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CLASSIFICATION, ECOLOGICAL CHARACTERIZATION, AND PRESENCE OF LISTED PLANT TAXA OF VERNAL POOL ASSOCIATIONS IN CALIFORNIA

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EXECUTIVE SUMMARY

Chapter 1: Introduction

A group of approximately 100 plant taxa more commonly occur in vernal pools than any other habitat. Most are native, amphibious annuals capable of slow underwater growth in winter followed by rapid development and reproduction in spring after the ponded water is gone. More than half are endemic to California, while others extend north to Oregon, Washington, and Idaho, east to Nevada, and south to Baja California. Some 15 taxa are federally listed (10 endangered and 5 threatened; all but two of the 15 are also state listed) and 37 others are either state-listed or considered to be "species of concern" by the California Native Plant Society (USFWS 2004; Lazar 2005). In this report, we investigated a subset of 18 rare taxa that had a distribution matching the geographic limits of our study.

Although vernal pools are most abundant in the Central Valley, they occur in >30 California counties in such diverse regions as the Modoc Plateau, the Mendocino coast, the Central coast, and southwestern basins. As mapped by Keeler-Wolf et al. (1998) and USFWS (2004), vernal pools are known to occur in 17 regions that differ in climate, topography, and rare plants. At the time of Euro-American contact, there may have been about 1.6 million hectares of vernal pool landscape throughout California (Holland 1968, Barbour et al. 2003, Barbour and Witham 2004). The proximity of vernal pools to areas of expanding agriculture and homes, and the relatively low cost of vernal pool land, have lead to rapid decline in vernal pool acreage, estimated to be a loss of 60-95%, depending on the region. In order to protect what is left, a classification of vernal pool community types and a linkage between rare taxa and those communities are needed.

Chapter 2: Classification.

Our classification is based on pool and vegetation data collected from 2177 plots (each 10 square meters in area), placed in 700 pools, at 68 locations. A "location" is a single-owner parcel of land, usually several hundred hectares in area and incorporating a network or complex of many vernal pools. The intensity of sampling correlated with the density of vernal pool locations and pools, thus 79% of all plots, pools, and locations were from the Central Valley.

Data were collected from all six Central Valley vernal pool regions, as defined by Keeler-Wolf et al. (1998), and from all but two (Carrizo and Sierra Valley) of the vernal pool regions outside the Central Valley. We also obtained data from southern Oregon and northwestern Nevada, locations outside of California's 17 vernal pool regions.

Vegetation of each pool was sampled as described by Barbour et al. (2003). Every species in a plot was recorded together with its estimated percent cover. Habitat data were also recorded. All data were entered into TURBOVEG database, analyzed with the statistical packages JUICE and PC-ORD, and the putative community types were manually refined, defined, and named.

We concluded that Californian vernal pool vegetation belongs to a single class Downingia-Lasthenia, named after the two characteristic vernal pool species *Downingia bicornuta* and *Lasthenia fremontii* (gold fields). This class comprises plant communities of hardpan, claypan and volcanic rock vernal pools, including those on fresh or alkaline soils and those located in deep centers or shallow edges of pools. Diagnostic species of the class, which occur throughout all of these habitats, include: *Lasthenia fremontii, Navarretia leucocephala, Downingia bicornuta, Plagiobothrys stipitatus, Psilocarphus brevissimus, Deschampsia danthonioides, Pilularia americana, Elatine californica, Veronica peregrina* ssp. *xalapensis*, *Alopecurus saccatus, Eryngium vaseyi*, *Isoetes orcuttii, Pogogyne zizyphoroides, Juncus bufonius, Eleocharis acicularis, Callitriche marginata, Crassula aquatica.* The geographic range of the class extends from southeastern Washington, throughout Oregon and California in North America, and in Chile and Argentina in South America.

Vernal pool communities in California fall into three groups called orders. (1) Communities in long-inundated pools are placed in the order Lasthenia glaberrima, unique in high constancy and abundance of the extremely flood-tolerant taxa *Lasthenia glaberrima* and *Eleocharis macrostachya*. (2) Communities in short-inundated pools or at shallow edges of deeper fresh-water pools are in the order Downingia-Lasthenia, unique in the presence of less flood-tolerant species such as *Cicendia quadrangularis, Blennosperma nanum, Triphysaria eriantha, Lasthenia californica*, and *Trifolium* *variegatum*. (3) Communities in saline/alkaline pools are in the order Frankenia-Lasthenia, unique in the presence of such halophytes as *Distichlis spicata, Frankenia salina, Cressa truxillensis, Eryngium aristulatum, Pleuropogon californicus*, and *Crypsis schoenoides*. The orders are broken down into 6 alliances and 37 associations. An additional alliance of playas and saline sinks does not contain vernal pools.

Chapter 3: Persistence

To test the robustness of the classification with respect to variation of rainfall from year to year, we analyzed a set of 156 vernal pools, the vegetation data of which had been collected along a 300-km-long section of a PGT/PGE gas pipeline corridor through the Northwestern Sacramento Valley vernal pool region. Each pool was visited twice each year (early spring and late spring) over a 5-year-period and the percent cover for every plant species encountered was recorded.

Precipitation varied over the 5 yr from 420 mm to 1050 mm and average pool species richness rose and fell with rainfall. The magnitude of change in abundance or presence/absence of individual species was highly variable. Diagnostic species (species that must be present in order to classify the unit) at the class level had higher persistence than those at the order level, and the order higher than those at the association level (averages of 73%, 63%, and 51%, respectively). We agreed in principle that any single diagnostic species could not be expected, for any vegetation type in general, to have 100% persistence, but that a lower persistence limit of 70% would be practical, realistic, and still useful; that is, we should choose diagnostic species that have >70% persistence.

If species with persistence <70% were eliminated from the list of diagnostic species, that still left 10 taxa at the class level that could be retained, and as many as seven in two of the orders, but only one for the order of alkaline/saline pools (however, that one species, *Downingia insignis*, had 100% persistence). Diagnostic species for classification levels below the order generally were more sensitive to annual fluctuations, but at least one diagnostic species with >70% persistence existed for most associations. These results indicate that a floristically-based statewide classification of vernal pool community types can be sufficiently robust to show that the same communities are present in the same pools, regardless of the current year's weather pattern.

Chapter 4. Presence of listed plants in Central Valley communities

This chapter examines 17 rare taxa that occur within the Central Valley. There were apparent relationships with the type of impervious soil horizon and/or the alkalinity/salinity of the soil. Three taxa (*Navarretia heterandra*, *Lasthenia conjugens,* and *Chamaesyce hooveri*) occurred in only one association each, *Castilleja campestris* ssp. *succulenta* and *Orcuttia tenuis* in three associations each, and *Gratiola heterosepala* in six different associations. The remaining taxa were linked with two associations each. The majority of rare species were correlated with small, shallow pools that had high total plant cover: taxa such as *Legenere limosa, Navarretia myersii, Downingia pusilla*, and *Castilleja campestris* ssp. *succulenta*. A fewer number of rare species were correlated with large, deep playas having low total plant cover, such as: *Tuctoria greenei, Lasthenia ferrisiae*, several *Orcuttia* species, and *Chamaesyce hooveri*.

Chapter 5: Implications for conservation, recovery, and management

One significant finding is that most community types are limited in their distribution to a single vernal pool region. Of the 29 associations and communities we defined as occurring within the Central Valley, only two were found in more than half of the six Central Valley vernal pool regions and 21 were limited to a single vernal pool region within the Central Valley. Associations of long-inundated pools tended to be more widespread than short-inundated fresh-water associations and than alkaline/saline associations. Given the high turnover of community types from region to region, only a small percentage of community diversity can be captured in any one preserve, no matter how large it is. Effective conservation requires the establishment of a network of many reserves distributed throughout all vernal pool regions, assuring the inclusion of all plant community diversity. The size of each preserve can vary. It should be large enough to maintain appropriate hydrology, to represent plant community diversity of the region and contain enough pools to replicate those community types, to avoid fragmentation, and to provide connectivity for plants, their pollinators, and other biota. At the same time, this is not to deny the potential value of protecting small areas. Where the pace and extent of habitat loss has severely fragmented and limited remaining vernal pool habitats to a size smaller than ideally desired, protecting such relict areas also has conservation importance. Although landscape-scale complexity cannot be captured in such small preserves, nevertheless they still maintain some sustainable ecosystem attributes such as habitats for vernal pool taxa. Small preserves may require more active management to compensate for their isolation.

Chapter 6: Restoration criteria and training

If our intent, in conservation and restoration, is to maintain community type diversity, then targets for restoration should not be widespread class species but instead more locally restricted species that are diagnostic for local communities.

A case study demonstrating how one might evaluate restoration success by using local natural communities as a target showed both the possibilities and limitations of this approach. Not all species have equal value in defining any given community. Generalists and non-natives should be given less weight than vernal pool specialists. Also, before calculating similarities, vegetation should be stratified to avoid comparing habitats that are dissimilar, such as comparing the pool bottom vegetation of created pools with the edge vegetation of natural pools. These results contributed to our suggestions for modifying current restoration standards.

These restoration standards, generated by the Army Corps of Engineers and the US Fish and Wildlife Service, appropriately address hydrology and flora as the most important targets. However, in our opinion, some of the details in those standards are difficult to quantify because of the formulas used. We suggest seven specific criteria or amendments to existing criteria used to judge the success of vernal pool restorations.

Finally, we propose that a training course be developed, with the collaboration of USFWS, the California Department of Fish and Game, and the California Native Plant Society; that it be offered on an annual basis; and that students be trained in the field on plant identification, sampling protocol for documenting plant community types, the use of an annotated key to determine vernal pool community types, and major ecosystem differences between vernal pools on floodplains, terraces, hardpans, claypans, and in saline/alkaline situations.

CHAPTER 1: INTRODUCTION

Vernal pools are seasonal ephemeral wetlands that fill and dry each year. They are shallow depressions underlain with a layer impermeable to water. In California, they become wetted in November with the onset of winter rains. Water collects in the depressions and stands for varying lengths of time (typically10-65 days at maximum depth <50 cm; Solomeshch et al. 2007) during winter and spring, then recedes as temperature rise and precipitation diminishes. The soil remains moist through April and May, then desiccates and stays dry until the following winter rains. The impermeable layer can be a claypan, cemented hardpan, or rock (Nikiforoff 1941, Weltkamp et al. 1996, Hobson and Dahlgren 1998). The inundation regime is too short and unpredictable to support aquatic species but long enough to eliminate upland species and the ponded water is relatively oligotrophic; these are the major attributes that differentiate vernal pools from salt pans, alkali meadows, and fresh-water marshes.

Recent hydrological studies show that vernal pools do not simply fill from direct precipitation nor do they empty solely by evapo-transpiration. Instead, lateral subsurface flow imparts a high degree of connectivity among pools. Once the soils have become saturated, water can move laterally above the impervious horizon, moving from hillocks into pools and vice-versa, ultimately draining downslope within a single watershed as late-season riverine flow (Hanes et al. 1990, Hanes and Stromberg 1998, Rains et al. 2005). This linkage buffers pool volume and chemistry, much like the effect that riparian vegetation has on adjacent waterways.

A specific group of approximately 100 plant taxa more commonly occur in vernal pools than any other habitat. Most are native, amphibious annuals capable of slow underwater growth in winter followed by rapid development and reproduction in spring after the ponded water is gone. More than half are endemic to California, while others extend north to Oregon, Washington, and Idaho, east to Nevada, and south to Baja California. Some 15 taxa are federally listed (10 endangered and 5 threatened; all but two of the 15 are also state listed) and 37 others are either state-listed or considered to be "species of concern" by the California Native Plant Society (USFWS 2004; Lazar 2005). In Chapter 4 we investigate a subset of 18 taxa that had a distribution matching the Great Valley region that was the geographic target for this report (Table 1-1).

Table 1-1. Listed taxa included in this report. Vernal Pool Regions (Keeler-Wolf et al. 1998): 1-Modoc Plateau, 2-Sierra Valley, 3-NW Sacramento Valley, 4-NE Sacramento Valley, 5-SE Sacramento Valley, 6-Mendocino, 7-Lake-Napa, 8-Santa Rosa, 9-Solano-Colusa, 10-Livermore, 11-Central Coast, 12-Carrizo, 13-San Joaquin, 14-Southern Sierra Foothills, 15-Santa Barbara, 16-Western Riverside County, 17- San Diego.

Species Name	**Status**	**VP Region**	**% Extant Occurrences Sampled by UCD Team**
Tuctoria mucronata	FE	9	100%
Orcuttia viscida	FE	5	30%
Lasthenia conjugens	FE	6, 7, 8, 9, 10, 11	14%
Orcuttia pilosa	FE	4, 9, 14	11%
Chamaesyce hooveri	FT	4, 9, 13, 14	8%
Orcuttia tenuis	FT	1, 3, 4, 5, 7	7%
Neostapfia colusana	FT	9, 13, 14	5%
Tuctoria greenei	FE	1, 4, 14	5%
Castilleja campestris ssp. *succulenta*	FT	6, 14	4%
Gratiola heterosepala	CA-E	1, 4, 5, 7, 9, 14	7%
Navarretia prostrate	CNPS 1B	11, 12, 13, 16, 17	27%
Astragalus tener var. *tener*	CNPS 1B	7, 9, 10, 11, 13	15%
Navarretia myersii ssp. *myersii*	CNPS 1B	5, 14	15%
Navarretia leucocephala ssp. *bakeri*	CNPS 1B	3, 4, 6, 7, 8, 9	12%
Legenere limosa	CNPS 1B	3, 4, 5, 7, 8, 9,	7%
Downingia pusilla	CNPS 2	3, 5, 7, 8, 9, 14	4%
Lasthenia ferrisiae	CNPS 4	9	--
Navarretia heterandra	CNPS 4	4, 5	--

Vernal pools also provide habitat for such rare and endangered animals as the longhorn fairy shrimp, conservancy fairy shrimp, delta green ground beetle, western spadefoot toad, and California tiger salamander, as well as a large number of migratory birds (Alexander 1976, Silveira 1998, Helm 1998, USFWS 2004).

Although vernal pools are most abundant in the Central Valley, they occur in >30 California counties in such diverse regions as the Modoc Plateau, the Mendocino coast, the Central coast, and southwestern basins. They are only excluded from deserts (pre-cipitation too low), elevation >1500 m (frost too frequent, precipitation too high), steep slopes, deep soils, and northwestern parts of the state (>800 cm of annual precipitation and thus beyond the definition of Mediterranean-type climate (Aschmann 1973 and 1985, Barbour and Minnich 2000). As mapped by Keeler-Wolf et al. (1998) and USFWS (2004), vernal pools are known to occur in 17 regions that differ in climate, topography, and rare plant species (Fig. 1). At the time of Euro-american contact, there may have been about 1.6 million hectares of vernal pool landscape throughout California (Holland 1968, Barbour et al. 2003, Barbour and Witham 2004). Unfortunately, the proximity of vernal pools to areas of expanding agriculture and homes, and the relatively low cost of vernal pool land, have lead to a rapid decline in vernal pool acreage, estimated to be a loss of 60-95%, depending on the region. It is this rapid decline in habitat and vegetation, taking with it rare taxa, that induced the USFWS to fund the research described in our February 2005 proposal and summarized in this report.

STRUCTURE OF THE REPORT

The objectives of the research described in the February 2005 proposal were: (1) to complete a classification of vernal pool plant community types that occur naturally in the Central Valley; (2) to distinguish Central Valley plant communities from those found elsewhere in California; (3) to name, floristically define, and environmentally characterize Central Valley vernal pool communities; and (4) to describe the geographic range, degree of commonness, and presence of state or federally listed plant taxa for each Central Valley community.

The rationale for the proposed research was that such information would provide a more realistic basis for knowing where to locate preserves for maximum capture of plant community and species diversity, how best to measure the degree of vegetation restoration success, and how to increase the probability of predicting the location of as-yet-undocumented populations of rare plant taxa.

The products promised in the proposal were: (1) the preparation of a major paper, ultimately to be published an appropriate international journal, provisionally titled "A floristically based classification of California vernal pool communities;" (2) the preparation of a more focused paper, ultimately to be published in a regional journal, provisionally titled "The distribution of listed plant taxa among Californian vernal pool communities;" (3) the assessment of persistence among diagnostic species through time, testing the hypothesis that vernal pool communities remain perennially identifiable despite the progression of seasons and fluctuations in annual precipitation; (4) testing the hypothesis that a practical and ecologically meaningful way to quantify the degree of success for vernal pool mitigation is to calculate the percent similarity of a mitigated community with natural community types known to occur in the region; and (5) a key to vernal pool plant communities in the Central Valley, written primarily for agency scientists, non-profit conservation staff, and private consultants.

The key would permit an individual to stand in the midst of vernal pool vegetation and identify/name the community type(s) present. Each type would be attributed in terms of diagnostic species, distributional range, habitat (pool depth, geologic substrate, type of impervious layer, and degree of salinity), degree of commonness or rarity, and the likely presence of listed taxa.

Consultation with those agencies will also be sought for the creation of a training course in the identification of vernal pool species, the method of visually dividing a vernal pool into more than one distinctive community type, and in using the vernal pool community key. At this point in time we are beginning to design a 5-day course that would be offered either through University of California Extension or under the aegis of a non-profit consulting company. The content of such a training course would have to be approved by those agencies most likely to send employees to it and the course would be open to agency visitation for the purposes of maintaining an agreed-upon level of rigor and content, documented by the awarding of a certificate of completion to each person who satisfactorily completes the course.

CHAPTER 2: CLASSIFICATION OF VERNAL POOL PLANT COMMUNITIES

A classification of vernal pool types that will capture their most important biological and ecological attributes is a critical step in the development of vernal pool conservation, regulation, and management strategies. This classification effort is part of a larger national vegetation classification program (NVC; Jennings et al. 2007) whose objective is to create a credible, standardized, widely accepted classification. The availability of such a classification will play a prominent role in resource conservation, ecosystem management, restoration planning, and predicting ecosystem responses to environmental change.

Our project's objective is not only to implement the NVC standards, but to develop and adapt them to the unique attributes of vernal pool vegetation, such as its seasonal and annual floristic variation due to its ephemeral nature..

PREVIOUS APPROACHES TO CLASSIFICATION

Existing vernal pool classifications can be divided into two groups based on whether they use only habitat characteristics or both biological and environmental information.

A landform-based classification (Jones and Stokes 1990; Smith and Verrill 1998) distinguished four pool types according to geomorphic settings: volcanic mud/lava flow, high terrace, low terrace, and drainageway. The advantage of habitat-based classifications is that they do not require botanical knowledge and an ability to recognize hundreds of troublesome tiny little plants. In many cases, habitat-based units can provide all necessary information because vernal pool biota are linked to such habitat characteristics as edaphic settings, pool age, size, depth, and hydrology, which collectively define habitat conditions suitable for plants and animals. However, habitat-based classifications are too coarse to address all the biotic diversity among vernal pools. They are also insufficient to provide information about species abundance, which habitat characteristics are most important for each species, and where to draw biologically sound boundaries between classification units. For successful management and conservation we need a classification that is based on vegetation characteristics linked with abiotic habitat traits.

The first ecologic-floristic classification of vernal pool vegetation was developed by Holstein (1984) and later refined by Holland (1986). Both recognized seven vernal pool types based on geographic regions, type of aquatard and/or underlying geology, and indicator species: Northern Hardpan, Northern Claypan, Northern Basalt Flow, Northern

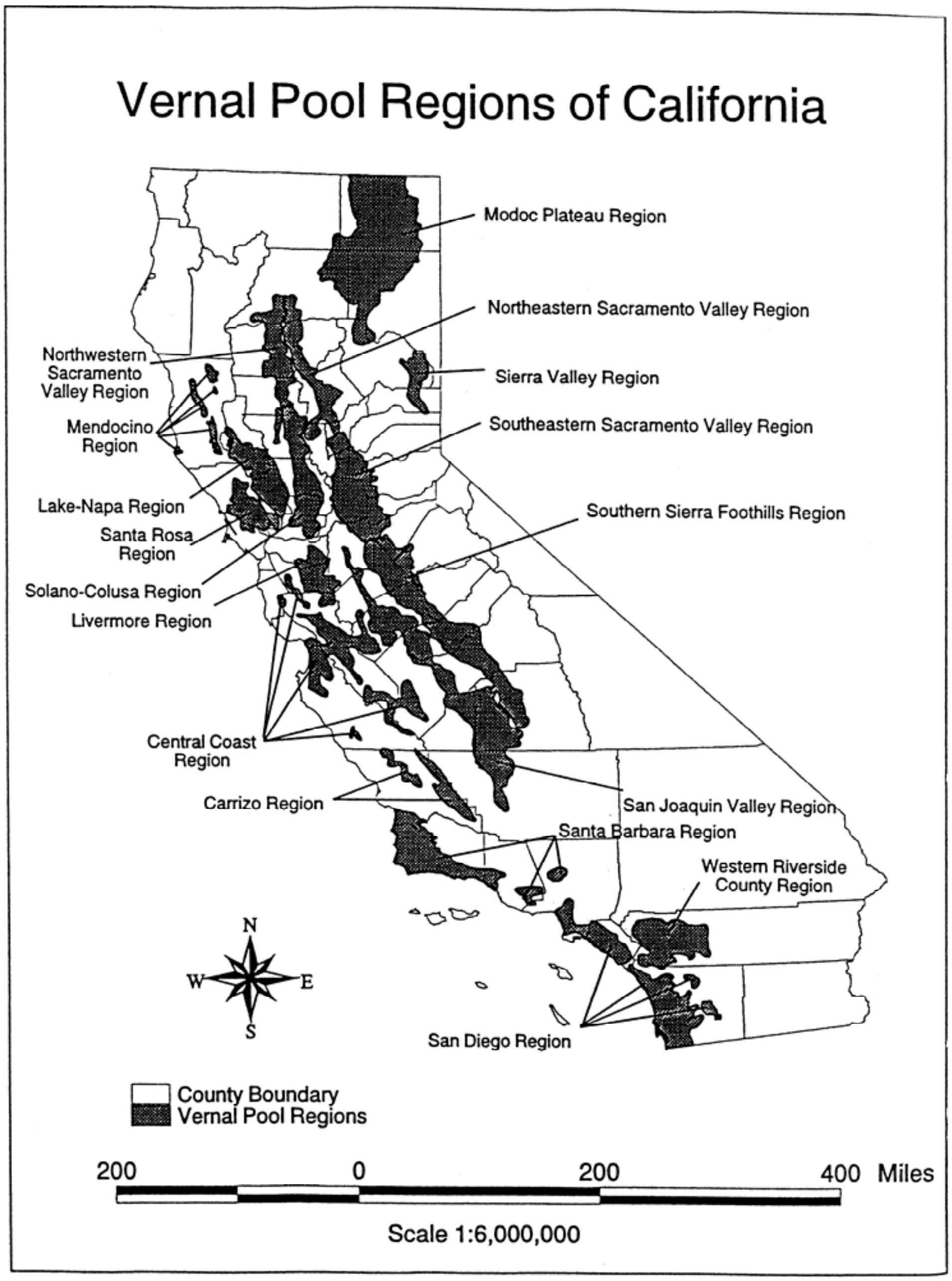


Fig. 2.1. Vernal pool regions recognized by Keeler-Wolf et al. (1998).

Sandstone, Southern Interior Basalt Flow, San Diego Mesa Hardpan, and San Diego Mesa Claypan Pools. This classification was revised by Sawyer and Keeler-Wolf (1995), who identified eight vernal pool types, but still using Holland's criteria. Although they retained most of Holstein-Holland types unchanged, they added additional species to refine and expand the classification. Keeler-Wolf et al. (1998) later subdivided California into 17 vernal pool regions (Fig. 2.1). Each region was characterized by a unique set of geologic, edaphic, and hydrologic conditions, as well as the presence of rare and endemic plants and animals. Their choice of geographic criteria successfully grouped pools with similar human impacts and into somewhat homogeneous floristic units. For example, among the 17 regions are Modoc Plateau and San Diego, which differ in climate, geology, flora, human impacts, degree of endangerment, and management options. However, these geographical regions do not define homogeneous vegetation types. Rather, each consists of a variety of vernal pool types. The classification of vernal pool regions was an important step toward developing vernal pool management areas, regions affected by the same threats and for which the same management tools could be applied.

An attempt to create a statewide fine-scale classification of vernal pools was made by Ferren et al. (1994, 1996), who listed hundreds of vernal pool types based on both abiotic and biotic traits. They built a hierarchical classification system of vernal pools, subdividing them from top down according to water regime / water chemistry / hydrogeomorphology / substrate / species dominance. They recognized more than 50 hydrogeomorphic units, such as Interior-Valley Vernal Swales, Interior-Valley Vernal Plains, Interior-Valley Vernal Pools, Coastal Dune Ponds, Montane Vernal Meadows, and Vernal Marshes, and below that level, several hundred more local types according to dominant plant or animal taxa. Because several dominants can be present, their system recognized mixed types such as "Nonpersistent Emergent Types (Dicots, Monocots, and Non-Flowering Vascular)". Classifications based on dominant species are typically applied to vegetation dominated by a small number of perennial species that maintain their dominance over a period of years. In many vernal pools, however, four or five annual dominant species coexist or replace each other during the spring months and also from year to year. As we will show later in this chapter, most pools consist of several equally represented growth forms and taxonomic groups that fluctuate in abundance seasonally and annually. Under Ferren's system, such pools would be placed in a single mixed type, which is not helpful for recognizing vernal pool diversity. Because of the broad overlapping of units based on single dominant species, and the enormous number of local types, this system has never been widely used.

Other researchers have applied a floristically based approach. Macdonald (1976) was the first to classify vernal pool vegetation types based on complete species lists. He studied vernal pool vegetation at Phoenix Park in Sacramento County by placing 10 m^2 plots within homogenous vegetation patches and listing all species that occurred in the plots along with their percent cover. He analyzed species assemblages from 41 plots using a numerical algorithm and identified 6 community types. All types were related to a microtopographic position along a gradient from blue oak woodland on hillock tops to *Eleocharis macrostachya* on deep vernal pool bottoms. Two similar studies were conducted by Jokerst (1990) and Holland and Dains (1990), but they were not taken to the classification level.

MATERIALS AND METHODS

Our classification is based on pool and vegetation data collected from 2177 plots (each 10 square meters in area), placed in 700 pools, in 68 locations. A "location" is a single-owner parcel of land, usually several hundred hectares in area and incorporating many vernal pools. An attempt was made to stratify locations by vernal pool region, landform, geologic substrate, soil traits, and topographic location. Superimposed on this template was the requirement that the owner(s) would grant permission to visit their property and gather data, and that access to their properties by road was possible. Those locations that combined several habitat categories were preferred over those that were more homogeneous, because heterogeneous properties would maximize the efficiency of data collection from diverse environmental settings. Locations were also constrained by the team's available field time and the budget. The intensity of sampling correlated with the density of vernal pool locations and pools; thus approximately 79% of all plots, pools, and locations were from the Central Valley.

Data were collected from all six Central Valley vernal pool regions, as defined by Keeler-Wolf et al. (1998), and from all but two (Carrizo and Sierra Valley) of the vernal pool regions outside the Central Valley. We also obtained data from southern Oregon and northwestern Nevada, locations outside of California's 17 vernal pool regions.

Within a given heterogeneous location, we subdivided the landscape into polygons of unique landform, geology, and topographic position, using air photos, topographic maps, and soil/geology maps, and sampled as many pools as possible in 1-2 days. If the location was homogeneous, then the team more or less sampled the first 6-10 pools encountered. The team consisted of a minimum of four individuals, and they usually broke into two pairs, so that two pools at a time could be sampled. At small locations, all pools could be sampled; at large locations only 10% of the pools could be sampled.

The vegetation of each selected pool was visually divided into 2-4 subtypes (some pools were homogeneous and could not be subdivided). These subtypes typically had narrow boundaries and appeared different because of the color of stems, leaves, or flowers, the height of the vegetation, or the dominant growth forms. For example, Fig. 2.2 is a sketch of an actual vernal pool in Jepson Prairie, Solano County. The pool had two different subtypes of vegetation, A and B. Subtype A recurred in two patches, both of which corresponded with the deeper parts of the basin (-15 cm below the fill line), whereas subtype B was a relatively shallower matrix of continuous vegetation (-10 cm below the fill line). Each subtype was sampled once with a 10 square meter plot subjectively placed in what seemed to be a representative location. Subtype A was visually distinct as bright green because of high abundance of *Lasthenia glaberrima*; subtype B was visually distinct because of the tall grass *Lolium multiflorum*, white-flowered *Limnanthes douglasii* ssp. *rosea*, yellow-flowered *Lasthenia fremontii*, and a greater species richness. We chose a plot area of 10 square meters because observations showed us that smaller plots failed to capture as many species and larger plots were too big to fit within a single subtype. The basic unit that was sampled, therefore, was not the entire vernal pool but rather the smaller homogeneous units within it.

Every species in a plot was recorded, together with its estimated percent cover. Habitat data (relative depth, pool shape, geologic substrate, elevation, geographic

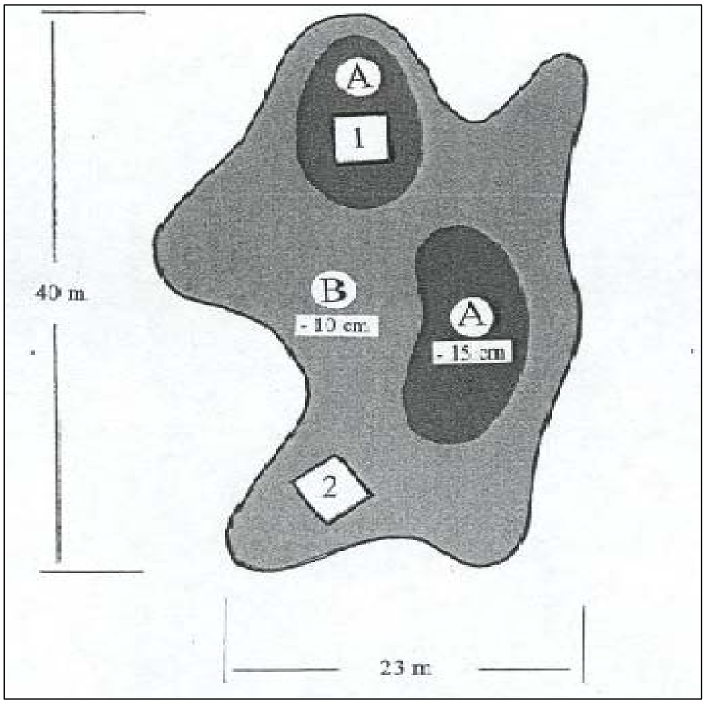


Fig. 2.2. Vegetation zonation within one Jepson Prairie pool. The location of visually different subtypes and of the 10 square meter plots are shown toscale. Subtype A occurred in the deepest parts of the pool (-15 cm) and subtype B occupied the shallowest parts (-10 cm). From Barbour et al. (2003).

location, etc.) were also recorded. Classification of community types was accomplished by placing floristic data from all sample plots into a single table, each column being a separate plot, each row being a separate species and the data in each cell being the percent cover of each species noted. A series of iterative re-arrangements of the table placed together more tightly species with similar distributions and plots with similar floristic composition. The iteration was performed with the widely used database TURBOVEG, developed for vegetation classification by Hennekens and Schaminee (2001). Then, the numerical classification algorithms TWINSPAN (Hill 1979), and

Multivariate analysis PC-ORD (McCune, Mefford 1999) were applied to produce a first-approximation of putative community types, later refined and made more distinctive by (Tichy 2002). In order to condense large tables, all plots belonging to the same community type are merged. The number in each cell is percent constancy of the species (for example, if species x occurred in 9 out of 10 of the plots now represented by a single row of data, species x would have 90% constancy). Condensed tables are called synoptic tables (Tables 2.1 – 2.5).

Data derived from earlier projects cannot be incorporated in our classification either because they sampled entire pools, meaning that they combined data from different communities into a single sample, or their sample plots were too small to capture the species richness (that is, samples were not floristically complete). As a result, our conclusions about community distribution are not exhaustive, but only based on the data we accumulated. There is a need for additional field work to improve our understanding of the ranges of those communities described here. Additionally, some new communities will be found.

RESULTS:

THE CLASS DOWNINGIA-LASTHENIA

All Californian vernal pool vegetation belongs to the class *Downingio-Lasthenietea*. This class comprises plant communities of hardpan, claypan and volcanic vernal pools, including those on fresh or alkaline soils and those in deep or shallow pools. Diagnostic species of the class, which occur throughout all of these habitats, include *Lasthenia fremontii, Navarretia leucocephala, Downingia bicornuta, Plagiobothrys stipitatus* var. *micranthus, Psilocarphus brevissimus* var. *brevissimus, Deschampsia danthonioides, Pilularia americana, Elatine californica, Veronica peregrina* ssp. *xalapensis*, *Alopecurus saccatus, Eryngium vaseyi/castrense, Isoetes orcuttii, Pogogyne zizyphoroides, Juncus bufonius, Eleocharis acicularis, Callitriche marginata, Crassula aquatica.* Among them are both California endemics and species with circumboreal distribution.

Californian vernal pools are similar to European ephemeral wetlands of the class Isoeto-Nanojuncetea Br.-Bl. et Tx. ex Westhoff, Dijk et Passchier 1946 in the joint presence of *Centunculus minimus*, *Crassula aquatica, Eleocharis acicularis, Juncus bufonius, J. capitatus, Lythrum hyssopifolia, Mentha pulegium, Montia fontana*, and *Myosurus minimus*. They also share vicariant species of *Callitriche, Elatine, Eleocharis, Isoetes, Marsilea,* and *Pilularia*. Nevertheless, Californian vernal pools are uniquely characterized by the high number of genera endemic to California or the west coast of North and South America, such as *Downingia, Lasthenia, Navarretia, Plagiobothrys, Pogogyne,* and *Psilocarphus*. These endemic taxa also typically contribute high cover. From data about the distribution of these species we can assume that the geographic range of the class extends from southeastern Washington, throughout Oregon and California in North America, and in Chile and Argentina in South America.

Many vernal species (natives and exotics) that are common also occur in other habitats, so they are not of diagnostic value; but they still are part of the vernal pool flora and they are listed near the end of Table 2.1.

Based on our analysis, there are three major, floristically distinct groups of vernal pool communities in the Central Valley. The key to those groups appears below. Keys to associations and association descriptions within each group are located later, when each group is characterized in detail. The distribution information about associations is not exhaustive and based only on our study. However, we assume that even limited distribution information can be helpful for those who use the key, and it will encourage users to note new locations.

Key to Groups (orders)

1. Halophytes (*Distichlis spicata, Frankenia salina, Cressa truxillensis, Myosurus minimus, Crypsis schoenoides*) present as a group or, if fewer then with >5% cover; habitat is saline or alkaline and a salt crust or salty soil taste is present; order Frankenia-Lasthenia fremontii (saline/alkaline pools) ……………………….……………… **Group C**

1. Halophytes absent, reduced in number, and only occasional; nonsaline habitat…...2

2. Species tolerant to long inundation (*Lasthenia glaberrima, Eleocharis macrostachya*) present with high cover; in optimal conditions, cover by these species >10% (to 80%); in lower parts of pools; saline or fresh water; order Lasthenia glaberrima …. **Group A**

2. Long-inundation species *Lasthenia glaberrima* and *Eleocharis macrostachya* absent or present with low cover; located in shallower parts of pools; fresh-water pools; *Lasthenia fremontii, Psilocarphus brevissimus, Navarretia leucocephala, Alopecurus saccatus, Deschampsia danthonioides, Eryngium vaseyi/castrence, E. castrense,* and *Pogogyne zizyphoroides* abundant in part or collectively; order Downingia-Lasthenia fremontii … ……………………………………………………………… **Group B**

DESCRIPTIONS OF COMMUNITY TYPES

Group A: Communities in long-inundated pools - alliance Lasthenia glaberrima

This group consists of a single alliance Lasthenia glaberrima. Diagnostic species of the alliance are *Lasthenia glaberrima* and *Eleocharis macrostachya*. Communities of this alliance develop in the deepest parts of vernal pools and indicate habitats with the longest period of inundation. They are characterized by the high relative cover, as well as high constancy, of *Lasthenia glaberrima* and *Eleocharis macrostachya*. Because deep pool bottoms keep moisture for longer period, they also have high constancy and abundance of such perennial species as *Eryngium vaseyi/castrense* and *Isoetes howellii*. These communities differ from those in other alliances of fresh-water pools in their absence or much lower constancy of *Blennosperma nanum* var. *nanum, Cicendia quadrangularis, Downingia cuspidata, Hemizonia fitchii, Lepidium nitidum, Limnanthes douglasii* ssp. *rosea, Plagiobothrys greenei*, and *Trifolium depauperatum*, which cannot survive such long periods of inundation. Lengthy inundation also leads to a lower degree of invasion by exotic species.

Communities of the *Lasthenia glaberrima* alliance occur throughout the Great Valley, Sierra Nevada foothills, and table mountains on a variety of geomorphic surfaces, landforms (Basin, Low and High Terraces, and Basalt and mud flows), and soil series

(Capay, Colusa, Corning, Hideaway, Pescadero, Redding, Riz, and San Joaquin,) and they may be underlayed by either a claypan, hardpan, or volcanic rock. They are restricted to fresh water pools but also occur in slightly saline/alkaline pools. Within the alliance are six associations: three characteristic of hardpan pools and three of claypan pools.

Key to associations: Group A - alliance Lasthenia glaberrima

1. *Downingia bicornuta, Ranunculus bonariensis* var. *trisepalus, Gratiola ebracteata,* and *Plagiobothrys undulatus* present and abundant in part or collectively; hardpan and volcanic rock pools……………………………………………………………………...2

1'. Those species absent as a group, or some present but with low cover; claypan and volcanic rock pools……………………………………………………………………...4

2. *Trifolium variegatum, T. depauperatum* var. *depauperatum, Juncus capitatus* present, with such upland native species as *Holocarpha virgata, Triteleia hyacinthina* and exotics *Erodium botrys, Vulpia bromoides, Briza minor, Trifolium dubium, Geranium dissectum* ……………………………**association Trifolium variegatum-Lasthenia glaberrima**

2'. Not as above……………………………………………………………………………3

3. *Downingia cuspidata, Isoetes nuttallii, Castilleja campestris* ssp. *succulenta, Gratiola heterosepala* present; *Gratiola ebracteata* and *Plagiobothrys undulatus* and *Ranunculus bonariensis* var. *trisepalus* absent or present at very low cover; in volcanic rock pools on table mountains………………**association Pogogyne douglasii-Lasthenia glaberrima**[2]

3'. *Gratiola ebracteata*, *Plagiobothrys undulatus,* and *Ranunculus bonariensis* var. *trisepalus* present ……..….**association Downingia bicornuta-Lasthenia glaberrima**

4. *Downingia insignis, Grindelia camporum, Epilobium densiflorum, Cressa truxillensis, Cotula coronopifolia,* and *Crypsis schoenoides* present; Solano-Colusa and Northern Sacramento Valley vernal pool regions; claypan pools…………………………………. ………………………. **association Downingia insignis- Lasthenia glaberrima**

4'. Not as above……………………………………………………………………………5

5. *Hemizonia fitchii, Lupinus bicolor, Pogogyne douglasii, Epilobium cleistogamum, Eryngium aristulatum, Myosurus minimus, Medicago polymorpha* present; on Vertisols

in Solano-Colusa vernal pool region……………………………………………………. …………………………………. **association Lupinus bicolor-Lasthenia glaberrima**

5'. Not as above……………………………………..……………………………..6

6. *Distichlis spicata, Pleuropogon californicus,* and *Downingia concolor* present; latter species has lower constancy but when present it is a good indicator of this community type; in the southern part of the Solano-Colusa vernal pool region……………………. ……………………….. **association Pleuropogon californicus-Lasthenia glaberrima**[2]

6'. *Downingia cuspidata, Isoetes nuttallii, Castilleja campestris* ssp. *succulenta, Gratiola heterosepala* present; *Gratiola ebracteata* and *Plagiobothrys undulatus* and *Ranunculus bonariensis* var. *trisepalus* absent or present at very low cover; volcanic rock pools on table mountains …… **association Pogogyne douglasii-Lasthenia glaberrima**[2]

Order/Alliance Lasthenia glaberrima: descriptions of associations

Association Downingia bicornuta-Lasthenia glaberrima (Table 2.1, columns 1-8). Diagnostic species: *Downingia bicornuta, Ranunculus bonariensis* var. *trisepalus, Gratiola ebracteata, Plagiobothrys undulata.* This association comprises plant communities of hardpan vernal pools on high terrace or low terrace landforms. Fits within the "Northern Hardpan" category of Sawyer and Keeler-Wolf (1995). It is the most widespread association of all orders, occurring on Riverbank, Laguna, Tuscan, Turlock Lake, and Modesto geomorphic surfaces, and on Alamo, Fiddyment, San Joaquin, Clear Lake, Redding, Toomes, Corning, Anita, Tuscan, and Cometa soil series. It is present in five Central Valley vernal pool regions: Northeastern Sacramento Valley, Northwestern Sacramento Valley, Southeastern Sacramento Valley, Solano-Colusa, and San Joaquin Valley. Nearly 140 samples were taken of this association, and it is summarized in columns 1-7 of Table 2.1. Pools average 5000 square meters. The association is dominated by *Lasthenia glaberrima* and *Eleocharis macrostachya*, and present in high constancy are *Downingia bicornuta, Ranunculus bonariensis* var. *trisepalus, Gratiola ebracteata,* and *Plagiobothrys undulatus*, which differentiate them from communities of other associations. Rare taxa encountered include *Legenere limosa, Gratiola heterosepala, Navarretia leucocephala* ssp. *bakeri, N. myersii* ssp. *myersii, N.*

prostrata, Orcuttia viscida, O. pilosa, and *Orcuttia tenuis*. The number of species per plot averages 16. Average depth below pool edge is 17 cm (range = 2-48 cm), and topographic position averages 4.2 (on a scale of 1-5, 5 being pool bottom and 1 being upland edge). Herb cover averages 80% (range = 50-95%) and herb height averages 13 cm (range = 4-45 cm).

