation. The remaining pools in western Santa Rosa Plains (Windsor area and some in Sonoma area) are largely tied to Huichica loam soils, strongly cemented old valley floor alluvial soils derived from mixed sedimentary, volcanic ash, or basic rock sources. These pool areas have a hummocky, mima mound micro topography with small swales and pools intermixed and are located on plains and terraces largely west and northwest of Santa Rosa. Pools in the vicinity of Laguna de Santa Rosa (near Sebastapol) and other parts of the southwestern Santa Rosa Plains are on Wright clay loams.

The few pools in the vicinity of Petaluma are large (Laguna Lake is up to 1 mile long and 0.5 mile wide) and occur on Clear Lake Clay soils. A large pool on Bennett Mountain is ecologically similar to Boggs Lake (Northern Volcanic Ash Flow Vernal Pool) and occurs on Pleasanton clay loam. Total acreage of pools in region is not available. Some vernal pool vegetation in the Cunningham Marsh area is on Blucher clay loam.

Viability

Housing development, agriculture, waste water irrigation, and long-term intensive livestock grazing have contributed to the decline and demise of most of the area's pools. In some cases pools spared in development projects in the Santa Rosa Plain area are declining in

viability as a result of being within "postage-stamp" reserves surrounded by homes. Altered hydrology due to lawn irrigation, increased refuse, and foot traffic has contributed to site quality reduction in some areas. Agriculture (including discing, vineyards, and orchards) has destroyed or damaged other vernal pool areas. Only a few moderately-sized viable vernal pool areas remain in the region. The floristic quality of the remaining pools has declined in some areas due to long-term intensive grazing.

Restoration Opportunities

Much of the original pool area in the Santa Rosa Plain has been destroyed either by intensive agriculture or by development. Other pool areas in Petaluma, Bennett Valley, and Valley of the Moon are heavily to moderately impacted by agriculture and long-term intensive grazing. The best restoration possibilities exist in grazed land with the largest extent of unaltered pool micro topography on Santa Rosa Plain. However, due to the highly fragmented nature of the pool landscape, the full range of pool variability will not be conserved in the most easily restored areas and some more difficult restoration challenges should be undertaken.

Protected Areas

The DFG Todd Road Reserve contains 75 acres of vernal pools and associated uplands. A portion of the Carinalli Property near Laguna de Santa Rosa (150 acres) and a recent acquisition of an adjacent 75 acres both contain some vernal pool habitat and have been acquired under the Santa Rosa Plain Vernal Pool Ecosystem Preservation Plan. Annadel State Park contains a pool at Ledson Marsh.

Sensitive Plants

Federal Endangered Species:
- Sonoma sunshine (*Blennosperma bakeri*) (FE)
- Burke's goldfields (*Lasthenia burkei*) (FE)
- Sebastapol meadowfoam (*Limnanthes vinculans*) (FE)

State Endangered Species:
- Sonoma sunshine (*Blennosperma bakeri*) (FE)
- Burke's goldfields (*Lasthenia burkei*) (FE)
- Sebastapol meadowfoam (*Limnanthes vinculans*) (FE)
- Many-flowered navarretia (*Navarretia leucocephala* ssp. *plieantha*) (FPE)

State Rare Species:
- North Coast semaphore grass (*Pleuropogon hooverianus*) (SC)

Federal Category 2 Species:
- Legenere (*Legenere limosa*) now extirpated from Sonoma County. (SC)

CNPS List 1B Species:
Alkali milkvetch (*Astragalus tener* var. *tener*) extirpated from the region. (SC)
Baker's navarretia (*Navarettia leucocephala* ssp. *bakeri*)

CNPS List 2 Species:
Dwarf downingia (*Downingia pusilla*)

CNPS List 3 Species:
Douglas' pogogyne (*Pogogyne douglasii* ssp. *parviflora*)

Sensitive Animals

Federal Category 1 Species:
California tiger salamander (*Ambystoma californiense*) (CSC)

No current status, but considered sensitive by NDDB:
California linderiella (*Linderiella occidentalis*)

Table 8. Information Summary for the Santa Rosa Vernal Pool Region.

Santa Rosa					
VERNAL POOL TYPE	VIABILITY (H, M, L)	RESTORATION OPPORTUNITY (H, M, L)	PROTECTED AREAS (Total Acres) or (H, M, L)	SENSITIVE PLANTS (No. of spp.)	SENSITIVE ANIMALS (No. of spp.)
Northern Vernal Pool	M	M	M	13	2
Northern Hardpan	L	M	M		

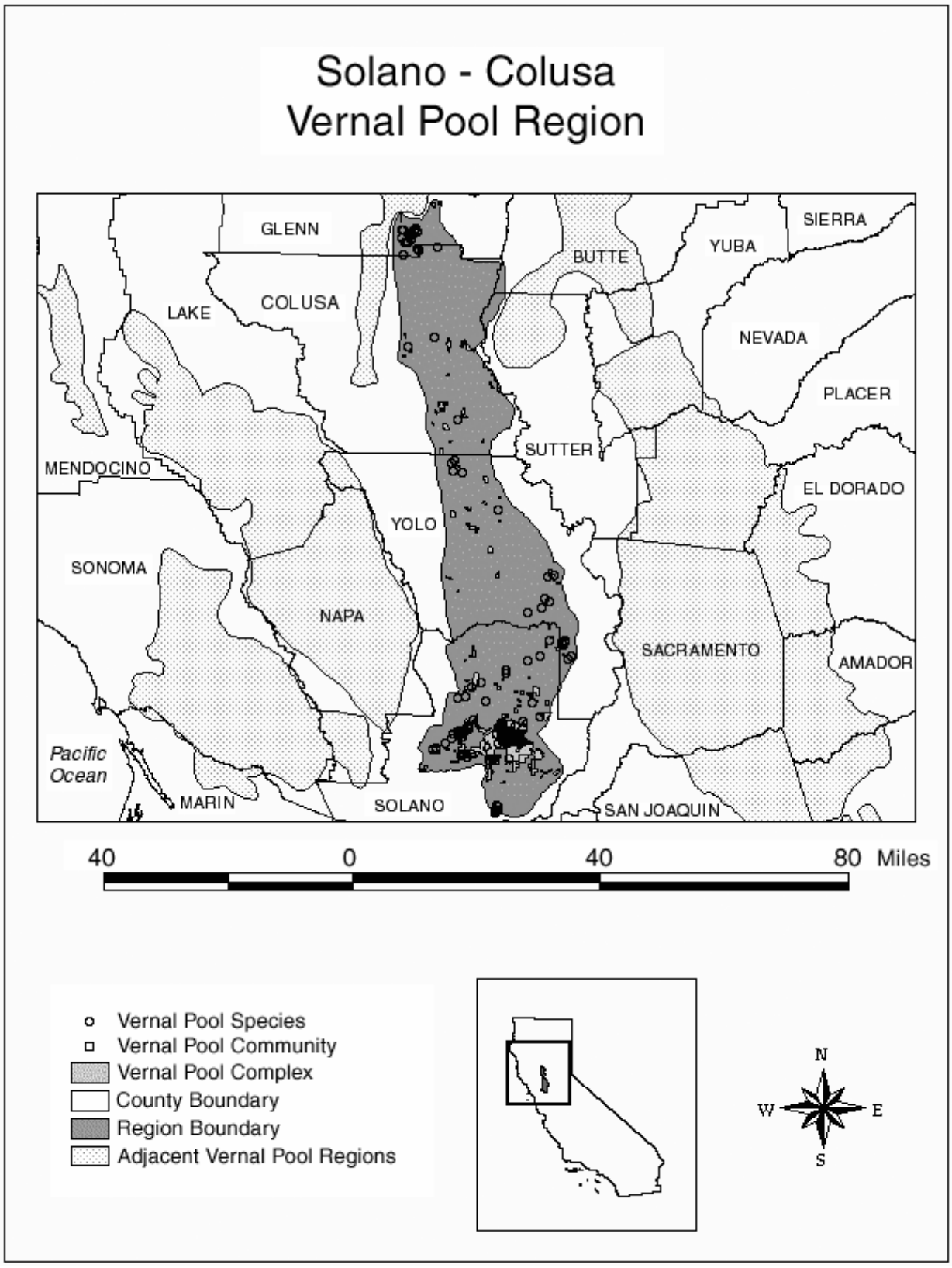

Figure 10. Map of the Solano - Colusa Vernal Pool Region

Solano-Colusa Region

Region Defined

The Solano-Colusa Vernal Pool Region is a relatively large area covering the majority of Solano County and ranging northward from the low lying plains adjacent to the Suisun Marsh and the Sacramento-San Joaquin Delta through the Colusa Basin of western Sacramento Valley to the vicinity of Princeton, Glenn County. It is best known for its excellent examples of Northern Claypan pools between Highway 113 and Travis Airforce Base. However, it also contains lesser examples of Northern Hardpan pools near Vacaville and claypan alkaline pools with several threatened taxa occur in the National Wildlife refuges of Glenn and Colusa Counties. This is the only known region to contain the Federal threatened Delta green ground beetle and the grass *Tuctoria mucronata*, both serve to distinguish it biologically from any other region. Due to its alkaline soils and low lying valley basin topography it shares many species with its southern Great Valley analog, the San Joaquin Valley Vernal Pool Region.

Pool Types

The region includes Northern Claypan and Northern Hardpan vernal pools.

Pool Descriptions

Northern Claypan Vernal Pools are the predominant type in the area. These pools are typically alkaline and may display whitish salt deposits in non-vegetated centers of dry pools. These pools are up to several acres in size and may occur singly or in small aggregations. The pools are often in combinations of small playa-like pools and hogwallow depressions. The few hardpan pools in the region occupy hogwallow topography in such areas as between Interstate 505 and 5 just north of Vacaville. Both pool types occur on deep alluvial soils. Soils underlying most of the claypan pools in the vicinity of Travis AFB, and Jepson Prairie are Pescadero Clay Loam or Sycamore series. The low-lying claypan pools of Glenn and adjacent Colusa counties occur on several soil series, the principal one being Willows but also probably including Riz and other series. These pools are clearly alkaline and have species such as *Atriplex persistens, Frankenia, Cressa*, and other salt-tolerant species associated with them. They are often larger than the hardpan type and may resemble small alkali playas with whitish salts visible at the surface of the pool areas following drying. Inundation periods and moisture periods are of longer duration on the claypan pools than the hardpan pools. Current acreage for each type is not available.

Viability

Agricultural practices, water diversion and impounding for waterfowl enhancement, development, and road-building have taken their toll on the Solano vernal pools. There are relatively few remaining viable sites in the region; some of these are within protected (or restricted use, e.g., DOD) lands. The Solano County Farmland and Open Space Foundation

(TNC recently transferred title to S.C.F &O.S.F) and the Department of Fish and Game manage adjacent reserves to protect portions of the Northern Claypan type (totaling approximately 2300 acres). The remaining Northern Hardpan types are threatened due to development of industrial parks and residential communities.

Restoration Opportunities

Much of the region's pool areas has been converted to agriculture or covered with housing developments. Restoration of some of the less intensely altered agricultural lands (including old rice fields) may be possible. The best restoration chances are with land where the primary impact has been over-grazing. Acreage of soil series available for restoration (minus developed and heavily altered agricultural land) is not available.

Protected Areas

The Solano County Farmland and Open Space Foundation's Jepson Prairie Preserve contains some of the best remaining examples of the claypan pools in the region including populations of the two endemic species to the region. The Calhoun Cut Ecological Area (DFG) also contains some claypan pools. Some protection is afforded to pools on DOD (Air Force) land south of Davis. 160 acres of vernal pool/grassland complex east of Travis Air Force Base was purchased for preservation by Chevron Corporation as part of mitigation for a project impacting pools near the interchange of Highways 505 and 80. The city of Woodland has agreed (with The Nature Conservancy) to protect some rare plant populations although these are not good vernal pool sites (old rice fields). There is much potential for further protection through easement and acquisition in the vernal pool/grassland area south of Dixon. Virtually all of the remaining of the claypan pools and transitions to alkali marsh in the northern portion of the region are managed for their ephemeral wetland value at Sacramento, Delevan and Colusa National Wildlife Refuges (approx. 140 acres of actual pools). The USFWS has identified some additional alkaline vernal pool lands (about 200 acres including surrounding uplands) on the west side of the Sacramento River (Amaral Property) near Graylodge Wildlife Area (DFG). These may be included in a mitigation banking zone (fide D. Meade 1997).

Sensitive Plants

Federal Endangered Species:
Crampton's tuctoria (*Tuctoria mucronata*) (FE)

State Endangered Species:
Boggs Lake hedge-hyssop (*Gratiola heterosepala*)
Colusa grass (*Neostapfia colusana*) (FT)
Crampton's tuctoria (*Tuctoria mucronata*) (FE)

Federal Proposed Threatened Species:
Hoover's spurge (*Chamaesyce hooveri*) (FT)

Federal Category 1 Species:
Hairy Orcutt grass (*Orcuttia pilosa*) (FE)
Contra Costa goldfields (*Lasthenia conjugens*) (FPE)

Federal Category 2 Species:
San Joaquin spearscale (*Atriplex joaquiniana*) (SC)
Legenere (*Legenere limosa*) (SC)

CNPS List 1B Species:
Alkali milkvetch (*Astragalus tener* var. *tener*) (SC)
Vernal pool saltbush (*Atriplex persistens*) (SC)
Heartscale *(Atriplex cordulata)*
Brittlescale *(Atriplex depressa)*
Heckard's pepper-grass (*Lepidium latipes* var . *heckardii*)
Baker's navarretia (*Navarretia leucocephala* ssp. *bakeri*)

CNPS List 2 Species*:*
Dwarf downingia (*Downingia pusilla*)

Sensitive Animals

Federal Endangered Species:
Conservancy fairy shrimp (*Branchinecta conservatio*)
Vernal pool tadpole shrimp (*Lepidurus packardi*)

Federal Threatened Species:
Vernal pool fairy shrimp (*Branchinecta lynchi*)
Delta green ground beetle (*Elaphrus viridis*)

Federal Category 1 Species:
California tiger salamander (*Ambystoma californiense*) (CSC)

Newly described restricted taxa:
A new subspecies of fairy shrimp (*Branchinecta coloradensis* ssp. nov) will be described from pools at Sacramento NWR (Belk and Rogers, pers. comm 1997).

Table 9. Information Summary for the Solano-Colusa Vernal Pool Region.

Solano-Colusa					
VERNAL POOL TYPE	VIABILITY (H, M, L)	RESTORATION OPPORTUNITY (H, M, L)	PROTECTED AREAS (Total Acres) or (H, M, L)	SENSITIVE PLANTS (No. of spp.)	SENSITIVE ANIMALS (No. of spp.)
Northern Claypan	M	M	M	16	7
Northern Hardpan	L	M	none known		

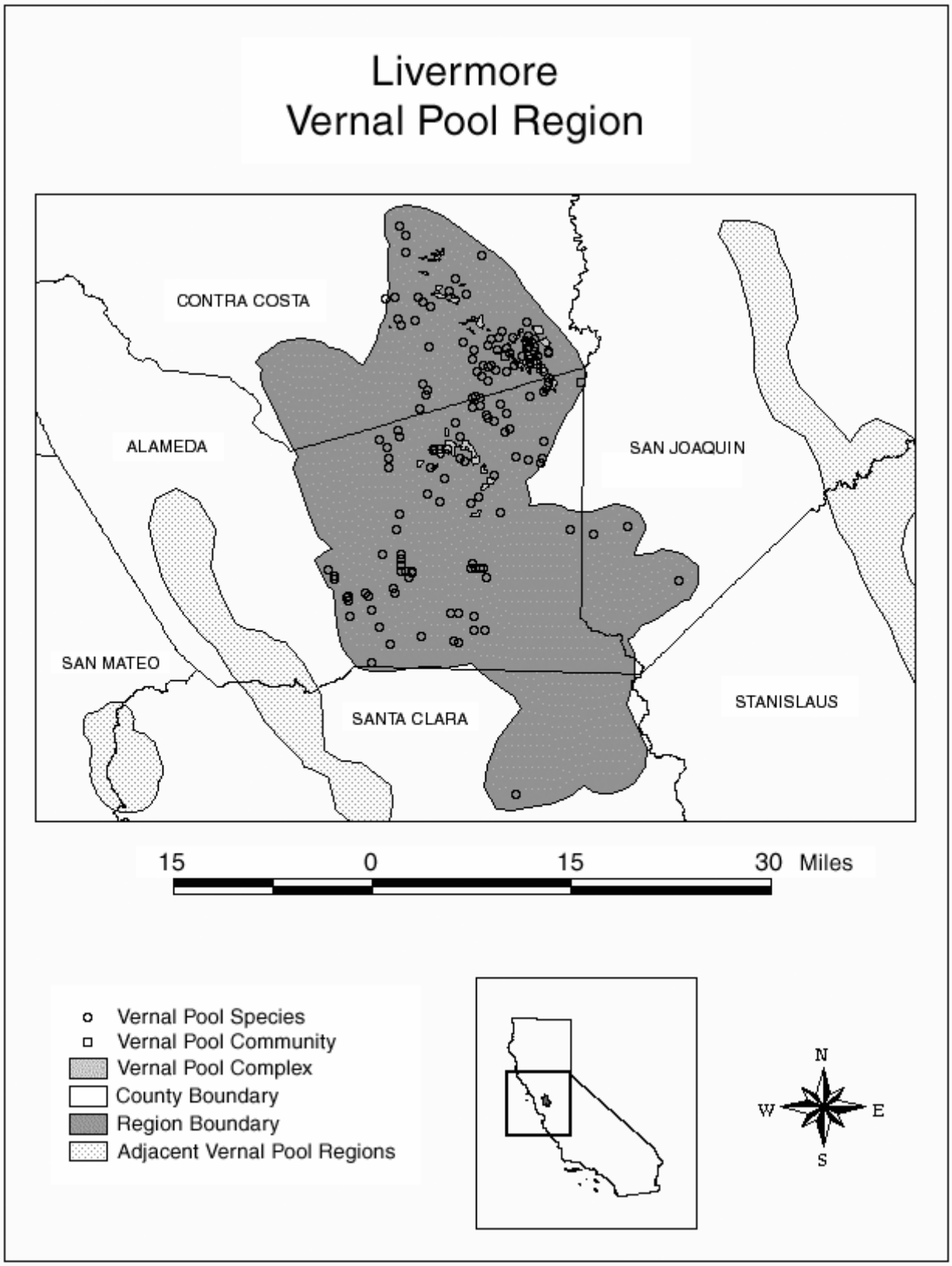

Figure 11. Map of the Livermore Vernal Pool Region

Livermore Region

Region Defined

The Livermore Vernal Pool Region is named for the Livermore Valley which occupies its central portion. It includes parts of eastern and southern Alameda County and parts of eastern Contra Costa County. It ranges south from the vicinity of Byron Hot Springs and west to the valleys of the Mount Hamilton Range. Although at one time vernal pools occupied a relatively large portion of the valley's area, their numbers are now greatly reduced. The best known remaining examples occur in the Springtown area, located in the northeastern Livermore Valley, and in the vicinity of the Byron airport. A few pools exist on the eastern base of the coast ranges east of Mt. Diablo, and some may occur in the structural valleys of the southern Diablo Range (no pool records, but pool species reported). Biotic relationships between the alkaline claypan pools of Byron and Springtown in this region and the adjacent San Joaquin Valley region are close. This region was established because it is geographically isolated from the San Joaquin region and because it does not contain any restricted Central Coast Region species. However, further research may show it more logical to merge this region with the San Joaquin and the Central Coast regions. So far as is known this is the only region that does not have any endemic indicator species.

Pool Types

The region includes Northern Claypan and perhaps some Northern Hardpan vernal pools.

Pool Descriptions

Northern Claypan Vernal Pools cover the largest portion of the area. These pools are typically alkaline and may display whitish salt deposits in non-vegetated centers of dry pools. The Byron pools are at the edge of the San Joaquin Delta less than a mile from sloughs located in the river floodplain. The pools at Springtown are formed from the overflow of Altamont Creek. These pools occur on level stream terraces and basin rims north and east of Livermore. Many are actually swales that hold water after the low-gradient intermittent creek has mostly dried. Soils underlying both the Springtown and Byron pools are Solano fine sandy loam described as being slightly to strongly alkaline with hogwallow micro relief. Some vernal pool animals live in rock-bound ephemeral pools. These are not vegetated with vernal pool plants and represent examples of tinajas not vernal pools. Some hardpan pools may remain on the eastern margin of the coast ranges. However, there are no confirmed reports. Inundation periods and moisture periods are of longer duration on claypan pools than on hardpan pools. Current total acreage for pools is not available.

Viability

Housing development, paving, agriculture, water diversions, degradation of water quality and long-term intensive grazing have contributed to the demise of most of the area's pools. Attempts at mitigation banking which would contribute to the local preservation of the Springtown pools (as a result of banking for the palmate-bracted bird's-beak, *Cordylanthus palmatus*) have been made, but none have been approved (B. Olson, pers. comm.). The Byron pools are affected by invasive non-native plants, OHV disturbance, and airport expansion. They occur adjacent to a small air strip. In general, the viability of the few pool areas in the region is low.

Restoration Opportunities

Due to the small proportion of available appropriate soil types, little restoration opportunity exists for the region.

Protected Areas

Other than the proposed mitigation bank alkali areas for Springtown and mitigation and management of pools at Byron Airport, no pool reserves are known for the region.

Sensitive Plants

Federal Endangered Species
Palmate-bracted bird's beak (*Cordylanthus palmatus*)

Federal Category 1 Species:
Contra Costa goldfields (*Lasthenia conjugens*) (FPE)
Congdon's tarplant (*Hemizonia parryi ssp. congdonii*) (SC)

CNPS List 1B Species:
Alkali milkvetch (*Astragalus tener* var. *tener*) (SC)
Heartscale *(Atriplex cordulata)*
Brittlescale *(Atriplex depressa)*
San Jaoquin spearscale *(Atriplex joaquiniana)* (SC)
Hispid bird's beak *(Cordylanthus mollis ssp. hispidus)*
Recurved larkspur (*Delphinium recurvatum*)

CNPS List 1A:
Hairless popcorn-flower (*Plagiobothrys glaber*)

CNPS List 3 Species*:*
Douglas' pogogyne *(Pogogyne douglasii* ssp. *parviflora)*
Little mousetail *(Myosurus minimus* ssp. *apus)* (SC)

Sensitive Animals

Federal Endangered Species:

Longhorn fairy shrimp (*Branchinecta longiantenna*) in this region known only from tinajas (rockbound pools).

Federal Threatened Species:

Vernal pool fairy shrimp (*Branchinecta lynchi*)

Federal Category 1 Species:

California tiger salamander (*Ambystoma californiense*) (CSC)

Table 10. Information Summary for the Livermore Vernal Pool Region.

Livermore					
VERNAL POOL TYPE	VIABILITY (H, M, L)	RESTORATION OPPORTUNITY (H, M, L)	PROTECTED AREAS (Total Acres) or (H, M, L)	SENSITIVE PLANTS (No. of spp.)	SENSITIVE ANIMALS (No. of spp.)
Northern Claypan	L	L	L	12	3
Northern Vernal Pool	M	M	none known		

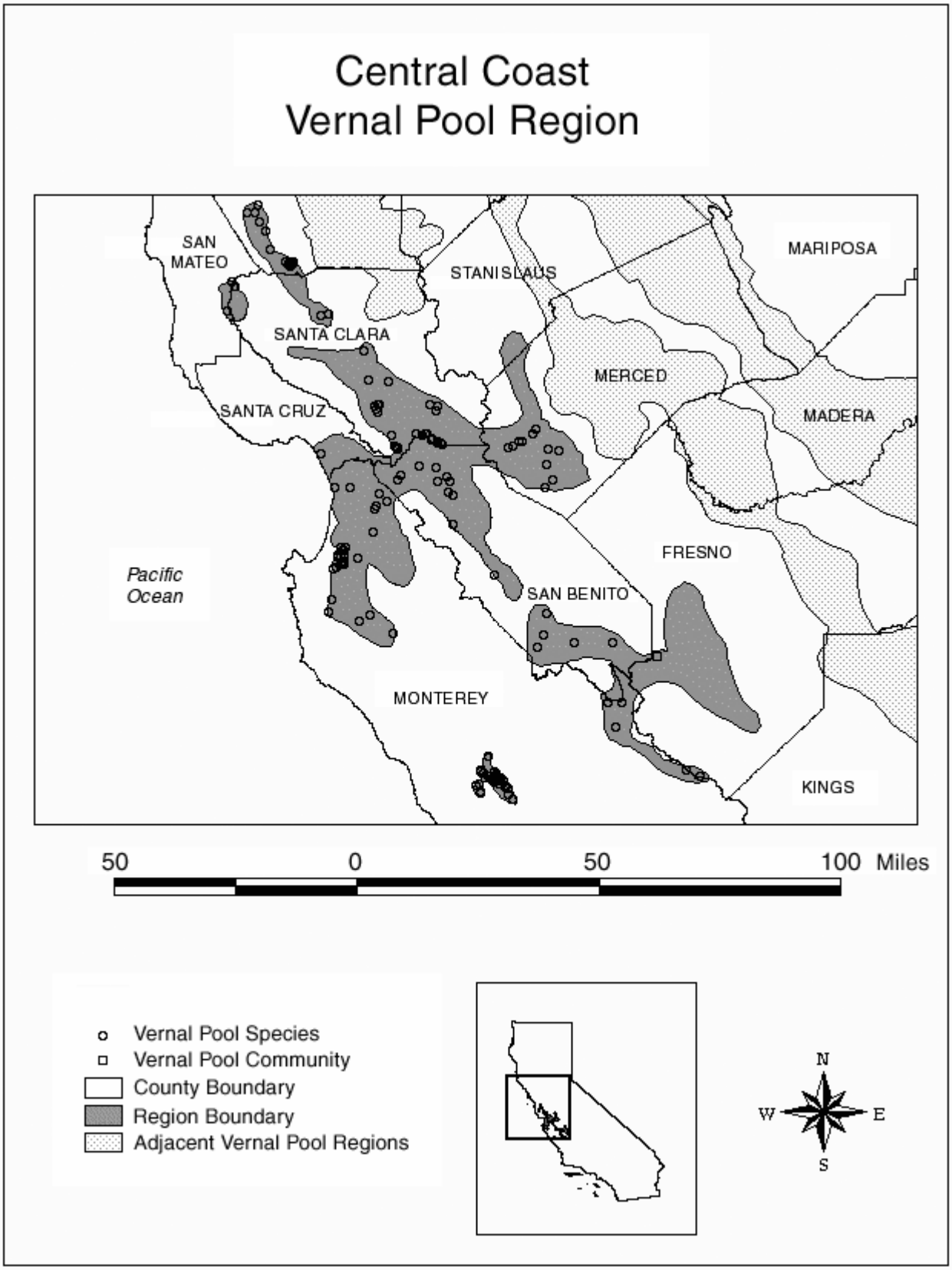

Figure 12. Map of the Central Coast Vernal Pool Region

Central Coast Region

Region Defined

The center of the Central Coast Vernal Pool Region is located in the Monterey Bay area. It extends northward to the Southern San Francisco Bay area and southward to the inner coastal range valleys of southern San Benito and San Luis Obispo County. The main distribution of this area extends from the coastal plain of southern Santa Cruz and northern Monterey counties inland to the upper Carmel River Valley and the vicinity of Hollister. This region lies entirely within the Coast Range Physiographic Province. It covers large areas of sedimentary rocks with some granitic intrusive and volcanic rocks. Vernal pools are scattered in this region and do not occur in large extensive complexes. The occurrences of pools are typically isolated and many are governed by geologic structural basins associated with fault lines. For these reasons it is difficult to delineate exact boundaries for the region. The map accompanying this region is provisional. Climatically, pools range widely from cool coastal to hot interior basins and foothill sites. Little information regarding pools in many parts of this region is available, and there are few records in the NDDB. The principal endemic vernal pool species of this region is the shining navarretia (*Navarretia nigelliformis* ssp. *radians*). However, with possible redefinition of this and the adjacent Carrizo Region, Hoover's button celery (*Eryngium aristulatum* var. *hooveri*) may also be considered a restricted regional indicator.

Pool Types

The only type listed from the NDDB is "Northern Vernal Pools" (a generalized, unclassified category).

Pool Descriptions

Coastal pools at Fort Ord and in Santa Cruz County are on marine sediments. Fault zone sag-pond pools occur in San Benito and Santa Clara counties. Vernally moist flats and pools occur on sedimentary and metamorphic rock at Fort Hunter Liggett as well as between Hollister and Tres Piños. Serpentine vernal pools occur in southern San Benito County and in Santa Clara County. These are all unclassified. The majority of the NDDB pool records in this region are for the California tiger salamander (*Ambystoma californiense*) and the shining navarretia (*Navarretia nigelliformis* ssp. *radians*). Little general biotic information is available. The broad array of pools spanning several climatic zones and substrate types suggests that a variety of pool types occur in the region. The total acreage of pools is not available.

Viability

Some of the coastal pools in Fort Ord and the interior pools at Fort Hunter Liggett have been degraded as a result of military operations and overgrazing but may now be restorable

due to base closure (Fort Ord) and conservation agreements. Other pools in the coastal zone in Santa Cruz County have been destroyed or are degraded by development and road construction. Agricultural practices have destroyed pools in San Benito and Santa Clara counties. Pools on Stanford University grounds have been disturbed and degraded from recreational activities and development. Because of the scattered occurrence of pools and the wide-ranging impacts upon them, viability in this region is generally low.

