Research Completed in the Vernal Pool Landscape at The Nature Conservancy's Vina Plains Preserve

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ABSTRACT. The Nature Conservancy (TNC) began purchasing property and conservation easements in the Vina area north of Chico in 1982 to safeguard the region's grassland and vernal pool habitats. An impervious hardpan derived from volcanic mudflows underlies the region, but soils have developed, and weathering and wind erosion have scoured out numerous Northern Hardpan Vernal Pools. The original 1547 acres was dedicated as the Vina Plains Preserve (VPP) in 1983 and tours given by Conservancy staff and local docents started in 1984. TNC has maintained ownership of the Preserve and has used both prescribed fire and (after a trial period without grazing) strategic livestock grazing as management tools to control invasive plants. VPP is an active cattle ranch, now open to the public on a reservation basis. Use of this vernal pool landscape has been hosted by TNC for college classes and for research on organisms and habitats. A good deal of peer-reviewed research here has been published by students and scientists, and this information constitutes a major resource. TNC continues to welcome research on the Preserve. Research done at VPP has been conducted on geomorphology, soils, habitats, invertebrates and plants (including endangered species), as well as on vertebrates and micro-organisms. TNC has enlarged the VPP and now owns 4600 acres, and this now constitutes a portion of its larger Lassen Foothills Project. This vernal pool landscape lies within the Northeastern Sacramento Valley Vernal Pool Region of the U.S. Fish and Wildlife Service's Vernal Pool Recovery Plan that was published in 2006. It is thought that 95% of California vernal pools have been lost to agriculture and development, so the importance of this land preserved and managed by The Nature Conservancy cannot be over-emphasized!

CITATION. Schlising, R.A., and B. Castro. 2019. Research completed in the vernal pool landscape at The Nature Conservancy's Vina Plains Preserve. Pages 13-25 in R.A. Schlising, E.E. Gottschalk Fisher, C.M. Guilliams, and B. Castro (Editors), Vernal Pool Landscapes: Past, Present and Future. Studies from the Herbarium Number 20, California State University, Chico, CA.

The purpose of this article is to catalog references of the research accomplished on the Vina Plains Preserve, and to recognize and promote this information as a major resource on vernal pool grasslands in California. Part I is a brief description of the preserve. Part II catalogues the research completed here through 2018 in five tables of references, according to type of organism and habitat.

I. DESCRIPTION OF THE VINA PLAINS PRESERVE

Location and Establishment

The Vina Plains Preserve (VPP), about 19 miles (30.6 km) north of Chico, California lies in the northern part of the Great Valley, on the southern edge of Tehama County. It is a landscape containing numerous vernal pools within