Within this widespread association, there were enough regional floristic differences to recognize eight variants: *Typica* (Table 2.1, column 1), *Eleocharis macrostachya* (Table 2.1 column 2), *Castilleja campestris* (Table 2.1 column 3), *Isoetes howellii* (Table 2.1 column 4), *Lilaea scilloides* (Table 2.1 column 5), *Glyceria occidentalis* (Table 2.1 column 6), *Lythrum portula* (Table 2.1 column 7), and *Convolvulus arvensis* (Table 2.1 column 8).

Association Trifolium variegatum-Lasthenia glaberrima (Table 2.1 column 9). Diagnostic species: *Trifolium variegatum, T. depauperatum*, and *Holocarpha virgata* plus the non-native species *Hordeum marinum* ssp. *gussoneanum, Erodium botrys, Vulpia bromoides, Briza minor*, and *Trifolium dubium*. The association is dominated by *Lasthenia glaberrima* and *Eleocharis macrostachya* and it differs from other associations in the high constancy of the native species *T. variegatum, T. depauperatum*, and *H. virgata* and a consistent presence of the non-native species *H. marinum* ssp. *gussoneanum, E. botrys, V. bromoides, B. minor*, and *T. dubium*, all facultative wetland plants much more common in the grassland. No rare species were encountered. This association comprises communities of hardpan pool edges and bottoms on low terrace and high terrace landforms, Riverbank, Red Bluff, Laguna, and Modesto geomorphic surfaces, and the soil series San Joaquin, Alamo, Fiddyment, Redding, Anita, Hideaway, and Crevis Creek. This type fits within the “Northern Hardpan” category of Sawyer and Keeler-Wolf (1995). Pool size averaged 1600 square meters. This description is based on 18 samples, most located in the Southeastern Sacramento Valley region, but once on Kennedy Table in the Southern Sierra Foothills region and once in the Northeastern Sacramento Valley region. The average depth of below pool edge is 7 cm (range = 1-24 cm) and pool position is 3.3. Herb cover averaged 80% (range = 65-92) and herb height averaged 15 cm (range = 7-25 cm).

Association Pogogyne douglasii-Lasthenia glaberrima (Table 2.1 column 10). Diagnostic species of the association: *Pogogyne douglasii, Downingia cuspidata*. Dominants include *Lasthenia glaberrima, L. fremontii, Eryngium castrense/vaseyi, Plagiobothrys stipitatus* var. *micranthus*. Two common vernal pool species, *Callitriche marginata* and *Psilocarphus brevissimus* var. *brevissimus*, have high constancy but low cover. Floristically, this association is unique in the presence of *P. douglasii* and *D. cuspidata*, and in the absence of diagnostic species of other associations. Species richness per plot is low (average = 11). Communities of this association occur in table mountain volcanic rock pools on volcanic landform with Lovejoy geomorphic surface and on Hideaway soil series, and they are characteristic of table mountains. This type fits within the "Northern Basalt Flow" category of Sawyer and Keeler-Wolf (1995). The association is based on 20 samples in the Southern Sierra Foothills region. Pool depth for this association averaged 16 cm (range = 14-18 cm) and pool position averaged 3.6. Herb cover averaged 57% (range = 25-85) and herb height averaged 16 cm (range = 5-50 cm).

Association Lupinus bicolor-Lasthenia glaberrima (Table 2.1 column 11). Diagnostic species of the association*: Lasthenia glaberrima, Lupinus bicolor, Hemizonia fitchii, Pogogyne douglasii, Medicago polymorpha, Myosurus minimus*. The only rare taxon encountered was *Hesperevax caulescens* (5% constancy). The association is based on 22 samples, all on clay pans of basin and basin rim landforms with Holocene geomorphic surface and the vertisol soil series Capay and Clear Lake. This type fits within the "Northern Claypan" category of Sawyer and Keeler-Wolf (1995). Pool areas are large, averaging 49,000 square meters. The association was limited to the Solano-Colusa region. Average depth for the association is 16 cm (range = 5-20) and pool position averaged 3.8. Plant cover averaged 64% (range = 45-85%) and plant height averaged 7 cm (range = 2-12 cm).

Association Pleuropogon californica-Lasthenia glaberrima (Table 2.1 column 12). Diagnostic species of the association: *Distichlis spicata, Pleuropogon californica,* *Myosurus minimus*. This association comprises plant communities of deep bottoms of slightly saline/alkaline claypan vernal pools. They are dominated by *Lasthenia glaberrima* and *Eleocharis macrostachya*, but they are unique in the presence of salt-tolerant species. The widespread vernal pool species *Eryngium castrense/vaseyi, Lasthenia fremontii, Psilocarphus brevissimus* var. *brevissimus,* among others, are typically present. Species richness per plot averaged 14. The non-native species *Lolium multiflorum, Lythrum hyssopifolia,* and *Erodium botrys* are common, and *L. multiflorum* is sometimes abundant. Rare taxa encountered are *Legenere limosa* (17% constancy, meaning that *Legenere* was found in 17% of all plots belonging to this association), *Downingia pusilla* (13%), *Gratiola heterosepala* (2%), and *Lasthenia conjugens* (2%). The association description is based on 53 samples in the Solano-Colusa vernal pool region, in claypan pools on alluvial fan, basin rim, and low terrace landforms with Modesto geomorphic surface and on soil series Pescadero, San Ysidro, Antioch, and Solano, Sycamore. This type fits within the "Northern Claypan" category of Sawyer and Keeler-Wolf (1995). Pool area was intermediate, 5500 square meters. Pool depth for this association averaged 15 cm (range = 4-45 cm) and pool position was extreme, averaging 4.6. Plant cover averaged 75% (range = 55-95%) and plant height averaged 10 cm (range= 4-25 cm)

Association Downingia insignis-Lasthenia glaberrima (Table 2.1 column 13). Diagnostic species of the association: *Lasthenia glaberrima, Downingia insignis, Grindelia camporum, Cotula coronopifolia, Epilobium densiflorum, Cressa truxillensis, Crypsis schoenoides*. No rare taxa were encountered. The association is based on 15 samples, all in somewhat saline/alkaline claypan pools on basin and basin rim landforms with Holocene and Modesto geomorphic surfaces and on the soil series Colusa, Riz, and Willows (once only). This type fits within the "Northern Claypan" category of Sawyer and Keeler-Wolf (1995). Pools are large, averaging 11,500 square meters. The association is limited to the Solano-Colusa region.

Group B: Communities of fresh-water, short-inundated, shallow, and flashy pools - order Downingia bicornuta-Lasthenia fremontii

The diagnostic species of the order are: *Blennosperma nanum, Downingia cuspidata, Hemizonia fitchii, Trifolium depauperatum, Limnanthes douglasii* ssp. *rosea, Cicendia quadrangularis, Lepidium nitidum, Plagiobothrys greenei.*

This order represents a broad variety of vernal pool communities of relatively shallow pool bottoms and pool edges. They occur on various landforms ranging from low and high terraces to volcanic basalt and lava flows. Geologic formations range from Modesto, Riverbank, Turlock Lake, Red Bluff, and Laguna formations on terraces to Mehrten, Valley Spring and Lovejoy formations on volcanic mud flows and basalts. Soil varies from Palexeralfs and Durixeralfs on terraces to Haploxeralfs and Xerorthents on basalt and mud flows. Communities of this order are found in both hardpan and claypan pools, but always in fresh-water systems. Despite tremendous variety of edaphic and physiographical conditions, these pools share a group of common taxa. This order has the richest flora of all three orders, in part because taxa from ecotones with uplands are included (such as non-natives *Hypochaeris glabra, Bromus hordeaceus, Erodium botrys, Vulpia bromoides, Aira caryophyllea,* and *Briza minor,* and the natives *Hemizonia fitchii, Trifolium depauperatum,* and *Lepidium nitidum).* Order includes four alliances Lupinus bicolor-Eryngium aristulatum (claypan vernal pools on vertisols), Downingia bicornuta-Lasthenia fremontii (various types of hardpan pools), Layia fremontii-Achyrachaena mollis (hardpan vernal pools on shallow, rocky soils), and Montia fontana-Sidalcea calycosa (volcanic rock pools on table mountains).

Key to associations: Group B – order Downingia bicornuta-Lasthenia fremontii

1. *Lupinus bicolor, Eryngium aristulatum, Hemizonia congesta* ssp. *luzulifolia, Trifolium willdenovii, Hesperevax caulescens, Medicago polymorpha* present and abundant in part

or collectively; claypan pools on vertisols ..…….…………………………………...……
……………...…………………… **association Lupinus bicolor-Eryngium aristulatum**

1'. Those species absent as a group, or some present but with low cover; hardpan pools or volcanic rock pools……………………………………………………… ………….... 2

2. *Layia fremontii, Achyrachaena mollis, Triphysaria eriantha* ssp. *eriantha, Clarkia purpurea, Taeniatherum caput-medusae* present and abundant in part or collectively; hardpan pools in the Northeastern and Northwestern vernal pool regions ………. …….. 3

2'. Those species absent as a group, or some present but with low cover; hardpan pools or volcanic rock pools………………………………………………………….………….... 4

3. *Plagiobothrys austinae, Chlorogalum angustifolium, Dodecatheon clevelandii* ssp. *patulum, Lasthenia californica, Microseris acuminata, Navarretia tagetina, Plantago erecta, Vulpia microstachys* present and abundant in part or collectively ……………..… …………………………..….. **association Plagiobothrys austinae-Achyrachaena mollis**

3'. Those species absent as a group, or some present but with low cover. *Layia fremontii, Achyrachaena mollis, Triphysaria eriantha* ssp. *eriantha, Clarkia purpurea, Taeniatherum caput-medusae* as well as such vernal pool species as *Lasthenia fremontii, Eryngium vaseyi/castrense, Psilocarphus brevissimus* present and abundant …………… ……………………………..……. **association Layia fremontii-Achyrachaena mollis**

4. *Montia fontana* and *Sidalcea calycosa* present and abundant in part or collectively, table mountain vernal pools on volcanic rock substrata …………………………………. …………………………………...… **association Montia fontana-Sidalcea calycosa**

4'. Hardpan vernal pools, not on table mountains, not on volcanic lava flow substrata …………………………………………………………………………...…….….… 5

5. *Downingia bicornuta, Ranunculus bonariensis* var. *trisepalus, Gratiola ebracteata, Castilleja campestris* ssp. *campestris* present and abundant in part or collectively ….…. 6

5'. Those species absent as a group, or some present but with low cover; hardpan pools or volcanic rock pools (*Downingia bicornuta* presen in the association Downingia cuspidata/bicornuta) ..……………………………………………….…………….…….. 7

6. *Holocarpha virgata , Trifolium variegatum, Trifolium depauperatum, Hypochaeris glabra, Erodium botrys, Bromus hordeaceus, Vulpia bromoides* present and abundant in part or collectively ……… **association Ranunculus bonariensis-Holocarpha virgata**

6’. Those species absent as a group or some present but with low cover. *Downingia bicornuta, Ranunculus bonariensis* var. *trisepalus, Gratiola ebracteata, Castilleja campestris* ssp. *campestris* are not surrounded by upland species ………………………. ……..........................……….. **association: Downingia bicornuta-Lasthenia fremontii**

7. *Downingia cuspidata* and/or *Downingia bicornuta* are present, Northeastern Sacramento Valley region ....…… **association Downingia cuspidata/bicornuta**

7’.

8. *Downingia ornatissima* is present, Northeastern and Northwestern Sacramento Valley regions …………..................... **association Downingia ornatissima-Lasthenia fremontii**

8’. *Downingia ornatissima, Downingia cuspidata,* and *Downingia bicornuta* are absent, Vernal pool species *Eryngium vaseyi/castrense, Plagiobothrys stipitatus* var. *micranthus, Psilocarphus brevissimus* var. *Brevissimus* are presentand abundant, hardpan pools in Northeastern and Northwestern Sacramento Valley regions …………………………….. .... **Basal community Eryngium vaseyi/castrense**

Order Downingia bicornuta-Lasthenia glaberrima: descriptions of alliances and associations

Alliance Lupinus bicolor-Eryngium aristulatum

Diagnostic species of alliance: *Lupinus bicolor, Eryngium aristulatum, Hemizonia congesta* ssp. *luzulifolia, Trifolium willdenovii, Medicago polymorpha*. Alliance includes communities of claypan vernal pools on vertisol soil series. This alliance was only recorded in the Solano-Colusa region and corresponds to “Northern Claypan” category of Sawyer and Keeler-Wolf (1995). Alliance includes one association with two subassociations.

Association Lupinus bicolor-Eryngium aristulatum (Table 2.2, columns 1 and 2). Diagnostic species: *Hemizonia congesta* ssp. *luzulifolia, Lupinus bicolor, Eryngium aristulatum, Trifolium willdenovii, Medicago polymorpha*. No rare taxa were encountered. The association was defined on the basis of 18 samples, all in claypan pools of basin and basin rim landforms with Holocene geomorphic surface and on the vertisol soil series Capay and Clear Lake. This type is included in the "Northern Claypan" category of Sawyer and Keeler-Wolf (1995). This association was restricted to the Solano-Colusa region. Pools are large, averaging 50,000 square meters. Average depth below fill line for this association is 4 cm (range = 3-8 cm) and average pool position is 2.7. Plant cover averages 73% (range = 60-92%) and plant height averages 9 cm (range = 3-18 cm). Two sub-associations are distinguished: *Lasthenia glabrata* ssp. *glabrata* and *Lepidium latipes* var. *latipes*. Subassociations were sampled in two different pools. They are floristically rather distinct and potentially could be recognized as two separate associations when more data on their distribution became available.

Community Hesperevax caulescens-Trifolium gracilentum [alliance Lupinus bicolor-Eryngium aristulatum] (Table 2.2, column 19). Diagnostic species: the natives *Hesperevax caulescens, Trifolium gracilentum* and *Microseris elegans,* plus the non-natives *Hedypnois cretica, Erodium cicutarium, Soliva sessilis,* and *Sonchus oleraceus*. No rare taxa were encountered. This is an uncommon community, defined on the basis of only 5 plots, all in hardpan pools on alluvial fan landform, with Modesto geomorphic surface, and on Bear Creek soil. The community is limited to the Southern Sierra Foothills region. Even though it occurs in hardpan pools, its floristic composition consists of species found on vertisols, such as *Hesperevax caulescens, Psilocarphus oregonus , Lupinus bicolor,* and *Medicago polymopha*, therefore at this time we chose to place this community in this alliance. Pools are small, 400 square meters. Pool depth is 7 cm (range = 1-10 cm) and pool position is extreme bottom (5.0). Plant cover is 57% (range = 30-75%) and height is 7 cm (range = 4-12 cm).

Alliance Downingia bicornuta-Lasthenia fremontii

Diagnostic species: *Downingia bicornuta, Ranunculus bonariensis* var. *trisepalus, Gratiola ebracteata, Castilleja campestris* ssp. *campestris*. The alliance unites a group of associations of hardpan pools on terraces, on a wide variety of landforms and soils series. Pools are relatively small. This alliance is found in the Southeastern, Northeastern, Northwestern Sacramento Valley vernal pool regions, as well as in Southern Sierra Foothills region. It fits within the "Northern Hardpan" category of Sawyer and Keeler-Wolf (1995) and includes four association Downingia bicornuta-Lasthenia fremontii, Ranunculus bonariensis-Holocarpha virgata, Downingia ornatissima-Lasthenia fremontii, Downingia cuspidata/bicornuta. The first two associations occur in the Southeastern Sacramento Valley and in Southern Sierra Foothills regions, and they have a high constancy for species of the alliance. The latter two associations occur in the Northeastern and Northwestern Sacramento Valley regions, are somewhat impoverished floristically and their affiliation with the alliance is thus weaker.

Association Downingia ornatissima-Lasthenia fremontii (Table 2.2, column 4). Diagnostic species: *Downingia ornatissima*. Rare taxa that can be present (but seldom in this case) are *Downingia pusilla, Orcuttia tenuis,* and *Limnanthes floccose* ssp. *californica*. The association description is based on 100 samples. It is common in hardpan pools on high terrace and low terrace landforms with Red Bluff and Riverbank geomorphic surfaces, and on Redding, Corning, Arbuckle, and Tuscan soil series. Pools are small, averaging 1000 square meters. This type is included in the "Northern Hardpan" category of Sawyer and Keeler-Wolf (1995). Pool depth where the communities exist averages 9 cm (range = 0-26) and pool position averages 3.6. Plant cover is 79% (range = 40-99%) and height is 10 cm (range = 5-15 cm).

Association Downingia cuspidata/bicornuta (Table 2.2, columns 5 and 6). Diagnostic species: *Downingia cuspidata, D. bicornuta, Marsilea vestita*. The rare species *Legenere limosa, Orcuttia tenuis,* and *O. pilosa* were occasionally present. This association is also unique in the absence of *Ranunculus bonariensis* var. *trisepalus, Castilleja campestris* ssp. *campestris*, and *Gratiola ebracteata*, common elements in other associations. This is a relative common association in volcanic pools on volcanic, high terrace, or mud flow landforms, with Red Bluff, Tuscan, or Holocene geomorphic surfaces, and on Toomes, Tuscan, or Anita soil series. It is only found in the Northeastern Sacramento Valley region, and it fits within the "Northern Mudflow" category of Sawyer and Keeler-Wolf (1995). Pools are large, 25,000 square meters in area. The association is defined from 131 plots. Pool depth is 17 cm (range = 5-54 cm) and pool position is 3.3. Plant cover is 63% (range = 20-99%) and height is 21 cm (range = 3-50 cm).

Two subtle variants are distinguished based on the presence of the rare taxa *Orcuttia tenuis, O. pilosa,* and the fact that they seldom co-occurred and were sampled at different locations.

Association Downingia bicornuta-Lasthenia fremontii (Table 2.2, columns 7-10). Diagnostic species: *Downingia bicornuta, Ranunculus bonariensis* var. *trisepalus, Gratiola ebracteata, Castilleja campestris* ssp. *campestris*. Species richness per plot is relatively high, averaging 20 species. The rare taxa *Downingia pusilla*, *Gratiola ebracteata, Navarretia myersii, Legenere limosa,* and *Orcuttia viscida* were sometimes present. This association is described on the basis of 178 plots. It is a common association in hardpan pools on Low terrace, high terrace, and (occasionally) on volcanic landforms, with Riverbank, Modesto, Turlock, Laguna, Valley Springs, Mehrten, and China Hat geomorphic surfaces, and on a wide variety of soils series (Pentz, Redding, Bear Creek, Rocklin, Cometa, San Joaquin, Amador, Gillender, Crevis Creek, Hicksville, Clear Lake, Fiddyment, Kaseberg, and Alamo). Pools are small, 700 square meters in area. This common association fits within the "Northern Hardpan" category of Sawyer and Keeler-Wolf (1995), and it occurs in the Southeastern Sacramento Valley and Southern Sierra Foothills vernal pool regions. Pool depth is 9 cm (range = 0-19) and pool position is 4.1. Plant cover is 75% (range = 52-98%) and height is 11 cm (range = 3-30 cm).

Four variants are recognized: Typica, Orcuttia viscida, Navarretia myersii, all in the Southeastern Sacramento Valley Region, and a forth far to the south in the Southern Sierra Foothills region. That latter variant –Alopecurus saccatus-- lacks two of the four diagnostic species of the association (*Gratiola ebracteata,* and *Castilleja campestris* ssp. *campestris*), as well as several other common taxa (*Navarretia leucocephala* and *Leontodon taraxacoides*). The variant's name reflects the much higher constancy of *Alopecurus saccatus* compared to the other variants.

Association Ranunculus bonariensis-Holocarpha virgata (Table 2.2, columns 11-14). Diagnostic species*: Ranunculus bonariensis* var. *trisepalus, Juncus capitatus, Holocarpha virgata*. No rare taxa were encountered. The association is based on 85 plots. This is a common association in hardpan pools on a wide variety of landforms (sedimentary, alluvial fan, low terrace, high terrace, and volcanic), geomorphic surfaces (Modesto, Turlock, Riverbank, Laguna, Valley Springs, Mehrten, Ione), and soil series (Redding, Bear Creek, Pentz, Keyes, Corning, Hornitos, Amador, Gillender, San Joaquin, Clear Lake, Fiddyment, Kaseberg, Alamo, Cometa). It is limited to Southeastern Sacramento Valley and Southern Sierra Foothill vernal pool regions. Pools are very small, averaging 450 square meters. This association fits within the "Northern Hardpan" category of Sawyer and Keeler-Wolf (1995). Pool depth is 5 cm (range = 2-35 cm) and pool position is 3.6. Plant cover is 70% (range = 35-99%) and height is 36 cm (15-70 cm).

This association has the same distribution as Downingia bicornuta-Lasthenia fremontii described above. But it differs in the smaller pool size and, we believe, a drier microenvironment, reflected in the much higher constancy of such pool edge/upland species as *Holocarpha virgata*, *Plagiobothrys greenei, Trifolium variegatum, T. depauperatum, Cicendia triangularis, Erodium botrys, Bromus hordeaceus, Vulpia bromoides, Hypochaeris glabra, Briza minor* etc.

Four variants are recognized. **Variant Limnanthes douglasii** (Table 2.2, column 14) from the Southern Sierra Foothills region differs in the presence or higher constancy of *Limnanthes douglasii* var. *rosea*, *Plagiobothrys leptocladus,* and *Epilobium cleistogamum*, and in the absence of *Layia fremontii, Sidalcea calycosa, Juncus capitatus, Leontodon taraxacoides, Anagallis minima,* and *Briza minor*. Three variants occur in the Southeastern Sacramento Valley region, two of which were local and one was more widely distributed. Local **variant Navarretia myersii** (Table 2.2, column 12) was found in Howard Ranch, and was unique in the presence of *Navarretia myersii* ssp. *myersii*, higher constancy of *Hemizonia fitchii* and *Blennosperma nanum* var. *nanum*, and in the absence of *Navarretia leucocephala*. The second local **variant Limnanthes alba** (Table 2.2, column 13) at Mather Field differed in the high constancy of *Limnanthes alba*, absence of the otherwise common vernal pool species *Trifolium depauperatum* var.

depauperatum, *Pogogyne zizyphoroides,* and in lower constancy of *Psilocarphus brevissimus* var. *brevissimus*, *Plagiobothrys stipitatus* var. *micranthus*, and *Deschampsia danthonioides*. The more widespread **variant Typica** (Table 2.2, column 11) had no distinguishing species beyond those of the association.

Community Eryngium vaseyi/castrense [Basal community of the alliance Downingia bicornuta-Lasthenia fremontii] (Table 2.2, column 3).

Diagnostic species: no diagnostic species were present to assign 86 samples to a particular association. Diagnostic species of class and order were present on these plots, which place them within the order Downingia-Lasthenia. This community is similar with associations Downingia ornatissima-Lasthenia fremontii and Downingia cuspidata-Lasthenia fremontii that are common in the same geographic regions, geologic settings, and soils, but it differs in the absence of *Downingia ornatissima* and *D. cuspidata* respectively. *Downingia* species however have low persistence and therefore they might be temporarily absent on the plots during dry years with their seeds remaining in the soil as a seed bank. It is very likely therefore that some of the stands included in this basal community belong to associations Downingia ornatissima-Lasthenia fremontii and Downingia cuspidata-Lasthenia fremontii.

Rare taxa present in the community Eryngium vaseyi/castrense are *Castilleja campestris* ssp. *succulenta* (5% constancy) and *Downingia pusilla* (3% constancy). This community is found in hardpan pools on alluvial fan, low terrace, and high terrace landforms with Riverbank, Laguna, China Hat, Modesto, and Red Bluff geomorphic surfaces, and on Corning, Redding, San Joaquin, Greenfield, Tuscan, and Berrendos soils. This type fits within the “Northern Hardpan” category of Sawyer and Keeler-Wolf (1995). Pools are small, averaging 1000 square meters. It is limited to Southern Sierra Foothills and Northeastern Sacramento Valley vernal pool regions. Depth averages 11 cm (range = 0-36 cm) and pool position averages 4.1. Vegetation cover averages 68% (range = 35-99%) and height averages 10 cm (range = 5-15 cm).

Alliance Layia fremontii-Achyrachaena mollis

Diagnostic species of the alliance: *Layia fremontii, Achyrachaena mollis, Triphysaria eriantha* ssp. *eriantha, Taeniatherum caput-medusae, Clarkia purpurea*. The alliance comprises vegetation of hardpan vernal pools that develop on shallow rocky soils in the Northeastern Sacramento Valley and Northwestern Sacramento Valley vernal pool regions. They occur on high terraces with Red Bluff and Riverbank geomorphic surfaces, and on Corning, Redding, Arbuckle, Toomes, and Anita soil series. The alliance corresponds to the "Northern Hardpan" category of Sawyer and Keeler-Wolf (1995). It differs from other alliances in the high constancy of *Layia fremontii, Achyrachaena mollis, Triphysaria eriantha* ssp. *eriantha, Clarkia purpurea, Taeniatherum caput-medusae*, that also occur in surrounding grasslands.

<u>Association Layia fremontii-Achyrachaena mollis</u> (Table 2.2, columns 15 and 16). Diagnostic species of the association are similar to those of the alliance: *L. fremontii, Achyrachaena mollis, Triphysaria eriantha* ssp. *eriantha, Taeniatherum caput-medusae, Clarkia purpurea, Downingia ornatissima*. No rare taxa were encountered. The association was defined from 56 plots, all in hardpan pools on high terrace and low terrace landforms with Red Bluff and Riverbank geomorphic surfaces, and on Corning, Redding, Arbuckle, Toomes, and Anita soil series. The association is limited to Northeastern Sacramento Valley and Northwestern Sacramento Valley vernal pool regions. It fits within the "Northern Hardpan" category of Sawyer and Keeler-Wolf (1995). Pools are among the smallest of any association, 100 square meters in area. Pool depth is 5 cm (range = 0-16 cm) and pool position is 3.5. Plant cover is 70% (range = 15-85%) and height is 14 cm (range = 5-20 cm). Two variants are distinguished, one in the Northwestern Sacramento Valley region and the other in the Northeastern Sacramento Valley region.

<u>Association Plagiobothrys austinae-Achyrachaena mollis</u> (Table 2.2, columns 17 and 18). Diagnostic species: *Plagiobothrys austinae, Chlorogalum angustifolium, Dodecatheon clevelandii* ssp. *patulum, Lasthenia californica, Microseris acuminata,*

Navarretia tagetina, Plantago erecta, Vulpia microstachys. No rare taxa were encountered. The association was defined on the basis of 40 plots. This association has a limited distribution, in volcanic rock vernal pools on volcanic landform with Red Bluff or Holocene geomorphic surfaces, and on Tuscan or Inskip soil series. Pools are intermediate, 2400 square meters in area. This association fits within the "Northern Basalt Flow" category of Sawyer and Keeler-Wolf. Pool depth is 7 cm (range = 0-21 cm) and pool position is 4.1. Plant cover is 49% (range = 23-75%) and height is 12 cm (range = 6-20 cm). Two sub-associations are recognized: *Brodiaea minor* and *Linanthus parviflorus*.

Alliance Montia fontana-Sidalcea calycosa

Diagnostic species of the alliance: *Montia fontana, Sidalcea calycosa*. The alliance contains vernal pool vegetation specific to table mountains; that is, in volcanic rock pools on volcanic landform with Lovejoy geomorphic surface, atop island-like mesas 500 m in elevation, on Hideaway or Kramn-Beatsonhollow soil series. At present, the association includes only one association, but possibly future analysis will subdivide it into two different associations.

<u>Association Montia fontana-Sidalcea calycosa</u> (Table 2.2, columns 20-22). Diagnostic species: *Montia fontana, Sidalcea calycosa*. Two rare taxa were encountered *Castilleja campestris* ssp. *succulenta* and *Gratiola heterosepala*. This is an association specific to table mountains; that is, in volcanic rock pools on volcanic landform with Lovejoy geomorphic surface, atop island-like mesas 500 m in elevation, on Hideaway or Kramn-Beatsonhollow soil series. Pools are small, 2000 square meters. The association is restricted the Northeastern Sacramento Valley and Southern Sierra Foothill vernal pool regions. Pool depth is 9 cm (range = 1-35 cm) and position is 3.9. Plant cover is 72% (range = 25-100%) and height is 17 cm (range = 4-30 cm). Two variants are recognized: *Castilleja campestris* ssp. *succulenta* and *Mimulus guttatus*. On table mountains, an association within this alliance could co-occur in the same pool with the association

Pogogyne douglasii-Lasthenia glaberrima (Lasthenia glaberima – alliance), which occurs on deeper locations.

Group C: Communities of saline/alkaline pools – alliance Frankenia salina-Lasthenia fremontii

The diagnostic species of the alliance are: *Myosurus minimus, Plantago elongata, Downingia insignis, Cressa truxillensis, Distichlis spicata, Frankenia salina, Eryngium aristulatum, Crypsis schoenoides, Cotula coronopifolia.*

The communities in this alliance occur in saline or alkaline claypan pools on the Central Valley floor at the elevations typically < 30 m above sea level. They are on Basin and Basin Rim landforms and on Holocene-age alluvial deposits < 20,000 years old. Soils are alkaline (pH >9) and in the Natrixeralfs Great Group. Subsoil layers accumulate sodium-rich clay and have a xeric moisture regime. Low permeability of water and flat topography make pools almost disconnected hydrologically, and they loose water mostly through evaporation (Rains at al. 2006).

Pools and especially playas are large and might be flooded for periods of time, typically longer (until late May and June) than other pool types. Consequently, plants in these pools develop later. Floristically, communities of saline/alkaline pools differ from other vernal pool vegetation in the presence of halophytes. Many of these species are perennials *(Cressa truxillensis, Distichlis spicata, Frankenia salina, Eleocharis macrostachya, Eryngium aristulatum)*, which probably indicate a longer period of inundation, a shorter dry phase, and a shallower ground water table. Although environmental stress usually depresses invasibility, in this case these pools are often heavily invaded by salt-tolerant non-native species such as *Crypsis schoenoides, Polypogon monspeliensis,* and *Cotula coronopifolia*. Communities of this alliance are home for many rare species such as *Lasthenia ferrisiae, Lasthenia conjugens, Atriplex persistens*, *Orcuttia pilosa, Navarretia leucocephala ssp. bakeri, Astragalus tener* var. *tener, Downingia pusilla*. Eleven associations and one derivate community are (Table 2.4, columns 7-21) recognized within this alliance.

Group C: Key to associations of saline/alkaline pools

0. Sacramento Valley communities…………………………………………………......1

0'. San Joaquin Valley communities…………………………………………………8

1. *Lasthenia ferrisiae, L. conjugens*, *Salicornia subterminale*, *Spergularia platensis*, and *Lepidium dictyotum* var. *acutidens* present as a group; the southern part of the Solano-Colusa vernal pool region ……**association Lasthenia ferrisiae/conjugens**

1'. Taxa above not present as a group…………………………………..……………2

2. *Downingia insignis, Epilobium densiflorum, E. pygmaeum* present, Northern part of Solano-Colusa vernal pool region .... **association Downingia insignis-Psilocarphus brevissimus** …..3

2'. Species present not as above, southern part of Solano-Colusa vernal pool region .4

3. *Navarretia leucocephala, Grindelia camporum*, and *Polypogon monspeliensis* present and often abundant. Sacramento Wildlife Refuge …... ………. **Downingia insignis-Psilocarphus brevissimus, subass. Grindelia camporum**

3'. *Eleocharis acicularis, Scirpus maritimus*, and *Xanthium strumarium* present. Sacramento Wildlife Refuge ....…... ……... **Downingia insignis-Psilocarphus brevissimus, subass. Eleocharis acicularis**

3''. Species of diagnostic of subassociations Grindelia camporum and Eleocharis acicularis are not present. *Lagophylla* species, *Hemizonia fitchii, Malvella leprosa* ocasionally present. Dolan Ranch .... **Downingia insignis-Psilocarphus brevissimus, subass. Lagophylla sp.**

4. *Lasthenia platycarpha, L. dictyotum, Lepidium latipes* var. *latipes, L. oxycarpum, Crassula connata, Brodiaea coronaria, Plantago coronopus,* and *Poa secunda* present. Jepson Prairie, Gridley Ranch .... **association Lasthenia platycarpha-Lepidium dictyotum**

4'. Not as above…………………………………………………………………….5

5. *Crypsis schoenoides* and *Cressa truxillensis* abundant, *Atriplex persistens, Croton setigerus, Juncus balticus, Lasthenia glaberrima, Polygonum arenastrum, Gnaphalium palustre* present. Communities occur on edges of playas. Wilcox Ranch ....**association Atriplex persistens-Lasthenia glaberrima**

5’. *Pleuropogon californicus, Lasthenia fremontii*, *Crassula aquatica, Callitriche marginata* present. Many locations in the southern part of Solano-Colusa vernal pool region ....………… 6

6. Indicator species of long inundation *Lasthenia glaberrima* and *Eleocharis macrostachya* abundant, *Pilularia americana, Lilaea scilloides* present. In deepest parts of pool bottoms .... **association Pleuropogon californicus-Lasthenia glaberrima**[2]

6’. Not as above …………………………………………………..……………….. 7

7. Indicators of short period of inundation *Limnanthes douglasii* ssp. *rosea, Blennosperma nanum* var. *nanum, Triphysaria eriantha* ssp. *eriantha, Trifolium depauperatum.* var. *depauperatum, Cicendia quadrangularis, Phalaris lemmonii, Psilocarphus tenellus* var. *globiferus, Achyrachaena mollis, Hemizonia congesta* ssp. *luzulifolia, Holocarpha virgata, Plagiobothrys greenei, Vulpia bromoides,* and *Hypochaeris glabra* present. Vernal pool edges, sometimes only 1-2 meters wide ……. ....**association Pleuropogon californicus-Limnanthes douglasii**

7’. *Lasthenia fremontii* abundant, *Crassula aquatica, Pogogyne zizyphoroides, Myosurus minimus* more common than in two defined above associations. Neither indicators of long inundation (*Lasthenia glaberrima* and *Eleocharis macrostachya*), nor short inundation (*Limnanthes douglasii* ssp. *rosea, Blennosperma nanum* var. *nanum, Triphysaria eriantha* ssp. *eriantha, Cicendia quadrangularis, Achyrachaena mollis, Plagiobothrys greenei*, *Vulpia bromoides*, *Hypochaeris glabra* etc.) are abundant .... **association Pleuropogon californicus-Lasthenia fremontii**

8. *Plagiobothrys stipitatus* var. *micranthus, Pilularia americana, Callitriche marginata* present. Southern Sierra Foothills vernal pool region 9

8’. Not as above or these species are rare and not present as a group. San Joaquin Valley vernal pool region 11

9. *Hemizonia pungens, Deschampsia danthonioides, Trifolium variegatum, Trifolium depauperatum* var. *amplectens, Phalaris lemmonii, Medicago polymorpha*, and *Downingia bella* present. Edges of deep pools or bottoms of shallow pools. Southern Sierra Foothills vernal pool region … **association Downingia bella-Hemizonia pungens**

9’. Not as above. *Lilaea scilloides, Pilularia americana, Callitriche marginata* are typically present indicating longer period of inundation ....…................... 10

10. *Downingia bella* abundant, *Epilobium brachycarpum,* and *Marsilea vestita* present. Often occurs within the same pools with association Downingia bella-Hemizonia pungens but at deeper locations. Southern Sierra Foothills vernal pool region ………… ....**association Downingia bella-Lilaea scilloides**

10'. *Downingia cuspidata, Myosurus minimus* present. Southern Sierra Foothills vernal pool region …………………… **association Downingia cuspidata-Myosurus minimus**

11. *Hordeum depressum* present, *Hordeum murinum* ssp. *leporinum, Spergularia rubra, Lepidium nitidum* present …………... ………………...……….. **community Hordeum depressum/murinum ssp. leporinum**

11'. *Distichlis spicata* or *Cressa truxillensis* is usually abundant, *Hordeum marinum* ssp. *gussoneanum, Downingia pulchella, Navarretia prostrata, Plagiobothrys undulatus, Plagiobothrys humistratus, Myosurus* spp. Present ....…………………………..….12

12. *Distichlis spicata* dominant, *Myosurus minimus, Lasthenia chrysantha, Lasthenia glabrata* ssp. *glabra, Lasthenia glabrata* ssp. *coulteri, Navarretia prostrata,* and *Atriplex persistens* occasionally present…….**association Downingia pulchella-Distichlis spicata**

12'. *Cressa truxillensis* and *Frankenia salina* dominant, *Myosurus sessilis,* and *Cuscuta howelliana* occasionally present ...**association Downingia pulchella-Cressa truxillensis**

Alliance Frankenia salina-Lasthenia fremontii: descriptions of associations

Association Lasthenia ferrisiae/conjugens. (Table 2.3, columns 1 and 2). Diagnostic species include *Lasthenia ferrisiae, L. conjugens* (a rare taxon), *Salicornia subterminalis, Spergularia platensis*, and *Lepidium dictyotum* var. *acutidens*. No rare taxa were encountered. Species richness per plot ranges from 15 to 28. This is an uncommon association in claypan pools on basin rim landform with Modesto geomorphic surface, and on the Solano soil series. Pools are large (22,500 square meters). As true for all associations and communities that follow, they fit within the "Northern Claypan" category of Sawyer and Keeler-Wolf (1995). It is restricted to the Solano-Colusa region. The association's definition is based on 22 plots. Pool depth is 36 cm (range = 4-67 cm) and pool position is 3.1. Plant cover is 47% (range = 15-90%) and height is 8 cm (2-12 cm).

Association Downingia insignis-Psilocarphus brevissimus (Table 2.3, columns 3-5). Diagnostic species: *Lasthenia insignis, Grindelia camporum, Navarretia leucocephala, Polygonum monspeliensis*, and *Epilobium densiflorum*. The rare taxon *Orcuttia pilosa* can be present (6% constancy). This is the most common, widely distributed association on alkaline claypans in the Sacramento Valley. It occurs on basin and basin rim landforms with Modesto or Holocene geomorphic surfaces, and on Riz or Willows soil series within the Solano-Colusa vernal pool region. Species richness is moderate, 10-20 per plot. Pool depth is 12 cm (range = 1-25 cm) and position is 4.0. Plant cover is 65% (range = 15-90%) and height is 12 cm (range = 1-60 cm).

Three subassociations are recognized: *Eleocharis acicularis*, *Grindelia camporum*, and *Lagophylla* spp.

Association Atriplex persistens-Lasthenia glaberrima (Table 2.3, column 6). Diagnostic species: *Atriplex persistens, Lasthenia glaberrima, Navarretia leucocephala* ssp. *bakeri, Croton setigerus, Juncus balticus, Polygonum arenastrum, Gnaphalium palustre*. No rare taxa were encountered. A relatively uncommon association in claypan pools on low terrace landform, with Modesto geomorphic surface. Association description is based on 22 plots. Pools are large (45,000 square meters). Restricted to the Solano-Colusa region. Pool position is 3.5, plant cover is 55% (range = 45-75%), and plant height is very short (4 cm, range = 3-6 cm).

Association Pleuropogon californicus-Lasthenia fremontii (Table 2.3, column 7). Diagnostic species: *Pleuropogon californicus, Navarretia leucocephala* ssp. *bakeri, Lasthenia fremontii* (the latter is dominant). More rare taxa were encountered in this association than any other: *Astragalus tener* var. *tener, Downingia pusilla, Legenere limosa*, and *Gratiola heterosepala* (none with >5% constancy). This is a common association (44 plots) in the Solano-Colusa region, in claypan pools on alluvial fan, basin rim, and low terrace landforms on Modesto or Holocene geomorphic surfaces, and on Antioch, Pescadero, Solano, Capay, and Colusa soil series. It occurs on vernal pool bottoms and forms a distinctive yellow central part when *Lasthenia fremontii* is in flower.