Restoration Opportunities

The best opportunities for restoration exist on the military reservations. Seasonal intensive grazing practices, military maneuvers, and other potential impacts may be modified or ceased to enhance the natural values of these areas. Pools on Stanford University are now treated as reserves and should be restorable. The remaining areas of historical pool locations are largely either under intensive agriculture or urban and suburban development.

Protected Areas

The University of California Hastings Natural History Reservation has examples of upper Carmel Valley vernal pools. Fort Hunter Liggett and Fort Ord are developing conservation plans and conducting natural resource inventories in line with base closure arrangements. The pools on these areas will be identified as conservation priorities. Some pools on serpentine in the San Benito Mountain area are located on Bureau of Land Management land. Some pools occur at San Simeon State Park. The total acreage of protected pools is probably small, but currently no precise information is available.

Sensitive Plants

Federal Category 1 Species:
Contra Costa goldfields (*Lasthenia conjugens*) historical records only. (FPE)
Hoover's button-celery (*Eryngium aristulatum* var. *hooveri)* (SC)

CNPS List 1B Species:
Alkali milkvetch (*Astragalus tener* var. *tener*) historical records only (SC)
Shining navarretia (*Navarretia nigelliformis* ssp. *radians*)

CNPS List 3 Species:
Vernal barley (*Hordeum intercedens*)

Sensitive Animals

Federal Threatened Species:
Vernal pool fairy shrimp (*Branchinecta lynchi*)

Federal Category 1 Species:
California tiger salamander (*Ambystoma californiense*) (CSC)

Federal Category 3c:
California linderiella (*Linderiella occidentalis*)

Unidentified fairy shrimp have been noted in several rock-bound tinajas in the eastern portion of the area. They have tentatively been identified as species of *Branchinecta*.

Table 11. Information Summary for the Central Coast Vernal Pool Region.

Central Coast					
VERNAL POOL TYPE	VIABILITY (H, M, L)	RESTORATION OPPORTUNITY (H, M, L)	PROTECTED AREAS (Total Acres) or (H, M, L)	SENSITIVE PLANTS (No. of spp.)	SENSITIVE ANIMALS (No. of spp.)
Northern Vernal Pool	M	M	M*	5	3

* Includes acres to be protected from military base closures.

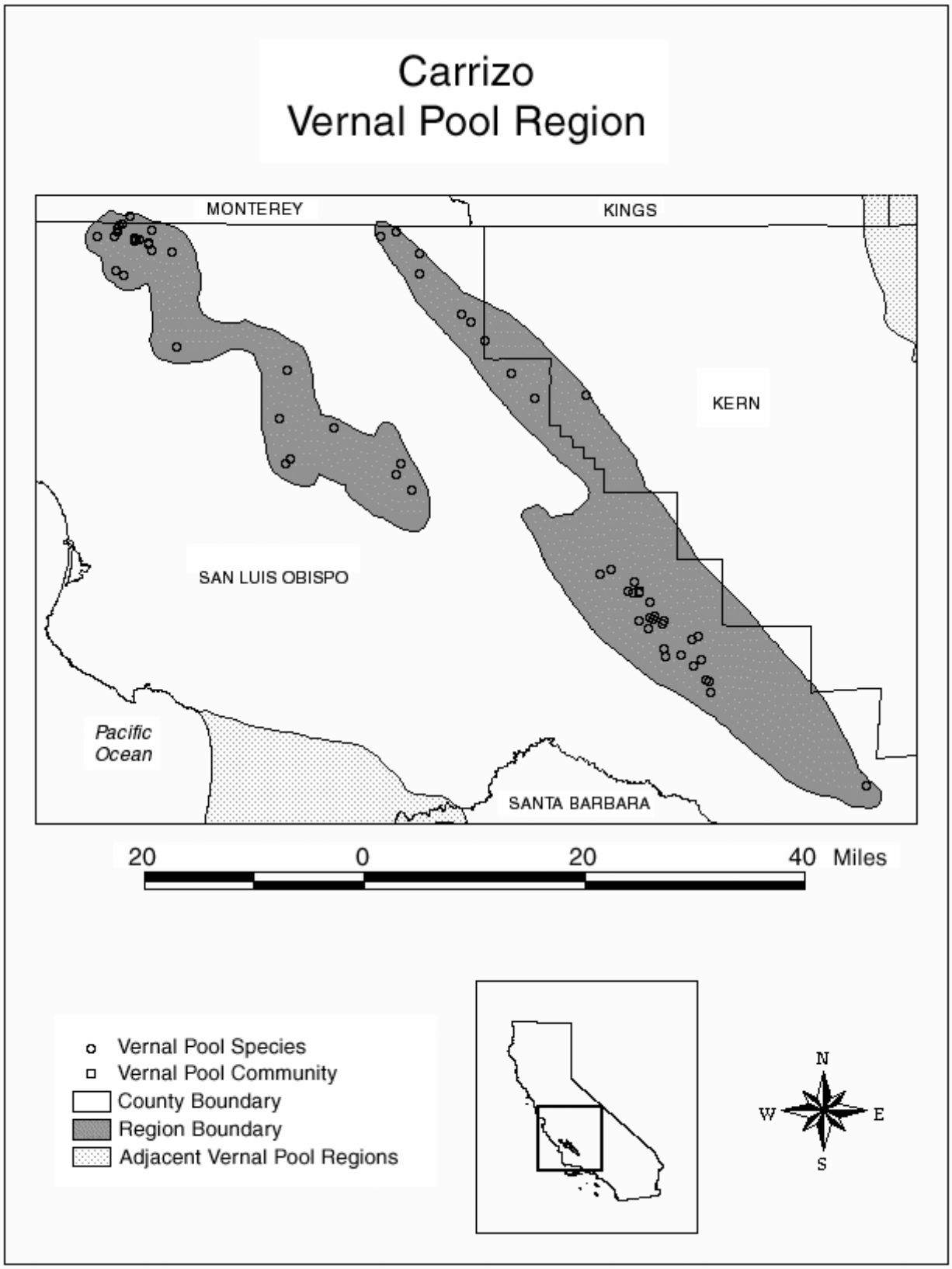

Figure 13. Map of the Carrizo Vernal Pool Region

Carrizo Region

Region Defined

The Carrizo Vernal Pool Region occurs almost entirely within San Luis Obispo County. It occupies the large dry interior basin of the Carrizo Plain and stretches northward along the San Andreas Fault Zone to the vicinity of Cholame near the Monterey County boundary. An outlier area occurs in the Camatta Ranch area several miles west of the Carrizo Plain. This area lies entirely within the South Coast Range Geomorphic Province. Pools of the Carrizo Plain are associated with low alkaline areas adjacent to Soda Lake. Isolated pools also occur northward along the San Andreas Fault zone into the Temblor Range. The pools at Camatta Creek and Ranch are poorly known but appear to be limited in size and number. These and the isolated pools of the San Andreas Fault Zone area may be better classed with the adjacent Central Coastal Region. We await further biological information. The only known endemic in the region is Jared's pepper grass (*Lepidium jaredii* ssp. *jaredii).*

Pool Types

The pools associated with the low lying portion of the Carrizo Plain are Northern Claypan types. Those along the fault zone and those in the Camatta area are not classified (generally known as Northern Vernal Pools).

Pool Descriptions

The Carrizo Plain pools occur as numerous shallow depressions in a Valley Saltbush Scrub matrix adjacent to Soda Lake. The pools in the Camatta area are apparently small and scattered and are surrounded by annual grassland and gray pine savanna. Those along the fault north of the Carrizo Plain are small sag pond types surrounded by annual grassland or Interior Coast Range Saltbush Scrub.

Viability

Due to the lack of development and the degree of protection, most of the pools in this area are viable. The main series of pools on the northern end of Soda Lake are all in the Carrizo Plain Natural Area (CPNA) cooperatively managed by the Bureau of Land Management (BLM), DFG and The Nature Conservancy (TNC). The isolated fault zone pools are in private holdings and are moderately to heavily grazed.

Restoration Opportunities

Restoration opportunities are available for many of the pools in this region. The most significant impacts in most areas are from long-term intensive grazing and could be mitigated by fencing and livestock removal prior to breeding, flowering, and/or fruiting of vernal pool species or elimination of grazing altogether.

Protected Areas

The Nature Conservancy, Department of Fish and Game, and Bureau of Land Management joint Carrizo Plains Natural Area protects 144,000 acres , of which about 20% is low valley sink habitat that includes the majority of the pools known for this part of the region. Other areas are not protected and are in private holdings including ranches and oil company lands. It is possible that some of the pools in the Camatta Creek drainage are on the Los Padres National Forest.

Sensitive Plants

Federal Category 1 Species:
Hoover's button-celery (*Eryngium aristulatum* var. *hooveri)* (SC)

Federal Category 2 Species:
Lost Hills crownscale (*Atriplex vallicola)* (SC)
Coulter goldfields (*Lasthenia glabrata* ssp. *coulteri)* (SC)

CNPS List 1B Species:
Recurved larkspur (*Delphinium recurvatum*)
Jared's pepper grass (*Lepidium jaredii* ssp. *jaredii)*
Shining navarretia (*Navarretia nigelliformis* ssp. *radians)*

Sensitive Animals

Federal Endangered Species
Longhorn fairy shrimp (*Branchinecta longiantenna*)

Federal Threatened Species:
Vernal pool fairy shrimp (*Branchinecta lynchi*)

Federal Category 1 Species:
California tiger salamander (*Ambystoma californiense*) (CSC)

Federal Category 2 Species:
Western spadefoot toad (*Scaphiopus hammondii*) (CSC)

Table 12. Information Summary for the Carrizo Vernal Pool Region.

Carrizo					
VERNAL POOL TYPE	VIABILITY (H, M, L)	RESTORATION OPPORTUNITY (H, M, L)	PROTECTED AREAS (Total Acres) or (H, M, L)	SENSITIVE PLANTS (No. of spp.)	SENSITIVE ANIMALS (No. of spp.)
Northern Vernal Pool	M	M	M	6	4

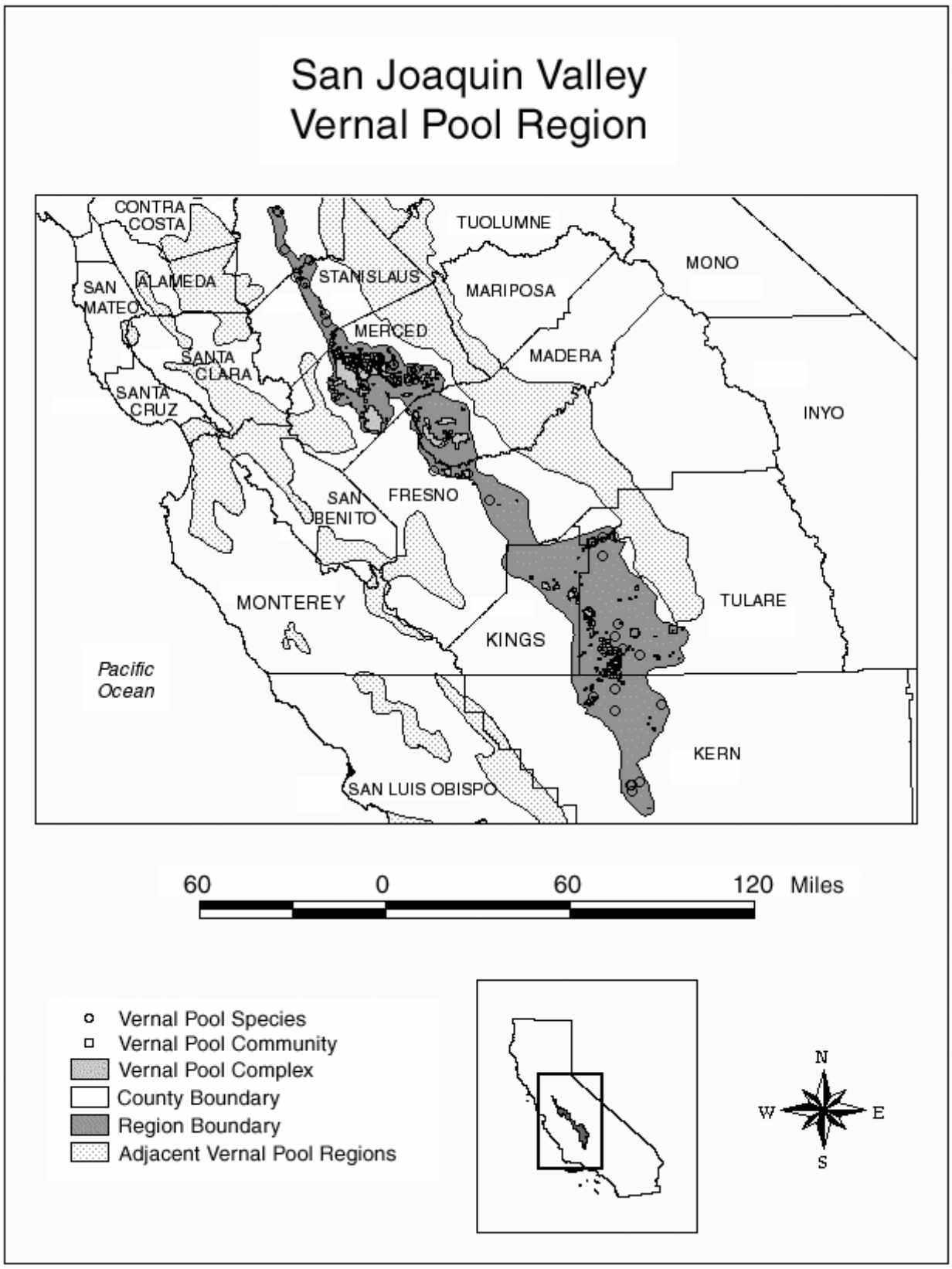

Figure 14. Map of the San Joaquin Valley Vernal Pool Region

San Joaquin Valley Region

Region Defined

The San Joaquin Valley Vernal Pool Region occupies the low lying San Joaquin Valley, no parts of the region are over ca. 500 ft elevation. It stretches from central San Joaquin County to northern Kern County. It includes several well known pool complexes; the San Luis National Wildlife Refuge in Merced County, Sandy Mush Road in Merced County (not currently an easement aquisition boundary), the Cottonwood Creek, and Pixley Vernal Pools Preserve pools in Tulare County. This region is the southern Great Valley analog to the Solano-Colusa Region of the Sacramento Valley. It occupies basin margin alkaline soils and shares many species with the Solano-Colusa Region including the rare *Atriplex joaquiniana,* and *Atriplex persistens*. It contains the endemic rare species *Atriplex miniscula* and *Orcuttia inaequalis*. The area may be contrasted with the Solano-Colusa Region to the north by a more extensive development of alkaline claypan pools, well-developed transition of these pools to extensive alkaline wetlands, and lower average annual precipitation.

Pool Types

Northern Claypan is the primary pool type known from the region.

Pool Descriptions

Northern Claypan pools are scattered throughout the region in the lower elevations of the main San Joaquin Valley. They may occur as small mima mound types or larger alkali pools. Some of these verge on other playa-like alkali wetlands and Valley Sink Scrub. A few remaining aeolian vernal pools nested among stabilized or mostly stabilized sand dunes exist. Some of these may be protected in the Semitropic Ridge TNC Reserve. The biota of these pools is little known. Additional information is needed to understand the ecological differences between the valley sink alkali scalds and the claypan pools in this region.

Viability

Large areas of Northern Claypan pools have been lost to agriculture and urban development. The widespread development of drip irrigation in the last decade has resulted in the conversion of many acres of vernal pool habitat to vineyards and orchards.

Restoration Opportunities

In many cases agricultural practices and urban development have obliterated any restoration opportunities for Northern Claypan pools.

Protected Areas

The Pixley Vernal Pool Preserve (Tulare County) is managed by The Center for Natural Lands Management (recently transferred from TNC) and has excellent examples of Northern Claypan Vernal Pools. The Grassland Ecological Area of western Merced County includes now a unit of San Luis NWR, Great Valley Grasslands State Park, San Luis NWR, Merced NWR, (including Arena Plains and East Bear Creek Units), and private cattle ranches and duck clubs (many of which have U.S. Fish and Wildlife Service conservation easements.

Additional reserves are necessary for protecting Northern Claypan pools particularly in the northern and central portions of the region. Information on total acreage preserved in the region is not available. Region 4 of DFG is evaluating vernal pool habitat and is making progress in identifying high quality areas for conservation and acquisition.

Sensitive Plants

State Endangered Species:
Colusa grass (*Neostapfia colusana*) (FT)

State Rare Species:
Greene's tuctoria (*Tuctoria greenei*) (FE)

Federal Proposed Threatened Species:
Hoover's spurge (*Chamaesyce hooveri*) (FT)

Federal Category 2 Species:
Henderson's bent brass (*Agrostis hendersonii*) (SC*)
Lost Hills crownscale (*Atriplex vallicola*) (SC)
Coulter goldfields (*Lasthenia glabrata* ssp. *coulteri*) (SC)
Little mouse-tail (*Myosurus minimus* ssp. *apus*) (SC)

CNPS List 1B Species:
Alkali milk-vetch (*Astragalus tener* var. *tener*) (SC)
Heartscale (*Atriplex cordulata*) (SC)
Brittlescale (*Atriplex depressa)* (SC)
Lesser saltscale (*Atriplex minuscula*) (SC)
Vernal Pool saltbush (*Atriplex persistens*) (SC)
San Joaquin saltbush (*Atriplex joaquiniana*) (SC)
Hispid bird's-beak (*Cordylanthus mollis* ssp. *hispidus*)
Recurved larkspur (*Delphinium recurvatum*)
Legnere (*Legenere limosa*) extirpated from the region.

CNPS List 2 Species:
Dwarf downingia (*Downingia pusilla*)

CNPS List 3 Species:
Vernal barley (*Hordeum intercedens*)
Nelson's pepperwort (*Marsilea oligospora*)

Sensitive Animals

Federal Endangered Species:
Conservancy fairy shrimp (*Branchinecta conservatio*)
Longhorn fairy shrimp (*Branchinecta longiantenna*)
Vernal pool tadpole shrimp (*Lepidurus packardi*)

Federal Threatened Species:
Vernal pool fairy shrimp (*Branchinecta lynchi*)

Federal Category 1 Species:
California tiger salamander (*Ambystoma californiense*) (CSC)

Federal Category 2 Species:
Molestan blister beetle (*Lytta molesta*)
Western spadefoot toad (*Scaphiopus hammondii*) (CSC)

Federal Category 3c:
California linderiella (*Linderiella occidentalis*)

Unknown status (undescribed species):
Mid Valley Fairy shrimp (*Branchinecta mesovalliensis*)

Table 13. Information Summary for the San Joaquin Valley Vernal Pool Region.

San Joaquin Valley					
VERNAL POOL TYPE	VIABILITY (H, M, L)	RESTORATION OPPORTUNITY (H, M, L)	PROTECTED AREAS (Total Acres) or (H, M, L)	SENSITIVE PLANTS (No. of spp.)	SENSITIVE ANIMALS (No. of spp.)
Northern Claypan	M	M	M	19	9
Northern Hardpan	M	M	M		
Northern Basalt Flow	H	H	L		

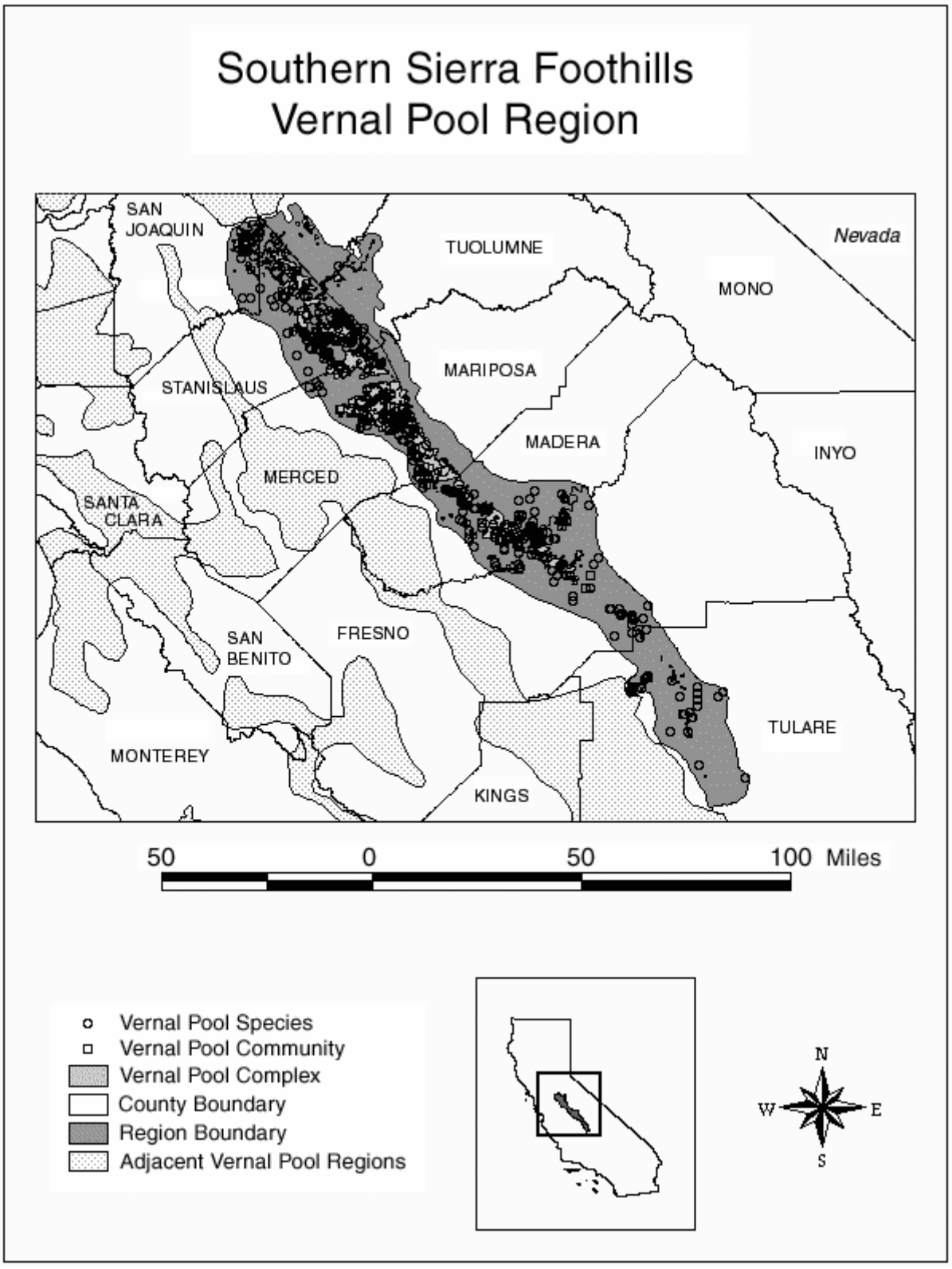

Figure 15. Map of the Southern Sierra Foothills Vernal Pool Region

Southern Sierra Foothills Region

Region Defined

This region occupies the rolling foothill country of the central and southern Sierra Nevada above the San Joaquin Valley basins. It stretches from central Calaveras County, south of the Calaveras River to central Kern County in the Tehachapi Pass area. It includes several well known pool complexes including the Hickman pools in Stanislaus County, the complexes at Flying M Ranch in Merced County, the extensive complexes at Castle Air Force Base, the Fresno/Madera County Table Mountain pools, and the Tuolumne County Table Mountain pools. Within the region are the endemic vernal pool plant species: spiny-sepaled button-celery (*Eryngium spinosepalum*), and succulent owl's-clover (*Castilleja campestris* ssp. *succulenta*).

Pool Types

Northern Hardpan and Northern Basalt Flow pools are known from the region.

Pool Descriptions

Hardpan pools occur on soils of the alluvial fans and terraces. Hardpan soil series in the region include Amador, Corning, Hornitos, Pentz, Peters, Yokohl and San Joaquin. Many hardpan complexes composed of numerous small pools and swales on mima mound topography are scattered in the northern portion of the region. However, further south in Fresno and Tulare counties, these pools become less common as the soils that support them are less widespread.

Northern Basalt Flow pool complexes occur atop several basalt flows in the foothills. These are typically small, irregularly clustered pools with "flashy hydrology." They are perched on the narrow, sinuous basalt mesas above the surrounding low-lying terrain. Soils for Big Table Mountain near Friant are classified as Hideaway extremely stony loam. Perhaps the most extensive occurrence of this type is atop the "Table Mountain" near Sonora. However, little survey work has been done there. The total acreage for each pool type in the region is not available.

Some Northern Claypan pools exist in the region.

Viability

The largely untillable and difficult to access basalt flow pools are small in extent but least disturbed, with light to moderate grazing as their primary impact. However, some housing development has recently taken place on this pool type near Sonora. The Northern Hardpan pools are most extensive and are subject to a variety of impacts. Primary among these is long-

term intensive and the widespread development of drip irrigation. Upland housing development has also reduced the extent of hardpan pools in many areas, especially adjacent to urban centers.

Restoration Opportunities

The best opportunities for restoration are in moderately grazed areas of basalt flow and hardpan pools.

Protected Areas

The Nature Conservancy has conservation easements for vernal pools on two large parcels of the Flying M Ranch in Merced County. The two parcels total 2400 acres. DFG's 900 acre Stone Corral Ecological Reserve, Tulare County protects a number of high quality hardpan pools. The Tulare County Historical Society has preserved an isolated 10 acre parcel of hardpan pools in mima mound topography called the Hogwallow Preserve. The vernal pool habitat on one extensive table mountain (Big Table Mountain/McKenzie Table) of the Northern Basalt Flow complex near Friant is protected by DFG, BLM, Department of Parks and Recreation, Sierra Foothill Conservancy and the Bureau of Reclamation. The extensive parcel owned by TNC has been transferred to the Sierra Foothill Conservancy. The pools at Castle Air Force Base, currently undergoing base closure activities (DFG is involved), are extensive. Region 4 of DFG is evaluating vernal pool habitat and is making progress in identifying high quality areas for conservation and acquisition. On the Tuolumne County table mountain complex, BLM owns a 20 acre parcel of vernal swale habitat and some additional acreage of upland.

Sensitive Plants

State Endangered Species:
- Colusa grass (*Neostapfia colusana*) (FT)
- San Joaquin Valley Orcutt grass (*Orcuttia inaequalis*) (FT)
- Hairy Orcutt grass (*Orcuttia pilosa*) (FE)
- Succulent owl's-clover (*Castilleja campestris* ssp. *succulenta*) (FPT)
- Boggs Lake hedge-hyssop (*Gratiola heterosepala*)

State Rare Species:
- Greene's tuctoria (*Tuctoria greenei*) (FE)

Federal Proposed Threatened Species:
- Hoover's spurge (*Chamaesyce hooveri*) (FT)

Federal Category 2 Species:
- Henderson's bent brass (*Agrostis hendersonii*) (SC*)
- Spiny-sepaled button-celery (*Eryngium spinosepalum*) (SC)
- Little mouse-tail (*Myosurus minimus* ssp. *apus*) (SC)

CNPS List 1B Species:
Legnere (*Legenere limosa*) extirpated from the region. (SC)
Pincushion navarretia (*Navarretia myersii* ssp. *myersii*)

CNPS List 2 Species:
Dwarf downingia (*Downingia pusilla*)

CNPS List 3 Species:
Vernal barley (*Hordeum intercedens*)
Nelson's pepperwort (*Marsilea oligospora*)

Sensitive Animals

Federal Endangered Species:
Conservancy fairy shrimp (*Branchinecta conservatio*)
Vernal pool tadpole shrimp (*Lepidurus packardi*)

Federal Threatened Species:
Vernal pool fairy shrimp (*Branchinecta lynchi*)

Federal Category 1 Species:
California tiger salamander (*Ambystoma californiense*) (CSC)

Federal Category 2 Species:
Molestan blister beetle (*Lytta molesta*)
Western spadefoot toad (*Scaphiopus hammondii*) (CSC)

Federal Category 3c:
California linderiella (*Linderiella occidentalis*)

Unknown status (undescribed species)
Mid Valley Fairy shrimp (*Branchinecta mesovalliensis*)
Colorado Fairy Shrimp (*Branchinecta coloradensis* ssp. nov)

Table 14. Information Summary for the Southern Sierra Foothills Region.