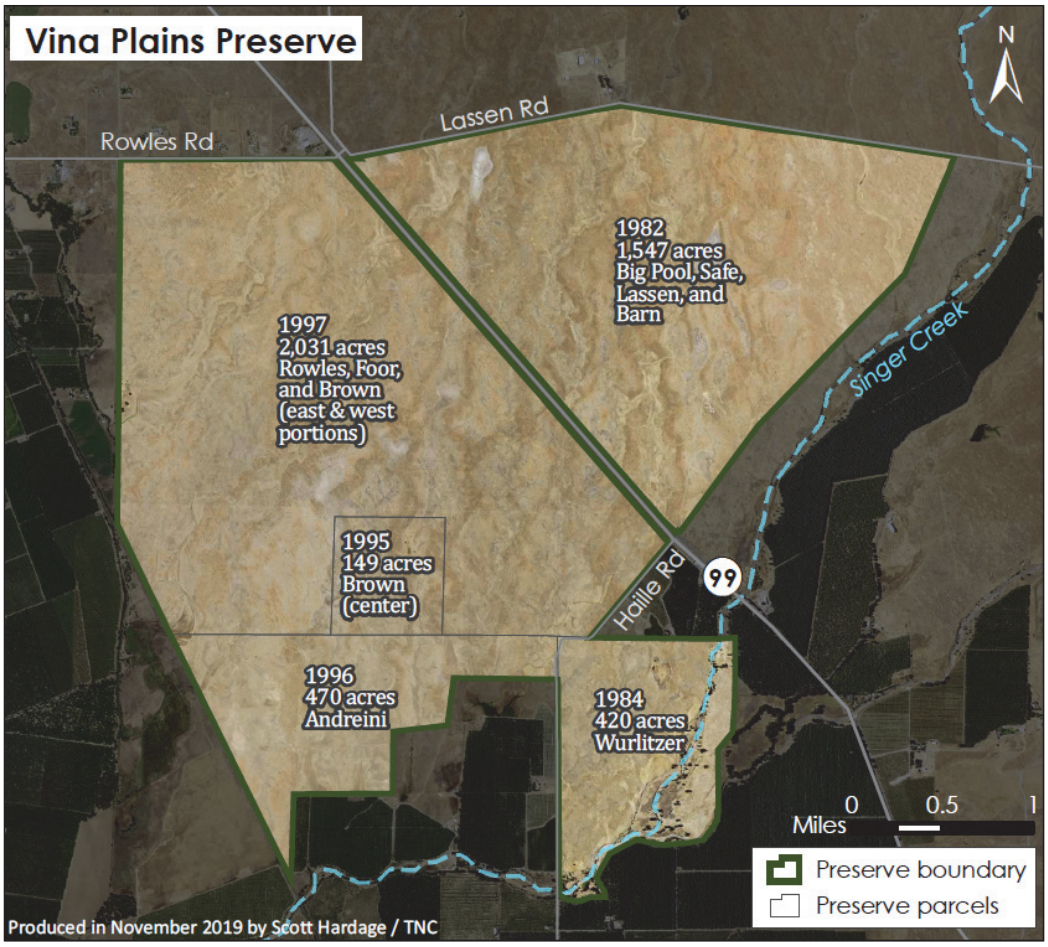

FIGURE 1. Vina Plains Preserve lies in two counties, with the Andreini and Wurlitzer parcels in Butte County and the remaining parcels in Tehama County.

a grassland matrix. The Preserve initially covered just 1547 acres (626 ha) south of Lassen Road and bounded by Singer Creek on the east. It was purchased/established by The Nature Conservancy in the spring of 1982. This initial area of the preserve is mainly covered by the United States Geological Survey topographic Richardson Springs quadrangle, within Township 24N and Range 1W, with an extension into the Vina quadrangle with parts of sections 20 and 29. This initial part of the VPP (including Big Pool, Safe, Lassen, and Barn parcels, as in Figure 1) was dedicated in the spring of 1983.

The Conservancy trained a large group of docents to give public tours of the landscape, starting in 1984. By 1985 a Docent Committee had researched and written a handbook based on the expertise of local biologists, geologists, ranchers and others. That handbook, last updated in 1994, but now out of print (Vina Plains Preserve Docent Committee, 1994) contains a brief history of the land that was then occupied by the Preserve. This handbook has served as a major reference to features of the Preserve for use in public outreach by The Conservancy, and for basic background information used by numerous people doing research on the Preserve. A major contributor to that handbook was Pauleen Broyles, who assembled the first catalog of vascular plants and much other background information (Broyles, 1983, 1987). Holing (1988) described the initial parts of the Vina Plains Preserve in a book enumerating California preserves of The Nature Conservancy.

As is common regionally, the Preserve is rich with historic and prehistoric cultural resources. These are protected and largely managed by the Northeast Information Center (NEIC) at California State University, Chico.

Climate, Topography, Substrates and Biota

Features of the Mediterranean climate, which exists in the region, have been summarized for the Preserve and adjacent areas by Douglas Alexander (Alexander, 2007). Other re-searchers at the Preserve have also provided details on the weather constituting the cool, wet winters and hot, dry summers (e.g., Bogiatto and Karnegis, 2007). Alexander (1976) also provided a classical, detailed phenological description (based especially on pools just north of the present-day Preserve) of how weather influences the annual cycles of growth and dormancy in vernal pool organisms here and in Mediterranean vernal pools elsewhere.

Elevation in the original part of the Preserve averages about 66 meters (217 feet) above sea level, and relief varies by only about 4.5 meters (15 feet) from north to south (Broyles, 1987; Vina Plains Preserve Docent Committee, 1994); USGS Richardson Springs quad). Numerous swales and vernal pools ranging greatly in size occur throughout the region. Syrdahl (1993) recorded maximum depths for many of the larger pools where research has been done. The major pools in this original part of the Preserve were surveyed and given numbers (King, 1992). These pool numbers are shown in Figure 2, taken from the docent handbook (Vina Plains Preserve Docent Committee, 1994), and have been used/cited in numerous research reports since then. Some of these numbered pools are shown in an aerial view of part of the original VPP, on the cover of the book, *Vernal Pool Landscapes* (Schlising and Alexander, 2007).

Geology and soils in the original part of the VPP have been summarized (Vina Plains Preserve Docent Committee, 1994; Broyles, 1983, 1987). Presumed geologic history is described as originating from alluvial deposits that have become cemented into conglomerate rock. Weathering of rock by precipitation and temperatures, and transport of soils by wind have influenced present-day conditions. Features of soils in particular areas (e.g., large pools, shallow pools and swales, gentle hilltops, low-lying non-pool areas) are described in various research reports included in the second part of this article.

Lists of the known vertebrates, invertebrates and vascular plants are included in the Vina Plains Preserve Docent Committee Handbook (1994). Several additional species are recognized in various research reports listed in Part II. A complete list of vascular plants was provided (Oswald, 1989) for the Wurlitzer Parcel, land added to the Vina Plains Preserve in 1984 (southernmost parcel in Figure 1).

Expansion of the Preserve

From 1995 through 1997 substantial acreage was added to the Vina Plains Preserve on the west side of Highway 99. The Preserve now covers 4600 acres (1862 ha, Figure 1). In addition, in about 1997 TNC began acquiring conservation easements in the region to protect vernal pools and other conservation values identified on private rangelands nearby VPP.