This association covers most of the pool area and it is surrounded by the community of the association Pleuropogon californicus-Limnanthes douglasii, which exists as a white band at the periphery of the pool. If pools are deep enough, than in the deepest area the association Pleuropogon californicus-Lasthenia glaberrima occurs as a green patch surrounded by association Pleuropogon californicus-Lasthenia fremontii. Pool depth is 17 cm (range = 0-46 cm) and pool position is 4.3. Plant cover is 65% (range = 15-90%) and height is 7 cm (range = 2-20 cm).

Association Pleuropogon californicus-Limnanthes douglasii ssp. rosea (Table 2.3, column 8). Diagnostic species: *Pleuropogon californicus, Navarretia leucocephala* ssp. *bakeri, Cicendia quadrangularis, Limnanthes douglasii* ssp. *rosea, Psilocarphus oregonus, Achyrachaena mollis, Psilocarphus tenellus* var. *globiferus, Hemizonia congesta* ssp. *luzulifolia, Phalaris lemmonii*. The rare taxa *Astragalus tener* var. *tener* (5% constancy) and *Downingia pusilla* (12% constancy) may be present. Communities of this association typically occur at vernal pools edges and form white belts around pools in spring when *Limnanthes douglasii* ssp. *rosea* is in flower. They are found in claypan pools on alluvial fan, basin rim, or low terrace landforms, with Modesto geomorphic surface, and on Solano, Antioch, Pescadero, and San Ysidro soil series. Altogether 65 plots of this association were sampled in Jepson Prairie and three other nearby locations, all in the Solano-Colusa vernal pool region. Pool area is moderate, 2100 square meters. Pool depth is 9 cm (range = 0-19 cm) and pool position is 4.4. Plant cover is low (60%, range 45-80%) and height is 9 cm (range = 3-20 cm).

Association Lasthenia platycarpha-Lepidium latipes (Table 2.3, column 9). Diagnostic species: *Lasthenia platycarpha, Lepidium dictyotum*, *L. latipes* var. *latipes, L. oxycarpum, Crassula connata, Brodiaea coronaria, Plantago coronopus, Poa secunda, Cynodon dactylon*. The association description is based on 16 plots from large claypan pools (17,000 square meters) on basin rim landform with Modesto geomorphic surface, on the Solano soil series. The rare taxon *Astragalus tener* var. *tener* was present in only one of the plots. All plots are located in Jepson Prairie and Gridley Ranch – two nearby locations in the Solano-Colusa vernal pool region. Diagnostic species of the association are not vernal pool species but rather are typical of grassland habitats. In this association they grow on shallow vernal pool bottoms and edges and co-occur with vernal pool species such as *Deschampsia danthonioides, Lasthenia fremontii, Juncus bufonius,* and *Crassula aquatica*. Several common vernal pool species such as *Plagiobothrys stipitatus* var. *micranthus, Eleocharis macrostachys, Pillularia americana,* and *Callitrihe marginata* are not present. Presence of upland species and declining number of vernal pool species make us think that in comparison with other associations of the order Downingia-Lasthenia this association represents communities of relatively drier, shorter inundated habitats. Pool depth is 19 cm (range = 2-45 cm) and pool position is 3.3. Plant cover is low (59%, range = 15-90%) and so is plant height (6 cm, range = 2-8 cm).

<u>Association Downingia bella-Hemizonia pungens</u> (Table 2.3, column 10). Diagnostic species: *Downingia bella, Hemizonia pungens, Trifolium variegatum, T. depauperatum* var. *amplectens,* and the exotics *Medicago polymorpha, Lactuca serriola, Senecio vulgaris.* No rare taxa were encountered. A relatively uncommon association (13 plots) in claypan pools of low terrace landform, with Riverbank geomorphic surface, and on Exteter, Quonal, and Lewis soil series. Pools are very small (200 square meters), and all are within the Southern Sierra Foothills region. Pool depth is shallow (5 cm, range = 1-11 cm) and pool position is 3.1. Plant cover is 83% (range = 15-99%) and height is 26 cm (range = 7-40 cm).

<u>Association Downingia bella-Lilaea scilloides</u> (Table 2.3, column 11). Diagnostic species: *Downingia bella, Lilaea scilloides, Marsilea vestita, Epilobium brachycarpum*. No rare taxa were encountered. Similar distribution to the association above: claypan pools on low terrace landform, with Riverbank geomorphic surface and on Exeter, Quonal, and Lewis soils. Pools very small (200 square meters). Description based on 13 plots, all within the Southern Sierra Foothills region. Pool depth is 8 cm (range = 3-11 cm) and pool position is 4.0. Plant cover is 70% (range = 55-95%) and height is 20 cm (range = 10-35 cm).

Association Downingia cuspidata-Myosurus minimus (Table 2.3, column 12). Diagnostic species: *Downingia cuspidata, Myosurus minimus, Lilaea scilloides*. No rare taxa were encountered. Similar distribution to two associations above: in claypan pools on low terrace landform, with Riverbank geomorphic surface and on Qunal-Lewis soil series. Pools very small (250 square meters), and all within the Southern Sierra Foothills region. Association description is based on 13 plots. Pool depth is shallow (6 cm, range = 3-10 cm) and pool position is 3.7. Plant cover is low (54%, range = 15-80%) and height is short (6 cm, range = 1-12 cm).

Community Hordeum depressum/leporinum [Derivate community of the order Frankenia-Lasthenia] (Table 2.3, column 13). Diagnostic species: *Hordeum depressum, H. murinum* ssp. *leporinum*. No rare taxa were encountered. This community is characteristic of claypan pools on low terrace landform with Riverbank geomorphic surface, and on the Crosscreek soil series. Community description is based on 15 plots sampled at Pixley Ranch located in the San Joaquin Valley vernal pool region. Pools very small (100 square meters in area). Pool depth is 8 cm (range = 0-16 cm) and pool position is 4.1. Plant cover is 70% (range = 10-99%) and height is 11 cm (range = 1-25 cm). This community has high constancy of the native salt-tolerant species *Hordeum depressum* and upland non-native species such as *Hordeum murinum* ssp. *leporinum*, *Bromus hordeaceus, Vulpia myuros, Erodium botrys*, and *Spergularia rubra*. The halophytic species *Distichlis spicata, Frankenia salina*, and *Cressa truxillensis* that are common in saline vernal pools are not present in this community. Because this community was locally described, does not have unique diagnostic species, and differs mostly in the presence of the non-native species *Hordeum murinum* ssp. *leporinum*, we decided not to define it as an association, but instead as a derivate community.

Association Downingia pulchella-Distichlis spicata (Table 2.3, column 14). Diagnostic species: *Downingia pulchella, Distichlis spicata, Atriplex persistens, Lasthenia glabrata* ssp. *glabra, L. glabrata* ssp. *coulteri, Myosurus minimus, Navarretia prostrata*. No rare taxa were encountered. A relatively common association (49 plots) in claypan pools on dunefield or basin landforms, with Modesto geomorphic surface

(Holocene rarely), and on Hillmar, Edminster, or Kesterson soil series. Moderate-small pools (1000 square meters in area), all in the San Joaquin Valley region. Pool depth is 8 cm (range = 0-19 cm) and pool position is 3.5. Plant cover is 70% (range = 3-97%) and height is 14 cm (range = 3-30 cm).

Association: Downingia pulchella-Cressa truxillensis (Table 2.3, column 15). Diagnostic species: *Downingia pulchella, Cressa truxillensis, Frankenia salina, Myosurus minimus, Navarretia prostrata*. The rare taxon *Astragalus tener* var. *tener* could be present (but only at 5% constancy). A relatively common association (based on 43 plots) in claypan pools on basin and basin rim landforms, with Modesto or Holocene geomorphic surface, and on Edminster or Kesternson soil series. Moderate size pools (3300 square meters in area), all in the San Joaquin Valley vernal pool region. Pool depth is 10 cm (range = 1-21 cm) and pool position is 3.7. Plant cover is very low (50%, range = 1-96%), and plant height is low (6 cm, range = 1-25 cm).

Playa and alkali sinks: Alliance Cressa truxillensis-Distichlis spicata

Some rare species that have traditionally been considered as vernal pool taxa--*Neostapfia colusana, Tuctoria mucronata, T. greenei*, *Chamaesyce hooveri, Orcuttia pilosa* (USFWS 2004)—were seen in our data set to fall outside of vernal pool vegetation. In comparison with vernal pool communities, they lack most or all species diagnostic for the vernal pool class Downingia-Lasthenia such as *Lasthenia fremontii, Plagiobothrys stipitatus, Navarretia leucocephala, Psilocarphus brevissimus, Pogogyne zizyphoroides, Callitriche marginata, Crassula aquatica, Alopecurus saccatus* etc. (Table 2.4). We sampled these communities because these rare species occurred in them and at the time we did not know their floristic relationship to vernal pools. Communities of this group develop in saline/alkaline habitats and their halophytic components (*Cressa truxillensis, Frankenia salina, Distichlis spicata, Eryngium aristulatum,* and *Crypsis schoenoides*) were also present in saline/alkaline vernal pools.

Although this vegetation is more similar to playas than to vernal pools, we describe here those community types that contain the rare taxa listed above. Absence of the suite of vernal pool species indicates substantial ecological differences between these communities and those of the class Downingia-Lasthenia. We put them in the alliance Cressa truxillensis-Distichlis spicata that ultimately will be placed within another class, which unites halophytic vegetation of playas and alkali sinks.

All communities described within this alliance had very limited distributions, due to the rarity of their diagnostic species. Descriptions of range distribution and species composition are based only on our dataset and they will be improved when additional locations of these rare species are sampled and classified. Because of this data limitation, we classify the vegetation into communities, rather than associations.

<u>Community Neostapfia colusana-Malvella leprosa</u> (Table 2.4, column 1)
Diagnostic species: *Neostapfia colusana, Malvella leprosa, Phyla nodiflora.* This community is limited to Olcott Lake in Jepson Prairie, in the southern part of the Solano-Colusa region, on Modesto geomorphic surface, Basin Rim landform, and Pascaredo soil series. Olcott Lake is a large playa several hectares in area. Cover varied from 15 to 70% and height of herbs from 3 to 20 cm. Plots were sampled in August. In contrast to the community below, which also contains Neostafia colusana, this community has a much stronger perennial component, including *Malvella leprosa, Phyla nodiflora,* and *Cressa truxillensis,* which may indicate a longer availability of moisture. Three vernal pool species--*Eryngium aristulatum*, *Eleocharis macrostachya,* and *Psilocarphus brevissimus* var. *brevissimu*s were sporadically present.

<u>Community Neostapfia colusana-Polypogon maritimus</u> (Table 2.4, column 2).
Diagnostic species: *Neostapfia colusana, Psilocarphus brevissimus, Polypogon maritimus.* This community occurs in the southern part of the Solano-Colusa region, about 12 km southeast of Davis, on Holocene geomorphic surface, alluvial fan landform, and the Marine soil series. All 8 plots are from a single pool 90 m long x 20 m wide under the management of the Department of Defense. Cover varied from 35 to 75% and height varied from 3 to 8 cm. Plots were sampled in August 2005. Five vernal pool species were sporadically encountered: *Psilocarphus brevissimus* var. *brevissimus, Downingia insignis, Alopecurus saccatus, Eryngium aristulatum*, and *Plagiobothrys*

stipitatus var. *micranthus.* Although none of these species was abundant, their presence indicates a stronger connection with vernal pool vegetation than the previous community type.

Community Tuctoria mucronata (Table 2.4, column 3). Diagnostic species: *Tuctoria mucronata.* This community has a very limited distribution. It was sampled in another single pool within the Department of Defense area described above, in the southern part of the Solano-Colusa region 12 km southeast of Davis. The pool was approximately 70 m long x 15 m wide. Cover varied from 25 to 60% and height varied from 3 to 15 cm. It also was found in the Hamilton Ranch (which is just south of the Wilcox Ranch in the Jepson Prairie area) on Modesto geomorphic surface, basin rim landform, and the Pascadero soil series, where one additional plot was sampled. This community is floristically very similar to Neostapfia colusana-Polypogon maritimus exception of the presence/absence of *Tuctoria mucronata* and *Neostapfia colusana*. Both occurred within two different pools, several hundred meters apart. The similarity in location and flora suggest either (1) that the habitats differed in some subtle, unexamined way or (2) that the distribution was by chance. It is unlikely that the two rare taxa competed with each other, because both had low cover (<15%). If competition were a driving force, then it would more likely be between the rare taxa and the dominant *Crypsis schoenoides* with 40% average cover. Additional autecological and synecological research are necessary to explain the distributional pattern.

Community Chamaesyce hooveri-Scirpus maritimus (Table 2.4, column 4). Diagnostic species: *Chamaesyce hooveri* and *Scirpus maritimus* . This community was found in playas in the Sacramento Wildlife Refuge, within the northern part of the Solano-Colusa region on Modesto geomorphic surface, basin and basin rim landforms, and Willows and Riz soil series. Cover varied from 15 to 50% and height varied from 3 to 15 cm. This community differs from the three above in the presence of the perennial halophytes *Distichlis spicata* and *Scirpus maritimus*. The other perennials *Cressa truxillensis, Frankenia salina,* and *Eryngium aristulatum* present in this community were also found in community Neostapfia colusana-Malvella leprosa from Olcott Lake in the southern part of the Solano-Colusa region.

Community Orcuttia pilosa (Table 2.4, column 5). Diagnostic species: *Orcuttia pilosa*. As with community Chamaesyce hooveri (above), this community was sampled in the Sacramento Wildlife Refuge, within the Solano-Colusa region on Modesto geomorphic surface, basin and basin rim landforms, and Willows and Riz soil series. Our description is based on three samples in two pools. Total herb cover varied from 15 to 50% and height varied from 3 to 15 cm. This community is floristically very similar to community Chamaesyce hooveri with the exception of the presence/absence of *Orcuttia pilosa* and *Chamaesyce hooveri*. Where we encountered these two communities, they occurred in separate pools.

Community Atriplex persistens (Table 2.4, column 6). Diagnostic species: *Atriplex persistens.* This community was encountered only once, in the same location as the previous two communities (Chamaesyce hooveri and Orcuttia pilosa). Total herb cover was 30%, including 28% for Atriplex persistens. Herb height was 25 cm. Species richness was very low, only *Distichlis spicata* and *Crypsis schoenoides* accompanying *Atriplex persistens*.

Community Tuctoria greenei-Chamaesyce hooveri (Table 2.4, column 7). Diagnostic species: *Tuctoria greenei, Chamaesyce hooveri, Marsilea vestita*. Two species *Tuctoria greenei,* and *Chamaesyce hooveri* are rare. At this time, the community seems held together only in the presence of the rare plant *Tuctoria greenei*; only 11 plots are in the database. The community was sampled in a large playa-type pool 37,500 square meters in area on high terrace landform with a Red Bluff geomorphic surface and on the Anita soil series, located in the Northeastern Sacramento Valley region. Pool depth is 28 cm (range = 16-33 cm) and position is extreme bottom (5.0). Vegetation cover is low, only 38% (range = 4-60%) and height is short (9 cm, range = 3-30 cm). Species richness is low. Since it was sampled only in one pool, we do not know whether it repeats itself elsewhere, and therefore we chose not to describe it as an association.

Central Valley vernal pools in a California-wide context

This report focuses on the Central Valley, where the highest density and variety of pools occur. It includes six of the vernal pool regions recognized by Keeler-Wolf et al. (1998), as columns 1-13 (Table 2.5): Northwestern Sacramento Valley, Northeastern Sacramento Valley, Southeastern Sacramento Valley, Southern Sierra Foothills, Solano-Colusa, and San Joaquin Valley. Table 2.5 highlights how vegetation from those six regions are related to other regions: Central Coast (column 14), Livermore (15), Mendocino (16 and 17), Santa Rosa (18), Santa Barbara (21), Western Riverside (22), San Diego (23), Modoc (24 and 25). Three Keeler-Wolf regions are not shown: Lake-Napa, Carrizo, and Sierra Valley because we have too few samples to make a robust comparison. Two regions outside Keeler-Wolf's regions are, however, included: Southern Oregon (19 and 20) and Western Nevada (26-29).

The diversity of vernal pool communities from the Central Valley falls into three major groups. Communities of long-inundated pools (columns 1-3) are placed in the order Lasthenia glaberrima; shallower pools (columns 4-7) are in the order Downingia-Lasthenia; saline/alkaline pools (columns 8-13) are in the order Myosurus-Lasthenia. Communities of long-inundated pools are unique in high constancy and abundance of the extremely flood-tolerant taxa *Lasthenia glaberrima* and *Eleocharis macrostachya*. Communities of short-inundated pools (such as upland edges or uniformly shallow and "flashy" pools) are unique in the presence of less-tolerant species such as *Cicendia quadrangularis, Blennosperma nanum, Trifolium depauperatum, Triphysaria eriantha, Lasthenia californica, Trifolium variegatum, Layia fremontii, Lepidium nitidum*, and *Microseris acuminata*, as well as upland species such as *Hypochaeris glabra, Erodium botrys, Vulpia bromoides, Bromus hordeaceus, Aira caryophyllea*, and *Briza minor*, and the natives *Plagiobothrys greenei* and *Achyrachaena mollis*. Saline/alkaline pools are different in the higher presence of such halophytes as *Distichlis spicata, Plagiobothrys leptocladus, Frankenia salina, Myosurus minimus, Cressa truxillensis, Eryngium aristulatum, Pleuropogon californicus*, and *Crypsis schoenoides*.

Table 2.5 is an overview of diversity among all Californian vernal pool regions, allowing a visual comparison between the Central Valley pools and those regions outside the valley. Central Coast and Livermore pools fall into the order of Central Valley alkaline pools. Mendocino and Santa Rosa pools are unique in their presence *of Mentha pulegium, Plagiobothrys bracteatus, Pleuropogon californicus* var. *davyi, Juncus xiphioides*, and *Geranium dissectum*. As can be seen from columns 16-18, they have fewer class species but they still fall within the long-inundated and short-inundated Central Valley pool orders. Oregon pools (19 and 20) stand out in the presence of *Downingia yina* and *Eryngium petiolatum* and the higher constancy of *Triteleia hyacinthina, Isoetes nuttallii*, and *Trichostema lanceolatum*. They are similar enough to Central Valley pools to fall within the long-inundated and short-inundated pool orders. Santa Barbara communities have higher constancy of *Plagiobothrys undulatus*, but otherwise they are undistinguishable from Central Valley pools. Southern California pools (columns 22 and 23) differ in the presence of such endemic taxa as *Eryngium aristulatum* var. *parishii, Navarretia prostrata, Orcuttia californica, Hemizonia fasciculata, Pogogyne abramsii*, and *Brodiaea orcuttii*. They also contain most species of the class, so they fall within the long-inundated and short-inundated pool orders. There are no halophytes in these pools. Pools from the Modoc region (columns 24 and 25) are different in the presence of *Epilobium ciliolatum, E. brachycarpum, E. pallidum, Eryngium alismifolium, E. mathiasiae, Polygonum polygaloides* ssp. *confertifolia, Brodiaea coronaria* ssp. *coronaria*, and ssp. *minima*. At the same time they have many class species, so they will form some subunit (level not yet determined, possibly as high as an order) within the class. Finally, pools from Nevada (columns 26-29) are floristically distinctive: they do not contain diagnostic species of the class and they have instead species not found in Californian pools, such as *Muhlenbergia richardsonis, Phlox gracilis, Camissonia tanacetifolia, Potentilla newberryi, Artemisia tridentata, Gayophytum diffusum, Polyctenium williamsiae, Agoseris heterophylla, Collinsia sparsiflora, Polygonum douglasii, Bromus tectorum, Rumex salicifolius* var. *lacustris, Erodium cicutarium, Descurainia sophia*. With additional work, this vegetation will no doubt be described as another class.

In sum, Central Valley vernal pool vegetation, at the level of orders, is diverse enough to capture the vegetation of other regions in Table 2.5, except for Modoc and Nevada. Listed taxa and species of concern are boldfaced in the table as a group. Some have diagnostic value (eg, *Lasthenia conjugens*, *Eryngium aristulatum* var. *parishii*) but others are too rare. Many vernal species (natives and exotics) that are common also occur in other habitats, so they are not of diagnostic value; but they still are part of the vernal pool flora and they are listed near the end of Table 2.5.

DISCUSSION

Altogether, 29 entities at the level of community or association were defined and named (Table 2.6). Seven subassociations and 18 variants were also defined. Below, we will use this classification to link the distribution of rare plant taxa with communities and associations. Such linkage is of value for placing these taxa in an ecological context, for predicting the location of new populations of those taxa, and for identifying locations for re-introducing those taxa. Of course, the conclusions reached in Table 2.6 are limited by the information in hand. Therefore, the absence of rare taxa for any given association does not mean that rare taxa are absent everywhere that association exists—it only means that rare taxa have not yet been found occurring in that association in our database. But for those associations with rare taxa, we can say this association provides a suitable habitat for certain rare taxa and that the habitat can be used for re-introduction of those rare taxa.

Table 2.6. Summary of associations: Number of plots and vernal pool regions in which the association occurs; the nature of the impervious layer; the depth in the pool and the topographic position (1-5, 1 shallow edge and 5 pool bottom) at which the association is found; average pool area in square meters, and the number of rare taxa encountered in plots of that association.

Association name	Plots/Regions	Substrate	Depth/Position	Size	Rare spp
Long-inundated					
Downingia bicornuta-Lasthenia glaberrima	139/6	hardpan	17/4.2	5,000	7

Trifolium variegatum-Lasthenia glaberrima	18/3	hardpan	7/3.3	1,600	
Pogogyne douglasii-Lasthenia glaberrima	20/1	volcanic rock	16/3.6	4,000	
Lupinus bicolor-Lasthenia glaberrima	22/1	claypan	16/3.8	49,000	
Pleuropogon californica-Lasthenia glaberrima	53/1	claypan	15/4.6	5,500	4
Downingia insignis-Lasthenia glaberrima	15/1	claypan	15/5.0	11,500	
Short-inundated, shallow, flashy					
Lupinus bicolor-Eryngium aristulatum	18/1	vertisol claypan	4/2.7	49,500	
Community Eryngium vaseyi/castrense	86/2	hardpan	11/4.1	1,000	2
Downingia ornatissima-Lasthenia fremontii	100/2	hardpan	9/3.6	1,000	3
Downingia cuspidata/bicornuta	131/1	volcanic rock	17/3.3	25,000	1
Downingia bicornuta-Lasthenia fremontii	178/2	hardpan	9/4.1	700	2
Ranunculus bonariensis-Holocarpha virgata	85/2	hardpan	5/3.6	450	
Layia fremontii-Achyrachaena mollis	56/2	hardpan	5/3.5	100	
Plagiobothrys austinae-Achyrachaena mollis	40/1	volcanic rock	7/4.1	2,400	
Community Hesperevax caulescens-Trifolium gracilentum	5/1	hardpan	7/5.0	400	

Montia fontana- Sidalcea calycosa	78/2	volcanic rock	9/3.9	2,100	
Community Tuctoria greenei	11/1	claypan	28/5.0	37,500	2
Alkaline/Saline					
Lasthenia ferrisiae/ conjugens	22/1	claypan	36/3.1	22,500	
Downingia insignis- Psilocarphus brevissimus	112/1	claypan	12/4.0	17,500	1
Atriplex persistens- Lasthenia glaberrima	19/1	claypan	17/3.5	45,000	
Pleuropogon californicus- Lasthenia fremontii	44/1	claypan	17/4.3	9,500	4
Pleuropogon californicus- Limnanthes douglasii	65/1	claypan	9/4.4	2,100	
Lasthenia platycarpha- Lepidium latipes var. latipes	16/1	claypan	19/3.3	16,900	1
Downingia bella- Hemizonia pungens	13/1	claypan	5/3.1	200	
Downingia bella- Lilaea scilloides	13/1	claypan	8/4.0	200	
Downingia cuspidata- Myosurus minimus	13/1	claypan	6/3.7	300	
Community Hordeum Depressum/murinum ssp. leporinum	15/1	claypan	8/4.1	100	
Downingia pulchella- Distichlis spicata	49/1	claypan	8/3.5	1,100	
Downingia pulchella- Cressa truxillensis	43/1	claypan	10/3.7	3,200	1

The order of long-inundated pools had the fewest named entities, which makes ecological sense in that the longer the inundation, the fewer the number of species present. Thus, long-inundated sites have few species and this limits the number of possible combinations of taxa. We should expect few community types, and we should expect that those types would have broader distributions than communities in other orders. Indeed, the association Downingia bicornuta-Lasthenia glaberrima was found in all six of the Central Valley's vernal pool regions. It occurred on low terrace and high terrace landforms, on five geomorphic surfaces (Riverbank, Laguna, Tuscan, Turlock Lake, and Modesto), and on 10 soil series (Alamo, Fiddyment, San Joaquin, Clear Lake, Redding, Toomes, Corning, Anita, Tuscan, and Cometa). This, in contrast to the usual distribution of other types that occurred in only one or two regions and were much more restricted in geomorphic surface or soil series. Fewer rare taxa were present in this order, as expected because fewer taxa of all kinds—rare or common—should be tolerant of long periods of inundation. Although one other association from long-inundated sites—Trifolium variegatum-Lasthenia glaberrima—occurred in three regions, the remaining four associations were limited to single regions. Apparently, not all associations in this order had equally broad tolerances of different microenvironments.

A nearly equal number of communities/associations were in the order of alkaline pools and fresh-water, short-inundated pools. We could interpret this pattern as meaning that an equal number of species assemblages can be tolerant of dry soil, and "dry" can be at the edge of deep fresh-water pools, the bottom of flashy fresh-water pools, or in saline/alkaline pools that may be long inundated, but are physiologically dry.

The commonness, or rarity of the 29 named entities were obviously not equal, as seen from the first column of data in Table 2.6, where the number of plots and number of regions in which each type occurred is summarized. A few types, found in two regions and in 100 or so plots, can easily be identified as the most common: Downingia bicornuta-Lasthenia glaberrima, community Eryngium vaseyi-castrense, Downingia ornatissima-Lasthenia fremontii, Downingia bicornuta-Lasthenia fremontii, Ranunculus bonariensis-Holocarpha virgata, and Montia Fontana-Sidalcea calycosa. The majority of types, and all the associations in alkaline/saline pools are restricted to a single vernal pool region.

Based on our dataset, the least frequently found associations -- with fewer than 20 plots and present in only one region -- were Downingia insignis-Lasthenia glaberrima; Lupinus bicolor-Eryngium aristulatum, community Hesperevax caulescens-Trifolium gracilentum, Atriplex persistens-Lasthenia glaberrima, Lasthenia platycarpha-Lepidium latipes var. latipes, Downingia bella-Hemizonia pungens, Downingia bella-Lilaea scilloides, Downingia cuspidata-Myosurus minimus, and communities Tuctoria greenei-Chamaesyce hooveri, and Hordeum depressum/murinum ssp. leporinum. The rest of the 27 units were somewhere between common and infrequent. At this point we are not stating that infrequent means rare in some legal sense, because more data on the distribution of these communities are needed. We have not settled yet on a quantitative method for expressing degree of rarity for vernal pool associations, but developing such a method would be invaluable for rating the impact of any one "take." This is work for the next phase.

Pool size did not correlate with the orders. For example, we might have expected the alkaline/saline claypan pools to be largest. Indeed, some were among the largest (45,000 square meters), but some were the smallest of all (100-300 square meters). A similar range of sizes is apparent for short-inundated fresh-water pools and long-inundated pool orders.

Another attribute that did not correlate as expected, was the depth in the pool at which a type occurred, and the topographic position of that location (third column in Table 2.6). One might expect that the deeper the location, the larger the position number should be. In a few cases those two factors did correlate: Downingia insignis-Lasthenia glaberrima occurred at a relatively deep 15 cm and its position was consistently pool bottom (5.0); and Lupinus bicolor-Eryngium aristulatum occurred at a relatively shallow 4 cm and its position was very high in the pool, 2.7. But many others seemed to be poorly correlated if at all. Perhaps these attributes are not very useful in predicting community position across multiple locations and regions due to other environmental variables confounding the relationships. We expect that these attributes will significantly correlate at some local scale.

The pattern of association distributions among vernal pool regions was not equal (Table 2.7). This is not unexpected, because substrates are highly correlated with vernal pool regions. The Solano-Colusa and San Joaquin Valley regions, for example, are characterized by claypans, whereas the Northeastern Sacramento Valley and Southern Sierra Foothills regions are characterized by hardpans or volcanic rocks. Beyond this, the Solano-Colusa region is rich, with 10 associations (mostly claypan types), whereas the Northwestern Sacramento Valley, with only two, is very depauperate. These patterns may express unique environmental differences among the regions. However, they may be affected by sampling intensity, which was not equal among all regions.

Table 2.7. Distribution patterns of 29 defined associations and communities. Some associations are located in more than one region, so the numbers do not add to 29.

	Number of associations per substrate		
Vernal pool region	Claypan	Hardpan	Volcanic
Northwestern Sacramento Valley		2	
Northeastern Sacramento Valley	1	5	3
Southeastern Sacramento Valley		4	
Southern Sierra Foothills	3	5	2
Solano-Colusa	10	1	
San Joaquin Valley	3		

CHAPTER 3: PERSISTENCE OF DIAGNOSTIC SPECIES AND COMMUNITY TYPES

For half a dozen years, we have been creating a classification of vernal pool associations, alliances, and orders that are defined and named after one or more diagnostic species. If the diagnostic species are not resistant to stresses, such as annual fluctuations in precipitation, then their abundance and even presence/absence will vary every year, and so will the community type(s) that they represent. A useful classification system should be robust. To test the robustness, we analyzed a set of vernal pools, the vegetation data of which had been collected over a five year period of time.

METHODS

All field data were provided by Carol Witham. She located 10 vernal pool complexes along a 300-km-long section of a PGT/PGE gas pipeline corridor that largely ran through the Sacramento Valley, from Fall River Mills in Shasta County to Jepson Prairie in Solano County. A total of 156 vernal pools were permanently located within those complexes, 80 of which were consistently visited twice each year (early spring and late spring) over a 5-year-period of 1994-1998. This subset of 80 pools was used in analyses. They are located in seven vernal pool complexes, from Red Bluff in Tehama County to Wilson Creek in Glenn County (Table 3.1). All 80 pools fell within a single vernal pool region, the Northwestern Sacramento Valley of Keeler-Wolf et al. (1998).

During each visit, the absolute percent cover for every species in each pool was recorded. The pool area sampled was defined as the area within the boundary of the high water mark, which is defined as the zone where the vegetation composition shifts in dominance from wetland to upland plant species. In general, the width of this boundary zone is <1 m. Daily precipitation for each complex was obtained from data available at the University of California’s Integrated Pest Management Program website (Statewide IPM Program 2004). Precipitation totals were partitioned into seasonal components (e.g. Sep-Nov, Dec-Feb, Mar-May).

Table 3.1. Location and elevation of the seven vernal pool complexes, the number of pools within each that had been sampled twice a year for 5 years, and average species richness per pool over the entire period of observation. Sites are arranged from north to south.

Site name	County	Elevation (m)	No. pools	Richness
Red Bluff	Tehama	88	8	37
Coyote Creek	Tehama	82	1	45
Truckee Creek	Tehama	95	12	38
Thomes Creek	Tehama	99	18	40
Corning	Tehama	106	24	38
Hall-Stony Creek	Tehama	103	15	31
Wilson Creek	Glenn	77	2	34

Surveys and statistical analyses were performed at the whole-pool scale rather than the within-pool scale of other studies of this report. We used repeated measures ANOVA, which takes into account covariance within repeatedly sampled pools (Sokal and Rohlf 1995), and linear regression to examine the relationship between precipitation and species richness. The complete data set included 800 samples and 187 plant taxa.

A Mantel test was used to detect relationships between distances with 1000 runs of randomized data, for a Monte Carlo test of significance (McCune and Grace 2002). Tests were run comparing the similarities of species composition among pools to eight variables: distance apart along the pipeline, year, season, annual precipitation, and the three seasonal components of annual precipitation. Data were analyzed with the software package PC-ORD for Windows, Version 4.27 (McCune and Mefford 1999).

Temporal persistence for any given species was quantified as temporal persistence (P), calculated as:

$$P = \frac{100 \left(\sum a/b \right)}{n},$$

where a = the number of occurrences of a species in one pool over time, b = the number of sample periods for that pool, and n = the number of pools in which a particular taxon was present at least once during the 5 years of observation. Persistence is expressed as a percentage. It represents the average probability of finding a species in a pool in consecutive surveys over time. The full 156 pools were used in temporal persistence calculation.

RESULTS AND DISCUSSION

Precipitation varied over the 5 years from an average low in 1993-4 of 420 mm to an average high in 1997-8 of 1050 mm (Fig. 3.1). Mean pool species richness rose and fell with rainfall, from a low of 33 species in 1993-4 to 41 in 1997-8 (Fig. 3. 2). The

Fig. 3. 1. Average precipitation (mm) across ten vernal pool sites for 5 yr. Total rainfall is partitioned into three seasonal components. From the bottom of each bar to the top they are: Sep-Nov, Dec-Feb, and Mar-May. From Buck (2004).

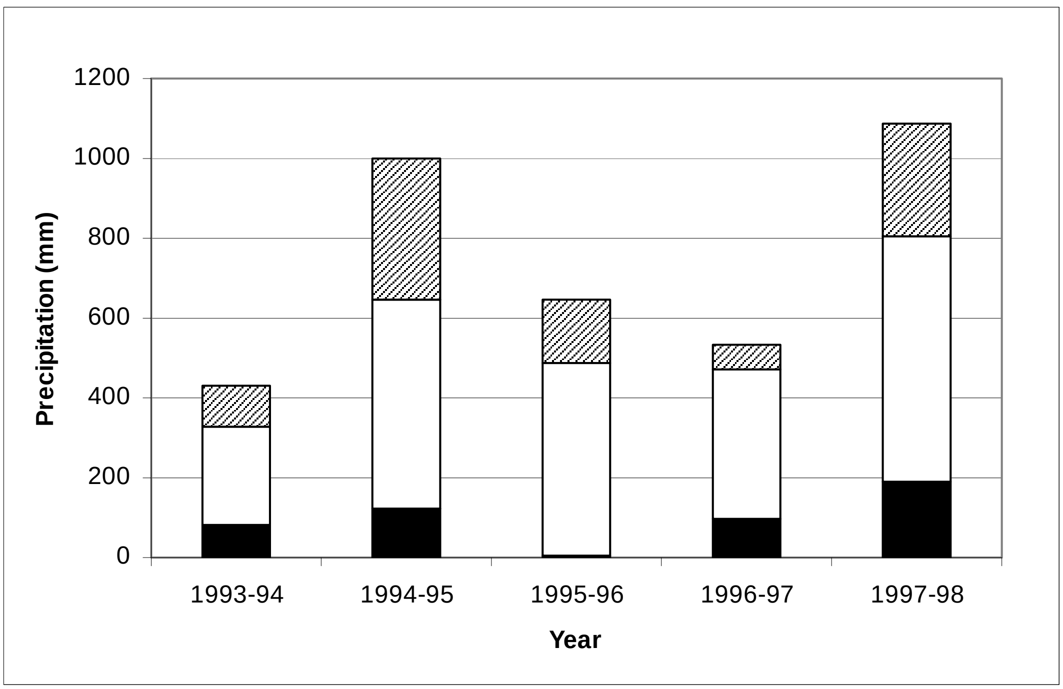
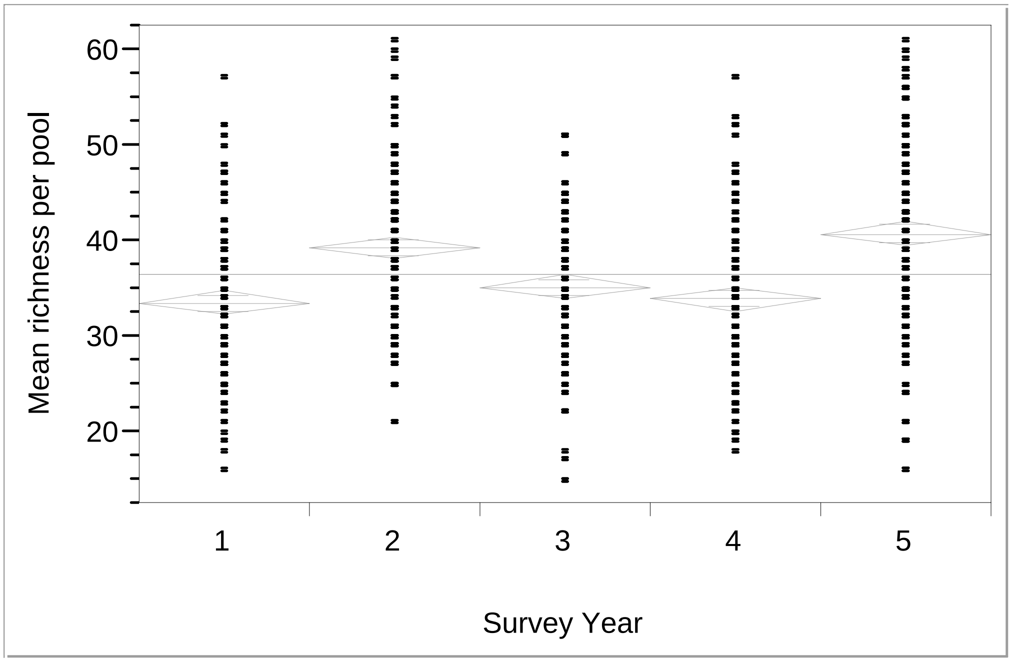


Fig. 3. 2. Mean species richness per pool over 5 yr for 80 pools. Diamonds above the grand mean line are significantly different from those below the line. From Buck (2004).



correlation between annual rainfall and richness was significantly positive at $p < 0.0001$. Partitioning of annual precipitation into seasonal components showed that winter and spring (but not fall) seasons were significantly correlated with richness ($p < 0.0001$).

The magnitude of change in abundance or presence/absence of individual species was highly variable. Diagnostic species at the class level in general had higher persistence than those at the order level, and those at the association level were the lowest (73%, 63%, and 51%, respectively; Table 3.2). Each classification level had a range of persistence values for the several species that had been preliminarily chosen by Barbour et al. (2003, 2005) as diagnostic elements. For example, at the class level, six of 15 diagnostic taxa had persistence values > 90%, and only five had values < 70%. If the number of diagnostic taxa were selectively reduced to those with relatively high persistence, as many as 10 could be retained that had persistence > 70%. Similarly, the diagnostic taxa for two out of the three orders could be selectively reduced in number to include two to seven each that had persistence values > 70%. Only Order 3, the order for saline vernal pools within the Central Valley, had just one diagnostic species with > 70% persistence (but in this case, that single diagnostic species-- Downingia insignis--had 100% persistence.

Table 3.2. Temporal persistence (P, in percent) for diagnostic species of the class Downingio bicornutae-Lasthenietea fremontii, three orders within it, and 11 associations within those orders. The classification levels and their diagnostic species were defined by Barbour et al. (2003, 2005).

Species name	Classification Level	P
Eryngium vaseyi	Class	99
Lasthenia fremontii	Class	95
Deschampsia danthonioides	Class	94
Pogogyne zizyphoroides	Class	92
Navarretia leucocephala ssp. leucocephala	Class	91
Psilocarphus brevissimus var. brevissimus	Class	90
Juncus bufonius var. occidentals	Class	79
Crassula aquatica	Class	76
Plagiobothrys stipitatus var. micranthus	Class	75
Alopecurus saccatus	Class	70
Veronica peregrina ssp. xalapensis	Class	54
Callitriche marginata	Class	50
Isoetes orcuttii	Class	45
Pilularia americana	Class	42
Eleocharis acicularis var. acicularis	Class	41
Eleocharis macrostachya	Order 1	77
Lasthenia glaberrima	Order 1	60
Trifolium depauperatum	Order 2	86
Erodium botrys	Order 2	85
Hypochaeris glabra	Order 2	81
Limnanthes douglasii ssp. rosea	Order 2	76
Plagiobothrys greenei	Order 2	74
Hemizonia fitchii	Order 2	73
Blennosperma nanum var. nanum	Order 2	71
Lepidium nitidum var. nitidum	Order 2	65
Bromus hordeaceus	Order 2	63
Cicendia quadrangularis	Order 2	60
Vulpia bromoides	Order 2	51
Downingia insignis	Order 3	100
Cressa truxillensis	Order 3	58
Plantago elongata	Order 3	49
Cotula coronopifolia	Order 3	48
Myosurus minimus	Order 3	32
Crypsis schoenoides	Order 3	15
Pleuropogon californicus	Ass	78
Isoetes howellii	Ass	31

Castilleja campestris	Ass	69
Mimulus tricolor	Ass	73
Hesperevax caulescens	Ass	53
Psilocarphus oregonus	Ass	51
Holocarpha virgata ssp. virgata	Ass	44
Trifolium gracilentum var. gracilentum	Ass	43
Cerastium glomeratum	Ass	39
Trifolium variegatum	Ass	29
Medicago polymorpha	Ass	25
Achyrachaena mollis	Ass	76
Triphysaria eriantha ssp. eriantha	Ass	74
Layia fremontii	Ass	72
Phalaris lemmonii	Ass	70
Microseris acuminata	Ass	61
Psilocarphus tenellus var. globiferus	Ass	46
Taeniatherum caput-medusae	Ass	46
Lasthenia californica	Ass	41
Lupinus bicolor	Ass	43
Trifolium willdenovii	Ass	38
Navarretia tagetina	Ass	68
Chlorogalum angustifolium	Ass	64
Plantago erecta	Ass	59
Plagiobothrys austinae	Ass	43
Vulpia microstachys	Ass	40
Navarretia pubescens	Ass	20
Montia fontana	Ass	36
Mimulus guttatus	Ass	33
Frankenia salina	Ass	75

Diagnostic species of classification levels below the order generally were more sensitive to annual fluctuations: 11 species had persistence >60%, 3 species between 50% and 60%, and 16 species between 20% and 50%. Thus, associations whose diagnostic species have high persistence would have been likely to be identifiable most years. Associations whose diagnostic species was <50%, meaning that those species were absent at most visits, would have been less recognizable some years.