Southern Sierra Foothills					
VERNAL POOL TYPE	VIABILITY (H, M, L)	RESTORATION OPPORTUNITY (H, M, L)	PROTECTED AREAS (Total Acres) or (H, M, L)	SENSITIVE PLANTS (No. of spp.)	SENSITIVE ANIMALS (No. of spp.)
Northern Claypan	M	M	M	15	9
Northern Hardpan	M	M	M		
Northern Basalt Flow	H	H	L		

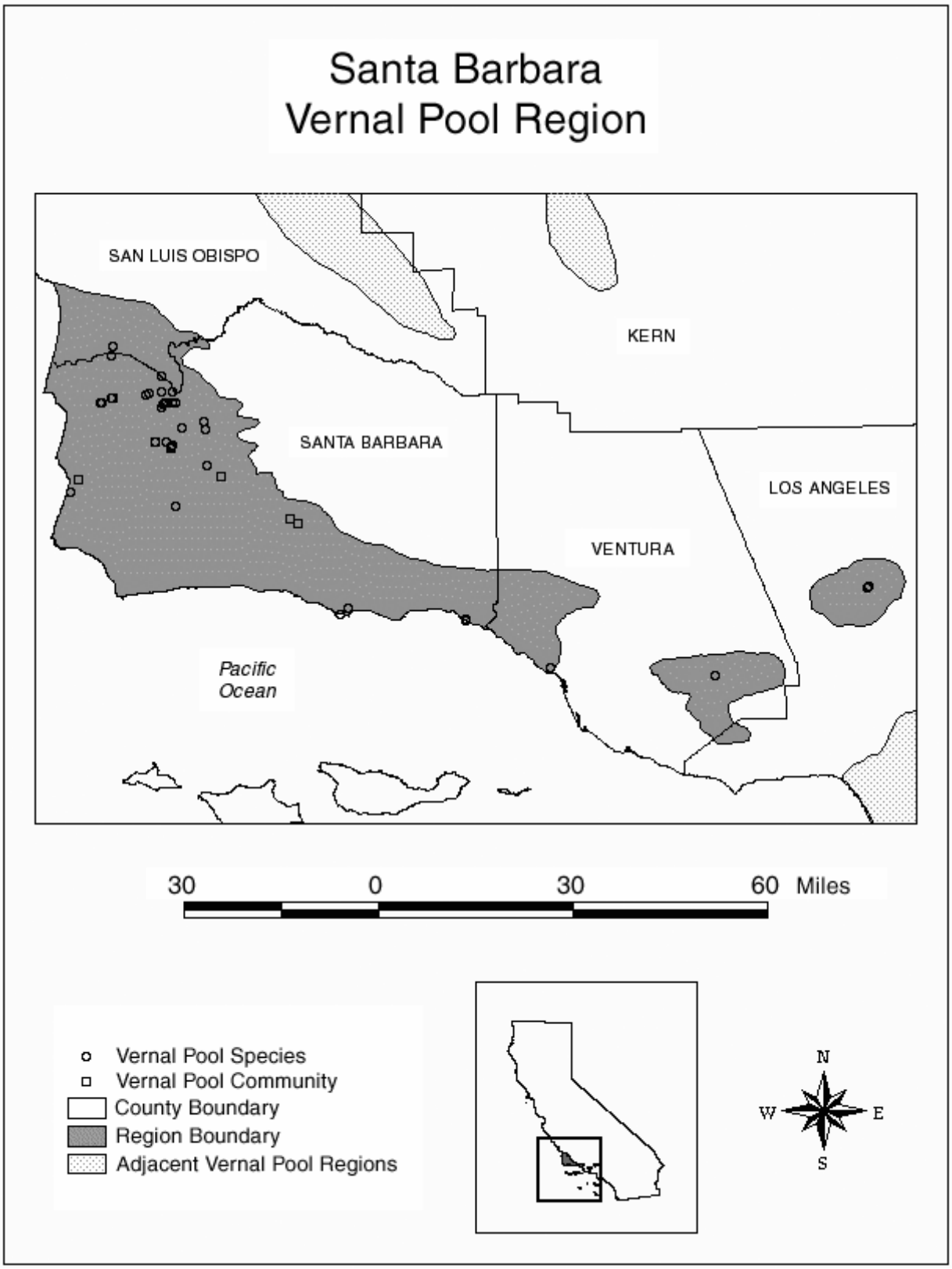

Figure 16. Map of the Santa Barbara Vernal Pool Region

Santa Barbara Region

Region Defined

The Santa Barbara Vernal Pool Region covers all of southern and western Santa Barbara County from the Santa Maria area south and east to the western portion of Ventura County adjacent to Ojai and the Ventura River drainage. Two small outlier areas are also included: the upper Santa Clara River Basin and the Simi Valley. Further research may link some of these outliers more closely with other southern California regions. This region includes portions of two geomorphic provinces, the South Coast Ranges and the Transverse Ranges. However, pools in both provinces occur on soils derived from similar sedimentary and weakly metamorphosed sedimentary rocks. The Santa Maria and Burton Mesa portions of the area have numerous small pool complexes while other areas such as the San Antonio Creek watershed, the Santa Rita Valley, and the SantaYnez River Valley typically contain pools which are widely scattered.

Pool Types

Pool types in this region are poorly defined biologically. Because they are floristically transitional between northern and southern California pools and because soil conditions are uncertain for the majority of these pools, they remain unclassified in NDDB. Some have been called "Southern Vernal Pools" in the NDDB. It is likely that more than one type is involved, and some types may verge on other seasonal wetlands such as seeps and vernal marshes. Structurally, pools in the region vary from fault sag-pond, to coastal marine terrace deposit types (see Ferren, et al. 1996).

Pool Descriptions

Pools in the Santa Barbara Region vary from small regular depressions in hummocky terrain to larger (up to 12 acres) isolated valley bottom and small closed basin type pools. Surface soils underlying many of the north county pools are surprisingly sandy and permeable (Betteravia series, Tangair series, Arnold series) while others are underlain by relatively impervious soils (Narlon sand-hardpan variant and clay-rich Botella, Salinas, Shedd, Chamise, and Santa Ynez series). It is likely that the subsoils of even the sandy-bottomed pool complexes contain accumulations of clay which reduce their permeability. Some of the largest pools in the region occur in shallow basins in the outlier areas of Simi Valley and the Upper Santa Clara River. Due to their geographic proximity to the Los Angeles Basin and the Peninsular Ranges they are more similar floristically to pools in those areas than to other pools in the region. Hydrology is likely to be flashy in the smaller pools and in pools with sandy soils and more persistent in the larger, deeper clay-soil pools. Current acreage for pool types is unavailable.

Viability

The majority of the region is moderately to heavily affected by several negative impacts. Some of the most thoroughly researched vernal pool restoration state-wide has been undertaken in the Isla Vista area although some pools in Isla Vista and other areas have been heavily disturbed with no restoration undertaken. In general, the majority of the pools in the region appear to be in some jeopardy. The most imperiled are in the coastal zone. Long-term intensive grazing, road construction, OHV use, housing development, and military operations are among the most important negative impacts. Impacts to some pools also include invasion of non-native plant species and feral pig damage.

Restoration Opportunities

Much of the northwestern portion of the region (Burton Mesa, Santa Maria) is in a developing zone with numerous impending impacts. Restoration opportunities have not been explored here although in the similarly impacted Goleta and Isla Vista areas several pools have been created and restored. Grazing is a general impact throughout much of the region. It is likely that much of the long-term intensively grazed pool area can be effectively restored by fencing with additional management such as burning.

Protected Areas

The majority of this region is in private ownership. Small areas of the coastal terrace pools near the University of California Santa Barbara (UCSB) are part of the University of California Natural Reserve at Coal Oil Point. Other areas near UCSB are part of the Del Sol Vernal Pool Reserve managed by the Isla Vista Recreation and Parks District. However, this area contains several restored pools with uncertain long-term conservation values. Some pools probably occur on Los Padres National Forest land, but no information is available for them. Some pools may be protected in the Burton Mesa Chaparral Preserve (Unocal Corp recently transferred to State Lands Commission). Additional protection and study is warranted for all of the unclassified pools in this region.

Sensitive Plants

Federal Endangered Species:
California Orcutt grass (*Orcuttia californica)* (FE)

State Endangered Species:
California Orcutt grass (*Orcuttia californica)* (FE)

Federal Proposed Threatened Species:
Spreading navarretia (*Navarretia fossalis*) (FPT)

Federal Category 2 Species:
Blochman's dudleya (*Dudleya blochmaniae* ssp. *blochmaniae) (SC)*
Southern tarplant (*Hemizonia parryi* ssp. *australis*) *(SC)*
Coulter goldfields (*Lasthenia glabrata* ssp. *coulteri*) *(SC)*
Sanford's arrowhead (*Sagittaria sanfordii*) *(SC)*

Sensitive Animals

Federal Proposed Endangered:
San Diego fairy shrimp (*Branchinecta sandiegonensis*)

Federal Category 1 Species:
California tiger salamander (*Ambystoma californiense*) (CSC)

Federal Category 2 Species:
Western spadefoot toad (*Scaphiopus hammondii*) (CSC)

Federal Category 3c:
California linderiella (*Linderiella occidentalis*)

Table 15. Information Summary for the Santa Barbara Vernal Pool Region.

Santa Barbara					
VERNAL POOL TYPE	VIABILITY (H, M, L)	RESTORATION OPPORTUNITY (H, M, L)	PROTECTED AREAS (Total Acres) or (H, M, L)	SENSITIVE PLANTS (No. of spp.)	SENSITIVE ANIMALS (No. of spp.)
Southern Vernal Pool	M	M	L	7	4

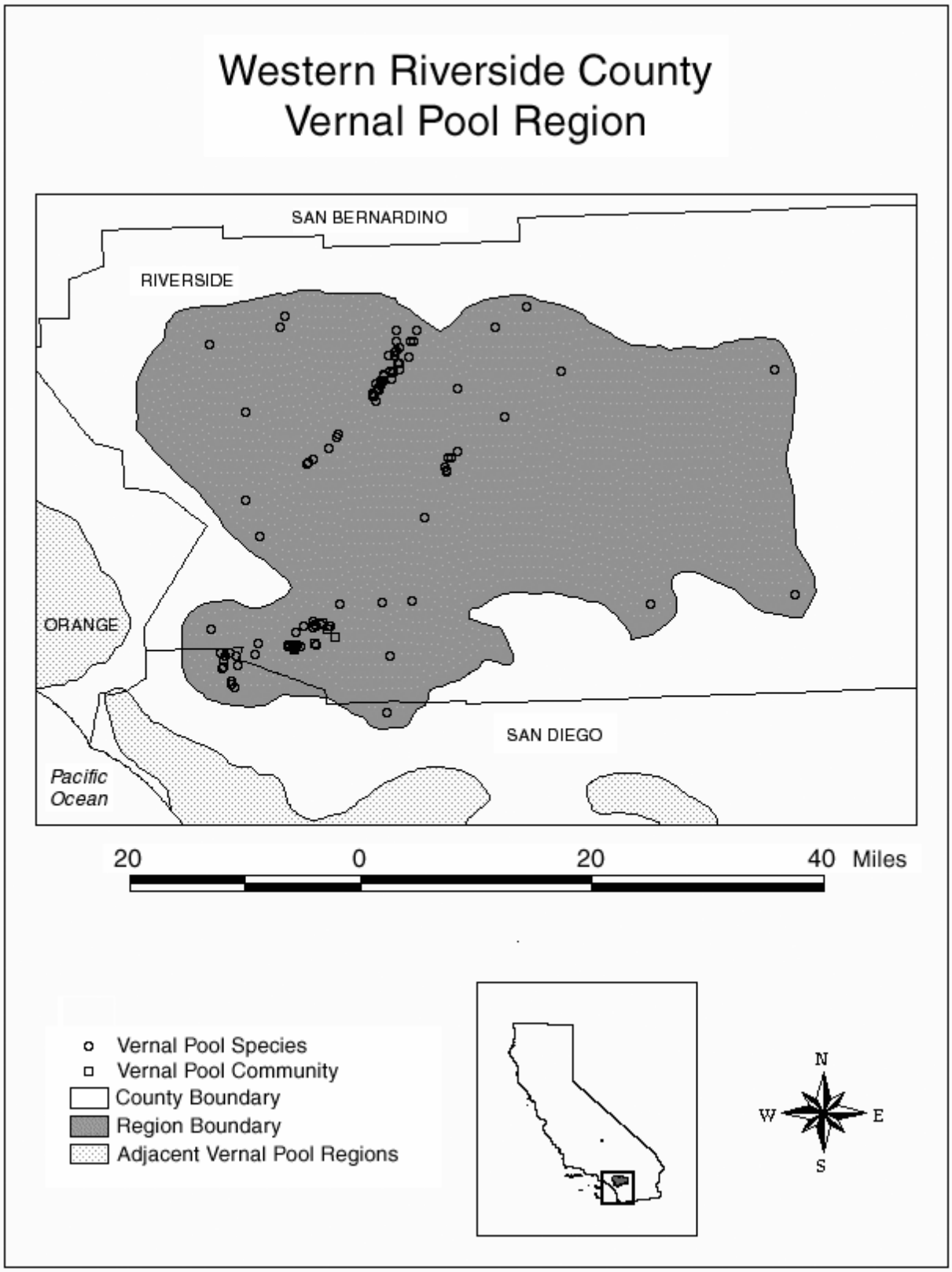

Figure 17. Map of the Western Riverside County Vernal Pool Region

Western Riverside County Region

Region Defined

The Western Riverside County Vernal Pool Region encompasses the western part of Riverside County including the Perris Basin of the lower San Jacinto River Valley, several small basins in the area between Temecula and Lake Skinner, and the Santa Rosa Plateau area southwest of Lake Elsinore. Also included is the Hidden Lake pool in the montane zone of the San Jacinto Mountains. The region lies between the Santa Ana Mountains to the west and the Santa Rosa and San Jacinto mountains to the east. The area is geographically defined as part of the Peninsular Range but contains a variety of vernal pool situations ranging from alkali alluvial clay bottom lands, to high montane basins, and volcanic plateaus. A reduced subset of pools is scattered in the few remaining non-developed areas of the region. The Santa Rosa Plateau portion of this region contains several rare south coast vernal pool species including the recently described Santa Rosa Plateau fairy shrimp (*Linderiella santarosae*). It also contains the southern-most population of the vernal pool fairy shrimp (*Branchinecta lynchii*). The Hidden Lake pool is the only known locality for the Hidden Lake bluecurls (*Trichostema austromontanum* ssp. *compactum*). The pools and adjacent vernally moist alkali flats of the San Jacinto Valley near Hemet have the rare endemic San Jacinto Valley crownscale (*Atriplex coronata* ssp. *notatior*). All of these endemic species are characteristic restricted species for this region.

Pool Types

The Santa Rosa Plateau pools are the only known locality for the Southern Basalt Flow Vernal Pools. The pools in the Perris Basin are not presently classified but resemble claypan pools of the San Joaquin Valley and South Coast Ranges. The isolated large vernal pools such as that at Skunk Hollow are also not presently classified. Some of these large pools converge on vernal lakes and marshes while some of the alkaline pools of the Perris Basin have been classified as vernal alkali plains.

Pool Descriptions

The Perris Basin pools occupy the prehistoric bed of San Jacinto Lake (and its remnant, Mystic Lake) and are in plains with low relief, some of the pools verging on alkali flats. The pools are few, shallow, and relatively small in size. Pools occur in both the San Jacinto and Salt Creek drainages within the Perris Basin. Pools are found southwest of Hemet and scattered along the margins of the San Jacinto River, extending from Mystic Lake to Perris, including portions of the San Jacinto Wildlife Area (DFG). These pools occupy alkali plains on soils mapped as Domino-Travers-Willows association. These soils are alkaline and have a subsoil layer of impervious caliche. The Willows series is also found in the Sacramento Valley and underlies Northern Claypan pools there, underscoring their similarity to the Riverside pools. Hydrology of the Perris Basin pools is variable; some are filled when the San Jacinto River overflows its banks.

The Santa Rosa Plateau pools are variable in size, ranging up to about ten acres (vernal lake) and occurring on the Mesa del Colorado and adjacent mesas on basalt flows. There are fewer than a dozen of these pools. They often have isolated basalt boulders in or adjacent to them and are underlain by very shallow soils over bedrock. Hydrology of the smaller pools is flashy, filling and refilling normally occurring several times in the wet season. The larger pools hold water longer and contain spikerush (*Eleocharis* sp.) and other marsh species in their deeper portions .

The isolated pool at Skunk Hollow is relatively large (up to 10 acres) and verges upon a vernal lake. It may remain wet through much of the year and only contain vernal pool species on the drying margins. The Skunk Hollow pool is on Willows silty clay and is likely to have some similarities with pools in the old Salt Creek drainage west of Hemet.

Viability

The most heavily threatened and most severely reduced pool types are the Perris Basin pools. Rapid urban growth on top of already existing agricultural modification has all but extirpated these pools in most areas. The Santa Rosa Plateau pools are largely protected in the Santa Rosa Plateau Ecological Reserve managed by The Nature Conservancy (TNC). However, some pools outside the TNC reserve have been destroyed by development. Adjacent pools in the area of the San Jacinto Wildlife Area (WA) are privately owned, but the City of Hemet and USFWS are aware of the pools and may protect some sites. The Temecula pools, including Skunk Hollow, are very threatened by development. Other scattered pools in the region are privately owned and are under varying degrees of pressure from development and grazing.

Restoration Opportunities

Restoration possibilities exist in the Perris Basin due to recently slowing economic growth. Land acquisition and mitigation efforts through the City of Hemet and the USFWS may result in several pool areas being preserved and restored.

Protected Areas

The Santa Rosa Plateau reserve covers (x acres) of pools and includes all of the remaining examples of the Southern Basalt Flow Vernal Pools. The DFG San Jacinto Wildlife Area (WA) protects a small portion of the Perris Basin pools although the majority of those remaining occur outside of the WA. Additional protection and study are necessary for the Perris Basin and the unclassified pools such as Skunk Hollow.

Sensitive Plants

Federal Endangered Species:
San Diego button-celery (*Eryngium aristulatum* var. *parishii*) (FE)
California Orcutt grass (*Orcuttia californica*) (FE)

State Endangered Species:
Thread-leaved brodiaea (*Brodiaea filifolia*) (FPT)
San Diego button-celery (*Eryngium aristulatum* var. *parishii*) (FE)
Parish's meadowfoam (*Limnanthes gracilis* ssp. *parishii*) (SC)
California Orcutt grass (*Orcuttia californica*) (FE)

Federal Proposed Endangered:
San Jacinto Valley crownscale (*Atriplex coronata* ssp. *notatior)*

Federal Proposed Threatened Species:
Spreading navarretia (*Navarretia fossalis*) (FPT)
Hidden Lake bluecurls (*Trichostema austromontanum* ssp. *compactum*) (FPT)

Federal Category 2 Species:
South Coast saltscale (*Atriplex pacifica*)
Parish's brittlescale (*Atriplex parishii*) (SC)
Orcutt's brodiaea (*Brodiaea orcuttii*) (SC)
Smooth tarplant (*Hemizonia pungens* ssp. *laevis*)
Coulter goldfields (*Lasthenia glabrata* ssp. *coulteri*) (SC)
Little mouse-tail (*Myosurus minimus* ssp. *apus*) (SC)

CNPS List 2 Species:
Wright's trichocoronis (*Trichocoronis wrightii* var. *wrightii*) (SC)

Sensitive Animals

Federal Endangered Species:
Riverside fairy shrimp (*Streptocephalus woottoni*)

Federal Threatened Species:
Vernal pool fairy shrimp (*Branchinecta lynchi*)

Federal Category 2 Species:
Western spadefoot toad (*Scaphiopus hammondii)* (CSC)

Recently Described Local Species:
Santa Rosa Fairy Shrimp (*Linderiella santarosae*)

Pools on the Santa Rosa Plateau contain the only known populations of the recently described *Linderiella santarosae* (C. Erickson and M. Simovich, pers. comm.)

Table 16. Information Summary for the Western Riverside County Vernal Pool Region.

Western Riverside					
VERNAL POOL TYPE	VIABILITY (H, M, L)	RESTORATION OPPORTUNITY (H, M, L)	PROTECTED AREAS (Total Acres) or (H, M, L)	SENSITIVE PLANTS (No. of spp.)	SENSITIVE ANIMALS (No. of spp.)
Southern Basalt Flow	H	H	H	16	4
Southern Vernal Pools	L	M	L		

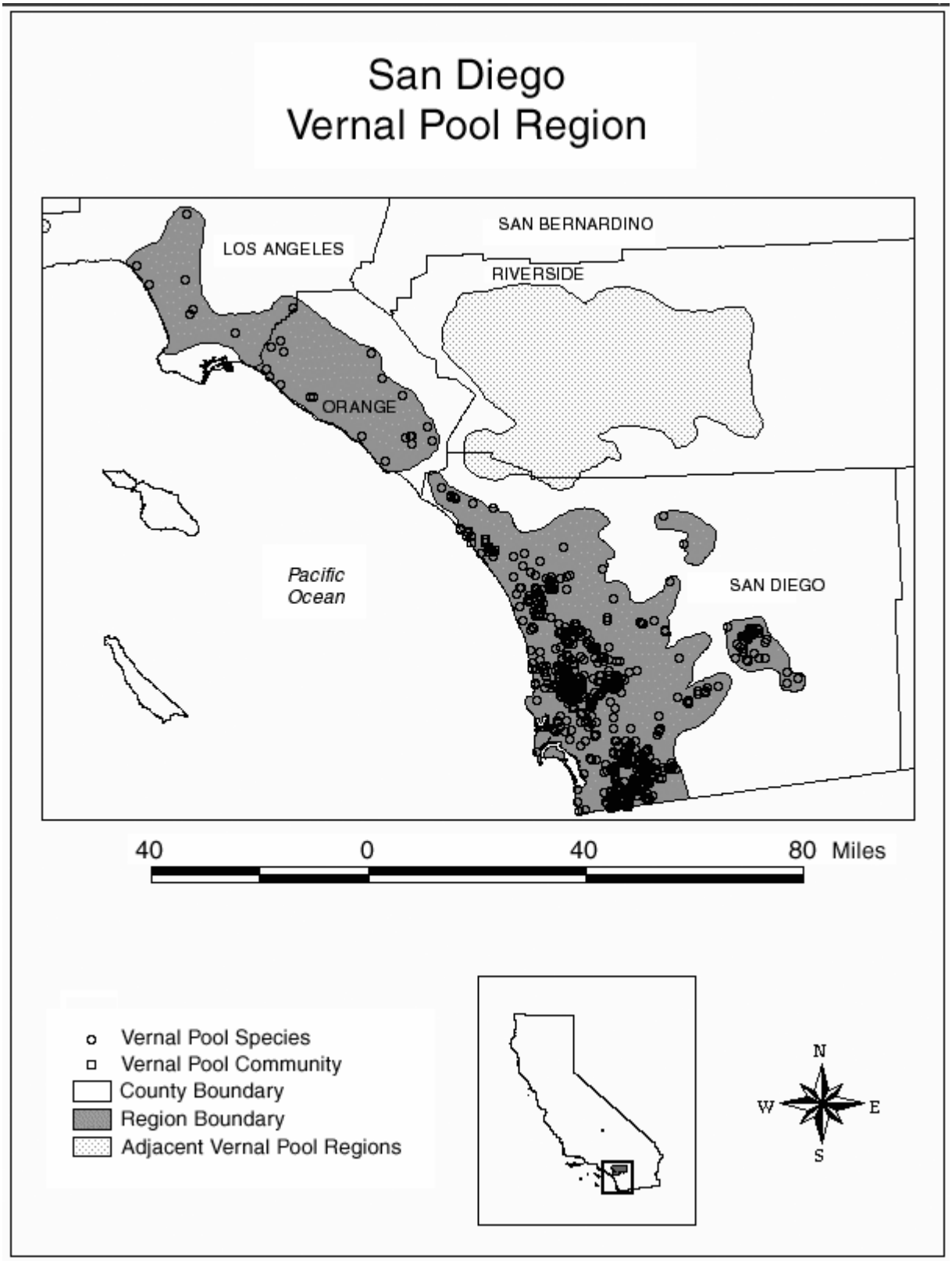

Figure 18. Map of the San Diego Vernal Pool Region

San Diego Region

Region Defined

The main portion of the San Diego Vernal Pool Region occupies the extreme southwestern portion of the state stretching along the coast from the Camp Pendleton area near the Orange-San Diego county border south to the Otay Mesa area adjacent to the Mexican border. It extends inland in a continuous belt to the vicinity of Ramona about 40 miles from the coast and is represented by two outliers further inland. One is the Cuyamaca Lake area with its endemic vernal pool plants, *Limnanthes gracilis* ssp. *parishii* and *Downingia concolor* var. *brevior*, and the other is the Lake Henshaw area where a few more widespread vernal pool species have been reported. In addition to the two aforementioned species, other plants such as *Pogogyne abramsii* and *Pogogyne nudiuscula* are endemic to the main San Diego region as is the San Diego fairy shrimp (*Branchinecta sandiegonensis*). Two types of vernal pools (San Diego Mesa Claypan and San Diego Mesa Hardpan) have also been identified as endemic to the county. The pools of the main portion of the region are perhaps the best known of any in the state due to three separate assessments from 1979 through 1986. Prior to the extensive urbanization of coastal Los Angeles and Orange counties vernal pools also occured there (see map). Currently there are only a few remnant pools and hints of disturbed vernal pool mima mound landscapes in coastal Orange County (Riefer and Prior 1996). There is some evidence from old aerial photographs that vernal pool terrain similar to the mesas of northern San Diego County existed at least as far north as San Clemente and Laguna Beach.

Pool Types

San Diego Mesa Claypan and San Diego Mesa Hardpan vernal pools are known from the region as well as unidentified types at Cuyamaca Lake and Lake Henshaw.

Pool Descriptions

Both San Diego Hardpan and Claypan types occur along the coastal mesas of western San Diego County. San Diego Mesa Hardpan pools are the most abundant in the region. They are underlain by reddish-colored soils with an iron-silica cemented hardpan (primarily Redding, Olivenhain, and Huerhuero soil series) and often with a coarse cobbly surface texture. Surrounding vegetation is typically Chamise Chaparral, but occasionally annual grassland or Coastal Sage Scrub. These pools are small, often clustered in complexes, and may occur in hummocky terrain (mima mound topography).

The San Diego Mesa Claypan type is concentrated in the Otay Mesa and Jamul areas with a few other more northerly county occurrences. It is underlain by markedly finer soils than the previous type. These soils have a grayish color and lack an iron-cemented hardpan (Olivenhain, Las Flores-Placentia series). Like the hardpan pools, they are small in size and may occur in complexes, but are most often associated with grassland and not Chamise

Chaparral. This type also ranges south in Mexico to the vicinity of Ensenada. Most of these pools are found in mima mound topography.

The pools at Cuyamaca Lake are poorly defined and resemble swales and low gradient drainages more often than individual pools. They are associated with the margins of Cuyamaca Lake and adjacent low lying areas. The pools at Mt. Laguna, south of Cuyamaca Lake include large pools at Filaree Flat, Laguna Campground, and Shrine Camp and the mound and pool topography within the campground. The pools near Lake Henshaw are not described and occupy the broad gently sloping valley floor east of the main lake where several large intermittent pools and lakes (Lost Lake, Big Lake, Swan Lake) exist. The climate at both the Cuyamaca and Henshaw sites is colder and wetter than that of the coastal terrace pools. Current area for the two coastal pool types including matrix of other intervening communities is estimated at about 4000 acres. Acreage of the interior outlier area types is not available.

Pools in coastal Orange county have been hypothesized as forming as a result of seismic activity with mima mound landscape being maintained by pocket gophers (Riefner and Pryor, 1996).

Viability

A largely complete inventory of the coastal pools was made in 1986. Current estimates of the remaining coastal pools are between 2000 and 2400 pools representing a 90% decline from estimates of original pool numbers and at least a 32% decline since 1979. San Diego coastal pools have been included in recent multi species planning efforts initiated by State, Federal, and County agencies. The coastal pools have been divided into about 36 "pool series" with a number of pools within each series. Greatest losses have occurred in the Mira Mesa, Peñasquitos, and Miramar Industrial areas which account for 73% of all the pools lost in the county between 1979 and 1986. Other substantial losses have occurred in the Otay Mesa area where over 40% of the pools have been lost between 1979 and 1990. Existing environmental regulations have not been very effective in halting the destruction of pools, and many locally preserved pools are in small, difficult to manage reserves.

The most significant current impact to San Diego coastal pools is construction projects. However, vehicle damage, military activities, dumping, damming of pools, drainage into pools from broken irrigation lines (P. Zedler pers. comm.), other drainage alteration, exotic plant invasion, and agriculture also are important negative impacts. The Cuyamaca Lake pools are threatened by lake enlargement and trespass vehicular use although some sites are within Cuyamaca Rancho State Park. Impacts other than long-term intensive grazing are not known for the Lake Henshaw sites.

Restoration Opportunities

Despite the heavy losses in much of the urban and suburban parts of the county some innovative restoration work has been done including exhuming of previously buried pools at Miramar Naval Air Station and inoculation with seeds, eggs, and soil from previously destroyed pool beds. However, many restoration opportunities have been lost due to complete development of the sites and the soils capable of supporting the communities. No mitigation/restoration projects have documented the successful establishment of vernal pool crustaceans.

Protected Areas

Small protected areas occur on San Diego City reserves, Caltrans mitigation lands, Camp Pendleton (USMC), Sweetwater Authority land, San Diego County land, and The Nature Conservancy land. Portions of the Cuyamaca Lake sites are included in the Helix Water District (the majority) and on California State Park lands (Cuyamaca Rancho State Park). The Environmental Trust (a non-profit organization) has ownership of areas near the Ramona Airport and on Otay Mesa. Additional lands will be protected under multi species planning agreements. No area around Lake Henshaw is protected. Few significant mitigation sites remain. The US Fish and Wildlife Service (1997) proposes to establish a vernal pools stewardship program that would include acquisition of lands, cooperative agreements, coordinated planning and shared resources with local, State, and Federal agencies. These areas include Miramar Naval Air Station, Otay Mesa, Del Mar Mesa, Montgomery Field, Sweetwater Reservoir, Lower Otay Reservoir, Lopez Ridge, and Spring Canyon. The preferred alternative would conserve approximately 2300 acres of vernal pool habitat.