Public Outreach

The Vina Plains grasslands have provided perfect field-laboratories for both undergraduate and graduate Plant Ecology class projects, hosted by TNC. For over 30 years, students from Chico State University learned field sampling techniques while conducting many small-scale studies on presence, phenology, reproduction, soil preference, and other aspects of the Preserve's flora and invertebrate fauna. During this period, prior to federal listing of species of vernal pool invertebrates and plants,

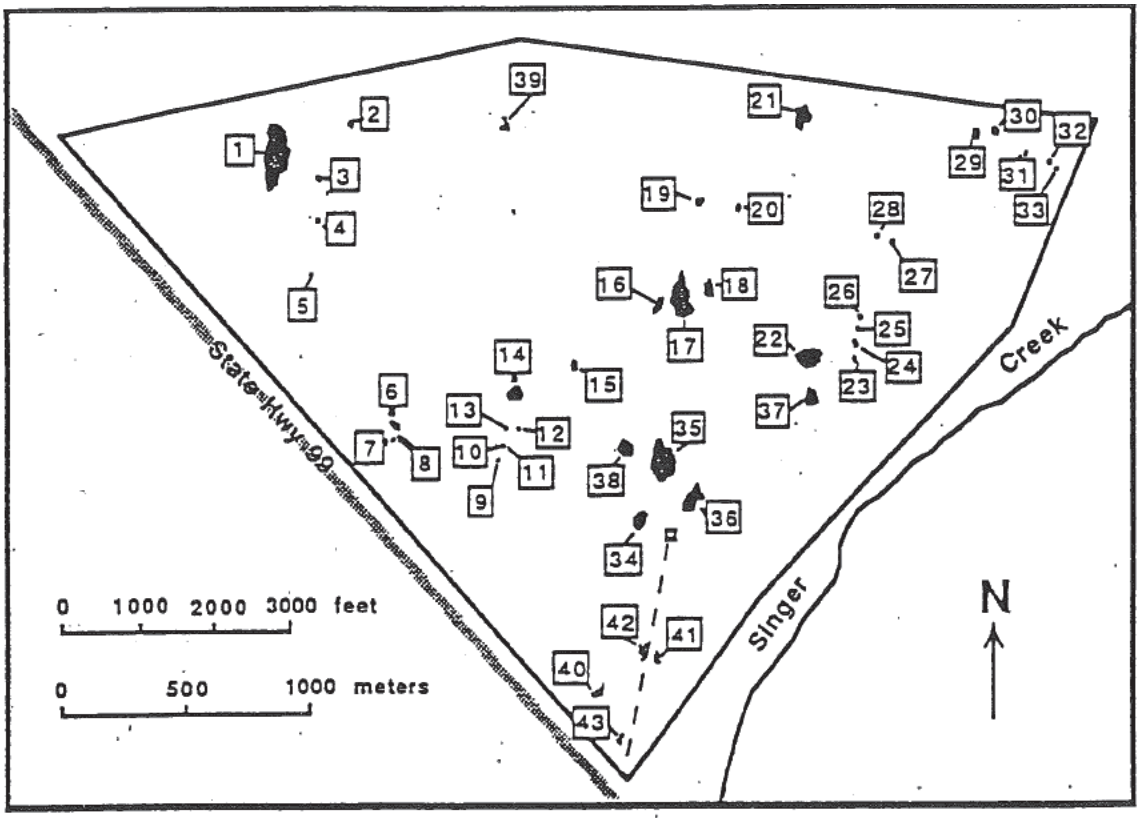

FIGURE 2. Original Vina Plains Preserve (in Tehama County), from the docent handbook, with vernal pool numbers established by King (1992).

college classes could freely net and examine organisms in the Preserve's pools.

Starting in 1983, TNC assembled a team of docents who prepared extensively in the field and then led many public field trips at the Preserve. Some of these field trips were also co-led or hosted by the local Mt. Lassen Chapter of the California Native Plant Society. A TNC docent committee also prepared the Vina Plains Preserve handbook for public use, first in 1984 and revised in 1994.The Preserve has also been used by other groups—such as the Altacal Chapter of the Audubon Society—in observing burrowing owls, raptors and other grassland birds.

Vina Plains Preserve has also served as a dependable reference site for agency biologists and ecologists as they carry out their responsibilities to conserve rare plants and invertebrates in the northern Sacramento Valley region. For example, agency botanists have visited known VPP occurrences of rare plants such as *Orcuttia pilosa*, *Tuctoria greenei*, *Fritillaria pluriflora*, *Paronychia ahartii*, and *Chamaesyce hooveri* to train field botanists and provide direct observation of phenology, morphology and microhabitat for comparison during subsequent project surveys.

Policies and procedures for research and other visitation are regularly updated by TNC.