Eleven rare taxa had the lowest persistence of all, with a 40% probability (on average) of detecting a rare species in a pool in consecutive surveys over time (Table 3.3).

Table 3.3. Rare vernal pool taxa recognized by the California Native Plant Society (2001) that were detected among the 80 vernal pools over the 5 yr period of time. Persistence (P) is expressed as a percent.

Species	Status	P
Juncus leiospermus var. leiospermus	1B	63
Downingia pusilla	2	61
Psilocarphus brevissimus var. multiflorus	4	61
Hesperevax caulescens	4	53
Navarretia cotulifolia	4	43
Pogogyne floribunda	1B	43
Navarretia leucocephala ssp. bakeri	1B	37
Legenere limosa	1B	29
Paronychia ahartii	1B	25
Navarretia heterandra	4	14
Astragalus tener var. tener	IB	14

Examples of extremely low persistence include: *Astragalus tener* var. *tener*, which occurred only once (and then at < 1% cover) in five years of observations; *Juncus leiospermus* var. *leiospermus* was found in one pool for the first two years, then was not detected again; *Legenere limosa* blinked in and out of four pools; and *Navarretia cotulifolia*, *Paronychia ahartii*, and *Pogogyne floribunda* each occurred only three times. These results emphasize the importance of repeated surveys conducted over different years in order to detect certain rare taxa. In addition, some species presence was tied tightly to season, for example, *Navarretia heterandra* was usually found in late season surveys. This reinforces the importance of conducting rare plant surveys that are timed appropriately with the life cycle of the given species.

The degree of correlation between species composition in a given pool and abiotic factors was statistically significant for some factors (habitat type defined by Holland (1986) and geographic distance), but in most cases the Mantel statistic (r) was low, meaning that dissimilarity over time was only weakly related to measured factors (year and season; Table 3.4). Surprisingly, annual precipitation was not significantly related to changes in whole pool species composition. Geographic distance had more to do with floristic differences than did climate: the species composition of pools far apart are much more different, at any one time or over time, than the species composition of nearby pools or of releves within pools. This result implies that a floristically-based statewide classification may very well be robust in describing differences in vegetation across a geographic range.

Table 3.4. Mantel statistic (r) and significance of correlations between species composition within plots and abiotic variables. Asterisk = not statistically significant at p = 0.01.

Variable	r	p-value
Habitat (landform)	0.518	0.001
Location along pipeline	0.409	0.001
Year	0.113	0.001
Season (early vs late)	0.025	0.001
Annual precipitation	0.014	0.075*
Fall precipitation	-0.027	0.050*
Winter precipitation	0.108	0.001
Spring precipitation	0.121	0.001

Because of the year-to-year variability, not all species are visible each year, although they are present in a seed bank. Vernal pool vegetation *does* exhibit resistance to annual variations in climate stress, but the degree of resistance increases with the scale of the classification level examined. Class and orders are recognizable because their diagnostic species are present most of the time. The fluctuations of floristic composition potentially effect lower ranked units and decrease species constancy making it more difficult to recognize community types. To reduce this effect on classification we recommend: (1) selecting the more annually persistent species as diagnostic when possible; (2) to identify multiple diagnostic species in order to increase the probability that some of them will be present at any given time; and (3) to weight the significance of the presence or absence of a diagnostic species by taking into account what is known about its year-to-year persistence.

CHAPTER 4: PRESENCE OF LISTED PLANTS IN CENTRAL VALLEY COMMUNITIES

While vernal pool ecosystems are rare in and of themselves, some vernal pool taxa are even further restricted. In order to determine why some species are rare, one must first understand the habitat and ecology of the species. This information is not available for the majority of vernal pool species. The goals of this chapter are: (1) to characterize the habitat requirements of rare vernal pool plant species; (2) to identify the community types that most commonly provide habitat for rare taxa; and (3) to summarize what is known about the environmental variables that influence the distribution of rare vernal pool plants.

RESULTS AND DISCUSSION

This chapter examines 17 rare taxa that occur within the Central Valley. Those include nine federally listed species, four species of concern identified by the USFWS (2004), and five species listed by CNPS as being of concern (Table 4.1). One Central Valley taxon not included in our study is *Limnanthes floccosa* ssp. *californica*, because we encountered it only once, and that was insufficient for us to summarize its habitat. Using our plot data and classification described in Chapter 2, we attributed each species in terms of the kinds of pools it occurred in, associated species, species richness, plant communities, and degree of invasion by non-native taxa.

By summarizing the various measurements and observations taken for each rare species, we were able to link certain habitat preferences with rare taxa (Table 4.1). For example, some species were most often encountered in deep pools (>40 cm): *Lasthenia ferrisiae*, *Neostapfia colusana*, *Orcuttia viscida*, *O. tenuis*, and *Gratiola heterosepala*; and others in shallow pools (<20 cm): *Navarretia heterandra* and *Castilleja campestris* ssp. *succulenta*. Rare taxa that occurred in the largest pools (> 50,000 m^2 in area) include *Lasthenia ferrisiae*, *Gratiola heterosepala*, *Orcuttia pilosa*, *O. tenuis*, and *Tuctoria greenei*; those that occurred in the smallest pools (< 5,000 m^2) were *Navarretia myersii* ssp. *myersii*. *Tuctoria mucronata* was sampled in two pools of very different size.

Table 4.1. Habitat characterization of listed rare vernal pool plant species. Data are summarized from the UC Davis vernal pool team database from field work conducted between 2001 and 2005. "Federal" means federally listed; FC means either proposed for federal listing or of federal concern; "CA" means state listed only; "CNPS" means of concern to the California Native Plant Society. A dash (-) indicates that data were not taken. "Site" is synonymous with "location" as used in other parts of this report.

Species Name	**Listing**	**Sites**	**Pools**	**Releves**	**Avg. Releve Herb Cover (%)**	**Avg. Pool Max Depth (cm)**	**Avg. Releve Depth (cm)**	**Avg. Pool Area (m2)**	**% Non-native**	**Richness**
Astragalus tener var. *tener*	FC, CNPS 1B	6	10	11	70	27	14	32,500	20	20
Castilleja campestris ssp. *succulenta*	Federal-Threatened	4	15	35	59	19	9	5,500	18	15
Chamaesyce hooveri	Federal-Threatened	2	6	12	29	21	20	37,400	23	5
Downingia pusilla	CNPS 2	2	4	4	66	20	12	10,200	20	22
Gratiola heterosepala	FC, CA-Endangered	6	9	23	57	41	24	69,500	14	14
Lasthenia conjugens	Federal-Endangered	3	11	42	75	23	17	14,200	26	15
Lasthenia ferrisiae	CNPS 4	2	2	14	64	68	31	66,800	31	17
Legenere limosa	FC, CNPS 1B	4	9	24	73	23	14	27,600	19	17
Navarretia heterandra	CNPS 4	4	5	9	64	12	+3	9,400	25	23
Navarretia leucocephala ssp. *bakeri*	CNPS 1B	4	10	21	64	23	19	29,000	26	24
Navarretia myersii ssp. *myersii*	CNPS 1B	2	24	51	64	20	15	1,540	22	23
Neostapfia colusana	Federal-Threatened	2	2	20	50	41	-	25,400	23	6
Orcuttia pilosa	Federal-Endangered	3	7	28	45	26	19	57,200	11	11
Orcuttia tenuis	Federal-Threatened	5	6	41	68	42	31	184,100	20	12
Orcuttia viscida	Federal-Endangered	3	6	17	64	45	42	18,800	16	12
Tuctoria greenei	Federal-Endangered	1	1	8	30	33	30	160,200	10	5
Tuctoria mucronata	Federal-Endangered	2	2	11	37	-	-	3,300	17	5

Many of the rare grass species tend to occupy pool basins that have relatively low plant cover. Pools containing *Neostapfia colusana*, *Orcuttia pilosa*, *Tuctoria greenei*, and *T.*

mucronata had a low total herb cover (< 50%), indicating that densely vegetated pools may be an environment in which these grasses cannot survive.

Although it is commonly written that vernal pool plants are poor competitors with exotic species, three of the listed species in our study occurred in pools with ≥30% cover from non-native plants: *Lasthenia ferrisiae*, which grew in the deepest pools of all the rare species (68 cm); *Navarretia fossalis*, found in fairly shallow pools of 18 cm; and *Pogogyne nudiuscula*, in shallow pools of 15 cm depth.

The pools with the lowest percent cover of non-natives contained *Tuctoria greenei* and *Orcuttia pilosa*, with maximum depths averaging 26-30 cm. These two taxa were capable of existing of the most extreme habitats (long inundated and highly saline), which are relatively non-invasible by non-natives.

There were apparent relationships with the type of impervious soil horizon and/or the alkalinity/salinity of the soil. A few rare taxa were associated with volcanic mudflows: *Castilleja campestris* ssp. *succulenta, Gratiola heterosepala,* and *Orcuttia tenuis*. More rare taxa were associated with alkaline/saline pools: *Astragalus tener* var. *tener, Downingia pusilla, Lasthenia conjugens, Lasthenia ferrisiae, Navarretia leucocephala* ssp. *bakeri.* Four rare taxa were associated with large saline/alkaline sinks: *Neostapfia colusana*, *Orcuttia pilosa*, *Tuctoria mucronata*, and *Chamaeyce hooveri*.

The pattern of rare species distribution with associations was variable. Very few rare taxa occurred with only one association: *Navarretia prostrata* and *N. heterandra* were exclusively found in Downingia bicornuta-Lasthenia glaberrima, *Lasthenia conjugens* was exclusively found in Pleuropogon californica-Lasthenia glaberrima (but rarely), and *Chamaesyce hooveri* was exclusively found with community Tuctoria greenei-Chamaesyce hooveri (and vice-versa). *Gratiola heterosepala*, in contrast, was linked with no less than six different associations, *Castilleja campestris* ssp. *succulenta* was linked with three associations, and *Orcuttia tenuis* was also linked with three associations. The remaining ten rare taxa were linked with two associations each.

In sum, the hope for predicting new populations of rare taxa, by searching for particular associations, is still promising, but clearly limited. Only minorities of the rare taxa were strongly linked with a single association, and furthermore had a high enough constancy, to make such a community-based search likely to bear results. Seldom did a rare taxon have >10% constancy in any given association.

Species summaries

The next section of the chapter reviews each of the 17 species separately, in alphabetical order, with a combination of prose and tabular material.

***Astragalus tener* v. *tener* (alkali milk-vetch)**
Status: CNPS List 1B.
Description and Range: *Astragalus tener* v. *tener* is an annual member of the family Fabaceae. It flowers from March through June and can occur at elevations of 1 to 60 m (CNPS 2001), in playas and in grasslands as well as in alkali vernal pools (CNPS 2001). *A. tener* v. *tener* is known from 5 vernal pool regions with the majority of extant occurrences in the Solano-Colusa Vernal Pool Region (69%) followed by the San Joaquin Valley Vernal Pool Region (23%).

The database contains information on *A. tener* v. *tener* from two of the five vernal pool regions (Solano-Colusa and San Joaquin Valley). Data were collected from five sites in the Solano-Colusa Vernal Pool Region and one site in the San Joaquin Valley Vernal Pool Region. A total of 10 pools and 11 releves were collected from the six sites (Table 4.2). Sites containing *A. tener* v. *tener* occurred on both Modesto and Holocene geomorphic surfaces and three landforms including: alluvial fans, low terrace, and basin rim. This species was found on quite a few different soil series; Antioch, Solano, Solano-Pescadero, Capay clay, Edminster-Kesterson, and Sycamore.

Associations: Lupinus bicolor-Eryngium aristulatum; occasionally.

Habitat and Ecology of Sites: Maximum depth of all pools at each site was averaged as well as the depth across releves at each site. Across all sites, the average maximum depth of the pools was 27 cm with the shallowest pool 6 cm and the deepest pool 72 cm deep.

On average, releves were taken at a depth of 14 cm with the shallowest at 5 cm and the deepest releve at 33 cm. Average pool area across sites was 32,500 m2 with a maximum pool area of 155,200 m2 and a minimum pool area of 750 m2. The average total herb cover across sites was 70% with a maximum herb cover of 91% and a minimum herb cover of 15%. Average cover of litter was <5% across sites and the average cover of algae was 5% across sites. The average species richness across sites was high at 20 species. There were a total of 86 species that co-occurred with *A. tener* v. *tener,* 26% that are not native to California.

Table 4.2. *Astragalus. tener* v. *tener* occurrence and distribution. Occurrence data comes from a 2006 search of the CNDDB Rarefind 3 database. Sites, pools and releves indicate data collected by the UC Davis team.

Vernal Pool Region	**County**	**Historical Occurrences**	**Extant Occurrences**	**Sites**	**% Occurrences Sampled**	**Pools**	**Releves**
Central Coast	Alameda	6	1				
	Monterey	1	0				
	San Benito	1	0				
	Santa Clara	4	0				
Livermore	Alameda	4	1				
	Contra Costa	2	0				
San Joaquin Valley	Merced	9	9	1	11%	2	2
	San Joaquin	1	0				
	Stanislaus	1	0				
Solano-Colusa	Solano	24	19	4	21%	7	7
	Yolo	11	8	1	13%	1	2
Santa Rosa	Napa	2	1				
	Sonoma	1	0				
TOTALS		**67**	**39**	**6**	**15%**	**10**	**11**

Castilleja campestris s. succulenta **(succulent owl's-clover)**

Status: Federally threatened, CA endangered, CNPS List 1B.

Description and Range: *Castilleja campestris* s. *succulenta* is an annual hemiparasitic member of the Scrophulariaceae family. It flowers in April and May and can occur in vernal pools at elevations of 50 to 750 m (CNPS 2001). *C. campestris* s. *succulenta* is known from 2 vernal pool regions and has all but one of its 91 occurrences in the Southern Sierra Foothills Vernal Pool Region (CNDDB 2006). The other occurrence is in the SE Sacramento Valley Vernal Pool Region (CNDDB 2006).

The UCD database contains information on *C. campestris* s. *succulenta* from 4 sites in the Southern Sierra Foothills Vernal Pool Region. A total of 15 pools and 35 releves were collected in these 4 sites (Table 4.3). Sites containing *C. campestris* s. *succulenta* occurred on three geomorphic surfaces; Redding, Keyes, and Lovejoy and on both high terrace and volcanic landforms. This species was surveyed on three soils series; Chinahat, Riverbank, and Hideaway.

Associations:

Pogogyne douglasii-Lasthenia glaberrima; common

Montia fontana-Sidalcea calycosa; occasional.

Downingia bicornuta-Lasthenia fremontii; occasional.

Habitat and Ecology of Sites: Maximum depth of all pools at each site was averaged as well as the depth across releves at each site. Across all sites, the average maximum pool depth was 19 cm with the shallowest pool being 8 cm and the deepest pool 42 cm deep. Those releves that contained *C. campestris* s. *succulenta* had an average depth of 9 cm with a range of 2 cm to 20 cm. The average pool area of the 15 pools sampled was 3,900 m^2, with the smallest pool $200 m^2$ and the largest pool 24,500 m^2.

Average total herb cover in *C. campestris* s. *succulenta* releves across the 4 sites was 59% with a range of 20% to 97%. Average cover of bare rock was also fairly high with at 18% with a low of 0% and a high of 55%. Average open water cover was 9% and average algal cover was 7%; however, the majority of the releves had no cover of open water and algae with only a few releves having a very high cover. Species richness across sites averaged 15 per releve. There were a total of 67 plant species co-occurring with *C. campestris* s. *succulenta,* 18% of which were non-native species.

Table 4.3. *Castilleja campestris* s. *succulenta* occurrence and distribution. Occurrence data comes from a 2006 search of the CNDDB Rarefind 3 database. Sites, pools and releves indicate data collected by the UC Davis team.

Vernal Pool Region	County	Historical Occurrences	Extant Occurrences	Sites	% Occurrences Samples	Pools	Releves
SE Sacramento Valley	San Joaquin	1	1				
Southern Sierra Foothills	Fresno	11	10	1	10%	7	21
	Madera	9	9	1	11%	3	3
	Merced	65	65	2	3%	5	11
	Stanislaus	5	5				
TOTALS		**92**	**91**	**4**	**4%**	**15**	**35**

***Chamaesyce hooveri* (Hoover's spurge)**

Status: Federally Threatened and CNPS List 1B.

Description and Range:

Chamaesyce hooveri is a prostrate annual member of the Euphorbiaceae family. It can flower from July through August and occurs in vernal pools at elevations of 25 to 250 meters (CNPS 2001). *C. hooveri* is believed to have a significant seed bank and pollination is thought to be by a variety insects (Stone et al. 1988 as cited in USFWS 2004). The prostrate growth form of this species is believed to contribute to a resistance to light and moderate grazing (Stone et al. 1987), however, there are several locations where heavy grazing has been shown to negatively affect the *C. hooveri* population (Stone et al. 1987). *C. hooveri* is known from 4 vernal pool regions with the majority of extant occurrences in the NE Sacramento Valley Vernal Pool Region (58%) followed by the Southern Sierra Foothills Vernal Pool Region (27%).

Our database has information on *C. hooveri* from two of the four vernal pool regions (NE Sacramento Valley and Solano-Colusa). Data were collected from two sites with a total of 6 pools and 12 releves sampled (Table 4.4). *C. hooveri* occurred on both Modesto and Red Bluff geomorphic surfaces and three landforms including Basin, Basin Rim, and High Terrace. This species was also found of three different soil series; Willows, Riz and Anita.

Associations: Tuctoria greenei-Chamaesyce hooveri; common.

Habitat and Ecology of Sites: Maximum depth of all pools at each site was averaged as well as the depth of all releves at each site. Across all sites, the average maximum pool depth was 21 cm with the shallowest pool sampled 8 cm and the deepest pool sampled 33 cm. Those releves that contained *C. hooveri* had an average depth of 20 cm with a range of 8 cm to 33 cm. The average pool area in the two sites sampled was 37,400 m^2, with the smallest pool 940 m^2 and 160,200 m^2. Average herb cover in releves with *C. hooveri* across both sites was 29% (maximum of 45% in one releve, minimum of 4% in another releve). Average litter cover and bare rock cover were both less than 1%. Species richness was low at 5 per releve across all sites. There were a total of 13 plant species co-occurring with *C. hooveri,* three of which were non-native.

Table 4.4. *Chamaesyce hooveri* occurrence and distribution. Occurrence data comes from a 2006 search of the CNDDB Rarefind 3 database. Sites, pools and releves indicate data collected by the UC Davis team.

Vernal Pool Region	**County**	**Historical Occurrences**	**Extant Occurrences**	**Sites**	**%Occurrences Sampled**	**Pools**	**Releves**
NE Sacramento Valley	Butte	4	3				
	Tehama	14	12	1	8%	1	4
Southern Sierra Foothills	Tulare	6	5				
	Stanislaus	2	2				
Solano-Colusa	Glenn	3	3	1	30%	5	8
San Joaquin Valley	Merced	1	1				
TOTALS		**30**	**26**	**2**	**8%**	**6**	**12**

***Downingia pusilla* (dwarf downingia)**

Status: CNPS List 2.

Description and Range: *Downingia pusilla* is an annual member of the Campanulaceae. It flowers from March to May and is present in vernal pools at elevations of 1 to 445 m. This species is known to occur in six vernal pool regions with most extant occurrences evenly distributed among them (CNPS 2001).

The UCD database has information on *D. pusilla* from four sites, one in the Solano-Colusa Vernal Pool Region, two from the Southern Sierra Foothills Vernal Pool Region and one from the NW Sacramento Valley. A total of 16 pools and 23 releves were sampled at these four sites (Table 4.5). *Downingia pusilla* occurred on five different geomorphic surfaces; China Hat, Ione, Laguna, Modesto, and Red Bluff with four separate landforms including alluvial fan, basin rim, high terrace, and sediments. The soils were quite variable and included San Ysidro, Antioch, Pescadero, Corning-Redding, Redding, Corning, and Hornitos.

Associations:

Pleuropogon californicus-Lasthenia glaberrima; occasionally.

Downingia bicornuta-Lasthenia fremontii; rarely.

Downingia ornatissima-Lasthenia fremontii; rarely.

Habitat and Ecology of Sites: Maximum depth of all pools at each site was averaged as well as the depth across releves at each site. Across sites, the average maximum pool depth is 20 cm with the shallowest pool sampled 6 cm deep at its maximum and the deepest pool sampled 39 cm deep at its maximum. Average depth of the releves was 12 cm with a minimum of 2 cm and a maximum of 25 cm. Across all sites, the average pool area was 10,200 m^2 with the smallest pool sampled 220 m2 and the largest pool sampled 56,500 m^2. Average herb cover across sites is about 66% with a range of 33% to 95%. Average cover of litter and open water were both minimal with average values of < 5% across sites. Average algal cover was 7% across sites and average cover of bare rock was

5% across sites. The 23 releves sampled had an average richness across sites of 22 species per releve. A total of 88 species were found to co-occur with *D. pusilla*, of which 20% were not native to California.

Table 4.5. *Downingia pusilla* occurrence and distribution. Occurrence data comes from a 2006 search of the CNDDB Rarefind 3 database. Sites, pools and releves indicate data collected by the UC Davis team.

Vernal Pool Region	County	Historical Occurrences	Extant Occurrences	Sites	% Occurrences Sampled	Pools	Releves
Lake-Napa	Napa	8	7				
	Solano	1	1				
NW Sacramento Valley	Tehama	12	12	1	8%	2	2
Santa Rosa	Sonoma	15	12				
Solano-Colusa	Solano	22	22	1	5%	10	17
SE Sacramento Valley	Placer	17	15				
	Sacramento	8	7				
	San Joaquin	1	1				
	Yuba	2	2				
Southern Sierra Foothills	Fresno	1	1				
	Merced	10	10	2	20%	4	4
	Stanislaus	17	17				
TOTALS		**114**	**107**	**4**	**4%**	**16**	**23**

***Gratiola heterosepala* (Boggs Lake Hedge-Hyssop)**

Status: State Endangered and CNPS List 1B.

Description and Range: *Gratiola heterosepala* is an annual member of the Scrophulariaceae, it flowers from April to August and can occur in vernal pools at elevations of 10 to 2,375 m in elevation (CNPS 2001). The species has seeds that germinate and grow under water; however, it lacks the distinctly different aquatic juvenile foliage present in many other vernal pool species such as *Orcuttia* (Dittes and Guardino Consulting 2003). *G. heterosepala* is self-compatible (Kaye et al. 1990 as cited in USFWS 2004) and is believed to have a significant seed bank evidenced by greatly fluctuating populations (Corbin et al. 1994 as cited in USFWS 2004). This species is known from six vernal pool regions with the primary area of concentration in the Modoc Plateau Vernal Pool Region (45%) followed by the NE Sacramento Valley Vernal Pool Region (20%) (CNDDB 2006).

Our database has information on *G. heterosepala* from five of the six vernal pool regions it is known from. There are no samples from the Modoc Plateau Vernal Pool Region. A total of 9 pools and 23 releves were collected in these six sites (Table 4.6). Sites containing *G. heterosepala* occurred on a high number of geomorphic surfaces including Lovejoy, Modesto, Red Bluff, and Laguna. It was surveyed on many landforms including volcanic, basin rim, and high terrace and on at least six soil series.

<u>Associations:</u>
Pogogyne douglasii-Lasthenia glaberrima; commonly.
Downingia bicornuta-Lasthenia fremontii; occasionally.
Downingia bicornuta-Lasthenia glaberrima; rarely.
Pleuropogon californicus-Lasthenia glaberrima; rarely.
Montia fontana-Sidalcea calycosa; rarely.
Downingia cuspidata-Lasthenia fremontii; rarely.

<u>Habitat and Ecology of Sites:</u> Maximum depth of all pools at each site was averaged as well as the depth of all releves at each site. Across all sites, the average maximum pool depth was 41 cm for the 4 sites in which this measurement was taken. Releves that contained *Gratiola heterosepala* had an average depth of 24 cm with a range of 5 cm to 70 cm. The average pool area across sites was about 69,500 m2 with the smallest pool sampled 3,000 m2 and the largest pool sampled 283,000 m2. Average herb cover in releves with *G. heterosepala* across sites was 57% with a high of 85% and a low of 5%. Average litter cover was < 1%; however there was a significant amount of bare rock cover, algal cover, and open water cover with average cover values of 20%, 6%, 15%, respectively. Species richness in the releves sampled averaged 14 species in each releve

containing *G. heterosepala* across sites. There was a total of 58 plant species found to co-occur with G. heterosepala, 14% of which were not native to California.

Table 4.6. *Gratiola heterosepala* occurrence and distribution. Occurrence data comes from a 2006 search of the CNDDB Rarefind 3 database. Sites, pools and releves indicate data collected by the UC Davis team.

Vernal Pool Region	County	Historical Occurrences	Extant Occurrences	Sites	% Occurrences Sampled	Pools	Releves
Lake-Napa	Lake	3	3				
Modoc Plateau	Lassen	2	2				
	Modoc	19	19				
	Shasta	14	14				
	Lake	3	3	1	30%	1	1
NE Sacramento Valley	Tehama	17	17	2	12%	2	4
Solano-Colusa	Solano	6	6	1	17%	1	2
SE Sacramento Valley	Placer	3	3				
	Sacramento	11	9	1	11%	2	2
	San Joaquin	4	4				
Southern Sierra Foothills	Fresno	4	4	1	25%	3	14
	Madera	2	2				
	Merced	1	1				
TOTALS		**87**	**85**	**6**	**7%**	**9**	**23**

***Lasthenia conjugens* "Contra Costa goldfields"**

Status: Federally Endangered, CNPS List 1B.

Description and Range: *L. conjugens* is an annual member of the Asteraceae. It flowers from March through June and can occur in vernal pools at elevations of 0-470 m (CNPS 2001) and is known from six vernal pool regions with the majority of extant occurrences in the Solano-Colusa Vernal Pool Region (43%) followed by the Central Coast Vernal Pool Region (24%) (CNDDB 2006).

Our database has information on *L. conjugens* from two sites in the Solano-Colusa Vernal Pool Region and one site in the Central Coast Vernal Pool Region. A total of 42 releves from 11 pools were sampled in these three sites (Table 4.7). Sites containing *L. conjugens* were all found on the Modesto geomorphic surface with either a low terrace or basin rim landform. It was found on three soil series including Solano, Sycamore, and Pescadero.

Associations: Pleuropogon californicus-Lasthenia glaberrima; rarely.

Habitat and Ecology of Sites: The maximum pool depth averaged 23 cm across sites, with the shallowest pool sampled being 5 cm deep and the deepest pool being 72 cm deep. Those releves that contained *L. conjugens* had an average depth of 17 cm, with a range of 5 cm above the pool's edge to 62 cm below the pool's edge. The average pool area across sites was 14,200 m^2, with a low of 100 m^2 and a high of 70,700 m^2. Total herbaceous cover in *L. conjugens* releves averaged 75% across the 3 sites, with a range of 40% to 95% herb cover. Average cover of litter and algae were both minimal (< 5%) at all sites. Species richness across all sites averaged 15 per releve. There were a total of 88 plant species found to co-occur with *L. conjugens*, including 23 that were not native to California.

Table 4.7. *Lasthenia conjugens* occurrence and distribution. Occurrence data comes from a 2006 search of the CNDDB Rarefind 3 database. Sites, pools and releves indicate data collected by the UC Davis team.

Vernal Pool Region	County	Historical Occurrences	Extant Occurrences	Sites	% Occurrences Sampled	Pools	Releves
Central Coast	Monterey	2	2				
	Alameda	4	3	1	30%	8	20
	Santa Clara	1	0				
Lake-Napa	Napa	2	1				
Livermore	Contra Costa	5	2				
Mendocino	Mendocino	1	1				
Santa Barbara	Santa Barbara	1	0				
Santa Rosa	Marin	1	1				
	Napa	2	1				
	Sonoma	1	1				
Solano-Colusa	Solano	12	9	2	22%	3	22
TOTALS		**32**	**21**	**3**	**14%**	**11**	**42**

***Lasthenia ferrisiae* "Ferris's goldfields"**

Status: CNPS List 4.

Description and Range: *L. ferrisiae* is an annual in the Asteraceae. It flowers from February through May and can be present in alkali and clay vernal pools at elevations of 20-700 m (CNPS 2001). There are no listed occurrences of *L. ferrisiae* in the CNDDB (CNDDB 2006).

The UCD database contains information on *L. ferrisiae* from one site (McCoy, near Fairfield) in the Solano-Colusa Vernal Pool Region. Twenty plots were sampled from one large pool (Table 4.8). This species occurred on a Modesto geomorphic surface underlain by basin rim landform, and is associated with Solano soil series.

Associations: Lasthenia ferrisiae/conjugens

Habitat and Ecology of Sites: The pool was 150 by 150 m across and had maximum depths of 64 cm. Average depth of the releves across sites was 31 cm, with a maximum of 62 cm and a minimum of 4 cm. Releves had 64% herb cover on average, with a range of 40% to 90%. Average cover of litter was < 1% across sites. Species richness in the releves averaged 17 with a total of 54 plant species found to co-occur with *L. ferrisiae* including 17 species that are not native to California. Occurrence data comes from a 2006 search of the CNDDB Rarefind 3 database. Sites, pools and releves indicate data collected by the UC Davis team.

Table 4.8. *Lasthenia ferrisiae* occurrence and distribution.

Vernal Pool Region	County	Historical Occurrences	Extant Occurrences	Sites	% Occurrences Sampled	Pools	Releves
Solano-Colusa	Solano	--	--	1	--	1	20

***Legenere limosa* "legenere"**

<u>Status</u>: CNPS List 1B.

<u>Description and Range:</u> *L. limosa* is an annual member of the Campanulaceae. It blooms from April through June and can occur in vernal pools at elevations of 1-880 m (CNPS 2001). *L. limosa* is one of the most variable vernal pool annual plants as it has been observed to disappear for several decades before once again reappearing (Holland 1984 as cited in USFWS 2004) suggesting that it has a long-lived seed bank. *L. limosa* occurs in eight vernal pool regions with the majority of extant occurrences in the SE Sacramento Valley Vernal Pool Region (52%) followed by the Solano-Colusa Vernal Pool Region (20%) (CNDDB 2006).

The UCD database has information on *L. limosa* from three of the vernal pool regions it is known from (SE Sacramento Valley, Solano-Colusa, and NE Sacramento Valley). A total of 9 pools with 24 releves were sampled in these four sites (Table 4.9). This species is quite variable, occurring on four geomorphic surfaces: Riverbank, Modesto, Turlock Lake, and Redbluff. It was also found on three landforms including Low and High Terrace and Basin Rim underlain by five soil series.

<u>Associations:</u>

Pleuropogon californicus-Lasthenia glaberrima; occasionally.
Downingia bicornuta-Lasthenia glaberrima; occasionally.
Downingia bicornuta-Lasthenia fremontii; rarely.
Downingia cuspidata-Lasthenia fremontii; rarely.

<u>Habitat and Ecology of Sites:</u> Average maximum depth for pools containing *L. limosa* was 23 cm, with the shallowest pool being only 4 cm and the deepest pool 38 cm. Those releves that contained *L. limosa* had an average depth of 14 cm, with a range of 5 cm to 91 cm. The average pool area across sites was 27,600 m^2, with a low of 220 m^2 and a high of 141,400 m^2. The average pool size tended to be smaller in the SE Sacramento Valley Vernal Pool Region and was the largest in the NE Sacramento Valley Vernal Pool Region. Average total herb cover in *L. limosa* releves across sites was 73%, with a range

of 60% to 95%. Average litter cover, bare rock cover, and open water cover were all < 5%. Overall, algal cover averaged 9% across sites. Releves containing *L. limosa* had an average species richness of 17 species in each releve sampled across sites. There were a total of 74 plant species found to co-occur with *L. limosa*, including 14 that were non-native.

Table 3-9. *Legenere limosa* occurrence and distribution. Occurrence data comes from a 2006 search of the CNDDB Rarefind 3 database. Sites, pools and releves indicate data collected by the UC Davis team.

Vernal Pool Region	County	Historical Occurrences	Extant Occurrences	Sites	% Occurrences Sampled	Pools	Releves
Central Coast	San Mateo	1	1				
Lake-Napa	Lake	3	2				
	Napa	1	1				
Solano-Colusa	Solano	13	11	1	9%	3	10
SE Sacramento Valley	Sacramento	23	22	1	5%	2	3
Other	Placer	3	2				
	Sonoma	2	1				
	Stanislaus	1	0				
	San Joaquin	3	2	1	50%	3	5
	Shasta	3	3				
	Tehama	5	5	1	20%	1	6
	Alameda	1	1				
	Santa Clara	1	1				
	Yuba	3	3				
TOTALS		**63**	**55**	**4**	**7%**	**9**	**24**

***Navarretia heterandra* "Tehama navarretia"**

Status: CNPS List 4, Oregon – Endangered.

Description and Range: *N. heterandra* is an annual herb from the Polemoniaceae that flowers from April through June (CNPS 2001). This species can occur in vernal pools at elevations of 30-945 m (CNPS 2001). The CNDDB does not track occurrence information for *N. heterandra* (CNDDB 2006).

Our database contains information on *N. heterandra* from four sites in two vernal pool regions. Data were collected from three sites in the NE Sacramento Valley Vernal Pool Region and one site from the SE Sacramento Valley Vernal Pool Region. A total of 5 pools and 9 releves were sampled from the 4 sites (Table 4.10). Sites containing *N. heterandra* occurred on three geomorphic surfaces including Holocene, Red Bluff and Riverbank under three landforms; Low and High Terraces and Volcanic and three soil series.

Associations: Layia fremontii-Achyrachaena mollis; occasionally.

Habitat and Ecology of Sites: Across all sites, the average maximum depth of the pools was 12 cm, with the shallowest pool 7 cm deep and the deepest pool 18 cm deep. On average, releves were taken at an elevation of 3 cm above the pool's edge, with a range of 11 cm above the pool's edge to 2 cm below the pool's edge. Average pool area across sites was 9,400 m^2, with the smallest pool sampled 1,600 m^2 and the largest pool 21,400 m^2. Average herb cover across sites was 64%, with a range of 50% to 75%. Average cover of litter and bare rock both averaged < 5% across sites. Species richness across sites averaged 23 species. There were a total of 80 species found to co-occur with *N. heterandra*, 20 of these were non-native.

Table 3-10. *Navarretia heterandra* occurrence and distribution. Occurrence data comes from a 2006 search of the CNDDB Rarefind 3 database. Sites, pools and releves indicate data collected by the UC Davis team.

Vernal Pool Region	County	Historical Occurrences	Extant Occurrences	Sites	% Occurrences Sampled	Pools	Releves
SE Sacramento Valley	Placer	--	--	1	--	1	1
NE Sacramento Valley	Tehama	--	--	3	--	4	8
TOTALS				**4**		**5**	**9**

***Navarretia leucocephala* ssp. *bakeri* "Baker's navarretia"**

Status: CNPS List 1B.

Description and Range: *N. leucocephala* ssp. *bakeri* is an annual from the Polemoniaceae. It flowers from May through July and can occur in vernal pools at elevations of 15-1740 m (CNPS 2001). *N. leucocephala* ssp. *bakeri* can be distinguished from its sister taxa by having a head that is cymosely branched within and a calyx that is not villous (Day 1995). In addition, the corolla tube is inclusive, equal to or greater than the calyx and the stems are erect with 10-60 flowered inflorescences (Day 1993a). *N. leucocephala* ssp. *bakeri* occurs in six vernal pool regions, with the majority of extant occurrences in the Santa Rosa Vernal Pool Region (42%) followed by the Solano-Colusa Vernal Pool Region (21%) (CNDDB 2006).

Our database has information on *Navarretia leucocephala* ssp. *bakeri* from four sites in the Solano-Colusa Vernal Pool Region. A total of 10 pools and 21 releves were collected from the 4 sites (Table 4.11). Sites containing *Navarretia leucocephala* ssp. *bakeri* occurred on a Modesto geomorphic surface under a Basin Rim landform and both Solano and Pescadero soil series.

Associations:

Downingia bicornuta-Lasthenia glaberrima; rarely.

Pleuropogon californicus-Lasthenia glaberrima; rarely.

Habitat and Ecology of Sites: Maximum depth and releve depth of the pools was available for 3 of the 4 sites sampled. Maximum depth averaged 23 cm, with the shallowest pool 10 cm deep and the deepest pool 46 cm deep. Depth at which the releves were taken averaged 19 cm, with the shallowest releve at 0 cm and the deepest releve 45 cm. Pool area was taken in all 10 pools, with an average area of 29,000 m^2. The smallest pool sampled was 600 m^2 and the largest pool sampled was 141,400 m^2. Releves containing *N. leucocephala* ssp. *bakeri* averaged 64% total herb cover across sites, with the lowest herb cover at 15% and a maximum herb cover of 80%. Releves containing *N.*

leucocephala ssp. *bakeri* also had about 5% algal cover; while average cover of litter and bare rock were both < 1% across sites. Species richness averaged 24 species per releve across sites (Table 16-4b). A total of 99 plant species were found to co-occur with *N. leucocephala* ssp. *bakeri*, with 26 of those species (26%) non-native.

Table 3-11. *Navarretia leucocephala* ssp. *bakeri* occurrence and distribution. Occurrence data comes from a 2006 search of the CNDDB Rarefind 3 database. Sites, pools and releves indicate data collected by the UC Davis team.

Vernal Pool Region	County	Historical Occurrences	Extant Occurrences	Sites	% Occurrences Sampled	Pools	Releves
Lake-Napa	Lake	3	3				
	Napa	2	1				
Mendocino	Mendocino	5	5				
Santa Rosa	Marin	1	1				
	Sonoma	17	13				
NE Sacramento Valley	Sutter	1	1				
NW Sacramento Valley	Glenn	1	1				
	Tehama	1	1				
Solano-Colusa	Colusa	1	1				
	Solano	7	5	4	80%	10	21
	Yolo	1	1				
TOTALS	**11**	**40**	**33**	**4**	**12%**	**10**	**21**

Navarretia myersii ssp. ***myersii*, "pincushion navarretia"**

Status: CNPS List 1B.

Description and Range: *Navarretia myersii* ssp. *myersii* is an annual herb in the Polemoniaceae that flowers in May (CNPS 2001). This species can occur at elevations of 20-330 m (CNPS 2001). *Navarretia myersii* ssp. *myersii* can be distinguished from its closest *Navarretia* counterparts by its unbranched head and villous calyx tube (Day 1995). In addition, its corolla is 12-21 mm long and white (Day 1995). *N. myersii* ssp. *myersii* is known from two vernal pool regions (SE Sacramento Valley Vernal Pool

Region and Southern Sierra Foothills Vernal Pool Region), with the majority of extant occurrences in the SE Sacramento Valley Vernal Pool Region (69%) (CNDDB 2006).

Our database contains information on *N. myersii* ssp. *myersii* from the SE Sacramento Valley Vernal Pool Region. Data were collected from a total of two sites, 24 pools, and 51 releves (Table 4.12). This species was found on both Laguna and Valley Spring geomorphic surfaces with Sediment and High Terrace landforms, with 3 different soil series.

<u>Associations:</u>

Downingia bicornuta-Lasthenia fremontii; commonly.

Downingia bicornuta-Lasthenia glaberrima; occasionally.

<u>Habitat and Ecology of Sites:</u> Across all sites, the average maximum pool depth was 20 cm, with a range of 9 cm to 44 cm. Those releves that contained *N. myersii* ssp. *myersii* had an average depth of 15 cm, with the shallowest releve taken at 0 cm and the deepest releve at 36 cm. The average pool area across sites was 1,540 m^2, with the smallest pool sampled 380 m^2 and the largest pool 4,000 m^2. Average total herb cover across sites was 64%, with a range of 35% to 85% herb cover. Average covers of algae, litter, open water, and bare rock were all < 5% across sites. Species richness in releves containing *N. myersii* ssp. *myersii* averaged 23/releve. A total of 90 species were found to co-occur with *N. myersii* ssp. *myersii*, with 20 of those species non-native.