Sensitive Plants

Federal Endangered Species:

- San Diego button-celery (*Eryngium aristulatum* var. *parishii*) (FE)
- California Orcutt grass (*Orcuttia californica*) (FE)
- San Diego Mesa mint (*Pogogyne abramsii*) (FE)
- Otay Mesa mint (*Pogogyne nudiuscula*) (FE)

State Endangered Species:

- San Diego thorn mint (*Acanthomintha ilicifolia*) (FPE)
- Thread-leaved brodiaea (*Brodiaea filifolia*) (FPT)
- Cuyamaca Lake downingia (*Downingia concolor* var. *brevior*) (SC)
- San Diego button-celery (*Eryngium aristulatum* var. *parishii*) (FE)
- Parish's meadowfoam (*Limnanthes gracilis* ssp. *parishii*) (FPT)
- California Orcutt grass (*Orcuttia californica*) (FE)
- San Diego Mesa mint (*Pogogyne abramsii*) (FE)
- Otay Mesa mint (*Pogogyne nudiuscula*) (FE)

Federal Proposed Threatened Species:

- Spreading navarretia (*Navarretia fossalis*) (FPT)

Federal Category 2 Species:
Orcutt's brodiaea (*Brodiaea orcuttii*) (SC)
Variegated dudleya (*Dudleya variegata*) (SC)
San Diego barrel cactus (*Ferocactus viridescens*) (SC)
Southern tarplant (*Hemizonia parryi* ssp. *australis*) (SC)
Coulter goldfields (*Lasthenia glabrata* ssp. *coulteri*) (SC)
San Diego goldenstar (*Muilla clevelandii*) (SC)
Little mouse-tail (*Myosurus minimus* ssp. *apus*) (SC)

Sensitive Animals

Federal Endangered Species:
Riverside fairy shrimp (*Streptocephalus woottoni*)

Federal Proposed Endangered Species:
San Diego fairy shrimp (*Branchinecta sandiegonensis*)

Federal Category 2 Species:
Western spadefoot toad (*Scaphiopus hammondii*) (CSC)

Table 17. Information Summary for the San Diego Vernal Pool Region.

San Diego					
VERNAL POOL TYPE	VIABILITY (H, M, L)	RESTORATION OPPORTUNITY (H, M, L)	PROTECTED AREAS (Total Acres) or (H, M, L)	SENSITIVE PLANTS (No. of spp.)	SENSITIVE ANIMALS (No. of spp.)
San Diego Mesa Hardpan	L	M	L	19	3
San Diego Mesa Claypan	L	M	L		
Southern Vernal Pools	M	M	M		

Table 18. State-wide Information Summary for the California Vernal Pool Regions.

Region Information Summary					
VERNAL POOL TYPE	VIABILITY (High, Medium, Low)	RESTORATION OPPORTUNITY (High, Medium, Low)	PROTECTED AREAS (Acreage: High, Medium, Low)	SENSITIVE PLANTS (No. of spp.)	SENSITIVE ANIMALS (No. of spp.)
Modoc Plateau Region					
Northern Basalt Flow	H	H	M	8	none known
Volcanic Mudflow	H	H	M		
Northwestern Sacramento Valley Region					
Northern Hardpan	M	M	none known	10	4
Northern Claypan	M	M	L		
Northeastern Sacramento Valley Region					
Northern Hardpan	M	M	L	15	5
Northern Basalt Flow	M	H	L		
Northern Volcanic Mudflow	M	H	L		
Southeastern Sacramento Valley Region					
Northern Hardpan	M	M	L	9	6
Northern Volcanic Mudflow	M	M	L		
Mendocino Region					
Northern Vernal Pool	M	M	L	7	1
Lake-Napa Region					
Northern Volcanic Ash Flow	M	H	125±	18	1
Northern Basalt Flow	M	H	L		
Northern Vernal Pool	M	M	L		
Santa Rosa Region					
Northern Vernal Pool	M	M	M	13	2
Northern Hardpan	L	M	M		
Solano-Colusa Region					
Northern Claypan	M	M	M	16	7
Northern Hardpan	L	M	none known		
Livermore Region					
Northern Claypan	L	L	L	12	3
Northern Vernal Pool	M	M	none known		
Central Coast Region					
Northern Vernal Pool	M	M	M	5	3
Carrizo Region					
Northern Claypan	H	H	H	6	4
Northern Vernal Pool	M	M	none known		
San Joaquin Valley Region					
Northern Claypan	M	M	M	19	9
Northern Hardpan	M	M	M		
Northern Basalt Flow	H	H	L		

Southern Sierra Foothills Region					
Northern Claypan	M	M	M	9	15
Northern Hardpan	M	M	M		
Northern Basalt Flow	H	H	L		
Santa Barbara Region					
Southern Vernal Pool	M	M	L	7	4
Western Riverside County Region					
Southern Basalt Flow	H	H	H	16	4
Southern Vernal Pool	L	M	L		

Conclusions

The purpose of this report is to focus conservation efforts on the biotic and ecosystem aspects of vernal pool conservation. We have tried to do this by pointing out the broad ecological and geographic range among pools in California by identifying ecologically defined vernal pool regions. Some basic tenets of this report include:

- Vernal pools are ecosystems. Conservation activity should be directed at the integrated ecosystem unit, not just its environmental, botanical, or zoological aspects. Spatial and temporal conservation issues need to be addressed. For example, on a local spatial scale the vernal pool ecosystem, or "complex" includes vernal pools *and* the associated uplands. While on a local temporal scale the definition of vernal pools should not just include the wet phase of the pool, but the dry phase as well.

- Within each defined region is an overlapping suite of species with different tolerances for vernal pools (See Appendix C). Regions may be defined geographically by identifying unique biological and environmental characteristics.

- Within each region is a suite of environmental conditions related to climate, substrate, and landscape evolution, which has driven the organization of vernal pool ecosystems.

- These suites of species and environments vary in scale from the local to the regional level. At each level the full range of ecological variability should be conserved.

- To assure conservation of all vernal pool ecosystems and provide a framework for their continued evolution we need to maintain different mixes of species in different areas and viable populations of all species. This includes conserving large areas - allowing for connectivity between pools, between pool complexes and between pool and upland environments fostering emigration an immigration of populations of vernal pool species.

We expect this report to provide a framework for future comprehensive conservation strategies for California's vernal pools. These strategies may be broken into a dichotomy with one side emphasizing immediate action based on existing information and the other longer-range action based on research suggested by our knowledge gaps. Below we discuss some of the ramifications of these two approaches.

Immediate Action

Areas of highest impacts require immediate conservation attention and cannot wait for detailed scientific studies that could refine concepts of prioritization of protection. Based on the existing regional approach, assumptions must be made if immediate conservation action is to be taken. One of the primary assumptions is that these regions are ecologically distinct and that they encompass the full range of variability of pools and pool species in the state.

It should be remembered that the data that went into defining the vernal pool regions was sporadic and uneven (see below) and their ecological distinctiveness has not been fully analyzed. However, using these regions as a means to show the general distribution of pools is not particularly risky. Employing this direct action approach within each region requires more redundancy in site selection and will capture a less focused (more repetitive) swath of pool resources than if it were to focus on detailed specific information from each region. This translates to a relatively large area conserved per region (and likely more dollars spent), but the assurance that the variability is included would be high.

By grouping these regions into two categories - those requiring immediate conservation attention, and those that don't - we can defer some conservation effort and concentrate on the most needy areas first. Below we provide a list of regions with brief justifications for their inclusion as a higher or lower conservation priority. Clearly, those less imperiled regions are not necessarily out of jeopardy, but either do have a head start in conservation planning or are currently relatively unthreatened. In fact, actions in secondary areas now will preclude more difficult decisions later and loss of important resources. The regions are not intended to be listed in order of priority.

Areas requiring highest priority conservation action due to loss of habitat, lack of protected areas, or other reasons:

- Northwest Sacramento Valley: Limited protected areas, limited restoration possibilities, rapid urban expansion, particularly in Redding area.

- Northeastern Sacramento Valley: Despite some large reserves there are limited protected areas in much of the region, a high number of sensitive species,and high urban-conversion rate.

- Southeastern Sacramento Valley: Limited protected areas, especially for volcanic mudflow pools, high urban conversion rate. Although pools in part of this region (Sacramento Co. Yuba Co.) are receiving strong conservation consideration, Placer and San Joaquin Counties have a number of pool conservation issues remaining to define.

- Mendocino: Only a few small reserves, pool resources relatively unknown (thus range of variability poorly known), restricted species largely limited to highly urbanized and agriculturalized valleys.

- Lake-Napa: Although reserves protect ash flow pools, no reserves exist for the other two general pool types known from the region. Urban and agricultural threats are strong for the pools in the Napa Valley.

- Santa Rosa: Highly fragmented small reserves, full range of variability not protected, several sensitive species, numerous competing impacts including urban expansion and agriculture. Conservation planning priorities started, but not fully resolved.

- Livermore: No reserves for vernal pools, very small acreage remaining.

- San Joaquin Valley: Although large conservation areas occur, additional conservation of pools in NE and S portion of the region is needed.

- Southern Sierra Foothill: Large areas of region are being urbanized or converted to agriculture and impacts to pool resources have not been mitigated.

- Santa Barbara Region: Few conservation areas exist, most pool occurrences are small and isolated, many pool areas are threatened. Despite relatively few sensitive species, full range of pool settings is not conserved.

- Western Riverside County: Although Santa Rosa Plateau pools areas are well conserved, all others in region are highly threatened and have been greatly reduced.

Areas requiring little immediate conservation activity due to relatively low impacts and stable management and planning:

- Modoc Plateau: Much area in low population zone with USFS and BLM resource managers working on conservation of sensitive vernal pool resources.

- Central Coast: Few sensitive species, relatively low urban growth in most of region, conservation on public lands including BLM, USFS, DOD (base closure).

- Carrizo: A single large reserve addresses vernal pool resources, majority of rare species in reserve.

- Solano-Colusa: Although much reduced from former extent, remaining variety of pools are well protected and managed for conservation.

- San Diego: Although severely reduced, pools in this region are receiving strong conservation consideration and all listed vernal pool species will soon be included in a comprehensive recovery plan.

- Sierra Valley: Although fragmented and reduced, remaining pool areas are largely under USFS management with active rare species management plans guiding their conservation.

Conservation Activity:

If we are to focus first on the high priority regions listed above, how are we to best decide a plan of action to improve their conservation status? The following suggestions are made based on current conservation planning theory being implemented by the Department of Fish

and Game and in other habitat conservation planning efforts occurring in vernal pool areas in various parts of the State:

- Focus conservation activities on an ecologically defined area (region or ecological subdivision of a region) and with minor modifications due to politically defined areas (e.g., county).

- Map distribution of pools at a large scale throughout the region (1:24,000 at minimum).

- With the aid of GIS identify and obtain the best available digital coverages of soils, ownership, county planning maps, vernal pool distribution, sensitive vernal pool species information.

- Perform analysis clarifying high priority areas based on combination of overlapping traits such as unique soils and pools, concentrations of sensitive species, large contiguous extent of vernal pool landscape, existing reserves.

- Prioritize conservation efforts on areas which clearly lack protection and reflect unique values.

- In addition to species composition, use standard concepts such as large contiguous pool landscapes (complexes, including uplands) with range of pool sizes, and depths and representation of all distinct pool types to drive high priority site conservation.

- The larger conservation units require less management and translate to less cost per acre and fewer threats to viability.

- Work with local and regional governments, and private landowners to facilitate conservation agreements protecting a suite of vernal pool species and ecosystems in the region.

Long-Range Action

Ideally, the most realistic and efficient means of vernal pool conservation would first allow us time for a complete ecological and biological inventory of the existing pool resources (all species and all ecosystems). Following that, a detailed conservation plan would be completed at multiple scales including continental, state, regional, and local levels. The plan would allow for full representation of vernal pool ecosystems in a system of conservation areas. The pool ecosystems in California would thus be a part of a wider plan to conserve ephemeral wetlands on a continental and global scale.

It is a safe assumption that we do not have the luxury of proceeding with such a purely scientific approach to the exclusion of more expeditious modes. Hence, some compromises must be made allowing for more rapid assessment, but still affording more certainty that the range of variability of the vernal pool resource is conserved than the existing information

would give us. These compromises can be nested into geopolitical and biological/ecological categories.

Geopolitical Compromises:

One of the likely geopolitical compromises is that pools in California would be treated as a political unit, despite the fact that SW and SE Oregon, NW Nevada, and adjacent Baja California clearly have vernal pool resources. If we work just in California, it is likely that we will have to make further geopolitical compromises. One is that an assessment will infrequently come with ecological boundaries, but, more likely with political ones (e.g, counties). If we work with political boundaries at any scale, we should attempt to coordinate with other groups in adjacent areas containing similar pool resources. Thus, we would minimize the possibility that important pool resources would be missed just because they were across the border. If we are to ever validate the existence of the vernal pool regions we will need to collect far more biological and ecological information than we currently have. We need to understand the natural limits of the regions and plan for them as ecological units, not political ones.

Biological/Ecological Compromises:

The most useful guarantee that all vernal pool species in the state maintain their viability would be a complete species inventory of all vernal pools in each area where they occur and an assessment of the viability of these species, so that representative populations of all species could be selected for conservation. This is a very laborious task. It may be possible in some highly restricted vernal pool regions, but unlikely in the near future from many.

A compromise solution would be to sample the suites of species in a selection of vernal pools and determine relationships between these suites of species. A subset of all pools across the state could be sampled and a classification built from these samples. The classification, though not including every pool in existence, would provide a means to categorically inventory types of pools. If the pool's environments were sampled at the same time, a correlation between the species and the physical types of pools could be explored. The development of a quantitative biologically driven classification will show the range of natural variation. Then we can assess what has been conserved and what still needs to be. This ecological classification of pools could be used as a surrogate for having a bank of detailed information about all the vernal pool species.

Information Gaps

Both the direct and long-range approaches can and probably should be employed in any conservation strategy for vernal pools simultaneously. However, both currently have significant stumbling blocks in their implementation due to information gaps. At the least, ignoring these gaps will lead to a more expensive and less certain conservation plan. At the worst, we will miss certain important elements of vernal pool ecosystems and thus will not

have assured a full range of pool variability in the conservation plan. Discussed below are some of the information gaps currently existing which restrict comprehensive vernal pool resource assessment.

Regional definition problems:

We don't yet know the biological and ecological definition of the vernal pool regions. Our survey and our partitioning of the state into pool regions is preliminary. It is based largely on: a) a small data set from the NDDB which tracks only rare species and high quality examples of communities, b) a medium scale mapping effort (40 acre mmu) that displays the vernal pool complexes in the Great Valley and surrounding area, and c) sporadic vernal pool mapping efforts elsewhere. NDDB and CNPS records do not provide uniform state-wide coverage and tell us where species have been found, not where they aren't found.

In this report boundaries are drawn variously from region to region. Most are based on some idea of the limits of driving environmental variables (pool supporting soils, geology, etc). In the Great Valley area boundaries of regions are based on actual mapping of pool complexes (for USFWS). However, we don't know whether these regions are ecological entities or whether they just mark the edges of pool distribution. Typically, it is the individuality of the regions that we don't understand, not their outer perimeter limits.

We have stated that these regions are not to be substituted for specific conservation actions such as mitigation banking. Insufficient information to determine the degree of ecological similarity of pools within these regions is the primary reason for this statement. Currently, we know that pools occur in a given region and we know that there is some suite of species and environmental conditions that tie these areas together. However, we suspect that if each region was analyzed, we would find anomalous pools dissimilar to surrounding pools and that pools in some geographic regions likely resemble pools in other regions more so than their immediate neighbors. Thus, a useful activity would be to compare pools across a range of regions, sampling a range of pool types within them to look for quantifiable patterns of similarity and draw conclusions from that study. It is likely that some region boundaries will change substantially based on a further understanding of their similarity.

How many acres of pools are there in the State?

We don't know the actual acreage of vernal pools and the acres protected in various conservation activities outside of the Great Valley and San Diego Regions. A valuable activity would be to implement a systematic state-wide pool mapping inventory focusing on the regions of highest priority as listed above.

Paucity of basic environmental information for geographic analysis:

We need to acquire and produce GIS layers for vernal pools based on the important variables that influence the distribution and the classification of vernal pools. These include

series level soils information, geology, and climatic variation as well as current land use patterns. These variables should be mapped at a scale which is useful for local assessment (e.g, at least 1:24,000). Some of these GIS layers (soils for example) would be useful for understanding restoration potential. We don't know the acreage of vernal pool supporting soils compared to the actual acreage of developed and heavily altered agricultural land in any but a few areas.

How should pools be classified?

We don't know how to classify pool types within the regions. The current classification used in this report is insufficient to distinguish the biotic variation at a smaller scale throughout California and can only hint at the environmental variables that drive the natural arrangement of vernal pool ecosystems (see above "Prolonged Action" section for a suggestion).

Pool species and ecosystem dynamics:

We don't know more than the rudiments about maintenance of stable vernal pool ecosystems. Such things as minimum population size, amount of upland (buffer) needed, important species interactions, climatic effects, and other events which influence population dynamics are lacking but for a handful of exceptions.

Pool resilience and restoration potential:

We don't know the restorability of pools under various conditions of degradation. Thus, if certain regions lack sufficient intact vernal pools, but contain some examples of degraded pools we don't know if these can be successfully restored.

Develop a coordinated conservation plan:

Another significant gap is a detailed, generally accepted view of vernal pool conservation planning. In other words, once we have the data for an assessment how do we implement it? With interagency coordination and strong governmental support we should be able to have an implementation plan for state-wide vernal pool conservation. Ideally a time line for vernal pool conservation activity should be created and a number of steps identified for completion by the most appropriate agencies and organizations.

Shifting Conservation Focus for Vernal Pools

Over the past three years since the first draft of this report was written the focus on California vernal pool resource assessment has changed. The somewhat provincial perspective of vernal pools as a Central Valley and South Coast phenomenon has been broadened. It is

now clear that vernal pool landscapes are found throughout much of California. It is also clear that variation within this distribution of vernal pools is significant. The notion of several generic categories of vernal pool types ranging widely over the state is being replaced with the concept of multi-scale variation from the local to the regional level. Within this framework of variation is a range of environmental and biological phenomena that may be best expressed by a hierarchical relationship at state, regional, and local levels.

Currently regions described in this report have been used as a framework for vernal pool recovery by the US Fish and Wildlife Service in the Central Valley. The Department of Fish and Game and US Fish and Wildlife Service are focusing resource assessment in several of the vernal pool regions at several different scales. A project has begun to more quantitatively describe the variation and to develop a classification that reflects the pattern across the regions described in this report.

Vernal pool ecosystems and complexes are now recognized as ecological units that are related to other ecosystems. There is a continuum between permanent wetlands and ephemeral wetlands. Vernal pools as a type of ephemeral wetland are related to other ephemeral wetlands such as vernal lakes, desert playas, rock tanks (tinejas), and snowmelt pools. Conservation of the biological resources within vernal pools is beginning to take into account these other ephemeral wetlands as many species are shared between them.

The above concepts are an adaptation of ecological thinking that has pervaded conservation biology over the past few years. Hierarchical thinking and the realization of working within the full range of variability of any ecological system have been strongly supported in the conservation biology literature (e.g., Grumbine 1993, Lubchenco et al 1991, Jensen and Bourgeron 1994). If such conservation action can maintain pace and eventually overtake the destruction of vernal pool habitat there is hope that the vernal pools of California and beyond can continue to persist and evolve.

Literature Cited

Cheatham, N.H. 1976. Conservation of vernal pools. *In* Jain, S. Vernal pools: their ecology and conservation. Institute of Ecology Publication No. 9. pp. 86-89. University of California, Davis.

Grumbine, R.E. 1993. What is ecolosystem management? Conservation Biology 8:27-38.

Ferren, W.F., P.L. Fiedler, R.A. Leidy, K.D. Lafferty, and L.A.K. Mertes. 1996. Classification and description of wetlands of the central and southern California coast and coastal watersheds. Madroo 43:125-182.

Harden, J.W. 1987. Soils developed in granitic alluvium near Merced, California. *In* Harden, J.W. A series of soil chronosequences in the western United States. United States Geological Survey Bulletin 1590-A.

Holland, R.F. 1976. The vegetation of vernal pools: a survey. *In* Jain, S. Vernal pools: their ecology and conservation. Institute of Ecology Publication No. 9. pp. 11-15. University of California, Davis.

Holland, R.F. and S.K. Jain. 1988. Vernal pools. *In* Barbour, M.J. and J. Major. Terrestrial vegetation of California. California Native Plant Society Special Publication No. 9. pp. 515-531.

Jensen, M.E. and P.S. Bourgeron, eds. 1994. Volume II: Ecosystem management: principles and applications. Pacific Northwest Research Station, Portland OR, USDA Forest Service General Technical Report PNW-GTR-318.

Jokerst, J.D. 1990. Sacramento County vernal pools: their distribution, classification and management. Jones and Stokes Assoc., Inc. Sacramento, CA.

King, J.L., M.A. Simovich and R.C. Brusca. In prep. Endemism, species richness, and ecology of crustacean assemblages in northern California vernal pools. Submitted to Hydrobiologia.

Lubchenco, J.A., M. Olson, L.B. Brubaker, S.R. Carpenter, M.M. Holland, S.P. Hubbell, S.A. Levin, J.A. McMahaon, P.A. Matson, J.M. Melillo, H.A. Mooney, C.H. Peterson, H.R. Pulliam, L.A. Real, P.J. Regal, and P.G. Risser. 1991. The sustainable biosphere initiative: an ecological research agenda. Ecology 72:371-412.

Riefner, R.E., and D.R. Prior. 1996. New locations and interpretation of vernal pools in southern California. Phytologia 80:297-327

Sawyer, J.O. and T. Keeler-Wolf. 1995. A Manual of California Vegetation. California Native Plant Society, Sacramento.

Simovich, M., J. King and R. Brusca. 1992. Invertebrate survey 1991-1993 PGT-PGE/Bechtel Pipeline Expansion Project. University of San Diego, San Diego, California.

Skinner, M. 1996. Vernal pools: California and Baja California U.S.A. and Mexico. *In* Davis, S.D., V.H. Heywood and A. C. Hamilton. Centres of plant diversity, Vol. 3: The Americas. World Wide Fund for Nature.

Skinner, M.W. and B.M. Pavlik. 1994. Inventory of rare and endangered vascular plants of California. California Native Plant Society Special Publication No. 1, 5th edition.

Stone, R.D. 1990. California's endemic vernal pool plants: Some factors influencing their rarity and endangerment. *In* Ikeda, D.H. and R.A. Schlising. Vernal pool plants: Their habitat and biology. Studies from the Herbarium No. 8. pp. 89-108. California State University, Chico.

Taylor, D.W. G. Clifton, R.F. Holland, and C.W. Witham. 1992. Vernal pools along the PGT-PGE Pipeline Expansion Project, California. Biosystems Analysis, Inc., Santa Cruz, California.

Thorne, R.F. 1981. California's vernal pools unique? *In* Jain, S.K. and P.B. Moyle. Vernal pools and intermittent streams. Institute of Ecology Publication No. 28. pp. 1-8. University of California, Davis.

Thorp, R.W. 1990. Vernal pool flowers and host specific bees. *In* Ikeda, D.H. and R.A. Schlising. Vernal pool plants: Their habitat and biology. Studies from the Herbarium No. 8. pp. 89-108. California State University, Chico.

Thorp, R.W. and J.M. Leong. 1995. Native bee pollinators of vernal pool plants. Fremontia 23: 3-7.

U.S. Fish and Wildlife Service (USFWS). 1994. Endangered and threatened wildlife and plants; determination of endangered status for the Conservancy fairy shrimp, longhorn fairy shrimp, and the vernal pool tadpole shrimp; and threatened status for the vernal pool fairy shrimp. Federal Register 59: 48136-48153.

U.S. Fish and Wildlife Service (USFWS). 1996. Great Valley vernal pool complex mapping project. Sacramento Field Office US Fish and Wildlife Service.

U.S. Fish and Wildlife Service (USFWS). 1997. Environmental assessment and land protection plan: Vernal pools stewardship project. San Diego National Wildlife Refuge. US Fish and Wildlife Service, Portland Oregon.

Zedler, P.H. 1987. The ecology of southern California vernal pools: a community profile. U.S. Fish and Wildlife Service Biological Report 85 (7.11).

Appendix A: Sensitive Vernal Pool Taxa tracked by the NDDB

Plants

Scientific Name	Common Name
Acanthomintha ilicifolia	San Diego thorn mint
Agrostis hendersonii	Henderson's bent grass
Astragalus tener var. *tener*	Alkali milk vetch
Atriplex joaquiniana	San Joaquin spearscale
Atriplex parishii	Parish's brittlescale
Atriplex persistens+	Vernal pool saltbush
Atriplex vallicola	Lost Hills crownscale
Blennosperma bakeri (R-Santa Rosa)*	Sonoma sunshine
Brodiaea filifolia	Thread-leaved brodiaea
Brodiaea orcuttii	Orcutt's brodiaea
Castilleja campestris ssp. *succulenta* (R-E San Joaquin)	Succulent owl's-clover
Chamaesyce hooveri	Hoover's spurge
Downingia concolor var. *brevior* (R-San Diego)	Cuyamaca Lake downingia
Downingia pusilla	Dwarf downingia
Dudleya blochmaniae ssp. *blochmaniae*	Blochman's dudleya
Dudleya variegate	Variegated dudleya
Eryngium aristulatum var. *hooveri*+ (R-Carrizo)	Hoover's button-celery
Eryngium aristulatum var. *parishii*	San Diego button-celery
Eryngium constancei (R-Lake-Napa)	Loch Lomond button-celery
Eryngium spinosepalum (R-E San Joaquin)	Spiny-sepaled button-celery
Ferocactus viridescens	San Diego barrel cactus
Gratiola heterosepala	Boggs Lake hedge-hyssop
Hemizonia parryi ssp. *australis*+	Southern tarplant
Hordeum intercedens+	Vernal barley
Horkelia bolanderi (R-Lake-Napa)	Bolander's horkelia
Ivesia aperta var. *aperta*	Sierra Valley ivesia
Ivesia sericoleuca	Plumas Ivesia
Juncus leiospermus var. *ahartii*	Ahart's dwarf rush
Juncus leiospermus var. *leiospermus*	Red Bluff dwarf rush
Lasthenia burkei	Burke's goldfields
Lasthenia conjugens	Contra Costa goldfields
Lasthenia glabrata ssp. *coulteri*	Coulter goldfields
Legenere limosa	Legenere
Lepidium latipes var. *heckardii* (R-Solano-Colusa)	Heckard's pepper-grass
Limnanthes bakeri	Baker's meadowfoam

Limnanthes floccosa ssp. *californica* (R-NE Sacramento)	Butte County meadowfoam
Limnanthes gracilis ssp. *parishii*	Parish's meadowfoam
Limnanthes vinculans (R-Santa Rosa)	Sebastopol meadowfoam
Marsilea oligospora+	Nelson's pepperwort
Mimulus pygmaeus	Egg Lake monkeyflower
Muilla clevelandii	San Diego goldenstar
Myosurus minimus ssp. *apus*	Little mouse-tail
Navarretia fossalis	Spreading navarretia
Navarretia leucocephala ssp. *bakeri*	Baker's navarretia
Navarretia leucocephala ssp. *pauciflora* (R-Lake-Napa)	Few-flowered navarretia
Navarretia leucocephala ssp. *plieantha* (R-Lake-Napa)	Many-flowered navarretia
Navarretia myersii ssp. *deminuta* (R-Lake-Napa)	Pincushion navarretia
Navarretia myersii ssp. *myersii*	Pincushion navarretia
Navarretia nigelliformis ssp. *radians*	Shining navarretia
Neostapfia colusana	Colusa grass
Orcuttia californica	California Orcutt grass
Orcuttia inaequalis (R-E San Joaquin)	San Joaquin Valley Orcutt grass
Orcuttia pilosa	Hairy Orcutt grass
Orcuttia tenuis	Slender Orcutt grass
Orcuttia viscida (R-SE Sacramento)	Sacramento Orcutt grass
Paronychia ahartii	Ahart's paronychia
Parvisedum leiocarpum	Lake County stonecrop
Plagiobothrys strictus	Calistoga popcornflower
Pleuropogon hooverianus	North Coast semaphore grass
Pogogyne abramsii	San Diego Mesa mint
Pogogyne douglasii ssp. *parviflora*+	Douglas' pogogyne
Pogogyne floribunda+ (R-Modoc Plateau)	Profuse-flowered pogogyne
Pogogyne nudiuscula (R-San Diego)	Otay Mesa mint
Polygonum polygaloides ssp. *esotericum*	Modoc County knotweed
Sagittaria sanfordii	Sanford's arrowhead
Trichostema austromontanum ssp. *compactum* (R-W Riverside)	Hidden Lake bluecurls
Trichocoronis wrightii ssp. *wrightii*	Wright's trichocoronis
Tuctoria greenei	Greene's tuctoria
Tuctoria mucronata (R-Solano-Colusa)	Crampton's tuctoria

* Restricted species, used to define vernal pool region
+ Taxon tracked but no occurrence information currently in the NDDB