Management

When the Preserve was acquired in the 1980s, TNC removed cattle grazing for several years, but returned it several years later after results of studies by Jaymee Marty (Marty, 2005, 2007) and others (Darrell Woods, 2007; Sheila Barry, 1998) showed the benefits of grazing. In

more recent years management at VPP has included selective cattle grazing, and rotational prescribed burning led by Cal Fire under a Vegetation Management Plan with TNC. After Tom Griggs served as manager, he summarized the challenges and values of the "adaptive management" that has been carried out since the Preserve was established (Griggs, 1980) and that continues into the present. He emphasized the value of local ranchers' judgement about the intensity and timing of grazing to control invasive plant species.

In 2014 the VPP Preserve Manager, Andrea Craig, conducted a vigorous hand-pulling pilot study pulling invasive cocklebur (*Xanthium strumarium*) in one large pool, using LEAF student volunteers (Leaders in Environmental Action for the Future).

Alexander and Schlising (1997, 1998) discussed the importance of maintaining a vernal pool landscape of a preserve as a whole, rather than merely as a set of individual pools. Management in a vernal pool landscape like that of the Vina Plains Preserve must take into account the different types of vernal pools, and must be based on an understanding of the life cycles of common as well as rare organisms present in pools and adjacent uplands (Alexander and Gallagher, 1995).

Importance for the Vernal Pool Recovery Plan

In 2005, the U.S. Fish and Wildlife Service issued the final Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon, to provide for conservation of the vernal pool species listed several years before. Its intent is to outline actions necessary to "recover" listed vernal pool species so they can be delisted or downlisted. The Vina Plains Preserve occupies a large Priority 1 "Core Area" within the Plan's Northeastern Sacramento Valley Vernal Pool Region (USFWS, 2005a; page III-47, Figure III-9b and page IV-11, Table IV-2). Covered species for Vina Plains include six plants and three crustaceans. Within the Vina Plains Core Area, much smaller areas have been designated as Critical Habitat, Units 6-7 (USFWS, 2005b). However, TNC managers at the Preserve were actively implementing many of the voluntary "government actions" called for in the Recovery Plan's guidance document for many years before the organisms were listed or Recovery Plan existed. Therefore, the VPP is a strong component of the Recovery Plan, as it may be one of the few vernal pool landscapes demonstrating the benefits of long-term conservation management for the listed vernal pool plants and invertebrates.

References Cited in Part I on Description of the Vina Plains Preserve

ALEXANDER, D.G. 1976. Ecological aspects of the temporary annual pool fauna. Pages 32-36 in S. Jain (Editor), Vernal Pools: Their Ecology and Conservation. Institute of Ecology Publication Number 9, University of California, Davis, CA.

ALEXANDER, D.G. 2007. Thirty years research on vernal pool macroinvertebrates from Vina Plains. Pages 89-110 in R.A. Schlising and D.G. Alexander (Editors), Vernal Pool Landscapes. Studies from the Herbarium Number 14, California State University, Chico, CA.

ALEXANDER, D.G., and S.P. GALLAGHER. 1995. A proposal to form a committee to identify & coordinate vernal pool preserves & to oversee vernal pool mitigation in California's Central Valley. Anostracan News 3(1):1-2.

ALEXANDER, D.G., and R.A. SCHLISING. 1997. Vernal pool ecology and vernal pool landscape management as illustrated by rare macroinvertebrates and vascular plants at Vina Plains Preserve, Tehama County, California. Report submitted to the California

Department of Fish and Game, Region 1, Redding, CA.

ALEXANDER, D.G., and R.A. SCHLISING. 1998. Patterns in time and space for rare macroinvertebrates and vascular plants in vernal pool ecosystems at the Vina Plains Preserve, and implications for vernal pool landscape management. Pages 161-168 in C.W. Witham, E.T. Bauder, D. Belk, W.R. Ferren, Jr., and R. Ornduff (Editors), Ecology and Management of Vernal Pool Ecosystems – Proceedings from a 1996 Conference. California Native Plant Society, Sacramento, CA.

BARRY, S. J. 1998. Managing the Sacramento Valley vernal pool landscape to sustain the native flora. Pages 236-240 in C.W. Witham, E.T. Bauder, D. Belk, W. R. Ferren, Jr., and R. Ornduff (Editors), Ecology and Management of Vernal Pool Ecosystems – Proceedings from a 1996 Conference. California Native Plant Society, Sacramento, CA.

BOGIATTO, R.J., and J.D. KARNEGIS. 2007. The use of eastern Sacramento Valley vernal pools by ducks. Pages 111-118 in R.A. Schlising and D.G. Alexander (Editors), Vernal Pool Landscapes. Studies from the Herbarium Number 14, California State University, Chico, CA.

BROYLES, P.F. 1983. A Flora of The Nature Conservancy's Vina Plains Preserve, Tehama County, California. M.S. Thesis in Botany, California State University, Chico, CA.

BROYLES, P.F. 1987. A flora of Vina Plains Preserve, Tehama County, California. Madroño 34:209-227.

GRIGGS, F.T. 1980. Vina Plains Preserve: Eighteen years of adaptive management. Fremontia 27(4):48-51.

HOLING, D. 1988. California Wild Lands: A Guide to the Nature Conservancy's Preserves. Chronicle Books, San Francisco, CA.