Table 3-12. *Navarretia myersii* ssp. *myersii* occurrence and distribution. Occurrence data comes from a 2006 search of the CNDDB Rarefind 3 database. Sites, pools and releves indicate data collected by the UC Davis team.

Vernal Pool Region	County	Historical Occurrences	Extant Occurrences	Sites	% Occurrences Sampled	Pools	Releves
SE Sacramento Valley	Amador	2	2				
	Calaveras	1	1				
	Placer	1	1				
	Sacramento	5	5	2	40%	24	51
Southern Sierra Foothills	Merced	4	4				
TOTALS		**13**	**13**	**2**	**15%**	**24**	**51**

***Navarretia prostrata* "prostrate navarretia"**

Status: CNPS List 1B.

Description and Range: *N. prostrata* is an annual herb from the Polemoniaceae and flowers from April through July (CNPS 2001). This species can occur in vernal pools at elevations of 15-700 m (CNPS 2001). *N. prostrata* can be distinguished from its closest sister taxa by having a head that is not branched within and corollas that are 6-9 mm long (Day 1995). *N. prostrata* can be distinguished from *N. fossalis* by having a longer corolla and shorter calyx (Moran 1977). While *N. prostrata* and *N. fossalis* both occur together on the Santa Rosa Plateau, there are numerous differences between the two species that are maintained in nature (Day 1993b as cited in Day 1995). *N. prostrata* is known from five vernal pool regions, with the majority of occurrences in the San Diego Vernal Pool Region (32%) followed by the Central Coast Vernal Pool Region (27%) (CNDDB 2006).

Our database has information on *N. prostrata* from six sites, four of which are in the San Joaquin Valley Vernal Pool Region, one in the Central Coast Vernal Pool Region, and one in the Western Riverside County Vernal Pool Region. In these six sites, data were collected from 11 pools and 49 releves (Table 4.13). This species was found on two geomorphic surfaces, Holocene and Modesto, on three landforms Basin, Basin Rim, and Dunes, and on three soil series.

Associations: Downingia bicornuta-Lasthenia glaberrima; rarely.

Habitat and Ecology of Sites: The maximum depth for all pools averaged 22 cm, with the deepest pool sampled 47 cm and the shallowest 12 cm. The average depth at which the releves containing *N. prostrata* were taken was 11 cm, with the deepest releve 47 cm below the pool's edge and the shallowest releve 6 cm above the pool's edge. Average pool area across sites was 19,000 m^2, with the largest pool 48,700 m^2 and the smallest pool 360 m^2. Average herb cover across sites was 74%, with a maximum herb cover of 100% and a minimum herb cover of 25%. Average algal, litter, and bare rock covers were all < 5% across sites. Species richness across sites averaged 15 per releve. A total of 102 species were found to co-occur with *N. prostrata*, including 24 that were non-native.

Table 3-13. *Navarretia prostrata* occurrence and distribution. Occurrence data comes from a 2006 search of the CNDDB Rarefind 3 database. Sites, pools and releves indicate data collected by the UC Davis team.

Vernal Pool Region	County	Historical Occurrences	Extant Occurrences	Sites	% Occurrences Sampled	Pools	Releves
Carrizo	San Luis Obispo	3	3				
Central Coast	Alameda	2	2	1	50%	1	1
	Monterey	5	4				
San Diego	Los Angeles	6	0				
	Orange	3	3				
	San Diego	4	4				
San Joaquin Valley	Merced	4	4	4	100%	7	29
Western Riverside County	Riverside	2	2	1	50%	3	19
Other	San Bernardino	2	0				
TOTALS		**31**	**22**	**6**	**27%**	**11**	**49**

***Neostapfia colusana* "Colusa grass"**

Status: Federally Threatened, CA Endangered, and CNPS List 1B.

Description and Range: *N. colusana* is an annual member of the Poaceae. *N. colusana* flowers from May to August and can occur in vernal pools at elevations of 5-200 m (CNPS 2001). *N. colusana* is the least specialized of all the members of the Orcuttieae tribe to the aquatic environment (Keeley 1998). *N. colusana* is known from three vernal pool regions, with the majority of occurrences in the Southern Sierra Foothills Vernal Pool Region (82%) followed by the San Joaquin Valley Vernal Pool Region (10%) (CNDDB 2006).

The UCD database has information on *N. colusana* from the Solano-Colusa Vernal Pool Region. Data were collected from two sites for a total of 2 pools and 20 releves (Table

4.14). Sites included Modesto and Holocene geomorphic surfaces with Basin Rim and Alluvial Fan landforms underlain by two soil series, Pescadero and Marvin.

Habitat and Ecology of Sites: The only data collected on depth was a single maximum depth measurement which was 41 cm. However, the area of two of the three pools was taken, with areas of 5,700 m^2 and 45,200 m^2. Average herb cover was 50% in releves with *N. colusana*, with a minimum of 13% and a maximum herb cover of 75%. Both litter cover and algal cover were less than 5% for releves containing *N. colusana*. Average species richness in the releves is low (about 6 species per releve), which is consistent with the observation in The Draft Recovery Plan for Vernal Pool Ecosystems (USFWS 2004) stating that *N. colusana* tends to grow in single species stands. There was a total of 30 species found to co-occur with *N. colusana*, including 7 that were non-native.

Table 4.14. *Neostapfia colusana* occurrence and distribution. Occurrence data comes from a 2006 search of the CNDDB Rarefind 3 database. Sites, pools and releves indicate data collected by the UC Davis team.

Vernal Pool Region	County	Historical Occurrences	Extant Occurrences	Sites	% Occurrences Sampled	Pools	Releves
San Joaquin Valley	Merced	6	1				
Solano-Colusa	Colusa	1	0				
	Yolo	2	2	1	50%	1	12
	Solano	2	2	1	50%	1	8
Southern Sierra Foothills	Merced	26	22				
	Stanislaus	23	15				
TOTALS		**60**	**42**	**2**	**5%**	**2**	**20**

***Orcuttia pilosa* “hairy Orcutt grass”**

Status: Federally Endangered, CA Endangered, and CNPS List 1B.

<u>Description and Range:</u> *O. pilosa* is an annual member of the Poaceae. It blooms May through September (relatively late compared to most vernal pool taxa) and can occur in vernal pools at elevations of 55-200 m (CNPS 2001). *O. pilosa* is morphologically distinguished from other *Orcuttia* species by its equal lemma teeth and upright culms that branch from the lower nodes (Reeder 1982). *O. pilosa* is known from three vernal pool regions, with the majority of extant occurrences in the Southern Sierra Foothills Vernal Pool Region (41%), followed by the NE Sacramento Valley Vernal Pool Region (37%), and the Solano-Colusa Vernal Pool Region (22%) (CNDDB 2006). One of the occurrences in the Southern Sierra Vernal Pool Region is an introduction into an artificial vernal pool (CNDDB 2006).

Our database has information on *O. pilosa* from two of the three vernal pool regions (NE Sacramento Valley and Solano-Colusa). Data were collected from two sites in the NE Sacramento Vernal Pool Region and one in the Solano-Colusa Vernal Pool Region. A total of seven pools and 28 releves were collected in these three sites (Table 4.15). Sites landforms; Basin Rim, Basin and High Terrace. Soil series included Anita, Riz and Willows.

<u>Associations:</u>

Downingia cuspidata-Lasthenia fremontii; commonly.
Downingia bicornuta-Lasthenia glaberrima; rarely.

<u>Habitat and Ecology of Sites:</u> Across all sites, the average maximum pool depth was 26 cm, with the shallowest pool being 18 cm deep and the deepest pool 40 cm deep. Those releves that contained *O. pilosa* had an average depth of 19 cm, with a range of 9-28 cm. The average pool area across sites was about 57,200 m^2, with a low of 2,800 m^2 and a high of 42,000 m^2. Average total herb cover in *O. pilosa* releves across the 3 sites was 45%. Average litter cover and average bare rock cover were both minimal (< 5%) at all sites. Species richness across sites averaged 11 per releve. There was a total of 56 plant species found to be co-occur with *O. pilosa*, including 6 (11%) that were non-native.

Table 4.15. *Orcuttia pilosa* occurrence and distribution. Occurrence data comes from a 2006 search of the CNDDB Rarefind 3 database. Sites, pools and releves indicate data collected by the UC Davis team. * one occurrences was introduced into an artificial vernal pool.

Vernal Pool Region	County	Historical Occurrences	Extant Occurrences	Sites	% Occurrences Sampled	Pools	Releves
NE Sacramento Valley	Butte	1	1				
	Tehama	10	9	2	22%	4	20
Solano-Colusa	Glenn	6	6	1	17%	3	8
Southern Sierra Foothills	Madera	12*	9*				
	Merced	2	0				
	Stanislaus	8	2				
TOTALS		**39**	**27**	**3**	**11%**	**7**	**28**

***Orcuttia tenuis* "slender Orcutt grass"**

Status: Federally Threatened, CA Endangered, and CNPS List 1B.

Description and Range: *O. tenuis* is an annual member of the Poaceae. It flowers from May through October (relatively late for vernal pool taxa) and can occur in vernal pools at elevations of 35-1,760 m (CNPS 2001). *O. tenuis* can be distinguished from other members of the *Orcuttia* genus by its equal lemma teeth and upright culms that branch from the upper nodes (Reeder 1982). Of all the *Orcuttia* species, *O. tenuis* has been observed to occur in the highest density stands (Stone et al. 1987, Griggs & Jain 1983). This high density may give *O. tenuis* a distinct advantage under grazing pressure, advantages such as resistance to trampling invasion by exotics species post-grazing (Stone et al. 1987). In addition, *O. tenuis* seeds are thought to need fungi in order for germination to be activated (Griggs 1981). *O. tenuis* is known from 5 vernal pool regions, with the majority of extant occurrences in the NE Sacramento Valley Vernal Pool Region (43%) and the Modoc Plateau Vernal Pool Region (38%) (CNDDB 2006). Three of the occurrences in the NE Sacramento Valley Vernal Pool Region are introductions into artificial vernal pools (CNDDB 2006).

Our database has information on *O. tenuis* from two of the five vernal pool regions (NE Sacramento Valley and Lake-Napa). A total of 6 pools and 41 releves were collected in these 5 sites (Table 4.16). Pools with *O. tenuis* occurred on Red Bluff geomorphic surface with either a High Terrace or Mudflow landform including three soil series; Anita, Tuscan and Toomes.

Associations:

Downingia cuspidata-Lasthenia fremontii; commonly.
Downingia ornatissima-Lasthenia fremontii; occasionally.
Layia fremontii-Achyrachaena mollis; rarely.
Downingia bicornuta-Lasthenia glaberrima; rarely.

Habitat and Ecology of Sites: Measurements on depth were available for all sites except Boggs Lake. The maximum depths averaged 42 cm, with a minimum of 20 cm and a maximum of 65 cm. Those releves that contained *O. tenuis* had an average depth of 31 cm, with a range of 5-62 cm. The average pool area across sites was 184,100 m^2, with the smallest pool 37,200 m^2 and the largest pool 371,500 m^2. Average total herb cover in *O. tenuis* releves across the 5 sites was 68%, with a range of 25% to 95%. Percent covers of litter, bare rock, and open water were all minimal with an average of < 5%. Algal cover averaged 12%, but varied widely from 0% in the majority of releves to 100%. Species richness was averaged at 12 per releve. Of the 70 species found to co-occur with *O. tenuis* in the releves sampled, 14 were not native to California.

Table 4.16. *Orcuttia tenuis* occurrence and distribution. Occurrence data comes from a 2006 search of the CNDDB Rarefind 3 database. Sites, pools and releves indicate data collected by the UC Davis team. * three occurrences were introduced into artificial vernal pools.

Vernal Pool Region	County	Historical Occurrences	Extant Occurrences	Sites	% Occurrences Sampled	Pools	Releves
Lake-Napa	Lake	2	2	1	50%	1	6
Modoc Plateau	Lassen	5	5				
	Modoc	4	4				
	Plumas	4	4				
	Shasta	13	12				
	Siskiyou	2	2				

NE Sacramento Valley	Butte	2	2				
	Tehama	30*	29*	4	14%	5	35
NW Sacramento Valley	Shasta	9	9				
SE Sacramento Valley	Sacramento	3	3				
TOTALS		**74**	**72**	**5**	**7%**	**6**	**41**

Orcuttia viscida **"Sacramento Orcutt grass"**

Status: Federally Endangered, CA Endangered, and CNPS List 1B.

Description and Range: *O. viscida* is an annual member of the Poaceae. It flowers from April to July and occurs in vernal pools at elevations of 30-100 m (CNPS 2001). *O. viscida* can be distinguished from other *Orcuttia* species by its unequal lemma teeth that are 6-7 mm long and which terminate in awns at least 1 mm long (Reeder 1982). *O. viscida* appears to have a larger population when precipitation levels reach a certain threshold amount or greater (Holland 1987). *O. viscida* is the rarest of the *Orcuttia* species (Stone et al. 1987) as it only occurs in the SE Sacramento Valley Vernal Pool Region and is endemic to Sacramento County.

The UCD database has information on *O. viscida* from three vernal pool sites all within the SE Sacramento Valley Vernal Pool Region. In these three sites, a total of 6 pools and 17 releves were sampled (Table 4.17). *O. viscida* can be found on a High Terrace landform and a Laguna geomorphic surface underlain by either Redding or Corning soils.

Associations:

Downingia bicornuta-Lasthenia fremontii; commonly.

Downingia bicornuta-Lasthenia glaberrima; occasionally.

Habitat and Ecology of Sites: Measurements on depth were available for all sites except Rancho Seco. The 5 pools in which depth data was taken had an average depth of 45 cm, with the shallowest pool 23 cm and the deepest pool 70 cm. Releves were taken at an average depth of 42 cm in the 15 releves in which depth was recorded. This depth of the releves ranged from 18 cm to 70 cm. The average pool area for all 6 pools was 18,800 m^2, with the smallest pool 2,900 m^2 and the largest pool 42,400 m^2. Average total herb cover in *O. viscida* releves across the 3 sites was 64%, with a range of 5% to 90%. Average covers of litter, bare rock, and algae were all < 5%. Species richness across sites averaged 12 per releve. There were a total of 43 species found to co-occur with *O. viscida*, including 7 that were non-native.

Table 4.17. *Orcuttia viscida* occurrence and distribution. Occurrence data comes from a 2006 search of the CNDDB Rarefind 3 database. Sites, pools and releves indicate data collected by the UC Davis team. * one occurrences was introduced into an artificial vernal pool.

Vernal Pool Region	**County**	**Historical Occurrences**	**Extant Occurrences**	**Sites**	**% Occurrences Sampled**	**Pools**	**Releves**
SE Sacramento Valley	Sacramento	10*	9*	3	30%	6	17

***Tuctoria greenei* "Greene's tuctoria"**

<u>Status</u>: Federally Endangered, CA – Rare, and CNPS List 1B.

<u>Description and Range:</u> *T. greenei* is an annual member of the Poaceae. It flowers May through September (relatively late for vernal pool taxa) and can occur in vernal pools at elevations of 30-1,070 m (CNPS 2001). *T. greenei* can be distinguished from other members of the genus by its terminal inflorescence, which is exerted from the upper leaves at maturity (Reeder 1982). The inflorescence is born on culms 30 cm or less long thereby distinguishing it from Mexican Tuctoria, *Tuctoria fragilis* (Reeder 1982). *T. greenei* is thought to be one of the most susceptible of the Orcuttieae Tribe to grazing due to its preference for the margin zone in vernal pools (Stone et al. 1987). *T. greenei* is known from three vernal pool regions with the majority of extant occurrences in the NE Sacramento Valley Vernal Pool Region (64%), followed by the Southern Sierra Foothills Vernal Pool Region (32%), with only one extant occurrence in the Modoc Plateau Vernal Pool Region (CNDDB 2006).

Our database has information on *T. greenei* from one site located in the NE Sacramento Valley Vernal Pool Region. Data were collected from one pool with 8 releves (Table 4.18). This pool has a Red Bluff geomorphic surface, Laguna landform, and Anita soil series.

Associations: Tuctoria greenei-Chamaesyce hooveri; commonly.

Habitat and Ecology of Site: The pool sampled had a maximum depth of 33 cm. The 8 releves were taken in an average depth of 30 cm, with a range of 21 cm to 33 cm. The pool was fairly large with an area of 160,200 m^2. Average total herb cover in the releves containing *T. greenei* was 30%, with a minimum of 4% and a maximum of 50%. Litter cover in these releves averaged 1%; however, bare rock cover had a higher average of about 6%. This 6% average was due mostly to one releve that had a 40% bare rock cover, whereas the other 7 releves had either 0% or 1% cover of bare rock. Species richness averaged 5 per releve with a total of 10 species co-occurring with *T. greenei*, only one out of these ten was non-native.

Table 4.18. *Tuctoria greenei* occurrence and distribution. Occurrence data comes from a 2006 search of the CNDDB Rarefind 3 database Sites, pools and releves indicate data collected by the UC Davis team.

Vernal Pool Region	County	Historical Occurrences	Extant Occurrences	Sites	% Occurrences Sampled	Pools	Releves
NE Sacramento Valley	Tehama	13	10	1	10%	1	8
	Butte	4	4				
Southern Sierra Foothills	Fresno	3	0				
	Madera	1	0				
	Merced	11	7				
	San Joaquin	2	0				
	Stanislaus	5	0				
	Tulare	1	0				
Modoc Plateau	Shasta	1	1				
TOTALS		**41**	**22**	**1**	**5%**	**1**	**8**

***Tuctoria mucronata* "Solano grass"**

Status: Federally Endangered, CA Endangered, and CNPS List 1B.

Description and Range: *T. mucronata* is an annual member of the Poaceae that flowers April through August and can occur in vernal pools at elevations of 5-10 m (CNPS 2001). *T. mucronata* can be distinguished from other members of the genus by having a terminal inflorescence that is partially included in the upper leaves at maturity (Reeder 1982). This inflorescence is born on culms 30 cm or less long (Reeder 1982). While many species in the Orcuttieae Tribe seem to do best in wet years, Holland (1987) showed that *T. mucronata* had smaller populations in years that were really wet, as well as in years that were really dry. *T. mucronata* is only known from the Solano-Colusa Vernal Pool Region, with only 2 of the 3 known sites remaining extant (CNDDB 2006)

Our database has information on *T. mucronata* from both extant sites. The Hamilton site had one pool and one releve (< 10 individuals) while the DOD site had more individuals of *T. mucronata* and therefore more releves taken. A total of two pools and 11 releves were sampled across the 2 sites (Table 4.19). Each site had a different geomorphic surface, Holocene and Modesto, one located on an Alluvial Fan landform with the other a Basin Rim landform. The two soil series were Marvin and Pescadero.

Habitat and Ecology of Sites: Data on depth of the pools and releves was not recorded at either site. However, pool area was recorded for one of the sites, with a pool area of 3,300 m^2. Average herb cover across releves was about 37%, with a range of 25% to 65%. The cover of litter was < 1%. There were a total of 12 species that co-occur with *T. mucronata*, including 2 that were non-native.

Table 4.19. *Tuctoria mucronata* occurrence and distribution. Occurrence data comes from a 2006 search of the CNDDB Rarefind 3 database. Sites, pools and releves indicate data collected by the UC Davis team.

Vernal Pool Region	County	Historical Occurrences	Extant Occurrences	Sites	% Occurrences Sampled	Pools	Releves
Solano-Colusa	Solano	2	1	1	100%	1	1
	Yolo	1	1	1	100%	1	10
TOTALS		**3**	**2**	**2**	**100%**	**2**	**11**

CLUSTER ANALYSIS AND CORRELATIONS WITH ENVIRONMENTAL VARIABLES

To identify which environmental variables contribute the most to predicting rare species distribution, analyses were performed using CANOCO (ter Braak 2002). In order to use the most consistent data, plots taken outside of California, that were not 10 m^2 in area and lacking information on depth of the pool, depth of the plot, or GPS coordinates were removed from the analysis.

A Canonical Correspondence Analysis (CCA) was performed on the dataset. A primary matrix of the sample units and species was set up, as well as two other matrices with the environmental variables and the co-variables. The environmental variables used in this analysis included cover of natives and non-natives, soil, litter, algae, open water, bare rock, drop (i.e. animal dropping), and punch (i.e. indentations made from animal hooves); total vegetation cover; the area of the pool, its maximum depth, and the depth at which releves were taken (expressed as a negative number). Geologic substrate, landforms, and soil series could not be ordinated because they are non-continuous and non-quantitative variables. The co-variables used in this analysis include coordinates and phenology. Co-variables were included in an effort to remove the effect that location and time of sampling might have on the results.

In the CCA diagrams that follow, vernal pools are physically located in the center of ordination space near the exus of axes, while playas lie in the upper-left quadrant of the diagram. Playas, which are large, deep, and poorly vegetated and are differentiated in the ordination by vectors of increasing pool area, maximum depth, and cover soil. Pools, on the other hand, are differentiated along increasing vectors of total vegetation cover and relative elevation. We have already shown in Chapter 2 that playas are so floristically distinctive that they cannot be classified as vernal pools.

Species richness was highest (total ~ 20) in vernal pool plots and much lower (total ~6) in playa plots (Fig. 4.1). Native species richness followed the same pattern (~14 in vernal pool plots, ~4 in playa plots; Fig. 4.2). Figure 4.3 summarizes the position of rare species in ordination space, and we can see that the majority of rare species were correlated with small, shallow, pools that had high total plant cover: taxa such as *Legenere limosa, Navarretia myersii, Downingia pusilla*, and *Castilleja campestris* ssp. *succulenta*. A fewer number of rare species were correlated with large, deep playas having low total plant cover, such as: *Tuctoria greenei, Lasthenia ferrisae*, several *Orcuttia* species, and *Chamaesyce hooveri*. At this level, the distribution of rare species is predictable; some are associated with playas and others with pools, some with shallow pools and others with deep pools, some with open vegetation and others with high plant cover.

This analysis confirms the conclusions reached in Chapter 2 that there is no single community type that contains all—or even a majority of--rare taxa; quite the opposite, seldom do more than two rare taxa co-occur in a particular pool. Collectively, rare species are widely distributed over many community types, therefore the protection and management of rare vernal pool taxa, must incorporate many varieties of habitats that are known to support rare species.

CHAPTER 5: IMPLICATIONS FOR CONSERVATION AND MANAGEMENT AT DIFFERENT SCALES

A significant finding is that most community types are limited in their distribution to a single vernal pool region. Of the 29 associations and communities we defined as occurring within the Central Valley, only two were found in more than half of the six Central Valley vernal pool regions and 21 were limited to a single vernal pool region within the Central Valley. Associations of long-inundated pools tended to be more widespread than short-inundated fresh-water associations and than alkaline/saline associations in large part because deep pools harbor fewer species and thus the choice for diagnostic species that distinguish local associations is more limited.

The implication for conservation is that it will be better to select many reserves than one or even a few reserves. Given the high turnover of community types from region to region, only a small percentage of total community diversity can be captured in any one preserve, no matter how many hectares it might contain. At best, each vernal pool region deserves its own network of reserves, perhaps one focal reserve and a nexus of satellite reserves.

Another significant finding is that vernal pools are complexes of two or more community types (although some uniformly shallow pools can contain only a single community type). Each community type is geographically autonomous, meaning that it can be spatially associated in the same pool, with a number of other community types. Although some combinations of community types are more common than others, the fact remains that pools are usually composed of two or more independent communities and the vegetation of vernal pools can be most accurately and defensibly classified by sampling homogeneous sub-pool units, rather than entire pools as a unit.

The implication for conservation and restoration is that the units to be conserved and to serve as targets for restoration are the variety of community complexes characteristic of the surrounding region. For example, if five community types occur in the region, and they can co-occur in various combination, then each combination should be protected. In other words, whatever variety of pools and community types—large, small, shallow, deep, fresh, saline—occur in a region should be encompassed in the network of protected areas. Each reserve needs to be large enough to include a variety of deep and shallow pools that collectively contain the mixtures of community types characteristic of the region, including rare taxa and rare community types.

At the same time, this is not to deny the potential value of protecting small areas. Where the pace and extent of habitat loss has severely fragmented and limited remaining vernal pool habitats to a size smaller than ideally desired, protecting such relict areas also have conservation importance. Although landscape-scale complexity cannot be captured in such small preserves, nevertheless they still maintain some sustainable ecosystem attributes such as habitats for vernal pool taxa. Small preserves may require more active management to compensate for their isolation.

CHAPTER 6: RESTORATION CRITERIA AND TRAINING

As summarized by De Weese (1998), vernal pool restoration by "creation" has been a common mitigation technique for the past two decades. De Weese evaluated the degree of mitigation success of more than 1500 constructed pools in the Sacramento Valley between 1988 and 1994. She found that the percentage of pools meeting all compliance criteria varied with the year of creation, from 25 to 100%, overall averaging 62%. The usual reasons for failing to attain vegetation standards were construction on inappropriately steep slopes and on soils without natural horizons that restrict drainage, failure to apply sufficient inoculant to the pools, failure to construct pools where natural pools did not already exist, and lack of continuous weed control.

Solomeshch et al. (2007), Ferren and Gevirtz (1990), Leidy and White (1998) criticized current compliance criteria on several grounds: the length of monitoring time has not been standardized and it is usually too brief (3-5 years at most), agreement as to which attributes should be measured has not been reached, and some criteria are not ecologically meaningful. It is the latter attribute that we addressed in our work for USFWS.

At present, success criteria include the cover, number, vigor, and identity of vernal pool endemics present. Our classification work has shown that a subset of approximately a dozen vernal pool plant taxa is widely distributed throughout California and they constitute the species that characterize the single vegetation class that includes all the kinds of vernal pools in California. At the same time, however, there are as many or more additional taxa that are diagnostic for the community types within that class. Both groups of species can be called "endemic" to vernal pools, but their distributions are enormously different. If our intent, in conservation and restoration, is to maintain community type diversity, then targets for restoration should not be widespread class species but instead more locally restricted species that are diagnostic for local communities.

CASE STUDY OF EVALUATING RESTORATION SUCCESS ON A COMMUNITY BASIS

The vegetation of 13 created and 13 natural pools, all within Wurlitzer Ranch near Chico, was studied. This site was selected because, in our opinion, the degree of care and planning taken with pool construction and subsequent monitoring was exceptional. The design was created and the results quantified by vernal pool experts and independent consults Rod Macdonald and Steve Talley, followed by UC Davis MS candidate Sandi Starr (2004).

Wurlitzer Ranch is a 24-ha preserve 10 km north of Chico in the Sacramento Valley that was established as a mitigation site in 1992. It originally supported 40 natural pools on a terrace of Red Bluff and Modesto-Riverbank formations with 0-2% slopes. During 1994-1996, 60 pools were constructed that imitated the size, shape, and range of depths of adjacent natural pools. They were inoculated with material from either on-site pools or from pools “taken” at the Doe Mill Preserve a few kilometers south of the Wurlitzer Preserve. In spring of 2002, half of the site and pools was burned to control the abundance of medusa head grass. Grazing by domesticated livestock has been absent since 1992.

In the spring of 2003, 26 pools were jointly selected for study by Macdonald, Talley, and Starr. Some 84 within-pool plots, each 10 square meters in area, representing visually homogeneous community types, were sampled, using the same protocols that our state-wide survey employed (Barbour et al. 2003). Data were entered in Turboveg format and exported to Excel (Microsoft 1985-2001) for formatting. PC-Ord 4 (McCune and Mefford 1999) and Excel were used for non-metric multidimensional scaling ordination, cluster analysis, linear regression, and indicator species analysis. In addition to single-species and community-type analyses, we examined patterns of species richness, native species richness, non-native species richness, percent of native species, and the number of vernal pool indicator (vpi) and vernal pool associates (vpa) present.

Comparison of the floristic composition of plots did show differences between created and natural pools. The first three divisions of an agglomerative hierarchical cluster analysis of the 84 plots (Fig. 5.1), at 0-55% information levels, did separate unequal ratios of constructed-to-natural pools. A chi-square analysis of the ratios created by the first two levels of branching failed to show that they were statistically different at p = 0.05 (Table 5.1), meaning that the horizontal lines in the dendrogram (formed by the second branching) were not different enough to represent discrete plant communities. An NMS ordination figure, based on differences in the floristic composition among plots, revealed little separation of plots in created pools (Fig. 5.2, triangles in left portion of ordination space) from those in natural pools (circles in right portion), and instead a great deal of overlap among plots from created and natural pools. The overlap suggests that there were many species in common, but it does not prove that the communities were convergent.

A test of community similarity need not require the complex ordination and clustering figures used for this example. Rather, a Sorensen similarity index could be calculated, where

$$\text{SSI (\%)} = \frac{\text{(2) x (number of taxa in common, any two samples)}}{\text{(number of taxa in one sample + number in other)}} \text{ x (100) .}$$

The possible range of Sorensen similarity index (SSI) values extends from 0 (no species in common) to 100 (all species in common). A general rule of thumb, among experienced phytosociologists, is that any two plot samples or summaries belong to the same community type when SSI >50% (Mueller-Dombois and Ellenberg 1974). In the Wurlitzer case, we would create a list of all species encountered in all plots from created pools, a list of all species encountered in all plots from natural pools, and a list of all species in common. Using the actual plot data, the formula is:

$$\text{SSI} = \frac{(2) \times (53)}{(82 + 77)} \times (100) = 67\% ,$$

which is > 50%, indicating that the two community types are similar. However, this relatively high value can be attributed to a large number of non-native species found in both types of pools, confounding any conclusion about restoration success.

This case study shows us both the possibilities and limitations in grading restoration success on a whole-community basis. Not all species have equal value in defining any given community. Generalists and non-natives should be given less weight than vernal pool specialists. Also, before calculating similarities, vegetation should be stratified to avoid comparing habitats that are dissimilar, such as comparing the pool bottom vegetation of created pools with the edge vegetation of natural pools.

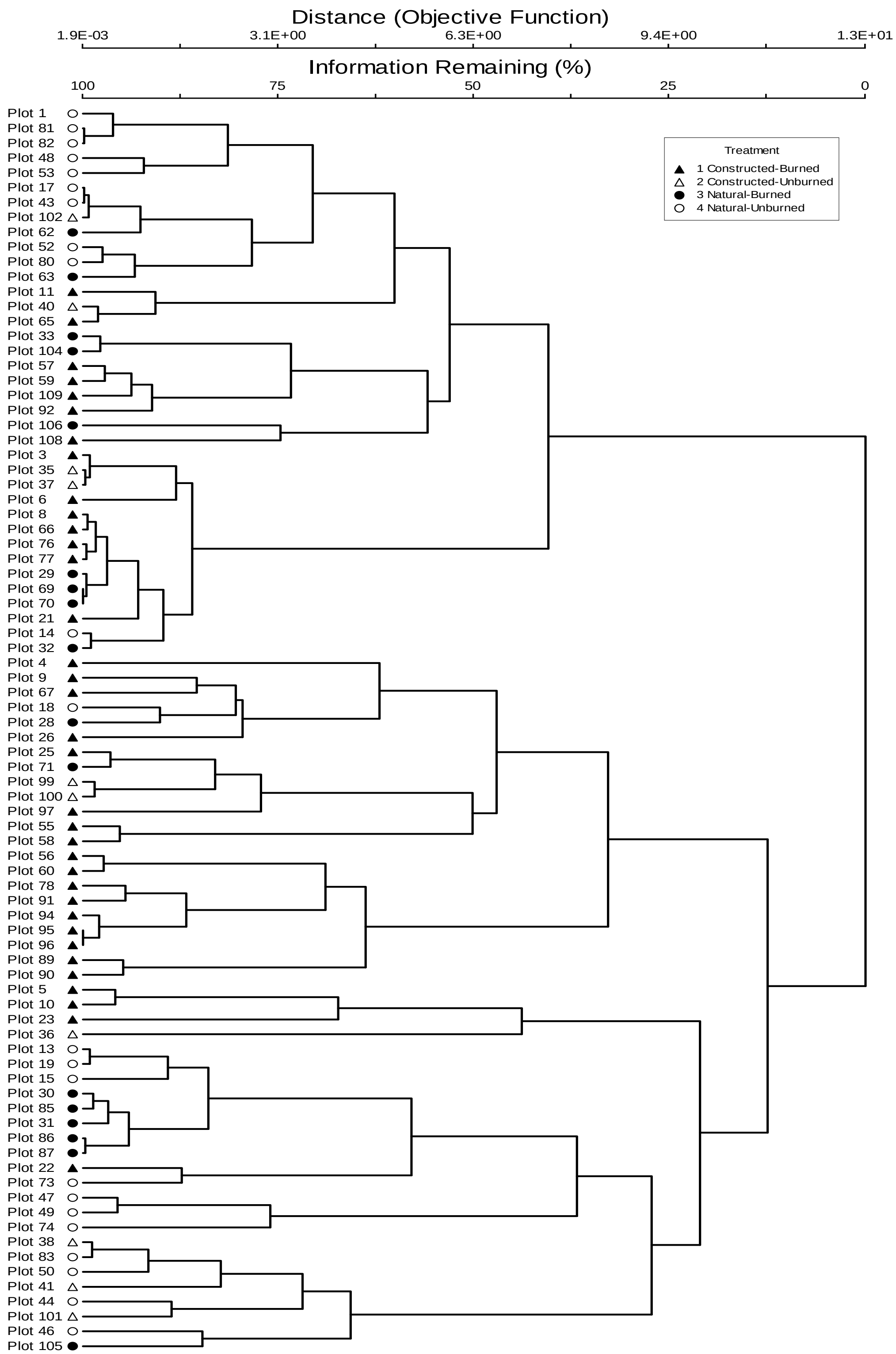


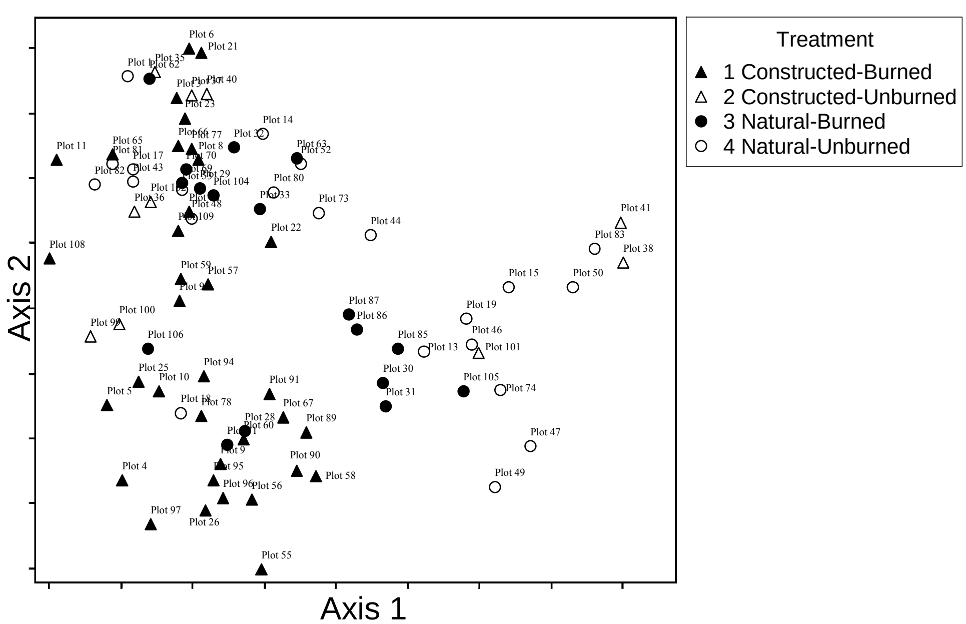
Fig. 5.1 Dendrogram for all 101 species of the within-pool data set, created by agglomerative hierarchical cluster analysis using Sorensen distance measures. Triangles are plots from constructed pools; circles are from natural pools. From Starr (2004).

TABLE 5.1. Chi-square test of the ratio of treatments observed vs the ratio expected (assuming no treatment effect) for the first two levels of branching in the dendrogram shown in Fig. 5.1

Treatment	Expected	Group 1 Observed	Group 2 Observed
1 Constructed-Burned	0.422	0.378	0.477
2 Constructed-Unburned	0.108	0.108	0.136
3 Natural-Burned	0.205	0.243	0.136
4 Natural-Unburned	0.265	0.270	0.250

Group 1 Chi	Group 2 Chi
0.999663 **NS**	0.998013 **NS**

Fig. 5.2. Ordination of plots from four treatments. Triangles are plots from constructed pools, circles are plots from natural pools. From Starr (2004).



Current restoration standards appropriately address hydrology and flora as the most important targets. However, in our opinion, some of the details in those standards are difficult to quantify because of the formulas used. We suggest the following changes:

(1) The current criterion specifies that created pools should not hold water longer and/or deeper than 125% of the values in reference pools. In order to make this criterion more consistent and statistically defensible, it should be amended to state, "Depth and/or duration of ponded water in created pools should not differ statistically ($p = 0.05$) from those in nearby natural pools." That is, the hydrologic variety of created pools should mirror that of the natural pools.

(2) The current criterion is that absolute and relative cover by vernal pool endemics in constructed pools should not be less than the minimum among reference pools. The minimum is not appropriate because that value will often be zero for any given species in at least one or some of the reference pools. Amend to read, "Absolute and relative cover of each vernal pool endemic in constructed pools should not be statistically different ($p = 0.05$) from the average values of each species in reference pools."

(3) The current criterion is that the number of vernal pool endemics in constructed pools should not be less than the lowest number of species among the reference pools. We suggest that the minimum should not be a measure for success because the floristically poorest reference pool may be an anomaly. Amend to read, "The number of vernal pool endemics in constructed pools should not be statistically lower ($p = 0.05$) than the average number of those taxa among reference pools."

(4) The current criterion is slightly modified by adding a statistical requirement: "The vigor (biomass accumulation) and reproductive activity (seed production) of vernal pool endemics in constructed pools should not be statistically lower ($p = 0.05$) than those of the same species in reference pools."

(5) Current criteria do not address exotic species, therefore, we propose a new criterion, "The number and cover of non-native species in any constructed pool should not be significantly higher ($p = 0.05$) than the average among reference pools."

(6) Current criteria are species-oriented rather than community oriented, therefore we propose a new criterion, "The identity of community types in created pools

and the mixture in which they occur should match that of reference pools (using a Sorensen Similarity Index formula where "matching" means an SSI >50%." In other words, constructed pools collectively should contain deep, shallow, and edge community types if reference pools have those community types, meaning that the depth, side slope, shape, and area of created pools should be as diverse as that of reference pools.

(7) A follow-up new criterion, based on (6) above, is that "Reference pools should be chosen subjectively so that collectively they represent the diversity of species and communities that exist in the pools to be taken." We add this criterion to avoid the random selection of inappropriate pools as reference targets, and to address the need to replicate community type diversity in addition to the presence of particular species.

(8) We recommend the deletion of the present criterion, "…any vernal pool endemic that is dominant (>20% relative cover) in at least 30% of the reference pools shall be present as a dominant species in all of the constructed pools." Again, this emphasis on common, widespread dominant species could result in the homogenization of constructed pools. Furthermore, many natural pools would fail to meet this criterion because of innate floristic differences.

TRAINING OPPORTUNITIES

In this report, we have provided names and attributes for an hierarchical series of plant community types, from local associations to more regional alliances, orders, and classes. The task yet to complete is demonstrating the degree of adequacy and usefulness of the classification. If the community types are too difficult to differentiate for the average field botanist, then the classification will not be used for long. If the classification is appropriate, it may still not be used unless it becomes institutionalized, meaning that its use is not only encouraged by agencies, but its use becomes routinely expected.

We propose to develop a training course, with the collaboration of USFWS, the California Department of Fish and Game, and the California Native Plant Society; that is offered on an annual basis. The course would train students on plant identification, sampling protocol for documenting plant community types, the use of an annotated key to determine vernal pool community types, and major ecosystem differences between vernal pools on floodplains, terraces, hardpans, claypans, and in saline/alkaline situations. We propose that the class be five consecutive days in length, that its location vary from year to year, that it be staffed by a minimum of three vernal pool experts and three assistants, that enrollment be capped at 20, and that the class be open to agency staff, NGO staff, consultants, and academics. We expect that the cost per individual for such a class (including transportation, lunches, and field supplies) would be approximately $1200. A prototype of such a course is actually being planned for April 18-20 by Carol Witham of the California Native Plant Society; its focus is only on taxonomy, however, and no time will be devoted to determining plant communities.

Similar certification courses have been in existence for the past 15 years in the training of biologists for surveys of marbled murrelets (jointly designed by CDFG, USFWS, USDA Forest Service, and California Department of Forestry and Fire Protection) and northern spotted owls (jointly designed by CDFG and USFWS); for training foresters in archaeology (CDFF); and in certifying specialists in wetland delineation (Society of Wetland Science). The programs above are not mandated by regulatory/statutory legislation. Individuals are simply encouraged to enroll by informal policy expectations that those who hold certain positions will routinely take the course to become certified.