Animals

Scientific Name	Common Name
Amphibians	
Ambystoma californiense	California tiger salamander
Scaphiopus hammondii	Western spadefoot toad
Crustaceans	
Branchinecta conservatio	Conservancy fairy shrimp
Branchinecta longiantenna	Longhorn fairy shrimp
Branchinecta lynchi	Vernal pool fairy shrimp
Branchinecta mesovalliensis[+]	Mid-valley fairy shrimp
Branchinecta sandiegonensis (R-San Diego)*****	San Diego fairy shrimp
Lepidurus packardi	Vernal pool tadpole shrimp
Linderiella occidentalis	California linderiella
Linderiella santarosae [++]	Santa Rosa Plateau linderiella
Streptocephalus woottoni	Riverside fairy shrimp
Insects	
Elaphrus viridis (R-Solano-Colusa)	Delta green ground beetle
Lytta molesta (R-E San Joaquin)	Molestan blister beetle

***** Restricted species, used to define vernal pool region indicated
[+] Not formally described yet, no occurrences recorded in NDDB
[++] Recently described, no occurrences recorded in NDDB

Appendix B: Habitats and Vernal Pool Regions for Sensitive Vernal Pool Taxa

Scientific name Common name	Habitat Codes from the Natural Diversity Database (NDDB)	Habitat Codes from the CNPS Electronic Inventory	Vernal pool region(s) where the taxon has been found (+extirpated)	Restricted taxon -- if blank, then facultative
Plants				
Acanthomintha ilicifolia San Diego thorn mint	Chaparral Coastal scrub Valley/foothill grassland Vernal pool	Chaparral Coastal scrub Valley/foothill grassland Vernal pools generally clay	San Diego	
Agrostis hendersonii Henderson's bent grass	Valley/foothill grassland Vernal pool Wetland	Valley/foothill grassland (mesic) Vernal pools	NW Sacramento NE Sacramento SE Sacramento S Sierra	
Astragalus tener var. *tener* Alkali milk vetch	Alkali playa Valley/foothill grassland Vernal pool Wetland	Playas Valley/foothill grassland Vernal pools (alkaline)	Lake-Napa Santa Rosa+ Solano Livermore Central Coast+ San Joaquin	
Atriplex joaquiniana San Joaquin spearscale	Chenopod scrub Meadow and seep Valley/foothill grassland	Chenopod scrub Meadows Valley/foothill grassland generally alkaline	Solano-Colusa San Joaquin	
Atriplex parishii Parish's brittlescale	Chenopod scrub Meadow and seep Vernal pool Wetland	Chenopod scrub Playas Vernal pools	W Riverside	+
Atriplex persistens Vernal pool	(Recently described, taxon tracked but no occurrence information currently in the	(Recently described, not in the CNPS Electronic Inventory)	Solano-Colusa San Joaquin	

saltbush	NDDB.)			
Atriplex vallicola Lost Hills crownscale	Chenopod scrub Valley/foothill grassland Vernal pool Wetland	Chenopod scrub Valley/foothill grassland Vernal pools generally alkaline	Carrizo San Joaquin	
Blennosperma bakeri Sonoma sunshine	Vernal pool Wetland	Valley/foothill grassland (mesic) Vernal pools	Santa Rosa	Restricted
Brodiaea filifolia Thread-leaved brodiaea	Chaparral Cismontane woodland Valley/foothill grassland Vernal pool	Coastal scrub Cismontane woodland Valley/foothill grassland Vernal pools generally clay	W Riverside San Diego	
Brodiaea orcuttii Orcutt's brodiaea	Closed-cone conifer forest Chaparral Cismontane woodland Meadow and seep Ultramafic Valley/foothill grassland Vernal pool Wetland	Closed-cone conifer forest Chaparral Cismontane woodland Meadows Valley/foothill grassland Vernal pools generally clay sometimes serpentinite	W Riverside San Diego	
Castilleja campestris ssp. *succulenta* Succulent owl's clover	Vernal pool Wetland	Vernal pools	S. Sierra Foothill	Restricted
Chamaesyce hooveri Hoover's spurge	Vernal pool Wetland	Vernal pools	NE Sacramento S Sierra Foothill	
Downingia concolor var. *brevior* Cuyamaca Lake downingia	Meadow and seep Vernal pool Wetland	Meadows (mesic) Vernal pools	San Diego	Restricted
Downingia pusilla	Valley/foothill grassland	Valley/foothill grassland (mesic)	NW Sacramento	

Dwarf downingia	Vernal pool Wetland	Vernal pools	NE Sacramento SE Sacramento Lake-Napa Santa Rosa Solano-Colusa S. Sierra Foothill	
Dudleya blochmaniae ssp. *blochmaniae* Blochman's dudleya	Coastal bluff scrub Coastal Scrub Valley/foothill grassland	Coastal bluff scrub Coastal scrub Valley/foothill grassland generally rocky, often clay or serpentinite	Santa Barbara	
Dudleya variegata Variegated dudleya	Chaparral Cismontane woodland Coastal scrub Valley/foothill grassland Vernal pool Wetland	Chaparral Cismontane woodland Coastal scrub Valley/foothill grassland Vernal pools generally clay	San Diego	
Eryngium aristulatum var. *hooveri* Hoover's button-celery	(Taxon tracked but no occurrence information currently in the NDDB.)	Vernal pools	Carrizo	Restricted
Eryngium aristulatum var. *parishii* San Diego button-celery	Coastal scrub Valley/foothill grassland Vernal pool Wetland	Coastal scrub Valley/foothill grassland Vernal pools generally mesic	W Riverside San Diego	
Eryngium constancei Loch Lomond button-celery	Vernal pool Wetland	Vernal pools	Lake-Napa	Restricted
Eryngium spinosepalum Spiny-sepaled button-celery	Valley/foothill grassland Vernal pool Wetland	Valley/foothill grassland Vernal pools	S Sierra Foothill	Restricted
Ferocactus viridescens	Chaparral	Chaparral	San Diego	

San Diego barrel cactus	Coastal scrub Valley/foothill grassland Vernal pool	Coastal scrub Valley/foothill grassland Vernal pools		
Gratiola heterosepala Boggs Lake hedge-hyssop	Vernal pool Wetland	Marshes and swamps (lake margins) Vernal pools	Modoc Plateau NW Sacramento NE Sacramento SE Sacramento Lake-Napa Solano-Colusa S Sierra Foothill	
Hemizonia parryi ssp. *australis* Southern tarplant	(Taxon tracked but no occurrence information currently in the NDDB.)	Marshes and swamps (estuary margins) Valley/foothill grassland (vernally mesic) Vernal pools	Santa Barbara San Diego	
Hordeum intercedens Vernal barley	(Taxon tracked but no occurrence information currently in the NDDB.)	Valley/foothill grassland (saline flats and depressions) Vernal pools	Central Coast San Joaquin S. Sierra Foothill	
Horkelia bolanderi Bolander's horkelia	Cismontane woodland Vernal pool Wetland	Lower montane conifer forest Meadows (edges, vernally mesic) Valley/foothill grassland (edge habitats)	Lake-Napa	Restricted
Juncus leiospermus var. *ahartii* Ahart's dwarf rush	Vernal pool Wetland	Vernal pools	NE Sacramento SE Sacramento	
Juncus leiospermus var. *leiospermus* Red Bluff dwarf rush	Chaparral Cismontane woodland Valley/foothill grassland Vernal pool Wetland	Chaparral Cismontane woodland Valley/foothill grassland Vernal pools generally vernally mesic	NW Sacramento NE Sacramento	
Lasthenia burkei Burke's goldfields	Meadow and seep Vernal pool	Meadows (mesic) Vernal pools	Mendocino Lake-Napa	

	Wetland		Santa Rosa	
Lasthenia conjugens Contra Costa goldfields	Valley/foothill grassland Vernal pool Wetland	Valley/foothill grassland (mesic) Vernal pools	Mendocino+ Lake-Napa Solano Livermore Central Coast+	
Lasthenia glabrata ssp. *coulteri* Coulter goldfields	Alkali playa Salt marsh Valley/foothill grassland Vernal pool Wetland	Marshes and swamps (coastal salt) Playas Vernal pools	Carrizo San Joaquin Santa Barbara W Riverside San Diego	
Legenere limosa Legenere	Vernal pool Wetland	Vernal pools	NW Sacramento NE Sacramento SE Sacramento Lake-Napa Santa Rosa+ Solano-Colusa S. Sierra Foothill	
Lepidium latipes var. *heckardii* Heckard's pepper-grass	Valley/foothill grassland Vernal pool Wetland	Valley/foothill grassland (alkaline flats)	Solano-Colusa	Restricted
Limnanthes bakeri Baker's meadowfoam	Freshwater marsh Meadow and seep Marsh and swamp Valley/foothill grassland Vernal pool Wetland	Meadows Marshes and swamps (freshwater) Valley/foothill grassland (vernally mesic) Vernal pools	Mendocino	
Limnanthes floccosa ssp. *californica* Butte County	Valley/foothill grassland Vernal pool Wetland	Valley/foothill grassland (mesic) Vernal pools	NE Sacramento	Restricted

meadowfoam				
Limnanthes gracilis ssp. *parishii* Parish's meadowfoam	Meadow and seep Vernal pool Wetland	Meadows (vernally mesic) Vernal pools	W Riverside San Diego	
Limnanthes vinculans Sebastopol meadowfoam	Vernal pool Wetland	Meadows (mesic) Vernal pools	(Lake-Napa)* Santa Rosa	Restricted
Marsilea oligospora Nelson's pepperwort	(Taxon tracked but no occurrence information currently in the NDDB.)	Marshes and swamps Vernal pools generally muddy	Modoc Plateau San Joaquin S. Sierra Foothill	
Mimulus pygmaeus Egg Lake monkey flower	Great Basin scrub Lower montane conifer forest Meadow and seep Wetland	Great Basin scrub (clay) Lower montane conifer forest Meadows generally vernally mesic	Modoc Plateau	
Muilla clevelandii San Diego goldenstar	Chaparral Coastal scrub Valley/foothill grassland Vernal pool Wetland	Chaparral Coastal scrub Valley/foothill grassland Vernal pools generally clay	San Diego	
Myosurus minimus ssp. *apus* Little mouse-tail	Vernal pool Wetland	Vernal pools (alkaline)	San Joaquin S. Sierra W Riverside San Diego	
Navarretia fossalis Spreading navarretia	Chenopod scrub Vernal pool Wetland	Chenopod scrub Marshes and swamps (assorted shallow freshwater) Vernal pools	Santa Barbara W Riverside San Diego	
Navarretia leucocephala ssp. *bakeri* Baker's navarretia	Cismontane woodland Lower montane conifer forest Meadow and seep	Cismontane woodland Lower montane conifer forest Meadows (mesic)	NW Sacramento Mendocino Lake-Napa	

	Vernal pool Wetland	Valley/foothill grassland Vernal pools	Santa Rosa Solano	
Navarretia leucocephala ssp. *pauciflora* Few-flowered navarretia	Chaparral Vernal pool Wetland	Vernal pools (volcanic ash flow)	Lake-Napa	Restricted
Navarretia leucocephala ssp. *plieantha* Many-flowered navarretia	Meadow and seep Vernal pool Wetland	Vernal pools (volcanic ash flow)	Lake-Napa (Santa Rosa)*	Restricted
Navarretia myersii ssp. *deminuta* Pincushion navarretia	Valley/foothill grassland Vernal pool Wetland	*Navarretia myersii*: Vernal pools	Lake-Napa	Restricted
Navarretia myersii ssp. *myersii* Pincushion navarretia	Valley/foothill grassland Vernal pool Wetland	*Navarretia myersii*: Vernal pools	SE Sacramento S Sierra Foothill	
Navarretia nigelliformis ssp. *radians* Shining navarretia	Cismontane woodland Valley/foothill grassland Vernal pool Wetland	Cismontane woodland Valley/foothill grassland Vernal pools	Central Coast Carrizo San Joaquin	
Neostapfia colusana Colusa grass	Vernal pool Wetland	Vernal pools	Solano S Sierra Foothill	
Orcuttia californica California Orcutt grass	Vernal pool Wetland	Vernal pools	Santa Barbara W Riverside San Diego	
Orcuttia inaequalis San Joaquin Valley Orcutt grass	Valley/foothill grassland Vernal pool Wetland	Vernal pools	S. Sierra Foothill	Restricted
Orcuttia pilosa Hairy Orcutt grass	Vernal pool Wetland	Vernal pool	NE Sacramento S. Sierra Foothill	
Orcuttia tenuis Slender Orcutt grass	Valley/foothill grassland Vernal pool	Vernal pools	Modoc Plateau NW Sacramento	

	Wetland		NE Sacramento SE Sacramento Lake-Napa	
Orcuttia viscida Sacramento Orcutt grass	Vernal pool Wetland	Vernal pools	SE Sacramento	Restricted
Paronychia ahartii Ahart's paronychia	Cismontane woodland Valley/foothill grassland Vernal pool Wetland	Cismontane woodland Valley/foothill grassland Vernal pools	NW Sacramento NE Sacramento	
Parvisedum leiocarpum Lake County stonecrop	Cismontane woodland Valley/foothill grassland Vernal pool Wetland	Cismontane woodland Valley/foothill grassland Vernal pools generally vernally mesic depressions in rock outcrops	Lake-Napa	
Plagiobothrys strictus Calistoga popcornflower	Broadleaved upland forest Valley/foothill grassland Vernal pool Wetland	Broadleafed upland forest Meadows Valley/foothill grassland generally alkaline areas near thermal springs	Lake-Napa	
Pleuropogon hooverianus North Coast semaphore grass	Broadleaved upland forest North Coast conifer forest Vernal pool Wetland	Broadleafed upland forest Meadows North Coast conifer forest Vernal pools generally mesic	Mendocino Santa Rosa	
Pogogyne abramsii San Diego Mesa mint	Chaparral Coastal scrub Valley/foothill grassland Vernal pool Wetland	Vernal pools	San Diego	
Pogogyne douglasii ssp. *parviflora* Douglas' pogogyne	(Taxon tracked but no occurrence information currently in the NDDB.)	Chaparral Cismontane woodland Lower montane conifer	NE Sacramento Mendocino Lake-Napa	

		forest Meadows Marshes and swamps Valley/foothill grassland Vernal pools generally mesic	Santa Rosa Livermore	
Pogogyne floribunda Profuse-flowered pogogyne	(Taxon tracked but no occurrence information currently in the NDDB.)	Vernal pools	Modoc Plateau	Restricted
Pogogyne nudiuscula Otay Mesa mint	Vernal pool Wetland	Vernal pools	San Diego	Restricted
Polygonum polygaloides ssp. *esotericum* Modoc County knotweed	Great Basin scrub Meadow and seep Vernal pool Wetland	Great Basin scrub (mesic) Vernal pools	Modoc Plateau Sierra Valley	
Sagittaria sanfordii Sanford's arrowhead	Marsh and swamp Vernal pool Wetland	Marshes and swamps (assorted shallow freshwater)	NW Sacramento NE Sacramento SE Sacramento Santa Barbara	
Trichocoronis wrightii ssp. *wrightii* Wright's trichocoronis	Marsh and swamp Riparian forest Wetland	Meadows Marshes and swamps Riparian forest Vernal pools generally alkaline	W Riverside	
Trichostema austromontanum ssp. *compactum* Hidden Lake bluecurls	Closed-cone conifer forest Upper montane conifer forest	Upper montane conifer forest seasonally submerged lake margins	W Riverside	Restricted
Tuctoria greenei Greene's tuctoria	Valley/foothill grassland Vernal pool Wetland	Vernal pools	Modoc Plateau NW Sacramento NE Sacramento S Sierra Foothill	

Tuctoria mucronata Crampton's tuctoria	Vernal pool Wetland	Vernal pools	Solano-Colusa	Restricted
Scientific name Common name	Habitat Codes from the Natural Diversity Database (NDDB)	Habitat Codes from the CNPS Electronic Inventory	Vernal pool region(s) where the taxon has been found (+extirpated)	Restricted taxon -- if blank, then facultative
Animals				
Amphibians				
Ambystoma californiense California tiger salamander	Cismontane woodland Meadow and seep Riparian woodlands Valley/foothill grassland Vernal pool Wetland	Not applicable	NE Sacramento SE Sacramento Santa Rosa Solano Livermore Central Coast Carrizo San Joaquin S Sierra Foothill Santa Barbara	
Scaphiopus hammondii Western spadefoot toad	Cismontane woodland Coastal scrub Valley/foothill grassland Vernal pool Wetland	Not applicable	NW Sacramento SE Sacramento Carrizo San Joaquin S Sierra Foothill Santa Barbara W Riverside San Diego	
Crustaceans				
Branchinecta conservatio Conservancy fairy shrimp	Vernal pool	Not applicable	NW Sacramento NE Sacramento SE Sacramento	

			Solano San Joaquin S Sierra Foothill	
Branchinecta longiantenna Longhorn fairy shrimp	Valley/foothill grassland Vernal pool Wetland	Not applicable	Livermore Carrizo San Joaquin	
Branchinecta lynchi Vernal pool fairy shrimp	Vernal pool	Not applicable	NW Sacramento NE Sacramento SE Sacramento Solano Livermore Central Coast Carrizo San Joaquin S Sierra Foothill W Riverside	
Branchinecta mesovalliensis Mid-valley fairy shrimp	(Not formally described yet, no occurrences recorded in the NDDB)	Not applicable	SE Sacramento San Joaquin S. Sierra Foothill	
Branchinecta sandiegonensis San Diego fairy shrimp	Coastal scrub Vernal pool Wetland	Not applicable	(Santa Barbara)* San Diego	Restricted
Lepidurus packardi Vernal pool tadpole shrimp	Vernal pool	Not applicable	NW Sacramento NE Sacramento SE Sacramento Solano San Joaquin S Sierra Foothill	
Linderiella occidentalis California	Vernal pool	Not applicable	NE Sacramento SE Sacramento	

linderiella			Santa Rosa Central Coast San Joaquin S Sierra Foothill Santa Barbara	
Linderiella santarosae Santa Rosa Plateau linderiella	(Recently described, no occurrences recorded in the NDDB)	Not applicable	W Riverside	
Streptocephalus woottoni Riverside fairy shrimp	Coastal scrub Valley/foothill grassland Vernal pool Wetland	Not applicable	W Riverside San Diego	
Insects				
Elaphrus viridis Delta green ground beetle	Vernal pool Wetland	Not applicable	Solano	Restricted
Lytta molesta Molestan blister beetle	Vernal pool Wetland	Not applicable	San Joaquin S Sierra Foothill	

* Taxon is reported, but not documented in a region in parentheses
+ the taxon is believed to be extirpated from the region indicated

Appendix C: Plant and Animal Taxa Known to be Associated with Vernal Pools

The following table has been developed to display the range of species that are found in vernal pool habitats and to stress the species that are particularly associated with or restricted to vernal pools in California. It includes all species of plants that have vernal pools mentioned as habitat by the Jepson Manual (Hickman 1993) and by the NDDB. The plant list has also been refined using a number of regional references from specific project studies and other local biological assessments (see references at end of table). The plants listed include taxa that are considered indicators, associates, or generally occurring in the vicinity of vernal pools (see definitions below).

The same basic definitions also apply to the animals listed in the table. However, the animal list is generally restricted to species that are known to breed in pools. The reason for the difference lies in the difficulty of compiling a list of all animals that are at some time of their life cycle associated with vernal pools. Invertebrate information is based on relatively few published accounts. It is likely that the animal list will be significantly refined with much recent interest in the vernal pool fauna.

This list is preliminary and refinement is necessary, both from the standpoint of the species included and their geography. The ultimate goal will be to regionalize the flora and fauna of pools to such a point that we will be able to determine the biological representativeness of a given pool or complex within any California vernal pool region. This will greatly assist in our understanding of vernal pool conservation needs.

In the table, the range for plants is that defined by the Jepson Manual, using the standard Jepson abbreviations (Hickman 1993). Habitat listings are as the data we have access to and reference codes are all tied to the reference list following the table. Species designated by asterisks are not native to California.

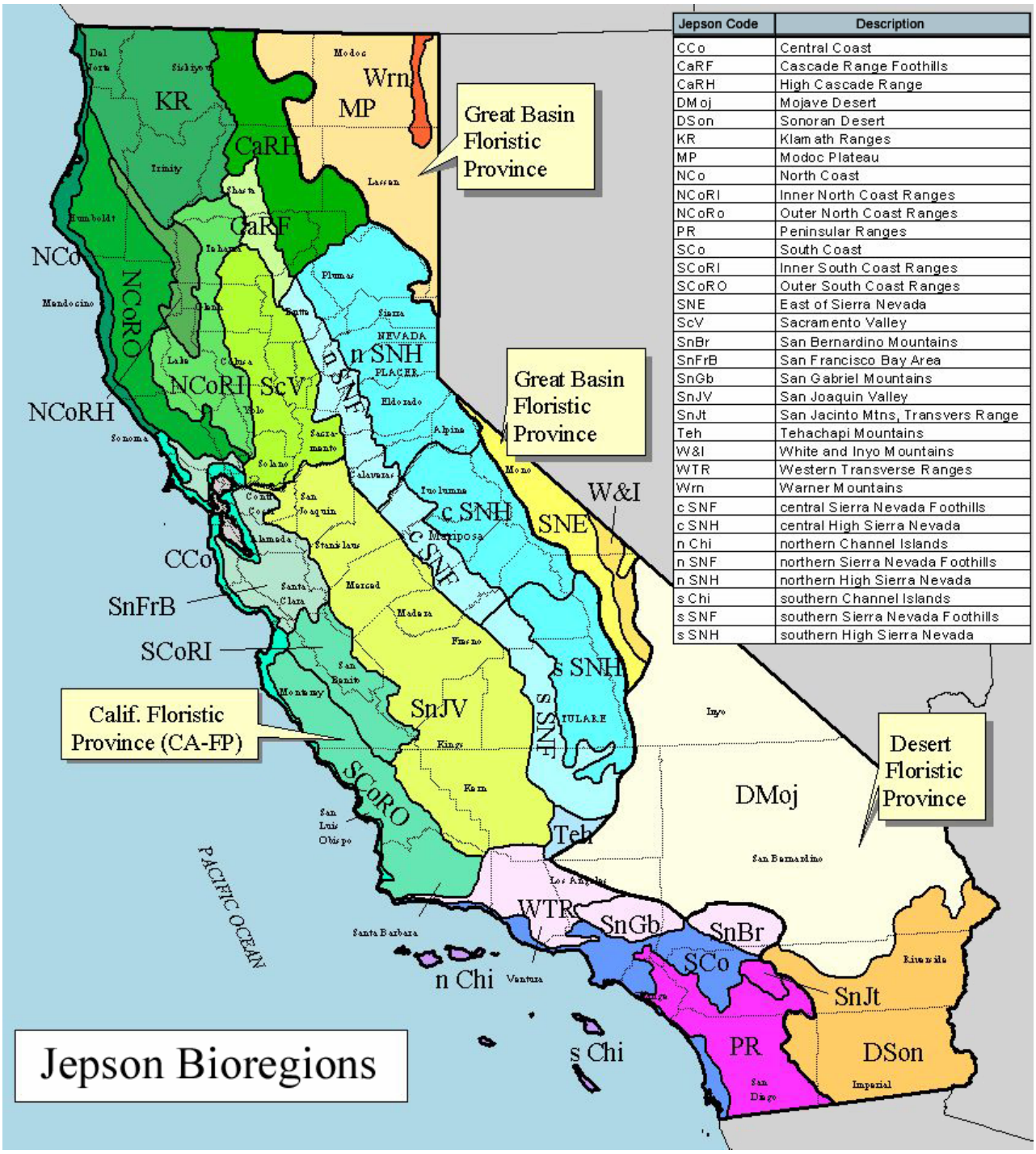

Figure 19. Map of the Jepson Bioregions

Plant Species Associated With Vernal Pools

Vernal pool indicators (vpi) = species that are restricted to vernal pools and are not known from other habitats

Vernal pool associates (vpa) = species that regularly occur in vernal pools but are not restricted to them, also occurring in other similar wetland habitats

Generalists (gen) = species that can occur in more than one habitat, either wetland or upland, or sometimes both, including vernal pools, pool margins, disturbed areas, and grasslands.

vpi? = a species that is a vpi in certain region(s) only, and can be a vpa or gen in other regions

vpa? = a species that is a vpa in certain region(s), and is gen in other regions

vpi/vpa = a species that is a vpi in some regions and a vpa in other regions, yet not known to be a gen

Scientific Name **Family, Indicator code**	**Range**	**Habitat**
Acanthomintha ilicifolia LAMIACEAE gen	s SCo, sw PR (San Diego Co)	vernal pools, clay depressions on mesas, slopes in chaparral, coastal-sage scrub
Achyrachaena mollis ASTERACEAE gen	CA-FP; s OR, n Baja	grassy areas
Agoseris heterophylla ASTERACEAE gen	CA (exc SNE, D); to BC, ID, NM, Mex.	many open habitats
Agrostis elliottiana (= *A. exigua)* POACEAE vpa	NCoRI, CaRF, n SNF, n ScV; to s US	vernal pool margins
Agrostis hendersonii POACEAE vpi	CaRF, n SNF, ScV, n SnJV; OR	vernal pools
Agrostis microphylla POACEAE vpa?	NCo, s NCoR, CCo, SCo; to BC & Baja	thin rocky soils, cliffs, sometimes on serpentine, vernal pools
*Agrostis tandilensis** POACEAE vpi	Deltaic GV (Solano Co), s SCo (San Diego Co), expected elsewhere	vernal pools
*Aira caryophyllea** POACEAE gen	NW, w CaR, SNF, GV, CW, e SW; to BC, e US, Baja; native to Europe	sandy soils, open or disturbed sites
Allium amplectans LILIACEAE gen	CA-FP; (exc SNH); to BC	clay soils incl serpentine; open or wooded places
Allium lemmonii	n&c SNH, MP; to OR, ID, NV	drying clay soils

LILIACEAE vpa?		
Allium tolmiei LILIACEAE vpa?	MP; to WQ, ID, NV	rocky clay flats
Alopecurus carolinianus POACEAE vpa?	NW, GV, SW to BC, e NAm; natural habitats in s SCo, weedy elsewhere	vernal pools, open disturbed ground
Alopecurus saccatus (*A. howellii*) POACEAE vpi?	NW, s SN, CW, GV, SW; to WA	vernal pools, moist open meadows
*Amaranthus albus** AMARANTHACEAE gen	CA; widespread NAm, to Eurasia; native to trop Am	weed of waste places, roadsides, fields
Ambrosia pumilla ASTERACEAE vpa?	s SCo (San Diego Co); Baja	rare; disturbed sites
Ammania robusta LYTHRACEAE gen	NCoR, s SNF, GV, CW, SCo, s ChI (Santa Catalina Island), DSon; to c US, Mex	wet places, drying pond and ditch margins
Amsinckia eastwoodiae BORAGINACEAE gen	NCoRI, SNF, Tih, GV, SCoR, SW	open valleys, hills
*Anagallis arvensis** PRIMULACEAE gen	CA-FP; to e NAm; native to Europe	disturbed places, ocean beaches
Aristida oligantha POACEAE gen	NW; CaRF, SNF, GV, MP; to OR, e US	dry slopes, fields, grassland shrubland, woodland
*Artemisia biennis** ASTERACEAE gen	NCoRO, SnJV, CW, SCo, WTR, SnBr, GB; NAm; native to Europe	disturbed moist soils
Artemisia cana ssp. *bolanderi* ASTERACEAE gen	CaRH, s SNH, GB; to OR, NV	gravelly soils, meadows, streambanks
Asclepias fascicularis ASCLEPIADACEAE gen	CA (exc NCo, CCo, SCo, D); to WA, UT, Baja	dry ground, valleys, foothills, along creeks in vernally wet, grassy depressions
Astragalus tener var. *ferrisiae* FABACEAE gen	presumed extinct	alkaline flats, vernally-moist meadows
Astragalus tener var. *tener*	s ScV, n SnJV, e SnFrB (where mostly extirpated)	alkaline flats, vernally-moist meadows

FABACEAE vpa		
Astragalus tener var. *titi* FABACEAE gen	c CCo, SCo (where possibly extirpated)	moist sandy depressions near coast, coastal bluffs, dunes
Atriplex cordulata CHENOPODIACEAE vpa	s ScV, SnJV	rare, saline or alkaline soils (locally abundant in alk soil of vernally wet flats)
Atriplex coronata var. *coronata* CHENOPODIACEAE vpa?	s ScV, SnJV, e SCoRI	fine, alkaline soils
Atriplex coronata var. *notatior* CHENOPODIACEAE vpa	e SCo (San Jacinto Valley, Riverside Co)	alkali sinks
Atriplex depressa CHENOPODIACEAE vpa	s ScV, SnJV	rare, alkaline or clay soils; locally common along vernal pool margins and vernally wet upland
Atriplex fruticulosa CHENOPODIACEAE vpa	Teh, s ScV, SnJV, SnFrB, SCoRI, w DMoj	clay or alkaline soils , open sites, shrubland; common in vernally wet grassy fields and along dry vernal pool margins
Atriplex joaquiniana CHENOPODIACEAE vpa?	s ScV, SnJV, SCoRI (e slope)	rare, alkaline soils
Atriplex miniscula	SnJV	rare, alkaline soils of playas, grasslands
Atriplex pacifica CHENOPODACEAE vpa?	Sco, ChI	coastal bluff scrub, coastal scrub, playas
Atriplex parishii CHENOPODIACEAE vpa?	presumed extinct; previously SW (exc ChI), w DMoj; Baja	alkaline or clay soils
Atriplex persistens CHENOPODIACEAE vpi	ScV (Glenn & Solano cos), SnJV (Merced & Tulare cos) [new sp. described in Stutz, H.C. and G. Chu. 1993. *Atriplex persistens* (Chenopodiaceaceae), a New Species from Calfornia. Madroño. 40:209-213.]	very rare, common only locally on alkaline soil of dry beds of vernal pools
Atriplex vallicola CHENOPODIACEAE vpa	SnJV	dried ponds, alkaline soils
*Bassia hyssopifolia**	CA (exc NW, SNH); widespread NAm; native to Eurasia	disturbed sites, fields, roadsides; on dry margins of