KING, G. 1992. Geomorphology of piedmont vernal pool basins, California. The California Geographer 32:19-38.

MARTY, J.T. 2005. Effects of cattle grazing on diversity in ephemeral wetlands. Conservation Biology 19:1626-1632.

MARTY, J.T. 2007. Managing for biodiversity in vernal pool grasslands using fire and grazing. Pages 175-185 in R.A. Schlising and D.G. Alexander (Editors), Vernal Pool Landscapes. Studies from the Herbarium Number 14, California State University, Chico, CA.

OSWALD, V.H. 1989. Survey of the Vascular Plants of Vina Plains Preserve, Wurlitzer Unit. Department of Biological Sciences, California State University, Chico, CA. Unpublished.

SCHLISING, R.A., and D.G. ALEXANDER (Editors), 2007. Vernal Pool Landscapes. Studies from the Herbarium Number 14, California State University, Chico, CA.

SYRDAHL, R.L. 1993. Distribution Patterns of Some Key Macroinvertebrates in a Series of Vernal Pools at Vina Plains Preserve, Tehama County, California. M.S. thesis in Biological Sciences, California State University, Chico, CA.

U.S. FISH AND WILDLIFE SERVICE (USFWS). 2005a. Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon. Portland, OR.

U.S. FISH AND WILDLIFE SERVICE (USFWS). 2005b. CFR Vol. 70, No.154 August 11, 2005 Rules & Regulations, pg. 46962.

VINA PLAINS PRESERVE DOCENT COMMITTEE. 1994. Vina Plains Preserve Handbook. The Nature Conservancy of California. Unpublished.

WOODS, D. 2007. Grazing vernal pools and preserving the land. Pages 163-165 in R. A. Schlising and D.G. Alexander (Editors), Vernal Pool Landscapes. Studies from the Herbarium, Number 14. California State University, Chico, CA.

II. Reports on the Biology of Organisms and Habitats at the Vina Plains Preserve

Criteria for Inclusion of Reports

Reports included cover research that has been completed and written up in formal scientific format. For inclusion, a report must have been peer-reviewed by at least two persons knowledgeable in the subject matter. University theses and dissertations are included, since they are reviewed by a thesis committee. Studies representing surveys of organisms covering a broader area than the Vina Plains Preserve alone are usually not included in this report, unless there are data referring specifically to VPP.

Arrangement of Reports in Tables

Reports are sorted into five numbered tables, each preceded by brief introductory comments, according to type of organisms and habitat:

1. Vertebrates of grasslands and pools,
2. Invertebrates of vernal pools,
3. Microbes of pools,
4. Plants of vernal pools, and
5. Plants of grasslands.

Within each table, reports are listed in chronological order and then alphabetized by author. Each report is listed in one table, with the following information:

- Year,
- Author(s),
- Title, in bold, to indicate nature of the research, and
- Source.

Several reports are included in more than one table when the research is relevant to multiple habitats (e.g., pools and grasslands). The source of a report falls into one of three categories:

- Journal or a book,
- Thesis or dissertation available in (but not necessarily circulating from) a library, or
- Document or report published or printed by an agency or other organization.

Reports on Vertebrates of Grasslands and Vernal Pools at the Vina Plains Preserve

There is a paucity of research on vertebrates at the Vina Plains Preserve (Table 1). The article by Jackson Shedd (Table 1) includes recent discoveries of spadefoots (a toad-like amphibian) both in the Preserve and elsewhere in the Northern Sacramento Valley.

TABLE 1. Reports on vertebrates of grasslands and vernal pools at the Vina Plains Preserve.

1991. Hunter, John E. **Grazing and pocket gopher abundance in a California annual grassland.** Southwestern Naturalist 36:117-118.
2007. Bogiatto, Raymond J. and John D. Karnegis. **The use of eastern Sacramento Valley vernal pools by ducks.** Pages 111-118 in R.A. Schlising and D.G. Alexander (Editors), Vernal Pool Landscapes. Studies from the Herbarium Number 14, California State University, Chico, CA.
2010. Bogiatto, Raymond J., Sabrina M. Wright-Myers, Stacy H. Kraus, Jennifer L. Moore, and John W. Hunt. **The use of eastern Sacramento Valley vernal pool habitats by geese and swans.** California Fish and Game 95:175-187. [same article published in the book listed below]

TABLE 1, continued. Reports on vertebrates of grasslands and vernal pools at the Vina Plains Preserve

2011. Bogiatto, Raymond J., Sabrina M. Wright-Myers, Stacy H. Kraus, Jennifer L. Moore, and John W. Hunt. **The use of eastern Sacramento Valley vernal pool habitats by geese and swans.** Pages 89-100 in D. G. Alexander and R. A. Schlising (Editors), Research and Recovery in Vernal Pool Landscapes. Studies from the Herbarium Number 16, California State University, Chico, CA.
2016. Shedd, Jackson D. **Distribution of the Western Spadefoot (*Spea hammondii*) in the Northern Sacramento Valley of California, with comments on status and survey methodology.** Pages 19-29 in R.A. Schlising, E.E. Gottschalk Fisher, and C.M. Guilliams (Editors), Vernal Pools in Changing Landscapes. Studies from the Herbarium Number 18, California State University, Chico, CA.