If USFWS staff is interested in the development of such a course and certification program, we will be pleased to work with them and to have in place a first offering during April of 2008.

Finally, we propose to continue working on providing an annotated key suitable for distribution (outside this report) to agency personnel and others who will require it. The key presented this draft is incomplete and its format can be improved and simplified if we subdivide the key into regions.

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Table 2.1. Communities of long-innundated pools: Order Lasthenietalia glaberrimae.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13
No. of relevés	64	16	10	11	5	13	6	13	18	20	22	53	15
Diagnostic species of the order Lasthenietalia glaberrimae													
Lasthenia glaberrima	**100**	.	**80**	**100**	**100**	**92**	**100**	**85**	**61**	**100**	**100**	**87**	13
Eleocharis palustris	**77**	**100**	**90**	**100**	**100**	**62**	**100**	**85**	**94**	15	**77**	**77**	**100**
Diagnostic species of association Downingia bicornuta-Lasthenia glaberrima													
(S) Downingia bicornuta	**59**	**50**	**60**	**100**	**100**	**46**	**50**	**92**	**56**	**60**	9	.	.
Ranunculus bonariensis v. trisepalus	**47**	25	**80**	.	**100**	**85**	**83**	**69**	**89**	5	.	.	.
Gratiola ebracteata	**44**	38	**40**	9	**60**	**54**	**67**	8	33	.	.	.	.
Plagiobothrys chorisianus v. undulatus	14	6	20	9	20	**69**	17	**54**	39	.	.	9	.
Diagnostic species of variants													
(S) Castilleja campestris s. campestris	6	19	**70**	.	20	.	17	.	17	.	5	25	.
Trichostema lanceolatum	8	6	**50**	9	.	.	.	.	6	.	.	.	.
Glyceria declinata	.	19	**40**	.	20	.	.	.	.	.	.	.	.
Isoetes howellii	.	6	.	**100**	.	.	**50**	.	.	10	.	.	.
Lilaea scilloides	5	19	.	27	**100**	**62**	**50**	.	11	.	.	**40**	.
Glyceria occidentalis	2	.	.	.	.	**100**	17	.	.	.	.	.	.
Lythrum portula	.	.	20	.	.	.	**100**	.	6	.	.	.	7
Convolvulus arvensis	.	.	.	.	.	.	.	**100**	33	.	.	.	.
Diagnostic species of association Trifolium variefatum-Lasthenia glaberrima													
Trifolium variegatum	9	12	10	.	20	8	.	.	**83**	.	.	2	.
Erodium botrys	8	6	20	.	.	8	.	.	**72**	.	.	25	.
Juncus capitatus	5	.	.	.	.	.	.	.	**56**	.	.	4	.
Vulpia bromoides	2	.	10	.	.	8	.	.	**56**	.	.	6	.
Briza minor	.	.	.	.	.	.	.	.	**67**	.	.	.	.
Holocarpha virgata	2	.	.	.	.	.	.	.	**50**	.	.	4	.
Trifolium dubium	.	.	.	.	.	.	.	.	**50**	.	.	.	.
Triteleia hyacinthina	3	.	.	9	.	.	.	.	**50**	.	.	.	.
Geranium dissectum	2	.	.	.	.	.	.	.	33	.	.	.	.
(S) Trifolium depauperatum v. depauperatum	3	.	10	.	.	.	.	.	33	.	5	2	.
Diagnostic species of association Pogogyne douglasii-Lasthenia glaberrima													
Downingia cuspidata	5	19	.	9	.	.	.	8	6	**65**	.	15	.
Isoetes nuttallii	.	.	.	.	.	8	.	.	.	**65**	.	.	.
Castilleja campestris s. succulenta*	.	.	.	.	.	.	.	.	.	**60**	.	.	.
Gratiola heterosepala***	2	.	.	.	.	.	.	.	.	**55**	.	2	.
Diagnostic species of association Lupinus bicolor-Lasthenia glaberrima													
Hemizonia fitchii	3	12	**60**	.	.	8	.	.	17	.	**86**	8	.
Lupinus bicolor	3	.	10	.	.	.	.	.	6	.	**73**	4	.
Downingia species	2	6	20	.	.	15	.	.	.	15	**68**	6	.
Pogogyne douglasii	.	.	.	.	.	.	.	.	.	25	**64**	.	.
Epilobium cleistogamum	23	25	.	27	.	15	.	15	11	5	**59**	4	.
Eryngium aristulatum	2	6	.	.	.	.	.	.	.	.	**45**	8	.
Medicago polymorpha	.	.	.	.	.	.	.	.	.	.	**41**	2	.
(S) Myosurus minimus s. minimus	2	.	.	.	.	.	.	.	.	.	**82**	23	**67**
Frankenia salina	.	.	.	.	.	.	.	.	.	.	27	9	7
Diagnostic species of association Pleuropogon californicus-Lasthenia glaberrima													
Distichlis spicata	.	.	.	.	.	.	.	.	.	.	9	**72**	33
Pleuropogon californicus	.	.	.	.	.	.	.	.	.	.	.	**77**	.
Downingia concolor	.	.	.	.	.	.	.	.	.	.	.	21	.
Diagnostic species of association Downingia insignis-Lasthenia glaberrima													
Downingia insignis	.	.	.	.	.	.	.	.	.	.	.	9	**87**
Grindelia camporum	5	.	.	.	.	.	.	.	.	.	18	.	**67**
Cotula coronopifolia	.	.	.	.	.	.	33	.	6	.	.	17	**60**
Epilobium densiflorum	.	.	.	.	.	.	.	.	.	.	.	.	**53**
Cressa truxillensis	.	.	.	.	.	.	.	.	.	.	.	.	**47**
Crypsis schoenoides	.	.	.	.	.	.	.	.	.	.	.	.	**47**
Diagnostic species of the class Downingio-Lasthenietea													
(S) Plagiobothrys stipitatus v. micr	**81**	**81**	**80**	**64**	**80**	**54**	**50**	**77**	**56**	**90**	**100**	**62**	**40**
(S) Psilocarphus brevissimus v. brev	**78**	**62**	30	27	**80**	**69**	17	**77**	**44**	**70**	**100**	**68**	**87**
Lasthenia fremontii	**64**	38	**50**	18	**40**	31	**83**	**62**	**72**	**60**	**86**	**79**	**87**
Crassula aquatica	**53**	**62**	**60**	27	**80**	**77**	**50**	**62**	**44**	**45**	**100**	**72**	**73**
Alopecurus saccatus	**41**	19	**40**	**64**	**60**	**69**	33	31	22	**55**	**55**	**72**	.
Eryngium castrense	**42**	**69**	20	**82**	**80**	**77**	**100**	.	**44**	**100**	.	**53**	.
Eryngium vaseyi	14	6	**80**	.	20	15	.	**92**	**44**	.	**50**	.	**40**
Eryngium species	38	12	.	18	.	.	.	8	6	.	.	21	.
Callitriche marginata	**44**	**50**	10	27	20	**54**	.	8	17	35	**64**	**74**	7
(S) Navarretia leucocephala s. leuco	**59**	19	**60**	**45**	20	38	.	**85**	**44**	.	**64**	.	**60**
Deschampsia danthonioides	27	12	**40**	**45**	**60**	23	**67**	38	39	30	**41**	21	20
Pilularia americana	22	**44**	30	18	**60**	31	17	23	.	**45**	32	**51**	27
Isoetes orcuttii	30	31	30	.	**60**	.	33	23	22	**70**	18	28	.
(S) Eleocharis acicularis v. acicula	23	31	30	18	**80**	**46**	**83**	31	**44**	**55**	9	2	20
Juncus bufonius	17	12	**40**	.	20	8	.	15	**83**	.	**50**	13	.
(S) Veronica peregrina s. xalapensis	3	12	20	.	.	.	.	.	11	.	**91**	13	**40**
Pogogyne ziziphoroides	14	6	**40**	.	20	.	33	8	**44**	.	36	13	.
Plagiobothrys leptocladus	9	6	.	**45**	**40**	8	**50**	8	11	.	.	26	27
Cuscuta howelliana	19	12	**40**	9	**40**	.	17	31	6	.	18	.	.
Elatine californica	3	31	.	.	.	38	.	.	6	10	14	9	20
Callitriche heterophylla	6	12	10	.	.	.	33	.	.	5	.	.	.
Juncus uncialis	5	6	.	.	.	.	.	.	6	.	.	6	.
(S) Marsilea vestita	8	.	.	.	.	.	.	8	6	.	.	2	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13
No. of relevés	64	16	10	11	5	13	6	13	18	20	22	53	15
Plagiobothrys stipitatus v. stipitat	.	.	.	.	.	.	.	.	.	.	9	2	.
Species with special status													
Legenere limosa	9	.	.	.	.	15	.	15	.	.	.	17	.
Orcuttia viscida	3	.	10	.	.	15	.	.	.	.	.	.	.
Orcuttia tenuis	3	.	.	.	.	.	.	.	.	.	.	.	.
Orcuttia pilosa	.	.	.	.	.	.	.	8	.	.	.	.	.
Hesperevax caulescens	.	.	.	.	.	.	.	.	.	.	5	.	.
Downingia pusilla	.	.	.	.	.	.	.	.	.	.	.	13	.
Lasthenia conjugens	.	.	.	.	.	.	.	.	.	.	.	2	.
Common native species													
Croton setigerus	**44**	31	**50**	9	20	23	.	38	39	.	.	8	.
Brodiaea species	16	12	.	.	.	.	17	8	39	.	32	15	.
Limnanthes douglasii s. rosea	.	12	.	.	.	.	.	.	6	5	.	36	.
Achyrachaena mollis	3	.	20	.	.	.	.	.	6	.	.	8	.
Downingia ornatissima	12	6	10	.	.	.	.	8	11	.	.	.	.
Phalaris lemmonii	3	.	.	.	20	.	.	.	.	.	23	8	.
Anagallis minima	9	6	.	.	.	.	.	.	28	.	.	.	.
Cicendia quadrangularis	3	.	.	.	.	8	.	8	22	.	.	8	.
Ranunculus aquatilis	5	.	.	27	.	31	17	.	.	5	.	.	.
Elatine species	6	.	.	.	.	.	17	8	.	30	.	.	.
Epilobium species	3	.	.	.	.	.	.	.	.	5	.	9	.
(S) Lasthenia glabrata s. glabrata	.	6	.	.	.	.	.	.	.	.	32	2	.
Lepidium latipes v. latipes	.	.	10	.	.	.	.	.	.	.	36	.	.
Montia fontana	.	6	.	.	20	.	.	.	17	10	.	4	.
Epilobium torreyi	.	19	.	.	.	.	.	.	33	.	.	.	.
Hemizonia congesta s. luzulifolia	.	.	.	.	.	.	.	.	.	.	23	8	.
Navarretia leucocephala s. bakeri	2	.	.	.	.	.	.	.	.	.	.	11	.
Plantago elongata	.	6	.	.	.	.	.	.	.	.	.	9	7
Mimulus tricolor	2	6	.	9	20	8	.	15	.	.	.	.	.
Psilocarphus oregonus	.	.	.	.	.	.	.	.	.	.	18	6	.
Common exotic species													
Lythrum hyssopifolia	36	38	**40**	**45**	**40**	**46**	33	**77**	**94**	.	32	**53**	**87**
Lolium perenne s. multiflorum	31	19	**50**	9	**40**	23	.	**77**	**72**	.	**100**	**51**	33
Hordeum marinum s. gussonianum	30	38	**40**	.	**40**	23	17	23	**83**	5	**41**	17	13
Leontodon taraxacoides	27	6	**70**	.	**40**	15	33	31	**72**	.	5	.	.
Polypogon monspeliensis	12	6	**50**	.	.	.	**50**	.	11	.	**50**	2	**67**
Rumex crispus	6	.	30	.	20	.	.	8	28	.	23	11	.
Hypochaeris glabra	5	.	.	.	.	8	33	.	33	.	9	17	.
Poa annua	8	12	.	.	20	38	17	8	22	.	9	.	.
Bromus hordeaceus	3	.	.	.	.	.	.	8	39	.	.	4	7
Lactuca serriola	2	.	.	.	.	.	.	.	6	5	18	4	7
Taeniatherum caput-medusae	.	.	.	.	.	.	.	.	.	.	.	6	.
Rumex species	2	.	.	.	.	.	.	.	.	.	23	.	.
Polypogon maritimus	3	12	.	.	.	15	.	.	.	.	.	.	.
Ranunculus muricatus	.	.	.	.	.	.	17	.	22	.	.	2	.
Anthemis cotula	2	.	10	.	.	.	.	.	.	.	9	.	.
Cerastium glomeratum	.	.	.	.	.	.	.	.	11	.	.	2	.
Less common native and exotic species													
Lasthenia californica	.	.	.	.	.	.	.	.	.	25	.	.	.
Epilobium pygmaeum	6	.	.	.	.	.	.	8	.	.	.	.	.
Blennosperma nanum v. nanum	2	.	.	.	.	.	.	.	.	.	.	8	.
Machaerocarpus californicus	.	.	.	18	.	.	.	.	.	.	.	.	20
Trifolium wormskioldii	.	.	.	.	.	.	.	.	.	.	23	.	.
Malvella leprosa	5	.	.	.	.	.	.	.	.	.	.	.	7
Phyla nodiflora	5	.	.	.	.	.	.	8	.	.	.	.	.
Limnanthes alba	.	.	.	.	20	.	.	.	17	.	.	.	.
Plagiobothrys greenei	.	.	.	.	.	.	.	.	11	.	.	4	.
Trifolium fucatum	.	.	.	.	.	.	.	.	.	.	18	.	.
Elatine ambigua	3	.	.	.	.	8	.	.	.	.	.	.	.
Psilocarphus tenellus v. globiferus	2	.	.	.	.	8	.	.	.	5	.	.	.
Sidalcea calycosa	.	.	10	.	20	.	.	.	.	5	.	.	.
Trifolium depauperatum v. amplectens	.	.	10	.	.	.	.	.	.	.	9	.	.
Trifolium species	.	.	.	.	.	.	17	.	.	.	9	.	.
Epilobium pallidum	.	6	.	.	.	.	.	8	6	.	.	.	.
Triphysaria eriantha s. eriantha	.	.	.	.	.	.	.	.	.	.	9	2	.
Trifolium barbigerum	.	.	.	.	.	.	.	.	.	.	5	4	.
Layia chrysanthemoides	.	.	.	.	.	.	.	.	.	.	.	6	.
Cardamine oligosperma	2	.	.	.	.	.	.	.	6	.	.	.	.
Navarretia prostrata	3	.	.	.	.	.	.	.	.	.	.	.	.
Navarretia myersii s. myersii	.	12	.	.	.	.	.	.	.	.	.	.	.
Clarkia purpurea	2	.	.	.	.	.	.	.	6	.	.	.	.
Lotus denticulatus	.	.	.	.	.	.	.	.	11	.	.	.	.
Lepidium latipes v. heckardii	.	.	.	.	.	.	.	.	.	.	9	.	.
Psilocarphus brevissimus v. multiflo	.	.	.	.	.	.	.	.	.	.	.	4	.
Plagiobothrys humistratus	.	.	.	.	.	.	.	.	.	.	.	4	.
Bolboschoenus maritimus	.	.	.	.	.	.	.	.	.	.	.	.	13
Crypsis vaginiflora	2	.	.	.	.	.	.	.	.	.	.	.	.
Hemizonia pungens s. maritima	2	.	.	.	.	.	.	.	.	.	.	.	.
Juncus xiphioides	2	.	.	.	.	.	.	.	.	.	.	.	.
Elatine brachysperma	.	6	.	.	.	.	.	.	.	.	.	.	.
Lasthenia species	.	6	.	.	.	.	.	.	.	.	.	.	.
Hemizonia parryi s. parryi	.	6	.	.	.	.	.	.	.	.	.	.	.
Brodiaea minor	.	.	10	.	.	.	.	.	.	.	.	.	.
Cuscuta species	.	.	.	9	.	.	.	.	.	.	.	.	.
Plagiobothrys austiniae	.	.	.	.	.	.	17	.	.	.	.	.	.
Sidalcea hirsuta	.	.	.	.	.	.	.	8	.	.	.	.	.
Layia fremontii	.	.	.	.	.	.	.	.	6	.	.	.	.
(S) Navarretia intertexta	.	.	.	.	.	.	.	.	6	.	.	.	.
Castilleja attenuata	.	.	.	.	.	.	.	.	6	.	.	.	.
Lepidium nitidum	.	.	.	.	.	.	.	.	6	.	.	.	.
Plagiobothrys glyptocarpus	.	.	.	.	.	.	.	.	6	.	.	.	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13
No. of relevés	64	16	10	11	5	13	6	13	18	20	22	53	15
Potamogeton nodosus	.	.	.	.	.	.	.	.	.	5	.	.	.
Chamaesyce species	.	.	.	.	.	.	.	.	.	.	5	.	.
Plantago aristata	.	.	.	.	.	.	.	.	.	.	5	.	.
Juncus balticus	.	.	.	.	.	.	.	.	.	.	5	.	.
Trifolium bifidum	.	.	.	.	.	.	.	.	.	.	5	.	.
Trifolium depauperatum v. stenophyll	.	.	.	.	.	.	.	.	.	.	.	2	.
Microseris douglasii	.	.	.	.	.	.	.	.	.	.	.	2	.
Hordeum depressum	.	.	.	.	.	.	.	.	.	.	.	2	.
(S) Crassula connata	.	.	.	.	.	.	.	.	.	.	.	2	.
Elatine chilensis	.	.	.	.	.	.	.	.	.	.	.	2	.
Epilobium brachycarpum	.	.	.	.	.	.	.	.	.	.	.	2	.
Mimulus guttatus	.	.	.	.	.	.	.	.	.	.	.	.	7
Lemna minor	.	.	.	.	.	.	.	.	.	.	.	.	7
(S) Hemizonia pungens	.	.	.	.	.	.	.	.	.	.	.	.	7
Rumex dentatus	.	.	.	.	.	.	.	.	.	.	.	.	27
Rumex pulcher	2	.	10	.	.	.	.	.	.	.	5	.	.
Agrostis avenacea	2	6	.	.	.	8	.	.	.	.	.	.	.
Trifolium hirtum	.	6	.	.	.	.	.	.	11	.	.	.	.
Agoseris species	.	.	.	.	.	.	.	.	.	.	5	.	.
Senecio vulgaris	.	.	.	.	.	.	.	.	.	.	9	2	.
Glyceria species	2	.	.	.	20	.	.	.	.	.	.	.	.
Matricaria discoidea	2	.	.	.	.	.	.	.	6	.	.	.	.
Xanthium strumarium	2	.	.	.	.	.	.	8	.	.	.	.	.
Lepidium latifolium	2	.	.	.	.	.	.	.	.	.	5	.	.
Aira caryophyllea	.	.	.	.	.	.	.	.	11	.	.	.	.
Avena fatua	.	.	.	.	.	.	.	.	6	.	.	2	.
Polygonum arenastrum	2	.	.	.	.	.	.	.	.	.	.	.	.
Spergularia rubra	.	.	.	.	.	8	.	.	.	.	.	.	.
Galium parisiense	.	.	.	.	.	.	.	.	6	.	.	.	.
Sonchus species	.	.	.	.	.	.	.	.	6	.	.	.	.
Bromus diandrus	.	.	.	.	.	.	.	.	.	5	.	.	.
Lythrum species	.	.	.	.	.	.	.	.	.	.	5	.	.
Lotus species	.	.	.	.	.	.	.	.	.	.	.	2	.
Atriplex species	.	.	.	.	.	.	.	.	.	.	.	.	7

Table 2.2. Communities of short-inundated, shallow, and flashy pools: order Downingio bicornutae-Lasthenietalia fremontii

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
No. of relevés	9	9	86	100	70	61	108	13	32	25	31	17	13	24	20	36	25	15	5	43	22	13
Association Lupinus bicolor-Eryngium aristulatum (Vertisols)																						
Lupinus bicolor	**100**	**100**	.	5	4	5	1	.	.	.	6	.	.	.	15	39	.	7	20	5	.	.
Eryngium aristulatum	**100**	**78**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium willdenowii	78	78	1	.	.	2	.	.	.	.	3	.	.	17	.	36	.	**47**	.	2	.	.
Hemizonia congesta s. luzul	**44**	**56**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Medicago polymorpha	**100**	**56**	.	.	.	.	.	.	.	.	3	.	.	12	.	3	.	27	**80**	.	.	.
Association Lupinus bicolor-Eryngium aristulatum subass. Lasthenia glabrata																						
Lasthenia glabrata glabrata	**100**	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pogogyne douglasii	**100**	11	.	.	.	2	.	.	.	.	.	.	.	.	.	11	.	.	.	28	**45**	.
Grindelia camporum	**56**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lupinus subvexus v.suxbvexus	**56**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polypogon monspeliensi	**56**	11	.	2	.	.	8	.	6	.	13	.	8	4	5	.	.	.	.	.	.	.
Lactuca serriola	**44**	11	.	.	.	.	.	.	.	.	3	.	.	.	15	19	4	7	**60**	.	5	.
Senecio vulgaris	**44**	33	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	7	20	.	.	.
Association Lupinus bicolor-Eryngium aristulatum subass. Lepidium latipes																						
Lepidium latipes v. latipes	.	**89**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Psilocarphus oregonus	.	**78**	.	10	4	.	.	.	.	4	3	12	.	12	15	8	.	7	**80**	.	.	8
Trifolium fucatum	.	**67**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Castilleja attenuata	11	**44**	.	.	.	.	.	.	.	.	10	29	23	8	.	.	4	.	.	2	.	.
Microseris species	.	**44**	1	1	.	.	.	.	.	.	.	.	.	.	.	8	.	.	.	.	.	8
Phalaris lemmonii	.	**44**	.	.	3	.	1	.	.	.	.	.	.	4	.	.	4	.	.	.	.	.
Calandrinia ciliata	.	**44**	.	2	.	.	.	.	.	.	.	.	.	.	.	.	12	20	.	2	.	.
Association Downingia ornatissima-Lasthenia fremontii (Northwestern & Northeastern Sacramento Valley)																						
Downingia ornatissima	.	.	.	**87**	.	8	19	31	6	8	29	12	.	.	**55**	**50**	.	.	.	.	.	.
Association Downingia cuspidata-Lasthenia fremontii (Northwestern & Northeastern Sacramento Valley)																						
Downingia cuspidata	.	.	.	.	**53**	**52**	10	.	28	36	10	6	.	.	.	3	8	.	.	30	**77**	23
Marsilea vestita	.	.	8	2	21	36	.	8	.	.	.	.	.	.	.	3	.	.	.	.	.	.
Association Downingia cuspidata-Lasthenia fremontii var. Orcuttia tenuis (Northeastern Sacramento Valley - Dales Lake, Hogg Lake, Tuscan)																						
Orcuttia tenuis	.	.	.	.	**41**	3	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.
Machaerocarpus californicus	.	.	.	.	31	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.
Association Downingia cuspidata-Lasthenia fremontii var. Orcuttia pilosa (Northeastern Sacramento Valley – Rowles Road, Lassen Road)																						
Orcuttia pilosa	.	.	.	.	.	31	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Association Downingia bicornutae-Lasthenia fremontii (Southeastern Sacramento Valley & Southern Sierra Foothills)																						
Downingia bicornuta	.	.	.	.	**61**	**87**	**71**	**54**	**81**	**56**	23	**71**	38	21	.	14	.	.	.	.	.	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
No. of relevés	9	9	86	100	70	61	108	13	32	25	31	17	13	24	20	36	25	15	5	43	22	13
Ranunculus bonariensis trisepalus	.	.	5	2	.	.	**69**	.	**44**	**60**	**71**	35	**54**	**50**	.	.	.	.	.	.	.	15
Gratiola ebracteata	.	.	2	13	3	.	**65**	**46**	**78**	4	**42**	.	38	4	.	.	.	7	.	.	.	15
Castilleja campestris campestris	.	.	.	.	.	.	31	31	**75**	.	16	**53**	38	.	.	.	.	.	.	.	.	.
Association Downingia bicornutae-Lasthenia fremontii var. Orcuttia viscida (Southern Sierra Foothills – Keifer Ranch)																						
Orcuttia viscida	.	.	.	.	.	.	1	**85**	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Association Downingia bicornutae-Lasthenia fremontii var. Navarretia myersii (Howard Ranch)																						
Navarretia myersii s. myersii	.	.	.	.	.	.	3	.	**88**	.	.	**82**	.	.	.	.	.	.	.	.	.	.
Association Ranunculus bonariensis-Holocarpha virgata (Southeastern Sacramento Valley Region)																						
Juncus capitatus	.	.	1	2	.	.	20	.	25	.	**71**	**71**	**69**	4	35	.	4	.	.	.	.	.
Limnanthes alba	.	.	.	.	.	.	2	.	.	.	10	12	**85**	.	.	.	.	.	.	.	.	.
Association Layia fremontii-Achyrachaena mollis (Northeastern Sacramento Valley)																						
Achyrachaena mollis	.	.	3	7	.	5	3	.	.	.	16	.	.	8	**80**	**89**	**48**	**100**	.	.	.	.
Layia fremontii	.	22	2	1	3	.	5	.	.	.	16	29	38	.	15	**53**	**80**	**40**	.	14	.	.
Triphysaria eriantha s. eriantha	22	**78**	2	1	.	.	1	.	.	.	10	29	8	4	35	**44**	**68**	**93**	.	16	.	.
Taeniatherum caput-med	.	.	.	5	3	2	1	.	.	.	3	.	23	.	**50**	25	**44**	**80**	.	.	.	.
Clarkia purpurea	.	.	2	.	.	.	.	.	.	.	.	.	.	.	35	3	28	**40**	.	2	.	.
Association Plagiobothrys austinae-Achyrachaena mollis (Northeastern Sacramento Valley)																						
Navarretia tagetina	.	.	3	3	.	.	.	.	.	.	.	18	8	8	25	11	**72**	**87**	.	9	.	.
Plantago erecta	.	.	.	.	.	.	.	.	.	.	.	18	.	.	30	6	**60**	**67**	.	7	.	.
Lasthenia californica	.	.	.	1	1	.	4	.	.	4	10	12	.	.	30	28	**56**	**73**	.	16	.	.
Microseris acuminata	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	31	**40**	**100**	**40**	5	.	.
Vulpia microstachys	.	.	2	1	.	.	.	.	.	4	.	18	38	.	5	8	**72**	**67**	.	30	.	.
Plagiobothrys austiniae	.	.	2	.	1	.	.	.	.	.	.	24	.	.	.	.	**60**	**87**	.	12	.	.
Chlorogalum angustifolium	.	.	.	.	.	.	1	.	.	.	.	.	.	4	.	6	36	**87**	.	2	.	.
Dodecatheon clevelandii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	36	27	.	.	.	.
Association Plagiobothrys austinae-Achyrachaena mollis subass. Brodiaea minor																						
Brodiaea minor	.	.	6	.	.	.	7	15	.	.	6	.	.	.	.	.	**72**	.	.	.	.	.
Association Plagiobothrys austinae-Achyrachaena mollis subass. Linanthus parviflorus																						
Linanthus parviflorus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**67**	.	.	.	.
Navarretia pubescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	12	**60**	.	.	.	.
Micropus californicus	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	**53**	.	.	.	.
Sedella pumila	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	**60**	.	12	.	.
Poa secunda	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	**47**	.	2	.	.
Crassula solierii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	4	**47**	20	7	.	.
Petrorhagia species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**53**	.	.	.	.
Community Hesperevax caulescens-Trifolium gracilentum (Southern Sierra Foothills – Icord Ranch)																						
Hesperevax caulescens	11	33	.	.	1	.	.	.	.	.	.	.	.	.	5	25	.	.	**100**	.	.	.
Trifolium gracilentum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	**60**	.	.	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
No. of relevés	9	9	86	100	70	61	108	13	32	25	31	17	13	24	20	36	25	15	5	43	22	13
Hedypnois cretica	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	**100**	.	.	.
Microseris elegans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**60**	.	.	.
Erodium cicutarium	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**40**	.	.	.
Soliva sessilis	.	.	.	.	.	.	.	.	.	.	6	.	.	12	.	.	.	.	**40**	.	.	.
Sonchus oleraceus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**40**	.	.	.
Association Montia fontana-Sidalcea calycosa (Table Mountains)																						
Montia fontana	.	.	1	2	1	.	2	.	3	.	6	12	8	.	20	17	8	.	.	**58**	23	**77**
Sidalcea calycosa	.	.	.	.	1	.	8	.	3	.	16	18	**62**	.	.	3	.	.	.	35	5	**46**
Variant Montia fontana-Sidalcea calycosa var. Castillea campestris succulenta (South Sierra region - Big Table Mnt. & Kennedy Table Mnt.)																						
Castilleja campestris succulenta	.	.	5	.	.	.	.	.	.	28	.	.	.	.	.	.	.	.	.	12	32	.
Gratiola heterosepala	.	.	.	.	1	3	.	15	.	.	.	.	.	.	.	.	.	.	.	2	9	.
Variant Montia fontana-Sidalcea calycosa var. Mimulus guttatus (Northeast Sacramento Valley - Oroville Table Mountain)																						
Mimulus guttatus	.	.	.	.	1	2	.	.	.	.	.	.	23	.	.	.	.	.	.	.	.	**77**
Plagiobothrys glyptocados	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	**62**
Species with special status																						
Legenere limosa	.	.	.	.	3	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Downingia pusilla	.	.	3	2	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.
Orcuttia inaequalis	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.
Limnanthes floccosa s.californica	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species indicators of shallow pools: order Downingio-Lasthenietalia fremontii																						
Hemizonia fitchii	**78**	**56**	14	24	16	8	19	.	28	8	10	**59**	.	17	**50**	**61**	**76**	20	**60**	2	.	**46**
Hypochaeris glabra	.	11	33	12	7	3	7	8	.	16	**52**	**59**	38	**88**	**75**	19	**84**	**73**	**100**	**40**	.	31
Limnanthes douglasii s. rosea	.	.	3	18	17	2	.	.	.	28	.	.	.	**75**	.	**50**	**40**	13	20	**77**	**64**	**54**
Trifolium variegatum	.	.	3	.	6	3	6	8	6	16	39	24	**54**	**75**	.	39	.	.	**80**	**81**	27	**77**
Trifolium depauperatum	.	22	12	13	4	2	6	.	3	12	**65**	**41**	.	**50**	**90**	**56**	**44**	**87**	**60**	19	.	.
Erodium botrys	.	**44**	26	2	1	2	9	.	.	16	**87**	**82**	**54**	**79**	**75**	6	**40**	**53**	**60**	9	.	15
Vulpia bromoides	.	.	9	3	1	.	1	.	3	.	**61**	**65**	**62**	38	**80**	14	36	13	20	33	.	.
Bromus hordeaceus	22	11	27	9	4	2	6	.	3	12	**58**	**47**	**100**	**92**	**85**	39	**76**	**93**	**100**	**51**	.	8
Aira caryophyllea	.	.	1	6	1	.	1	.	.	.	19	29	**46**	.	**75**	8	**72**	27	.	.	.	.
Cicendia quadrangulari	.	.	19	7	1	.	6	8	19	8	**42**	**76**	15	21	35	3	28	**40**	.	2	.	8
Blennosperma nanum v. nanum	.	.	.	9	1	.	.	.	3	.	.	**41**	.	4	.	36	**52**	**40**	.	**51**	5	23
Briza minor	.	.	1	2	1	.	4	8	3	.	**52**	**53**	**100**	12	**55**	.	16	.	.	.	.	.
Holocarpha virgata	.	11	.	2	.	.	6	8	.	.	**61**	6	**46**	29	.	3	.	.	**100**	9	.	.
Plantago elongata	.	11	1	8	1	.	1	.	.	.	3	6	.	4	**55**	8	16	**60**	.	9	.	.
Poa annua	.	11	8	2	1	.	8	.	9	12	26	**41**	.	**46**	.	17	16	7	20	21	.	38
Triteleia hyacinthina	.	.	.	6	6	.	7	.	19	.	26	**41**	31	.	**45**	25	12	.	**40**	14	5	.
Plagiobothrys greenei	.	.	13	4	1	.	4	.	3	8	26	18	23	33	**60**	3	**44**	.	**100**	.	.	.
Epilobium torreyi	.	.	17	3	4	2	2	.	.	.	10	6	**46**	4	.	39	32	**73**	.	2	.	.
Cerastium glomeratum	11	**67**	.	2	3	.	2	.	.	4	6	.	.	8	20	14	4	.	**60**	5	.	.
Avena barbata	.	.	1	5	.	.	.	.	.	.	.	12	38	4	**60**	8	16	33	.	7	.	.
Lepidium nitidum	11	11	3	7	1	.	2	.	.	.	13	6	.	8	**75**	19	**52**	**73**	**80**	**47**	.	8