CHENOPODIACEAE gen		pools and vernally wet fields
Bergia texana ELATINACEAE vpa?	GV, SCo; to e WA, c & s US, ne Mex	moist, disturbed soils, sand bars along rivers, margins of pools
Blennosperma bakeri ASTERACEAE vpi	NCoR, ne SnFrB (s Sonoma Co)	wet grasslands, drying edges of vernal pools and along swales
Blennosperma nanum ASTERACEAE vpi?	NCoR, SNF, GV, CW, SCo, ChI	grassland, scrub, woods, gen wet, open areas
Bloomeria crocea LILIACEAE gen	SCoR, TR, PR	grassland, open woodlands, chaparral edges
*Briza minor** POACEAE gen	NCo, NCoRO, CCo, n SCoRO, n&c SNF, s ScV, n SnJV, DSon (Rancho Mirage); to OR, e US; native to s&w Europe	shaded or moist, open sites
Brodiaea filifolia LILIACEAE vpa?	s SCo (w San Diego Co), w PR (Riverside & San Diego cos), extirpated from LA & San Bern. cos	grassland, vernal pools
Brodiaea jolonensis LILIACEAE gen	SCoRO, w SW (incl Santa Cruz Island); n Baja	vernal pool margin, grassland, foothill woodland on clay
Brodiaea coronaria LILIACEAE gen	NW, CaR, n&c SN; to BC	grassland, volcanic mesas
Brodiaea minor LILIACEAE gen	n&c SNF, e ScV, ne SnJV	grassland, gravelly clay soils
Brodiaea orcuttii LILIACEAE vpa	PR (s Riverside & San Diego cos)	grassland near streams, vernal pools
*Bromus hordeaceus (=B. mollis)** POACEAE gen	CA (uncommon D); Am; native to Eurasia	open, often disturbed areas
Bromus madritensis ssp. *rubens** POACEAE gen	CA; to BC, e US, n Mex; native to Europe	open, gen disturbed places
Calandrinia ciliata PORTULACACEAE gen	CA-FP, w MP, s SNE; to NM, CAm; nw SAm	sandy to loamy soil, grassy areas, cult. fields
Callitriche heterophylla CALLITRICHACEAE vpa	CA-FP; MP; to e NAm	becoming stranded at edge of pools or streams or submersed

Callitriche heterophylla var. *bolanderi* CALLITRICHACEAE vpa	CA-FP; MP; to BC	becoming stranded at edge of pools or streams or submersed
Callitriche marginata (=C. longipedunculata) CALLITRICHACEAE vpa	CA-FP; to BC, Baja	becoming stranded (often in vernal pools) or submersed
Calochortus longebarbatus var. *longebarbatus* LILIACEAE gen	CaRH, MP; to s-c WA	vernal meadows, heavy clay soil meadows, vernally moist places in yellow pine forest, chaparral
Camissonia tanacetifolia ONAGRACEAE gen	CaR, SN, GV; to WA, ID, NV	open fields, moist slopes, clay soils
*Capsella bursa-pastoris** BRASSICACEAE gen	CA; NAm; native to Europe	disturbed sites; gardens
Cardamine oligosperma BRASSICACEAE gen	CA-FP; BC, MT, CO	wet meadows, shady banks, creek bottoms
Cardionema ramosissimum CARYOPHYLLACEAE gen	NCo, CCo, SCo; to WA, Mex, also in Chile	sandy beaches and hills, dunes, bluffs
Carex pansa CYPERACEAE gen	NCo, CCo, SnFrB, ChI; to WA	coastal sand
Castilleja attenuata (=Orthocarpus a.) SCROPHULARIACEAE gen	CA-FP; to BC, n Baja; also c Chile	grassland
Castilleja campestris (=Orthocarpus c.) SCROPHULARIACEAE vpi?	s NCoRI, CaR, n SN, GV, MP; s OR	vernal pools, moist places
Castilleja campestris ssp. *campestris* SCROPHULARIACEAE vpa	range of sp.	habitats of sp.
Castilleja campestris ssp. *succulenta* SCROPHULARIACEAE	s SNF, e SnJV	habitats of sp.

vpi		
Castilleja densiflora SCROPHULARIACEAE gen	NCoR, c SNF, s CCo, SCoR, SW; n Baja	grassland
Castilleja lacera (=Orthocarpus l.) SCROPHULARIACEAE gen	CaR, n&c SN, MP; s OR	grassland
*Centaurea solstitialis** ASTERACEAE gen	CA-FP; native to s Europe	invasive, pastures, roadsides, disturbed grassland or woodland
Centaurium muehlenbergii (=C. floribundum) GENTIANACEAE gen	NW, (esp Humboldt Co), CaRF, n SNF, s ScV, n SnJF, n&c CW, n MP; to ID, w NV	common to moist, open forest
Centaurium trichanthum GENTIANACEAE gen	NCoRI, SnFrB	alkaline or saline flats, moist chaparral or open forest
Centaurium venustum GENTIANACEAE gen	NCoRO, CaRF, SNF, e SnJV, SW (exc n ChI, esp San Diego Co), DMoj	dry scrub, grassland, forest
Centunculus minimus PRIMULACEAE vpi?	NCo, n SNF (Calaveras Co), CCo, SnFrB, SCo; to BC, e NAm, Eur, SAm	vernal pools, moist places
*Cerastium glomeratum** CARYOPHYLLACEAE gen	CA-FP (exc s SNH); native to Europe	dry hillsides, grassland, chaparral, disturbed areas
Chamaesyce hooveri EUPHORBIACEAE vpi	GV (Butte, Tehama, & Tulare cos)	vernal pools
Chamomilla occidentalis (=Matricaria o.) ASTERACEAE vpa	NCoRO, CaRH, SNH, SnJV, SnFrB, SCoRO, SCo	undisturbed alkali flats, vernal pools, edges of salt marshes
*Chamomilla suaveolens (=Matricaria matricarioides)** ASTERACEAE gen	KR, NCoR, CaRH, SN, GV, w CW, SCo; native to nw NAm, ne Asia	disturbed sites, sand bars, river banks, footpaths, roadsides, grazed land
Cicendia quadrangularis GENTIANACEAE gen	NCo, NCoRO, c SNF, GV, CCo; to OR; SAm	open places
Claytonia perfoliata	CA-FP, GB, DMtns; to BC, MT, CAm	vernally moist, often shady

PORTULACACEAE gen		or disturbed sites
Collinsia parviflora SCROPHULARIACEAE gen	CA-FP, Wrn; to BC, e Can, CO	moist, more or less shady places in mtns
*Convolvulus arvensis** CONVOLVULACEAE gen	CA; native to Europe	orchards, gardens, grassland
Conyza canadensis ASTERACEAE gen	CA; more or less worldwide	waste ground
Cordylanthus mollis ssp. *hispidus* SCROPHULARIACEAE	GV (at least Merced County)	alkaline flats
Cordylanthus palmatus SCROPHULARIACEAE vpa	GV (Colusa, Yolo, Alameda, San Joaquin, Madera, Fresno cos)	alkaline flats
*Cotula coronopifolia** ASTERACEAE gen	NCo, CCo, SCoR, SCo; native to s Africa	saline and freshwater marshes along coast
Crassula aquatica (=Tillaea a.) CRASSULACEAE vpi?	NCo, SNF, GV, CW, SW (exc n ChI); to AK, ne US, Mex, n Eurasia	salt marshes, vernal pools, ponds
Crassula connata (=Tillaea erecta) CRASSULACEAE gen	NW, SNF, GV, CW, SW, DSon; to OR, TX, n CAm; also in w SAm	open areas, locally abundant
Crassula solieri CRASSULACEAE vpi	NCoRI, CaRF, n SNF, GV, SCo; to OR, WY, TX, Baja; Chile	vernal pools
*Crassula tillaea (=Tillaea muscosa)** CRASSULACEAE gen	NCoRI, n&c SNF, GV, CCo, SW; native to Medit.	open, gravelly sites
Cressa truxillensis CONVOLVULACEAE vpa	CA-FP, DMoj; to OR, TX, Mex	saline and alkaline soils of vernally wet upland fields and drying beds of vernal pools
*Crypsis alopecuroides** POACEAE gen	KR, NCoRI, CaRH, CCo (Marin Co), SNE; to WA, e US; native to Europe	bottom-lands, reservoir and river margins
Crypsis schoenoides	CA-FP, c&e US; native to Europe	wet places

(*Heleochloa s.)** POACEAE vpa		
*Crypsis vaginiflora (= C. niliaca)** POACEAE vpa	NCoR, CaR, GV, SW (Los Angeles Co); ID; native to Eurasia	wet soils, lake margins, vernal pools
Cuscuta howelliana CUSCUTACEAE vpi	NCoRI, CaRF, n SNF, GV	esp. on *Eryngium* in vernal pools
Cuscuta salina var. *papillata* CUSCUTACEAE gen	NCo; to UT, AZ	salt flats, saline ponds; parasite of *Frankenia*, lesser on *Suaeda* and *Bassia* on vernally wet flats and margins of vernal pools
Cyperus eragrostis CYPERACEAE gen	CA-FP; OR; temp SAm	vernal pools, streambanks, ditches
Damasonium californicum ALISMATACEAE gen	NCoRI, n SNF, ScV, MP; OR, ID, NV	ponds, vernal pools, streams, ditches
Danthonia californica POACEAE gen	NW, CaR, SN, CW, SnBr, s PR, MP; w Can, w US, SAm (Chile)	gen moist, open sites, meadows, forests
Delphinium recurvatum RANUNCULACEAE vpa?	GV	poorly drained, fine, alkaline soils in grassland
Deschampsia danthonioides POACEAE vpa	CA-FP, MP; to AK, AZ, Baja, SAm	moist to drying open sites, meadows, streambanks, temporary ponds
Dichelostemma capitatum ssp. *capitatum (D. lacuna-vernalis*) LILIACEAE vpa?	CA; to OR, UT, NM, n Mex	open woodlands, scrub, desert, grassland
Distichlis spicata POACEAE vpa?	CA; s Can, US	salt marshes, moist alkaline areas
Downingia bacigalupii CAMPANULACEAE vpa	CaR, n SNH, MP; to s OR, sw ID	vernal pools, wet ditches, grassy meadows
Downingia bella CAMPANULACEAE vpi	GV (Colusa to Tulare cos), SCo (S. Rosa Plateau, Riverside Co), WTR (extreme n Ventura, s Kern cos)	vernal pools
Downingia bicornuta	NCoRI (sporadic), CaRF, SN, MP; to s OR, sw ID, w NV	vernal pools, roadside ditches, lake margins

CAMPANULACEAE vpa		
Downingia bicornuta var. *bicornuta* CAMPANULACEAE vpa	Range of sp.	habitats of sp.
Downingia bicornuta var. *picta* CAMPANULACEAE vpa	CaRF, n&c SNF	habitats of sp.
Downingia concolor CAMPANULACEAE vpa	s NCoR, w ScV, s SnFrB, c PR	vernal pools, mud flats, pond margins
Downingia concolor var. *brevior* CAMPANULACEAE vpa	c PR (Cuyamaca Lake/Mtns)	shores
Downingia concolor var. *concolor* CAMPANULACEAE vpa	s NCoR, w ScV (Lake to Solano cos), SnFrB (Monterey Co)	habitat of sp.
Downingia cuspidata CAMPANULACEAE vpa	NW, c SNF, SnJV, SCoRO, PR; Mex	vernal pools, lake margins, meadows
Downingia elegans CAMPANULACEAE vpa	NW; to WA, ID	vernal pools, wet ditches, grassy meadows
Downingia insignis CAMPANULACEAE vpa	n SNH, c GV (Glenn to Stanislaus cos), MP; w NV	vernal pools, roadside ditches, lake margins
Downingia laeta CAMPANULACEAE vpa	MP; to s-c Can, MT, WY, UT	ditches, ponds, streams, vernal pools
Downingia ornatissima CAMPANULACEAE vpa	GV	vernal pools, roadside ditches
Downingia ornatissima var. *eximia* CAMPANULACEAE vpa	ScV, n SnJV	habitats of sp.
Downingia ornatissima var. *ornatissima* CAMPANULACEAE vpa	ScV, n SnJV	habitats of sp.
Downingia pulchella CAMPANULACEAE vpa	s TEH, c&s ScV, n SnJV, s SnFrB	vernal pools, roadside ditches

Downingia pusilla (=D. humilis) CAMPANULACEAE vpa	NCoRI, s ScV, n&c SnJV; Chile	vernal pools and swales, roadside ditches, moist grasslands
Downingia yina CAMPANULACEAE vpa?	KR, CaR; to WA	boggy places near lakes, ponds, vernal pools, mtn meadows
Draba verna BRASSICACEAE gen	CA-FP, MP; circumboreal	open or disturbed areas
Dudleya blochmaniae ssp. *blochmaniae* CRASSULACEAE vpa?	s CCo, SCo; n Baja	open, rocky slopes, often serpentine or clay-dominated
Dudleya lanceolata CRASSULACEAE gen	SCoR, TR, PR, DMtns; n Baja	rocky slopes
Dudleya variegata CRASSULACEAE gen	s SCo, s PR (San Diego Co); n Baja	dry hillsides, mesas
Echinodorus berteroi ALISMATACEAE vpa?	NCoRI, GV, CW, SW; to se US, SAm	ponds, ditches
Elatine brachysperma ELATINACEAE vpi?	CA; c&s US	muddy shores, shallow pools
Elatine californica ELATINACEAE vpa?	s NCoRH (Snow Mtn), GV; to WA	pools, ponds, rice fields, stream banks
Elatine chilensis ELATINACEAE vpa	n SNH, MP (Madeline Plains, Lassen Co, Sierra Valley, Plumas Co), PR; temp SAm	muddy shores of ponds; *E. gracilis*, SN (Little Truckee River, NV Co), vernal pools, probably should be included here
Elatine heteranda ELATINACEAE vpa?	NCoR, SN	pond edges
Elatine rubella ELATINACEAE vpa?	CA; widespread in w NAm	muddy shores, shallow vernal pools, ditches, rice fields
Eleocharis acicularis CYPERACEAE vpa?	CA-FP, MP; to se US, n Mex; circumboreal	marshes, meadows, riverbanks, vernal pools in sagebrush scrub to lodgepole-pine forest
Eleocharis acicularis var. *acicularis*	CA-FP; to se US, n Mex; circumboreal	habitats of sp.

CYPERACEAE vpa?		
Eleocharis acicularis var. *bella* CYPERACEAE vpa?	NW, CaR, SN, MP; to WA, n-c US, n Mex	marshes in sagebrush scrub to lodgepole-pine forest
Eleocharis macrostachya (E. palustris) CYPERACEAE vpi?	CA; temp, montane w hemisphere	marshes, pond margins, vernal pools, ditches
Eleocharis montevidensis CYPERACEAE gen	NW, CW, SW; to TX, SAm	moist, often sandy openings
*Eleocharis pachycarpa** CYPERACEAE vpa?	n NCoRO (Humboldt Co), SN (Amador & El Dorado cos); NV; native to Chile	saltmarshes, vernal pools
Eleocharis parishii CYPERACEAE gen	CA (exc MP); to OR, NV, MN, n Mex	moist, often sandy openings
Elymus glaucus POACEAE gen	CA; to AK, Great Plains, n Mex	open areas, chaparral, woodland, forest
Epilobium brachycarpum ONAGRACEAE gen	CA-FP, (exc ChI), MP; to BC, SD, NM, also e Can; introd. to SAm	dry open woodland, grassland, roadsides
Epilobium cleistogamum ONAGRACEAE vpa?	SNF, GV, SCoRO	vernal pools, clay flats
Epilobium densiflorum ONAGRACEAE gen	CA-FP (exc SCo, ChI); to BC, MT, n Baja	streambanks, outwashes
Epilobium minutum ONAGRACEAE gen	NW, CaR, n&c SN, ScV, CW, MP; to BC, MT, w NV	dry open disturbed areas, vernal pools, often after fire
Epilobium pallidum ONAGRACEAE gen	CaR, nSNF, ScV, MP; to sw OR, ID	streambanks, moist slopes
Epilobium pygmaeum (Boisduvalia glabella) ONAGRACEAE vpi?	CA-FP (exc ChI, e TR), MP; to w Can, ND, UT, n Baja	vernal pools, clay mud flats
Epilobium torreyi ONAGRACEAE vpa?	NW (exc NCo), CaR, SN, GV, SnFrB, SCoRO, MP, sw DMoj; to BC, ne NV	streambanks, moist slopes
Eremocarpus setigerus	CA-FP, w D; to WA	dry open often disturbed areas

EUPHORBIACEAE gen		
*Erodium botrys** GERANIACEAE gen	CA-FP; native to s Europe	dry open or disturbed sites
*Erodium cicutarium** GERANIACEAE gen	CA; widespread US; native to Eurasia	open, disturbed sites, grassland, shrubland
*Erodium moschatum** GERANIACEAE gen	CA-FP; native to Europe	open disturbed sites
Eryngium alismaefolium APIACEAE vpa	CaRH, MP; to OR, ID, NV	vernal pools, flooded meadows
Eryngium aristulatum APIACEAE vpi?	NCoR, SnFrB, SCoR, SCo; Baja	vernal pools, ditches, etc.
Eryngium aristulatum var. *aristulatum* APIACEAE vpa?	NCoR, SnFrB	vernal pools, lake shores, drying lakes, wet depressions
Eryngium aristulatum var. *hooveri* APIACEAE vpa?	s SnFrB, SCoR	vernal pools, lagunas
Eryngium aristulatum var. *parishii* APIACEAE vpi?	s SCo, PR (San Diego & Riverside cos); Baja; now apparently confined to mesas near San Diego, Santa Rosa Mesa	vernal pools, marshes
Eryngium armatum APIACEAE vpa?	NCo, CCo	depressions in coastal prairie, bluffs
Eryngium castrense APIACEAE vpa?	CaRF, n&c SNF, adjacent GV	vernal pools, wet depressions, pond margins
Eryngium constancei APIACEAE vpi	NCoR (Lake Co)	vernal pools in meadows
Eryngium mathiasiae APIACEAE vpa	MP	roadside ditches, wet depressions
Eryngium pinnatisectum APIACEAE vpa	near boundary of n&c SNF, adjacent GV (Amador, Calaveras, Sacramento, & Tuolumne cos)	vernal pools, wet depressions
Eryngium racemosum APIACEAE gen	n SnJV, adjacent SNF	seasonally flooded clay depressions in riparian scrub

Eryngium spinosepalum APIACEAE vpi	e SNJV, adjacent SNF	vernal pools, depressions
Eryngium vaseyi APIACEAE vpi/vpa	ScV, SCoRI, SCo	vernal pools, (alkaline) depressions
Ferocactus viridescens CACTACEAE gen	SCo (San Diego Co); Baja	sandy to rocky areas
Frankenia salina (=F. grandifolia) FRANKENIACEAE vpa?	GV, CCo, SCo, ChI, SNE, DMoj; to NV, Mex, SAm	seasonally flooded salt marshes, alkali flats, border of vernal pools
Fritillaria liliacea LILIACEAE gem	CW	rare; heavy soil, open hills and fields near coast
Fritillaria pluriflora LILIACEAE gen	NCoRI, n SNF, edges of ScV, s OR	rare; adobe soil of interior foothills
*Gastridium ventricosum** POACEAE gen	CA-FP, MP; to OR, Can, ne US; native to Europe	open, gen dry, disturbed sites
*Geranium dissectum** GERANIACEAE gen	CA-FP; to e NAm; native to Europe	open disturbed sites
*Geranium molle** GERANIACEAE gen	CA-FP; widespread in NAm; native to Europe	open to shaded sites, disturbed ground
Glyceria occidentalis POACEAE gen	NCo, NCoRO, n SNH, ScV, CCo; to BC, ID	wet places
Gnaphalium palustre ASTERACEAE vpa?	most of CA (exc MP); to w Can, MT, NM	moist places (vernal pools, dry bed of marshes, edge of flooded plain)
Gratiola ebracteata SCROPHULARIACEAE vpa	n&c CA-FP; to BC, MT	wet muddy places
Gratiola heterosepala SCROPHULARIACEAE vpi	NCoRI, c SNF, ScV, MP	shallow water, margins of vernal pools
Gratiola neglecta SCROPHULARIACEAE vpa?	c NCo (Mendocino Co), w KR (Humboldt Co), CaRH, n&c SNH, MP	wet muddy places, vernal pools, sandbars

Grindelia camporum var. *bracteosum* ASTERACEAE gen	sw GV, s SCoRO, SCo, WTR, PR; Baja	clay or sandy roadsides, stream-banks, dry washes
Grindelia camporum var. *camporum* ASTERACEAE vpa?	NCoRI, GV, SnFrB, SCoRO, SW	sandy or saline bottomlands, fields, roadsides, dry margins of vernal pools, and similar vernally wet but summer dry places
Grindelia nana ASTERACEAE gen	CaR, MP, (introd elsewhere); to WA, MT, ID	dry, sandy hills, fields, roadsides
Heliotropium curassavicum BORAGINACEAE gen	CA; NV, AZ; subtrop, trop Am	moist to dry saline soils, vernally wet depressions, beds of vernal pools
Hemizonia fitchii ASTERACEAE gen	NW, CaRF, n&c SNF, n&c GV, SCoR, n ChI (S.C. Isl), n SnBr; sw OR	fields, open woodland
Hemizonia fasciculata ASTERACEAE gen	s CCo, s SCoRO, SW; to c Baja	coastal grassland, wooodland
Hemizonia increscens ssp. *increscens* ASTERACEAE gen	CCo, SnFrB (uncommon), SCoR, n SCo, n ChI	coastal grassland, foothills
Hemizonia parryi ASTERACEAE gen	sw NCoR, w CW, w SW; nw Baja	seasonally wet (often saline or alkaline) grassland near coast
Hemizonia parryi ssp. *australis* ASTERACEAE gen	SCo; n Baja	seasonally moist (alkaline) grassland
Hemizonia pungens ASTERACEAE gen	CaRF, GV, SCoR, alien in SW; to WA	grassland, depressions, marshes
Hemizonia pungens ssp. *septentrionalis* ASTERACEAE gen	CARF, ScV; to WA	grassland, abundant on margins of drying vernally wet flats and drainages
Hesperevax caulescens ASTERACEAE vpa?	s SNF, n&c GV, sw PR	dry mud of vernal pools and flats
Holocarpha virgata ASTERACEAE gen	NCoRI, n&c SNF, GV, ne CW, c&s SCo	grassland
Holosteum umbellatum var.	KR, CaR, CCo; native to c, e, &s Europe	disturbed areas

umbellatum CARYOPHYLLACEAE gen		
Hordeum brachyantherum POACEAE gen	CA (exc D); to AK, Rocky Mtns, Mex, Eurasia	meadows, pastures, streambanks
Hordeum brachyantherum ssp. *californicum* POACEAE gen	CA-FP; OR	habitat of sp.
Hordeum depressum POACEAE vpa?	CA (exc mtns); to WA, ID	moist sites, vernal pools, gen. alkaline soils
Hordeum intercedens POACEAE vpa?	SW; nw Baja	vernal pools, dry saline streambeds, alkaline flats
Hordeum murinum ssp. *gussoneanum (H. geniculatum)** POACEAE gen	CA (exc mtns); to BC, ID, AZ; native to Europe	dry to moist, disturbed sites
Hordeum murinum ssp. *glaucum** POACEAE gen	CA; to BC, e US, n Mex; native to Europe	moist, gen disturbed sites
Hordeum murinum ssp. *leporinum** POACEAE gen	range of *H. m.* ssp. *glaucum*	habitat of *H. m.* ssp. *glaucum*
Horkelia bolanderi ROSACEAE vpa	NCoRI (Colusa, Lake, & Menocino? cos)	edges of vernally wet places in pine forest
Horkelia cuneata ROSACEAE gen	CCo, SCoRO, SCo	old dunes, open chaparral
Hutchinsia procumbens BRASSICACEAE gen	CA (exc KR, SNH); to BC, Labrador, Baja, also Europe	alkali flats, saline seeps, shaded sites, sagebrush, juniper woodland
*Hypochaeris glabra** ASTERACEAE gen	CA-FP; native to Europe	weed of disturbed places
Idahoa scapigera BRASSICACEAE gen	CaR, SnFrB (Mount Hamilton), NCoRI (Mount St. Helena), nSN, s SNF, SCoRI, GB; to BC, MT	moist ledges, slopes, meadows, foothills
Isoetes howellii	NCoR, CaRF, SNF, SnFrB, SCoR, SCo,	vernal pools, lake margins

ISOETACEAE vpi?	PR; to WA, MT, UT	
Isoetes nuttallii ISOETACEAE gen	NCoR, SaRF, SN, n SnJV, SnFrB, SCoRO, SCo, PR; to BC	seasonally wet soil, temporary streams
Isoetes orcuttii ISOETACEAE vpi	n SNH, GV, SCo, PR; Baja	vernal pools
Ivesia aperta ROSACEAE gen	n SNH, MP	great basin scrub, vernally moist meadows, vernal pools
Ivesis sericoleuca ROSACEAE vpa	n SNH	vernal pools, vernally moist meadows
Juncus bufonius JUNCACEAE vpa?	CA; more or less worldwide	moist (sometimes saline) open or disturbed places
Juncus bufonius var. *bufonius* JUNCACEAE vpa?	CA; more or less worldwide	moist (sometimes saline) open or disturbed places
*Juncus capitatus** JUNCACEAE vpa?	CaRF, n SNF, GV; scattered in s-c US; native to Eurasia, n Afr	vernal pools
Juncus kelloggii JUNCACEAE vpa?	NCo, NoCR, ScV, CCo; to BC	damp sandy or clay soils, vernal pools, seeps, fields, meadows
Juncus leiospermus var. *ahartii* JUNCACEAE vpi	e ScV, ne SnJV (Butte & Calaveras cos)	vernal pool margins
Juncus leiospermus var. *leiospermus* JUNCACEAE vpa	n ScV, CaRF (Shasta, Tehama, & Butte cos)	habitat of sp.
Juncus mexicanus JUNCACEAE gen	CA (exc GV); to WA, CO, TX, SAm	coast to montane meadows
Juncus occidentalis (=J. tenuis var. *congestus)* JUNCACEAE gen	NCo, CCo, n & c SN; OR, NV, AZ	moist areas
Juncus phaeocephalus JUNCACEAE vpa?	NCo, n SNH, CCo, SnFrB, SCo, n ChI, SnBr, PR	moist places
Juncus phaeocephalus var.	NCo, nSNH, CCo, SnFrB, SCo, n ChI,	coastal meadows and

phaeocephalus JUNCACEAE vpa?	SnBr, PR	borders of marshes
Juncus rugulosus JUNCACEAE vpa?	s SNF, CCo, TR, PR, DMtns	wet places
Juncus tenuis JUNCACEAE vpa?	NW, CW; and more or less worldwide	damp places
Juncus tiehmii JUNCACEAE vpa?	SN, SCoR, TR, PR; to OR, ID, NV, Baja	bare, moist granitic sand of seeps, streamsides, meadows
Juncus triformis JUNCACEAE vpa?	SN, SnJV, SCo, PR	vernal pools, granitic seeps
Juncus uncialis JUNCACEAE vpi?	KR, NCoRI, GV, SCoRO, SCo, MP; OR, NV	vernal pool margins, other drying places
Juncus xiphioides JUNCACEAE gen	CA; OR, AZ, Baja	wet places
Lasthenia burkei ASTERACEAE vpi	s NCoRI (s Mendocino, s Lake, & ne Sonoma cos)	vernal pools, wet meadows
Lasthenia californica (=L. chrystostoma) ASTERACEAE vpa?	CA-FP; w DMoj; sw OR, AZ, Mex.	many habitats, highly variable and abundant (e.g. vernally moist alkaline flats, grassy uplands)
Lasthenia chrysantha ASTERACEAE vpa	s ScV, SnJV	vernal pools, wet saline flats
Lasthenia conjugens ASTERACEAE vpi	formerly NCo, s ScV, SnFrB, SCo; now deltaic ScV (Napa & Solano cos)	vernal pools
Lasthenia coronaria ASTERACEAE vpa?	SCo, PR, w D; nw Baja	sunny, open places
Lasthenia ferrisiae ASTERACEAE vpi	ScV (2 stations), SnJV	vernal pools or wet saline flats
Lasthenia fremontii ASTERACEAE vpi/vpa	GV	vernal pools, wet meadows
Lasthenia glaberrima ASTERACEAE vpi?	NCoR, ScV, n SnJV, CW, MP (rare); to sw WA	vernal pools, wet places