Reports on Invertebrates of Vernal Pools at the Vina Plains Preserve

The 1976 article by Doug Alexander is a relatively early, classic description of vernal pool phenology and organism life histories, based on studies on a large pool just north of the Preserve. Many of the reports on invertebrates (Table 2) are unpublished masters' theses found in the Chico State University Library. Surprisingly, little detailed information has been obtained on insects at the Vina Plains Preserve, the sole exception being the master's thesis on predation by Notonectid bugs by Shelly Kirn.

TABLE 2. Reports on invertebrates of vernal pools at the Vina Plains Preserve.

1970. Michener, E. A. **Population Dynamics of Two Species of *Diaptomus* (Copedpoda: Calonoida) in an Ephemeral Pond.** M. A. Thesis in Biology, Chico State College, CA.
1972. Wolt, Terrill B. ***Cyzicus mexicanus* (Crustacea: Conchostraca) Life History and a Comparison of Growth, Maturity and Egg Production in Five Ponds.** M. A. Thesis in Biology, California State University, Chico, CA.
1973. Newman, K. C. **Urea and Uric Acid Levels in Active and Estivating Snails, *Bakerilymnaea cockerelli*.** M. A. Thesis in Biology, Chico State University, CA.
1974. Lanway, Craig. **Environmental Factors Affecting Crustacean Hatching in Five Temporary Ponds.** M. A. Thesis in Biology, California State University, Chico, CA.
1975. Newman, K. C., and Robert E. Thomas. **Ammonia, urea and uric acid levels in active and estivating snails, *Bakerilymnaea cockerelli*.** Comparative Biochemistry and Physiology A. 50(1A):109-112.

TABLE 2, continued. Reports on invertebrates of vernal pools at the Vina Plains Preserve.

1976. Alexander, Douglas G. **Ecological aspects of the temporary annual pool fauna.** Pages 32-36 in Subodh Jain (Editor), Vernal Pools: Their Ecology and Conservation. Institute of Ecology Publication Number 9, University of California, Davis, CA
1983. Ahl, Janna S. **The Reproductive Biology and the Availability of Eggs to Over Summer in the Tadpole Shrimp, *Lepidurus packardi*.** M. A. Thesis in Biology, California State University, Chico, CA.
1984. Patton, Scott. **The Life History Patterns and the Distribution of Two Anostraca, *Linderiella occidentalis* and *Branchinecta* sp. [*Branchinecta conservatio*]** M. S. Thesis in Biology, California State University, Chico, CA
1991. Ahl, Janna S. **Factors affecting contributions of the tadpole shrimp, *Lepidurus packardi*, to its oversummering egg reserves.** Hydrobiologia 212:137-143.
1992. Alexander, Douglas G., and Rickelle L. Syrdahl. **Invertebrate biodiversity in vernal pools.** The Northwest Environmental Journal 8:162-163.
1992. Gallagher, Sean P. **Interpopulation Variation and the Life History of the Vernal Pool Snail *Fossaria* [*Bakerilymnaea*] *sonomensis* in Two Pools in Tehama County, California.** M. S. Thesis in Biology, California State University, Chico, CA.
1993. Syrdahl, Rickelle L. **Distribution Patterns of Some Key Macroinvertebrates in a Series of Vernal Pools at Vina Plains Preserve, Tehama County.** M. S. Thesis in Biology, California State University, Chico, CA.
1993. Gallagher, Sean P. **Life history variation in the temporary pool snail, *Fossaria sonomensis* in the northern Sacramento Valley.** American Midland Naturalist 130:372-385.
1994. Ballantyne, Robert J. **Feeding Dynamics of *Hesperodiaptomus eiseni* from California Vernal Pools.** M. A. Thesis in Biology, California State University, Chico, CA.
1995. Eads, John A. **A Genetic Comparison of Two Populations of the Endangered Fairy Shrimp, *Branchinecta conservatio*, Using RAPD Techniques.** M. S. Thesis in Biology, California State University, Chico, Ca.
1996. Gallagher, Sean P. **Seasonal occurrence of habitat characteristics of some vernal pool Branchiopoda in Northern California.** Journal of Crustacean Biology 16:323-329.

TABLE 2, continued. Reports on invertebrates of vernal pools at the Vina Plains Preserve.

