Vernal Pool Creation in the Sacramento Valley: A Review of the Issues Surrounding Its Role as a Conservation Tool

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Abstract. Considerable controversy and debate exist regarding the ability to successfully create or restore vernal pool ecosystems and the appropriateness of using habitat creation and restoration for mitigating impacts to vernal pools. The role creation and restoration should play in conservation and management is a basic element of the debate. This paper first presents evidence of human activity that accidentally created vernal pools over the last 20 to 50 years. These artificial pools support diverse floristic and invertebrate populations, thus supporting the argument that functioning pool systems can be created. Purposeful creation has occurred since the mid-1980s when isolated wetlands, including vernal pool systems, became subject to regulation under Section 404 of the Clean Water Act and compensatory mitigation for impacts began. Many creation efforts have proven successful, while others have failed to meet the desired wetland functions and values. Causes of failure include a lack of goal definition leading to varying interpretations of what a "successfully created vernal pool" is or, in some cases, a lack of habitat variability as a goal in design and thus a lack of biodiversity in the created habitat. To meet required performance standards or minimize costs, created pools have often been built based on a single model with less diversity than natural complexes. Other efforts have suffered from insufficient geomorphic and soils analyses, and insufficient buffer areas and management guidelines. Recommendations for successful creation and restoration include clearly defining goals and conducting detailed geomorphic, topographic, and soils analyses as the dominant factors in design. The full range of variability in physical parameters (e.g., depth and size of pools) and ecological diversity in natural pool complexes should be considered as the primary design goal for creation, as an alternative to creating all mitigation pools with performance standards that echo the mean of a set of reference pools. With the historical loss of vernal pool habitat and the present rate of land conversion in the Central Valley, creation and restoration of vernal pool complexes are an appropriate tool in the conservation of vernal pool ecosystems. They should serve as a complement to preservation of natural systems in large conservation areas and as tools that provide educational and interpretive values, as well as stewardship in smaller, more urban settings.

Citation. Pages 190-194 *in:* C.W. Witham, E.T. Bauder, D. Belk, W.R. Ferren Jr., and R. Ornduff (Editors). Ecology, Conservation, and Management of Vernal Pool Ecosystems – Proceedings from a 1996 Conference. California Native Plant Society, Sacramento, CA. 1998.

Introduction

Vernal pools are ephemeral wetlands that form in shallow depressions underlain by a substrate near the surface that restricts the percolation of water (see U.S. Fish and Wildlife Service 1994 for a full definition of vernal pools). As vernal pools continue to be lost due to urban, industrial, and agricultural development and other human activity, considerable controversy surrounds the application of wetland regulations to the protection and mitigation of these seasonal wetlands in California. Part of the controversy is focused on efforts to create vernal pool ecosystems. The debate focuses not only on the ability to create vernal pool systems, but also on the appropriateness of using habitat creation and restoration to mitigate impacts. The role creation and restoration should play in conservation and management is a fundamental element of the debate.

The purpose of this paper is to promote thoughtful discussion of these issues, in light of the most recent evidence of successes and failures of both accidentally created and purposefully created vernal pools. The specific issues this paper will attempt to address are:

a) Why consider creating vernal pools?
b) Has vernal pool creation proven feasible in the Central Valley to date?
c) If it is determined that creating a vernal pool ecosystem is desirable, what is the appropriate planning and design process?
d) What is the appropriate role of creation and restoration in the conservation and management of vernal pool ecosystems in the Central Valley of California?

Why Consider Creating Vernal Pools?

The majority of all vernal pool creation efforts in the Central Valley of California are conducted to comply with federal regulatory requirements under Section 404 of the federal Clean Water

Act and the federal Endangered Species Act. Avoidance of fill of wetland resources is always the option preferred by the regulatory and resource agencies when a public or private land development project, such as a flood control project or housing development, is proposed. However, in practice, some vernal pool impacts do occur and vernal pool creation is often required to comply with the "no net loss" and "in kind" mitigation policies of these agencies.

Formerly, onsite compensatory mitigation was favored. More recently, in some situations, offsite mitigation for vernal pool impacts has been used and formal mitigation banks have developed. These mitigation banks have many advantages, including incorporation of many of the concepts of conservation biology, such as large core areas and reduced edge effects. However, creation or restoration of vernal pools are still required components of banking if no net loss and in kind mitigation policies are to be satisfied.

HAS VERNAL POOL CREATION PROVEN FEASIBLE IN THE CENTRAL VALLEY TO DATE?

Vernal pool creation in the Central Valley occurred first by accident, and only relatively recently (in the mid- to late 1980s) as a requirement of compensatory mitigation to offset development impacts. Analysis of older accidental creation activity provides additional insight into the feasibility of vernal pool creation because of the extended period to test for sustainability.