Lasthenia glabrata ASTERACEAE vpa	NCoRI, Teh, ScV, n SnJV, SnFrB, SCoRO, SCo, n ChI (Santa Rosa Isl), PR, w DMoj	vernal pools
Lasthenia glabrata ssp. *coulteri* ASTERACEAE vpa	Teh (1 station), s SCoRO, SCo, n ChI (Santa Rosa Isl), PR, w DMoj	vernal pools
Lasthenia glabrata ssp. *glabrata* ASTERACEAE vpa	NCoRI, ScV, n SnJV, SnFrB, n SCoRO	vernal pools
Lasthenia platycarpha ASTERACEAE vpa	ScV, n SnJV, SnFrB (very uncommon)	vernally moist alkali flats
Layia chrysanthemoides ASTERACEAE gen	NCo, NCoR, GV, CW	grassy or open heavy soil
Layia fremontii ASTERACEAE gen	c NCoR (Mendocino Co), CaRF, SNF, GV	grassy slopes in heavy soil
Legenere limosa CAMPANULACEAE vpi	s NCoR, s ScV, n SnJV, SnFrB (Santa Cruz Mtns)	wet areas, vernal pools
Lemna miniscula LEMNACEAE gen	CA exc MP; w US, SAm, Eur, n Asia	freshwater
Lepidium dictyotum BRASSICACEAE gen	CA (exc NW, SN); to WA, Baja	saline soils, dry streambeds, fields
Lepidium dictyotum var. *acutidens* BRASSICACEAE gen	CaR, GV, SW, MP; to WA, Baja	alkaline flats, streambeds, abundant on vernally wet grassy flats and near vernal pools
Lepidium jaredii ssp. *jaredii* BRASSICACEAE vpa?	ScoRI, SnSJV	alkali bottoms, slopes, washes
Lepidium latipes var. *heckardii* BRASSICACEAE vpa	s ScV (Yolo Co)	rare, alkaline flats, locally abundant in vernally moist alkaline fields
Lepidium latipes var. *latipes* BRASSICACEAE vpa?	NCo, NCoR, GV, CCo, SnFrB, SCoRI, SCo; Baja	alkaline soils, fields, vernal pools, grassland
Lepidium nitidum BRASSICACEAE vpa?	CA (exc e D); to c US	alkaline soils, flats, slopes, pools

Lepidium nitidum var. *nitidum* BRASSICACEAE vpa?	range of sp.	meadows, alkaline flats, vernal pools
Lepidium oxycarpum BRASSICACEAE gen	GV, CW; probably alien in BC	fields, vernal pool margins, alkaline flats
Leymus triticoides POACEAE gen	CA (exc D); to WA, Rocky Mtns, TX	moist, often saline, meadows
Lilaea scilloides JUNCAGINACEAE vpi?	NCo, NoCRI, SN, GV, CW, SCo, PR, GB; to Can, MT, Mex, Chile; naturalized in Australia	vernal pools, ditches, streams, ponds, lake margins
Limnanthes alba LIMNANTHACEAE vpa	s NCoR, CaRF, n&c SNF, s SNH, GV	winter-wet grasslands, woodlands, edges of vernal pools, ephemeral streams
Limnanthes alba ssp. *alba* LIMNANTHACEAE vpa	s NCoR, n&c SNF, GV	winter-wet grassland, woodland
Limnanthes alba ssp. *versicolor* LIMNANTHACEAE vpa	CaRF, n & c SNF, n SNH	habitats of sp.
Limnanthes bakeri LIMNANTHACEAE vpi?	c NCoRO (near Willits, Mendocino Co)	vernal pools, marshy margins
Limnanthes douglasii LIMNANTHACEAE vpa	NCo, NCoR, CaRF, c SNF, GV, CCo, SnFrB, SCoR; sw OR	wet meadows, edges of vernal pools, ephemeral streams
Limnanthes douglasii ssp. *douglasii* LIMNANTHACEAE vpa	NCo, NCoRO, CCO, SnFrB; sw OR	wet meadows
Limnanthes douglasii ssp. *nivea* LIMNANTHACEAE vpa	NCoR, SnFrB, SCoR	wet meadows, edges of vernal pools, ephemeral streams
Limnanthes douglasii ssp. *rosea* LIMNANTHACEAE vpa	NCoRI, CaRF, c SNF, GV	wet meadows, edges of vernal pools
Limnanthes floccosa LIMNANTHACEAE vpa	KR, NCoRI (near Kelseyville, Lake Co), CaR, ScV	moist meadows, vernal pools
Limnanthes floccosa ssp. *californica*	ScV (Butte Co)	vernal pool edges

LIMNANTHACEAE vpi		
Limnanthes floccosa ssp. *floccosa* LIMNANTHACEAE vpa	KR, CaR, NCoRI (near Kelseyville, Lake Co)	moist meadows, vernal pools
Limnanthes gracilis ssp. *parishii* LIMNANTHACEAE vpa	PR	moist meadows, ephemeral stream edges
Limnanthes striata LIMNANTHACEAE vpa?	KR, n&c SNF	vernal pools, stream edges
Limnanthes vinculans LIMNANTHACEAE vpi	s NCoRO (s Sonoma Co)	wet meadows, vernal pools
Limosella aquatica SCROPHULARIACEAE gen	CaR, SNH, CCo, SnFrB, SnBr, MP; to AK, e NAm, Eurasia	wet, muddy, periodically flooded places
*Lolium multiflorum** POACEAE gen	CA-FP; to AK, e NAm; native to Europe	disturbed sites, abandoned fields
*Lolium perenne** POACEAE gen	same as *L. multiflorum*	same as *L. multiflorum*
*Lotus corniculatus** FABACEAE gen	CA (exc D); to n US; native to Eurasia	disturbed areas, vernally wet and marshy places
Lotus purshianus FABACEAE gen	CA (exc DSon); to Can, c US, Mex	coast, chaparral, mtn forests, water courses, roadsides, other weedy areas
Lotus rubriflorus FABACEAE gen	NCoRI (Colusa Co), SnFrB (Stanislaus Co)	oak woodland, grassland
Lupinus arboreus FABACEAE gen	NCo, CCo (probably native to Sonoma to Ventura cos, naturalized farther n)	coastal bluffs, dune, or more inland
Lupinus nanus FABACEAE gen	CA-FP (exc s SW); to BC	open or disturbed areas
*Lythrum hyssopifolium** LYTHRACEAE vpa?	CA-FP, to e US; native to Europe	marshes, drying pond margins; vernal pools
*Lythrum tribracteatum**	GV, SnFrB, n MP; native to s Europe	wet areas, drying ponds, ditches, drying margins of

LYTHRACEAE vpa?		vernal pools
Madia sativa ASTERACEAE gen	NW, CW, SW; to AK, n Baja; also sw SAm	coastal grassland
Malvella leprosa (=Sida l. var. *hederacea)* MALVACEAE gen	CA (esp GV); to WA, ID, TX, Mex, SAm	valleys, orchards, gen in saline soil
Marsilea oligospora MARSILEACEAE vpa?	KR, n SNH, MP; to WA, MT, WY	creek beds, flood basins, vernal pools, etc. (aquatic)
Marsilea vestita MARSILEACEAE vpa?	KR, NCoRI, CaR, s SNF, SNH, GV, CCo, SnFrB, SCoRO, SCo, WTR, SnBr, PR, MP, DSon; to w&c Can, Mex, also Peru	habitats more or less as *M. oligospora*
*Mentha pulegium** LAMIACEAE vpa?	NW, SnJV, CW, SCo; to OR, e US; native to Europe	moist areas, ditches
Microseris campestris ASTERACEAE gen	c & s SNF, SnJV, e CW	open clay grasslands, often near vernal pools
Microseris douglasii ASTERACEAE gen	NCoR, SNF, Teh, GV, CW, SCo, ChI; OR, Baja	inland clay soils, grassland, often near vernal pools or serpentine outcrops
Microseris douglasii ssp. *douglasii* ASTERACEAE gen	range of sp. exc ChI	habitats of sp.
Microseris douglasii ssp. *platycarpha* ASTERACEAE gen	c&s SCo, s ChI; Baja	habitats of sp.
Microseris douglasii ssp. *tenella* ASTERACEAE gen	w-c GV, CW, SCo, n ChI	habitats of sp.
Microseris elegans ASTERACEAE gen	NCoR, SNF, GV, CW, SCo, ChI; Baja	gen. inland clay grassland, often near vernal pools
Mimulus angustatus SCROPHULARIACEAE vpa?	c NCoRO (Longvale, Mendocino Co), s NCoRI, CaRF, n SNF, SnJV (Pinehurst, Fresno Co)	vernally wet depressions
Mimulus floribundus SCROPHULARIACEAE	CA-FP (esp c & s SNF); to BC, SC, n Mex	crevices, seeps around granite outcrops, near streams

gen		
Mimulus guttatus SCROPHULARIACEAE vpa?	CA; to AK, w Can, Rocky Mtns, n Mex	wet places, gen terrestrial, sometimes emergent or floating mats
Mimulus latidens SCROPHULARIACEAE vpa?	NCoRI, GV, CW, e SCo (Menifee Valley, w Riverside Co); Baja	vernally wet depressions
Mimulus pulchellus SCROPHULARIACEAE vpa?	n&c SNF (Calaveras, Tuolumne, & Mariposa cos)	vernally wet depressions
Mimulus pygmaeus SCROPHULARIACEAE vpa	s CaRH, n SNH (Lake Almanor region, Plumas Co), MP (Egg Lake, Modoc Co, w of Eagle Lake, Lasssen Co); s OR	vernally wet depressions
Mimulus tricolor SCROPHULARIACEAE vpi	s NCoRO (s Sonoma Co); NCoRI, e GV, sw MP; OR	vernally wet depressions
Monardella undulata LAMIACEAE gen	CCo, SnFrB	dunes, sandy soils in sagebrush scrub
Montia fontana PORTULACACEAE vpa?	CA (exc D); to AK, e NAm; and more or less worldwide	ponds, streams, vernal pools, seeps, ditches
Muhlenbergia richardsonis POACEAE gen	KR, CaRH, SNH, SCoRO, TR, SnJt, GB, DMtns; to Can, ne US, Mex	open sites, moist meadows, talus slopes, along streams
Muilla clevelandii LILIACEAE vpa	s SCo (sw San Diego Co)	mesa grassland, scrub edges
Muilla maritima LILIACEAE vpa?	c&w NW, CW, SW, uncommon in c SNF, GV, w D; Baja	grassland, open scrub, woodland, in alkaline, granitic, or serpentine soils
Myosurus apetalus RANUNCULACEAE vpa?	KR, CaR, SN (exc Teh), ScV, SnBr, MP; to BC, MY, CO, Chile	wet places, vernal pools, marshes, shrubland
Myosurus minimus RANUNCULACEAE vpa	NCoR, CaRF, SNF, GV, SnFrB, s SCoRO, SCo, SnJt, MP; to BC, e US, Eurasia	wet places, vernal pools, marshes
Myosurus sessilis RANUNCULACEAE vpa?	GV; s OR	vernal pools, grassland
Nama stenocarpum	SW; to TX, Mex	intermittently wet areas

HYDROPHYLLACEAE vpa?		
Navarretia atractyloides POLEMONIACEAE vpa?	NCoR, SnFrB, SCoR, ChI, TR, PR; OR, Baja	open, rocky, or sandy areas
Navarretia eriocephala POLEMONIACEAE gen	n&c SNF, e ScV	heavy soil of seasonally wet flats
Navarretia fossalis POLEMONIACEAE vpi	s SCoRO (San Luis Obispo Co), SW; Baja	vernal pools, ditches
Navarretia hamata POLEMONIACEAE gen	SnFrB, SCoRO, SW; Baja	dry, sandy or rocky places in coastal or inland chaparral
Navarretia heteranda POLEMONIACEAE vpa	NCoRI, CaRF, w ScV, e SnFrB, SCoRI, MP; OR	heavy soil, vernal pools, wet or drying flats
Navarretia intertexta POLEMONIACEAE vpa?	KR, NCoR, CaR, SN, GV, SnFrB, SCoR, MP; to BC, MT, WY, CO, AZ, Baja	open wet areas, meadows, vernal pools
Navarretia intertexta ssp. *intertexta* POLEMONIACEAE vpa?	KR, NCoR, CaR, SNF, GV, SnFrB, SCoR; OR	habitat of sp.
Navarretia intertexta ssp. *propinqua* POLEMONIACEAE vpa?	CaR, SNH, MP; to BC, MT, WY, CO, AZ, Baja	habitat of sp.
Navarretia leucocephala POLEMONIACEAE vpi?	NCoRI, CaR, s SNH, GV, GB; to WA, NV	vernal pools
Navarretia leucocephala ssp. *bakeri* POLEMONIACEAE vpi	NCoRI, w ScV	vernal pools
Navarretia leucocephala ssp. *leucocephala* POLEMONIACEAE vpi	GV; OR	vernal pools
Navarretia leucocephala ssp. *minima* POLEMONIACEAE vpi?	CaR, n SN, GB; to WA, UT	vernal pools
Navarretia leucocephala ssp. *pauciflora*	s NCoRI (Lake & Napa cos)	vernal pools

POLEMONIACEAE vpi		
Navarretia leucocephala ssp. *plieantha* POLEMONIACEAE vpi	s NCoR (Lake & Sonoma cos)	vernal pools
Navarretia myersii ssp. *deminuta* POLEMONIACEAE vpi	NCoRI (1 site: Lake Co.)	vernal pools
Navarretia myersii ssp. *myersii* POLEMONIACEAE vpi	c SNF, c GV (4 sites: Sacramento, Amador, & Merced cos)	vernal pools
Navarretia nigelliformis POLEMONIACEAE vpi	SNF, GV, SCoRI	vernal pools, clay depressions
Navarretia nigelliformis ssp. *nigelliformis* POLEMONIACEAE vpi	range of sp.	habitat of sp.
Navarretia nigelliformis ssp. *radians* POLEMONIACEAE vpi	SCoRI	habitat of sp.
Navarretia prostrata POLEMONIACEAE vpa	w SnJV (Merced Co), SCoRI, c SCo (Los Angeles Co), PR (Santa Rosa Plateau)	alkali floodplains, vernal pools
Navarretia squarrosa POLEMONIACEAE gen	NCoR, n SNF (Sacramento, Amador cos), SnFrB, SCoR; to BC	open wet gravelly flats, slopes
Navarretia tagetina POLEMONIACEAE vpa?	n & c SNF, NCoRI, GV; to WA	open grassy flats, vernal pools
Neostapfia colusana POACEAE vpi	GV (Colusa, Merced, Solano, & Stanislaus cos)	vernal pools
Odontostomum hartwegii LILIACEAE vpa?	NCoRI, n&c SNF	clay, often serpentine soils
Ophioglossum californicum OPHIOGLOSSACEAE gen	n&c SNF, CCo, SCo; Mex	grassy pastures, chaparral, vernal pool margins
Orcuttia californica POACEAE vpi	SW (Los Angeles, Riverside, & San Diego cos); n Baja	vernal pools

Orcuttia inaequalis POACEAE vpi	SnJV (Fresno, Madera, Merced, Stanislaus, & Tulare cos)	vernal pools
Orcuttia pilosa POACEAE vpi	GV (Madera, Merced, Stanislaus, & Tehama cos)	vernal pools (rare)
Orcuttia tenuis POACEAE vpi	NCoRI (Lake Co), CaRF (Shasta & Tehama cos)	vernal pools
Orcuttia viscida POACEAE vpi	ScV (Sacramento Co)	vernal pools
*Parapholis incurva** POACEAE gen	NCo, CCo, SCo, ChI; to BC, Mex; native to Europe	disturbed, well-drained soils of salt marshes, gen above high tide level
Paronychia ahartii CARYOPHYLLACEAE gen	CaRF, ScV	rare; well-drained, rocky outcrops, often vernal pool edges, volcanic uplands
Parvisedum leiocarpum CRASSULACEAE vpa	s NCoRI (Lake Co)	dry vernal pools, rocky depressions
Parvisedum pumilum CRASSULACEAE vpa?	s NCoRO, NCoRI, n & c SNF, GV	rock outcrops, clay soils, vernal pools
Perideridia bolanderi APIACEAE gen	NW, SN, GB; to WY, UT	meadows, scrub, pine forest, blue-oak woodland, summer-dry clay soil
Perideridia bolanderi ssp. *involucrata* APIACEAE gen	n & c SNF	blue-oak woodland, in summer dry clay soil
Phacelia inundata HYDROPHYLACEAE vpa	MP, OR,NV	alkaline flats, dry lake margins
Perideridia gairdneri ssp. *gairdneri* APIACEAE vpa?	s NCo (Sonoma Co), CCo (scarce s of Monterey Co), Sco	moist places in coastal flats, grassland, pine groves
*Phalaris caroliniana** POACEAE gen	NCo, c SNF, CCo, SCoRO, SW; native to e US	disturbed areas, vernal pools
Phalaris lemmonii POACEAE vpa?	NCoRO, c SN, GV, SnFrB, SCoR, SCo	gen moist areas (shallow vernal pools), shrubland, woodland
*Phalaris paradoxa**	GV, SW; native to Medit Europe	disturbed areas

POACEAE vpa?		
*Physalis lancifolia** SOLANACEAE vpa?	GV, SnFrB, SCoRI, DSon; to TX, c Mex; native to SAm	wet places (e.g. dry bed of vernal pools), fields, waste places
Pilularia americana MARSILEACEAE vpa?	NCoRI, CaRF, n&c SNF, n SNH, GV, SCoR, SCo, WTR, PR; OR, Baja, c&se US, SAm	vernal pools, mud flats, lake margins, reservoirs, etc.
Plagiobothrys acanthocarpus BORAGINACEAE vpi	s ScV, SnJV, SCo (mesas near San Diego); Mex	vernal pools, moist clay soil
Plagiobothrys austinae BORAGINACEAE vpa?	CaRF, SNF, e ScV, ne SnJV	vernal pools, wet sites
Plagiobothrys bracteatus BORAGINACEAE vpi?	CA-FP (esp sw); sw PR, nw Mex	vernal pools, wet places in grassland, coastal sagescrub, chaparral
Plagiobothrys glaber BORAGINACEAE	GV, ScoR (extinct?)	alkaline grasslands and vernally moist areas
Plagiobothrys greenei BORAGINACEAE vpa?	NCoR, CaRF, SNF, ScV, n SnJV; OR	wet sites, grassland to woodland
Plagiobothrys hispidulus BORAGINACEAE vpa?	KR, SN,TR, PR, WA, WY, NV	moist or drying sites in mountains
Plagiobothrys humistratus BORAGINACEAE vpa?	GV (foothills)	vernal pools, wet places, grassland
Plagiobothrys hystriculus BORAGINACEAE vpa	sw ScV (Solano Co)	grassland, probably vernal pools, wet sites
Plagiobothrys leptocladus BORAGINACEAE vpi?	SW, w DMoj; to AK, c Can, Mex	gen. alkaline clay soils in vernal pools, wet places
Plagiobothrys nothofulvus BORAGINACEAE gen	CA-FP, rarely edge of D; to WA, Mex	grasslands, woodlands
Plagiobothrys stipitatus BORAGINACEAE vpa	CA-FP, GB; OR	vernal pools, wet sites
Plagiobothrys stipitatus var. *micranthus* BORAGINACEAE vpa?	CA-FP, GB; se OR	vernal pools, wet sites in grassland to conifer forests

Plagiobothrys stipitatus var. *stipitatus* BORAGINACEAE vpa	CA-FP (esp GV, NW), OR	vernal pools, wet sites in grassland
Plagiobothrys strictus BORAGINACEAE vpa	s NCoRI	moist sites near hot springs
Plagiobothrys tener BORAGINACEAE vpa?	NCoR, CaR, n SN, MP	moist meadows, stream banks in chaparral, oak woodlands, conifer forests
Plagiobothrys trachycarpus BORAGINACEAE vpa?	SnJV, SnFrB, SCo, WTR	vernal pools, wet places in grassland, scrub, chaparral, woodland
Plagiobothrys undulatus BORAGINACEAE vpi?	NCo, NCoRO, s ScV, CCo, SnFrB, SCoRO, SCo, WTR, PR	vernal pools, wet places
Plantago elongata (*P. bigelovii*) PLANTAGINACEAE vpa?	CA-FP (exc CaR, SN); to BC	saline and alkaline places, beaches, vernal pools
Plantago erecta PLANTAGINACEAE gen	CA-FP; to OR, Baja	sandy, clay, or serpentine soils, grassy slopes and flats, open woodland
*Plantago lanceolata** PLANTAGINACEAE gen	CA-FP; native to Europe	weed of waste places, lawns, roadsides, margins of pools
Pleuropogon californicus POACEAE vpa?	NW, CARF, n & c SNF	wet places, redwood, oak forests
Pleuropogon hooverianus POACEAE vpi?	s NCo, n CCo	marshy areas, redwood groves
*Poa annua** POACEAE gen	CA (esp near coast); more or less world-wide; native to Europe	disturbed moist ground, lawns, etc.
Poa napensis POACEAE vpa	se NCoRO (near Calistoga, Napa Co)	low sterile ground near hot springs
Pogogyne abramsii LAMIACEAE vpi	s SCo (San Diego Co)	vernal pools of coastal terraces
Pogogyne douglasii LAMIACEAE vpa	NCoRO, NCoRI, SNF, GV, CW	vernal pools, swales
Pogogyne douglasii ssp. *parviflora*	NCoRO	vernal pools, swales

LAMIACEAE vpi		
Pogogyne floribunda LAMIACEAE vpa	MP	vernal pools, seasonal lakes
Pogogyne nudiuscula LAMIACEAE vpi	s SCo (San Diego Co); Baja	vernal pools on coastal mesas
Pogogyne serpylloides LAMIACEAE vpa?	NCoR, n&c SNF, SnFrB, SCoRO	protected grassy areas
Pogogyne zizyphoroides LAMIACEAE vpi?/vpa	NCoRO, n&e SNF, GV, SnFrB; s OR	vernal pools, depressions
*Polycarpon tetraphyllum** CARYOPHYLLACEAE gen	NCoRO, n SNF, ScV, CCo, SCo, SnGb; native to s Europe	disturbed areas, roadsides, shaded waste areas
Polyctenium fremontii BRASSICACEAE vpa?	GB; to ID, NV	saline soils, playas, lake margins, wet meadows
*Polygonum arenastrum** POLYGONACEAE gen	CA; to e NAm, native to Europe	disturbed places
*Polygonum aviculare** POLYGONACEAE gen	CA; to WA, Atlantic Coast; native to Europe	sandy beaches, salt marshes, near the coast and alkaline places in the interior
Polygonum polygaloides ssp. *polygaloides* POLYGONACEAE vpa?	CA; to BC, MT, CO, AZ	vernally moist places
Polygonum polygaloides ssp. *confertiflorum* POLYGONACEAE vpa?	NW, CaR, n SN, MP; to WA, MT, WY	vernal pools, wet meadows
Polygonum polyglaides ssp. *esotericum* POLYGONACEAE vpa	MP (near Goose Lake, Modoc Co; Sierra Valley, s Plumas Co)	vernal pools, other seasonally wet places
*Polypogon interruptus** POACEAE vpa?	CA; to Great Plains, sc US; native to SAm	streambanks, ditches, vernal pools
*Polypogon monspeliensis** POACEAE vpa?	CA; NAm; native to s&w Europe	moist places, along streams, ditches
Potamogeton pusillus	NCo, KR, n SNF, SNH, GV, SnFrB,	shallow water, ponds, lakes,

POTAMOGETONACEAE vpa?	SCor, SW (exc ChI), GB, DMoj; circumboreal	reservoirs, ditches, vernal pools, slow streams
Potamogeton pusillis var. *pusillus* POTAMOGETONACEAE vpa?	range of sp.	habitat of sp.
Psilocarphus brevissimus ASTERACEAE vpi?	CA-FP, MP; to WA, MT, UT, nw Baja, s SAm	vernal pools and flats
Psilocarphus brevissimus var. *brevissimus* ASTERACEAE vpi?	range of sp.	habitats of sp.
Psilocarphus brevissimus var. *multiflorus* ASTERACEAE vpi?	deltaic GV, SnFrB	vernal pools, flats
Psilocarphus elatior ASTERACEAE vpa?	KR, CaR, MP; sw BC, ID	vernally moist places
Psilocarphus oregonus ASTERACEAE vpi?	n CA-FP (rare and doubtful in s CA-FP), MP; to WA, ID, Baja?	vernal pools, rarely moist slopes
Psilocarphus tenellus ASTERACEAE vpi?	CA-FP; to BC, ID, nw Baja, c Chile	vernal pools, coastal dunes, dry disturbed soils
Psilocarphus tenellus var. *globiferus* ASTERACEAE vpi?	c&s SNF, SnJV, CCo, SnFrB; c Chile	vernal pools, coastal dunes
Psilocarphus tenellus var. *tenellus* ASTERACEAE gen	CA-FP; to BC, ID, nw Baja	dry slopes on gen. disturbed soil, rarely vernal pools
Ranunculus aquatilis RANUNCULACEAE vpa?	CA-FP; (exc ChI), GB; to AK, e NAm, Mex	ponds, lake margins, marshes, rivers
Ranunculus bonariensis var. *trisepalus (=R. alveolatus)* RANUNCULACEAE vpa	n & c SNF, e GV (exc s SnJV)	clay soils, vernal pools
Ranunculus californicus RANUNCULACEAE gen	CA-FP; s OR, Baja	grassland, oak woodland, mixed-evergreen or coniferous forest

Ranunculus lobbii RANUNCULACEAE vpa?	NCo, s NCoR, CCo, SnFrB; to BC	shallow water, vernal pools, oak woodland, mixed evergreen or redwood forest
*Ranunculus muricatus** RANUNCULACEAE vpa?	NW, CaR, SNF, GV, SnFrB, SCoRO; to WA, se US, native to Europe	wet fields, ditches, vernal pools
Ranunculus orthorhynchus var. *bloomeri* RANUNCULACEAE vpa?	NCo, NCoR, deltaic GV, CCo, SnFrB; OR	meadows, wet open areas, shrubland, woodland, or forest
Rorippa curvisiliqua BRASSICACEAE gen	CA-FP; to AK, Rocky Mtns	uncommon, streambanks, seepage areas, lake shores
Rorippa nasturtium-aquaticum BRASSICACEAE gen	CA-FP; temp worldwide	aquatic: common in quiet water, streams, springs, marshes, lake margins, wet banks
Rotala ramosior LYTHRACEAE vpa?	NCoRI, n&c SN, GV; to WA, e US, SAm	irrigated fields, lake and pond margins, streams
*Rumex acetosella (=R. angiocarpus)** POLYGONACEAE gen	GB; to Can, c US, TX	lake shores, playas, wet depressions
*Rumex crispus** POLYGONACEAE gen	CA; NAm, native to Eurasia	disturbed places; vernal pools
*Rumex dentatus** POLYGONACEAE vpa?	n SnJV (possibly the only US site); native to Eurasia	wet places (common on edges of vernal pools, seasonally flooded marshes), rice fields
*Rumex pulcher** POLYGONACEAE gen	CA; native to Medit.	disturbed places
Rumex salicifolius var. *lacustris* POLYGONACEAE vpa?	GB (esp MP); s OR, NV	beds, shores of more or less salty lakes
Sagina decumbens ssp. *occidentalis* CARYOPHYLLACEAE vpa?	NW, n & c SN, GV, CCo, SCo, ChI, PR; to BC	dry streams, chaparral, grassy areas, rock outcrops, vernal pools
Sagittaria sanfordii ALISMATACEAE vpa?	n NCo(Del Norte Co), GV (where mostly extirpated), n SCo(Ventura Co, now extirpated)	ponds, ditches

*Senecio vulgaris** ASTERACEAE gen	CA (exc D); native to Eurasia	gardens, farmlands, other disturbed sites
Sesuvium verrucosum AIZOCEAE gen	GV, SCoRO, SCo WTR, PR, SNE, D; to OR, KS, SAm	moist or seasonally dry flats, margins of gen saline wetlands
Sibara virginica BRASSICACEAE vpa?	GV, to e US, Baja	borders of vernal pools, streambanks, open ground
Sidalcea calycosa ssp. *calycosa* MALVACEAE vpa	NCoRO, CaRF, SNF, n SnFrB	wet places esp. vernal pools, swales
Sidalcea hirsuta MALVACEAE gen	NCoR, CaRF, n&c SNF, GV	vernally wet places, grassland, or open woodland
*Silene gallica** CARYOPHYLLACEAE gen	CA-FP; to BC, eUS; native to Europe	fields, disturbed areas
*Soliva sessilis** ASTERACEAE gen	NW, SNF, CW, SW, expected elsewhere; native to SAm	disturbed areas, esp hard-packed paths, roadsides, lawns
*Spergularia bocconii** CARYOPHYLLACEAE gen	c SNF, GV, CCo, SCo, s ChI; OR; native to sw Eur, Medit.	salt marshes, alkaline areas, sandy soils; dessicated pools
Spergularia macrotheca var. *leucantha* CARYOPHYLLACEAE vpa?	GV, SnFrB, SCoRO, SCo, DMoj	alkaline soils, flood plains, vernal pools and meadows, marshy ground
Spergularia macrotheca var. *longistyla* CARYOPHYLLACEAE vpa?	NCo, NCoRI, GV	alkaline marshes, mud flats, meadows, hot springs
Spergularia marina CARYOPHYLLACEAE gen	NCo, NCoRO, c SNF, GV, CCo, SnFrB, SCo, ChI, PR, D; to WA, e US, SAm; Eurasia	mudflats (of drying vernal pools and ponds), alkaline fields, sandy coasts or river bottoms, salt marsh
*Spergularia rubra** CARYOPHYLLACEAE gen	NW, CaR, c SNF, n&c SNH, ScV, CW, SCo, SnGb, PR; to BC, e NAm, SAm; native to Europe	open forests, gravelly glades, meadows, mud flats, disturbed areas
*Spergularia villosa**	NCoRO, nSNF, ScV, CCo, SCoRI, s ChI; Baja; native to s SAm	sandy slopes and bluffs, clay ridges and plains, disturbed