1997. Alexander, Douglas G., and Robert A. Schlising. **Vernal Pool Ecology and Vernal Pool Landscape Management, as Illustrated by Rare Macroinvertebrates and Vascular Plants at Vina Plains Preserve, Tehama County, California.** Report submitted to California Department of Fish and Game, Region 1, Redding, CA.
1997. Kirn, Shelly A. **Environmental Factors Affecting *Notonecta kirbyi* (Hemiptera; Notonectidae) Predation in Vernal Pools at Vina Plains Preserve, Tehama County, California.** M. S. Thesis in Biology, California State University, Chico, CA.
1998. Alexander, Douglas G., and Robert A. Schlising. **Patterns in time and space for rare macroinvertebrates and vascular plants in vernal pool ecosystems at the Vina Plains Preserve, and implications for vernal pool landscape management.** Pages 161-168 in C. W. Witham, E. T. Bauder, D. Belk, W. R. Ferren, Jr., and R. Ornduff (Editors), Ecology and Management of Vernal Pool Ecosystems – Proceedings from a 1996 Conference, California Native Plant Society, Sacramento, CA.
2007. Alexander, Douglas G. **Thirty years research on vernal pool macroinvertebrates from Vina Plains.** Pages 89-110 in R. A. Schlising and D. G. Alexander (Editors), Vernal Pool Landscapes. Studies from the Herbarium Number 14. California State University, Chico, CA.

Reports on Microorganisms of Vernal Pools at the Vina Plains Preserve

The single report in Table 3 is the only known completed research on microorganisms in the vernal pools at VPP.

TABLE 3. Reports on microorganisms of vernal pools at the Vina Plains Preserve.

2004. Blosser, Gavin. **Diversity and Characterization of Arbuscular Mycorrhizal Fungi in the Soils of Vernal Pools in Northern California.** M. S. thesis in Botany, California State University, Chico, CA.

Reports on Plants of Vernal Pools at the Vina Plains Preserve

A number of the reports cited below (Table 4) are masters' theses that are not published but are available in the library at Chico State University. Other reports, such as Stone et al. and Witham, are published, and represent detailed, wide-ranging status surveys of rare organisms that refer specifically to the Vina Plains Preserve (or to the land before the Preserve was established).

The reports by Tom Griggs have some detail relating to VPP. Sarah Gordon et al. cite materials of *Tuctoria greenei* used from Vina Plains Preserve, both east and west of Highway 99.

TABLE 4. Reports on plants of vernal pools at the Vina Plains Preserve.

1974. Griggs, F. Thomas. **Systematics and Ecology of the Genus *Orcuttia* (Gramineae).** M. S. Thesis in Botany, California State University, Chico, CA.
1976. Griggs, F. Thomas. **Life history strategies of the genus *Orcuttia* (Gramineae).** Pages 57-62 in S. K. Jain (Editor), Vernal Pools: Their ecology and evolution. Institute of Ecology Publication Number 9, University of California, Davis, CA
1983. Broyles, Pauleen F. **A Flora of The Nature Conservancy's Vina Plains Preserve, Tehama County, California.** M. S. Thesis in Botany, California State University, Chico, CA
1987. Broyles, Pauleen F. **A flora of Vina Plains Preserve, Tehama County, California.** Madroño 34:209-227. [Plant vouchers are at Chico State University.]
1988. Stone, R. Douglas, W. B. DaVilla, D. W. Taylor, G. L. Clifton, and J. C. Stebbins. **Status Survey of the Grass Tribe Orcuttieae and *Chamaesyce hooveri* (Euphorbiaceae) in the Central Valley of California.** U. S. Fish and Wildlife Service Technical Report.
1991. Reiner, Richard. **Rare Plant Habitat Restoration at Vina Plains Preserve (Tehama County).** Final report submitted to Sandy Morey, Endangered Plant Program, Natural Heritage Division, California Department of Fish and Game.
1989. Schlising, Robert A. **Yearly fluctuations in a vernal pool annual, *Sidalcea hirsuta*.** Pages 285-301 in J. H. Bock and Yan B. Linhart (Editors), The Evolutionary Ecology of Plants. Westview Press, Boulder, CO.
1997. Hale, John S. **The Biogeography of the Unicorn Plant (*Proboscidea louisianica* (Miller) Thellung ssp. *louisianica*) at the Vina Plains Preserve, Tehama County, California.** M. A. Thesis in Geography, California State University, CA.
1998. Alexander, Douglas G. and Robert. A. Schlising. **Patterns in time and space for rare macroinvertebrates and vascular plants in vernal pool ecosystems at the Vina Plains Preserve, and implications for vernal pool landscape management.** Pages 161-168 in C. W. Witham, E. T. Bauder, D. Belk, W. R. Ferren, Jr., and R. Ornduff (Editors), Ecology and Management of Vernal Pool Ecosystems—Proceedings from a 1996 conference, California Native Plant Society, Sacramento, CA.
1998. Warren, Caroline J. **Seed Ecology of *Chamaesyce hooveri* (Euphorbiaceae) at Vina Plains Preserve, Tehama County, California.** M. S. Thesis in Botany, California State University, Chico, CA.
2004. Costella, Guistina C. **Seed Dormancy and Germination in *Sidalcea hirsuta* (Malvaceae): A Species Endemic to Vernal Pools.** M. S. Thesis in Biological Sciences, California State University, Chico, CA.

TABLE 4, continued. Reports on plants of vernal pools at the Vina Plains Preserve.