Creation as Part of Past Land Management Activities

An example of historical accidental creation of a vernal pool complex occurs in borrow pits at the Mormon Island saddle dam in Folsom, California. Aerial photography of the project area from the 1930s and 1940s shows the natural landscape of the project site heavily disturbed by past mining. The U.S. Army Corps of Engineers excavated a large area (approximately 20 acres) to a depth of 10 feet or more in the early 1950s, to supply material to create the Mormon Island saddle dam (S. Sherer, pers. comm.). Today, the bottom of this borrow pit has a vernal pool complex that supports diverse flora and fauna.

Another example is found adjacent to this site where another large, artificially created vernal pool occurs. Aerial photographs from 1937 and 1940 show no pool existing. In the 1940s, miners dredging for gold created a siltation pond at the site. Fifty years later it represents a highly functioning, sustainable, created pool supporting a wide diversity of flora and fauna, including California Linderiella (*Linderiella occidentalis*).

A third example of an accidental vernal pool creation site occurs in a borrow pit, approximately 25 feet deep, located at the southern end of the now-closed Mather Air Force Base. Aerial photographs from 1937 confirm that the pit did not exist historically. Although the date of the pit excavation at this site is not known, it does appear in aerial photographs taken in 1964 that also show a high level of human disturbance in the area. Today, the pit is stable, and several vernal pools exist on the pit bottom. The pools were artificially created, and after more than 30 years they support a diversity of typical vernal pool flora and fauna, including Vernal Pool Fairy Shrimp *(Branchinecta lynchi*), Vernal Pool Tadpole Shrimp (*Lepidurus packardi*) and California Linderiella.

These examples of accidental creation provide convincing evidence that sustainable pool ecosystems with native flora and fauna can be created. Dr. Michael Barbour, keynote speaker at the June 1996 Vernal Pool Conference in Sacramento, California, suggested that creation sites should function for a minimum of 10 years before being deemed sustainable. The vernal pool plants and invertebrates in the above-referenced pools have gone well beyond the 10- year test. These examples of successfully created vernal pools appear to be sustainable in the long term.

Creation as Mitigation

The U.S. Fish and Wildlife Service (USFWS) has conducted an evaluation of constructed vernal pools as part of a monitoring evaluation of mitigation implemented by numerous applicants for wetland fill permits from the U.S. Army Corps of Engineers (De Weese, 1998). The USFWS study provides useful data on this evolving discipline. Although failures have occurred, there are also successes, especially in more recent projects. Overall, 83% of the surveyed projects complied with permit performance standards. Typical problems with mitigation creation are:

a) Lack of goal definition and documentation of goals by mitigation designers and regulatory staff;
b) Creation of pools on inappropriate geomorphic landform and/or soils;
c) Failure to establish appropriate hydrology;
d) Inappropriate pool densities (often due to high land costs and onsite mitigation requirements);
e) Failure to recognize potential effects of land use changes in the area;
f) Negative edge effects of human activity due to inadequate core area size and buffer; and
g) Lack of consideration of grazing and fire management in the long-term stewardship of mitigation sites.

Examples of created vernal pools which appear to demonstrate that creation can be successful include the Highland Reserve mitigation pools in Roseville, California (Sugnet & Associates, 1995) and the Parkway pools in Folsom, California (Jones & Stokes Associates, 1997). These pools are difficult to distinguish from natural pool/ecosystems 8 years and 4 years later, respectively. Monitoring of vegetation and hydrology of pools

created at the Highland Reserve project shows that the created pools are successfully mimicking conditions found in the onsite natural pools. Monitoring at the Parkway site shows that the majority of created pools there also are mimicking the natural pools, not only in vegetative composition but also in invertebrate species composition and diversity.

WHAT IS THE APPROPRIATE PLANNING AND DESIGN PROCESS FOR VERNAL POOL ECOSYSTEM CREATION?

One of the biggest problems in evaluating past wetland creation efforts has been the lack of clear goal definition of the creation effort. Vernal pool creation projects have often been judged by others who had little information on the goals of the project (e.g., was the design objective to create shallow or relatively deep standing water?). In cases where goals are not defined clearly, reviewers appear to rely on their biases as to what the goals should be, and then judge the projects against them. For successful creation of vernal pool ecosystems and evaluation of the creation effort, design goals and objectives must be specific and the individuals and agencies reviewing and evaluating the success of a project must agree on these goals. The goals should be well documented so that as additional reviewers (i.e., new regulatory staff or academic interests) become involved, the goals against which a project is reviewed can remain constant. The following list of guidelines provides a starting point for the development of restoration or creation goals.