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
No. of relevés	9	9	86	100	70	61	108	13	32	25	31	17	13	24	20	36	25	15	5	43	22	13
Diagnostic species of the class Downingio-Lasthenietea																						
Lasthenia fremontii	**44**	**67**	**58**	**99**	**57**	**66**	**92**	31	**78**	**92**	**71**	**82**	23	**75**	**75**	**78**	**48**	**67**	.	**70**	**95**	23
Plagiobothrys stipitatus v. mic	**67**	**67**	**77**	**73**	**86**	**97**	**81**	**85**	**84**	**56**	**65**	**41**	8	**67**	30	**69**	28	**53**	**100**	35	**86**	**46**
Plagiobothrys leptocladus	.	.	12	**47**	19	3	5	8	9	**64**	3	6	.	**58**	**40**	6	.	.	.	.	.	.
Psilocarphus brevissimus brevis	**78**	**89**	**87**	**89**	**56**	**75**	**81**	**92**	**94**	**100**	**52**	**82**	8	**96**	**60**	**47**	12	20	20	**60**	**91**	.
Crassula aquatica	.	**89**	**73**	**72**	37	15	**81**	**69**	**91**	**84**	**68**	**88**	.	**83**	15	25	12	**60**	**40**	**47**	27	15
Deschampsia danthonioi	33	**56**	**43**	**68**	**57**	23	**52**	15	**78**	**52**	**65**	**94**	15	**54**	35	**64**	**84**	**60**	.	**81**	**77**	**54**
Eryngium castrense/vaseyi	.	.	**94**	**89**	**93**	**95**	**100**	**92**	**100**	**96**	**97**	**100**	**69**	**100**	**90**	**58**	20	**40**	**60**	**67**	**95**	**92**
Navarretia leucocephala leuc	**89**	11	29	**75**	**50**	**54**	**69**	31	.	4	**58**	.	**46**	8	**40**	**75**	32	**73**	.	.	.	23
Callitriche marginata	.	22	**43**	**43**	**41**	21	31	8	**56**	**88**	23	**47**	.	**42**	.	36	16	7	.	**47**	**50**	**46**
Alopecurus saccatus	**67**	**67**	24	**45**	**64**	30	13	8	16	**72**	10	18	.	33	.	33	4	7	.	19	**73**	8
Juncus bufonius	.	**78**	**47**	28	4	7	**42**	8	**50**	20	**87**	**100**	**77**	**58**	**60**	39	**56**	27	**60**	23	.	**46**
Pilularia americana	.	11	**52**	**41**	6	26	**50**	23	**78**	**52**	26	**53**	15	12	.	6	.	.	.	16	9	23
Pogogyne ziziphoroides	**89**	**78**	29	**57**	20	2	39	8	31	36	**71**	**82**	.	**46**	**95**	**50**	**92**	**100**	**80**	.	.	.
Isoetes orcuttii	.	.	30	**52**	37	38	**48**	**62**	**66**	**52**	**42**	**47**	**54**	12	15	14	12	.	.	14	36	23
Eleocharis acicularis	.	.	20	9	27	5	39	38	**72**	24	39	**71**	**46**	**42**	5	3	4	.	.	**51**	**55**	8
Veronica peregrina xalapensis	**56**	**89**	22	**52**	17	8	3	.	3	12	3	.	.	29	**45**	39	8	13	**80**	2	.	15
Juncus uncialis	.	.	13	37	3	.	37	.	**53**	32	19	35	.	4	10	36	4	7	.	12	5	23
Eleocharis palustris	**44**	.	5	3	26	8	38	**46**	34	.	16	12	31	4	.	6	.	.	.	5	9	15
Lasthenia glaberrima	11	**67**	1	2	27	11	19	23	.	.	26	6	.	.	.	.	.	7	.	14	**41**	.
Elatine californica	.	.	31	.	4	2	10	15	12	16	.	.	.	4	.	.	.	.	.	2	5	.
Cuscuta howelliana	22	.	2	13	29	25	36	.	6	.	13	.	.	.	.	6	.	.	.	.	.	.
Isoetes howellii	.	.	.	1	39	7	29	15	**44**	.	10	12	38	.	.	.	.	.	.	2	18	8
Lilaea scilloides	.	.	.	.	1	.	7	8	34	16	16	**41**	15	4	.	.	.	.	.	.	.	**62**
Isoetes nuttallii	.	.	.	1	.	3	.	.	9	8	3	6	.	12	.	.	.	.	.	.	.	.
Callitriche heterophyl	.	.	.	.	7	2	8	.	6	.	.	6	.	.	.	.	.	.	.	.	.	8
Plagiobothrys chorisia	.	.	1	.	1	.	7	.	.	16	13	.	.	.	.	.	.	.	.	.	.	.
Other species																						
Hordeum marinum s. gus	33	22	**84**	**66**	36	10	30	.	25	**52**	**74**	**41**	**92**	**92**	**85**	**78**	**64**	**53**	**100**	**81**	5	38
Brodiaea species	.	**67**	29	**82**	39	8	26	.	**69**	24	**61**	**53**	**69**	**46**	**100**	**83**	**52**	**80**	**60**	**67**	.	31
Lolium perenne s. mult	**100**	**100**	37	**42**	20	10	**41**	15	9	36	**94**	**47**	**69**	**88**	5	**97**	20	**67**	**100**	28	5	**100**
Croton setigerus	.	.	36	**53**	23	30	**43**	15	25	.	26	6	15	12	**45**	**50**	**56**	.	**80**	14	.	.
Lythrum hyssopifolia	11	.	**49**	7	21	8	**62**	15	**78**	28	**90**	**94**	**85**	**54**	.	.	.	.	.	.	.	.
Leontodon taraxacoides	.	.	5	37	4	.	**52**	15	**84**	.	**97**	**100**	**100**	.	**95**	3	.	.	.	.	.	8
Epilobium cleistogamum	.	11	21	4	29	**77**	4	38	.	**48**	3	.	.	38	.	14	.	.	**40**	2	5	.
Trichostema lanceolatu	.	.	28	6	9	.	20	.	9	20	13	6	.	33	.	.	8	7	.	.	.	.
Anagallis minima	.	.	8	.	.	.	31	.	9	4	**74**	35	31	4	10	.	.	.	.	.	.	.
Microseris douglasii	.	.	.	6	3	.	.	.	.	.	.	.	.	.	**45**	14	12	.	.	.	.	.
Mimulus tricolor	.	.	8	12	26	3	5	.	19	4	13	24	.	21	.	31	8	.	**80**	5	.	.
Trifolium depauperatum	.	.	8	1	3	.	3	.	.	8	19	24	.	38	.	6	.	.	**60**	12	.	.
Psilocarphus tenellus	.	.	8	4	1	.	4	.	6	4	10	6	.	21	20	.	8	.	.	7	.	.
Cardamine oligosperma	11	.	.	23	3	2	.	.	.	.	3	.	.	.	20	11	.	.	.	.	.	.
(S) Myosurus minimus s	.	22	6	14	9	3	.	.	.	4	.	.	.	.	.	8	.	7	.	2	.	8
Allium amplectens	.	.	3	5	7	2	1	.	.	.	.	.	.	.	20	8	20	.	.	5	.	.
Vulpia myuros	.	.	12	.	.	2	.	.	.	.	.	.	.	4	35	6	.	7	.	9	5	8
Geranium dissectum	.	.	.	.	4	.	.	.	.	4	16	.	8	12	.	25	.	.	**40**	2	.	.
Trifolium dubium	.	.	.	.	.	.	2	8	.	.	35	6	23	.	.	.	4	.	.	.	.	.
Odontostomum hartwegii	.	.	10	4	.	.	.	.	.	.	.	.	.	.	.	3	4	27	.	.	.	.
Plagiobothrys humistra	.	.	1	8	1	.	.	.	.	8	.	.	.	8	10	.	.	.	.	5	.	.
Trifolium depauperatum	.	.	.	1	1	.	.	.	.	.	3	.	.	12	5	17	.	13	20	.	.	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
No. of relevés	9	9	86	100	70	61	108	13	32	25	31	17	13	24	20	36	25	15	5	43	22	13
Filago gallica	.	.	.	2	.	.	.	.	.	.	.	.	.	.	30	3	20	.	.	.	.	.
Navarretia intertexta	.	.	.	1	.	.	.	.	.	.	10	6	38	.	10	.	.	.	.	.	.	.
Minuartia californica	11	.	.	1	.	.	.	.	.	.	.	.	.	4	.	.	36	27	.	.	.	.
Rumex crispus	22	22	.	.	9	.	2	.	.	.	6	.	.	.	.	.	.	.	.	.	.	23
Downingia species	.	.	10	.	.	.	.	8	.	.	.	.	.	.	.	3	.	.	.	5	5	.
Elatine species	.	.	.	2	.	.	8	.	9	4	3	.	.	4	.	.	.	.	.	.	.	.
Glyceria declinata	.	.	.	.	.	.	9	23	.	.	3	.	.	.	.	.	.	.	.	5	5	.
Convolvulus arvensis	.	.	.	.	.	21	2	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.
Ranunculus muricatus	.	.	1	.	.	.	.	.	.	12	10	.	.	12	.	3	.	.	**40**	.	.	15
Trifolium hirtum	.	.	2	.	.	.	.	.	.	.	13	6	.	.	.	.	.	13	.	.	.	.
Aristida oligantha	.	.	.	2	.	2	.	.	.	.	.	.	.	.	.	.	4	33	.	.	.	.
Trifolium microcephalu	.	.	2	.	.	.	.	.	.	.	3	.	.	.	.	3	.	20	.	.	.	.
Gastridium ventricosum	.	.	1	1	.	2	1	.	.	.	6	.	.	.	.	.	12	.	.	.	.	.
Elatine ambigua	.	.	.	.	1	.	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Epilobium species	.	.	.	4	.	2	1	.	3	.	.	.	.	.	10	3	.	.	.	.	.	.
Elatine rubella	.	.	1	.	9	.	.	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Epilobium pallidum	.	.	.	.	4	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polypogon maritimus	.	.	.	.	.	.	.	**54**	.	.	.	.	.	.	.	.	.	.	**40**	.	.	.
Avena fatua	.	11	.	.	.	.	1	.	.	.	.	.	8	.	.	6	.	.	.	2	.	.
Elatine brachysperma	.	.	.	.	.	.	.	.	25	.	.	.	.	.	.	.	.	.	.	.	.	.
Plagiobothrys stipitat	.	33	.	.	.	2	.	.	.	.	.	.	.	.	.	8	.	.	.	.	.	.
Sidalcea hirsuta	.	.	1	.	.	7	.	.	.	.	.	.	.	8	.	.	.	.	.	.	.	.
Xanthium strumarium	.	.	5	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brodiaea californica	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crypsis schoenoides	.	.	.	.	.	8	1	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.
Lythrum portula	.	.	.	.	.	.	.	8	12	.	.	6	.	.	.	.	.	.	.	.	.	.
Trifolium bifidum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20	3	.	.	.	.	.	.
Navarretia heterandra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	20	.	.	.	.	.
Spergularia rubra	.	22	1	.	.	.	.	.	.	.	10	.	.	.	.	.	.	.	.	.	.	.
Sagina decumbens s. oc	.	11	2	1	.	2	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.
Ranunculus aquatilis	.	.	3	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crassula tillaea	.	.	1	1	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	5	.	8
Epilobium pygmaeum	.	.	.	3	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anagallis arvensis	.	.	.	.	1	.	.	.	.	.	3	.	15	.	.	.	.	.	.	.	.	.
Cynodon dactylon	11	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brodiaea purdyi	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crypsis vaginiflora	.	.	.	.	.	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Agrostis avenacea	.	.	.	.	.	.	.	31	.	.	.	.	.	.	.	.	4	.	.	.	.	.
Bromus diandrus	.	.	.	.	.	.	.	.	.	.	.	.	15	4	10	.	.	.	.	.	.	.
Plagiobothrys species	33	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Microseris campestris	.	.	1	1	.	.	.	.	.	.	.	.	.	4	.	3	.	.	.	.	.	.
Cotula coronopifolia	.	.	1	.	.	.	.	.	.	.	.	.	.	12	.	.	.	.	.	.	.	.
Polypogon species	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Epilobium densiflorum	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.
Silene gallica	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.
Anthemis cotula	22	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.
Frankenia salina	.	33	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crassula connata	.	11	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chamaesyce species	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lotus denticulatus	.	.	.	.	.	.	.	.	.	.	.	.	23	.	.	.	.	.	.	.	.	.
Scribneria bolanderi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12	.	.	.	.	.
Trifolium depauperatum	.	11	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium barbigerum	.	11	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
No. of relevés	9	9	86	100	70	61	108	13	32	25	31	17	13	24	20	36	25	15	5	43	22	13
Centaurium muehlenberg	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Epilobium brachycarpum	.	.	.	1	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.
Rumex pulcher	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Glyceria occidentalis	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Juncus xiphioides	.	.	.	.	.	.	1	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.
Spergularia bocconii	.	.	.	.	.	.	.	.	.	4	.	.	.	4	.	.	.	.	.	.	.	.
Phalaris paradoxa	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.
Eleocharis species	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.
Rumex dentatus	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Myosurus minimus s. ap	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex species	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygonum arenastrum	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Typha species	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.
Juncus tenuis	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.
Poa bulbosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.
Juncus balticus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.
Lomatium caruifolium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	.	.	.	.	.
Astragalus tener v. te	.	22	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chamaesyce ocellata	.	.	.	4	.	.	.	.	3	.	.	.	.	.	.	.	.	7	.	.	.	.
Brodiaea coronaria	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Centaurium venustum	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.
Plagiobothrys acanthoc	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.
Lotus unifoliolatus v.	.	.	.	.	.	.	.	.	.	.	.	.	8	.	.	.	.	.	.	.	.	.
Mimulus latidens	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Allium hyalinum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	16	5	.
Matricaria discoidea	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.
Agoseris species	11	22	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lepidium latipes v. he	22	22	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Linanthus bicolor	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	4	.	.	.	.	.
Lotus micranthus	.	.	.	.	.	.	1	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.
Lotus wrangelianus	22	33	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Galium parisiense	.	.	.	.	.	.	.	.	.	.	.	.	23	.	.	.	.	.	.	.	.	.
Lepidium latifolium	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Elatine chilensis	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bromus madritensis	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	.	.	.	.
Heterocodon rariflorum	.	.	.	.	.	.	.	.	.	.	.	.	8	.	.	.	.	.	.	.	.	.
Cuscuta species	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sonchus species	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.
Petrorhagia dubia	.	.	.	.	3	.	.	.	.	.	.	.	.	.	5	3	4	.	.	.	.	.
Agrostis microphylla	.	.	.	.	.	.	.	.	.	.	.	12	.	.	.	.	.	.	.	.	.	.
Hypochaeris radicata	.	.	.	.	.	.	.	.	.	4	.	.	.	4	.	.	.	.	.	.	.	.
Plagiobothrys fulvus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	7	.	.	.	.
Dodecatheon clevelandi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12	.	.	.	.	.
Stellaria media	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	6	.	.	.	.	.	.
Sonchus asper	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.
Erodium moschatum	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	20	.	.	.
Perideridia species	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.
Ranunculus californicu	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.
Ranunculus canus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	23
Trifolium microdon	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.
Centaurea solstitialis	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.
Proboscidea species	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Capsella bursa-pastori	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
No. of relevés	9	9	86	100	70	61	108	13	32	25	31	17	13	24	20	36	25	15	5	43	22	13
Vicia villosa	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	3	.	.	.	.	.	.
Zigadenus fremontii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	7	.	.	.	.
Lessingia nemaclada	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13	.	.	.	.
Hesperevax acaulis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	.	.	.	.	.
Paronychia ahartii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	.	.	.	.	.
Torilis species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.
Thysanocarpus species	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.
Allium campanulatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.
Linanthus species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20	.	.	.
Dichelostemma capitatum	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sidalcea species	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Juncus leiospermus v.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
Brodiaea elegans	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.
Dactylis glomerata	22	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Agrostis species	22	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Calochortus luteus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.
Linanthus androsaceus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.
Collinsia species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	.	.	.	.
Dichelostemma congestu	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	.	.	.	.
Calochortus species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.
Lomatium species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.
Scirpus species	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.
Elatine heterandra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.
Chlorogalum pomeridian	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.
Limnanthes striata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.
Plagiobothrys distanti	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.
Torilis nodosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20	.	.	.
Geranium species	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lagophylla glandulosa	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scirpus tuberosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asclepias fascicularis	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lupinus subvexus	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Parentucellia viscosa	.	.	.	.	.	.	.	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carduus pycnocephalus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.
Sedella congdonii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.

Table 2.3. Order Frankenio-Lasthenietalia (saline/alkaline vernal pools).

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of relevés	10	11	16	80	16	19	44	65	16	13	13	13	15	49	43
Association Lasthenia ferrisia/conjugens															
Lasthenia ferrisiae	**90**	**100**	.	.	.	.	.	.	.	.	.	.	.	.	.
Lasthenia conjugens	**40**	**73**	.	.	.	.	2	2	.	.	.	.	.	.	.
Salicornia subterminalis	**100**	**82**	.	.	.	.	.	.	.	.	.	.	.	.	.
Spergularia platensis	**90**	**55**	.	.	.	.	.	.	.	.	.	.	.	.	.
Lepidium dictyotum v. acutidens	**50**	**45**	.	.	.	.	.	.	.	.	.	.	.	.	.
Parapholis incurva	**70**	36	.	1	.	.	.	.	.	.	.	.	.	.	.
Association Downingia insignis-Psilocarphus brevissimus															
Downingia insignis	.	.	**81**	**48**	**62**	.	18	.	.	.	.	.	.	.	.
Epilobium densiflorum	.	.	**75**	**59**	.	**42**	.	.	.	.	.	.	.	.	.
Association Downingia insignis-Psilocarphus brevissimus, Subassociation Eleocharis acicularis															
Eleocharis acicularis v. acicularis	.	9	**88**	6	.	.	9	3	.	.	.	.	.	8	9
Xanthium strumarium	.	.	**62**	5	.	.	.	.	.	.	.	.	.	.	.
Bolboschoenus maritimus	.	.	**56**	15	.	.	.	.	.	.	.	.	.	.	2
Association Downingia insignis-Psilocarphus brevissimus, Subassociation Grindelia camporum															
Grindelia camporum	.	.	.	**92**	.	.	.	.	.	.	.	.	.	20	.
Navarretia leucocephala s.leucocephala	.	.	19	**84**	.	.	2	.	.	.	.	.	.	.	.
Subassociation Lagophylla species															
Lagophylla species	.	.	.	.	38	.	.	.	.	.	.	.	.	.	.
Association Atriplex persistens-Lasthenia glaberrima															
Atriplex persistens	.	.	.	5	.	**53**	.	.	.	.	.	.	.	27	.
Eremocarpus setigerus	.	.	.	.	.	**42**	5	11	.	.	.	.	.	2	.
Polygonum arenastrum	.	.	6	2	6	**47**	2	.	.	.	.	.	.	.	.
Cynodon dactylon	.	.	.	.	.	**42**	.	.	.	.	.	.	.	.	.
Gnaphalium palustre	.	.	.	.	.	**42**	.	2	.	.	.	.	.	.	.
Navarretia leucocephala s. bakeri	.	.	.	.	.	**42**	25	14	.	.	.	.	.	.	.
Juncus balticus	.	9	.	.	.	26	.	2	.	.	.	.	.	.	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of relevés	10	11	16	80	16	19	44	65	16	13	13	13	15	49	43
Species diagnostic for association Pleuropogon californicus-Lasthenia fremontii and Pleuropogon californicus-Lymnanthes douglasii															
Pleuropogon californicus	.	.	.	.	.	.	**59**	**58**	12	.	.	.	.	.	.
Association Pleuropogon californicus-Lymnanthes douglasii															
Hypochaeris glabra	.	27	.	.	.	.	5	**77**	6	.	.	.	.	2	.
Cicendia quadrangularis	.	.	.	1	.	.	5	**48**	6	.	.	.	.	2	.
Brodiaea species	.	.	.	.	.	.	5	**72**	19	.	.	.	.	.	.
Limnanthes douglasii s. rosea	.	.	.	.	.	.	11	**62**	.	.	.	.	.	12	.
Psilocarphus oregonus	.	.	.	2	.	5	16	**55**	12	.	.	.	.	4	2
Phalaris lemmonii	.	.	.	.	.	.	7	**51**	.	**69**	31	.	.	6	2
Achyrachaena mollis	.	.	.	8	.	.	.	34	.	.	.	.	.	14	.
Downingia concolor	.	.	.	.	.	.	16	32	.	.	.	.	.	.	.
Psilocarphus tenellus v. globiferum	.	.	.	.	.	.	5	32	.	.	.	.	.	.	.
Hemizonia congesta s. luzulifolia	.	.	.	.	.	.	9	29	.	.	.	.	.	2	.
Diagnostic species for Pleuropogon californicus-Lymnanthes douglasii and Lasthenia platycarpha-Lepidium latipes															
Vulpia bromoides	.	36	.	2	12	.	5	**63**	**81**	8	.	.	.	.	9
Trifolium depauperatum v. depauperatum	.	18	.	.	.	.	2	**42**	**88**	.	.	.	27	2	.
Triphysaria eriantha s. eriantha	.	.	.	.	.	.	2	**49**	**56**	.	.	.	.	2	.
Blennosperma nanum v. nanum	.	.	.	.	.	.	9	**49**	**44**	.	.	.	.	16	.
Association Lasthenia platycarpha-Lepidium latipes															
Lasthenia platycarpha	.	.	.	1	.	.	5	5	**100**	.	.	.	.	2	2
Lepidium dictyotum	.	.	.	.	.	.	.	.	**81**	.	.	.	.	4	.
Lepidium latipes v. latipes	.	.	.	.	.	.	9	.	**75**	.	.	.	.	.	.
Crassula connata	.	.	.	.	.	.	.	3	**56**	.	.	.	33	.	.
Brodiaea coronaria	.	.	.	.	.	.	.	2	**50**	.	.	.	.	.	.
Plantago coronopus	.	.	.	5	25	21	5	3	**44**	.	.	.	.	.	5
Lepidium oxycarpum	.	.	.	.	6	.	.	.	38	.	.	.	.	.	.
Poa secunda	.	.	.	.	.	.	.	.	25	.	.	.	.	.	.
Association Downingia bella-Hemizonia pungens															
Hemizonia pungens	.	.	.	6	.	5	.	.	.	**85**	15	.	.	18	.
Trifolium variegatum	.	.	.	.	.	.	7	12	.	**85**	23	.	.	.	.
Trifolium depauperatum v. amplectens	.	36	.	.	.	.	.	3	.	**69**	.	.	7	8	2
Medicago polymorpha	.	27	.	1	19	.	2	5	.	**54**	8	.	.	2	.
Lactuca serriola	.	.	.	4	.	16	.	11	.	**54**	.	.	.	.	2

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of relevés	10	11	16	80	16	19	44	65	16	13	13	13	15	49	43
Senecio vulgaris	.	.	.	1	.	.	2	8	.	**46**	.	.	.	.	.
Species diagnostic for both associations Downingia bella-Hemizonia pungens and Downingia bella-Lilaea scilloides															
Downingia bella	.	.	.	12	.	.	.	.	.	**69**	**100**	.	.	.	.
Association Downingia bella-Lilaea scilloides															
Epilobium brachycarpum	.	.	.	.	.	.	2	.	.	15	**54**	.	.	.	.
Marsilea vestita	.	.	.	.	.	.	.	.	.	8	**46**	.	.	.	.
Lilaea scilloides	.	9	.	.	.	.	27	6	.	15	**92**	**46**	.	4	.
Association Downingia cuspidata-Myosurus minimus															
Downingia cuspidata	.	.	.	.	.	.	11	2	6	.	.	**92**	.	22	7
Community Hordeum depressum/murinum s. leporinum															
Hordeum murinum s. leporinum	.	.	.	.	.	.	.	.	.	23	.	.	**80**	.	2
Association Downingia pulchella-Distichlis spicata and Downingia pulchella-Cressa truxillensis															
Downingia pulchella	10	**64**	.	.	.	.	.	.	.	.	.	.	.	**47**	**72**
Navarretia prostrata	.	.	.	.	.	.	.	.	.	.	.	.	.	**31**	**28**
Myosurus minimus s. apus	.	.	.	.	.	.	.	.	.	.	.	.	.	14	**56**
Species with special status															
Neostapfia colusana	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.
Orcuttia pilosa	.	.	6	5	.	.	.	.	.	.	.	.	.	.	.
Legenere limosa	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.
Gratiola heterosepala	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.
Astragalus tener v. tener	.	.	.	.	.	.	5	5	6	.	.	.	.	.	5
Downingia pusilla	.	.	.	.	.	.	5	12	.	.	.	.	.	.	.
Diagnostic species of the order Frankenio-Lasthenietalia															
Distichlis spicata	10	36	12	**45**	**50**	**95**	**66**	**85**	**81**	38	**54**	38	.	**76**	7
Myosurus minimus s. minimus	20	**73**	19	**54**	38	.	**45**	14	.	**54**	**46**	**85**	**40**	**53**	5
Eryngium aristulatum	.	**45**	25	**79**	25	**100**	**82**	**80**	6	.	8	15	.	24	5
Cressa truxillensis	20	**45**	**56**	**78**	**56**	**74**	.	3	19	.	.	.	.	8	**98**
Crypsis schoenoides	.	9	**94**	**48**	**100**	**89**	9	.	.	15	23	**62**	.	18	2
Frankenia salina	**60**	**100**	19	**49**	19	**47**	25	9	25	.	.	.	.	18	**74**
Hordeum depressum	.	36	.	5	.	.	25	2	**88**	31	.	.	**80**	8	12

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of relevés	10	11	16	80	16	19	44	65	16	13	13	13	15	49	43
Cotula coronopifolia	20	**64**	6	21	**62**	21	34	22	.	.	.	.	7	4	35
Myosurus sessilis	.	.	.	5	12	.	7	.	.	.	.	.	.	2	33
Diagnostic species of the class Downingio-Lasthenietea															
Psilocarphus brevissimus v. brevissimus	.	**55**	**88**	**85**	**94**	**95**	**93**	**65**	12	**77**	**100**	**92**	**73**	**80**	**70**
Lasthenia fremontii	.	.	6	**88**	**94**	**47**	**82**	**86**	31	**100**	**62**	**62**	**93**	**73**	**60**
Crassula aquatica	.	27	.	**42**	38	11	**93**	**89**	31	38	31	8	**73**	**41**	28
Deschampsia danthonioides	.	.	6	**58**	31	**63**	32	**58**	**88**	**85**	15	.	**100**	**59**	12
Plagiobothrys leptocladus	.	**73**	.	26	**88**	**74**	**52**	31	12	.	.	.	**47**	39	26
Alopecurus saccatus	.	.	.	11	12	**58**	**68**	**46**	25	**92**	**100**	38	**60**	31	12
Plagiobothrys stipitatus v.micranthus	.	.	6	**51**	.	**95**	39	18	.	**100**	**100**	**92**	.	2	.
Callitriche marginata	.	9	6	4	12	.	**68**	**58**	.	38	**100**	**85**	27	14	5
Juncus bufonius	40	**82**	.	16	6	16	30	**62**	**44**	31	31	23	7	18	.
Eleocharis palustris	.	27	**44**	25	31	5	36	20	.	38	38	.	.	18	19
Pilularia americana	.	.	6	5	19	.	**52**	28	.	**54**	**100**	**85**	13	4	.
Lasthenia glaberrima	.	27	.	1	19	**89**	**73**	12	.	.	.	.	.	31	.
Veronica peregrina s. xalapensis	.	.	.	34	38	11	32	26	6	8	.	.	.	12	.
Pogogyne ziziphoroides	.	.	.	1	25	.	14	**78**	6	.	.	.	.	16	.
Elatine californica	.	.	6	4	12	.	30	.	.	8	31	.	.	24	7
Isoetes orcuttii	.	9	.	.	.	.	14	35	6	.	.	.	.	2	.
Cuscuta howelliana	.	.	.	11	.	16	5	.	.	.	.	.	.	4	30
Juncus uncialis	.	.	.	2	.	.	9	20	.	.	.	.	.	.	.
Juncus capitatus	.	.	6	1	.	.	5	18	.	.	.	.	.	.	.
Plagiobothrys stipitatus v. stipitatus	.	.	.	.	.	.	7	2	.	.	.	.	.	.	.
Downingia ornatissima	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.
Other species															
Plantago elongata	**50**	**100**	25	**71**	**100**	37	36	26	**88**	.	.	8	.	6	21
Plagiobothrys humistratus	.	**45**	.	.	.	.	7	28	31	.	.	.	.	37	30
Hemizonia fitchii	.	18	.	.	**50**	**47**	11	11	.	.	.	.	.	10	.
Lasthenia californica	20	**45**	.	.	.	.	2	38	.	.	.	.	.	4	2
Lepidium nitidum	.	9	.	.	.	.	2	14	**81**	15	.	.	**53**	2	.
Plagiobothrys chorisianus v. undulatus	.	.	.	.	.	.	9	2	.	.	.	.	.	31	26
Epilobium cleistogamum	.	.	.	.	**44**	.	27	6	.	.	.	.	.	.	.
Lasthenia glabrata s. glabra	.	.	.	.	.	.	.	.	.	.	.	.	.	33	.
Lasthenia glabrata s. coulteri	.	.	.	.	.	.	.	.	.	.	.	.	.	16	.
Plagiobothrys greenei	.	.	.	.	.	.	.	34	.	.	.	.	.	.	.
Holocarpha virgata	.	.	.	.	.	.	.	18	.	.	.	.	.	.	.
Layia chrysanthemoides	.	.	.	.	.	.	7	28	25	.	.	.	.	.	.
Castilleja attenuata	.	.	.	1	.	.	.	.	25	8	.	.	.	2	.
Minuartia californica	.	.	.	.	.	.	.	5	19	.	.	.	.	.	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of relevés	10	11	16	80	16	19	44	65	16	13	13	13	15	49	43
Castilleja campestris s. campestris	.	.	.	.	.	.	9	14	.	.	.	.	.	.	.
Trifolium barbigerum	.	.	.	.	.	.	2	25	6	.	.	.	.	.	.
Lepidium latipes	.	.	.	1	25	.	.	25	6	.	.	.	.	.	.
Malvella leprosa	.	.	.	.	25	5	.	.	.	.	.	.	.	2	2
Phyla nodiflora	.	.	.	.	19	.	18	.	.	.	.	.	.	10	.
Layia platyglossa	.	.	.	.	.	.	.	.	.	.	.	.	.	18	.
Hemizonia pungens s. maritima	.	.	.	.	.	.	.	.	.	.	.	.	.	16	.
Anthemis cotula	.	.	.	.	.	11	.	.	.	.	.	.	.	24	.
Lupinus bicolor	.	.	.	.	.	.	11	15	.	.	.	.	.	10	2
Lepidium dictyotum v. dictyotum	.	.	.	.	.	.	.	.	.	8	.	.	7	.	.
Lasthenia chrysantha	.	.	.	.	.	.	.	.	.	.	.	.	.	31	.
Atriplex species	.	9	6	8	6	.	.	.	6	.	.	.	33	.	.
Spergularia macrotheca	.	.	.	.	.	.	.	5	31	.	.	.	.	.	.
Suaeda moquinii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Puccinellia simplex	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hordeum marinum s. gussonianum	10	18	6	9	**50**	.	**43**	37	**62**	**100**	**100**	**92**	27	**88**	**79**
Lolium perenne s. multiflorum	10	**55**	.	2	**50**	**89**	**61**	**95**	**62**	.	.	8	.	37	.
Lythrum hyssopifolia	.	**55**	25	**46**	**62**	**53**	**50**	**66**	6	15	15	.	.	12	.
Polypogon monspeliensis	.	18	12	**60**	**100**	**42**	30	2	.	31	23	.	.	8	16
Bromus hordeaceus	.	**45**	.	6	38	.	7	25	**94**	**92**	15	.	**93**	35	**53**
Erodium botrys	.	.	.	.	.	11	5	**75**	19	**54**	8	.	**60**	4	2
Spergularia rubra	.	.	.	8	25	.	5	2	**62**	23	.	8	**73**	.	.
Vulpia myuros	.	.	.	5	.	.	.	2	6	**46**	.	.	**73**	16	9
Rumex dentatus	.	.	12	24	.	.	.	.	.	.	.	.	.	.	.
Poa annua	.	27	.	.	.	.	.	14	31	31	15	8	7	12	.
Rumex crispus	.	.	.	.	12	16	11	2	.	.	.	.	.	12	2
Lythrum tribracteatum	.	.	19	16	.	.	.	.	.	.	.	.	.	.	.
Cerastium glomeratum	.	.	.	.	.	.	.	15	.	31	.	.	.	4	.
Chenopodium species	.	.	12	12	.	.	.	.	.	.	.	.	.	.	.
Crassula tillaea	.	.	.	.	.	.	2	15	12	.	.	.	.	.	5
Bromus diandrus	.	.	.	.	.	.	.	6	12	8	.	.	13	4	2
Sagina decumbens s. occidentalis	.	.	.	4	.	.	.	9	12	.	.	.	.	.	.
Lythrum portula	.	.	6	9	19	.	.	.	.	.	.	.	.	.	.
Aira caryophyllea	.	.	.	.	.	.	2	11	12	.	.	.	.	2	.
Briza minor	.	.	.	.	.	.	.	17	.	.	.	.	.	.	.
Convolvulus arvensis	.	.	.	.	6	32	7	.	.	.	.	.	.	.	.
Centaurium muehlenbergii	.	.	.	12	.	.	.	.	.	.	.	.	.	.	.
Elatine species	.	.	12	.	.	11	9	.	.	.	.	.	.	.	2
Epilobium pygmaeum	.	.	6	2	.	.	.	.	.	.	.	.	.	6	7
Mimulus guttatus	.	.	.	8	.	.	.	.	.	8	.	.	.	.	.
Microseris campestris	.	.	.	.	19	.	.	2	.	.	.	.	.	6	.
Trifolium barbigerum v. barbiger	.	.	.	.	.	.	.	2	38	.	.	.	.	.	.
Montia fontana	.	.	.	.	.	.	.	11	.	.	.	.	.	.	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of relevés	10	11	16	80	16	19	44	65	16	13	13	13	15	49	43
Elatine rubella	.	.	25	.	.	.	5	.	.	.	.	.	.	.	.
Muilla maritima	.	.	.	.	.	.	.	8	6	.	.	.	.	.	.
Microseris douglasii s. douglasi	.	9	.	.	.	.	.	.	25	.	.	.	.	2	.
Hainardia cylindrica	.	.	.	.	.	.	.	2	25	.	.	.	.	.	.
Anagallis minima	.	.	.	.	.	.	.	8	.	.	.	.	.	.	.
Atriplex serenana	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Cuscuta salina	.	.	6	4	.	.	.	.	.	.	.	.	.	.	.
Schismus arabicus	.	.	.	.	.	.	.	.	19	.	.	.	.	.	.
Plantago aristata	.	.	.	.	.	.	5	.	.	.	.	.	.	4	.
Lomatium caruifolium	.	.	.	.	.	.	.	5	6	.	.	.	.	.	.
Atriplex argentea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sidalcea hirsuta	.	.	.	.	.	.	.	.	.	.	.	.	.	8	.
Pogogyne douglasii	.	.	.	.	.	.	5	.	.	.	.	.	.	2	.
Crassula solierii	.	.	.	.	.	.	.	2	12	.	.	.	.	.	.
Atriplex semibaccata	.	.	.	.	.	.	.	.	19	.	.	.	.	.	.
Calandrinia ciliata	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.
Trifolium willdenowii	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.
Lotus micranthus	.	27	.	.	.	.	.	.	.	.	.	.	.	.	.
Triphysaria eriantha	.	.	.	.	.	.	.	.	.	23	.	.	.	.	.
Amsinckia menziesii v. intermedia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Layia fremontii	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.
Allenrolfea occidentalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
Lasthenia species	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.
Heliotropium curassavicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Downingia species	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.
Microseris douglasii s. tenella	.	.	.	.	.	.	.	2	6	.	.	.	.	.	.
Microseris douglasii	.	.	.	.	.	.	.	2	6	.	.	.	.	.	.
Trifolium depauperatum v. divers	.	18	.	.	.	.	.	.	.	.	.	.	.	.	.
Limosella aquatica	.	18	.	.	.	.	.	.	.	.	.	.	.	.	.
Elatine ambigua	.	.	.	.	.	.	.	.	.	.	15	.	.	.	.
Castilleja exserta	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.
Hemizonia parryi s. parryi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Atriplex rosea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chamaesyce species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Epilobium ciliatum	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Lepidium strictum	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Cardamine oligosperma	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.
Epilobium species	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.
Chamaesyce ocellata	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.
Epilobium torreyi	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.
Juncus species	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.
Trifolium wormskioldii	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.
Triteleia hyacinthina	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of relevés	10	11	16	80	16	19	44	65	16	13	13	13	15	49	43
Navarretia species	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Psilocarphus brevissimus v. mult	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Linanthus species	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Trifolium bifidum	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Brodiaea coronaria s. coronaria	.	9	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium depauperatum v. stenop	.	.	.	.	.	.	.	.	.	8	.	.	.	.	.
Amsinckia species	.	.	.	.	.	.	.	.	.	8	.	.	.	.	.
Lepidium latipes v. heckardii	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
Elatine chilensis	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
Mimulus tricolor	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
Epilobium pallidum	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
Microseris acuminata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Crypsis vaginiflora	.	.	12	6	.	.	.	.	.	.	.	.	.	.	.
Erodium cicutarium	.	.	.	.	.	5	.	.	.	8	.	.	.	2	.
Spergularia bocconii	.	.	.	6	.	.	.	.	.	.	.	.	.	.	5
Geranium dissectum	.	.	.	.	.	.	2	5	.	.	.	.	.	6	.
Spergularia atrosperma	.	.	.	.	.	.	.	.	.	8	.	.	.	12	.
Spergularia species	.	.	6	2	.	.	.	.	19	.	.	.	.	.	.
Taeniatherum caput-medusae	.	.	.	.	.	.	.	8	.	.	.	.	.	.	.
Bromus rubens	.	.	.	.	.	.	.	.	.	8	.	.	33	.	.
Typha species	.	.	6	.	25	.	.	.	.	.	.	.	.	.	.
Sonchus oleraceus	.	.	.	.	.	.	2	2	.	.	.	.	7	.	2
Hordeum brachyantherum	.	.	.	.	.	.	.	3	.	8	.	.	.	.	.
Avena fatua	.	.	.	.	.	.	.	8	.	.	.	.	.	.	.
Chenopodium album	.	.	.	.	.	.	.	.	.	.	.	.	.	10	.
Amaranthus albus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lolium perenne	.	.	.	4	.	.	2	.	.	.	.	.	.	.	.
Spergularia villosa	.	.	.	.	.	21	.	.	.	.	.	.	.	.	.
Leontodon taraxacoides	.	.	.	.	.	.	2	5	.	.	.	.	.	.	.
Bromus madritensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Matricaria discoidea	.	.	.	.	.	.	.	.	.	.	.	.	.	4	5
Bassia hyssopifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lotus corniculatus	.	.	.	.	.	11	2	.	.	.	.	.	.	.	.
Vulpia microstachys	.	.	.	.	.	.	2	.	6	.	.	.	.	.	.
Mentha pulegium	.	.	.	.	.	.	7	.	.	.	.	.	.	.	.
Lotus species	.	.	.	.	.	.	7	.	.	.	.	.	.	.	.
Poa bulbosa	.	.	.	.	.	.	.	2	12	.	.	.	.	.	.
Melilotus indica	.	.	.	.	.	.	.	.	.	8	.	.	.	2	.
Lepidium latifolium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Agrostis avenacea	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.
Trifolium dubium	10	.	.	.	.	5	.	.	.	.	.	.	.	.	.
Trifolium repens	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.
Erodium moschatum	.	.	.	.	.	.	.	2	.	.	.	.	.	2	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of relevés	10	11	16	80	16	19	44	65	16	13	13	13	15	49	43
Amaranthus species	.	.	.	1	.	5	.	.	.	.	.	.	.	.	.
Capsella bursa-pastoris	.	.	.	.	.	.	.	.	.	15	.	.	.	.	.
Cyperus species	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.
Lactuca saligna	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Chenopodium species	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.
Aster chilensis	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.
Rumex pulcher	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.
Trifolium species	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.
Ranunculus muricatus	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.
Spergularia salina v. salina	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.
Chorizanthe polygonoides	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.
Hordeum species	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Centaurea calcitrapa	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Gastridium ventricosum	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Trifolium fragiferum	.	9	.	.	.	.	.	.	.	.	.	.	.	.	.
Malva species	.	.	.	.	.	.	.	.	.	8	.	.	.	.	.
Stellaria media	.	.	.	.	.	.	.	.	.	8	.	.	.	.	.
Typha angustifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2

Table 2.4. Playas and ankaly sinks with rare species: Alliance Cressa truxillensis-Distichlis spicata

Group No.	1	2	3	4	5	6	7
No. of relevés	11	8	11	8	3	1	10
Neostapfia colusana	**100**	**100**	.	.	.	.	.
Community Neostapfia colusana-Malvella leprosa							
Malvella leprosa	**91**	.	9	.	.	.	.
Phyla nodiflora	**82**	.	.	.	.	.	.
Community Neostapfia colusana-Polypogon maritimus							
Psilocarphus brevissimus berv	9	**62**	36	.	.	.	.
Polypogon maritimus	.	**50**	36	.	.	.	.
Community Tuctoria mucronata							
Tuctoria mucronata	.	.	**100**	.	.	.	.
Community Chamaesyce hoovery-Scirpus maritimus							
Chamaesyce hooveri	.	.	.	**100**	.	.	40
Scirpus maritimus	.	.	.	**50**	33	.	.
Community Orcuttia pilosa							
Orcuttia pilosa	.	.	.	.	**100**	.	.
Community Atriplex persistens							
Atriplex persistens	.	.	.	.	33	**100**	.
Community Tuctoria greenei-Marsilea vestita							
Tuctoria greenei	.	.	.	.	.	.	**80**
Marsilea vestita	.	.	.	.	.	.	**80**
Eryngium vaseyi/castrense	.	.	.	.	.	.	**90**
Proboscidea species	.	.	.	.	.	.	**50**
Diagnostic species of the order Frankenia-Lasthenia							
Crypsis schoenoides	55	100	100	100	100	100	.
Cressa truxillensis	100	12	9	100	67	.	.
Distichlis spicata	9	.	.	88	67	100	.
Eryngium aristulatum	27	25	9	12	100	.	.
Frankenia salina	27	.	9	25	67	.	.
Downingia insignis	.	25	.	.	33	.	.
Downingia species	.	.	.	.	.	.	30
D.s. of the class Downingia-Lasthenia							
Plagiobothrys stipitatus micra	.	38	36	.	.	.	30
Eleocharis macrostachya	27	.	.	.	.	.	.
Alopecurus saccatus	.	12	.	.	.	.	10
Navarretia leucocephala s.leuco	.	12	.	.	.	.	.