2007. Schlising, Robert A. **The nature of summer vascular plant life in large vernal pool basins at the Vina Plains Preserve.** Pages 59-88 in R.A. Schlising and D.G. Alexander (Editors). Studies from the Herbarium Number 14, California State University, Chico, CA.
2010. Boykin, Laura M., Laura Salter Kubatko, and Timothy K. Lowrey. **Comparison of methods for rooting phylogenetic trees: A case study using Orcuttieae (Poaceae: Chloridoideae).** Molecular Phylogenetics and Evolution 54:687-700.
2011. Gordon, Sarah P., Christina M. Sloop, Heather G. Davis, and J. Hall Cushman. **Population genetic diversity and structure of two rare vernal pool grasses in central California.** Conservation Genetics. Published online 05 October 2011.
2013. Gottschalk Fisher, Erin. **Road to Recovery: Introduction of Two Rare Vernal Pool Grasses, Greene's Tuctoria (*Tuctoria greenei*) and Colusa Grass (*Neostapfia colusana*).** M. S. Thesis in Botany, California State University, Chico, CA.
2013. Witham, Carol W. **Status Surveys for Seven Federally Listed Vernal Pool Grasses and *Chamaesyce hooveri* (Euphorbiaceae) in the Sacramento and San Joaquin Valleys (Great Valley), California.** U.S.D.A. Report prepared for the U.S. Fish and Wildlife Service's and Bureau of Reclamation's CVPIA Habitat Restoration Program, U.S. Fish and Wildlife Service, Sacramento, CA.
2016. Gottschalk Fisher, Erin E., Joseph G. Silveira, and Colleen Hatfield. **Introduction of two rare vernal pool grasses, Greene's Tuctoria (*Tuctoria greenei*) and Colusa Grass (*Neostapfia colusana*).** Pages 131-166 in R.A. Schlising, E.E. Gottschalk Fisher, and C.M. Guilliams (Editors), Vernal Pools in Changing Landscapes. Studies from the Herbarium Number 18, California State University, Chico, CA.
2016. Schlising, Robert A. **Variation over 21 years in a population of the endangered annual grass, *Orcuttia pilosa*, in a large vernal pool on the Vina Plains Preserve.** Pages 167-194 in R.A. Schlising, E.E. Gottschalk Fisher and C.M. Guilliams (Editors), Vernal Pools in Changing Landscapes. Studies from the Herbarium Number 18, California State University, Chico, CA.

Reports on Grassland Plants in Vina Plains Preserve

Several of the research projects reported in Table 5 were done entirely on the original part of the Vina Plains Preserve acquired in 1982 (Figure 1), except for the work of Leah Mahan, which was completed on the part of the Preserve west of Highway 99 (Figure 1). The report by Marc Doalson (on *Brodiaea*) has information from the Preserve and also from other areas in northern California outside the Preserve. All the reports in Table 5 (except for Broyles, 1987) are masters theses (not published in journals) that are available in the Chico State University Library.

The study by John Hale includes plants of *Proboscidea louisianica* growing in drainage ways and swales in the grassland as well as in vernal pools; thus, his study is also listed in Table 4 on plants of vernal pools. The flora of VPP, written by Pauleen Broyles is listed in this table for grassland plants, in Table 4 for vernal pools, and also in Part I—Description of the Vina Plains Preserve—for its details on the general nature of the Preserve.

TABLE 5. Reports on plants in grasslands at the Vina Plains Preserve.

1983. Broyles, Pauleen F. **A Flora of the Nature Conservancy's Vina Plains Preserve, Tehama County, California.** M. S. Thesis in Botany, California State University, Chico, CA
1987. Broyles, Pauleen F. **A flora of Vina Plains Preserve, Tehama County, California.** Madroño 34:209-227.
1991. Witzman, Jean **The Biology of *Fritillaria pluriflora* (Liliaceae): A Rare Endemic of the California flora.** M. S. Thesis in Botany, California State University, Chico, CA.
1993. Mitchelson, Steven R. **Factors Affecting Fruit Set and Survival of *Zigadenus fremontii* (Liliaceae) Growing in a Northern California Annual Grassland.** M. S. Thesis in Botany, California State University, Chico CA.
1997. Hale, John S. **The Biogeography of the Unicorn Plant (*Proboscidea louisianica* (Miller) Thellung ssp. *louisianica*) at the Vina Plains Preserve, Tehama County, California.** M. A. Thesis in Geography, California State University, CA.
1999. Delmas, Andy **The Effects of Fire on California's Grasslands in the Absence of Grazing, at the Nature Conservancy's Vina Plains Preserve, in Southern Tehama County.** M. S. Thesis in Biological Sciences, California State University, Chico, CA.
1999. Doalson, Marc C. **Morphological Variation and Reproductive Biology of a Native Californian Geophyte, *Brodiaea californica* (Liliaceae).** M. S. Thesis in Botany, California State University, Chico, CA.
2001. Leah Mahan **The Growth and Reproduction of *Centromadia fitchii* (A. Gray) Greene, a Tarweed, in the Northern Sacramento Valley of California.** M. S. Thesis in Botany, California State University, Chico, CA.