Define the target species. "We are the inhabitants of the vernal pool ecosystem and have our own bias as to what is a 'good' vernal pool" (M. Barbour, keynote address). The various "inhabitants" of vernal pools have different preferences. A pool that is "good" for a tiger salamander may not be "good" for vernal pool fairy shrimp. Figures 1 and 2 illustrate the variability in optimum conditions for various species.

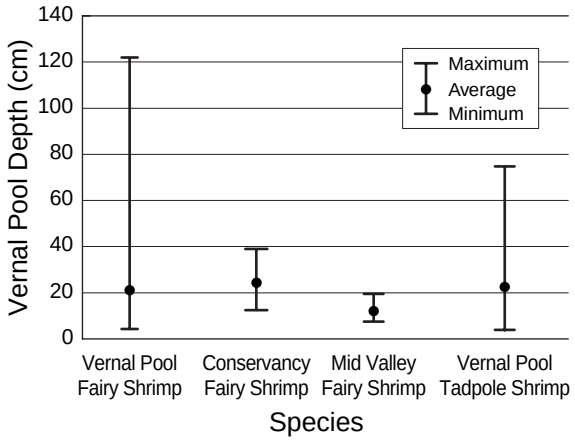

FIGURE 1. Depth of vernal pools with fairy shrimp and tadpole shrimp.

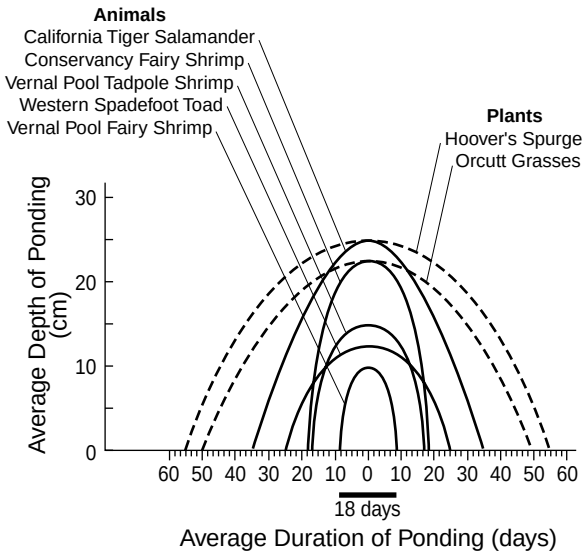

FIGURE 2. Illustration of preferred hydrologic habitat parameters for selected species that occupy seasonal wetlands. Other hydrologic parameters which may be important include surface area, pH, temperature, turbidity, O_2, concentration, alkalinity, total dissolved solids, etc. Source: Jones & Stokes Associates file data on natural pools throughout the Central Valley of California.

Mimic the spectrum of habitat. The continuum is a well-understood ecological concept and is well illustrated in vernal pools by the rings of different annual plant species concentrations found along zones of equivalent depth and duration of inundation. This concept has, however, often been ignored in mitigation efforts. An individual vernal pool along with its associated complex provides a range of overlapping niches. The continuum of niches allows pool complexes to buffer against the seasonal and annual variability in weather, as well as to maximize diversity onsite. In establishing goals for vernal pool creation, the full spectrum of habitat within the vernal pool ecosystems found in nature should be considered. This may appear to be in conflict with the first guideline listed above, but it does not have to be. Many vernal pool complexes have vastly different pool types. A project may not have to reproduce all pool types, and thus not all functions, but the full spectrum should be evaluated. Target species needs must be identified and included in the range of habitat created but it should not be the sole target. A single model approach should not be used.

If a mean value rather than a mean plus variant (e.g., depth of created pools) is used as the standard for pool design, the diversity of habitat and the ability of the pool complexes to be buffered against climate variability is reduced. Figure 3 illustrates the reduction of habitat variability and loss of buffering against long-term weather variability when the mean conditions of an impacted complex of pools is used as a stringent design parameter. Assuming a normal distribution, even targeting a range of

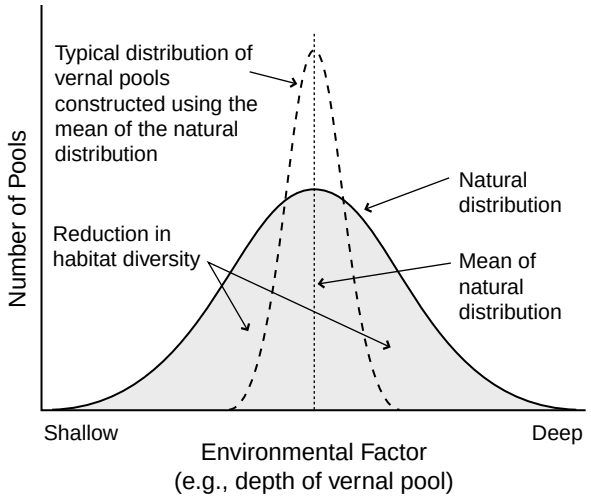

FIGURE 3. Natural and created vernal pools with the same mean and different variances. Habitat diversity and potential buffering of the system are reduced in systems with reduced variability.

conditions out to one standard deviation from the mean would leave out considerable habitat variability of a complex.