CARYOPHYLLACEAE gen		areas; dessicated pools
Sporobolus airoides POACEAE gen	SNF, Teh, s ScV, SnJV, s SCoRO, SW, s SNE, D; to e WA, c&s US, Mex	seasonally moist alkaline areas
Stachys ajugoides LAMIACEAE vpa?	CA; to BC, Baja	gen moist places; sometimes dry hillsides, many communities
*Stellaria media** CARYOPHYLLACEAE gen	NW, CaRH, c SNF, GV, CCo, SnFrB, SCo, ChI, DSon; native to sw Europe	oak woodlands, meadows, disturbed areas
*Taeniatherum caput-medusae (=Elymus c.-m.)** POACEAE gen	NCoR, CaR, SNF, GV, n SCo, expected elsewhere; to WA, Rocky Mtns; native to Europe	open ground; bad weed spreading on the n CA ranges
Trichocoronis wrightii var. *wrightii** ASTERACEAE vpa?	GV, SCo; native to s TX, ne Mex	moist places
Trichostema austromontanum ssp. *compactum* LAMIACEAE vpa?	SnJt (Hidden Lake)	montane vernal pools
Trichostema lanceolatum LAMIACEAE gen	CA-FP; OR, Baja	dry open, gen disturbed habitats
Trichostema laxum LAMIACEAE gen	NW	gravelly streambanks or sandy soil
Trichostema rubisepalum LAMIACEAE gen	s NCoRI (Napa Co), SCoRI (c SNF (Tuolumne & Mariposa cos)	gravelly streambeds
Trifolium depauperatum FABACEAE gen	NCoR, CaRF, SNF, n&c SNH, Teh, GV, CW, SCo, ChI, PR; w NAm, SAm	salt marshes, grassland, coastal woodlands, openings, wet meadows, ditches, roadsides, other disturbed places, open alkaline or spring-moist, heavy soils
Trifolium depauperatum var. *amplectens* FABACEAE gen	GV, SnFrB; to BC	grasslands, coastal woodlands
Trifolium variegatum	CA-FP, SNE; sporadic to BC, MT, CO, AZ, Baja	most variable of CA clovers, from fields, wet sites, to

FABACEAE vpa?		forests and woodland
Triphysaria eriantha SCROPHULARIACEAE gen	CA-FP, sw OR	grassland, foothills, coastal fields
Triphysaria pusilla SCROPHULARIACEAE gen	NCoR, c SNF, CW; to BC	grassland
Triphysaria versicolor ssp. *faucibarbata* SCROPHULARIACEAE gen	NCoR	grassland
Triteleia hyacinthina (*Brodiaea h.)* LILIACEAE vpa?	NW, CaR, SN, GV, n&c CW; to BC, ID	grassland, vernally wet meadows
Triteleia peduncularis LILIACEAE vpa?	NW, n&c CW	wet grassland, vernal streams and pools, often serpentine
Tuctoria greenei POACEAE vpi	GV (Butte, Fresno, Madera, Merced, San Joaquin, Stanislaus, Tehama, & Tulare cos)	vernal pools (rare)
Tuctoria mucronata POACEAE vpi	sw ScV (Solano Co)	vernal pools, grassland
Verbena bracteata VERBENACEAE gen	CaR, GV, SCoR, SW, GB, D; to BC, e NAm, n Mex	open disturbed places, pond or lake margins
Verbena lasiostachys var. *scabrida (=V. robusta)* VERBENACEAE gen	s NW, s SNF, Teh, CW, SCo, ChI (exc San Clemente Island), WTR, w PR; Baja	open dry to wet places
Veronica peregrina ssp. *xalapensis* SCROPHULARIACEAE vpa?	CA-FP; to w Can, Mex, SAm	moist places (like floor of drying vernal pools)
*Vulpia bromoides** POACEAE gen	CA-FP; to e US; native to Europe	dry disturbed places, coastal-sage scrub, chaparral
*Vulpia myuros** POACEAE gen	CA-FP, D; worldwide; probably native to Europe	generally open places, sandy soils
Vulpia myuros var. *hirsuta**	CA-FP, uncommon in D; worldwide;	open places, hilsides,

POACEAE gen	native to Europe	washes
Vulpia myuros var. *myuros** POACEAE gen	CA-FP; worldwide; native to Europe	open places, hillsides, washes, or vernally moist sites in chaparral
Vulpia octoflora POACEAE gen	CA; widespread in Am, Europe	sandy to rocky soils, open sites
Xanthium strumarium ASTERACEAE gen	CA-FP, D; worldwide	disturbed areas
Zannichellia palustris ZANNICHELLIACEAE gen	CA; more or less worldwide	streams, ponds, ditches, lakes

* = non-native species
+ = exceptional/ rare occurrence
[ ] = may be extirpated from its former representative region

Catalog of Animal Taxa Associated With Vernal Pools

Vernal pool indicators (vpi) = an animal species that is restricted to vernal pools and are not known from other habitats

Vernal pool associates (vpa) = an animal species that regularly occurs in vernal pools but are not restricted to them, also occurring in other similar wetland habitats

Generalists (gen) = an animal species that is distributed in a number of habitats, both wetland and upland, which can include disturbed places, vernal pools, and vernal pool margins

vpi? = an animal species that is a vpi in certain region(s) of distribution only, and can be a vpa or gen in other regions

vpa? = an animal species that is a vpa in certain region(s) of distribution only, and is gen in other regions

vpi/vpa = either a vpi or vpa for its entire distribution and not known to be a gen

Scientific Name Common Name, Indicator code	**Range**	**Habitat**
Amphibian		
Ambystoma californiense California tiger salamander vpa	Central Valley of CA and south in coastal CA to Santa Rita Hills (much of its former range in the valley has been eliminated)	seasonal water sources for breeding: vernal pools, seasonal ponds, isolated ponds, small lakes; uplands for non-breeding: annual grasslands, and grassy understory of valley-foothill hardwood
Hyla (Pseudacris) regilla	CA-FP, GB, D (California City and Soda Springs); to BC and Baja, e NV, w ID, w MT	grassland, chaparral, woodland, forest, desert oases, farmland

Pacific tree frog gen		
*Rana catesbeiana** Bullfrog gen	CA; native to e-c US; introduced w of the Rocky Mtns, Hawai'i, Mexico, Cuba, Jamaica, Japan, and Italy	hightly aquatic; prairie, woodland, chaparral, forests, desert oases, farmland, marshes, ponds, lakes, reservoirs, streams
Scaphiopus hammondii Western spadefoot toad vpa	Central Valley, bordering foothills, and coast ranges south of San Francisco Bay, into nw Baja (now extinct throughout much of lowland s CA)	valley-foothill grasslands, open chaparral, pine-oak woodlands; vernal pools are essential for breeding and laying eggs
Insect		
Order Coleoptera		
Agabus sp.		quiet running waters or associated with vascular plants in standing pools and ponds
Berosus punctatissimus gen	CA; to WA and Baja	aquatic
Copelatus chevrolati gen	sw US, Imperial Co.	aquatic
Deronectes striatellus gen	Pacific Coast	tolerant of many aquatic habitats
Elaphrus viridis vpa Delta Green Ground Beetle	In CA, between Jepson Prairie and Travis AFB	restricted to margins of vernal pools in grassland area
Hydrochara rickseckeri gen Rickseckers Water Scavenger Beetle	San Francisco Bay area, CA	aquatic
Lytta molesta vpa Molestan Blister Beetle	Central Valley of CA, from Contra Costa to Kern & Tulare cos	
Peltodytes sp.		aquatic (ponds or sheltered in stream currents)
Tropisternus lateralis gen	North and South America	shallow water
Order Diptera		
Chaoborus sp.		
Culiseta sp.		
Culex sp.		
Tipula sp.		

Order Ephemeroptera		
Callibaetus sp. gen		various aquatic habitats
Order Hemiptera		
Abedus indentatus gen	southern two-thirds of state, including the deserts	common in ponds and small pools in streams
Buenoa scimitra gen	CA: Coast Ranges, Central Valley, and Sierra foothills, from Sonoma Co to San Diego, and in the Imperial Valley; s US	wide variety of fresh and stagnant pools
Gerris sp. gen		ponds, lake margins, pools of streams
Notonecta sp. gen		wide variety of fresh and stagnant pools
Sigara sp. gen		quiet pools where they are primary converters of plant material and benthic organisms
Trichocorixa sp. gen		halobionts--saline or brackish waters
Order Hymenoptera		
Agopostemon texanus gen		pollen generalist
Andrena (Diandrena) sp. gen		oligolege on *Ranunculus*
Andrena (Diandrena) blennospermatis vpi	central CA	oligolege (pollen specialist) on *Blennosperma bakeri* and *B. nanum*, endemic to vernal pools
Andrena (Diandrena) puthua vpa	CA to nw Baja, commonly co-occur with two or more spp. at any one locality	oligolege on *Lasthenia*
Andrena (Diandrena) submoesta vpa	CA, commonly co-occur with two or more spp. at any one locality	oligolege on *Lasthenia*
Andrena (Diandrena) subchalybea gen		oligolege on *Agoseris* and *Layia*
Andrena (Hesperandrena) baeriae vpa	CA, commonly co-occur with two or more spp. at any one locality	oligolege on *Lasthenia*
Andrena (Hesperandrena) duboisi vpa	CA, commonly co-occur with two or more spp. at any one locality	oligolege on *Lasthenia*
Andrena (Hesperandrena) lativentris vpa	CA, commonly co-occur with two or more spp. at any one locality	oligolege on *Lasthenia*
Andrena (Hesperandrena) limnanthis vpa	Shasta and Lake cos to San Luis Obispo and Merced cos of CA	oligolege on *Limnanthes*, endemic to vernal pools and similar wet areas

Andrena (Scaphandrena) plana gen		oligolege? primarily on *Trifolium*
Andrena (Tylandrena) layiae vpi?	CA Central Valley; to Baja	on *Blennosperma bakeri*
*Apis mellifera** (Honey Bee) gen		pollen generalist, and most important pollinator of *Pogogyne abramsii*
Dialictus spp. (2) gen		pollen generalist? common on *Lasthenia*
Dialictus sp. gen		pollen generalist? common on *Downingia*
Euandrena sp. gen		oligolege on *Ranunculus*
Evylaeus sp. gen		pollen generalist?
Halictus ligatus gen	CA	pollen generalist
Halictus (Seladonia) tripartitus gen	CA	pollen generalist
Hesperanda sp. vpa		oligolege on *Lasthenia*
Lasioglossum titusi gen	CA	pollen generalist, emphasizing Asteraceae, esp Chichorea
Nomada spp. (3) gen		pollen generalist, parasitic (Cuckoo)
Osmia sp. gen		pollen generalist?
Panurginus vpa		oligolege on *Downingia*,endemic to vernal pools
Panurginus occidentalis vpa	Shasta Co to Tuolumne Co, CA	oligolege on *Limnanthes*, endemic to vernal pools and similar wet areas
Sphecodes spp. (2) gen		pollen generalist, parasitic (Cuckoo)
Order Odonata		
Anax junius gen	CA; North America	aquatic, common
Invertebrate		
Subphylum Crustacea Class Branchiopoda Order Anostraca		
Branchinecta sp.		
Branchinecta coloradensis vpa?	GB Desert, Modoc P., Moj Desert, Sierra Nevada, Central Valley (1 site); in all states w of Rocky Mtns exc ID & NM, and OK, Alberta, Saskatchewan	high mtns or high desert, seasonally astatic snowmelt, pools, roadside ditches, vernal pools, and alpine pools
B. conservatio vpi Conservancy fairy shrimp	grasslands of the northern two-thirds of the CA Central Valley	astatic, large turbid vernal pools formed by old, braided alluvium
B. dissimilis gen	CA (Sierra Nevada to Inyo Co);	seasonally astatic or aestival, glacially

	OR (Deschutes, Harney, & Lake cos)	scoured, alpine puddles, pools, or lakes usually in granitic basins filled with snowmelt
B. lindahli vpi?/vpa	C&S Coast Mtns, sw C Valley, w Moj D, Modoc P., Santa Cruz Isl; to Baja, Alberta, Kansas, and all states w of Rocky Mtns (exc ID)	roadside ditches, playas, prairie potholes, vernal pools
B. longiantenna vpa Longhorn fairy shrimp	eastern margin of the CA Central Coast mountains	seasonally astatic grassland vernal pools and ditches
B. lynchi vpi? Vernal pool fairy shrimp	Central Valley, Central and South Coast mountains	in astatic rain-filled pools of grasslands (small, clear-water sandstone or basalt-flow depression pools, grassed swale, or earth slump)
B. mackini vpa?	Modoc P., S Coast Range, w Moj D, sw C Valley; to UT, NB, Alberta, Saskatchewan	seasonally astatic and aestival playas, roadside ditches, earth fault pools of alkaline soils
B. mesovalliensis	has not been formally described yet	
B. sandiegonensis vpi San Diego fairy shrimp	San Diego Co mesas, CA (has been previously found from Baja to Santa Barbara Co)	vernal pools
Eubranchipus serratus	Modoc Plateau, NW Great Basin	vernal pools and lakes
Linderiella occidentalis vpa California linderiella	e C Valley, C&S Coast Mtns and disjunct populations in Riverside Co	seasonal pools in unplowed grasslands with old alluvial soils underlain by hardpan or in sandstone depressions
Linderiella santarosae vpi Santa Rosa linderiella	Santa Rosa Plateau, Riverside Co., CA	vernal pools
Streptocephalus wootoni vpa Riverside fairy shrimp	w Riverside & San Diego cos, CA	vernal pools/tectonic swales/earth slump basins in grassland & coastal sage scrub
Order Cladocera		
Alona cf. *davidi*[1] gen	disjunct localities in NAm and Mexico	large, deep, long-lived ponds and lakes
Alona cf. *setulosa*[1] gen	reported from WI, IN, FL, GA, MN, CA; c&e Canada	
Alona sp. A[1]		
Alona sp. B[1]		
Alona spp. (2) gen		open water: well-suited but not restricted to

		temporary water; common in freshwater habitats
Camptocercus sp. A[1]		
Ceriodaphnia reticulata gen	widely distributed and common in NAm, Mexico	open water
Chydorus cf. *sphaericus*[1] gen	cosmopolitan, yet the species complex is taxonomically unresolved and may need revision	open water
Daphnia cf. *middendorffiana* gen	TX to MT and westward in NAm, the Arctic	shallow ponds and lakes
Daphnia cf. *pulex* gen	continental NAm	open water: a most common inhabitant of ponds, permanent and temporary pools
Diaphanosoma cf. *birgei*[1] gen	little known, probably widespread in NAm	open water, esp lakes
Dunhevedia crassa[1] gen	widely distributed, but rare in NAm	open water
Leydigia leydigi	throughout NAm, yet uncommon	benthic in ponds
Macrothrix hirsuticornis gen	New England to CO and CA, widespread in NAm	epibenthic in open water
Macrothrix rosea gen	widely distributed	in vegetation
Moina cf. *micrura* gen	widely distributed and common (Old and New Worlds, disjunct localities thoughout NAm)	epibenthic in ponds and lakes
Moina wierzejskii gen		
Moina sp. gen		
Pleuroxus sp. A[1]		
Pleuroxus aduncus gen	northern and western US	in vegetation
Simocephalus sp. A[1]		
Simocephalus exspinosus		
Simocephalus vetulus[1] gen	NAm, SAm, Europe, Asia	ponds and along shorelines of lakes
unidentified sp. (Chydoridae)		
unidentified spp. (2)		
Order Conchrostraca		
Cyzicus californicus vpi	coastal c&s CA from San Diego Co to the Central Coast, and up the Central Valley	vernal pools

Lynceus brachyurus gen	ne US, west to CO, OR, WA, CA; Europe, Asia	permanent and temporary ponds
Lynceus sp.		
Order Notostraca		
Lepidurus packardi vpi Vernal pool tadpole shrimp	Sacramento Valley, CA	vernal pools and swales, clear to highly turbid water
Lepidurus couesii	Modoc Plateau	vernal pools, vernal lakes
Lepidurus lemmoni	Modoc Plateau	vernal pools, vernal lakes
Lepidurus sp. A		
Class Maxillopoda Subclass Copepoda		
Acanthocyclops carolinianus[1] gen	CA; known from east coast NC, TN	ephemeral pools, predominant in vernal pools of Sacramento Valley
Acanthocyclops vernalis gen	widely distributed in NAm	freshwater habitats, esp ephemeral waters
Aglaodiaptomus forbesi gen	Pacific coast states and western Canada, from Arizona and South Dakota, east to Saskatchewan	ponds and lakes
Attheyella sp. A[1]	close form to *Attheyella dentata*, of AK and Canada, of fresh and saline lakes	vernal pools in Sacramento Valley
Bryocamptus washingtonensis[1] gen	WA	ponds, among weeds of roadside ditch pond
Canthocamptus sp. A[1]		
Canthocamptus "robertcokeri"[1] gen	North America	freshwater habitats: large and small lakes, ponds, ditches
Cyclops sp.		
Cyclops vernalis gen		freshwater habitats
Diacyclops sp. A[1]		freshwater ephemeral pools, widespread in vernal pools of Sacramento Valley
Diacyclops crassicaudis var. *brachycercus*[1] gen	North America (CA, AK, NW, WI, NC, SC, TN, TX, Canada) and Europe	ephemeral ponds and groundwater-type habitats
Diacyclops navus[1] gen	Continental US, central Canada	shallow, usually freshwater permanent or temporary pools and marshes; wells, lakes, river, artificial containers
Eucyclops sp.		
Eucyclops elegans[1] gen	widespread in North America	primarily small slow-flowing streams and various shallow wetlands
Hesperodiaptomus	CA, from Alameda, Contra	perennial and ephemeral pools, primarily

caducus gen	Costa, San Mateo, Sacramento, and Amador cos; OR, WA, BC	coastal
Hesperodiaptomus eiseni gen	Pacific coast states to AK, east to Labrador and Nebraska; Siberia, Japan	typically occurs in vernal pools; ponds and lakes
Hesperodiaptomus hirsutus gen	CA; MT, WA, southern Canadian Rockies	pools and lakes
Leptodiaptomus tyrrelli gen	Asia and North America; AK east to Labrador, Rocky Mtn states west to Pacific coast	freshwater habitats ranging from large lakes to small ponds, esp oligotrophic waters
Microcyclops rubellus[1] gen	widespread in North America; probably cosmopolitan	benthic, found among vegetation
Skistodiaptomus pallidus gen	CA, AZ, Mississippi Valley, from north central US and the plains states, south to LA, TX	small ponds and large lakes
Class Ostracoda		
Bradleycypris sp. A[1]		
Bradleycypris cf. *affinis*		ostracods are very obvious and abundant in vernal pools, some spp. may be endemic; their specialization on bottom feeding and on organic detritus is ideal in shallow pools
Bradleycypris sp. n. McKenzie		see above
Bradleycypris reticulata? gen		
Candona sp. A[1]		
Candona sp. B[1]		
Candona sp. C[1]		
Candona sp. D[1]		
Candona "caudata" s.l. gen	cosmopolitan	permanent and ephemeral freshwater habitats
Candona "rawsoni" s.l. gen		
Candona cf. *stagnalis*		
Cypricercus reticulatus[1]	widespread in North America	ephemeral pools
Cypricercus sp. A (cf. *reticulatus*)[1]		
Cypricercus sp. B[1]		
Cypridopsis vidua[1] gen	cosmopolitan	fresh and brackish water
Cyprioconcha macra		

Cyprioconcha steveni		
Cypris subglosa[1] gen	Europe, Asia; first record in CA	ephemeral pools
Eucrypis sp. A[1]		
Eucrypis s.l. sp. A		
Eucrypis s.l. sp. B		
Eucypris virens	Old World, CA	permanent and ephemeral pools
Eucypris virens media	Old World, CA	permanent and ephemeral pools
Heterocyrpis aff. *H. carolinensis* (= *H. incongruens* by some)		
Heterocypris aff. *salinus*		
Heterocypris aff. *rotundatus*		
Heterocypris aff. *symmetricus*		
Heterocypris incongruens		
Limnocythere sp. n. McKenzie		
Limnocythere sp. A[1]		
Limnocythere sp. B[1]		
Limnocythere sp. C[1]		
Limnocythere aff. *paraornata*		
Limnocythere posterolimba		
Limnocythere reticulata		
Limnocythere cf. *sanctipatricii*		
? Megalocypris sp.		
Pelocypris aff. *ablomaculata*		
Potamocypris sp. A[1]		
Pseudoilycypris sp.		
unidentified sp. (Cypridae)		
Phylum Mollusca Class Gastropoda		
Lymnaea spp.		vernal pools?

Phylum Platyminthes **Class Turbellaria** **Order Rhabdocoela**		
Bothromesostoma personatum		vernal pools?
Bothromesostoma americanum		vernal pools?
Phylum Rotifera		
Brachionus quadridentata gen		freshwater habitats
Hexarthra sp. gen		see above
Lecane formosa gen		see above
Lecane luna gen		see above
Lecane ohiensis gen		see above
Lecane spp. (2) gen		see above
Lepadella patella gen		see above
Lepadella sp. gen		see above
Monostyla closterocerca gen		see above
Monostyla elachis gen		see above
Monostyla lunaris gen		see above
Monostyla spp. (2) gen		see above
Platyias quadricornis gen		see above
Polyarthra sp. gen		see above
Trichocera sp. gen		see above
Scardium longicaudum gen		see above
Squatinella tridentata gen		see above
22 unidentified illoricates gen		see above

* = non-native species
$^{+}$ = exceptional/rare occurrence
[ ] = usually representative in the region, but not found during specific study
^{1} = first California record

References for Range and Habitat Descriptions

Eng, L.L., D. Belk, and C.H. Eriksen. 1990. Californian Anostraca: Distribution, Habitat, and Status. Journal of Crustacean Biology. 10(2)247-277.

Hickman, J.C., ed. 1993. The Jepson Manual Higher Plants of California. University of California Press, Berkeley. 1400pp.

Pennak, Robert W. 1978. Fresh-water Invertebrates of the United States, Second Edition. John Wiley & Sons, Inc., New York. 803pp.

Appendix D: Holland Vernal Pool Classification

Hierarchy

Vernal Pool Categories
- Northern Vernal Pool
  - Northern Hardpan Vernal Pool
  - Northern Claypan Vernal Pool
- Northern Volcanic Vernal Pool
  - Northern Basalt Flow Vernal Pool
  - Northern Volcanic Mudflow Vernal Pool
- Southern Vernal Pool
  - Southern Interior Basalt Flow Vernal Pool
- San Diego Mesa Vernal Pool
  - San Diego Mesa Hardpan Vernal Pool
  - San Diego Mesa Claypan Vernal Pool

Definitions

Northern Hardpan Vernal Pool

Description: A low, amphibious, herbaceous community dominated by annual herbs and grasses. Germination and growth begin with winter rains, often continuing even when inundated. Rising spring temperatures evaporate the pools, leaving concentric bands of vegetation that colorfully encircle the drying pool.

Site factors: Old, very acidic, Fe-Si cemented hardpan soils (Redding, San Joaquin, and similar series). The microrelief on these soils typically is hummocky, with mounds intervening between localized depressions. Winter rainfall perches on the hardpan, forming pools in the depressions. Evaporation (not runoff) empties pools in the spring.

Characteristic species: *Castilleja (=Orthocarpus) campestris, Deschampsia danthonioides, Downingia bicornuta, D. cuspidata, D. pulchella, Epilobium torreyi (=Boisduvalia stricta), Eryngium vaseyi, Juncus leiospermus, J. uncialis, Lasthenia fremontii, Limnanthes alba, Limosella aquatica, Navarretia leucocephala, Plagiobothrys (= Allocarya) stipitatus micranthus, P. undulata, Pogogyne zizyphoroides, Psilocarphus brevissimus, Veronica arvensis*.

Distribution: "Red Dirt Hogwallow Lands", primarily on old alluvial terraces on the east side of the Great Valley from Tulare or Fresno counties north to Shasta County.

Northern Claypan Vernal Pool

Description: Similar to Northern Hardpan Vernal Pools, but with lower micro relief, and usually lower overall cover. Pools may be small (a few square meters) or quite large (covering several hectares).

Site factors: Fairly old, circum-neutral to alkaline, Si-cemented hardpan soils. Often more or less saline. Intergrades via Cismontane Swale with Cismontane Alkali Marsh which has water present throughout the year.

Characteristic species: *Cressa truxillensis, Downingia bella, D. insignis, Epilobium pygaeum (=Boisduvalia glabella), Eryngium aristulatum, Lasthenia ferrisiae, L. glaberrima, L. minor, Myosurus minimus, Plagiobothrys (=Allocarya) leptocladus, P. stipitatus stipitatus, Pogogyne douglasii, Spergularia marina, Veronica peregrina xalapensis.*

Distribution: On lower terraces and basin rims, toward the valley trough compared to Northern Hardpan Vernal Pools; Central San Joaquin Valley north to Glenn and Colusa counties.

Northern Basalt Flow Vernal Pool

Description: Very low, open mixture of amphibious annual herbs and grasses. Growth begins following fall rains and continues even while plants are submerged until standing water is evaporated in spring. Plant growth is abruptly terminated by warm spring weather. Pools typically are small, covering under about 50 square meters.

Site factors: Occur in small depressions on tops of massive basalt flows. These pools fill and empty many times during the winter, and have extremely thin soils over the solid bedrock that prevents downward rainwater percolation.

Characteristic species: *Blennosperma nanum, Callitriche marginata, Cicendia quadrangularis, Crassula aquatica, Downingia cuspidata, Epilobium (=Boisduvalia) densiflorum, Eryngium vaseyi, Gnaphalium palustre, Lasthenia fremontii, Linanthus ciliatus, Parvisedum pumilum, Psilocarphus brevissimus, P. tenellus.*

Distribution: Scattered along the western Sierra foothills between Shasta and Tulare counties, and in the volcanic tablelands of the Modoc Plateau in Shasta, Lassen, Modoc and Siskiyou counties.

Northern Volcanic Mudflow Vernal Pool

Description: A very, low open mixture of amphibious annual herbs and grasses. Germination occurs following early fall rains; flowering begins by late February, and most plant activity is finished by mid-May. Pools typically are small, covering at most a few score square meters.

Site factors: Restricted to irregular depressions in Tertiary pyroclastic flows (Lahars--largely on the Mehrten Formation). Shallow soils prevent forests from developing. Pools form in the small depressions following winter rains.

Characteristic species: *Downingia bicornuta, Lasthenia glaberrima, Limnanthes douglasii rosea, Navarretia tagetina*.

Distribution: Scattered on flat-topped mesas (many called "Table Mountain") along the Sierran foothills, mostly between 500-2000 feet elevation in the Blue Oak Woodland and Digger Pine-Chaparral Woodland.

Southern Interior Basalt Flow Vernal Pool

Description: A very low, open to nearly-closed mixture of amphibious annual herbs and grasses that require seasonal inundation and desiccation for completion of their life cycle. Most species are active in winter, flower in spring, and spend summers as seeds waiting for the return of fall rain. Pools range in size from a few score square meters to several hectares.

Site factors: Occurs mostly as small, playa-like lakes on tops of basalt-capped plateaus. Shallow soils over bedrock prevent woodlands from establishing. The pools fill at the onset of fall rains and dry by evaporation during warm spring weather.

Characteristic species: *Alopecurus saccatus, Blennosperma nanum, Callitriche marginata, Crassula aquatica, Downingia bella, D. cuspidata, Eryngium aristulatum parishii, Limnanthes gracilis parishii, Myosurus minimus, Navarretia prostrata, Orcuttia californica, Pilularia americana, Plagiobothrys undulatus, Psilocarphus brevissimus.*

Distribution: Apparently limited to 3 lava-capped mesas of the Santa Rosa Plateau in southwestern Riverside County.

San Diego Mesa Hardpan Vernal Pool

Description: Very similar in aspect to Northern Hardpan Vernal Pools, but with different species composition. Surrounding high ground, however, usually is mantled with chamisal rather than grassland. Pool sizes range from very small to moderate (up to about 700 square meters).

Site factors: Small depressions in flat-topped marine terraces. Fe-Si cemented hardpan

prevents downward drainage of rainwater. Soils often are stonier than Northern Hardpan Vernal Pools, and are always coarser and redder than San Diego Mesa Claypan Vernal Pools.

Characteristic species: *Eryngium aristulatum parishii*, *Myosurus minimus*, *Navarretia fossalis*, *Ophioglossum californicum*, *Pogogyne nudiuscula*.

Distribution: Formerly extensive on the flat marine terraces north of San Diego, but now almost extirpated by urban blight.

San Diego Mesa Claypan Vernal Pool

Description: Similar to Northern Claypan Vernal Pools, but less markedly saline/alkaline. Surrounded by grassland rather than chamisal.

Site factors: Soils decidedly finer textured and greyer than San Diego Mesa Hardpan Vernal Pools, and lacking an iron cemented hardpan.

Characteristic species: *Myosurus minimus apus*, *Navarretia fossalis*, *Orcuttia californica*, *Pogogyne abramsii*.

Distribution: Restricted to marine terraces between San Diego and Ensenada, Mexico and much reduced by agricultural and urban development.