Group No.	1	2	3	4	5	6	7
No. of relevés	11	8	11	8	3	1	10
Other species							
Amaranthus albus	.	12	27	.	.	.	.
Amaranthus species	.	12	45	.	.	.	.
Lepidium latifolium	.	25	.	.	.	.	.
Lasthenia species	.	12	.	.	.	.	.
Polypogon monspeliensis	9	.	.	.	.	.	.
Hemizonia parryi s. parryi	.	.	9	.	.	.	.
Atriplex rosea	.	.	9	.	.	.	.
Chenopodium species	.	.	9	.	.	.	.
Chamaesyce species	.	.	9	.	.	.	.
Heliotropium curassa	.	.	.	25	.	.	.
Grindelia camporum	.	.	.	12	.	.	.
Bassia hyssopifolia	.	.	.	12	.	.	.
Atriplex serenana	.	.	.	12	.	.	.
Epilobium cleistogamum	.	.	.	.	.	.	20
Eremocarpus setigerus	.	.	.	.	.	.	10
Scirpus tuberosus	.	.	.	.	.	.	10

Table 2.5. Synopsis of vernal pool diversity (California, Oregon, Nevada)

Regions: 1-13 - Central Valley, 14–Central Coast, 15 – Livermore, 16-18 – Mendocino and Santa Rosa, 19-20 – Oregon, 21 – Santa Barvara, 22-23 – Western Riverside and San Diedo, 24-25 – Modoc Plateau, 26-29 Nevada

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
No. of relevés	22	20	138	89	279	78	63	65	132	71	108	109	9	24	19	29	45	18	18	30	21	41	54	22	20	24	26	24	18
Diagnostic species of the class Downingio-Lasthenietea																													
(S) Psilocarphus brevissimus v. br	**100**	**70**	**65**	**51**	**72**	**47**	14	**65**	**94**	**89**	**86**	**65**	**67**	**50**	21	.	.	.	**50**	**57**	33	**78**	**91**	.	**90**	.	.	.	.
(S) Eryngium vaseyi	**50**	**100**	**95**	**96**	**87**	**88**	35	**78**	**94**	**69**	**63**	14	11	.	.	28	.	6	.	.	**100**	.	.	.	10	.	.	.	.
Lasthenia fremontii	**86**	**60**	**53**	39	**81**	**62**	**48**	**86**	**93**	**73**	**73**	**61**	.	.	26	.	.	.	.	.	.	.	.	.	.	.	.	.	.
(S) Plagiobothrys stipitatus v. mi	**100**	**90**	**75**	**90**	**63**	38	25	18	**82**	**46**	**41**	1	.	29	.	.	.	.	**61**	**100**	.	.	7	.	**65**	.	.	.	.
Crassula aquatica	**100**	**45**	**57**	22	**53**	**56**	21	**89**	**62**	**61**	37	33	33	21	21	.	38	.	.	.	**43**	37	**67**	.	.	.	.	.	.
Deschampsia danthonioides	**41**	30	31	9	**66**	**65**	**65**	**58**	**66**	**42**	**44**	**43**	.	.	32	7	**44**	.	**94**	**63**	.	29	**81**	36	**75**	.	.	.	.
(S) Navarretia leucocephala s. leu	**64**	.	**50**	36	**42**	36	30	.	**70**	3	**64**	.	.	.	.	.	.	.	33	**90**	.	.	.	.	5	.	.	.	.
Callitriche marginata	**64**	35	36	16	39	29	6	**58**	**48**	**42**	6	8	11	8	5	3	36	.	.	.	.	34	20	.	.	.	.	.	.
Alopecurus saccatus	**55**	**55**	**42**	20	29	5	5	**46**	**73**	**59**	9	21	.	4	5	.	.	.	**56**	**87**	29	**59**	.	.	15	.	.	.	.
Juncus bufonius	**50**	.	15	.	**43**	**94**	**49**	**62**	6	23	13	15	**89**	33	37	.	**64**	6	6	7	24	5	30	.	.	.	.	.	.
Pilularia americana	32	**45**	27	18	25	32	.	28	27	32	7	2	.	8	32	.	33	.	.	.	.	**44**	**57**	.	.	.	.	.	.
Pogogyne ziziphoroides	36	.	13	1	**49**	**71**	**78**	**78**	23	14	1	8	.	.	.	.	7	.	11	.	.	.	.	.	.	.	.	.	.
Isoetes orcuttii	18	**70**	25	38	25	**47**	6	35	**48**	8	.	2	11	.	.	.	7	6	.	.	.	32	13	.	.	.	.	.	.
(S) Eleocharis acicularis v. acicu	9	**55**	32	10	23	**53**	3	3	23	6	18	7	11	.	.	24	27	22	.	.	**86**	**44**	24	.	10	.	4	.	.
(S) Veronica peregrina s. xalapens	**91**	.	4	7	34	.	10	26	17	24	30	6	.	.	.	.	**44**	.	33	37	.	15	2	**55**	30	.	.	17	.
Limnanthes douglasii s. rosea	.	5	1	.	37	1	22	**62**	15	7	.	6	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.
Juncus uncialis	.	.	3	.	19	27	6	20	21	6	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Isoetes howellii	.	10	11	29	3	15	.	.	7	.	.	.	.	.	.	**55**	**67**	11	.	.	.	34	.	.	.	.	.	.	.
Lilaea scilloides	.	.	18	1	4	19	.	6	3	17	.	2	11	.	**42**	.	4	11	.	.	.	20	6	.	.	.	.	.	.
Elatine californica	14	10	9	2	3	1	.	.	5	18	6	14	.	.	32	.	.	.	.	.	.	10	22	.	.	.	.	.	.
Juncus capitatus	.	.	2	.	4	**83**	8	18	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Plagiobothrys stipitatus v. stipit	9	.	.	.	1	.	.	2	1	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diagnostic species of deep pools (order Lasthenietalia glaberrimae																													
Lasthenia glaberrima	**100**	**100**	**85**	17	9	6	2	12	17	**70**	3	14	33	.	32	**69**	24	11	33	**40**	.	5	.	.	.	.	.	.	.
Eleocharis palustris	**77**	15	**83**	13	6	17	2	20	15	27	28	16	33	29	21	**66**	33	39	.	13	**52**	**90**	**56**	**41**	**55**	.	.	.	.
Species that are more common in deep pools																													
(S) Downingia bicornuta	9	**60**	**64**	**82**	5	36	.	.	39	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ranunculus bonariensis v. trisepal	.	5	**52**	2	16	**56**	.	.	11	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.
Gratiola ebracteata	.	.	39	6	9	**45**	2	.	10	.	.	.	.	.	.	17	**53**	.	.	.	.	.	.	.	.	.	.	.	.
Downingia cuspidata	.	**65**	6	**43**	16	8	.	2	23	7	.	13	.	.	.	7	13	.	.	.	.	**54**	**44**	.	.	.	.	.	.
Downingia ornatissima	.	.	8	2	33	15	8	.	32	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
(S) Castilleja campestris s. campe	5	.	12	.	3	31	.	14	2	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cuscuta howelliana	18	.	19	21	4	5	.	.	26	7	8	14	.	.	.	7	.	.	.	.	.	.	2	.	35	.	.	.	.
Species that are more common in shallow pools (order Downingio-Lasthenietalia)																													
Hypochaeris glabra	9	.	4	.	37	**51**	**68**	**77**	5	3	.	2	22	.	.	.	16	.	.	.	.	2	22	.	.	.	.	.	.
Erodium botrys	.	.	7	.	23	**69**	**51**	**75**	5	6	.	7	.	8	.	.	4	.	.	.	.	.	7	.	.	.	.	.	.
Vulpia bromoides	.	.	2	.	16	**56**	**41**	**63**	.	7	1	16	33	29	5	.	11	33	.	.	10	.	6	.	.	.	.	4	.
Bromus hordeaceus	.	.	2	.	37	**63**	**89**	25	4	14	4	**52**	**44**	12	21	.	33	33	**61**	10	.	10	33	.	.	.	.	.	.
Lepidium nitidum	.	.	.	.	16	8	**60**	14	1	1	.	13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Plagiobothrys greenei	.	.	.	.	14	24	29	34	.	.	.	.	.	.	.	.	.	.	6	3	.	.	.	.	.	.	.	.	.
Aira caryophyllea	.	.	.	.	7	31	**52**	11	.	1	.	3	.	.	.	.	27	.	.	.	.	.	.	.	.	.	.	.	.
Cicendia quadrangularis	.	.	3	.	12	**51**	27	**48**	1	3	1	2	.	.	.	.	7	.	.	.	.	.	.	.	.	.	.	.	.
Blennosperma nanum v. nanum	.	.	1	1	14	17	**41**	**49**	2	6	.	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Briza minor	.	.	.	.	4	**67**	19	17	1	.	.	.	.	.	.	.	22	28	.	.	.	.	.	.	.	.	.	.	.
(S) Trifolium depauperatum v. depa	5	.	2	.	28	32	**70**	**42**	2	1	.	14	11	4	.	.	7	.	28	.	.	.	.	.	.	.	.	.	.
Navarretia tagetina	.	.	.	1	4	6	**68**	.	2	.	.	.	.	.	.	.	.	.	11	.	.	.	.	.	.	.	.	.	.
Achyrachaena mollis	.	.	3	.	17	5	**65**	34	3	.	6	6	.	.	.	3	18	.	**78**	7	.	.	.	.	.	.	.	.	.
Triphysaria eriantha s. eriantha	9	.	.	.	5	18	**79**	**49**	.	1	.	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lasthenia californica	.	25	.	.	3	5	**63**	38	2	1	.	3	**44**	.	.	.	16	.	**44**	3	.	.	4	.	.	.	.	.	.
Trifolium variegatum	.	.	8	.	34	28	5	12	7	4	.	.	.	.	.	.	**51**	11	.	.	.	.	.	.	.	.	.	.	.
Layia fremontii	.	.	.	1	6	22	**68**	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Microseris acuminata	.	.	.	.	4	.	**56**	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diagnostic species of saline/alkaline pools (order Myosuro-Lasthenietalia)																													
Plagiobothrys leptocladus	.	.	14	6	24	3	6	31	29	**61**	27	28	**89**	.	32	.	.	.	.	.	.	.	.	.	5	.	.	.	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
No. of relevés	22	20	138	89	279	78	63	65	132	71	108	109	9	24	19	29	45	18	18	30	21	41	54	22	20	24	26	24	18
Distichlis spicata	9	.	.	.	.	.	.	**85**	.	**77**	38	**48**	**44**	21	32	.	.	.	.	.	24	.	.	.	.	.	.	.	.
Frankenia salina	27	.	.	.	.	.	.	9	.	27	**44**	**41**	**100**	**100**	**58**	.	.	.	.	.	.	.	.	.	.	.	.	.	.
(S) Myosurus minimus s. minimus	**82**	.	1	2	5	.	.	14	11	28	**49**	26	**67**	21	11	.	.	.	39	**60**	.	7	.	.	15	.	.	29	.
Cressa truxillensis	.	.	.	.	.	.	.	3	.	24	**73**	**45**	**44**	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.
(S) Eryngium aristulatum	**45**	.	1	.	.	.	.	2	.	11	1	.	**44**	**62**	**100**	7	**44**	.	.	.	.	.	.	.	.	.	.	.	.
Cotula coronopifolia	.	.	1	.	1	1	.	22	1	31	23	16	**78**	**58**	.	.	.	.	.	.	33	5	2	.	.	.	.	.	.
Pleuropogon californicus	.	.	.	.	.	.	.	**58**	.	37	.	2	.	12	21	3	.	**67**	.	.	.	.	.	.	.	.	.	.	.
Crypsis schoenoides	.	.	.	4	.	.	.	.	2	37	**60**	9	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species affiliated to one or several vernal pool types																													
Pogogyne douglasii	**64**	25	.	.	8	.	.	.	2	3	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Castilleja campestris s. succulent	.	**60**	.	.	5	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gratiola heterosepala	.	**55**	1	4	1	.	.	.	1	1	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.
(S) Marsilea vestita	.	.	4	**42**	1	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	2	2	**41**	.	.	.	.	.
Vulpia microstachys	.	.	.	.	4	13	**59**	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	10	.	.	4	.
Plagiobothrys austiniae	.	.	1	.	2	5	**52**	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.
Plantago erecta	.	.	.	.	1	3	**57**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.
Epilobium torreyi	.	.	2	.	9	13	**41**	.	2	1	.	.	.	.	.	3	31	6	6	.	.	.	.	.	.	.	.	.	.
Psilocarphus oregonus	18	.	.	.	8	3	6	**55**	.	11	2	5	.	.	.	.	4	.	.	.	.	.	2	.	.	.	.	.	.
Phalaris lemmonii	23	.	2	.	1	.	2	**51**	2	4	.	4	.	.	.	.	.	39	.	.	.	.	9	.	.	.	.	.	.
Grindelia camporum	18	.	2	.	.	.	.	.	.	1	**68**	9	.	.	.	.	.	.	.	.	.	.	.	.	**80**	.	.	.	.
Epilobium densiflorum	.	.	.	3	.	.	.	.	.	11	**55**	.	.	.	.	.	.	.	17	7	.	.	.	.	.	.	.	.	.
Downingia insignis	.	.	.	.	.	.	.	.	.	17	**53**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Downingia pulchella	.	.	.	.	.	.	.	.	.	.	.	**50**	**78**	25	**100**	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lasthenia ferrisiae	.	.	.	.	.	.	.	.	.	.	1	.	**100**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arthrocnemum subterminale	.	.	.	.	.	.	.	.	.	.	1	.	**78**	8	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lepidium dictyotum v. acutidens	.	.	.	.	.	.	.	.	.	.	.	.	**44**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Spergularia platensis	.	.	.	.	.	.	.	.	.	.	1	.	**44**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Plagiobothrys humistratus	.	.	.	.	5	1	2	28	2	4	.	33	**44**	8	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Lasthenia conjugens	.	.	.	.	.	.	.	2	.	1	.	.	**89**	**83**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Mentha pulegium	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	**76**	**53**	22	.	.	.	.	.	.	.	.	.	.	.
Geranium dissectum	.	.	1	.	6	6	3	5	2	1	.	3	.	.	.	3	33	**72**	6	.	.	.	.	.	.	.	.	.	.
Plagiobothrys bracteatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	**71**	6	.	.	.	.	.	.	.	.	.	.	.
Juncus xiphioides	.	.	1	.	1	.	.	.	1	.	.	.	.	.	.	7	13	**67**	.	.	.	.	.	.	.	.	.	.	.
Pleuropogon californicus v. davyi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	24	2	.	.	.	.	.	.	.	.	.	.	.	.
Downingia yina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**61**	**97**	.	.	.	.	.	.	.	.	.
Triteleia hyacinthina	.	.	2	.	11	29	17	2	3	.	.	.	.	.	.	.	2	.	**83**	**43**	.	.	.	.	10	.	.	.	.
Eryngium petiolatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**50**	**57**	.	.	.	.	.	.	.	.	.
Isoetes nuttallii	.	**65**	1	2	2	3	.	.	1	.	.	.	.	.	.	7	13	.	22	**93**	.	.	.	.	.	.	.	.	.
Trichostema lanceolatum	.	.	9	6	14	9	5	.	11	.	.	.	.	.	.	.	11	.	39	**53**	.	.	.	.	.	.	.	.	.
Plagiobothrys chorisianus v. undul	.	.	22	2	3	3	.	2	3	6	.	24	.	.	.	.	.	.	.	.	**90**	**68**	.	.	.	.	.	.	.
Eryngium aristulatum v. parishii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**76**	**78**	.	.	.	.	.	.
Navarretia prostrata	.	.	1	.	.	.	.	.	.	.	.	25	.	4	.	.	.	.	.	.	.	**46**	.	.	.	.	.	.	.
Orcuttia californica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20	.	.	.	.	.	.	.
Hemizonia fasciculata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	**87**	.	.	.	.	.	.
Pogogyne abramsii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**44**	.	.	.	.	.	.
Brodiaea orcuttii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	37	.	.	.	.	.	.
Epilobium ciliatum	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	**86**	.	.	.	.	.
Eryngium alismifolium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**82**	.	.	.	.	.
Bromus japonicus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	22	3	.	.	.	32	**65**	.	.	.	.
Eryngium mathiasiae	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**85**	.	.	.	.
Epilobium brachycarpum	.	.	.	.	1	.	2	.	.	1	.	.	.	.	.	.	.	.	.	3	.	.	.	.	**85**	.	.	29	.
Polygonum polygaloides s. conferti	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**60**	.	.	.	.
Brodiaea coronaria s. coronaria	.	.	.	.	.	.	.	.	.	.	.	.	11	.	.	.	.	.	.	.	.	.	.	.	**50**	.	.	.	.
Navarretia leucocephala s. minima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**50**	.	.	.	.
Epilobium pallidum	.	.	1	8	1	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	**45**	.	.	.	.
Phlox gracilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	22	3	.	.	.	.	**65**	.	4	**58**	**44**
Muhlenbergia richardsonis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	**50**	**100**	**92**	17
Eleocharis species	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	23	.	**100**	31	38	**67**
Iva species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**46**	**92**	17	.
Artemisia tridentata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	**50**	**46**	.
Camissonia tanacetifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	29	38	**100**	**78**
Bromus tectorum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	36	10	.	12	**100**	**56**
Potentilla newberryi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**62**	**61**

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
No. of relevés	22	20	138	89	279	78	63	65	132	71	108	109	9	24	19	29	45	18	18	30	21	41	54	22	20	24	26	24	18
Rumex salicifolius v. lacustris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**42**	**67**
Gayophytum diffusum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	23	**54**	17
Polyctenium williamsiae	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	23	**67**	17
Erodium cicutarium	.	.	.	.	1	.	.	.	.	1	.	2	.	.	.	.	.	.	11	.	.	.	9	5	.	.	.	**79**	6
Agoseris heterophylla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13	.	6	.	.	.	.	.	35	.	.	**50**	6
Collinsia sparsiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	**75**	11
Polygonum douglasii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	.	.	**42**	17
Descurainia sophia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**42**	28
Hesperevax caulescens	5	.	.	.	3	.	5	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Legenere limosa	.	.	7	1	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Orcuttia viscida	.	.	4	3	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Downingia pusilla	.	.	.	.	1	.	.	12	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Neostapfia colusana	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Orcuttia pilosa	.	.	1	19	.	.	.	.	2	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Atriplex persistens	.	.	.	.	.	.	.	.	.	13	5	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lasthenia glabrata s. coulteri	.	.	.	.	.	.	.	.	.	.	.	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Limnanthes floccosa s. grandiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	22	.	.	.	.	.	.	.	.	.	.
Orcuttia inaequalis	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Limnanthes floccosa s. californica	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Orcuttia tenuis	.	.	1	26	1	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Common native species																													
Brodiaea species	32	.	10	16	**65**	**58**	**76**	**72**	39	3	.	3	.	.	.	.	36	6	11	.	.	2	15	.	.	.	.	.	.
Croton setigerus	.	.	35	24	34	21	33	11	35	14	.	1	.	.	.	14	**51**	6	**61**	**50**	.	15	2	5	30	.	.	.	.
Hemizonia fitchii	**86**	.	8	1	29	22	**52**	11	14	30	3	5	22	.	.	.	.	.	**61**	17	10	.	.	.	.	.	.	.	.
Plantago elongata	.	.	1	.	10	3	27	26	1	**42**	**66**	24	**100**	8	21	.	.	.	.	.	.	.	17	.	.	.	.	.	.
Epilobium cleistogamum	**59**	5	19	**52**	10	3	.	6	27	18	6	.	.	.	5	.	.	.	.	.	.	.	.	.	5	.	.	.	.
Anagallis minima	.	.	5	.	8	**58**	2	8	1	.	.	.	.	.	.	.	27	.	.	.	38	.	**70**	.	.	.	.	.	.
Lupinus bicolor	**73**	.	2	.	5	1	19	15	2	8	.	6	.	.	.	.	7	.	**44**	.	.	12	.	.	20	.	.	.	.
Mimulus tricolor	.	.	5	7	14	14	.	.	13	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	20	.	.	.	.
Holocarpha virgata	.	.	1	.	8	**40**	2	18	1	.	.	.	.	.	.	.	.	.	.	.	.	12	2	.	.	.	.	.	.
Cardamine oligosperma	.	.	1	.	9	1	5	.	4	1	.	.	.	.	.	3	18	11	6	3	.	.	.	.	.	.	.	.	.
Hemizonia pungens s. maritima	.	.	1	.	.	.	.	.	.	.	.	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Common exotic species																													
Hordeum marinum s. gussonianum	**41**	5	28	.	**77**	**63**	**62**	37	**42**	35	9	**81**	22	**79**	37	7	**40**	33	**44**	.	24	20	.	.	.	.	.	.	.
Lolium perenne s. multiflorum	**100**	.	32	2	**58**	**68**	**46**	**95**	31	**70**	5	26	**56**	**92**	16	.	**44**	**72**	11	.	**81**	27	7	.	.	.	.	.	.
Lythrum hyssopifolia	32	.	**42**	8	23	**94**	3	**66**	17	**52**	**43**	6	**67**	17	16	.	**44**	33	.	.	**95**	**63**	35	.	.	.	.	.	.
Leontodon taraxacoides	5	.	25	.	29	**96**	13	5	10	1	.	.	.	.	.	.	2	6	.	.	.	.	.	.	.	.	.	.	.
Polypogon monspeliensis	**50**	.	12	1	2	12	.	2	2	39	**55**	10	22	17	**47**	.	18	.	.	.	**52**	2	17	.	.	.	.	.	.
Rumex crispus	23	.	7	.	3	.	.	2	4	11	2	6	.	**50**	21	7	4	**78**	.	.	14	22	2	9	5	.	.	.	.
Lactuca serriola	18	5	1	.	4	.	11	11	.	4	3	1	.	12	.	.	4	11	28	7	.	.	.	**41**	**65**	.	.	4	.
Vulpia myuros	.	.	.	.	6	.	10	2	.	.	4	13	.	.	5	.	2	6	**50**	3	.	.	2	5	.	.	.	.	.
Trifolium dubium	.	.	.	.	2	19	5	.	.	1	.	.	.	.	.	.	29	.	.	.	.	.	.	.	.	.	.	.	.
Poa annua	9	.	11	.	16	24	13	14	2	.	.	11	33	.	.	.	13	.	.	.	14	.	.	.	.	.	.	.	.
Cerastium glomeratum	.	.	.	.	5	9	11	15	1	.	.	2	.	.	.	.	29	17	6	.	.	.	.	.	.	.	.	.	.
Less common species both natives and exotics																													
Avena barbata	.	.	.	.	5	10	33	.	.	.	.	.	.	.	.	.	11	28	.	.	.	.	2	.	.	.	.	.	.
Allium amplectens	.	.	.	.	4	.	17	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Clarkia purpurea	.	.	1	.	1	.	30	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Filago gallica	.	.	.	.	3	1	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	.	.	.	.	.	.
Navarretia pubescens	.	.	.	.	1	.	22	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium bifidum	5	.	.	.	1	1	5	2	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Microseris douglasii s. platycarph	.	.	.	.	1	.	8	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium depauperatum v. amplecte	9	.	1	.	3	1	10	3	.	.	.	5	33	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium depauperatum v. stenophy	.	.	.	.	1	.	.	.	.	.	.	.	.	17	.	.	.	.	.	.	.	5	2	.	.	.	.	.	.
Trifolium depauperatum v. diversif	.	.	.	.	.	.	.	.	.	.	.	.	22	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Callitriche heterophylla	.	5	7	4	1	.	.	.	2	.	.	.	.	.	.	34	20	.	.	.	.	.	.	.	.	.	.	.	.
(S) Lasthenia glabrata s. glabrata	32	.	1	.	.	.	.	.	.	.	.	15	.	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Navarretia leucocephala s. bakeri	.	.	1	.	.	.	.	14	.	27	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Psilocarphus brevissimus v. multif	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Callitriche longipedunculata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.
Taeniatherum caput-medusae	.	.	.	.	7	10	**49**	8	.	1	.	.	.	.	.	.	.	.	**50**	10	.	.	.	.	.	.	.	.	.
Montia fontana	.	10	1	.	15	6	19	11	1	.	.	.	.	.	.	.	36	11	.	.	.	.	.	.	.	.	.	.	.
Sidalcea calycosa	.	5	1	.	7	23	10	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
No. of relevés	22	20	138	89	279	78	63	65	132	71	108	109	9	24	19	29	45	18	18	30	21	41	54	22	20	24	26	24	18
Lasthenia platycarpha	.	.	.	.	2	1	33	5	.	4	1	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Downingia concolor	.	.	.	.	.	.	.	32	.	10	.	.	.	.	.	7	2	.	.	.	.	.	.	.	.	.	.	.	.
Myosurus minimus s. apus	.	.	.	.	.	.	.	.	.	.	.	28	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.
Myosurus sessilis	.	.	.	.	.	.	.	.	.	4	6	14	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Myosurus species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.
Crypsis vaginiflora	.	.	1	3	.	.	.	.	2	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pogogyne nudiuscula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9	.	.	.	.	.	.
Glyceria declinata	.	.	6	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Glyceria occidentalis	.	.	11	.	.	1	.	.	.	.	.	.	.	.	.	31	13	.	.	.	.	.	.	.	.	.	.	.	.
Lythrum portula	.	.	6	.	.	3	.	.	.	.	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hordeum depressum	.	.	.	.	.	.	.	2	.	18	3	22	33	4	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Malvella leprosa	.	.	2	.	.	.	.	.	.	4	2	2	.	4	.	.	.	.	.	.	.	7	9	.	.	4	.	17	.
Juncus balticus	5	.	.	.	1	.	.	2	.	6	1	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	38	.
Salicornia virginica	.	.	.	.	.	.	.	.	.	.	.	.	.	21	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lepidium oxycarpum	.	.	.	.	.	.	.	.	.	1	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phyla nodiflora	.	.	3	.	.	.	.	.	.	14	1	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex dentatus	.	.	.	.	.	.	.	.	.	1	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bolboschoenus maritimus	.	.	.	.	.	.	.	.	.	.	19	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Convolvulus arvensis	.	.	9	13	.	1	.	.	2	13	1	.	.	.	.	3	.	11	.	.	.	.	.	.	.	.	.	.	.
Trifolium wormskioldii	23	.	.	.	1	1	.	.	.	1	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.
Hemizonia congesta s. luzulifolia	23	.	.	.	.	.	.	29	.	6	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium barbigerum	5	.	.	.	1	.	.	25	.	1	.	1	.	17	5	.	16	.	.	.	.	.	.	.	.	.	.	.	.
Layia chrysanthemoides	.	.	.	.	.	.	.	28	.	4	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Psilocarphus tenellus v. globiferu	.	5	1	.	8	13	6	32	1	3	.	.	.	.	.	.	7	.	.	.	.	.	.	.	.	.	.	.	.
Lepidium latipes	.	.	.	.	.	.	.	25	.	6	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crassula tillaea	.	.	.	.	2	.	2	15	.	1	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
(S) Hemizonia pungens	.	.	.	.	.	.	.	.	.	1	5	8	.	.	21	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio vulgaris	9	.	.	.	1	.	2	8	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Medicago polymorpha	**41**	.	.	.	3	1	6	5	.	6	1	1	22	.	.	.	4	.	.	.	10	.	2	.	.	.	.	.	.
Downingia bella	.	.	.	.	.	.	.	.	.	.	9	.	.	.	.	.	.	.	.	.	.	20	.	.	.	.	.	.	.
Lepidium latipes v. latipes	36	.	1	.	.	.	.	.	.	6	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lepidium dictyotum	.	.	.	.	.	.	.	.	.	.	.	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Plantago coronopus	.	.	.	.	.	.	.	3	.	15	3	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa secunda	.	.	.	.	1	.	13	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	15	.	8	.	.
Minuartia californica	.	.	.	.	1	.	21	5	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Castilleja attenuata	.	.	.	.	1	24	3	.	.	.	1	5	.	.	.	.	11	.	.	.	.	.	.	.	.	.	.	.	.
(S) Crassula connata	.	.	.	.	1	.	.	3	.	.	.	8	.	.	.	.	.	.	.	.	.	.	22	.	.	.	.	.	.
Spergularia rubra	.	.	1	.	.	4	.	2	.	10	6	9	.	.	.	.	2	.	.	.	.	5	.	.	.	.	.	.	.
Hordeum murinum s. leporinum	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	10	10	2	.	.	.	.	.	.
Suaeda moquinii	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Parapholis incurva	.	.	.	.	.	.	.	.	.	.	2	.	22	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Atriplex species	.	.	.	.	.	.	.	.	.	.	8	1	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.
Spergularia macrotheca	.	.	.	.	.	.	.	5	.	1	.	5	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lasthenia chrysantha	.	.	.	.	.	.	.	.	.	1	.	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anthemis cotula	9	.	1	.	.	1	.	.	.	3	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Layia platyglossa	.	.	.	.	.	.	.	.	.	.	.	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Navarretia myersii s. myersii	.	.	1	.	1	27	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Epilobium pygmaeum	.	.	4	1	1	.	.	.	1	.	3	6	.	.	.	.	11	.	.	.	.	24	.	.	.	.	.	.	.
Downingia species	**68**	15	4	.	1	.	.	.	2	3	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygonum arenastrum	.	.	1	.	.	.	.	.	.	13	5	.	.	.	.	3	.	.	.	.	.	.	.	.	.	4	8	29	**50**
Brodiaea minor	.	.	1	.	3	8	32	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Elatine species	.	30	4	.	1	4	.	.	2	8	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chlorogalum angustifolium	.	.	.	3	2	.	38	.	.	.	.	.	.	4	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.
Mimulus guttatus	.	.	.	.	4	4	.	.	2	.	6	.	.	.	.	.	24	.	.	.	.	.	.	5	.	.	.	.	.
Machaerocarpus californicus	.	.	1	20	1	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Epilobium species	.	5	1	1	2	.	2	.	1	1	.	.	.	.	21	.	.	17	17	.	.	.	.	.	.	.	.	4	.
(S) Navarretia intertexta	.	.	.	1	1	12	3	.	.	.	.	.	.	.	.	.	29	.	.	.	.	.	.	9	10	.	.	.	.
Ranunculus aquatilis	.	5	8	2	1	.	.	.	1	.	.	.	.	.	.	28	9	.	.	.	.	.	.	.	.	.	.	.	.
Ranunculus muricatus	.	.	1	.	4	.	.	.	2	1	.	.	.	.	.	.	7	17	.	.	.	.	.	.	.	.	.	.	.
Trifolium willdenowii	.	.	.	.	3	.	19	5	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.
Limnanthes alba	.	.	1	.	1	24	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Elatine brachysperma	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	12	19	.	.	.	.	.	.
Polypogon maritimus	.	.	4	2	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
No. of relevés	22	20	138	89	279	78	63	65	132	71	108	109	9	24	19	29	45	18	18	30	21	41	54	22	20	24	26	24	18
Elatine rubella	.	.	.	9	1	.	.	.	.	3	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lythrum tribracteatum	.	.	.	.	.	.	.	.	.	.	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Xanthium strumarium	.	.	1	.	1	.	.	.	2	.	13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chenopodium species	.	.	.	.	.	.	.	.	.	.	11	.	.	.	.	.	.	.	.	.	.	.	.	9	.	4	.	.	.
Centaurium muehlenbergii	.	.	.	.	1	.	.	.	1	.	9	.	.	.	.	.	.	.	.	.	14	.	.	.	.	.	.	.	.
Spergularia bocconii	.	.	.	.	1	.	.	.	.	.	5	2	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Microseris douglasii	.	.	.	.	4	.	3	2	2	.	.	1	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Rumex species	23	.	1	.	.	.	.	.	1	.	.	.	.	.	.	21	11	.	.	.	.	.	.	.	.	.	.	.	.
Gastridium ventricosum	.	.	.	.	1	5	6	2	.	.	.	.	.	.	.	.	.	.	.	.	.	2	17	.	.	.	.	.	.
Odontostomum hartwegii	.	.	.	3	4	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bromus diandrus	.	5	.	.	1	3	.	6	.	.	.	6	.	4	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.
Calandrinia ciliata	.	.	.	.	1	.	11	5	.	.	.	.	.	.	.	.	2	6	.	.	.	.	.	.	.	.	.	.	.
Sonchus oleraceus	.	.	.	.	1	.	.	2	.	1	.	1	.	.	.	.	4	33	.	.	.	5	4	.	.	.	.	.	.
Sagina decumbens s. occidentalis	.	.	.	.	1	.	2	9	1	.	3	2	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Anagallis arvensis	.	.	.	.	1	5	.	.	.	.	.	.	.	.	.	.	27	6	.	.	.	.	.	.	.	.	.	.	.
Rumex pulcher	5	.	1	.	1	.	.	.	.	1	.	.	.	.	.	7	9	11	.	.	.	2	2	.	.	.	.	.	.
Lotus denticulatus	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**60**	.	.	.	.
Hordeum marinum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**44**	23	.	.	.	.	.	.	.	.	.
Avena fatua	.	.	.	.	1	3	3	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crassula solierii	.	.	.	.	1	.	14	2	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Navarretia hamata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	31	.	.	.	.	.	.
Elatine ambigua	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium hirtum	.	.	1	.	1	8	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Juncus tenuis	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	16	39	.	.	.	.	.	.	.	.	.	.	.
Sedella pumila	.	.	.	.	1	.	21	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Microseris campestris	.	.	.	.	1	1	.	2	.	4	.	3	.	.	11	.	.	.	.	.	.	.	4	.	.	.	.	.	.
Gnaphalium palustre	.	.	.	.	.	.	.	2	.	10	1	.	.	.	.	.	4	.	.	.	5	.	2	.	5	.	.	.	.
Cynodon dactylon	.	.	.	2	1	.	.	.	.	11	.	.	.	.	.	.	2	.	.	.	5	.	.	.	.	.	.	.	.
Sidalcea hirsuta	.	.	1	.	1	.	.	.	2	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hordeum brachyantherum	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	3	.	39	.	.	5	.	.	.	.	.	.	.	.
Draba verna	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	27	.	.	.	33	.
Dodecatheon clevelandii s. patulum	.	.	.	.	.	.	21	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aristida oligantha	.	.	.	4	1	.	10	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Elymus elymoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12	27	8	6
Carex douglasii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	23	29	.
Plagiobothrys glyptocarpus	.	.	.	.	3	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium microcephalum	.	.	.	.	1	5	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Micropus californicus v. californi	.	.	.	.	.	1	13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa bulbosa	.	.	.	.	.	.	2	2	.	.	.	2	.	.	.	.	.	.	6	.	.	.	.	5	.	.	.	.	.
Microseris douglasii s. douglasii	.	.	.	.	1	.	.	.	.	.	.	5	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Amaranthus species	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.
Eriogonum species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	38	8	.
Agrostis avenacea	.	.	2	.	.	.	2	.	2	1	1	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Trifolium fucatum	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Plagiobothrys species	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	28	.	.	.	.	5	5	.	.	.	.
Microseris species	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lomatium caruifolium	.	.	.	.	.	.	3	5	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Microseris douglasii s. tenella	.	.	.	.	1	1	2	2	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Astragalus tener v. tener	.	.	.	.	.	.	.	5	.	3	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Typha species	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	9	.	.	.	.	.
Linanthus parviflorus	.	.	.	.	.	.	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chamaesyce ocellata	.	.	.	3	1	.	2	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Muilla maritima	.	.	.	.	.	.	.	8	.	.	.	1	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Brodiaea coronaria	.	.	.	.	1	.	.	2	.	.	.	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ranunculus pusillus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	18	.	.	.	.	.	.	.	.	.	.	.	.
Lotus species	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	23	.	.	.	.	.
Navarretia heterandra	.	.	.	.	1	.	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Centaurium venustum	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15	.	.	.	.	.	.
Phalaris paradoxa	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	.	.	.	.	.	.	.
Bromus rubens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.
Taraxacum officinale	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	29	.
Ranunculus lobbii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	7	.	.	.	.	.	.	.	.	.	.	.	.
Petrorhagia species	.	.	.	.	.	.	13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
No. of relevés	22	20	138	89	279	78	63	65	132	71	108	109	9	24	19	29	45	18	18	30	21	41	54	22	20	24	26	24	18
Soliva sessilis	.	.	.	.	2	3	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Plagiobothrys acanthocarpus	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	7	.	.	.	.	.	.
Silene gallica	.	.	.	.	.	4	2	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Lotus unifoliolatus v. unifoliolat	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	27	.	.	.	.	.
Lagophylla species	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	6	.	.	.	.	.	5	.	.	.	.	.
Spergularia species	.	.	.	.	.	.	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygonum polygaloides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	17	.	.	.	.	.	.	.	.	.
Mimulus latidens	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Allium hyalinum	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Navarretia fossalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	11	.	.	.	.	.	.
Helianthus annuus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9	30	.	.	.	.
Matricaria discoidea	.	.	1	.	1	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Agoseris species	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	.	.	.	.	.	.	.	.	.	.
Lepidium latipes v. heckardii	9	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chamaesyce species	5	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	5	.	.	.	.	.
Brodiaea californica	.	.	.	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Linanthus bicolor	.	.	.	.	1	.	2	.	.	.	.	.	.	.	.	.	4	.	6	.	.	.	.	.	.	.	.	.	.
Hainardia cylindrica	.	.	.	.	.	.	.	2	.	.	.	4	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.
Trifolium barbigerum v. barbigerum	.	.	.	.	.	.	.	2	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex feta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	11	.	.	.	.	.	.	.	.	.	.	.
Lotus micranthus	.	.	.	.	1	.	.	.	.	.	.	.	33	.	.	.	2	6	.	.	.	.	.	.	.	.	.	.	.
Spergularia atrosperma	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Alopecurus aequalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	32	.	.	.	.	.
Galium parisiense	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	2	6	.	.	.	.	.	.	.	.	.	.	.
Phalaris species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	29	.	.	.	.	.	.	.	.
Polypogon interruptus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	29	.	.	.	.	.	.	.	.
Lepidium latifolium	5	.	1	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Elatine chilensis	.	.	.	4	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Veronica arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	10	.	.	.	.	.	.	.	.	.
Bromus madritensis	.	.	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Heterocodon rariflorum	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	9	6	.	.	.	.	.	.	.	.	.	.	.
Hedypnois cretica	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sisyrinchium bellum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9	.	.	.	.	.	.
Schismus arabicus	.	.	.	.	.	.	.	.	.	1	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Proboscidea species	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brodiaea purdyi	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Briza maxima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	6	.	.	.	.	.	.	.	.	.	.	.
Amaranthus albus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.
Lepidium perfoliatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	11
Osmorhiza occidentalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	25	.	.	.	.
Cuscuta species	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	5	.	.	.	.
Trifolium species	9	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.
Sonchus species	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14	.	.	.	.	.
Plantago aristata	5	.	.	.	.	.	.	.	.	3	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Petrorhagia dubia	.	.	.	.	1	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Agrostis microphylla	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	2	.	.	.	.	.	.
Juncus species	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	6	.	.	.	.	.	9	.	.	.	.	.
Hypochaeris radicata	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	11	.	.	.	.	.	.	.	.	.	.	.
Rumex acetosella	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	28	.	.	.	.	.	.	.	.	.	.	.
Vicia sativa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	28	.	.	.	.	.	.	.	.	.	.	.
Anthoxanthum odoratum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium subterraneum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9	.	.	.	.	.	.	.	.	.	.	.	.
Hordeum species	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Juncus patens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	2	6	.	.	.	.	.	.	.	.	.	.	.
Chenopodium album	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sisymbrium altissimum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	12	6
Sisymbrium irio	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	6
Cryptantha micrantha	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15	4	.
Gymnosteris nudicaulis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	15	.	.
Erigeron species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	23	.	.	.	.	.
Polygonum polygaloides s. kelloggi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	25	.	.	.	.
Pinus ponderosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20	.	.	.	.
Gnaphalium species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9	.	.	.	.	.	.	.	.	.	.	.	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
No. of relevés	22	20	138	89	279	78	63	65	132	71	108	109	9	24	19	29	45	18	18	30	21	41	54	22	20	24	26	24	18
Lolium arundinaceum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14	.	.	.	.	.	.	.	.	.	.	.	.	.
Callitriche species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13	.	.	.	.	.	.	.	.	.
Plagiobothrys fulvus	.	.	.	.	1	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium gracilentum	.	.	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dodecatheon clevelandii	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stellaria media	.	.	.	.	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sonchus asper	.	.	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	2	.	.	.	.	.	.
Scribneria bolanderi	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Erodium moschatum	.	.	.	.	1	1	.	2	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Perideridia species	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.
Danthonia californica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	11	.	.	.	.	.	.	.	.	.	.	.
Carex species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2	.	.	.	.	.	.	5	.	.	.	.	.
Ranunculus californicus	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.
Juncus hemiendytus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9	.	.	.	.	.	.	.	.	.	.	.	.
Ranunculus canus	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polypogon species	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melilotus indica	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Spergularia villosa	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lolium perenne	.	.	.	.	.	.	.	.	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cuscuta salina	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Atriplex serenana	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Montia linearis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	.	.	.	.	.	5	.	.	.	.
Chlorogalum parviflorum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	.	.	.	.	.	.
Conyza species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	18	.	.	.	.	.
Poa species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14	5	.	.	.	.
Downingia bacigalupii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20	.	.	.	.
Lasthenia species	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Orthocarpus bracteosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	.	.	.	.	.	.	.	.	.	.
Madia species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	11	.	.	.	.	.	.	.	.	.	.
Trifolium microdon	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.
Centaurea solstitialis	.	.	.	.	1	.	2	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Capsella bursa-pastoris	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Microseris elegans	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cirsium vulgare	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	6	.	.	.	.	.	5	.	.	.	.	.
Limnanthes douglasii s. nivea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	11	.	.	.	.	.	.	.	.	.	.	.
Wyethia angustifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	.	.	.	.	.	.	.	.	.	.	.
Holcus lanatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	.	.	.	.	.	.	.	.	.	.	.
Linum bienne	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.
Navarretia species	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	2	.	6	.	.	.	.	.	.	.	.	.	.
Atriplex semibaccata	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cynosurus echinatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	.	.	.	.	.	.	.	.	.	.	.	.
Amaranthus blitoides	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Cirsium species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	9	.	.	.	.	.
Spergularia salina v. salina	.	.	.	.	.	.	.	.	.	.	.	1	.	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chorizanthe polygonoides	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.
Lotus corniculatus	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Heliotropium curassavicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Cyperus species	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.
Castilleja exserta	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Allenrolfea occidentalis	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Allium haematochiton	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.
Eleocharis bolanderi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14	.	.	.	.	.
Senecio species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14	.	.	.	.	.
Juncus nevadensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15	.	.	.	.
Calycadenia fremontii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	.	.	.	.
Glyceria species	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hemizonia parryi s. parryi	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Clarkia gracilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	3	.	.	.	.	.	.	.	.	.
Micropus californicus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.
Vicia villosa	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Zigadenus fremontii	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lessingia nemaclada	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hesperevax acaulis	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
No. of relevés	22	20	138	89	279	78	63	65	132	71	108	109	9	24	19	29	45	18	18	30	21	41	54	22	20	24	26	24	18
Paronychia ahartii	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Torilis species	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.
Thysanocarpus species	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Allium campanulatum	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Linanthus species	.	.	.	.	1	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lathyrus hirsutus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Myosotis discolor	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.
Moenchia erecta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	6	.	.	.	.	.	.	.	.	.	.
Centaurea calcitrapa	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Nemophila species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	6	.	.	.	.	.	.	.	.	.	.	.
Baccharis pilularis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	6	.	.	.	.	.	.	.	.	.	.	.
Madia elegans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.
(S) Dichelostemma capitatum	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sidalcea species	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Juncus leiospermus v. leiospermus	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Mollugo verticillata	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bidens frondosa	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brodiaea elegans	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Downingia ornatissima v. eximia	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Geranium molle	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.
Juncus effusus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	2	.	.	.	.	.	.
Rumex conglomeratus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.
Galium species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.
Juncus oxymeris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	6	.	.	.	.	.	.	.	.	.	.	.
Limnanthes vinculans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	6	.	.	.	.	.	.	.	.	.	.	.
Trifolium repens	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lepidium strictum	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Limosella aquatica	.	.	.	.	.	.	.	.	.	.	.	.	22	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Idahoa scapigera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	.	.	.	.	.	.	.	.	.	.
Brodiaea jolonensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.
Chenopodium leptophyllum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	.
Ericameri nauseosa s. nauseosa v.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	.
Festuca rubra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	.	.
Sphaeralcea species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	.	.
Juncus saximontanus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9	.	.	.	.	.
Plagiobothrys scouleri v. hispidul	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.
Tragopogon dubius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	.	.	.	.
Pogogyne floribunda	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	.	.	.	.
Lythrum species	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Typha angustifolia	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia gracilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.
Clarkia purpurea s. quadrivulnera	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Calochortus luteus	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Linanthus androsaceus	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Collinsia species	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dichelostemma congestum	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Calochortus species	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lomatium species	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scirpus species	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Agrostis elliottiana	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thysanocarpus radians	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium ciliolatum	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Elatine heterandra	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chlorogalum pomeridianum	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Limnanthes striata	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Plagiobothrys distantiflorus	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Torilis nodosa	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sagina species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Phalaris aquatica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Galium murale	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Aegilops triuncialis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Triphysaria versicolor	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium arvense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
No. of relevés	22	20	138	89	279	78	63	65	132	71	108	109	9	24	19	29	45	18	18	30	21	41	54	22	20	24	26	24	18
Lomatium utriculatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.
Geranium species	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lagophylla glandulosa	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asclepias fascicularis	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lupinus subvexus	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tripsacum lanceolatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.
Valerianella locusta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.
Parentucellia viscosa	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potamogeton nodosus	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carduus pycnocephalus	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sedella congdonii	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Torilis arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.
Elymus glaucus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.
Galium aparine	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.
Hypericum anagalloides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.
Anthriscus caucalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.
Sherardia arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Lessingia species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Zigadenus species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Camissonia ovata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Vicia hirsuta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.
Triteleia peduncularis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Aster chilensis	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chenopodium species	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lactuca saligna	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium fragiferum	.	.	.	.	.	.	.	.	.	.	.	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gratiola species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.
Brodiaea terrestris s. kernensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Gilia species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Lamarckia aurea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Verbena bracteata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Nama stenocarpum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Ceratocephala testiculata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.
Chrysothamnus viscidiflorus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.
Artemisia arbuscula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.
Astragalus purshii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.
Polypogon viridis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.
Hypericum perforatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.
Trachypogon species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.
Salix species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.
Tragopogon species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.
Rorippa curvipes	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.
Medicago species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.
Typha latifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.
Rhus trilobata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.
Sanguisorba species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.
Rorippa species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.
Eleocharis obtusa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.
Athysanus pusillus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.
Descurainia pinnata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.
Festuca species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.
Senecio eurycephalus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.
Verbascum species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.
Rhus species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.
Eryngium articulatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.
Plagiobothrys scouleri v. cusickii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.