Define site capabilities. Habitat creation goals must be matched to the mitigation site's capabilities, not just the impact area's functions and values. Not recognizing this leads to unrealistic expectations and often to failure of mitigation efforts. Typical physical parameters to consider include: geomorphic setting, soils, hydrology, existing and proposed surrounding land uses, size of core and buffer areas, access, and stewardship.

Figure 4 illustrates the variability that can be found in environmental factors across different geomorphic conditions. With this level of variability in vernal pool landscapes, the creation site conditions must be considered when establishing creation goals, or the site's capabilities are not likely to match the goals.

Consider the entire complex and its relationship to its surroundings. When designing creation projects, consider the relationship of the upland grassland to the wetland habitat. The function of this area as habitat, watershed, buffer, and the potential for short- and long-term land uses changes in the surrounding landscape and the potential effects of those changes need to be addressed. Also consider the aesthetic value of mimicking the natural appearance of a vernal pool complex. Pool reserves in urban settings, if properly buffered, have significant value for interpretive and educational purposes. If these resources are to be appreciated and respected, interpretative displays, trails, and guided tours, or other means of education should be provided.

Consider short- and long-term management. Develop a long-term stewardship plan that addresses, among other items, short- and long-term management responsibilities, monitoring and maintenance, public access control, fire management, and grazing.

WHAT IS THE APPROPRIATE ROLE OF CREATION AND RESTORATION IN THE CONSERVATION AND MANAGEMENT OF VERNAL POOL ECOSYSTEMS IN THE CENTRAL VALLEY?

Creation and restoration must have defined goals and should be judged on the project's ability to meet those goals. If the main value to humans of a vernal pool complex is defined primarily on the "pristine"-ness of the unaltered geomorphic landscape, then creation and restoration of vernal pool complexes will have little value, yet ecological function will still be high. If the value of a vernal pool complex to humans is based on the ecological diversity and complexity of the native flora and fauna of the landscape (functions), then evidence shows that these vernal pools functions and, thus the human-implied values, can be created in a sustainable way. Whether vernal pools *should* be created in a given situation is another question. If a policy of no net loss of wetland function and value is supported and if it is accepted that development will occur, then restoration and creation must have a role in conservation planning. Creation and restoration should, however, be viewed as only one tool of many used to complement preservation.

Care should be taken in how creation, restoration, and preservation are intermingled because "creating vernal pools cannot replicate the emotional tie that humans feel with natural ecosystems and ancient landscapes" (Jokerst, 1993). Specific restoration or creation areas should be well defined as part of a master conservation program. They should be separate from, but complementary to, naturally occurring pools.

Because the natural world is an evolving and dynamic collection of systems, creation and restoration should be seen as intervention into an ongoing process. We should not generalize

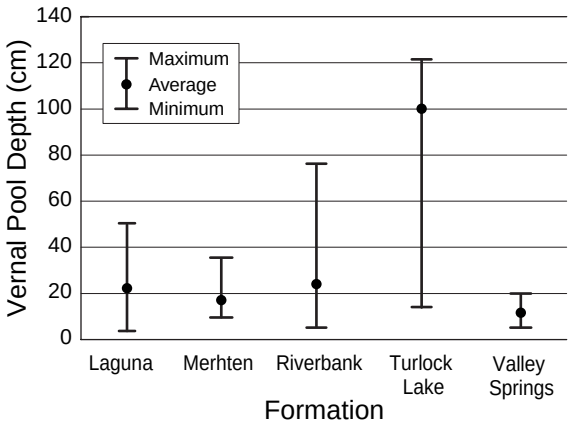

FIGURE 4. Variability of vernal pool depth across different geomorphic conditions.

or simplify; we should mimic and work with the diversity and complexity in nature and remember to be humble in our approach and expectations.

ACKNOWLEDGMENTS

The authors would like to express their appreciation to Cay Goude of the U.S. Fish and Wildlife Service and John Ranlett of Jones & Stokes Associates for their review and comments and to Cynthia Casanova of Jones & Stokes Associates for editing assistance.

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